UNITED STATES NATIONAL MUSEUM

BULLETIN 82

A MONOGRAPH OF THE EXISTING CRINOIDS

BY

AUSTIN HOBART CLARK

AND

AILSA McGOWN CLARK

VOLUME 1

THE COMATULIDS

PART 5—SUBORDERS OLIGOPHREATA (Concluded) AND MACROPHREATA

SMITHSONIAN INSTITUTION
WASHINGTON, D.C.

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FRANK A. TAYLOR
Director, United States National Museum.

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PREFACE

The preceding parts of U.S. National Museum Bulletin 82, A Monograph of the Existing Crinoids, volume 1, the Comatulids, by Austin Hobart Clark, have been published as follows:

Part 1, [General], vi+406 pp., figs. 1–513 in text and 514–602 on 17 pls., 1915.
Part 2, [General], xxv+795 pp., figs. 1–949 in text and 950–1364 on 57 pls., 1921.
Part 3, Superfamily Comasterida, vii+816 pp., 227 figs. on 82 pls., 1931.
Part 4a, Superfamily Mariametrida (except the family Colobometridae), vii+603 pp., 283 figs. on 61 pls., 1941.
Part 4b, Superfamily Mariametrida (concluded—the family Colobometridae), and Superfamily Tropiometrida (except the families Thalassometridae and Charitometridae), vii+473 pp., 220 figs. on 43 pls., 1947.
Part 4c, Superfamily Tropiometrida (the families Thalassometridae and Charitometridae), vii+383 pp., 104 figs. on 32 pls., 1950.

For volume 2 of this work, dealing with the stalked crinoids, Austin H. Clark left, upon his death on October 28, 1954, only isolated notes and references. Completion of this part of the monograph, therefore, must devolve upon a new generation of students of these interesting animals.

Completion of volume 1, part 5, was undertaken some years ago by Ailsa M. Clark of the British Museum (Natural History), who patiently and expertly revised and brought up to date (1960) Mr. Clark's original notes and manuscript, most of which had been done in the early 1920's, and retyped the whole into a publishable manuscript. This tedious task, gladly undertaken, is in the highest tradition of service to science. For this service, the Smithsonian Institution and its Museum of Natural History, and students everywhere, must acknowledge a deep indebtedness.

Richard S. Cowan
Director, Museum of Natural History,
Smithsonian Institution

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FOREWORD

Following the death of Mr. Austin Hobart Clark in 1954 I was invited by the authorities of the United States National Museum to complete the final part of volume 1 of this monograph. Most of the typescript was written about 1923, with the exception of the section on the Notocrinida which was done subsequent to 1938. There were also insertions from material included in the following papers:

A. H. Clark, Five new genera and two new species of unstalked crinoids. *Proc. U.S. Nat. Mus.*, vol. 83, pp. 245–250, 1936.

A. H. Clark, Crinoidea. *Sci. Res. Austral. Ant. Exped.*, vol. C8, No. 4, 1937.

A. H. Clark, Sea lilies of the Okhotsk and Japan Seas. *Explor. Mers U.R.S.S.*, vol. 23, pp. 217–229, 1937.

A. H. Clark, The family Antedonidae in the west tropical Atlantic. *Mem. Soc. Cubana Hist. Nat.*, vol. 14, pp. 139–159, 1940.

A. H. Clark, A new species of the crinoid genus *Cyclometra* from South Africa. *Trans. Roy. Soc. S. Afr.*, vol. 33, No. 2, pp. 189–192, 1952.

T. Gislén, Echinoderm Studies. *Zool. Bidrag Uppsala*, vol. 9, 1924.

A. A. Schorygin, Echinodermata aus den Sammlungen der Expeditionen des Wissenschaftlichen Meeresinstituts, etc. *Ber. Wiss. Meeresinst. Moscow*, Lief. 8, 1925.

A. A. Schorygin, Die Echinodermen des Barentsmeeres. *Ber. Wiss. Meeresinst. Moscow*, vol. 3, Lief. 4, 1928.

G. Gorbunow, Zur Kenntnis der Echinodermenfauna des Franz-Joseph Landes, etc. *Trans. Arctic Inst. Leningrad*, vol. 2, pp. 93–129, 1932.

G. Gorbunow, Zur Kenntnis der Echinodermenfauna der Nordinsel Küstengewären von Nowaja Semlja. *Trans. Arctic Inst. Leningrad*, vol. 7, pp. 41–69, 1933.

G. Gorbunow, Die Echinodermata der nordlichen halfte des Karischen Meeres. *Trans. Arctic Inst. Leningrad*, vol. 8, pp. 5–78, 1933.

D. D. John, Three new crinoids from the Indian Ocean. *Ann. Mag. Nat. Hist.*, ser. 10, vol. 20, pp. 161–173, 1937.

H. L. Clark, Echinoderms from Australia. *Mem. Mus. Comp. Zool.*, vol. 55, 1938.

D. D. John, Crinoidea, *Discovery Rep.*, vol. 18, 1938 (subfamily Zenometrinae only).

Besides this Mr. Clark left notes of references to species to be included in this volume from a number of other works published between 1923 and 1940.

The remaining insertions of material were made by myself from a study of the literature since 1923 mainly derived from the Zoological Record. Notable works include the reports of the *Discovery*, B.A.N.Z.A.R. and *Scotia* expeditions by Dr. Dilwyn John, that of the John Murray Expedition by Mr. Clark himself, and of Mortensen's Japanese crinoids by Dr. T. Gislén. These papers as well as personal observations occasioned a number of textual amendments which appear prefaced with my initials.

One of the most difficult omissions to rectify was the provision of a key to the subfamilies of the Antedonidae. These may have been quite distinct in 1917 when Mr. Clark produced his key to them, but the many new species and genera since added have obscured their limits so that it is no longer easy to separate them. Even the former primary division of the Zenometrinae from the rest by the columnar arrangement of the cirrus sockets has been rendered unreliable by the inclusion of species such as those of *Eumorphometra*, with more or less irregularly arranged cirri.

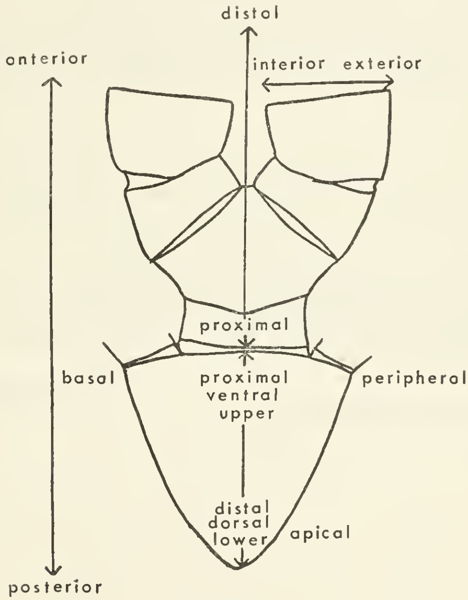
Also introduced are some tables to illustrate the range of variation of species where abundant material is known. Such species are in the minority in most groups of comatulids, many of those included in this part being known only from single specimens and these are often more or less incomplete.

The loss of the outer parts of the arms and of some or all of the cirri makes an estimate of the original size of many specimens very difficult. Until now the arm length and to a lesser extent the length of the longest cirri have been used as criteria of size but a crinoid received in the museum with complete arms is exceptional and often at least half of each arm has been lost. Gislén has given occasional measurements from the centrodorsal to the first syzygy on incomplete specimens and in 1955 the length from the first brachial to the second syzygy, while John has given the lengths of varying numbers of brachials remaining attached. Mr. Austin Clark himself in a few instances has used the length from the apex of the centrodorsal to the first syzygy, but this proportion is more liable to error owing to the variable dorsoventral flexion of the arms relative to the centrodorsal and also the often considerable variation in shape of the centrodorsal itself, even within a single species (notably *Leptometra celtica*). None of these authors has given comparable measurements in more complete specimens of the same or related species. It seems to me that a criterion of size that can be brought into general use is needed so that incomplete specimens can be compared with others and differences in proportions taken into account. Since no consistency exists between the measurements of other authors I decided to adopt two proportions, namely the arm width at the first syzygy and the length from the proximal edge of the division series (or distal edge of the radial or periphery of the centrodorsal if this overlies the radials in the midradial line) to the second syzygy, the positions of the proximal syzygies being sufficiently constant within the different groups dealt with here. Since both these sutures are tangential in alignment, measurement is simplified. The distance to the second syzygy rather than to the first was chosen since the greater length is less subject to error, though in both allowance should be made for dorsoventral flexure of the arms where this occurs. An alternative would have been the distance between the first two syzygies but this again is a shorter distance. The measurements of width were made with a micrometer eyepiece and a magnification of about 12, while, except in the smallest specimens, length was measured using a hand lens since accuracy to more than half a millimeter is not essential, the measurement often varying within that limit (or even more in large specimens) on different arms of the same specimen.

These two measurements also have the merit of providing an estimate of the stoutness of the arms, which appears to be characteristic of some species, notably in the subfamily Heliometrinae.

In the course of this work I have had occasion to examine many of the type specimens of crinoids in the British Museum as well as a number from the U.S. National Museum, for which I am indebted to the staff of the Division of Marine Invertebrates; for the study of others, from the *Siboga* collections in the Amsterdam Museum, my thanks are to Dr. Engel. I am also indebted to Mr. P.–A. Åndersson of the Stockholm Museum and to Dr. F. Jensenius Madsen of the Copenhagen Museum, who lent me type specimens of *Isometra vivipara*. In all these specimens I have taken these two measurements and inserted them in the descriptions in the hope that they will assist in comparisons with other material, and that their use will be adopted by others in the future to complement such measurements as the arm and cirrus length, already in use.

As for the illustrations to this part, it was decided that the inclusion of photographic plates is not justified for crinoids, more particularly for the almost uniformly 10-armed Antedonidae, many of which are superficially quite similar. Instead, line drawings have been substituted and these are supplemented by figures of species given in parts 1 and 2 of this work, and included systematically in this final part. Apologies are due for the relative inversion of my figures of centrodorsals and calyces. In drawing I tend to align comatulids with the dorsal side uppermost and the centrodorsal with its base towards the bottom, whereas Mr. Clark sees the whole oriented as in life, with the centrodorsal downwards.



Another confusion which I found on coming fresh to the study of crinoids lay in the orientation of some of the terms used in description. 'Proximal' and 'distal' are clear enough but 'anterior' and 'posterior' need some clarification for a radially symmetrical animal, particularly as Mr. Clark uses them in two distinct planes. One of these is across the disk, the radius and corresponding arm or arms opposite the anal interradius being anterior, while the other arms are right and left anterior or posterior. The second plane extends along the lengths of all the arms, the tips being anterior. In this final part of the monograph it is rarely necessary to distinguish one arm from another and the second usage is the one commonly found. Mr. Clark freely interchanges anterior and distal and posterior and proximal in descriptions of the division series and brachials. As for the centrodorsal, particularly in describing the more elaborate forms found in the Zenometrinae and the Atelecrinidae, he has used besides proximal and distal also upper, lower, basal, dorsal, and ventral as well as the usual apical and peripheral, which refer more to the cirri and cirrus sockets. Hartlaub also used proximal and distal but John favored dorsal and ventral, which are clear enough as long as it is remembered that dorsal is downwards. I have tried to eliminate most terms other than peripheral and apical and, where necessary, proximal and distal, but for the sake of comparison I have given above a figure illustrating the orientation of many of these terms, to supplement the glossary given in part 1.

As for volume 2 of this work, dealing with the stalked crinoids, it appears that Mr. Clark had made only isolated notes and references for it, so that a comprehensive study of this small but interesting group will not be forthcoming from this source.

After completion of the typescript, it was decided that this part of the monograph should stand under the joint authorship of Mr. Austin Clark and myself. References in the text to "the author" or "I" relate to Mr. Clark unless prefaced by the initials "A. M. C."

In addition to the acknowledgments and thanks expressed in the introductions to the earlier parts of the monograph, I would like to extend my thanks particularly to Dr. F. Jensenius Madsen of the Zoological Museum, Copenhagen, and to Elizabeth Pope of the Australian Museum, Sydney, for so readily supplying information about comatulids in the collections of their respective museums.

Finally I would like to take this opportunity of saying how much pleasure and instruction I derived from working alongside Mr. Clark, though not on crinoids, for several months in 1953 (for the award of a grant that made this possible, I am indebted to the International Federation of University Women). The completion of this monograph stands as a memorial to Mr. Clark.

Ailsa McGown Clark.

British Museum (Natural History)
June 1960

A MONOGRAPH OF THE EXISTING CRINOIDS

By Austin Hobart Clark and Ailsa McGown Clark

Order COMATULIDA A. H. Clark (continued)

Suborder OLIGOPHREATA A. H. Clark (continued)

Since the preceding part of this monograph was written there has been established the new superfamily Notocrinida, including the family Notocrinidae and the new family Aporometridae. This new superfamily is most logically placed between the superfamilies Mariametrida and Tropiometrida and therefore must be considered before the suborder Macrophreata.

Superfamily NOTOCRINIDA Gislén (emended)

Notocrinida Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 231, 237, 238.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42.

Diagnosis.—A superfamily of the suborder Oligophreata in which the arms and pinnules are rounded dorsally; the cirri are arranged in 10 regular columns on a more or less conical (Notocrinidae) or nearly discoidal (Aporometridae) centrodorsal; and the disk is plated. The included species are viviparous.

Geographical range.—Antarctic regions and southern Australia, north to Manning river, New South Wales, and Fremantle, Western Australia.

Bathymetrical range.—From the shore line down to 640 (?731) meters.

Thermal range.—From about 21° C. down to −1.84° C.

Remarks.—The superfamily Notocrinida was proposed since the publication of Part 3 of the present work. This superfamily includes two groups, the systematic positions of which have been variously understood by Prof. F. Jeffrey Bell, Dr. Hubert Lyman Clark, Dr. Th. Mortensen, Prof. Torsten Gislén, and the author.

Professor Bell described the first known species, *Antedon wilsoni*, which he assumed was closely related to *Perometra pusilla* (Antedonidae; Perometrinae). The next species was described by Dr. H. L. Clark under the name of *Himerometra paedophora*. Both of these species were considered by the author as the young of *Ptilometra*.

Dr. Mortensen in his discussion of the systematic position of *Notocrinus* said that it is at once evident that it can not belong to the Oligophreata. It is decidedly of the macrophreate type. Of the three families of the Macrophreata, Atelecrinidae, Antedonidae, and Pentametrocrinidae, the last, according to Mortensen, is at once excluded. The presence of basals recalls the Atelecrinidae, in which family similar small basals occur in *Atopocrinus*. But Mortensen noted that the peculiar character of the cirrus sockets so characteristic of the Atelecrinidae does not obtain in *Notocrinus*, and accordingly it can not be referred to that family either. Thus the family Antedonidae alone remains. Mortensen pointed out that the arrangement of the cirrus sockets in columns agrees with the subfamily Zenometrinae; but otherwise the characters of the centrodorsal, and the central pore and the large basal groove, do not correspond with this family; besides, the short, stout oral pinnules, the plating of the disk, and the retention of the basals and of the anal plate are characters not normally met with in the Antedonidae. Finally, Mortensen believed that the unique character of the genital organs seems to preclude the idea that *Notocrinus* can be referred to the Antedonidae any more than to any of the other families of comatulids. That this is not a special adaptation to the viviparous habit is evident, according to Mortensen, from the fact that the males also have the genital organs in the arms, not in the pinnules. Mortensen created for this new type the family Notocrinidae, which he assigned to the Macrophreata.

In a revision of the classification of the comatulids published in 1924 Dr. Torsten Gislén defined the superfamily Thalassometrida (corresponding essentially to the superfamily Tropiometrida as herein understood) and divided it into two subtribes, the Thalassometrida, *s. s.*, and the Notocrinida (see Part 3, pages 62, 63). The Notocrinida he divided into two sections, one in which the side- and covering-plates are moderate, the brachials and pinnule segments are rounded, and the gonads are in the arms, including only the family Notocrinidae; and another in which the side- and covering-plates are well developed, the brachials and pinnule segments are prismatic—triangular in cross section—and the gonads are in the pinnules, including the single new family Asterometridae (*Asterometra* and *Pterometra*). Dr. Gislén's conclusions were based on a very detailed study of some of the type specimens of *Notocrinus virilis*.

The author in Part 3 of the present work (page 65) placed the family Notocrinidae in the suborder Macrophreata, following Mortensen. Up to that time he had seen no specimens of *Notocrinus virilis*.

In his report, published in 1929, on some recent crinoids in the British Museum, he placed the family Notocrinidae in the Macrophreata, following the Antedonidae.

Since then he studied in great detail the series of eight specimens collected by the Australasian Antarctic Expedition under the direction of Sir Douglas Mawson, and this study convinced him that the family Notocrinidae is really referable to the Oligophreata, as determined by Gislén, though it can not be referred to any one of the three superfamilies included in that suborder.

The most practicable course seems to be to take Gislén's subtribe Notocrinida, redefined so as to exclude the Asterometridae (here referred to the Tropiometrida) and raise it to the rank of a superfamily which would find its most logical place between the superfamilies Mariametrida and Tropiometrida.

With the family Notocrinidae in the superfamily Notocrinida, is placed the family Aporometridae, including the single genus *Aporometra*. The reasons for including the Aporometridae in the same superfamily with the Notocrinidae are given on page 23.

The first published notice of the superfamily Notocrinida as understood herein was in 1938 by Dr. H. L. Clark who quoted (by permission) from a letter from the author in which he said that "The most satisfactory disposition of the Notocrinida would seem to be to consider it as a suborder [*i.e.*, superfamily] within the Oligophreata, equivalent to, and on the same basis as, the Comasterida, Mariametrida and Tropiometrida."

KEY TO THE FAMILIES OF NOTOCRINIDA

a^1. Large, arms 125 mm. or more in length; gonads situated on the arms at the bases of the pinnules; pinnules numerous, 50 or more on each side of an arm; ventral perisome of the pinnules with conspicuous bandlike side plates, 3 or 4 to each segment, not in lateral contact, each with a small covering plate beyond it; oral pinnules with most of the segments much broader than long; distal portion of the cirri laterally compressed (coasts of the Antarctic continent and adjacent islands; 80–640 (?731) meters)________________________________NOTOCRINIDAE, (p. 3)

a^2. Small, arms not more than 30 mm. in length; gonads on the pinnules at some distance from the arms; pinnules few, not more than 25 on each side of an arm; ventral perisome of the pinnules without calcareous deposits, or with a few small spicules; oral pinnules with all the segments beyond the first longer than broad, most of them much elongated; distal portion of the cirri flattened dorsoventrally (southern coast of Australia, north to Manning river, New South Wales, and Fremantle, Western Australia; 9–40 meters)____________APOROMETRIDAE, (p. 19)

Family NOTOCRINIDAE Mortensen

Notocrinidae MORTENSEN, Wiss. Ergeb. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918 p. 10 (diagnosis).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 80, 85, 91, 101, 118, 167, 192, 193, 205, 213, 231, 240 (discussion); Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 41.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 664.—GISLÉN, Kungl. Fysiogr. Sällsk., new ser., vol. 45, No. 11 (Lunds Univ. Årsskr., new ser., Avd. 2, vol. 30, No. 11), 1934, p. 18.—EKMAN, Tiergeographie des Meeres, 1935, p. 308.—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 103; Sci. Rep. Australasian Antarctic Exped., 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 6.—MORTENSEN, Kongl. Danske Vid. Selsk. Skr., nat. math., ser. 9, vol. 7, No. 1, 1937, p. 63 (larvae in relation to those of *Lamprometra klunzingeri*.—JOHN, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86; *Discovery* Reports, vol. 18, 1938, pp. 124, 126 (all spp. viviparous); Rep. B.A.N.Z.A.R.E. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 207.—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 95.

Diagnosis.—A family of the superfamily Notocrinida including 10-armed species of moderate or large size with the arms up to about 200 mm. in length; the gonads are situated on the arms at the bases of the pinnules; the pinnules are numerous, 50 or more on each side of an arm; the ventral perisome of the pinnules carries conspicuous bandlike side plates, not in lateral contact, 3 or 4 to each segment, each with a small covering plate beyond it; the oral pinnules have most of the segments much broader than long; and the distal portions of the cirri are laterally compressed.

Geographical range.—Coasts of the Antarctic continent and nearby islands.

Bathymetrical range.—From 80 to 640 (?731) meters.

History.—The history of the family Notocrinidae has been given in the remarks under the superfamily Notocrinida.

Genus NOTOCRINUS Mortensen*

Notocrinus MORTENSEN Vid., Medd. Nat. Foren. København, vol. 68, 1917, pp. 205–208 (diagnosis; type species *N. virilis;* discussion); Wiss. Ergeb. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, pp. 2–10 (detailed account); Studies in the development of crinoids, 1920, pp. 49–53, pls. 24–26 (larval stages).—BATHER, Nature, vol. 107, No. 2683, 1921, p. 132 (review of Mortensen).—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (locality).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 39, 56, 85, 91, 118, 167, 193, 206, 222, 236, 284 (discussion).—MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, Lief. 12, 1928,

*See also Addenda (p. 836) under 1962, 1963.

pp. viii, 108 (care of brood).—Ekman, Tiergeographie des Meeres, 1935, p. 307.—Mortensen, Kongl. Danske Vid. Selsk. Skr., nat. math., ser. 9, vol. 7, No. 1, 1937, pp. 63, 64 (larvae in relation to those of *Lamprometra*).—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (two Antarctic species; discussion), p. 88 (sexual characters and brood protection).—A .H. Clark, Sci. Rep. Australasian Antarctic Exped. 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 6.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42.—John, *Discovery* Reports, vol. 18, 1938, pp. 131, 193; Rep. B.A.N.Z.A.R.E. 1929–31, ser. B, vol. 4, pt. 6, 1939, pp. 207, 211.—Cuénot, *in* Grassé, Traité de zoologie, vol. 11, 1948, p. 55.—Dawydoff, *in* Grassé, Traité de zoologie, vol. 11, 1948, p. 315 (larva); p. 316.—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 75 (brood chambers), p. 87 (doliolaria larva lacks ciliated bands), p. 95 (includes two species), p. 113.

Note.—The characters and range of this genus are given under the family Notocrinidae of which it is the only known representative.

KEY TO THE SPECIES OF NOTOCRINUS

a[1]. Centrodorsal bare between the interradial columns of cirrus sockets; cirri long, with up to 90 segments (off the Antarctic continent; 80–640 meters) ---------- **virilis** (p. 4)

a[2]. Centrodorsal with additional cirrus sockets placed in the radial areas between the interradial columns; cirri moderate in length, with up to only about 40 segments (off the Antarctic continent; 130–603 meters) ---------- **mortenseni** (p. 14)

NOTOCRINUS VIRILIS Mortensen*

Figure 1,*a*

[See vol. 1, pt. 2, pl. 49, figs. 1329 and 1330, pl. 55, figs. 1349–1352]

Notocrinus virilis Mortensen, Vid. Medd. Nat. Foren. København, vol. 68, 1917, p. 206 (description; discussion; Swedish Antarctic station 5); figs. 1, 2, p. 206; Wiss. Ergeb. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, p. 2 (detailed description), pl. 1, figs. 1–5, pl. 2, figs. 1–4, pls. 3, 4; text fig. 1–5, pp. 3–5; Studies in the development of crinoids, 1920, pp. 49–53, pls. 24–26; text fig. 7, p. 53 (younger stages).—A. H. Clark, Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pp. 37, 38 (?*Myzostomum*); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (locality).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 44, 51, 53, 80, 195, 214; fig. 82, p. 81; fig. 111, p. 93; figs. 180–183, p. 98; figs. 194–199, p. 129; fig. 260, p. 199.—Koehler, Les echinodermes des mers d'Europe, vol. 1, 1924, p. 35 (brooding of young).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 664 (*Terra Nova* Sta. 341; notes).—Grieg, Bergens Mus Aarbog, 1929, No. 3, p. 5 (South Shetland; notes).—Tortonese, Natura, Milano, vol. 24, 1933, p. 165.—A. H. Clark, Sci. Rep. Australasian Antarctic Exped. 1911–14, ser. C, vol. 8, pt. 4, 1937, pp. 6, 7 (in key), p. 16 (Stas. 1, 3; notes).—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (Antarctic), p. 88 (brood protection); *Discovery* Reports, vol. 18, 1938, p. 124 (host of Myzostome), p. 125 (viviparity described by Mortensen, 1918, 1920), p. 126 (in distribution table), p. 127 (position of gonads), p. 129 (distribution), p. 132 (in key), p. 193 (stations; description of material), p. 194 (distribution), pp. 210–219 (pentacrinoid larvae), figs. 19 (cirri), 23, 24 (pentacrinoid larvae); Rep. B.A.N.Z.A.R.E. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 192 (constant differences between B.A.N.Z.A.R.E. and *Discovery* material from different sectors), pp. 207–209 (stations; supplementary description of new material), fig. 6.—Dawydoff, *in* Grassé, Traité de zoologie, vol 11, 1948, p. 321.

Notocrinus virile Hyman, The invertebrates, vol. 4, Echinodermata, 1955, fig. 28D (pinnule with testes).

Diagnostic features.—The truncated conical centrodorsal is usually higher than wide, with the two columns of cirrus sockets in each radial area separated by a tri-

*See also Addenda (p. 836) under 1963.

angular space without sockets, unlike *N. mortenseni* (see fig. 1*b*); the cirri are less than L in number but when the arm length is about 120 mm. the cirri are as long as 45 mm., with about 70 segments; when the arms are 200 mm. long the cirri are about 90 mm., with about 90 segments.

Description.—The centrodorsal is rather large, conical, half again as broad at the base as high, with a roughened dorsal pole. In large individuals the rim of the centrodorsal is rather deeply concave beneath the radials, so that the interradial angles are quite prominent. The cirrus sockets are arranged in 10 columns of 3 or 4 each, the 2 columns in each radial area being externally in contact with those in the neighboring radial areas, but separated from each other by a triangular midradial space.

The cirri are XXX–XL, stout and rather long, the longest reaching about 45 mm. in length. Their segments are short, the longest proximal being about a third longer than broad and those in the distal half being all broader than long. The short segments in the outer half of the cirri are produced dorsally into blunt keels or crests which in lateral view are smoothly rounded. The opposing spine is median, short, blunt, and nearly erect. The terminal claw is slightly longer than the penultimate segment, rather slender, and strongly curved. The cirri about the rim of the centrodorsal are mostly turned upward between the arms, and lean over the disk; those nearer the dorsal pole are generally directed downward.

Above each of the interradial prominences of the centrodorsal, in the angles between them and the radials, there is a small triangular plate interpreted by Mortensen as a basal, though probably the end of a basal ray.

The radials are short, more than 4 times as broad as long in lateral view, and strongly convex dorsally.

The IBr_1 are very short, with the distal border excavated by a broad rounded proximal process from the IBr_2; their lateral edges are widely separated from those of their neighbors, and are strongly convex; their distal borders are shorter than the proximal. The IBr_2 (axillaries) are slightly broader than long, with the distal borders strongly concave and the lateral angles projecting for some distance beyond the laterodistal angles of the IBr_1, and at the same time widely separated from those of their neighbors.

The 10 arms are 75+ mm., probably about 125 mm. in length, according to Gislén. All the brachials are short, broader than long, especially in the distal portion of the arms. They are all perfectly smooth and regularly convex dorsally.

Syzygies are very irregular in their occurrence. In one arm Mortensen gives the syzygies as occurring between brachials 3+4, 8+9, 19+20 and 28+29, while on the other arm of the same pair they were found between brachials 3+4, 9+10, 16+17 and 27+28. Other arms are given as having syzygies between brachials 4+5, 10+11 and 23+24; and between brachials 4+5, 10+11, 15+16, 36+37, etc. Mortensen says that the second syzygy may be found as far out as between brachials 13+14 or 14+15.

The oral pinnules are stout and short. P_1 is about 8 mm. long, with 15 segments, which become about as long as broad on the third and about twice as long as broad terminally. P_2 and P_3 are about 9 mm. long in fully grown examples. They resemble P_1, but the terminal segments are slightly spinous. P_4 may be also an oral pinnule without an ambulacral groove. The distal pinnules are about 10 mm. long with short

FIGURE 1.—Centrodorsals of: *a*, *Notocrinus virilis* Mortensen from *Terra Nova* station 341, B.M., 1914.8.12.392; *b*, *N. mortenseni* John from B.A.N.Z.A.R.E. station 40, B.M., 1948.1.7.167.

segments which terminally are scarcely twice as long as broad. The terminal segments are coarsely spinous on the dorsal side.

The testes of the males are very large, forming two alternating rows of conspicuous white bodies along the dorsal sides of the arms between about pinnules 3 to 14, each corresponding to a pinnule. They are about 4 mm. long. The ovaries of the females are smaller, only about 2 mm. long, similarly placed at the bases of the pinnules. (See part 2 of this work, plate 55.)

The sacculi are few and very inconspicuous, irregularly arranged.

The mouth is central. The anal tube is very conspicuous, situated near the oral angle of the posterior interradius. The disk bears numerous thick plates which form a close pavement between the arm bases, becoming more scattered toward the ventral surface. Ventrally they are especially prominent in the anal interradius and on the basal portion of the anal cone. Among these last there is usually one very conspicuous plate about twice the size of the other plates, or even larger. Mortensen says that there can be no doubt that this is the radianal ("anal") which accordingly persists throughout life in this species. In the oral angle of each interradius there is a fairly conspicuous plate which Mortensen says evidently represents the oral. It is, however, not wholly constant in its appearance.

Color.—Most of the specimens are, in alcohol, reddish at the base of the centrodorsal; the arms are straw colored and the cirri white.

Notes.—The somewhat damaged specimen collected by the whaler *Bransfield* at the South Shetlands according to Grieg has the largest cirri 40 mm. long with 55 segments. The distance between the radial and the first syzygy is 3 mm.

The specimen from *Terra Nova* station 341 has the arms about 160 mm. long.

The *Discovery* Investigations specimens range from 28 to 130 mm. in arm length. Their cirri showed a wider range of variation than did those of Mortensen, being XXI–XLII, with 36–76 segments.

The specimen from *Discovery* Investigations station 1658, in the Ross Sea and two *Terra Nova* specimens from station 295 in the same area differ from typical specimens from the Falkland sector of the Antarctic in having larger and more spinelike dorsal prominences on the distal segments of the cirri. Dr. John also notes that the oral pinnules are not entirely free, P_1 and P_a being attached to the disk by their first 3 to 5 segments, the other oral pinnules being attached to the arm tissues by a web. The syzygies are more irregularly placed than Mortensen records.

The B.A.N.Z.A.R.E. collections include specimens with arms from 20 to 200 mm. long. The largest ones have cirri up to 90 mm. long and with 90 segments. These large ones also have the ventral edge of the centrodorsal produced into very strong interradial corners. The radials are then triangular and the bare radial areas of the centrodorsal are sunk furrowlike below the level of the interradial areas which bear cirri. The centrodorsal may be as much as 11 mm. long. In the largest specimens P_1 is of 24 segments and 13 mm. long.

The color in life of the specimens from *Aurora* (Australasian Antarctic Expedition) station 3 was recorded on the label as "crimson." Dr. John comments that the cirri in the *Discovery* Investigations material showed a sharp color change between proximal and distal segments, the first 8 to 13 being a deep straw color, sometimes tinged with red, the rest white.

Several of the remarkable features of this unique species have already been described in volume 1, part 2, p. 320 (folded wall of the intestine); p. 367 (genital organs); p. 368 (marsupium); p. 369 (sexual differentiation); p. 511 (eggs and embryos); and pp. 616, 618, 675, 684 (parasite, probably a myzostome).

In the younger of two specimens (one half grown and one full grown) which Mortensen dissected, a fine pore was observed in the middle of the apex of the centrodorsal which was surrounded by 5 peripheral radially placed pores. Only the central pore completely perforated the wall of the centrodorsal, the peripheral pores having apparently obliterated their connection with the central cavity. In the larger specimen the peripheral pores have entirely disappeared, but there is still a distinct trace of the central pore. Mortensen remarks that the presence of these pores in half-grown individuals would seem to indicate that the stalk is retained for a considerably longer time than is usual in comatulids.

On the ventral aspect of the centrodorsal there is in each radial sector a large pit which is as deep as the central cavity and thus separates the two vertical series of cirrus canals. There is a very distinct leaflike basal furrow with raised edges in each interradial sector. The rim of the central cavity is not produced inward so as to form a diaphragm about the opening of the cavity as is usually the case.

Mortensen maintains that the elongate raylike structures of which the ends are visible externally in the interradial angles are true basals and not basal rays. He notes that the rosette is of a very primitive structure—a simple fairly thick plate without any of the usual processes—and this fact, combined with the other primitive features, the persistence of the central pore at the apex of the centrodorsal and of the radianal ("anal") he believes is decidedly against regarding these structures as basal rays, which in his view would mean an enormous development of this very specialized feature when at the same time other important structures remain in a primitive condition.

Young stages.—The eggs are from 0.2 to 0.3 mm. in diameter. Although quite a number of ripe eggs are found simultaneously in each ovary, never more than

3 embryos were found associated in a marsupium, and generally there were only 1 or 2. Mortensen says these facts would seem to indicate that some of the eggs do not develop. In some cases he found in marsupia without embryos a yellow coarsely granulated substance which had the appearance of being eggs in process of disintegration. This suggested that some of the eggs are destined to serve as nourishment for the developing embryos. The unusual size of the embryos would be accounted for by this suggestion, while the size of the eggs cannot explain it since their size is by no means unusual, not larger than in *Isometra vivipara.*

All the embryos found are in nearly the same stage of development. Although they occur in various sizes there is no essential difference in the developmental stages represented. Only in a single instance Mortensen found the vestibular invagination in a much younger stage than usual, being represented only by a slight concavity, along the ventral side, in which the ectoderm is considerably thickened. Internally except for a lesser development of the glandular sacs (mentioned beyond) the development of this larva is as advanced as that of the others.

Mortensen says that the occurrence of the same developmental stage in all the embryos would seem to indicate that the eggs are passed into the marsupia a number at a time, not one at a time and at any time as in *Isometra vivipara.*

He believes that this peculiarity in *Isometra vivipara* is correlated with the fact that in that species the spermatozoa are collected in a sort of vesicula seminalis in the ovary, perhaps through copulation, and are always available for fertilizing the ova, whereas in all other crinoids, so far as known, the eggs are extruded only when a male emits sperm, the sperm seemingly acting as a stimulus.

All the larvae are almost fully formed. The smallest are 0.9 mm., the largest 1.8 mm. in length. Evidently the egg membrane was ruptured a long time before the embryos reached that size. In embryos sectioned in position within the marsupia, parts of what would appear to be an outer membrane are seen close to the skin, but otherwise there is no trace of an egg membrane to be observed. Mortensen says that this accords well with the fact that the larvae grow to such large size that they must perforce be assumed to obtain nourishment from the mother; this nourishment could hardly pass through an egg membrane and, as there is no mouth, it must be taken in by absorption through the skin. Mortensen noted that in embedding the larvae in paraffin the skin would always break in various places in spite of the most careful treatment; but when they were embedded lying undisturbed within the marsupia the skin never broke.

The form of the larva is generally more or less irregular because of the pressure in the marsupium, but generally it is somewhat flattened and slightly concave on the ventral side and dorsally more arched, posteriorly more so than anteriorly. On the ventral side at the anterior end is a more or less distinct arcuate depression with the convexity directed anteriorly. This represents the suctorial disk. There is no apical pit.

The vestibulary invagination is narrow. In those larvae apparently most normal in shape is a shoulderlike prominence on either side at the anterior end, but Mortensen could not determine whether or not this is a typical feature.

In one larva there was a slender prominence like a thin stalk on one side, suggesting that it had been attached to the wall of the marsupium, but as nothing similar was observed in any other embryo Mortensen says this cannot be a normal feature.

In these larvae ciliated bands are wholly absent, and neither is there a general ciliation of the surface. Cilia are distinctly to be seen only in the suctorial disk and in the vestibular invagination.

The ectoderm is much thickened over the whole of the anterior end, gradually thinning out posteriorly. The extent of the thickened portion is variable; in some cases it passes below the hydrocoele, and in others it is confined to the part beyond the stomach and the hydrocoele. In the thickened portion of the ectoderm the histological details are difficult to make out. It is a mass of nuclei intermingled with glandular cells. In the region where the transition to the thinner portion takes place there can be discerned an outer layer of small closely aggregated nuclei and an inner layer of larger nuclei, between which is a mass of irregular threadlike structures. Mortensen says it can scarcely be doubted that this corresponds to the glandular cells found in the skin of other crinoid larvae, and it would appear that the inner larger nuclei belong to the glandular cells. In the thin part of the ectoderm only a few small nuclei lie close to the surface, and glandular cells are seen only here and there.

The ectoderm of the vestibular invagination differs from the external ectoderm only in being much thicker. The floor of the vestibule is richly provided with glandular cells from a point a little below its anterior end to about where the hydrocoele begins. There is no such shifting of the glandular and nuclear portions as there is in *Isometra vivipara*. The furrow is very distinctly ciliated. The cilia perforate the cuticle. Within the cuticle a darker line is visible, not a series of fine grains as was observed in *Isometra*.

The nervous system is remarkably developed for a larva devoid of both the power and opportunity for movement and therefore, seemingly, with no special need for it. It forms a conspicuous layer beneath the epidermis at the anterior end, reaching almost as far as the posterior end of the vestibular invagination. It is more restricted ventrally and is only visible beneath the suctorial disk, whence it is continued posteriorly as a distinct nerve running along either side of the vestibular invagination.

The endoderm forms a capacious sac with thin walls in which the nuclei are arranged in a layer of somewhat varying thickness, in many places even in a single layer. The lumen of the sac is entirely empty.

The hydrocoele forms a half ring lying in the usual place a little to the left of the vestibular invagination. The primary tentacles are just beginning to form, as is indicated by thickenings of its epithelium. A slight prolongation toward the parietal canal probably indicates the beginnings of the stone canal. The pore canal is closed. The parietal canal has a long and narrow anterior prolongation.

The coelomic vesicles have assumed their normal position, the left at the posterior (the future oral) end, the right at the dorsal side. The former extends upward on either side of the hydrocoele.

The chambered organ has been formed, and may be followed to near the anterior end.

Mortensen notes that while there is nothing unusual in the relations of the endoderm, the hydrocoele, and the parietal canal, a very unusual feature is apparently connected with the oral coelome. In the posterior end of the embryo are a number of fairly conspicuous sacs looking like large glands and apparently opening outward. As seen in transverse sections they may be fairly regularly arranged, 3 or 4 of them on either side; in other cases they are found only on one side, as seen in frontal sections. Mortensen believes it fairly safe to conclude that these sacs originate as prominences from the posterior wall of the (later) oral coelome, afterwards becoming completely separated off from the coelomic wall and acquiring an opening outward through the wall.

Histologically these sacs consist of a single layer of cells with nuclei somewhat larger than those in the surrounding mesenchyme. On the inner end of each cell a mass of small globules which stain yellow with picrocarmine is visible and appears conspicuous against the red nuclei and the finely granulated cytoplasm. This structure disappears toward the opening of the sac.

The mesenchyme is very extensively developed, and has a distinctly fibrillar structure. In the anterior portion can be distinguished an outer layer, with very few nuclei and highly developed fibrillae, and an inner portion with numerous nuclei and the fibrillae only slightly developed. There may be a fairly distinct boundary between these two parts. In the inner portion, which surrounds the chambered organ and the columnals, are found, besides the nuclei, a varying number of yolk globules, solitary, or collected in small ball-like masses. Sometimes such yolk globules may be found in the posterior end of the larva also, but here they are much less numerous than at the anterior end.

The skeleton is in very nearly the same stage of development in all the larvae, in spite of the considerable variation in their size. The circlets of orals and basals are typically developed, and there are 4 good-sized infrabasals. In one individual there are 5 infrabasals, 2 being much smaller than the others. There are about 25 columnals, and a terminal stem plate of the usual size accompanied by from 1 to 5 small supplementary plates which lie without any definite order about its periphery. In a few individuals in which the skeleton is in a slightly younger stage of development there are as yet none of these supplementary plates.

Mortensen was unable to see a reason for the occurrence of the supplementary plates.

Pentacrinoid larvae (from Dilwyn John, 1938).—The *Discovery* Investigations collected 20 pentacrinoids in the Bransfield Strait area of the Antarctic. These were taken to be *Notocrinus virilis*, since the largest of them exhibited several characters, notably the side- and covering-plates, of the adult *virilis*. They range in size from 1.4 to 9 mm. length of crown and from 6.4 to 13 mm. length of column.

The smallest one has a column of 34 columnals and a thick roughly circular terminal plate which appears to be simple. The first 7 columnals are short and discoidal. The most proximal is in contact with the basal plates. From the second to the seventh there is a gradual decrease in width. The eighth is about a third, the ninth about a half, as long as broad; the proximal half of each is encircled by a narrow projecting girdle. The remaining segments are about as long as broad except for 5 or 6 at the distal end which are shorter. They are rounded off to, and narrower at, each end than in the middle, where the projecting girdle occurs. The articular faces are very broadly oval, the long axes of those at the opposite end of each columnal at right angles to one another.

The sides of the basal cup are strongly rounded. Its height is equal to about half its diameter at the distal end. The distal corners of the basal plates are deeply cut away to receive the radials. The crown is damaged on one side and one ray has been broken away; it must be the right posterior ray, for there is no sign of the radianal plate against any of the other radials. In three rays that are complete the arms are of two, or sometimes three, brachials; they curl in above the apices of the orals.

The surfaces of the lower part of the oral plates are only a little sunken below the level of those of the basals, the radials, the costals (IBr_1), and the axillaries with which their edges are in contact. The texture of all the plates is coarse but that of the orals coarser than any; the surface of the proximal part of each is deeply pitted and some of the pits carry pale yellow spherical bodies which must be the glandular sacs known from the posterior end of the embryo. In preparations of embryos slightly older than that figured by Mortensen the sacs lie close against the oral plates, and, although they are not partly enclosed in their stereom, they might easily become so as growth proceeds.

Such sacs occur in all the older larvae of this series.

The fourth larva has a crown 2.1 mm. long and a column 7 mm. long. The stem is of 41 columnals and a thick lobed terminal plate which appears to be simple. There are 10 very short discoidal proximal columnals, those nearer the basal cup wider than the others. Most of the remaining columnals in the first half of the stem are nearly as long as broad but those of the distal half become progressively and gradually shorter towards the terminal plate.

The basal cup has strongly rounded sides. The radials are widely separated from one another. The arms of only two rays are complete; they are of five brachials. The radianal plate is in broad contact with the right posterior radial which makes it asymmetrical; it is in contact with the proximal half of the left posterior radial. It overrides the oral; no naked perisome is to be seen in this interradius. In other interradii the orals may be separated from the basals by a narrow strip of perisome.

The edges of the orals become free opposite the costals, beyond which the plates narrow as they turn in over the disk.

There are side plates along the ambulacra of the arms.

The ninth specimen in range of size has the crown 3 mm. long. The column is incomplete, only 29 columnals remaining. The first is short and closely associated with the basal cup. The second to fifth are short and discoidal. The sixth is discoidal but longer. The seventh is about half as long as broad. The eighth to near the twentieth are as long as broad, the remainder slightly broader than long.

The crown is similar to, though larger than, those of the previous stage described. Each of the basal plates is swollen so that the sutures between them run along depressions. The distal half of the radianal plate lies, not on the oral, but on a lobe of tissue at a higher level than, and overlapping the proximal edge of, the oral plate. This is taken to be the beginnings of the anal tube.

As in a slightly smaller stage from the same station there are glandular sacs on other ossicles than the orals.

The arms are of seven or more brachials.

The fifteenth specimen has the crown 4 mm. long and a column 10.5 mm. with 39 columnals and a thick slightly lobed terminal plate. The first columnal is incomplete, so that the second, although for the most part in touch with it, is in touch with the basal cup too. The second to seventh columnals are short, gradually increasing in length to the seventh which is half as long as wide. The tenth is as long as broad; the eleventh to the fourteenth slightly longer than broad. The remaining columnals gradually decrease in length. Only faint traces of the encircling girdles of the columnals remain. The articulating surfaces of the two ends of the columnals, or at least the longer ones, are broadly oval with the longer axis of one end at right angles to that of the other; this is only just perceptible.

The sides of the basiradial cup are nearly straight; its height is about half its distal diameter. The basals are considerably longer than the radials. The radials, except for the posterior pair, are in broad contact with one another; beyond the parts of the lateral edges which are in contact they narrow a little. The middle of the wide distal edge is indented for the articulation of the costal; it occupies about a half the distal edge of the radial. The lateral edges of the posterior radials meet proximally, but are cut away beyond to allow room for the radianal plate; it follows that both the radials are asymmetrical, and they are equally so.

The radianal plate is diamond-shaped and longer than broad. Its proximal half is in contact with the radials and costals; the distal half lies on the anal tube, which is much wider than it and has gently converging lateral edges and a straight distal margin. It is very near the edge of the disk; the level of the radianal plate is only a little below that of the radials.

The narrow end of the posterior oral may be seen beyond the anal tube, far below its level, curving over the disk. The other oral plates bend sharply in over the disk and rapidly narrow in their distal halves; they are separated from the radials by a narrow naked strip of perisome. The surface of the wider proximal part of each oral is pitted and some of the pits carry glandular sacs.

The arms are of 15 or 16 brachials with large side- and covering-plates and irregularly arranged sacculi. On the distal portions of some arms there is one sacculus to each segment. The rudiments of pinnules arise from the eleventh and succeeding brachials.

The largest specimen has the crown 9 mm. long and the column 13 mm. There are 38 columnals and a large lobed terminal plate. The first columnal has a single radial whorl of cirri of unequal lengths. The anterior and left anterior are of about 22 segments and reach to the first brachial, the right anterior is somewhat shorter, the left posterior is broken; the right posterior is a rudiment a third as long as the basal plate. The cirri arise from sockets which incise the columnal for its entire length. The second columnal is as wide as, and longer than, the first. There are indentations in both its proximal and distal margins opposite the larger cirri of the first columnal. The remainder of the column resembles that of slightly younger specimens. The columnals of the middle part of the stem are each encircled by a narrow median girdle.

The radials are in complete lateral contact. The radianal plate is far out of contact with the posterior radials, being separated from them by the naked perisome; its proximal edge is opposite the distal end of the costals. It is an oval plate resting on the anal tube, which extends some way beyond it—to opposite the end of the first brachial. The posterior oral plate is clearly visible behind the anal tube. The proximal borders of the orals of other interradii are opposite a point halfway along the axillaries, so that they are widely separated from the radials by an area of perisome; a number of plates are present in it. The oral plates are of coarse texture, with their proximal surfaces pitted as in younger specimens. The distal end of each narrows to a bar which bends in over the disk.

The arms are of 19 brachials. Pinnules of up to 9 or 10 segments occur on the ninth and succeeding brachials; the lower pinnules are not yet beginning to form. There are strong side- and cover-plates, of the same nature as those of the adult *Notocrinus virilis*, along the ambulacra. There are a few irregularly arranged sacculi along the arms.

Localities.—Weddell Quadrant; South Shetlands, south of the Falkland Islands; whaler *Bransfield;* attached to a harpoon line; March 22, 1915 [Grieg, 1929].

Antarctic (Swedish Antarctic Expedition) station 5; Weddell Quadrant; southeast of Seymour Island, east of James Ross Island (lat. 64°20′ S., long. 56°38′ W.); 150 meters [Mortensen, 1917, 1918, 1920; A. H. Clark, 1921, 1923, 1929; Gislén, 1924; Koehler, 1924; Grieg, 1929]. Type locality.

Terra Nova station 341; Victoria Quadrant; off Cape Bird Peninsula, Ross Island, off South Victoria Land, south of New Zealand; 80 meters; January 25, 1912 [A. H. Clark, 1929] (1, B.M.).

Aurora (Australasian Antarctic Expedition) station 1; Victoria Quadrant; off Adelie Land, south of Australia (lat. 66°50′ S., long. 142°06′ E.); 640–731 meters; bottom temperature −1.84° C.; bottom, thick ooze; December 22, 1913 [A. H. Clark, 1937] (3, Australian Mus.).

Aurora station 3; Victoria Quadrant; off Adelie Land (lat. 66°32′ S., long. 141°39′ E.); 287 meters; bottom temperature −1.62° C.; December 31, 1913 [A. H. Clark, 1937] (4, U.S.N.M., E. 3057).

Discovery Investigations station 170; off Cape Bowles, Clarence Island (lat. 61° 25′30″ S., long. 53°46′ W.); 342 meters; rock; at 325 meters, temperature −0.42° C., salinity 34.47‰; February 23, 1927 [John, 1938] (17 adults, 18 pentacrinoid larvae, B.M.).

Discovery Investigations station 175; Bransfield Strait, South Shetland Islands (lat. 63°17′20″ S., long. 59°48′15″ W.); 200 meters; mud, stones, and gravel; at 190 meters, temperature −0.48° C., salinity 34.34‰; March 2, 1927 [John, 1938] (7 adults, 2 pentacrinoid larvae, B.M.).

Discovery Investigations station 1658; off Franklin Island, Ross Sea (lat. 76°10′ S., long. 168°40′ E.); 520 meters; January 26, 1936 [John, 1938] (1, B.M.).

Discovery Investigations station 1948; east of Clarence Island (lat. 60°49′ S., long. 52°40′ W.); 490–610 meters; January 4, 1937 [John, 1938] (1, B.M.).

B.A.N.Z.A.R.E. station 34; off Kemp Land (lat. 66°21′ S., long. 58°50′ E.); 603 meters; January 6, 1930 [John, 1939] (9, B.M.).

B.A.N.Z.A.R.E. station 39; off Enderby Land (lat. 66°10′ S., long. 49°41′ E.); 300 meters; January 17, 1930 [John, 1939] (1, B.M.).

B.A.N.Z.A.R.E. station 40; off Enderby Land (lat. 66°12′ S., long. 49°37′ E.); 300 meters; January 17, 1930 [John, 1939] (2, Australian Mus.).

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 180–209 meters; at 200 meters, temperature −1.77° C., salinity 34.24‰; January 24, 1930 [John, 1939] (4, B.M.; 4, Australian Mus.).

B.A.N.Z.A.R.E. station 105; off MacRobertson Land (lat. 67°46′ S., long. 67°03′ E.); 163 meters; February 13, 1931 [John, 1939] (5, B.M., 6, Australian Mus.).

B.A.N.Z.A.R.E. station 107; off MacRobertson Land (lat. 66°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (11, B.M., 36, Australian Mus.).

Geographical range.—Confined to the immediate vicinity of the Antarctic continent and adjacent islands.

Bathymetrical range.—From 80 to 640 (?731) meters.

Thermal range.—From −0.42° to −1.84° C.

History.—This species was first described by Dr. Th. Mortensen in 1917 from a series of 15 specimens brought home by the Swedish South Polar Expedition of 1901–03. In the following year he described it in great detail and suggested for it the new family Notocrinidae. In 1920 he gave a detailed account of the early stages.

Dr. Torsten Gislén in 1924 described and figured a number of structural details from some of the original specimens.

In 1929 Dr. James A. Grieg recorded and gave notes on a specimen from the South Shetland Islands, and in the same year the author recorded another from *Terra Nova* station 341.

In June, 1937, Dr. D. Dilwyn John, in a paper on Antarctic comatulids based primarily on the *Discovery* collections, discussed this species and described briefly its sexual peculiarities and early stages. In his memoir on the crinoids of the Australasian Antarctic Expedition 1911–14, published on September 27 of the same year, the author recorded it from *Aurora* stations 1 and 3.

In 1938, the full *Discovery* report on the Crinoidea was published, in which Dr. John gave additional information on the characters of the species based on the abundant adult material from the South Shetlands and Ross Sea as well as detailed descriptions of the pentacrinoid larvae of this species.

The following year, the same author, in reporting on the Crinoidea of the B.A.N.Z.A.R.E. expedition from the shores of the Antarctic continent, described even larger specimens than had been taken by the *Discovery* Investigations and was able to give an account of the changes that take place with age.

NOTOCRINUS MORTENSENI John *

FIGURE 1,*b*

Notocrinus, new species, JOHN, Proc. Linn. Soc. London, 1937, sess. 149, pt.2, pp. 86,88.

Notocrinus mortenseni JOHN, *Discovery* Reports, vol. 18, 1938, pp.123 (listed), 124, 125, 127, 128, 129, 131, 132 (in key), 194 (localities; description; notes and comparisons); text-figs. 20, *a–g*, p. 196; pl. 6. fig. 2; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–1931, ser. B. vol. 4, pt. 6, 1939, p. 191 (listed), pp. 209–211 (stations; supplementary description), fig. 7.

Diagnostic features.—The conical or hemispherical centrodorsal is usually lower than wide, with additional cirrus sockets (except in immature specimens) in the radial areas between the regular columns; the cirri are up to LX in number, with up to 40 segments; at an arm length of about 105 mm. they are only 25 mm. long.

Description.—The centrodorsal may be conical or hemispherical, with a bare and smooth dorsal pole. The proximal border is produced interradially into small corners or low and wide projections. In some of the younger individuals the corners are raised into ridges free of cirrus sockets; in the others, and in the older ones, they are occupied, like the rest of the centrodorsal, with closely placed cirrus sockets.

The cirri are XXXVIII–LX or more, 21–32, 20–25 mm. long, composed of stout

*See also Addenda (p. 836) under 1963.

segments and strongly curved. The first three segments are short, the fourth or fifth is as long as broad, and the fifth or sixth to the ninth or twelfth are longer than broad, less so in old than in young individuals. Those beyond gradually become shorter until the distal are broader than long. On one of the segments between the sixth and the fifteenth a small projection appears at the distal end of the dorsal side; this develops gradually into a strong low keel that occupies nearly the whole of the dorsal side of the more distal segments. The terminal claw is small, and the opposing spine is not well developed; when most strongly developed it is more keellike than spinelike. In the old individual both claw and spine are small. In proportion to the size of the animal the cirri are much shorter than those of *N. virilis*, with but half as many segments, which are not uniform in length as in that species.

No basals are visible.

The radials and the IBr series resemble those of *N. virilis*. The radials are large and in lateral contact, entirely or except at the distal angles. The proximal margin of the radials is convex: the distal border is broader and concave. The IBr_1 are free laterally and are narrower distally than proximally. A synarthrial tubercle is formed with a posterior projection from the axillary. The two proximal edges of the IBr_2 (axillary) are nearly straight and the distal edges are concave.

The 10 arms in the largest specimen are 105 mm. long and are composed of about 114 brachials. The first brachials are much shorter than, and are slightly incised by, the second. The two brachials beyond the first syzygial pair, the fifth and sixth, are almost rectangular and, more especially in the larger specimens, broader than long. Those beyond as far as the third syzygy are wedge-shaped, almost triangular, and nearly as long as broad. Distally the brachials become less triangular and more quadrate and, toward the end of the arms, as long as or longer than broad. Toward the end the arm becomes zigzag because each brachial bends toward the side from which its pinnule springs.

Syzygies are numerous. The first is normally between brachials 3+4, but in one arm of one specimen it is between brachials 11+12. The second is usually between brachials 9+10, though it occurs also between brachials 6+7 or 8+9, and between any two from the tenth to the sixteenth. The third is usually between brachials 14+15, and the distal intersyzygial interval is from 2 to 5 muscular articulations.

The oral pinnules are short and stout, and taper to blunt tips. They are composed of a small number of rounded segments each of which, except perhaps for the first, is slightly longer than broad. P_1 is always heavier and slightly longer than P_2 and P_3, which are of the same length. P_1 is not entirely free; its first 2 to 4 segments are directly attached to the disk, and 1 or 2 beyond are connected with the disk by a web of tissue. The first segments of the other oral pinnules are similarly attached to the arms by webs of tissue.

In the younger specimens P_1 is 5.5 to 7 mm. long and is composed of 8 to 10 segments. P_2 and P_3 are 5 or 6 mm. long with 7 to 10 segments. In the old specimen from station 1948, P_1 is 11 mm. long, with 13 segments, and P_2 and P_3 are 9 mm. long, with 12 segments. P_4 is usually an oral pinnule and is variable even on the different arms of a single individual. It is usually longer than P_2 and P_3, though sometimes of the same length, with 7 to 12 segments. It is sometimes a genital pinnule of greater length and with more segments.

The number of genital pinnules on one side of the arm in the 9 younger specimens varies from 8 to 19, and is 23 in the older specimen. The gonads lie at their bases as in *N. virilis.* The first genital pinnules are longer than the orals, and they gradually increase in length. The most distal genital and the first of the distal pinnules are the longest, those beyond decreasing in length to the tip of the arm. P_5 is usually the first genital pinnule; in the younger specimens it is about 8 mm. long with 11 segments, in the old specimen 12 mm. long with 17 segments. The distal genital pinnules are 12 to 14 mm. long with 17 to 22 segments. The pinnules at the tips of the arms may be only about 10 mm. long with 9 or 10 segments. The genital and distal pinnules are composed of round segments the first one or two of which are as long as broad, the others slightly longer than broad. Their distal edges may be produced into a row of fine spines. The ends of the pinnules are often strongly curved. The dorsal sides of the last three or four segments are arched.

Side- and covering-plates are well developed along the arm and pinnule ambulacra. There are two or three pairs of each to every pinnule segment. The side-plates have a broad base produced distally into a column to the end of which the long and narrow covering-plate is attached. In the older specimen the bases of the side-plates along the lower segments of the pinnules are reduced.

Sacculi are very few and inconspicuous, widely and irregularly spaced.

As in *N. virilis*, the gonads lie in the angles between the pinnules and the arms. Only two of the specimens are males, both rather small and probably far from physically mature. Though they are easily seen from the side the testes are very much smaller and less conspicuous than those of *N. virilis*. They are about 1 or 2 mm. long, triangular, and lie with one side along the first two segments of the pinnule and another along the arm. Regarding the side which runs along the arm as the base, there is near the apex but slightly below it on the inside, a small papilla through which Dr. John assumed there is a pore for the passage of the spermatozoa to the outside.

The female reproductive organs consist of ovaries and brood pouches as in *N. virilis*. In the youngest specimens the brood pouch does not touch the ovary of the next pinnule on the same side of the arm. In the older specimen from station 1948 it does. The ovaries are oval, less than 1 mm. long in the younger specimens, about 1.5 mm. in the older. Each lies at the base of the pinnule, resting against it and the arm, and is not usually visible behind the base of the pinnule from the outside. The brood pouch lies in the angle between the arm and the pinnule, separated from the ovary by a thin septum in which there is a large round pore. Larvae escape from the brood pouch through a slitlike orifice on the inside. The brood pouches are easily seen from the outside and their walls are so thin that the embryos and the ciliated bands of the most developed may be seen through them. There are many more, though much smaller, embryos than in *N. virilis*. In the larger brood pouches of the younger specimens there may be over 30 embryos. One of the lower brood pouches of the older specimen was dissected out and found to contain no less than 92 embryos. The embryos vary in size from 0.25 to 0.48 mm. The smallest are globular, and only a little larger than the largest eggs in the ovary. The largest are oval with five broad bands of cilia; they are fully formed larvae at much the same stage of development as those of *N. virilis*, described by Mortensen, which are four times as long and have no trace of ciliated bands. Presumably they pass on to a free swimming stage before settling down and changing into pentacrinoid larvae. The older embryos are found in the distal part of the brood pouch, the younger in the proximal part near the ovary. One brood pouch may contain every stage between the egg and the fully formed larva.

Dr. John did not work out the development. The fully formed larva has two circles of plates, the orals and basals, and at least two infrabasal plates. There are 6 to 8 columnals. Dr. John saw no supplementary terminal plates.

The disk is incompletely plated. There is a close pavement of thin plates completely, or almost completely, covering the space between the bases of the arm pairs of the younger specimens. In the older specimen the plates are few and isolated. There are usually no plates on the small part of the disk to be seen between the two arms of one pair. On the ventral side of the disk of the younger specimens the plates are fewer and larger. There are one or two large plates at the oral corners of each interradius, and rows of large plates along the ambulacral grooves. The anal cone is covered with small plates. The ventral side of the disk of the older specimen cannot be seen.

In alcohol the younger specimens are of a pale straw color; the cirrus segments may be all of one color, white or dirty white, or the first six or more may be of a darker color—usually yellow—than the distal; the last three or four, including the terminal claw, may also be dark in color. The older specimen is dusky.

Notes.—The preceding description is taken from the original one by Dr. D. Dilwyn John. The larger specimen mentioned, from station 1948, is considerably older than any of the others, and is as robust as large examples of *N. virilis*. The radials are reduced to narrow strips, perhaps ten times as broad as long. The IBr_1 are in lateral contact for about half their length; the lateral edges of the distal half bend sharply inward toward the axillary so that the distal width of these ossicles is about three-fourths of the greatest proximal width. The arms are shorter but much more massive than in the other specimens.

When examining the B.A.N.Z.A.R.E. collection Dr. John studied the arrangements of the cirrus sockets on the centrodorsal more fully. He found that there are five regular double columns of sockets exactly corresponding to those of *N. virilis*—that is, one in each interradius extending from the ventral edge to the bare dorsal pole. The columns approximate to, or meet, one another around the edge of the dorsal pole. The radial spaces between the columns (which are bare in *N. virilis*) are occupied by other sockets, a single column in smaller specimens, two irregular columns in larger specimens. In older specimens the ventral edge of the centrodorsal is produced into large wide interradial corners bearing the most proximal cirri of the interradial columns; the areas bearing those columns are raised above the level of the radial areas of the centrodorsal. The centrodorsal is a cone with straight, or, more often, slightly convex sides. Its length is equal to, or slightly greater than, its diameter: it is not so elongated as in *N. virilis*. In the largest specimens it is 7 mm. long.

The cirri may be of up to 40 segments.

In some very small specimens which Dr. John took to be the young of this species there are only 10 columns of cirrus sockets on the centrodorsal. The arms were all broken but the distance from the apex of the centrodorsal to the first syzygy is about 4.5 mm. One of these specimens has a narrow circlet of basal plates, which no other specimen in the B.A.N.Z.A.R.E. collection showed, although they are present in even the largest specimens of *N. virilis*.

The pinnules of the larger specimens have more segments than in the *Discovery* material as well as being longer. P_1 may be of up to 16 segments and 13 mm. long;

P_2 and P_3 of up to 14 segments and 10 mm. long; the other pinnules of 30 segments and 18 mm. long.

In most of the specimens the disk between the rays and the arm bases is completely covered with rather large thin plates. The walls of the pouches containing the reproductive organs are not studded with plates as in *N. virilis;* they are thin and transparent. The largest number of embryos taken from one brood pouch of a female was 45.

Dr. John also noted that the arms taper rapidly from the base to the tips. The surfaces of the ossicles of the division series, and of the brachials and pinnulars of young specimens are uniformly beset with stout triangular spines. Older specimens are similarly covered but the spines are shorter and finer, especially on the more proximal ossicles, and give rise to a granular appearance.

The B.A.N.Z.A.R.E. took a single pentacrinoid which Dr. John deduced was of *N. mortenseni.* It has only four columnals remaining. The first two are short and discoidal, the second not so wide as the first. The third is narrower than the second and about half as long as wide. The crown is 4–5 mm. long, the arms being of 11 or 12 brachials and curled in at the ends. The basals are shorter in relation to the radials than they are in far larger pentacrinoids of *N. virilis.* The basiradial cup is wide and with rounded sides, as in young pentacrinoids of *N. virilis.* The basals and radials are of about equal length. The latter are in contact with one another, forming a complete circlet. Their distal borders are not incised for the articulation of the IBr_1. The orals are separated from the radials by narrow strips of naked perisome. The radianal is an oval plate resting on the posterior oral, and at one point touching the IBr_1 of the right posterior ray. There are no pinnules. The ambulacra of the arms are lined by large plates. The texture of the stereom of all the ossicles is particularly loose and, as a consequence, their surfaces are very rough and thorny.

Parasite.—Some myzostomes were found on the genital pinnules of the types.

Localities.—*Discovery* Investigations station 1948; east of Clarence Island (lat. 60°49′24″ S., long. 52°40′ W.); 490–610 meters; January 4, 1937 [John, 1938] (1, B.M., now selected as the lectotype). Type locality.

Discovery Investigations station 170; off Cape Bowles, Clarence Island (lat. 61°25′30″ S., long. 53°46′ W.); 342 meters; bottom, rock; at 335 meters, temperature −0.42° C., salinity 34.47°/₀₀; February 23, 1927 [John, 1938] (2, B.M.).

Discovery Investigations station 187; Neumayr Channel, Palmer Archipelago (lat. 64°48′30″ S., long. 63°31′30″ W.); 259–354 meters; bottom, mud; March 18, 1927 [John, 1938] (1, B.M.).

Discovery Investigations station 190; Bismark Strait, Palmer Archipelago (lat. 64°56′ S., long. 65°35′ W.); 315 meters; bottom, mud and rock; at 300 meters, temperature 0.55° C., salinity 34.49°/₀₀; 100–130 meters; bottom, mud, stones and rock; at 100 meters, bottom temperature −0.31° C., salinity 33.89°/₀₀; March 24, 1937 [John, 1938] (2, B.M.).

B.A.N.Z.A.R.E. station 30; off Princess Elizabeth Land (lat. 66°48′ S., long. 71°24′ E.); 540 meters; December 27, 1929 [John, 1939] (3, B.M.; 5, Australian Mus.).

B.A.N.Z.A.R.E. station 34; off Kemp Land (lat. 66°21′ S., long. 58°50′ E.); 603 meters; January 6, 1930 [John, 1939] (1, B.M.; 1, Australian Mus.).

B.A.N.Z.A.R.E. station 40; off Enderby Land (lat. 66°12′ S., long. 49°37′ E.); 300 meters; January 17, 1930 [John, 1939] (2 adults, 1 pentacrinoid larva, B.M.; 3, Australian Mus.).

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 180–209 meters; at 200 meters, temperature −1.77° C., salinity 34.24‰; January 24, 1930 [John, 1939] (1, Australian Mus.).

B.A.N.Z.A.R.E. station 107; off MacRobertson Land (lat. 66°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (4, B.M.; 3, Australian Mus.).

Geographical range.—Known only from off the Antarctic continent and the Graham Land area.

Bathymetrical range.—From 130 (?93) to 603 (?610) meters.

History.—This species was described and figured by Dr. D. Dilwyn John in 1938 on the basis of 10 specimens dredged by the *Discovery* Investigations.

In the following year the same author was able to amplify his description after studying the additional material obtained by B.A.N.Z.A.R.E. on the other side of the Antarctic continent.

Family APOROMETRIDAE H. L. Clark

Aporometridae H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 41; Echinoderm fauna of Australia, 1946, p. 23 (in key), p. 58 (limited to south and southwestern Australia).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (absent below 100 meters).

Apocrinidae (lapsus calami) Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 95 (includes only *Apocrinus, i.e. Aporometra*).

Diagnosis.—A family of the superfamily Notocrinida including 10-armed species of small size, with the arms not more than 30 mm. in length; the three known species are viviparous with the gonads and marsupia situated on the pinnules at some distance from the arms; the pinnules are few, not more than 25 on each side of an arm; the ventral perisome of the pinnules is without calcareous deposits, or carries a few small spicules; the oral pinnules have all the segments beyond the first longer than broad, most of them much elongated; and the distal portion of the cirri is flattened ventrally.

Geographical range.—Southern coast of Australia, north to Manning River, New South Wales, and Fremantle, Western Australia.

Bathymetrical range.—From 9 to 40 meters.

History.—The new family name Aporometridae was used as a heading over the new genus *Aporometra* by Dr. H. L. Clark in 1938. Under *Aporometra* Dr. Clark quoted from a letter from the author in which he agreed to the validity of the proposed new genus *Aporometra* and the necessity of creating a new family Aporometridae, and suggested placing the Aporometridae with the Notocrinidae in the superfamily Notocrinida.

Genus APOROMETRA H. L. Clark

Antedon (part) Bell, Ann. Mag. Nat. Hist., ser. 6, vol. 2, 1888, p. 402, and following authors.

Himerometra (part) H. L. Clark, Mem. Australian Mus., vol. 4, 1909, p. 524.

Ptilometra (part) A. H. Clark, Mem. Australian Mus., vol. 4, 1911, pp. 781, 783, 786.

Aporometra H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 41 (diagnosis; type species *Himerometra paedophora* H. L. Clark); Echinoderm fauna of Australia, 1946, p. 58 (characterized by relatively long and conspicuous cirri; key to species).

Apocrinus (lapsus calami) Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 95 (3 species.)

Note.—The characters and range of this genus are given under the family Aporometridae, of which it is the only known representative.

The genus *Aporometra* includes three species which are very closely related to each other and possibly should be regarded as local races of the same specific type.

[Note by A.M.C.] It is noteworthy that *Aporometra* is the only viviparous comatulid genus not known from the Antarctic. *Isometra* and *Phrixometra* extend up the coast of Argentina in deep water but are predominantly Antarctic genera.

Systematic position.—The systematic position of the genus *Aporometra* has not heretofore been satisfactorily determined. The first species to be described (*wilsoni*) was said to be the representative on the south coast of Australia of *Perometra pusilla*, a species belonging to the subfamily Perometrinae of the family Antedonidae. The second species (*paedophora*) was described as a species of *Himerometra*. Both these species were regarded by the senior author as the young of *Ptilometra*. These three genera are about as widely separated as they could be systematically.

Dr. H. L. Clark suggested that the status of his *Himerometra paedophora* and of Bell's *Antedon wilsoni* should be reexamined on the basis of numerous specimens of a similar kind that he had collected in Western Australia in 1929. He was so very kind as to send me all his specimens from Western Australia, together with his specimens of *Himerometra paedophora* and two syntypes of *Antedon wilsoni* borrowed from the British Museum through the courtesy of Dr. D. Dilwyn John.

With practically all the known specimens referable to species of *Aporometra* at hand, the question of its systematic position was examined in the greatest detail.

The necessary dissections were made on the specimens from Western Australia (Koombana Bay) with which it was assumed the others would agree.

An analysis of the characters presented by these specimens, and the conclusions reached through the study of these characters, follows.

The diameter of the central cavity in the centrodorsal is approximately a third of the diameter of the centrodorsal at the same level. The central cavity reaches the apex of the centrodorsal, but its lower half is separated from the upper half by a delicate partition having the upper surface concave, beneath which is a loose spongy filling. The longitudinal ridges on the sides of the central cavity are unusually high. Shallow radial pits are present on the ventral surface of the centrodorsal.

The rosette is highly developed, with both the radial and interradial extensions forming "spoutlike processes." It is relatively thick and is countersunk within the radial circlet.

The central portion of the radial pentagon is free of calcareous deposits.

The plane of the elements of the joint faces of the radials distal to the transverse ridge is at right angles to the dorsoventral axis and approximately at right angles to the plane of the dorsal ligament fossa, which is parallel to the dorsoventral axis. In other words, when the radial ring is viewed ventrally the joint face elements distal to the transverse ridges are at right angles to the direction of vision, while the dorsal ligament fossae, lying in a plane parallel to the direction of vision, are not visible. The muscular fossae are small and moderately excavated. The ligament pits are slightly developed.

The cirrus sockets are arranged in 10 regular columns.

The brachials from about the fourteenth onward are broader than long, remaining broader than long for some distance out on the arm.

The proximal brachial syzygies are between brachials 3+4, 7+8, and 12+13, and the distal intersyzygial interval is usually 2, sometimes 3, muscular articulations.

The pinnules are rounded dorsally and are not prismatic. Sometimes when dry the lower segments of the earlier pinnules give the impression of having a fine middorsal ridge, but this appears to be an optical effect due to a slightly increased density of the calcareous deposit in this region. The texture of the segments of P_1 is finer, more dense, and more uniform than that of the segments of the other pinnules so that the segments appear smoother with a regularly and evenly convex dorsal surface. The pinnules beyond P_1 are composed of broad, thin, short segments which are not more than half again as long as broad even in the slender distal pinnules, and are only slightly, if at all, constricted centrally. The first two segments of the pinnules are not broadened.

The disk is completely enclosed in a continuous pavement of small delicate plates. The ambulacral deposits in the pinnules, when present, consist of small and very slender needlelike spicules.

First of all it is necessary to determine whether *Aporometra* should be referred to the Oligophreata or to the Macrophreata on the basis of the characters used in the differentiation of these groups. These characters are given in volume 1, part 3, pp. 69 and 71.

The cavity in the centrodorsal is moderately large, not so large as in most of the Macrophreata, though larger than in the majority of the Oligophreata. Only the upper half is occupied by the chambered organ and associated structures, the lower half being occupied by a spongy calcareous filling. This secondary restriction of the volume of the central cavity of the centrodorsal suggests relationship with the Oligophreata rather than with the Macrophreata.

The rosette is unusually well developed and is of the type characteristic of the Oligophreata.

The central portion of the radial pentagon is entirely open, with no calcareous deposit, as in the Macrophreata; but this condition is also characteristic of certain types in the Oligophreata, as for instance the Tropiometridae.

The plane of the muscular fossae, although curving upward distally, makes a very considerable angle with the dorsoventral axis, as in typical Oligophreata.

The joint face elements of the articular faces of the radials distal to the transverse ridge are moderately excavated, meeting in the median line at an angle of much more than 90° as in the Oligophreata.

The brachials are broader than long until far out on the arm as is characteristic of most of the Oligophreata, in contrast to the majority of the Macrophreata.

The syzygies are regularly and closely spaced, a characteristic feature of most small comatulids with 10 arms, especially in the Macrophreata. The spacing of the three earliest syzygies is, however, unique. The closest approach to it is seen in the very small *Microcomatula mortenseni* (part 3, p. 287), belonging to the Oligophreata, in which the syzygies are between brachials 3+4, 8+9, and 12+13, and distally at intervals of 2 muscular articulations. This distribution differs from that found in *Aporometra* only in the position of the second syzygy, between brachials 8+9 instead of between brachials 7+8. In the very small *Antedon* (formerly *Compsometra*) *parviflora* and. *A longicirra*, belonging to the Macrophreata, syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations. In view of the general uniformity of the distribution of the syzygies in the Macrophreata and the variability in the Oligophreata, and in view of the fact that the nearest approach to the conditions in *Aporometra* is found in *Microeomatula*, the spacing of the syzgies may be regarded as suggesting relationship with the Oligophreata.

The pinnules are not prismatic. With their short and broad segments without a central constriction, of which the first two are not broadened, they resemble most closely the pinnules of certain of the Oligophreata.

Completely plated disks occur only in the Oligophreata; the completely, though thinly, plated disk of *Aporometra* therefore suggests reference to this group. The spicules along the pinnule ambulacra are not distinctive. Very similar spicules occur both in the Macrophreata (*Antedon petasus*, part 2, fig. 786, p. 366) and in the Oligophreata (*Cyllometra manca* [*albopurpurea*], part 2, fig. 777, p. 366). Such spicules are, however, more frequently found in the Oligophreata than in the Macrophreata.

From this analysis it would appear that *Aporometra* finds its proper place in the suborder Oligophreata.

Confirmation of this allocation is seen in the general structure of the centrodorsal with its 10 columns of cirrus sockets, but with the surface not divided into radial areas. Centrodorsals of the same general nature are seen in *Asterometra macropoda* (part 1, figs. 189, 190, p. 235), *Stiremetra arachnoides* (part 1, fig. 205, p. 239), and *Crinometra concinna* (part 1, fig. 206, p. 239). The centrodorsals of the few species in the Macrophreata in which the cirri are arranged in 10 columns are quite different.

Additional confirmation is seen in the cirri which in general resemble those of *Ptilometra* except that they are more or less flattened dorsoventrally at the tip. Broadening of the cirri occurs elsewhere only in the family Colobometridae, though here the broadening is usually confined to the proximal portion.

The relationships of *Aporometra* within the suborder Oligophreata remain to be determined. Since the proximal pinnules bear no comblike structure at the tip it can not belong to the Comasterida, and since the pinnules are not prismatic it can not be assigned to the Tropiometrida. The only other superfamily in this suborder is the Mariametrida.

The superfamily Mariametrida corresponds roughly to the genus *Himerometra* as it was understood in 1909 when Dr. H. L. Clark first described *Himerometra paedophora*. So his reference of the new species to this genus, with the reservations that he gave, was quite justified.

At that time the families, genera, and species now grouped in the Mariametrida were very imperfectly understood, and it was not at all unnatural that *paedophora* should have been considered as belonging to that assemblage.

As it is understood at present the superfamily Mariametrida includes the families Zygometridae, Eudiocrinidae, Himerometridae, Mariametridae, and Colobometridae. The entire absence of any suggestion of a dorsal crest on the oral pinnules, even on their bases, and the more or less conical centrodorsal on which the cirri are arranged in ten regular columns, prevent the reference of *Aporometra* to any of these families.

The structure of the centrodorsal in *Aporometra* resembles that of the centrodorsals found in several genera and species in the families Asterometridae, Thalassometridae, and Charitometridae of the superfamily Tropiometrida. The cirri also suggest those in certain species of Asterometridae, Thalassometridae, and Ptilometridae, though possibly they may more properly be compared with the cirri of some of the genera of the Colobometridae which are, at least in the proximal portion, similarly broadened.

The broadening of the cirri at the tip in *Aporometra* is, however, unique, as is also the structure of the articular faces of the radials, of the rosette, and of the very broad and thin pinnule segments.

In some respects *Aporometra* bears a certain resemblance to some of the species in the Mariametrida, and in others to some of the species in the Tropiometrida. Yet the correspondence in no case amounts to identity of structure, and besides *Aporometra* presents some features that are quite unique. Thus while *Aporometra* belongs to the suborder Oligophreata it can not be assigned to any of the superfamilies within that suborder.

It remains to be seen whether any other comatulid type may be considered as closely related to *Aporometra*.

The kind of centrodorsal characteristic of *Aporometra*, with 10 columns of cirrus sockets but with the surface not divided into radial areas, is found in *Notocrinus*. That genus also has the pinnules with no trace of carination and composed of extraordinarily short segments not longer than broad, and has a completely plated disk. The radial articular faces of *Aporometra* and *Notocrinus* are in general similar, though differing in details. Those of *Aporometra* are low and the elements on either side of the transverse ridge lie in planes approximately at right angles to each other, while those of *Notocrinus* are much higher and the elements on either side of the transverse ridge are in practically the same plane. Both *Aporometra* and *Notocrinus* are viviparous.

Dr. Torsten Gislén in 1924 made *Notocrinus* the type of a new subtribe, Notocrinida, of the Thalassometrida, which is essentially the equivalent of the Tropiometrida as herein understood. The subtribe Notocrinida he divided into two sections, one including forms with the side- and covering-plates moderately developed, the brachials and pinnules rounded, and gonads in the arms—the family Notocrinidae; and the other including forms with the side- and covering-plates well developed, brachials and pinnules prismatic (triangular in cross section), and gonads in the pinnules—the family Asterometridae (*Asterometra* and *Pterometra*).

The affinities of the family Asterometridae appear to the present author to be wholly with the families Ptilometridae and Thalassometridae in the Tropiometrida, and they may be omitted from further consideration in this connection.

The most satisfactory disposition of the Notocrinida would seem to be to consider it as a superfamily within the Oligophreata equivalent to and on the same basis as the Comasterida, Mariametrida, and Tropiometrida, and to place within it two families, Notocrinidae and Aporometridae, including *Notocrinus* and *Aporometra* respectively.

[Note by A.M.C.] In spite of the fact that two such experienced workers on crinoids as Dr. Gislén and Mr. Clark have linked the family Notocrinidae, distinguished by the extraordinary axillary gonads, with one or another family of comatulids with gonads, as usual, on the pinnules, I cannot think that this is justified. The Aporometridae appear to me to have no more in common with the Notocrinidae than they do with any other comatulid family, in fact less if due weight is given to the difference in the gonads.

History.—The genus *Aporometra* was established in 1938 by Dr. H. L. Clark who gave a full diagnosis and listed *Himerometra paedophora* H. L. Clark as the type species. In addition to *Himerometra paedophora* he included in the new genus *Antedon wilsoni* Bell and the new species *Aporometra occidentalis*. A key showing the interrelationships of these three species was given.

To this picture, no additions of note were made by Dr. H. L. Clark in his comprehensive work on Australian echinoderms in 1946.

KEY TO THE SPECIES OF APOROMETRA

a^1. Longest cirrus segments up to half again as long as broad (Port Phillip, Victoria). **wilsoni** (p. 28)

a^2. Longest cirrus segments not longer than broad.

b^1. Cirri with 25–35 (usually 28–30) segments, of which most are about as long as broad (New South Wales; 40 meters) **paedophora** (p. 24)

b^2. Cirri with 39–61 (usually 40–50) segments, of which the longest are from half again to twice as broad as long (Koombana Bay to Fremantle, Western Australia; 9–18 meters). **occidentalis** (p. 32)

APOROMETRA PAEDOPHORA (H. L. Clark)

[see vol. 1, pt. 2, fig. 939 (p. 549), and pl. 37, figs. 1228–1230]

Himerometra paedophora H. L. CLARK, Mem. Australian Mus., vol. 4, 1909, p. 524 (description and comparisons; description of the pentacrinoid young; discussion; off Manning river, New South Wales, 22 fathoms), pl. 47, figs. 4–10.—A. H. CLARK, Mem. Australian Mus., vol. 4, 1911, p. 784 (in synonymy of *Ptilometra mulleri*), p. 785 (young of *Ptilometra mulleri;* description and discussion); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 462 (young of *Ptilometra mülleri;* discussion, and comparison with similar young of *P. macronema* [=*A. wilsoni*] here described); Crinoids of the Indian Ocean, 1912, p. 189 (in synonymy of *Ptilometra müllcri*).—H. L. CLARK, Biol. Results Fishing Exper. F.I.S. *Endeavour*, 1909–14, vol. 4, pt. 1, 1916, p. 24 (possibly the same as *Antedon wilsoni;* perfectly sure it is not a *Ptilometra* and has no near relationship with that genus).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 281, footnote 1.

Antedon wilsoni (part) A. H. CLARK, Mem. Australian Mus., vol. 4, 1911, p. 715 (young of *Ptilometra macronema* or of *P. mulleri* [=*australis*]), p. 718 (records).—H. L. CLARK, Biol. Results Fishing Exper. F.I.S. *Endeavour*, 1909–14, vol. 4, pt. 1, 1916, p. 24 (possible that this is the same as *Himerometra paedophora;* perfectly sure the latter is not a *Ptilometra* and has no near relationship with that genus).

Ptilometra mulleri (part) A. H. CLARK, Mem. Australian Mus., vol. 4, 1911, p. 783 (*Himerometra paedophora* the young of this species), p. 786 (description and discussion).

Ptilometra mülleri (part) A. H. CLARK *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 462 (*Himerometra paedophora* the young of this species); Crinoids of the Indian Ocean, 1912, p. 189 (*Himerometra paedophora* in synonymy); U.S. Nat. Mus. Bull. 82, vol. 1, pt. 1, 1915, figs. 90, 91, p. 149.—MORTENSEN, Studies in the development of crinoids, 1920, p. 4 (young carried on the cirri [error for pinnules]).

Himerometra poedophora MORTENSEN, Studies in the development of crinoids, 1920, p. 60, footnote 39 (possible care of brood).

Aporometra paedophora H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42 (in key); Echinoderm fauna of Australia, 1946, p. 58 (in key), p. 59 (still only a single record from New South Wales).

Diagnostic features.—Most of the cirrus segments are about as long as broad. The arms are about 20 mm. long, and the cirri are VII–IX, 25–35 (usually 28–30).

Description.—The centrodorsal is thick-discoidal, with the cirrus sockets in a single marginal row.

The cirri are VII–IX, 25–30. The first two segments are about twice as broad as long, the third is somewhat longer, and the fourth and following are about as long as broad. The segments in the outer half of the cirri have the proximal edge of the dorsal half cut away and are somewhat compressed dorsally, being almost carinate on some of the cirri. The penultimate segment bears a prominent opposing spine which is terminally situated and reaches in height about half the width of the segment bearing it. The cirri are comparatively thick at the base and taper gradually until about the fourth segment after which they remain of the same width.

The ends of the basal rays are visible as slight tubercles in the angles of the calyx.

The radials are prominent, strongly concave anteriorly, and somewhat produced in the interradial angles. The IBr_1 are oblong, twice as broad as long, with the lateral edges straight. The IBr_2 (axillaries) are broadly pentagonal, about half again as long as the IBr_1, with the distal angle rounded and the lateral edges straight, continuing distally the lateral edges of the IBr_1. In life the IBr series are probably just in apposition, but the component segments are sharp edged and not laterally flattened.

The 10 arms are about 20 mm. long. The brachials are mostly wedge-shaped and about as long as broad, rounded dorsally and with no trace of carination; the first two brachials are slightly larger than the others.

Syzygies occur between brachials 3+4, 7+8, and usually 11+12 (sometimes 9+10 or 10+11), and distally at intervals of usually 2 muscular articulations, though frequently one syzygial pair immediately follows another.

P_1, P_2, and P_3 are small and weak, very short, equal in length to a syzygial pair and one other brachial, composed of five segments of which the first is about as long as broad and the remainder are rather longer than broad. These pinnules taper gradually from the base to the tip. P_4 and the pinnules following are about half again as long and much stouter, composed of about seven segments of which the first two are short and the remainder are rather longer than broad; the first three segments are stout, the pinnule tapering rather sharply from that point to the tip. The segments are rounded dorsally, but are rather sharply convex.

The sacculi are large and closely set along the ambulacra.

The color is light purple, the perisome deep purple.

There is no trace of an ambulacral skeleton.

The preceding description was drawn up from the type specimens which Dr. H. L. Clark courteously permitted me to study during a visit to Cambridge.

In two syntypes, immature but with numerous pentacrinoids, mostly young, the cirri have 32 or 33 segments the longest of which are not quite so long as broad; P_1 has 7 segments.

Young individuals.—Dr. H. L. Clark said that in the earliest free-swimming stage he found the arms are about 7 mm. long and have about 9 pinnules on each side. Distinct syzygies are present between brachials 3+4, 7+8, and 11+12, but in the remaining 16 to 18 brachials syzygies have not as yet developed. P_1 has only 4 or 5 segments, but is somewhat stouter than the pinnules succeeding. There are VI cirri, each with about 30 segments. The basals can no longer be distinguished, and the orals are reduced to a few large irregular fragments in each interradius of the disk.

Notes.—Dr. H. L. Clark originally described this species under the name of *Himerometra paedophora* in the following terms.

The centrodorsal is small and discoidal with the cirrus sockets arranged in a single row.

The cirri are X–XV, 25–35 (usually 28–30). The first four basal segments are broader than long, but the segments succeeding are about as long as broad. The segments are all smooth, or nearly so, until near the tip of the cirri, where a slight longitudinal keel is barely developed on the dorsal side of each segment. In some cases this keel gives rise to a slight spine, but even on the penultimate segment no conspicuous spine is found. The terminal claw is short and blunt.

The radials are barely visible. The elements of the IBr series are not at all swollen or peculiar in any way. The IBr_1 are much broader than long, narrower proximally than distally, perfectly smooth, and distinctly separated from each other. The IBr_2 (axillaries) are much broader than long, smooth, with the lateral edges very short and the distal edges slightly concave.

The 10 arms are 17 to 19 mm. long. The first brachials are broader than long with the outer edge somewhat longer than the inner, the inner edges of adjacent first brachials touching each other, at least proximally. The second brachials are similar, but the distal margin is not so straight. The first syzygial pair (composed of brachials 3+4) is about as long as broad, with the two component elements equal and discoidal. The brachials following are more or less oblong, with the outer and inner sides usually differing slightly in length. All the brachials are smooth and rounded dorsally, and not only do they not overlap, but they are scarcely in contact except at the syzygies.

Syzygies occur between brachials 3+4, 7+8, and 11+12 (rarely 10+11), and distally at intervals of 2 (or more commonly one) muscular articulations.

The pinnules are rather few, from 12 to 15 on each side of an arm, and are widely spaced owing to the length of the brachials and the frequent syzygies.

P_1 is stout, 2.3 mm. long, and is composed of 7 smooth and semicylindrical segments. The first two segments are about as broad as long, the third, fourth, and fifth are longer than broad, and the terminal segment is minute and blunt.

P_2 is very short, about 1 mm. long, with only 4 segments. The pinnules succeeding are less stout and are composed of 8 to 14 segments of which the basal ones are large, but only a little expanded laterally.

Sacculi are abundant and large, expecially on the distal pinnules, but there are very few on the disk. When dry, the disk shows many small calcareous plates, largest and most conspicuous beside the ambulacral furrows and around the base of the anal tube, which is about as long as half the diameter of the disk or longer. The oral surface of the arms and pinnules seems to be free from plates.

The color of the skeleton is very light brown, that of the soft parts and sacculi very dark brown. In the terminal half of the cirri more or fewer of the segments are dorsally marked, or strongly tinged, with purple.

This description was based upon 23 specimens from off Manning river, New South Wales.

Remarks.—Dr. H. L. Clark said that he placed this interesting species in the genus *Himerometra* only after considerable hesitation, on account of its small size, the absence of any swelling or convexity of the IBr series, and the very small number of cirri. He noted that it resembles *Oligometra* in many respects, but the large number of cirrus segments distinguishes it from the species of that genus. It seemed to him better to include it in the large and somewhat heterogeneous group *Himerometra* (in the sense in which it was understood in 1909) rather than to modify the definition of a smaller, natural group like *Oligometra*.

He remarked it might be thought that we have here simply a young form of *Ptilometra*, especially as these specimens occur only with the adults of that genus. Fortunately, however, there are young specimens of *Ptilometra* (*mülleri*) in the collection as small as the larger specimens of *paedophora*, and it is possible, therefore, to show that the two are not even nearly allied forms. The conical centrodorsal, the long cirri, and the crowded prismatic pinnules distinguish the Ptilometras at a glance. Moreover, it should be noted that pentacrinoid larvae were not present on the pinnules of any undoubted *Ptilometra mülleri*, even among those from *Thetis* station 28.

He said it was difficult for him to believe that the smallest Ptilometras, too young to have assumed any of their characteristic generic or specific features, should be the only ones that are breeding.

He noted in conclusion that while he was perfectly sure these comatulids are not Ptilometras, at the same time he was very much in doubt as to their real systematic position. He thought it most unlikely that they are really Himerometras, but he did feel reasonably sure that they belong in the family Himerometridae.

In 1911 the author referred *Himerometra paedophora* to *Ptilometra mülleri*, of which he stoutly maintained it was simply a young form. He said that the straight sides of the elements of the IBr series, the tapering cirri, and the uniformity of the proximal pinnules, together with the perisomic plating, especially on the pinnules, seen in the larger specimens, the distribution of the syzygies, and the abundance and large size of the sacculi, as well as the very characteristic musculature, show conclusively that these specimens can not be any species of *Himerometra*, young or old, but that they must belong to the genus *Ptilometra*. He remarked that if one can for the moment overlook the obsolescence or absence of carination on the outer part of the arms and on the pinnules—a character always late in making its appearance—the relationship is at once evident.

In answering Dr. H. L. Clark's arguments the author said that it is rarely the adults of any species which bear pentacrinoid young upon their pinnules or cirri, but usually young ones. The free swimming young always drift to leeward of the parents before settling down. At the next breeding season another brood drifts over to the place occupied by the brood of the preceding season and settles down upon it. Thus it is that while young comatulids often bear pentacrinoids, they are very rarely found on the fully grown. He noted that there are some nice examples of this in the Museum of Comparative Zoology at Cambridge, where the cirri of some young specimens of *Comactinia meridionalis* bearing pentacrinoids are preserved, and he said he had seen some scores of additional cases of the same thing.

The author remarked that the comatulids change from their comparatively undeveloped post-pentacrinoid condition to the perfect form very quickly. This is accompanied by a rapid development of P_2 and the pinnules immediately succeeding; a great increase in the width of the pinnulars and the brachials, so that the pinnules appear much closer together and the brachials shorter; and, in species with long cirri, by a rapid (distal) addition to the cirrus segments, the added segments as they appear becoming progressively more and more developed. In the Thalassometridae and in the Tropiometridae the carination of the brachials and pinnules is never present in the very young, but is rather suddenly assumed at an early stage—a graphic recapitulation of this may be observed in any regenerating specimen.

Dr. H. L. Clark, according to the author, failed to mention a single character by which his *paedophora* can be distinguished from the young of *Ptilometra mülleri* as predicated from the facts known in regard to the young of related species, and as we have now been able to study a specimen exactly intermediate between the *paedophora* stage and the adult condition there seems to be no escape from "the conclusion I had arrived at, and communicated to him, when Dr. Clark first showed me his *paedophora*, namely, that *paedophora* is nothing but the young of *Ptilometra mülleri*, the sacculi, the broad IBr series and first two brachials, the syzygies, and the ambulacral plating of the larger specimens preventing its reference to any species outside of that genus."

For about 25 years the question of the true systematic position of *paedophora* remained unsettled, the author maintaining that it is simply a young form of *Ptilometra mülleri*, and Dr. H. L. Clark insisting that, whatever it is, it certainly is not related to *Ptilometra*.

The author at the time of this writing (about 1937) admits that Dr. Clark's contention is correct, that *paedophora* is a species very widely different from *Ptilometra*.

Locality.—*Thetis* station 28; off Manning river, New South Wales, Australia; 40 meters; fine gray sand; 1898 [H. L. Clark, 1909, 1938, 1946; A. H. Clark, 1911, 1912, 1915, 1921; Gislén, 1924] (23, M.C.Z., 376).

History.—This species was described by Dr. H. L. Clark under the name of *Himerometra paedophora* in 1909. In 1911 it was redescribed and determined as a young form of *Ptilometra mülleri* by the present author. In subsequent references it was treated as a synonym of *Ptilometra mülleri*.

In 1938 Dr. H. L. Clark referred it to his new genus *Aporometra*, of which he made it the type, a disposition in which, as stated by Dr. Clark, the author concurred.

APOROMETRA WILSONI (Bell)

FIGURE 2

Antedon wilsoni Bell, Ann. Mag. Nat. Hist., ser. 6, vol. 2, 1888, p. 402 (Port Phillip, Victoria).—P. H. Carpenter, Proc. Roy. Soc. Victoria, new ser., vol. 2, 1890, p. 135 (Port Phillip).—A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 718 (young of *Ptilometra mulleri*), p. 781 (in synonymy of *Ptilometra macronema*); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 462 (identity); Crinoids of the Indian Ocean, 1912, p. 189 (in synonymy of *Ptilometra macronema*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 42 (in synonymy of *Ptilometra macronema*).—H. L. Clark, Biol. Results. Fishing Exper. F.I.S. *Endeavour*, 1909–14, vol. 4, pt. 1, 1916, p. 24 (possible that this is the same as *Himerometra paedophora*; perfectly sure the latter is not a *Ptilometra* and has no near relationship with that genus); Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42 (discussion; identity).

Nanometra wilsoni A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 349 (listed).

Ptilometra macronema (part) A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 781 (*Antedon wilsoni* in synonymy); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 462 (*Antedon wilsoni* a synonym); Crinoids of the Indian Ocean, 1912, p. 189 (same); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 42 (record of Bell's types of *Antedon wilsoni*).

Ptilometra mulleri (part) A. H. Clark, Mem. Australian Mus., vol. 4, 1911, p. 785 (Port Phillip), p. 786 (description of the specimen).

Aporometra wilsoni H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42 (in key); Echinoderm fauna of Australia, 1946, p. 58 (in key), p. 59 (still known from single record at Port Phillip, Victoria of Bell, 1888).

Diagnostic features.—The longest cirrus segments are distinctly longer than broad and may be just over half as long again as broad. The arms are up to at least 30 mm. in length and the cirri, which are X–XX, with up to 47 segments, are only a little shorter than the arms, up to 25 mm. long.

Description [modified by A.M.C.].—The centrodorsal is discoidal, with the broad dorsal pole flat or slightly convex. The cirrus sockets are arranged approximately in ten columns of one or two each, there being two columns in each radial area. The dorsal pole is clearly marked with several hollows which are presumably obsolete cirrus sockets.

The cirri are X–XX, 35–47 (usually 35–40), from 15 to 25 mm. long. In the largest syntype the first segment of the peripheral cirri is broader than long, the second is nearly as long as broad, the fourth to the tenth are just under half again as long as broad, and those following decrease slowly in length, the last 15 to 20 being slightly broader than long, or about as long as broad. In the middle portion the cirri are circular in cross section, but on the last 10 to 20 segments the dorsal surface becomes broadly flattened and develops a number of strong longitudinal striations. This portion of the cirrus is exceedingly flexible and is capable of being coiled into a spiral, whereas the proximal two-thirds is more rigid and usually straight in the preserved specimens. In the specimens with arm length 25 mm. or less, the segments are proportionately longer and the longest may be over one and a half times as long as broad.

The radials are short with the distal border strongly and evenly concave, and are about three times as long interradially as in the midradial line. They are completely joined interradially. The IBr_1 are nearly three times as broad as the median length, with the lateral borders produced and the lateral edges straight and parallel; the distal border is straight or slightly and evenly concave. The IBr_2 (axillaries) are 5-sided, and are nearly or quite twice as broad as long. The two lateral sides are about half as long as the median length and are parallel, continuing the parallel sides of the IBr_1. The proximal border is slightly convex, following the curvature of the distal border of the IBr_1, and the two distal sides, which are slightly concave, make with each other an angle of about 90°. The straight sides of the division series extend in a slight lateral flange.

The 10 arms are up to 30 mm. long. The proximal brachials are nearly rectangular in dorsal view with the proximal and distal sides almost parallel.

Syzygies usually occur between brachials 3+4, 7+8, and 12+13, and distally at intervals of two muscular articulations, but the second and third are variable in position.

P_1 is up to 6.0 mm. long, rather stout basally but evenly and gradually tapering to a fine point. It is composed of 8 to 10 segments of which the first is about as long as broad, the second is somewhat over twice as long as broad, and those following are nearly or quite four times as long as broad; the ventrolateral ends of the distal borders of the segments are slightly produced. In a specimen of arm length 15 mm., P_1 is 2.0 mm. long with 7 segments.

P_a is similar but more or less smaller and shorter, often very short, with 6 or 7 segments.

P_2 is the first genital pinnule. It is up to 3.0 mm. long, with 10 to 16 segments, more slender and much more flexible than P_1; most of the segments are about twice as long as broad and very slightly constricted centrally.

The genital pinnules extend as far as P_{12} in the largest syntype. The marsupia of the females are on the aboral sides of the pinnules. Each of the four opened contained only one or two embryos in process of development.

The distal pinnules are rather abruptly longer than the genital pinnules, 3.7 mm. long; they are composed of 16 segments, mostly about twice as long as broad and slightly constricted centrally, the terminal bearing a number of sharp recurved spines dorsally,

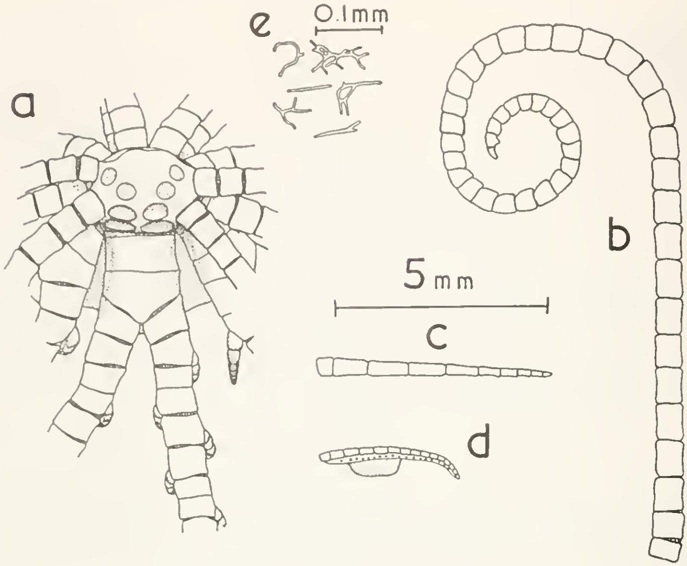


Figure 2.—*Aporometra wilsoni* (Bell), syntype, B.M., 93.7.8.8: *a*, Diagonal view of centrodorsal and proximal part of postradial series; *b*, peripheral cirrus; *c*, P_1; *d*, P_2; *e*, spicules from pinnule ambulacra.

and the one preceding being much roughened dorsally. Some of the ambulacral spicules are illustrated in figure 2.

The species is viviparous as H. L. Clark found to be the case in *A. occidentalis*. The more advanced embryos have reached the stage shown by Mortensen in *Isometra vivipara*, illustrated in his work of 1920 (pl. 22, figs. 6–8) on crinoid development. No ciliary bands can be seen.

Notes.—A specimen from Port Phillip in the Australian Museum has the 10 arms 25 mm. long. The cirri, which are XI, two to each radial area excepting in one case where there are three, are from 28 to 33 mm. long.

The elements of the IBr series resemble those of *Ptilometra macronema*. They and the first two brachials have the lateral edges perfectly straight and somewhat produced into a narrow flange-like border by which they are in lateral apposition. A broad synarthrial tubercle is just beginning to develop.

The arms are rounded dorsally with no trace of carination. The pinnules are rounded and not prismatic, though the larger show traces of a prismatic condition in the basal segments. The marginal lappets of the pinnule ambulacra are calcified.

Syzygies occur between brachials 3+4 and 7+8, and distally at intervals of two muscular articulations.

[NOTE BY A.M.C.] This species appears to me notable for the relatively large size of the cirri which are almost equal in proportions to the arms; also since the brachial joints are only a little oblique the resemblance between cirri and arms is heightened. The cirri are very firmly attached to the centrodorsal and if a break occurs it seems to be between the first and second cirrus segments. The number of cirri does not necessarily increase with size, as can be seen from table 1.

TABLE 1.—*Measurements of 11 syntypes of* Aporometra wilsoni *(Bell) in the British Museum (Natural History)*

B.M. reg. number	*Arm breadth at 3+4 (mm.)*	*IBr$_1$ to 7+8 (mm.)*	*Cirri*			*Arm length (mm.)*
			No.	*Segments*	*length*	
93.7.8.8–10	0. 85	6. 0	XVI	46	25	30
93.7.8.8–10	0. 7	5. 0	XIII	39	Coiled	20
93.7.8.8–10	0. 6	5. 0	XI	40	19	21
87.12.6.11	0. 8	5. 5	XIX	broken	–	c.30
87.12.6.11	0. 7	5. 0	X	38+	18+	c.22
87.12.6.11	0. 55	5. 0	XVII	38	c.15	broken
87.12.6.11	0. 45	3. 8	XIV	broken	–	c.15
87.12.6.11	0. 4	3. 5	X	broken	–	c.12
87.12.6.11	0. 3	3. 3	XII	22	6	8
88.11.12.7	1. 0	6. 0	XV	44	c.22	c.30
88.11.12.7	0. 5	4. 5	XVII	40	19	20

Localities.—Port Phillip, Victoria, Australia; J. Bracebridge Wilson [Bell, 1888; P. H. Carpenter, 1890; A. H. Clark, 1911, 1912, 1913] (11, B.M.; 2, M.C.Z.).

Port Phillip, Victoria [A. H. Clark, 1911] (1, Australian Mus.).

History.—This species was originally described in 1888 under the name of *Antedon wilsoni* by Prof. F. Jeffrey Bell.

Dr. P. H. Carpenter listed *Antedon wilsoni* from Port Phillip in 1890.

In his memoir on the recent crinoids of Australia published in 1911 the author said that *Antedon wilsoni,* so far as he could see, was nothing more than the young of *Ptilometra mülleri*—or possibly of *P. macronema.* He said further that "A specimen from Port Phillip, Victoria [in the Australian Museum], is certainly referable to '*Antedon wilsoni*' and '*Himerometra paedophora*' [see page 785] and no less certainly to either *Ptilometra mülleri* or *P. macronema,* but which of the two it is impossible to say with accuracy. The stage represented is somewhat in advance of that described as '*paedophora,*' more nearly coinciding with '*wilsoni.*' "

In his report upon the crinoids collected by the Hamburg Southwest Australian Expedition, published in 1911, the author said that *Antedon wilsoni* is the young of *Ptilometra macronema.* In 1912 he placed *wilsoni* without comment in the synonymy of *P. macronema.* In his memoir on the crinoids of the British Museum, published in 1913, he listed Bell's original specimens of *Antedon wilsoni* under *Ptilometra macronema.*

In 1938 Dr. H. L. Clark referred *Antedon wilsoni* to his new genus *Aporometra* a disposition in which, as stated by Dr. Clark, the author concurred.

APOROMETRA OCCIDENTALIS H. L. Clark

[See vol. I, pt. 1, fig. 92 (p. 151); pt. 2, fig. 205 (p. 141)]

Ptilometra macronema (part) A. H. CLARK *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 461 (small specimens from Koombana Bay, 14½–18 meters).

Aporometra occidentalis H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 42 (in key), p. 43 (description: Koombana Bay, Bunbury, 5–8 fathoms), p. 45 (Garden Island); Echinoderm fauna of Australia, 1946, p. 58 (in key), p. 59 (common at Koombana Bay and Garden Island, Fremantle, Western Australia).

Diagnostic features.—The longest cirrus segments are from half again to twice as broad as long. The arms are 25–30 (usually about 25) mm. long, and the cirri are XX, 39–61 (usually 40–50), from 20–27 (usually about 25) mm. long.

Description.—The centrodorsal varies from low hemispherical to a broadly rounded truncated cone, and from nearly twice as broad as high to about as high as broad. The cirrus sockets are arranged in 10 columns of 3 or 4 each. The columns may be closely crowded with the sockets all more or less angular, or the two uppermost sockets in each radial area may be separated in the midradial line by a bare slightly depressed area. The cirrus sockets are deep with sharply sloping sides and a large slightly reniform central fulcral ridge about twice as broad as high with an oval central perforation, the central fulcral ridge being separated from the sloping sides by a depressed bandlike area.

The cirri are XX, 39–61 (usually 40–50), from 20–27 (usually about 25) mm. long. The first two segments are somewhat over twice as broad as long, the second slightly longer than the first, and the third and following are about twice as broad as long, in the terminal third of the cirri becoming slightly shorter. The cirri taper slowly from the base to the distal fourth, thence slightly more rapidly to the tip. The segments in the terminal fourth are broadly flattened dorsally so that when viewed from the end they are much broader than high, ventrally strongly and evenly convex, dorsally only very slightly convex and here roughened with 8 to 12 fine parallel glassy narrow, more or less irregular and sometimes branched or anastomosing, longitudinal ridges similar to those on the ventral and lateral surfaces. The dorsal surface of the antepenultimate segment is slightly more convex than that of the segments preceding.

The radials project slightly beyond the rim of the centrodorsal. Their distal border is slightly concave. The IBr_1 are about three times as broad as the median length with the lateral borders produced and the lateral edges straight or very slightly concave and parallel or slightly diverging; the distal edge is slightly concave in the median third and slightly bowed outward in the lateral thirds. The IBr_2 (axillaries) are broadly rhombic, with broadly truncated lateral angles, and are about twice as broad as long. The lateral edges are short, from a third to a half again as long as those of the IBr_1 with which they form a straight line. The proximal border in the median third has a broadly rounded convexity incising the distal border of the IBr_1. The distal sides are slightly concave and make with each other an angle of somewhat more than 90°.

The 10 arms are 25 to 30 (usually about 25) mm. long. The first brachials are about twice as long exteriorly as interiorly, and about twice as broad as the exterior length. The second brachials are of about the same size but the distal border is somewhat more oblique. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly and is about as broad as the interior length. The next two brachials are about twice as broad as the median length and have slightly oblique ends. The brachials following, which alternate with syzygial pairs, are similar, but the ends become somewhat more oblique. In the outer half of the arm the brachials are about half again as broad as long.

Syzygies occur between brachials 3+4, 7+8, and 12+13, thence at intervals of two muscular articulations.

There are 17 or 18 pinnules on each side of the arm.

P_1 is 7.5 mm. long, with 14 segments, and tapers evenly from a moderately stout base to a slender but not delicate tip. It is moderately flexible. The first segment is about as broad as long, with the proximal border rounded. The second is about a third again as long as broad. The third is somewhat over twice as long as broad. The fourth and following are about three times as long as broad. The pinnule is perfectly smooth, the segments joining evenly end to end without any production of the distal ends. From the third onward the segments on the middle of the outer side bear a narrow roughened line marking the crest of a slight compression.

P_a is 4.2 mm. long, with 10 segments, resembling P_1 but correspondingly smaller and more slender.

P_2 is 3.0 mm. long, with 11 segments, of which the first is about as long as broad and with the proximal border well rounded, the second is about as long as broad, the third is about half again as long as broad, the fourth is a little longer, but the fifth is shorter and only slightly longer than broad. The following segments are all slightly longer than broad, though shorter than the fifth. The pinnule is rather stout basally and tapers evenly and regularly to a rather broad and stout distal portion. The third to fifth segments support a large ovoid gonad and marsupium, of which the side toward the base is thick and tough and the side toward the pinnule tip is thin and delicate. The third and following segments have a thin but prominent carinate ridge on the middle of the outer side.

P_3 is 3.3 mm. long with 11 segments and resembles P_2.

P_4 is 3.5 mm. long and resembles P_3.

The following pinnules to P_8 are similar, the gonad then gradually diminishing in size and disappearing after P_{14}.

The distal pinnules are 3.5 mm. long with 12 to 14 segments. The first segment is about twice as broad as long, the second is about as long as the proximal width, broader proximally than distally and with slightly concave sides, and the remainder are about half again as long as broad. The terminal segment is enlarged and has the broad dorsal surface armed with 12 to 15 stout recurved spines. The segment preceding is somewhat less enlarged and is armed dorsally with smaller spines or tubercles. The segment before this is often slightly enlarged. The distal pinnules are obscurely and broadly carinate, usually narrowly and sharply carinate on a few of the segments, or at least part of them. The proximal end of the last segment and the distal end of that preceding are very sharply oblique, so that the fibers connecting them are very long, allowing for an unusual amount of motion, and the two preceding articulations are nearly as flexible.

The disk appears naked on superficial examination, but is in reality completely covered with a continuous pavement of small and very delicate plates that become more regular and more conspicuous along the ambulacra. On the long anal tube there are several longitudinal rows of small plates, with scattered larger plates between them.

The ambulacral deposits in the pinnules consist, when present, of small and very slender spicules.

The color in alcohol is brown, varying from very dark to almost whitish. The cirri may be of the same color as the arms but are usually lighter and often white, in striking contrast to the arms.

The ventral surface of the centrodorsal is deeply concave in a small, but adult, individual, less deeply excavated in a larger specimen. The radial areas are moderately concave, and are separated by low rounded ridges. The central cavity, as viewed ventrally, is rather small and pentagonal, with rounded angles. From it 10 grooves run out for about a third the distance to the edge, the outer ends of the radial grooves, lying on the base of the interradial ridges, being pointed, and those of the midradial grooves being rounded. The central cavity is small, about a third the diameter of the centrodorsal, and extends downward for only about half its length.

The articular faces of the radials are very low, twice as broad as high or even broader, and lie at a very large angle with the dorsoventral axis. The dorsal ligament fossa is very low. The muscular and interarticular ligament fossae of the two sides are separated by a rounded median groove. The interarticular ligament fossae are low, their distal border making only a slight angle with the fulcral ridge and running either slightly upward or slightly downward from the central structures. At the inner end of the upper edge of the interarticular ligament fossa is a large thick circular boss that lies in the plane of the central canal and hence extends deep within the muscular fossa. The muscular fossae are small and low, scarcely larger than the interarticular ligament fossae.

Although the radial articular faces are oligophreate rather than macrophreate in their general structure, they do not resemble those of any other oligophreate genus.

The rosette is highly developed, with large interradial "spout-like" processes that extend upward at an angle of about 45° and terminate in a broadly thickened rim. In the center of the rosette, between these, is a pentagonal area enclosing a narrowly 5-pointed elevation with a raised area at the base of each of the rays. The rosette is not attached either to the radial pentagon or to the centrodorsal; after removal of the radial pentagon it remains closing the cavity of the centrodorsal.

Larva.—The skeletal elements of the larva as found in the sacs on the pinnules are as follows:

There are five large orals, usually all in contact, though the two ventral are often separated in the midventral line. The orals are stout and evenly curved, without upturned edges. The plane of the circlet of orals is at right angles to that of the terminal stem plate, and in the smaller individuals the aboral edge of the oral circlet is in contact with the border of the terminal stem plate.

Just beneath the orals are five basals of approximately the same size and similar in appearance. The basal circlet is usually widely open in the midventral line. In the younger larvae the basals beneath the two ventral orals completely fill the space between the orals and the terminal stem plate.

At the summit of the column and beneath the middle of the dorsal oral is a shallow 5-lobed saucer about half again as broad as the column. This is the circlet of underbasals, of which there are apparently three.

The column is composed of about 19 discoidal columnals, of which those in the upper half are very thin, those in the lower half becoming progressively thicker toward the terminal stem plate. The column is curved so that the axes of the two ends are at right angles to each other.

The terminal stem plate is circular, large and thick, three or more times as broad as the column.

Notes.—The three specimens collected by the Hamburg Southwest Australian Expedition in 1905 may be described as follows:

The largest specimen has the cirri arranged in 10 closely crowded columns of two (sometimes one) each.

The cirri are XVII, 41–44, from 15 to 20 mm. long, stout basally but tapering very evenly and gradually and becoming very slender at the tip where the dorsoventral width is not quite half of what it is at the base. The first segment is short and those following gradually increase in length, becoming about as long as broad on the third or fourth and, still further increasing, becoming nearly half again as long as broad on about the seventh. From this point onward the segments very slowly decrease in length, so that those in the distal third of the cirri are about half again as broad as long. The longer earlier segments show a tendency to be centrally constricted or "dice-box shaped." There are no dorsal spines or projections. The opposing spine is small, sharp, subterminal, and nearly erect.

The 10 arms are 27 mm. long.

Syzygies occur between brachials 3+4, 7+8, and 12+13, and distally at intervals of 2 muscular articulations.

P_1 is 4.5 mm. long, with 12 segments, of which the first is about a third again as broad as long, the second is about half again as long as broad, the third is slightly over twice as long as broad, and those following are about three times as long as broad. In the outer half of the pinnule the distal edges of the segments project slightly dorsally. The pinnule is moderately stout basally and tapers evenly and gradually to the tip, not being flagellate distally. It is more or less rounded prismatic.

P_2 is 3 mm. long, with 12 segments, smaller and weaker than P_1 with shorter segments.

P_3 is 3 mm. long and resembles P_2. The pinnules following become very slender, but do not increase in length.

The borders of the disk are only very slightly concave in the interbrachial areas.

The color is deep purple, the centrodorsal and cirri white.

The two other specimens are similar, but slightly smaller. One has the cirri very slightly purplish at the tip, and the other has a white mediodorsal line on the arms.

The three specimens from Fremantle are small, though mature. The arms are 13 mm. long, and the cirri are 9 mm. long. The longest cirrus segments are broader than long.

Dr. Clark said that the smallest individuals that he and Professor Bennett took at Bunbury were hardly 20 mm. across. The longest of the dozen cirri are about as long as the arms (say 8 to 10 mm.) and have some 35 segments. The largest individuals have the arms 25 to 30 mm. long and the longest of the XX–XXV cirri are but little shorter; they have more than 50 segments of which the terminal dozen are very small. There are only 20 to 25 pinnules on each side of the longest arms.

Dr. Clark remarked that the most interesting biological fact about this comatulid is that it is viviparous, that is to say, the eggs are not shed from the genital pinnules but undergo their development in and on them. He noted that the original specimens from which the species *paedophora* was described carried on the pinnules pentacrinoid larvae in various stages of growth. They were collected in late summer or early autumn (February and March). The specimens taken in Koombana Bay in late spring have the genital pinnules with large eggs and young embryos, not yet pentacrinoids. Each pinnule seems to have 4 or 5 eggs, but usually if development is well under way there are but 3 or 2 embryos. Dr. Clark suspected that only one pentacrinoid develops on each pinnule, the other eggs and embryos serving as nourishment.

He said he had little doubt but that the whole life history could be easily worked out at Bunbury during a summer and would be a very interesting and valuable study. He also suggested that the work might be done at Fremantle, since this species occurs at Garden Island.

Dr. Clark said that in alcohol this species undergoes practically no change of appearance, but dried specimens are paler and more rigid. The color of the oral surface is always brown, usually very dark, the disk being marked more or less with whitish. The dorsal side of the arms and calyx is brown, ranging from a distinctly yellowish to a deep somewhat purplish shade. The cirri are often purplish, brownish, or even reddish, but are generally very light and often almost white, in rather marked contrast to the arms, which they sometimes nearly equal in length, or even exceed.

He noted that the cirri are efficient "holdfasts," admirably adapted to the bottom on which the comatulids were living, for this was covered, more or less, with algae (chiefly *Cystophora*) and other vegetation (chiefly *Cymodocea*). The dredge came up full of these plants and the various comatulids (not to mention other echinoderms) were well tangled with them and with each other by means of the long recurving cirri.

Dr. Clark said it is worthy of note that he did not find *Ptilometra* at Bunbury, or at any other point on the Australian coast.

Remarks.—At the time he recorded the three specimens collected by the Hamburg Southwest Australian Expedition at Koombana Bay (1911), the author remarked that they had given him considerable trouble. He said that they appear to be exactly comparable to the *Antedon wilsoni* described by Bell, and to the *Himerometra paedophora* described by H. L. Clark, both of which proved subsequently to be but the young of species of *Ptilometra*, the former of *P. macronema* and the latter of *P. mülleri*.

The author wrote that the essential features presented by these little animals are as follows: The coefficient of variability between the three specimens is very high, indicating immature forms with a quite different adult stage. P_1 is more or less prismatic, showing that the animal belongs to the Oligophreata. In that group it comes nearest to P_1 in *Ptilometra*, with which it agrees in all particulars, even though the pinnules following are smaller instead of larger. The cirri are evidently immature; their distal taper, great length, and large number of segments, as well as the proportions of the segments, agree with the conditions found in *Ptilometra macronema*, though they are white, and in *Ptilometra macronema* the cirri are the darkest part of the animal. The outer pinnules have comparatively short segments, a condition which shows that the animals cannot belong to any group but the Charitometridae, Calometridae, or Thalassometridae (in a broad sense) and, except for the lack of carination and the juvenile characters, they come nearest to the pinnules of *Ptilometra macronema*.

[NOTE BY A.M.C.] As explained earlier, the idea of a close relationship with *Ptilometra* has since been discarded.

Localities.—Hamburg Southwest Australian Expedition station 56; Koombana Bay, 6–7 miles southwest of Bunbury, Western Australia; 14½–18 meters; rocky bottom with a few plantlike organisms; July 28, 1905 [A. H. Clark, 1911, 1915, 1921] (3, U.S.N.M., E.8035; H.M.).

Koombana Bay, 1 or 2 miles west of the breakwater at Bunbury, Western Australia; 9–15 meters; H. L. Clark and E. W. Bennett, October 26, 1929 [H. L. Clark, 1938] (148, M.C.Z., 964; U.S.N.M., E. 8035; 4, B.M.). Type locality.

Garden Island, near Fremantle, Western Australia; E. W. Bennett, 1929 [H. L. Clark, 1938] (3, M.C.Z.).

Geographical range.—Coast of southwestern Australia from Bunbury to Fremantle, Western Australia.

Bathymetrical range.—From shallow water down to about 18 meters.

History.—The first examples of this species known were three specimens collected by the Hamburg Southwest Australian Expedition off Bunbury in 1905 and recorded by the author as the young of *Ptilometra macronema* in 1911. One of these was figured in part 1 (fig. 92, p. 151) and another in part 2 (fig. 205, p. 141), both as the young of *P. macronema.*

On October 26, 1929, Dr. H. L. Clark and Prof. E. W. Bennett found this species to be very common, indeed the commonest comatulid, 1 or 2 miles west of the breakwater at Bunbury in 5 to 8 fathoms; they preserved a large number of specimens, of which Dr. Clark brought back 148. In addition he brought back 3 small specimens (labeled as having been taken near Garden Island off Fremantle) which had been given him by Professor Bennett.

Dr. Clark was so very kind as to submit all his specimens, of this and allied species, to me with the request that I determine their affinities and describe them if they proved to be new, and also diagnose the new genus which we agreed that they, together with *wilsoni* and *paedophora*, represented. I prepared the account given herein with a diagnosis of the new genus *Aporometra*, a key to the included species, and a description of *A. occidentalis.* But I was unwilling to publish it because of Dr. Clark's obvious prior rights. There was no reason why I should either diagnose a new genus worked out by him, or describe a new species collected and determined by him, especially as some years before I had identified it as something quite different. So I sent him my notes and descriptions to use as he saw fit.

Dr. Clark described *Aporometra occidentalis* in 1938, his description being an abridgment of the one given herein, and gave notes on the occurrence of the species and on its viviparous habit. He refused, however, to incorporate my account of the skeletal structure, or my description and figures of the young.

Suborder MACROPHREATA A. H. Clark

Antedonoida A. H. CLARK, Amer. Nat., vol. 42, No. 503, 1908, p. 723 (a new suborder; rounded pinnules and large eggs; range of genera and species).

Comatulida Macrophreata A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 174 (includes Antedonidae, Atelecrinidae and Pentametrocrinidae); Crinoids of the Indian Ocean, 1912, p. 44 (in key); Die Crinoiden der Antarktis, 1915, p. 113 (diagnosis; geological occurrence; geographical and bathymetrical ranges).

Macrophreata A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 649 (includes Antedonidae, Atelecrinidae and Pentametrocrinidae); *in* Michaelsen and Hartmeyer, Die Fauna Sudwest Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 438 (analysis of Australian species); Mem. Australian Mus., vol. 4, 1911, p. 717 (proportion of species in the Australian fauna), p. 725 (poorly represented in Australia); Crinoids of the Indian Ocean, 1912, p. 6 (19 genera in the East Indian region, 70 species in the E. Indian region; in other regions of the world this suborder far outnumbers the Oligophreata); *in* Springer and Clark, Zittel-Eastman's Paleontology, 1913, p. 236 (diagnosis; includes Atelecrinidae, Pentametrocrinidae and Antedonidae); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 2 and following (range; structural relation to temperature); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, p. 5 and following (Atlantic and corresponding Indo-Pacific genera); Journ. Washington Acad. Sci., vol. 4, No. 20, 1914, p. 581 (relation to temperature of habitat); vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance); Die Crinoïden der Antarktis, 1915, p. 163 (all shallow water crinoids of the Antarctic belong to the family Antedonidae of this suborder), p. 167 (2 of the 7 south Australian crinoids belong to this suborder); Amer. Journ. Sci., vol. 40. 1915, p. 67 (detailed philosophical discussion of the bathymetrical range); Smithsonian Misc, Coll., vol. 65, No. 10, 1915, p. 40 (phylogenetic study); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 196; Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pp. 2, 12, 20, 21; Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 59; Ark. Zool., vol. 19a, No. 32, 1928, p. 10.—Boone, Bull. Vanderbilt Mar. Mus., vol. 14, 1933, p. 69.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 93.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 15.—Tortonese, Boll. Mus. Zool. Univ. Torino, vol. 46, ser. 3, No. 82, 1938, p. 40.—H. L. Clark, Echinoderm fauna of Australia, 1946, p. 60.

Makrophreaten A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 167.

Diagnosis.—A suborder of Comatulida in which the central cavity in the centrodorsal containing the chambered organ and overlying structures is large; the rosette is not sunken below the dorsal surface of the radial pentagon, and its interradial extensions do not form "spoutlike" processes; or the radials may be essentially unmodified (Atelecrinidae); there is no calcareous deposit on the inner surface of the radials nor upon the central surface of the rosette, so that there is no trace of a central plug; the plane of the muscular fossae on the radial articular faces is nearly or quite parallel to the dorsoventral axis of the animal, so that the muscular fossae are separated from the very large central cavity only by thin calcareous lamina which are quite different from the more or less thick wedges seen in the Oligophreata; the joint face elements distal to the transverse ridge are strongly excavated, especially interiorly, so that they meet in the median dorsoventral line at an angle of usually 90°; the brachials from the second syzygy onward are usually triangular or very obliquely wedge-shaped; the second brachial syzygy is usually between brachials 9+10 (Antedonidae and Pentametrocrinidae) or 6+7 (Atelecrinidae); the distal brachial syzygies are evenly and closely spaced; the pinnules are all cylindrical or more or less flattened, never prismatic, and without a dorsal carination; in the distal pinnules the first two segments are broadened and those beyond the third are elongate; the radials are usually 5, but in two genera 10; and the arms with very rare exceptions are 5 or 10, or in species with 10 radials 10 or 20.

Geographical range.—Cosmopolitan; but absent from the Baltic and Black Seas.

Bathymetrical range.—From the low tide mark, and sometimes large tide pools, down to 5220 meters.

Thermal range.—From the high temperatures of the tropical littoral down to −1.85° C.

Remarks [by A.M.C.].—The key to the families of Macrophreata given in part 3 of this work (page 71) needs some modification since not only has the family Notocrinidae been removed to the suborder Oligophreata but also the *Siboga* collections yielded two new genera (one of them, *Sibogacrinus*, described here for the first time) which necessitate some qualifications in the characters used before.

KEY TO THE FAMILIES OF MACROPHREATA

[by A.M.C.]

a^1. First syzygial pair oblong or squarish or slightly wedge-shaped and the brachials immediately following more or less oblong; centrodorsal ranging in shape from discoidal to conical but the individual cirrus sockets never flanked by prominent ridges laterally; basals rarely visible at all in the adult and radials usually inconspicuous; only one or two proximal pinnules absent, if any, and that rarely.

b^1. Second post-radial ossicle always axillary (Cosmopolitan, 0–5220 meters)--ANTEDONIDAE (p. 39)

b^2. No axillaries, each radial (of which there may be 5 or 10) being followed by an undivided series of brachials (Antarctic; Indo-West Pacific, South Africa, North Atlantic, 254–3290 meters). PENTAMETROCRINIDAE (p. 766)

a^2. First syzygial pair very obliquely wedge-shaped, and the immediately following brachials triangular; centrodorsal always high conical, usually with pairs of prominent ridges or a continuous horseshoe-shaped ridge corresponding to each cirrus socket (absent in *Sibogacrinus*); basals still visible in the adult and radials large, except in the 5-armed *Atopocrinus*, the other genera having axillaries and 10 arms; at least nine of the proximal pinnules lacking (again except in *Atopocrinus*, while the condition is unknown in *Sibogacrinus*) (East Indies to the Hawaiian Islands and from the West Indies and northeast Atlantic, 532–1633 meters). ATELECRINIDAE (p. 811)

Family ANTEDONIDAE Norman

Comatuladae FLEMING, History of British animals, 1828, p. 494; ed. 2, 1842, p. 494.

Comatulidae FORBES, History of British starfishes, 1841, p. 12.—D'ORBIGNY, Cours elementaire de geologie et de paleontologie stratigraphique, 1852, vol. 2, fasc. 1, p. 138.—W. B. CARPENTER, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 692.—BELL, Proc. Zool. Soc. London, 1882, p. 530.—P. H. CARPENTER, *Challenger* Reports, Zool., vol. 26, pt. 60, 1888, pp. 27, 43, 63–66.

Comatuliens (part) DUJARDIN and HUPÉ, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 191.

Antedonidae NORMAN, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 101; ser. 6, vol. 7, No. 40, 1891, p. 386; No. 44, 1891, p. 181.—BATHER, Ann. Mag. Nat. Hist., ser. 6, vol. 7, 1891, p. 464 (should be applied to that comatulid family in which *Antedon* is placed); Natural Science, vol. 12, 1898, p. 341 (relation to Pentacrinidae; formation of columnals); Geol. Mag., new ser., vol. 5, Dec. 4, 1898, p. 324 (systematic position); Rep. British Assoc. for 1898, 1899, p. 923 (includes *Thiolliericrinus*, *Eudiocrinus*, *Promachocrinus;* referred to Grade Pinnata of Order 2, Flexibilia, of Sub-Class Dicyclica); *in* Wachsmuth and Springer's Monograph on crinoids, 1899, p. 324 (systematic position); *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, pp. 125, 136, 141, 195.—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 397 (represented in the Arctic by *Antedon*).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (includes *Eudiocrinus*, *Antedon* and *Thiolliericrinus;* part of Comatulidae as understood by P. H. Carpenter); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 126 (covering *Erythrometra*, *Thaumatometra*, *Coccometra*, *Trichometra*, *Bathymetra*, *Hypalometra* and *Isometra* gen. nov.), p. 136 (including *Perometra*, *Erythrometra*, *Zenometra*, *Psathyrometra*, *Adelometra*, *Heliometra*, *Promachocrinus*, *Thaumatometra*, *Thysanometra*, *Coccometra*, *Leptometra*, *Hathrometra*, *Iridometra*, *Trichometra*, *Bathymetra*, *Nanometra*, *Compsometra*, *Hypalometra*, *Isometra* and *Antedon*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (in key), p. 211 (includes *Antedon, Thysanometra, Coccometra, Heliometra, Promachocrinus, Trichometra, Adelometra, Psathyrometra, Zenometra, Hypalometra, Isometra, Bathymetra, Thaumatometra, Hathrometra, Leptometra, Compsometra, Iridometra, Nanometra, Erythrometra,* and *Perometra;* range), p. 211 (represented in the Hawaiian Islands), p. 212 (range of component genera); vol. 35, 1908, p. 119, fig. 17 (arm structure), p. 126 (arm structure compared with that of *Isocrinus naresianus;* Geogr. Journ., vol. 32, No. 6, 1908, p. 602 (genera characteristic of the Indo-Pacific-Japanese region), p. 603 (all Polar-Pacific comatulids included in this family); Amer. Nat., vol. 42, No. 500, 1908, p. 542 (all Polar-Pacific genera included in this family); vol. 43, 1909, p. 254 (represented in the Red Sea); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 175 (referred to the Comatulida Macrophreata); Vid. Medd. Nat. Foren. København, 1909, p. 119 (occurs at Singapore; species of this family have large eggs which presumably develop quickly; ecology), p. 126 (certain genera of this family are characteristic of the Intermediate region), p. 133 (existence of side and covering plates in species of this family first shown by Mortensen), p. 148 (distal portion of the arms of *Comatula pectinata* occasionally are of the type typical of this family), p. 152 (cirri compared with those of *Zygometra fluctuans*), p. 190 (intersyzygial interval of the species of this family remarkably true to species); Proc. U.S. Nat. Mus., vol. 36, 1909, pp. 361–365 (part of old genus *Antedon;* covering plates differ from those of *Comatilia* in being in two rows instead of in one), p. 495 (ambulacral plates of West Indian species of the *Fimbriata* group of *Actinometra* represent side plates of this family); vol. 40, 1911, p. 6 (8 species in Africa), p. 7 (list of species on Mediterranean coast, northwest coast, and west coast), p. 8 (species on southeast coast), p. 9 (species on northeast coast), p. 10 (West Indian and corresponding East Indian genera), p. 649 (referred to the Macrophreata); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 438 (1 genus and 2 species in Australia), p. 449 (relation of comparative length of arms to coldness of habitat in *Antedon* compared with the same in the species of Comasteridae); Mem. Australian Mus., vol. 4, 1911, p. 717 (proportionate abundance of species of this family according to P. H. Carpenter), p. 720 (the same as now known), p. 729 (in key), p. 731 (1 genus in Australia); Crinoids of the Indian Ocean, 1912, p. 5 (the East Indian *Cyclometra* gave rise to the Antarctic *Promachocrinus* and *Solanometra;* the East Indian *Trichometra* is represented by other species of *Trichometra* and by *Hathrometra* in the Atlantic), p. 6 (number of East Indian genera represented in the Atlantic; number represented in the Atlantic by closely allied genera; number of exclusively East Indian genera; number of East Indian species), p. 9 (4 of the 5 subfamilies absent from north Australia), p. 11 (represented in the Ceylon region by *Mastigometra* and *Trichometra*), p. 12 (represented in the Red Sea region by *Iridometra, Thaumatometra,* and *Cyclometra;* represented in southeast Africa by *Iridometra* and *Perometra*), p. 14 (East Indian and corresponding West Indian genera), p. 25 (range in detail; universal in occurrence; all subfamilies in the Atlantic as well as in the Indian Ocean; in the extratropical regions, excepting on the southern shore of Africa and of Australia, this family supplies almost, or quite, all the endemic species; this is the Macrophreate equivalent of all the Oligophreate families combined), pp. 46, 49, 50, 51 (in keys), p. 60 (key to the subfamilies), p. 61 (key to the genera).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 371.—A. H. Clark, *in* Springer and Clark, Zittel-Eastman's Paleontology, 1913, p. 236 (referred to the Macrophreata); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (temperature relations); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1914, p. 5 and following (Atlantic and corresponding Indo-Pacific genera); Die Crinoïden der Antarktis, 1915, p. 113 (synonymy; diagnosis; geological, geographical, and bathymetrical ranges), p. 163 (all known shallow water crinoids of the Antarctic belong to this family); Amer. Journ. Sci., vol. 40, 1915, p. 67 (detailed philosophical discussion of the bathymetrical range); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, p. 227 (detailed account of the distribution of Australian species); Amer. Nat., vol. 49, 1915, p. 526 (at present a dominant family); Journ. Washington Acad. Sci., vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetical and paleontological significance); vol. 7, No. 5, 1917, p. 127 (revision); No. 16, pp. 504–512 (detailed revision, with keys to the included subfamilies and genera); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 196 (key to the included subfamilies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 2.—Koehler, Faune de France, 1, Échinodermes, 1921, pp. 192, 195 (diagnosis).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 7, 10, 80, 124; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 19, 35, 44, 62, 80, 85, 91, 239, 241.—Mortensen, Danmarks Fauna, No. 27, 1924,

p. 20; Handbook of the echinoderms of the British Isles, 1927, p. 16 (in key), p. 25 (diagnosis), p. 26 (key to the included British genera).—KOEHLER, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 122 (diagnosis; remarks).—GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 43; Ark. Zool., vol. 19, No. 32, 1928, p. 10.—MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, Lief. 12, 1928, p. viii. 3.—VATOVA, Mem. Com. Talassogr. Ital., vol. 143, 1928, p. 362.—H. L. CLARK, Rec. South Australian Mus., vol. 3, No. 4, 1928, p. 369.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 658.—NOBRE, Echinodermes de Portugal, 1931, p. 159 (diagnosis), p. 163 (included genera).—A. H. CLARK, Ann. Mag. Nat. Hist., ser. 10, vol. 10, No. 58, 1932, p. 383.—SIEVERTS, Neues Jahrb. Min., Geol. und Pal., vol. 69, Beilage-Band, Abt. B, 1932, p. 159.—BERNASCONI, Anal. Mus. Argent. Cienc. Nat., Buenos Aires, vol. 37, 1932, p. 29 (brief diagnosis).—H. L. CLARK, Scientific Survey of Porto Rico and the Virgin Islands, vol. 16, pt. 1, 1933, p. 12.—DJAKONOV, Les échinodermes des mers arctiques (in Russian), Leningrad, 1933, p. 20 (in key), p. 22 (key to included species).—TORTONESE, Natura, Milano, vol. 24, 1933, pp. 163, 164.—EKMAN, Zoogeographica, vol. 2, No. 3, 1934, p. 347 (zoogeographic significance).—BUEN, Trab. Inst. Esp. Oceanogr. Madrid, No. 10, 1934, p. 83.—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., new ser., vol. 45, No. 11, 1934, pp. 18, 20, 53, 54.—EKMAN, Tiergeographie des Meeres, 1935, p. 63.—PALLARY, Bull. Soc. Hist. Nat. Afrique Nord, vol. 26, pt. 2, 1935, p. 58.—TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 59, 1936, p. 208.—KOLOSVARY, Folia zool. hydrobiol. Riga, vol. 9, 1936, p. 83.—A. H. CLARK, Temminckia, vol. 1, 1936, p. 315; John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, pp. 93, 102, 103.—MORTENSEN, Kongl. Danske Vid. Selsk. Skr., nat. math., ser. 9, vol. 7, No. 1, 1937, p. 63 (larva compared with that of *Lamprometra klunzingeri*).—KOLOSVARY, Festschrift für Embrik Strand, vol. 2, 1937, p. 467 (in key), p. 468 (diagnosis).—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 8, No. 1, 1937, p. 1; Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, pp. 4, 15, 20.—NOBRE, Echinodermes de Portugal, ed. 2, 1938, p. 186.—TORTONESE, Boll. Mus. Zool. Univ. Torino, vol. 46, ser. 3, No. 82, 1938, p. 43 (diagnosis).—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., new ser., vol. 49, No. 17, 1939, p. 10.—EALES, The littoral fauna of Great Britain, Cambridge, 1939, p. 228.—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139 (revision of west tropical Atlantic species).—ELIAS DA COSTA, Chaves dicotómicas para a classificação dos equinodermes Portugueses. IV. Crinoides, Porto, 1940, p. 8.—H. L. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 11; Echinoderm fauna of Australia, 1946, p. 60 (only 5 genera known from Australian seas besides a possible *Iridometra* from Queensland).—TORTONESE, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4.—FELL, Tuatara, Wellington, New Zealand, vol. 3, No. 2, 1950, p. 84 (in key).—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 57, 58 (depth range).—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, pp. 95–97.—TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, pp. 181, 182.

Antedoniden STEINMANN, Die geol. Grundlagen der Abstammungslehre, 1908, p. 158 (of polyphyletic origin).

Antedonidés A. H. CLARK, Bull. Mus. Hist. Nat. Paris, 1911, No. 4, p. 256.

Diagnosis.—A family of the suborder Macrophreata in which the basals are transformed into a rosette; there are 5 (in one genus 10) radials each of which bears a IBr series and 2 arms (IIBr series being only very exceptionally present); and the gonads are developed wholly within the pinnules.

Geographical range.—Cosmopolitan, but absent from the Baltic and Black Seas.

Bathymetrical range.—From the low tide mark, and sometimes in large tide pools, down to 5220 meters.

Thermal range.—From the high temperatures of the tropical littoral down to $-1.85°$ C.

Remarks [by A.M.C.].—Mr. Clark left no up-to-date key to the subfamilies of the Antedonidae, so the following one is modified from that given in his *Siboga* report of 1918. However, it is not altogether satisfactory and should be used only in conjunction with the brief diagnoses given at the end. Since these subfamilies were established, there have been fitted into them new genera and species which have tended to bridge the gaps between. For instance the zenometrin genera with cirrus sockets in columns in the radial areas separated by interradial spaces, such as *Zenometra*, *Sarametra* and *Psathyrometra*, are linked with the Bathymetrinae by genera such as *Leptometra* and *Eumorphometra* in which there are no interradial bare spaces on the centrodorsal and the columns may even (particularly midradially) be somewhat irregular. Also some species of subfamilies other than the Zenometrinae may have the sockets in quite distinct vertical rows, notably in the Heliometrinae. As for the proportions of the distal segments of P_1, specimens of *Thysanometra* have now been described in which these are distinctly longer than broad, contrary to the key.

KEY TO THE SUBFAMILIES OF ANTEDONIDAE

[Modified by A.M.C.; see above]

a^1. Cirrus sockets arranged in definite columns on a conical or columnar, usually large, centrodorsal. ZENOMETRINAE (p. 491)

a^2. Cirrus sockets arranged in transverse alternating rows, or irregularly, on a hemispherical to discoidal or conical centrodorsal.

b^1. P_1 is composed of numerous (usually more than 50 and never less than 30) short segments of which at least the first 6 or 7, and usually nearly all, are broader than long, and the distal are rarely more than twice as long as broad.

c^1. Cirri strong and curving, sometimes with dorsal processes on the distal segments.

d^1. Cirri large, the peripheral ones with more than 25 segments ----- HELIOMETRINAE (p. 285)

d^2. Cirri short, with less than 20 segments ----- ------------ ANTEDONINAE (part)* (p. 43)

c^2. Cirri weak and more or less straight -- ----------------------- THYSANOMETRINAE (p. 266)

b^2. P_1 rarely with more than 30 segments, often less than 20, and except for the basal ones these are mostly elongated, the distal ones several times as long as broad and the whole pinnule somewhat tapered.

c^1. The distal cirrus segments are entirely without dorsal processes on their distal ends; the cirri are usually (but not always) short, rarely with more than 20, never with more than 30, segments --------- --------------------------------------- ANTEDONINAE (p. 43)

c^2. The distal cirrus segments always have the distal dorsal edge prominent, with the median portion more or less produced in the form of a dorsal spine, and the middorsal line more or less strongly carinate.

d^1. Segments of the genital pinnules not conspicuously expanded.

e^1. P_2 resembles P_1, and always differs from the genital pinnules; P_a is sometimes and P_1 occasionally, absent ------------------------------------- PEROMETRINAE (p. 457)

e^2. P_2 resembles P_3 and the succeeding pinnules, and often bears a more or less developed gonad; all of the lower pinnules are invariably present ----- BATHYMETRINAE (p. 646)

d^2. Segments of the genital pinnules conspicuously expanded --- ------- ISOMETRINAE (p. 617)

ZENOMETRINAE (see figs. 25–34): Centrodorsal conical or columnar, with the cirrus sockets in vertical columns, sometimes with naked interradial spaces between the columns; cirri long, usually stout and flexible distally, rarely with less than 20 segments, sometimes with moderate dorsal projections on the distal segments; P_1 and P_2 usually similar, with most of the 10 to 20 (rarely as many as 45 or as few as 4) segments longer than broad, often very elongate.

HELIOMETRINAE (see figs. 15–18): Centrodorsal hemispherical to conical, with the cirrus sockets crowded irregularly or sometimes with a tendency towards arrangement in vertical rows; cirri long and strong with 25 to 75 segments, usually with

*This covers *Antedon bifida* and *petasus*, also *Annametra occidentalis*, which all have numerous, more or less short, segments in P_1.

moderate to strong dorsal projections on the short distal segments; P_1 very long and flagellate, with 30 to 82 short segments, the distal ones very rarely longer than broad and often with dorsal convexities simulating the combs of the comasterids; P_2 usually similar but sometimes with slightly longer segments.

THYSANOMETRINAE (see fig. 14): Centrodorsal low hemispherical, rarely almost discoidal or subconical, with the cirrus sockets irregularly arranged; cirri slender, often with the 15 to 30 segments very elongate, dorsal spines completely absent; P_1 long and flagellate, with 30 to 40 short segments, of which even the distalmost are rarely longer than broad; P_2 similar in length to P_1 but with only half as many segments, which are therefore much longer.

ANTEDONINAE (see figs. 3–13): Centrodorsal discoidal to hemispherical to rounded conical, with the cirrus sockets crowded irregularly; cirri relatively short, with segments rarely numbering more than 20, and completely lacking dorsal processes; P_1 with all the segments, except the basal ones, nearly always longer than broad, often several times longer, usually 12 to 20 segments, but sometimes (as in *Antedon* and *Annametra*) they may number up to 50 and may be rather short; P_2 longer than P_1 in about half the genera, though usually with a similar number of segments; in the rest it is shorter, with fewer segments.

PEROMETRINAE (see figs. 19–24): Centrodorsal low to high rounded conical, with the cirrus sockets crowded irregularly; cirri rather long with 25 to 55 segments, the distal ones with conspicuous dorsal prominences; P_1 with about 12, rarely up to 20 moderately long segments; P_2 similar but smaller; P_a sometimes and P_1 occasionally absent.

BATHYMETRINAE (see figs. 37–47): Centrodorsal conical to hemispherical, rarely almost discoidal, with the cirrus sockets crowded and usually alternating or irregular in position; cirri usually with 15 to 35, rarely over 45, segments, of which the longest are always longer than broad and may be up to six times as long; the distal segments usually have dorsal prominences; P_1 usually with about 20 elongate segments, rarely up to 42; P_2 may be shorter or longer, it is often the first genital pinnule.

ISOMETRINAE (see figs. 35–36): Centrodorsal conical to hemispherical, with the cirrus sockets alternating or irregularly placed; cirri stout, usually with 30 to 40 short segments, rarely up to 75, the longest segments never much longer than broad, the distal ones with dorsal keels, P_1 fairly stout with 5 to 17 moderately elongated segments; P_2 either longer or shorter than P_1 with 6 to 14 segments; genital pinnules marked off from those of all the other subfamilies by the conspicuous lateral expansion of two or more of the segments bearing the gonads.

Subfamily ANTEDONINAE

[NOTE BY A.M.C.] The word 'Antedoninae' was used by Delage and Herouard in their Traité de Zoologie Concret (vol. 3, 1903, p. 394), for the family Antedonidae in Bather's sense. This, and their other family names, formed by adding the suffix '-inae' to the name of the type genus, were not generally adopted and the first author of Antedoninae as a subfamily was A. H. Clark.

Antedoninae A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Antedon*, *Mastigometra*, *Compsometra* and *Iridometra*); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 438 (1 genus and 2 species in Australia); Mem. Australian Mus., vol. 4, 1911, p. 725 (genera *Mastigometra* and *Iridometra* absent from Australia);

Proc. U.S. Nat. Mus., vol. 39, 1911, pp. 559–560 (*Toxometra*, nov.); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, pp. 29, 31 (*Euantedon*, nov.); Crinoids of the Indian Ocean, 1912, p. 6 (East Indian genera common to Atlantic; genera allied to Atlantic genera; exclusively East Indian genera; number of East Indian species), p. 25 (detailed distribution; corresponds in many ways to the Comasteridae or Himerometridae of the Oligophreata; 0–78 fathoms in the East Indies, 146–163 fathoms in the Hawaiian Islands), p. 61 (in key); Bull. Inst. Océanogr. Monaco, No. 294, 1914, p. 7 (temperature relations); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, p. 5 and following (Atlantic and corresponding Indo-Pacific genera); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges); No. 20, p. 582 (relation to temperature of habitat); vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetical and paleontological significance); Amer. Journ. Sci., vol. 40, 1915, p. 67 (detailed discussion of the bathymetrical range); Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (includes *Antedon*, *Compsometra*, *Mastigometra*, *Euantedon*, *Toxometra*, *Dorometra*, *Eumetra*, *Iridometra*, *Hybometra*, *Andrometra*, and *Argyrometra*); No. 16, 1917, p. 504 (in key), p. 505 (key to the included genera); Unstalked crinoids of the *Siboga* Exped., 1918, p. 196 (in key), p. 197 (key to the included genera); Univ. Iowa, Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 2.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 10, 124, 130, 139, 147; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 31, 91, 231, 232, 239.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key), p. 27.—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 658; Temminckia, vol. 1, 1936, p. 315.—Gislén, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 8, No. 1, 1937, p. 1; Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, pp. 15, 21.—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, pp. 139, 143.—Cuénot, *in* Grassé, Traité de zoologie, vol. 11, 1948, p. 71.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (absent below 1,000 meters); *Atlantide* Rep., No. 3, 1955, p. 87 (*Compsometra* a synonym of *Antedon*).

Antedoninés A. H. Clark, Bull. Mus. Hist. Nat. Paris, No. 4, 1911, p. 256.

Diagnosis.—A subfamily of Antedonidae in which the cirrus sockets are closely and irregularly crowded or arranged in more or less regular alternating transverse rows (never in columns) on a discoidal to hemispherical or even rounded conical centrodorsal; the cirri, though of very variable length, are usually short with rarely more than 25 and never with more than 33 segments of which the distal are entirely without dorsal spines or other processes except for the opposing spine, which is rarely absent; and P_1 is rarely composed wholly or mostly of numerous short segments. The segments of the genital pinnules are never expanded.

Geographical range.—From southwestern and southern Japan as far eastward as Tokyo Bay to the Hawaiian, Society, and Tonga Islands, northern New Zealand, and the southern coast of Australia, and westward to the eastern coast of Africa from Suez to the Cape of Good Hope; from the Gulf of Guinea to Norway and Iceland, including the Mediterranean Sea and the Sea of Marmora, and from the Caribbean Sea to Rio de Janeiro.

Bathymetrical range.—From the low tide mark, and even tide pools, down to 932 meters.

The species of this family for the most part are inhabitants of shallow water. Of the 10 included genera only 4 (*Argyrometra*, *Eumetra*, *Iridometra* and *Andrometra*) are not known to occur along the shore line, and all of these have been taken within 80 meters of the surface.

Characters.—The centrodorsal in the Antedoninae shows considerable variation; while it is most frequently low hemispherical to almost discoidal with a comparatively large bare polar area and the cirrus sockets arranged in two, and a partial third, irregular and crowded rows about the margin, in some genera, as in *Eumetra*, *Iridometra*, *Argyrometra* and *Andrometra* the cirrus sockets become aligned in regular alternating rows, usually three or four, but sometimes as many as six, and the centrodorsal may acquire a more or less conical form; indeed in *Andrometra indica* it bears a strong resemblance to that of the species of *Hathrometra*. This increasing regularity in the arrangement of the cirrus sockets is correlated with increasing slenderness and delicacy in these organs and a proportionate decrease in the size of their sockets, while the assumption of the conical form shows the same correlation and is accompanied by the retention of small apical cirri. Both of these features are developed in the deeper and more quiet regions, but the former is noticeable to a considerable extent in certain of the small littoral species of *Dorometra*.

The cirri in the various species of this subfamily are exceedingly variable. While they afford, broadly speaking, the best and most reliable characters for the differentiation of the species, the several kinds overlap so completely that they are quite useless for purposes of generic definition; in *Antedon* alone practically all the types found in all the other genera are represented.

The length of the cirri varies from 4 to 27 mm. (40 mm. in *Eumetra chamberlaini*) or from 10 to 33 (48) percent of the length of the arms; in the different species of *Antedon* alone it varies from 10 to 28 percent of the arm length. In 34 of the species where both measurements are included in the descriptions the percentage is usually (in 21 species) from 16 to 25 percent, sometimes (in 9 species) between 10 and 15 percent, more rarely (in 3 species) between 25 and 35 percent, and only in *Eumetra chamberlaini* nearly 50 percent. The average for all species is 20 to 21 percent, so that in this group the cirri may be said to vary from a tenth to nearly half the arm length, with an average of about a fifth and a range between a tenth and a quarter, longer cirri being very exceptional.

The number of the cirri varies from X–XX to L–XC, and is most commonly XXVI–XXXV; in only a few species are there more than L. There appears to be no definite relation between the number of the cirri and the size of the animal or the depth inhabited.

The number of segments in the fully developed cirri varies from 10 to 33, with the greatest frequency between 14 and 16, several species having 12 or 13; only half as many species reach 17 as 16, and half as many 18 as 17; in only 5 species does the maximum number exceed 18, and in only 4 does the minimum for fully developed peripheral cirri reach 22 or more.

The form of the cirri varies from short and stout, strongly recurved in the distal half, with the longer proximal segments about twice as long as broad and the short distal segments, which are strongly compressed laterally and may appear about twice as broad as the proximal in lateral view, about as long as wide and with a prominent opposing spine (as in *Toxometra*, *Annametra*, *Mastigometra*, and *Antedon petasus*, *A. duebeni*, *A. bifida moroccana*, *A. arabica*, and *A. incommoda*) to elongate and slender, almost straight, with all the segments except the basal greatly elongated, and tapering to a sharp straight point distally with no opposing spine (as in *Antedon longicirra* and approximately in *Eumetra chamberlaini*); but they usually fall towards the first of these two extremes.

Short and stout cirri are characteristic of the larger littoral species (in *Antedon*, *Mastigometra*, *Annametra*, and *Toxometra*), while delicate cirri with much elongated segments which are strongly constricted centrally are found in very small species, and in medium sized species from deep water.

The distal ends of the cirrus segments may be unmodified, or they may be produced and overlap the bases of those succeeding. The earlier longer segments are usually from two to three times as long as broad; but they may be as much as six times as long as broad. The distal segments are never broader than long, but very rarely are more than twice as long as broad.

The longer earlier segments are always more or less constricted centrally so that the ventral, and usually also the dorsal, profile is more or less concave, and the width of the ends in lateral view may be as much as twice that of the central portion or even more, though usually it is less.

The dorsal surface of the segments is always rounded, never carinate.

The distal edges of the radials in the median line are usually even with the rim of the centrodorsal which may, however, extend beyond them. Interradially the distal angles of the radials are never produced, being visible as low and often very narrow triangles.

Occasionally (as in *Antedon duebeni*, *Annametra occidentalis*, sometimes in *Antedon bifida*, etc.) there are prominent groups of perisomic interradials between the IBr series.

The disk, which is somewhat, though never strongly, concave in the interradial areas, is naked or, rarely in the larger species, bears a greater or lesser number of calcareous concretions.

Sacculi are always abundant and conspicuous, regularly distributed along the sides of the ambulacral grooves.

The IBr series and arm bases in this group show but little variation. The IBr_1 are always narrow with converging sides which may, however, be extended laterally to meet those of their neighbors by a development of the ventrolateral border which often bears a tubercle at the anterolateral angle. The axillaries are always broad, usually as broad as long or broader than long, always with the median portion of the proximal border more or less produced downward at the expense of the IBr_1, with all the sides, especially the two distal, concave, always rising to a more or less prominent synarthrial tubercle with the IBr_1 and, if the ventrolateral borders of the latter are produced, with a ventrolateral production beneath the lateral angles to match, which frequently bears a tubercle.

There is never any spinosity, carination, or other ornamentation on the dorsal surface of the IBr series, though the synarthrial tubercles, when strongly developed, may be roundedly carinate. The development of spines on the edges of these ossicles is rare.

The first two brachials reduplicate the essential features of the elements of the IBr series, and the second is always much larger than the first and irregularly quadrate in form.

In this group the division series and arm bases always lie in planes making a very large angle with the dorsoventral axis, in some cases almost a right angle, so that when the arms are fully extended the animal is almost flat.

The arms vary in adult individuals from 15 to 200 mm. in length—very nearly this whole range is covered by *Antedon bifida* alone—but are usually between 20 and

50 mm. long, with about half as many species ranging up to 80 mm., and about half this number above 80 mm.

In structure the arms show a remarkable uniformity; between the first and second syzygies and somewhat beyond, the brachials are wedge-shaped, with the proximal and distal edges concave, usually about twice as broad as the median length; they then become almost or quite triangular, usually about as long as broad, and later wedge-shaped again, gradually elongating distally where the articulations are usually more or less swollen. The distal edges of the brachials are usually finely and inconspicuously spinous, very rarely prominently so. The dorsal surface is never carinate or otherwise modified.

Syzygies occur almost invariably between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

In only three species, all belonging to the genus *Antedon*, has a tendency to an increase in the number of arms over 10 been observed. *Antedon bifida* has been found with 11 and with 12 arms, the IIBr series having been 2 in all cases but one in which it was 4(3+4); *A. bifida moroccana* has been reported with 11 arms, one IIBr series of 2 being present; *A. mediterranea* and *A. petasus* with 12 arms have also been recorded, besides three specimens of *petasus* with 11 arms, but in these last the arm division, though occurring at the base, was abnormal in character. Possibly when other genera have been collected as widely as has *Antedon* similar anomalies will be found.

In regard to the oral pinnules, the genera of Antedoninae fall into two distinct classes, (a) with P_3 as well as P_2 and P_1 modified and differing from the succeeding pinnules, and (b) with P_3 of the same size and character as the succeeding pinnules.

In the first group, P_1, P_2 and P_3 may be similar and about the same length, longer than those succeeding (*Iridometra*); P_2 may be the largest and longest, though with P_3 of the same character and not much smaller (*Andrometra*); or P_3 may be the longest and stoutest pinnule on the arm, with P_1 and P_2 smaller and similar to each other, or with P_2 intermediate in size between P_1 and P_3 (*Toxometra*, *Dorometra* and *Eumetra*).

In the second group two genera (*Argyrometra* and *Euantedon*) have P_1 and P_2 with rarely more than 21 segments, P_2 being smaller except in *Argyrometra mortenseni*. In one genus (*Annametra*) P_1 and P_2 are similar, the latter being slightly longer than the former, with 18 to 35 segments.

In the remaining genera (*Mastigometra* and *Antedon*) P_1 is greatly elongated and much the longest pinnule, and P_2 may be intermediate between it and P_3, or of the same length as P_3 but ungrooved and without a gonad, or quite similar to P_3 in all ways.

The segments of all the oral pinnules beyond the basal are elongate and more than twice as long as broad in all the genera but *Annametra*, though they are never excessively long. In *Antedon* and in *Mastigometra* they are less elongated than in the remaining genera. When long the oral pinnules always become stiffened, at least in the basal half or two-thirds.

The middle and distal pinnules show very little variation throughout the group; the distal edges of the component segments, at least the outer ones, are always more or less armed with spines, and this spiny border may become highly developed in some species of *Antedon*.

The deposits along the sides of the ambulacral grooves of the pinnules consist usually of a single slender and smooth calcareous rod in each lappet which is straight or slightly curved or more or less abruptly bent in the middle. Sometimes this rod becomes stout and roughened at both ends, or irregularly broadened and perforated at one or both ends, or, rarely, converted into an irregular cribriform plate or an irregular branching spicule. In some cases there are two rods, one longer and one shorter, smooth or roughened, plain or with variously modified ends, rarely converted into an irregular plate. Occasionally, especially in the species of *Antedon*, ambulacral deposits are absent. (For the details of these deposits see vol. 1, part 2, pp. 264–265, and beyond.)

Some of the species of *Antedon* may also have spicules in the tentacles.

Relationships of the genera.—Since in this subfamily the characters differentiating the various genera lie almost wholly in the oral pinnules, and since in the comatulids as a whole the transformation of the oral pinnules from food collecting to tactile or defense organs represents specialization, the species in which this is at a minimum may, other things being equal, be considered as the most generalized.

The minimum of specialization in the oral pinnules occurs in *Antedon mediterranea* and in *A. adriatica* in which P_1 is the only outer pinnule to be modified, and, generally speaking, differs but little from P_2 and the following pinnules except in length. The assumption that these species are more or less primitive in character is borne out by the very generalized nature of the cirri which, though with numerous segments, are quite featureless and resemble, in a broad way, the first cirri of pentacrinoids, as well as by the similarly generalized nature of the IBr series which resemble those of pentacrinoids more than do those of any other species.

In the other species of *Antedon*, excepting *A. petasus* and *nuttingi*, P_2 though of the same size as P_3, does not bear a gonad and may lack the ambulacral groove; the cirri, strongly recurved distally and with short distal segments, are of a more specialized kind than those of *mediterranea* and *adriatica*, and the same is true of the very short IBr series. The other Atlantic species appear in every way to be comparable to the Pacific species formerly included in *Compsometra* in which, however, the cirri may be of the short-segmented type (as in *A. incommoda*), or greatly attenuated and elongate, or more or less generalized, while the segments of the lower and middle pinnules have strongly everted and produced distal ends.

In *Antedon petasus* P_3 is similar to P_1 and intermediate in length between that pinnule and P^3; in its other features this species closely resembles the second group of species of *Antedon*. *A. petasus* is so very like the species of *Mastigometra* in every way as to render its separation from them a matter of some difficulty, and to suggest that perhaps *Mastigometra* had best be considered as a synonym of *Antedon*.

In *Annametra* P_1 and P_2 are alike, both similarly modified, with 18 to 35 segments, and are more different from P_3 than is true of the preceding examples, while the cirri resemble those of all the preceding except *Antedon mediterranea* and *A. adriatica*.

In *Euantedon* P_1 and P_2 are of the same character, with relatively few segments, not more than 23, and differ from P_3 more strongly even than in *Annametra*; the cirri also are modified in a rather different direction.

In *Argyrometra* P_1 and P_2 become still more reduced, with less than 15 segments, and the cirri, broadly speaking, are like those of *Euantedon*.

Of the genera in which three pairs of pinnules are modified as oral pinnules, *Iridometra* has them all long, but similar. *Andrometra*, with P_2 enlarged and assuming the functions of P_1 as seen in *Antedon*, appears to be more generalized than the other genera, in which P_3 is enlarged and has to a greater or lesser degree assumed the normal functions of P_1. Of the three remaining genera, *Eumetra* shows the least modification of the oral pinnules, while in *Dorometra* there is a progressive reduction of P_2 which in such species as *D. nana* has become, like P_1, apparently functionless in correlation with a high degree of specialization in the cirri and a very small size.

The most highly specialized genus in the subfamily appears to be *Toxometra*, in which cirri of the *Antedon bifida* type, with the characteristic features exaggerated, reappear.

[NOTE BY A.M.C.] A re-examination of the unique holotype of *Hybometra senta*, formerly included in the Antedoninae, has shown that the large conical centrodorsal and arrangement of the cirrus sockets ally it with *Poliometra* and *Caryometra* of the subfamily Zenometrinae, rather than with any genus of the Antedoninae. Its cirri and P_1 are unfortunately unknown.

In 1938 Dr. H. L. Clark described the genus *Monilimetra* with four species from north-west Australia. Mr. Austin Clark included all these in *Toxometra* in the typescript of this monograph but left no comparison between *Monilimetra* and *Toxometra* or reasons for this move.

Gislén, 1955, has pointed out that *Antedon bifida* and to a lesser extent *A. hupferi* may have the distal ends of the pinnule segments more or less spinous, which character has, until now, been thought to be characteristic of the genus *Compsometra*. He does not believe, and I concur, that there is enough difference in this or any other character for two genera to be distinguished and also comments that the inclusion by Mr. Clark of the Atlantic species *nuttingi* in *Compsometra* breaks down the geographical separation of the Indo-Pacific species of *Compsometra* from the Atlantic ones of *Antedon* (though *nuttingi* appears to be rather aberrant, having different proportions of the first two pinnules—a character which Gislén supports Mr. Clark in believing is important—from the species of both *Antedon* and *Compsometra*). The name *Compsometra* therefore becomes relegated to the synonymy of *Antedon*.

It seems to me that the generic distinctions in this subfamily are often too artificial. In some cases differential proportions of the pinnules are regarded as diagnostic, elsewhere they are set aside. In checking the following key against a table of numerical characters derived from the descriptions of the species, some anomalies were found which necessitated considerable alterations to the key and which suggested that certain of the species could be better placed in other genera. *Eumetra aphrodite* could well be transferred to *Dorometra*, as discussed on p. 77, leaving *Eumetra* monotypic, *E. chamberlaini* being marked off from the rest of the subfamily by the relatively long cirri equal to nearly half the arm length, with up to 33 segments, the highest number recorded in the Antedoninae. *Annametra* I believe should also be a monotypic genus. The type species, *A. occidentalis* from South Africa, is distinguished from all the other species of the subfamily by the very short segments of P_1, which are not longer than wide (see fig. 6, p. 95). *Annametra minuta* from Japan does approach it in having these segments less than twice as long as wide and relatively short cirrus segments but some other species of Antedoninae are also similar with regard to these characters.

As for the genera, *Argyrometra* and *Euantedon* seem to me to be very poorly differentiated from one another. In 1917 and in this typescript, Mr. A. H. Clark distinguished them by the number of segments in P_1 (18 to 21 in *Euantedon* and 12 or 13 in *Argyrometra*), the total size (not diagnostic) and the shape of the centrodorsal (conical in *Argyrometra* and hemispherical in *Euantedon*). However, he describes the centrodorsal of *A. crispa*, the type species of *Argyrometra*, as hemispherical. Also in two species of *Euantedon*, *tahitiensis* and *sinensis*, no complete P_1 is known. Since different species exhibiting a considerable range in number of segments of P_1 have been included in single genera elsewhere in this subfamily—notably 12 to 23 in *Toxometra* and 8 to 49 in *Antedon* (12 to 28 in *A. serrata* alone)—I do not think that a difference of about 5 or 6 segments can be used as a character of generic significance. In 1928 Dr. H. L. Clark described a species from South Australia, *paucicirra*, which he placed in *Euantedon* though it has only 10 to 12 segments in P_1. If the diagnosis of *Euantedon* is broadened to accommodate this species then the only character which may be of sufficient weight to distinguish the two genera is the very large number of cirri, LX or more, in the relatively small known specimens of *Argyrometra crispa* and *mortenseni*. However, in the typescript Mr. Clark has included in *Argyrometra* the species *Iridometra exquisita* which has only XL–L cirri at an arm length two-thirds again as great as in the type specimens of the two other species. It seems to me better to refer *exquisita* to the rediagnosed *Euantedon*.

In the following key the inverse proportions of the proximal pinnules in the two species of *Argyrometra* have necessitated their separate inclusion. Although the key splits off *Antedon petasus* from the rest of the genus, the different proportions of P_2 relative to P_3 seem to provide the best means of separating *Euantedon* and *Mastigometra* from *Antedon*.

KEY TO THE GENERA OF ANTEDONINAE

a^1. P_2 not of the same length and character as the succeeding pinnules.
  b^1. P_3 the longest and stoutest pinnule on the arm.
    c^1. Distal ends of the cirrus segments not overlapping the bases of those succeeding; dorsal edge of the outer 4–6 cirrus segments about as long as the proximal border (Philippines to northwest Australia; 0–510 meters) ---------- **Toxometra** (p. 51)
    c^2. Distal ends of the cirrus segments more or less produced and overlapping the bases of those succeeding; outer cirrus segments much longer than the proximal width.
      d^1. Smaller (arms up to 60 mm. long) with not over 17 cirrus segments; cirri less numerous, XX–LI (rarely over XL) (southern Japan and the Bonin Islands to Tonga and northern Australia, and westward to the east coast of Africa and Mauritius; 0–728 meters). **Dorometra** (p. 61)
      d^2. Larger (arms up to 80 mm. long) with 16–33 cirrus segments; cirri more numerous, up to LX (rarely less than XL) (Philippines, southern Japan and the Lesser Sunda Islands; 69–146 meters) ---------- **Eumetra** (p. 77)
  b^2. P_3 not the longest and stoutest pinnule on the arm.
    c^1. P_1, P_2, and P_3 similar and of approximately equal length, with at least 13 segments, usually about 18 (southern Japan to Timor and the Admiralty Islands; 80–731 meters). **Iridometra** (p. 86)
    c^2. P_2 much longer than both P_1 and P_3 though similar to the latter (Andaman Islands to southern Japan; 55–274 meters) ---------- **Andrometra** (p. 81)

a^2. P_2 of the same length and character as the following pinnules.
  b^1. P_2 a little larger than P_1.
    c^1. P_1 with 18 to 35 segments, not more than twice as long as broad (South Africa and southern Japan; 0–17 meters) ---------- **Annametra** (p. 91)
    c^2. P_1 with 8 to 12 segments up to four or five times as long as broad (New Zealand; 110–175 meters) ---------- **Argyrometra mortenseni** (p. 98)
  b^2. P_2 smaller than P_1, often only half as long.
    c^1. P_2 distinctly smaller than P_2.
      d^1. P_1 with 10 to 21 segments.

e^1. Cirri about LXX when the arm length is only 30 mm.; P_1 and P_2 with about the same number of segments (Hawaiian Islands; 270–298 meters).
Argyrometra crispa (p. 97)

e^2. Cirri only over L when the arm length exceeds 100 mm.; P_2 with fewer segments than P_1 (Moluccas, Philippines and China to the Society Islands and southern Australia; 0–397 meters) ---------- **Euantedon** (p. 99)

d^2. P_1 with 25 to 50 segments, rarely as few as 20.

e^1. Brachials more or less thickened at their distal edges (Ceylon to the Society Islands; 0–48 meters) ---------- **Mastigometra** (p. 106)

e^2. Brachials not flared at their distal edges (western Sweden, Norway, the Faeroe Islands and southwest of Iceland; 27–326 meters) ---------- **Antedon petasus** (p. 130)

c^2. P_3 similar in size to P_2, not distinctly smaller (north-east and tropical Atlantic, the Mediterranean, Arabian Sea to southern Japan and southern Australia, 0–932 meters).
Antedon (p. 111)

Genus TOXOMETRA A. H. Clark

Toxometra A. H. Clark, Proc. U.S. Nat. Mus., vol. 39, 1911, p. 560 (diagnosis; type *T. paupera;* referred to the Antedoninae); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 10 (absent from Japan; reason), p. 11 (absent from the west coast of the Malay peninsula and further west), p. 25 (range), p. 63 (in key), p. 232 (original reference; type); *in* Springer and Clark, Zittel-Eastman's Paleontology, 1913, p. 237 (in the Antedoninae); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Antedoninae); No. 16, p. 506 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 197 (in key; range), p. 210.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 7 (distribution), pp. 129, 130, 131.

Monilimetra H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 47 (diagnosis; type *M. nomima* sp. nov.); Echinoderm fauna of Australia, 1946, p. 60 (in key), p. 62 (genus limited to N.W. Australia; key to species).

Diagnosis.—A genus of Antedoninae in which P_3 is much the longest and stoutest pinnule on the arm; the distal ends of the cirrus segments do not overlap the bases of those succeeding and the dorsal length of the outer 4 to 6 cirrus segments is about equal to their proximal width.

Type species.—*Toxometra paupera* A. H. Clark, 1911.

Geographical range.—From Flores to Negros and Mindanao, Philippines, and northwest Australia.

Bathymetrical range.—From the shore line down to 510 meters.

Thermal range.—From the temperature of the tropical reefs down to 11.95°C.

Remarks [by A. M. C.].—Mr. A. H. Clark included, without comment, the nominal genus *Monilimetra* H. L. Clark, 1938, in the synonymy of *Toxometra.* Since it also shares with *Dorometra* the character of the enlarged P_3 some comparison is called for as justification for this move, particularly as it was with *Dorometra* that H. L. Clark gave a comparison. The cirrus segments of *Toxometra paupera* are distinguished from those of the species of *Dorometra* by the absence of flared and overlapping distal ends and the relatively shorter distal segments. *Monilimetra bicolor* appears to approach *Dorometra* in these characters, to judge from H. L. Clark's figures, but the other three species of *Monilimetra* have cirri approximating more to those of *Toxometra.* No mention was made by H. L. Clark of spinous distal productions of the brachials in any of the species of *Monilimetra,* which are therefore taken to have smooth brachials like those of *Dorometra* rather than flared spinous ones like *Toxometra paupera.* However, this character probably has no great reliability.

In the absence of any material of *Monilimetra* for comparison I am leaving Mr. A. H. Clark's disposition of the species unchanged.

In the following key the characters used by H. L. Clark for the species of *Monilimetra* have been retained in default of more reliable ones. In view of the variable proportions of P_4 relative to P_3 in *T. paupera* it is doubtful whether this character is of any use in distinguishing *T. lepta*. The occurrence of four sympatric species seems to me improbable and the morphological differences between them too slight for all to be justified.

KEY TO THE SPECIES OF TOXOMETRA

a^1. Brachials smooth, not flared distally.
  b^1. P_4 almost as large as P_3.
    c^1. Fourth to sixth cirrus segments more than twice as long as wide; P_1 5–6 mm. long; color in life purple and white, with the cirri all white (north-west Australia; 9–15 meters). **bicolor** (p. 52)
    c^2. Fourth to sixth cirrus segments less than twice as long as wide.
      d^1. Proximal pinnules relatively long and slender, P_3 with over 30 segments, measuring about 25 mm., P_1 measuring 12 mm.; color in life brownish, sometimes variegated (north-west Australia) ---------- **nomima** (p. 53)
      d^2. Proximal pinnules not very elongated, P_3 with about 24 segments, measuring under 20 mm., P_1 measuring about 8 mm.; color in life purple and white with pinnules banded (north-west Australia; 0–15 meters) ---------- **poecila** (p. 55)
  b^2. P_4 conspicuously smaller than P_3 (north-west Australia; 9–15 meters) ---------- **lepta** (p. 57)
a^2. Brachials flared and spinous (Flores to the Philippines; 0–510 meters) ---------- **paupera** (p. 58)

TOXOMETRA BICOLOR (H. L. Clark)

Monilimetra bicolor H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 55 (description; between Cape Villaret and Broome, 5–8 fathoms; also near False Cape Bossut, near entrance to Roebuck Bay, and Pearl Shoal, 7 fathoms); figs. 11, 12, p. 56; Echinoderm fauna of Australia, 1946, p. 63 (in key; arm bases purple, cirri white).

Diagnostic features.—The cirri have 15 to 17 segments, of which the fifth and sixth are more than twice as long as wide; P_4 is almost as large as P_3, which has about 25 segments; the brachials are not conspicuously flared.

Description.—The centrodorsal is low, hemispherical, about 2 mm. in diameter, and almost completely covered with cirri.

The cirri are about XXXVIII, 15–17, crowded and more or less recurved. The fourth to sixth segments are elongated, more than twice as long as the diameter of the nearly cylindrical middle; those following are longer than broad and increasingly compressed. The opposing spine is sharp and rather prominent, and the terminal claw is sharp but not strongly curved.

The radials are concealed. The IBr_1 are short, at least four times as broad as long. The IBr_2 (axillaries) are low pentagonal with the lateral margins very short and the width much greater than the length. The synarthrial articulations are very open.

The 10 arms are approximately equal, about 35 to 40 mm. long. The number of brachials exceeds 80. The character of the brachials and the position of the syzygies are essentially as in *T. nomima*.

P_1 is 5 or 6 mm. long with some 20 segments of which the basal are short and broad and the distal are somewhat longer than broad; on the whole the pinnule is quite moniliform. P_2 is longer and less moniliform but has about the same number of segments. P_3 is much longer and stouter, 12 to 15 mm. long with about 25 segments, of which all but the basal two or three are much longer than broad. P_4 is almost as long and stout as P_3, while P_5 is markedly smaller and P_{10} is the smallest of the pinnules. Spininess of the distal margins of the pinnule segments is not very marked, but with a lens it is evident on the basal and middle segments of P_3 to P_{10}.

The color (dry) is deep purple on the calyx and basal portion of the arms; the pinnules, except for some of the larger basal ones, are lighter and distally quite light so that the arms appear distinctly lighter near the tips. The cirri are pure white in striking contrast, the very basal segments, however, being deep purple.

Notes.—Dr. H. L. Clark said that this species is very close to *T. nomima* and might perhaps be considered a color form of that species, but the difference in the cirri seems to be constant and the coloration of the present form is so striking that it seems better to regard it as a distinct species.

Dr. H. L. Clark remarked it is evident that this species cannot be considered common in the Broome region.

The specimen from near the entrance to Roebuck Bay is somewhat larger and darker than the type, the pinnules being all dark. The arms are about 50 mm. long. The cirri are all wanting.

The superb specimen from Pearl Shoal has the arms about 60 mm. long and cream white, but the pinnules on the basal 10 to 18 mm. of each arm are red-purple, in sharp contrast. The cirri are pure white.

The specimen from near False Cape Bossut resembles the holotype, but all the cirri and most of the pinnules are wanting.

Localities.—Near the entrance to Roebuck Bay, Western Australia; H. L. Clark, June 1932 [H. L. Clark, 1938].

Pearl Shoal; 13 meters; H. L. Clark, September 26, 1929 [H. L. Clark, 1938].

Between Cape Villaret and Broome; 9–15 meters; H. L. Clark, June 1932 [H. L. Clark, 1938] (1, M.C.Z. 946). Type locality.

Near False Cape Bossut; H. L. Clark, September 1929 [H. L. Clark, 1938].

Geographical range.—Coast of northwestern Australia from Broome southward to False Cape Bossut.

Bathymetrical range.—From 9 to 15 meters.

History.—*Monilimetra bicolor* was described by Dr. Hubert Lyman Clark in 1938 from a specimen from between Cape Villaret and Broome in 5 to 8 fathoms, which he had collected in June 1932. At the same time it was recorded from three other localities and brief notes were given on the specimens.

TOXOMETRA NOMIMA (H. L. Clark)

Monilimetra nomima H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 48, figs. 5, 6, p. 49 (description; Broome; Roebuck Bay; near False Cape Bossut; between Broome and Cape Villaret); Echinoderm fauna of Australia, 1946, p. 62 (in key), p. 63 (rare at Broome; color variable, predominantly brown).

Diagnostic features.—The fifth and sixth cirrus segments are only a little longer than wide; P_4 is nearly as large as P_3, having about 30 segments; the brachials are not conspicuously flared.

Description.—The centrodorsal is low-hemispherical, not quite 3 mm. in diameter and well covered with cirrus sockets except at the dorsal pole; the sockets nearest the pole are very small, those near the margin being the largest.

Only 3 cirri are present and all these are broken, but one lacks only the terminal claw; this has 13 segments which are short, broad, and except basally distinctly compressed; the fourth to sixth segments are the longest, but are not much longer than their distal width. The opposing spine is small and inconspicuous. As shown by two paratypes the terminal claw is not conspicuous or peculiar, but is normally curved.

The radials are concealed. The IBr_1 are about four times as broad as long. The IBr_2 (axillaries) are more or less triangular with slightly concave sides, not quite so long as broad. The synarthrial articulations between the elements of the IBr series and between the first two brachials are not at all close.

The 10 arms are all broken, but would not have exceeded 35 mm. in length, and the number of brachials was probably not more than 70, counting syzygial pairs as one. The first brachials are short, twice as long exteriorly as interiorly, where they are rather markedly in contact; their length along the outer edge is equal to about half their width. The second brachials are somewhat longer, and the first syzygial pair (composed of brachials 3+4) equals the second brachial in size. The following three or four brachials are about twice as broad as long and are nearly oblong; after that they become more wedge-shaped, though never triangular.

Syzygies occur between brachials 3+4 and 9+10 and then at irregular but usually rather short intervals.

P_1 is about 12 mm. long, very slender, with about 23 segments of which the basal 6 to 12 are about as long as broad, the length then increasing so that the moniliform character of the pinnule disappears near the tip. P_2 is about 14 mm. long with some 25 segments of which only 2 or 3 at the base are as broad as long and the distal are twice as long as broad. P_3 is much longer and stouter, apparently about 25 mm. long (Dr. H. L. Clark said that the terminal portion is too much curved and twisted for measurement), with more than 30 segments. P_4 is about as stout as P_3 but not so long, although it has about 30 segments. P_5 is much smaller and shorter, with about 20 segments. The pinnules following are somewhat smaller but soon increase in length, although they remain very slender. Beginning with P_3 the outer distal corner of each segment projects as a minute spine and the distal margin begins to be slightly serrate; this spininess of the distal margin of the pinnule segments becomes very marked near the middle of the arm but decreases again on the distal pinnules.

The color (dry) is brown, lightest on the centrodorsal and arm bases and again distally, darkest on the dorsal side of the eighth to twentieth brachials, where it is a deep purple-brown. The change of shade is very gradual and nowhere abrupt. Beginning at the very base of each ray a light yellowish brown line, ill-defined and soon broken into irregular patches, runs out on the dorsal side of each arm; there are also minute specks of this light shade on each side of this line. The pinnules and cirri are light brown or even pale brownish white. Distally the arms are somewhat banded as each segment is brown with a broad light margin.

Notes.—Dr. Clark referred to this species four paratypes and two other specimens. He said that one is uniformly cream colored dorsally and is probably bleached. Another appears to be uniformly yellow-brown, but under a lens faint markings corresponding to those of the holotype are barely distinguishable. The other two paratypes are light reddish brown or fawn color, variegated with a darked purplish brown; they are, however, in poor condition and were apparently stained, probably by contact with other echinoderms in the collecting or preparing of the specimens. A fifth specimen, somewhat similar to these but much lighter in color and a little smaller and more delicate in structure, is referred to this species but is not considered a paratype. It has the cirri XXXIII, 13–15, but they seem more slender and much less compressed than in the paratypes, none of which, however, have retained enough of their evidently very fugacious cirri for adequate comparison. As regards the pinnules, the proportions are just as in the types but the measurements and actual number of segments are considerably less than in the holotype. Thus P_3 has fewer than 20 segments and is only 10 to 15 mm. long, and P_4 is distinctly smaller, but is much more like P_3 than like P_5. Dr. Clark regarded these peculiarities of the pinnules as youthful characters which would soon have been outgrown. Another specimen that he referred to *nomima* is very young, with the arms only 10 to 12 mm. long. The pinnules are all very slender and with few segments and the cirri are about XXV, 11. Dr. Clark said that the chief reason for referring this very juvenile specimen to *nomima* is its resemblance to the much larger atypical fifth specimen just discussed, the peculiarities of which he believed are due to immaturity, even though the arms are fully 30 mm. long.

Dr. Clark said that this species is undoubtedly the commonest of the Antedonidae in the Broome region and was taken at least four times.

Localities.—Roebuck Bay, Western Australia; H. L. Clark, August 1929 [H. L. Clark, 1938].

Broome; H. L. Clark, June 1932 [H. L. Clark, 1938] (1, M.C.Z., 953). Type locality.

Between Broome and Cape Villaret; H. L. Clark. 1932 [H. L. Clark, 1938].

Near False Cape Bossut; H. L. Clark, September 1929 [H. L. Clark, 1938].

Geographical range.—Coast of northwestern Australia from Broome southward to False Cape Bossut.

Bathymetrical range.—Littoral and sublittoral; Dr. Clark gave no depths but spoke of several of the specimens as dredged.

History.—*Monilimetra nomima* was described by Dr. Hubert Lyman Clark in 1938. In his account of this species Dr. Clark mentioned two specimens taken in Roebuck Bay in August 1929; two more dredged near False Cape Bossut early in September 1929; and three secured at different times in dredging between Broome and Cape Villaret.

TOXOMETRA POECILA (H. L. Clark)

Monilimetra poecila H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 53 (description; between Cape Villaret and Broome, 5–8 fathoms; also near Cape Bossut, near entrance to Roebuck Bay, and Pearl Shoal, 7 fathoms); Echinoderm fauna of Australia, 1946, p. 63 (in key; color conspicuously variegated white, yellow, and purple).

Diagnostic features.—The cirri have 16 to 18 segments of which the fifth and sixth are the longest but only a little longer than broad, P_4 is hardly, if at all, smaller than P_3 which has about 24 segments; the brachials are not conspicuously flared.

Description.—The centrodorsal is low hemispherical, more than 2 mm. in diameter, the small bare area at the dorsal pole without evident cirrus sockets.

The cirri are XXXIII, 16–18, crowded and more or less recurved. The segments are short and broad. The first three are broader than long, the fourth is about as broad as long, and the fifth and sixth are evidently longer than broad. The segments following are about as long as the distal width. The opposing spine is insignificant. The terminal claw is small but sharp and curved. While the cirri are flattened on the sides they are not markedly compressed.

The radials are concealed. The IBr_1 are short, about four times as broad as long. The IBr_2 (axillaries) are low pentagonal, broader than long, with the lateral margins very short. The synarthrial articulations are not at all close, the lower brachials in particular being very noticeably separated except at the very margin.

The 10 arms are rather unequal, the longest exceeding 50 mm. The number of brachials exceeds 140 on the longest arm. The form of the brachials and the position of the syzygies is essentially as in *T. nomima.*

P_1 is about 8 mm. long with some 20 segments, of which the basal are as broad as long and even distally the length barely exceeds the width, yet owing to the lack of constrictions between the segments the moniliform character of the pinnule is not as striking as it might be. P_2 is similar but is longer and stouter; the number and relative proportions of the segments is about the same. P_3 is conspicuously larger in every way, nearly 20 mm. long with about 24 segments. P_4 is very similar to P_3 and little, if at all, smaller. P_5 and the subsequent pinnules decrease uniformly in size to about P_{11} or P_{12}, after which the length increases a little but the stoutness does not. The spininess of the distal margins of the pinnule segments is more or less evident on P_4 to P_{10}, but is not very conspicuous.

The color (dry) is variegated with whitish, yellow, and purple; the ground color of the centrodorsal, cirri, bases of arms and pinnules, is whitish, of the dorsal side of the arms yellow. On each cirrus segment, excepting the most proximal and the two terminal, there is a conspicuous purple spot, and often these spots tend to run together dorsally, making an incomplete or sometimes complete, girdle around the segment. Each pinnule has from 8 to 10 purple bands of somewhat indefinite position and completeness. Each basal brachial has a large purple spot on each side dorsally, but beyond the eighth the spots tend to coalesce more or less into an indefinite band of dull purple or dusky. The regenerating portions of the arms are a uniform light yellow without markings, but the pinnules borne on them are banded. The disk is variegated with whitish and purple.

Notes.—Dr. H. L. Clark said that there are three paratypes, but all are more badly broken than is the holotype. One of these, taken at the same time and place, is similar in size and structure so far as can be determined, but is much darker in color, the yellow on the arms is pale, the purple is much more abundant, and the spots have coalesced into broad irregular bands. The two other paratypes show the same contrast in color, but it is even more marked. The lighter one is nearly white (possibly the yellow has been bleached in the alcohol in which it is preserved), variegated with a dull reddish purple (the shade may have been altered in alcohol), and with the pinnules less frequently and conspicuously banded. The darker specimen is deep red-purple with a whitish middorsal line on the IBr series and the pinnules purple and white banded as usual.

Dr. H. L. Clark said that this unusually lovely comatulid is very sensitive to handling, and only the holotype has any arms still attached to the calyx. Two of the paratypes were taken on September 5, 1929, "at extreme low water, far south of the jetty" at Broome. His field notes go on to say, "ten long, slender, very graceful arms; finely variegated with purple and white; very delicate and went all to pieces in pail, breaking the arms up into little bits." When the two specimens taken in 1932 were dredged, the present holotype was very little damaged, so it was possible by plunging it at once into strong alcohol to get a very good specimen, even the cirri remaining in place. Dr. Clark commented that obviously this fine species cannot be considered at all common in the Broome region.

Localities.—Between Cape Villaret and Broome, Western Australia; 9–15 meters; H. L. Clark, June 1932 [H. L. Clark, 1938] (2, M.C.Z. 956). Type locality.

Broome; at extreme low water, far south of the jetty; H. L. Clark, September 5, 1929 [H. L. Clark, 1938].

Geographical range.—From Broome to Cape Villaret, Western Australia.

Bathymetrical range.—From the low tide mark to 15 meters.

History.—*Monilimetra poecila* was described by Dr. H. L. Clark from a specimen dredged between Cape Villaret and Broome in 5–8 fathoms in June 1932. At the same time he mentioned another from the same locality, and two more from Broome taken on September 5, 1929.

TOXOMETRA LEPTA (H. L. Clark)

Monilimetra lepta H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 51 (description; Broome, 5–8 fathoms); figs. 7, 8, p. 52; Echinoderm fauna of Australia, 1946, p. 63 (in key; very light colored).

Diagnostic features.—The cirri have 15 to 17 segments, of which the fifth and sixth are the longest but not quite twice as long as wide; P_3 is conspicuously larger than P_4, with at least 23 segments as opposed to about 15; the brachials are not conspicuously flared.

Description.—The centrodorsal is low hemispherical, about 2 mm. in diameter, with the bare dorsal pole rough with minute cirrus sockets.

The cirri are XXXV, 15–17, crowded and more or less strongly recurved. The fourth to sixth segments are the longest and least compressed, but the length is scarcely equal to twice the diameter at the middle; distally the segments become shorter and broader and moderately compressed. The opposing spine is low and inconspicuous. The terminal claw is small but sharp and curved.

The radials are concealed. The IBr_1 are short, at least four times as broad as long. The IBr_2 (axillaries) are more or less triangular or low pentagonal; the lateral margins may be considered as blunt points on a triangle or as very short sides of a pentagon; the width of the axillaries is considerably greater than the length. The synarthrial articulations are not very close, and synarthrial tubercles are insignificant or wanting.

The 10 approximately equal arms are about 35 to 40 mm. long. The number of brachials probably exceeds 80. The characters of the brachials and position of the syzygies are essentially as in *T. nomima*.

P_1 is about 6 mm. long with some 20 segments of which only the basal 6 or 7 are broader than long, so that the moniliform character of the pinnule is not conspicuous. P_2 is similar but is longer and stouter, with about the same number of segments, but only about three of the basal are broader than long. P_3 is conspicuously longer, at least 15 mm. long, and stouter, with 23 or more segments, of which all but the two or three basal ones are much longer than broad. P_4 is distinctly smaller with about 15 segments and P_5 is similar but smaller still. The pinnules following are not peculiar. The spininess of the distal margins of the pinnule segments is more or less evident under a lens, but is not at all conspicuous.

The disk is plump and relatively large.

The holotype (dry) has the cirri, pinnules, and sides of the arms very pale brown, nearly white, the dorsal surface of each arm with a broad dark brown or blackish stripe. In alcohol the color is not essentially different. The disk is pale grayish, more brown on the anal cone and dark along the margins of the food grooves.

Notes.—Dr. H. L. Clark says that there are five paratypes, also dredged in the vicinity of Broome in June 1932. Apparently all the specimens were taken at the same time and place. They agree well in structural details and are distinctly more slender than *T. nomima*. In color they show some diversity, and not one has the dark stripe on the arms. Three are uniformly very light, a dull pale cream color on the dorsal side. One of these has the cirri white with no markings, while in the second a few distal segments of the largest cirri have a dusky blotch. The third has the cirri dusky or purplish gray. The two other specimens have more or less dusky or light brownish purple blotches on the brachials on each side, but these are not conspicuous. In the larger the cirri are nearly white, but in the smaller they are almost lead color.

A seventh specimen, which may properly be called a paratype, was taken on Pearl Shoal in 1929. The arms are all broken and the cirri are nearly all gone, but Dr. Clark did not hesitate to refer it to this species, as the pinnules correspond completely and such cirri as are present agree with those of *lepta*. The color, a uniform light shade not quite white, is also appropriate.

Dr. Clark said that this is the most *Dorometra*-like of any of the four species at Broome. The moniliform character of P_1 is by no means striking and the resemblance of the comatulid to *Dorometra* is obvious.

Localities.—Broome, Western Australia; 9–15 meters; H. L. Clark, June 1932 [H. L. Clark, 1938] (1 M.C.Z., 950). Type locality.

Pearl Shoal; H. L. Clark, 1929 [H. L. Clark, 1938].

Geographical range.—Known only from the vicinity of Broome, Western Australia.

Bathymetrical range.—From 9 to 15 meters.

History.—*Monilimetra lepta* was described by Dr. Hubert Lyman Clark in 1938 from a specimen that he had collected at Broome, Western Australia, in 5–8 fathoms in June 1932. Five others also dredged in the vicinity of Broome he designated as paratypes. A seventh taken on Pearl Shoal in 1929 he also regarded as a paratype.

TOXOMETRA PAUPERA A. H. Clark

[See vol. 1, pt. 2, fig. 767, p. 362]

Toxometra paupera A. H. Clark, Proc. U.S. Nat. Mus., vol. 39, 1911, p. 560 (description; *Albatross* Stas. 5519, 5536); Crinoids of the Indian Ocean, 1912, p. 232 (synonymy; localities); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 210 (synonymy; detailed description; *Siboga* Stas. 79*a*, 96, 99 and Maumeri), pp. 272, 276 (listed), pl. 25, figs. 82, 83.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 7 (habitat), p. 131.—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 659 (between Cebu and Leyte; 154 fathoms).

Toxometra purpurea A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 138 (description; *Siboga* Sta. 96); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 210 (= *T. paupera*), pl. 25, fig. 82.

Diagnostic features.—The cirri have 13 to 16 segments, of which the longest are about twice as long as broad; P_4 varies from two-thirds as long as P_3 to almost the same length; the brachials are flared and spinous at their distal ends.

Description.—Centrodorsal small, truncated hemispherical, the dorsal pole small and papillose; cirrus sockets arranged in three closely crowded alternating marginal rows.

Cirri XXIV, 13–16, 10 mm. long, recalling those of *Antedon petasus* but smoother dorsally and more slender proximally; first segment short, second slightly longer, third as long as broad or slightly longer than broad, fourth slightly longer than the third, fifth and sixth the longest, just under twice as long as the proximal width, the following gradually becoming laterally compressed and, though remaining actually of the same length, increasing in lateral diameter and becoming therefore relatively shorter so that the last four before the penultimate are only slightly longer than broad; in the proximal portion the cirri are in lateral view slender, and rounded in cross section; in the distal half they become strongly compressed and in lateral view about twice as broad as in the proximal half; there are no dorsal processes; opposing spine short, subterminal to submedian, its base involving only a small part of the dorsal surface of the segment; in height scarcely one-third the distal diameter of the penultimate segment, directed obliquely forward; terminal claw somewhat longer than the penultimate segment, stout and strongly curved.

Radials just visible beyond the rim of the centrodorsal; their distal angles are separated.

IBr_1 short, about four times as broad as long in the median line, trapezoidal, widely separated interradially, their sides making an angle of nearly 120° with those of their neighbors; IBr_2 broadly pentagonal; the anterior angle measures approximately 90°; the lateral edges are nearly as long as those of the IBr_1 and make with them an angle of about 120°; the synarthrial tubercles are rather prominent, and the elevation is continued somewhat anteriorly onto the axillary.

Arms 10, about 90 mm. long; first brachial short, over twice as broad as long exteriorly, the exterior length being rather more than twice as great as the interior; the inner edges of adjacent first brachials are united basally, but distally diverge at a very broadly obtuse angle; second brachial about twice as large as the first, irregularly quadrate; first syzygial pair (composed of the third and fourth brachials) nearly twice as long interiorly as exteriorly, the inequality falling chiefly in the hypozygal, twice as broad as long in the median line; next four brachials slightly wedge-shaped, twice as broad as the greater length, the following become triangular, about as long as broad, and after the proximal quarter of the arm wedge-shaped, about as long as broad, and terminally somewhat longer.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of three muscular articulations. The width at the first syzygy is 1.2 mm. and the length from the beginning of the division series to the second syzygy is 7.0 mm.

P_1 is 5.5 mm. long, composed of 15 segments, of which the first is short, the second longer, the third nearly as long as broad, the fourth slightly longer than broad, and the seventh and following about twice as long as broad; the pinnule is small and slender, and tapers evenly from the base to a slender and delicate tip; there is a slight swelling on the distal edge of the second and third segments; P_2 7.5 mm. long, with 16 segments, resembling P_1 but proportionately stouter; the distal edges of the third and following segments are slightly produced and finely spinous; as in P_1 the dorsal edge of the second and third segments is slightly thickened; P_3 from 12 to 13 mm. long with 22 segments, resembling P_2 but proportionately stouter; P_4 from 5.0 to 5.5 mm. long with 14 segments, similar in size to P_2 but with the distal segments very slightly shorter; P_5 6 mm. long with 15 segments, slightly stouter than P_4 and not tapering so rapidly;

distal pinnules 6.5 mm. long with about 16 segments, very slender, the segments beyond the two basal much elongated.

Notes.—The preceding description is based upon the larger specimen from *Siboga* station 96. The type specimen, from *Albatross* station 5519, is smaller and less developed. It may be described as follows.

The centrodorsal is small, low hemispherical or thin discoidal, the bare dorsal pole about 1 mm. in diameter. The cirrus sockets are arranged in three closely crowded alternating rows.

The cirri are XXII, 11–12 (usually 11), 7 mm. long. The first segment is short, the second is twice as broad as long, the third is from one third to one half again as long as broad, the fourth is about twice as long as the median diameter, and the fifth is not quite so long as the fourth. The following segments gradually decrease in length, the antepenultimate being about one third again as long as broad and the penultimate only slightly, if at all, longer than broad. The third and following segments are slightly constricted centrally, with rather prominent ends, this feature gradually dying away distally. The fourth and following segments have a slight serrate production of the distal dorsal edge, which is not sufficient to appear in lateral view as a definite process. The opposing spine is prominent, though small, terminal or subterminal, and the terminal claw is slightly longer than the penultimate segment, rather slender, moderately and evenly curved.

The distal borders of the radials are even with the edge of the centrodorsal. The IBr_1 are short, oblong, three times as broad as long, just in contact basally, the distal border rather prominently everted, and with a prominent dorsoventrally elongated tubercle occupying the outer half or two thirds of the median line. The IBr_2 (axillaries) are almost triangular, about twice as broad as long, the lateral edges about one half as long as those of the IBr_1, the anterior borders, like those of the IBr_1, strongly everted and very finely serrate, and with a very prominent dorsoventrally elongate tubercle in the proximal two thirds.

The 10 slender arms are 80 mm. long. The first brachial is slightly wedge-shaped, twice as broad as the median length, the two of each arm pair interiorly united for the basal half, the inner sides thence diverging at a right angle; the distal edge is everted, and there is a median tubercle in the distal half as on the IBr_1. The second brachial is of about the same size, but much more obliquely wedge-shaped; the distal edge is strongly everted, and there is a median tubercle in the proximal half. The first syzygial pair (composed of the third and fourth brachials) is slightly longer interiorly than exteriorly, about as broad as the median length, with the distal edge very strongly everted and the syzygial line raised into a sharp ridge. The following three brachials are slightly wedge-shaped, twice as broad as the median length, with the distal edges very strongly everted; those succeeding become very obliquely wedge-shaped, almost triangular, about as long as broad, with the distal edges strongly produced and serrate, and after the second syzygy longer than broad, and distally twice as long as broad. The production of the distal edges of the brachials becomes rather less marked after the proximal fourth of the arm, but persists to the tip.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 4.5 mm. long, slender, rather stiff, evenly tapering to a pointed tip, composed of 12 segments, of which the first is about twice as broad as long, the second and third are about as broad as long or slightly longer, and the following increase in length so that the distal are about three times as long as broad. P_2 is 6 mm. long, similar to P_1 but proportionately stouter, with about 14 segments of which the distal are rather more elongated than are those of P_1. P_3 is from 7.0 mm. to 7.5 mm. long, similar to P_2 but proportionately stouter, with 17 segments of which the outer have slightly produced distal ends. P_4 is 6.5 mm. long, about as stout basally as P_3 but more slender distally, the outer segments with more prominent distal ends. P_5 is 5 mm. long, nearly as stout basally as P_4, but more slender distally and composed of longer segments. The following pinnules are similar to P_5, gradually becoming longer and more slender. The distal pinnules are 6 mm. long.

The color in alcohol is brownish yellow with the perisome dark brown.

Localities.—Siboga; Maumeri, on the southern coast of Flores; coral reef [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 79*a;* East Borneo Bank (lat. 2°38′30″ S., long. 117°46′ E.); 54 meters; fine coral sand; June 12, 1899 [A. H. Clark, 1918] (2, U.S.N.M., E. 447; Amsterdam M.).

Siboga station 99; anchorage off North Ubian (lat. 6°07′30″ N., long. 120°26′ E.); 16–23 meters; June 28–30, 1899 [A. H. Clark, 1918] (2, Amsterdam M.).

Siboga station 96; southeastern side of the Pearl Bank, Sulu (Jolo) archipelago; 15 meters; lithothamnion; June 27, 1899 [A. H. Clark, 1912, 1918] (2, Amsterdam M.).

Albatross station 5536; between Negros and Siquijor; Apo Island (center) bearing S. 26° W., 11.8 miles distant (lat. 9°15′45″ N., long. 123°22′00″ E.); 510 meters; temperature 11.95° C.; green mud; August 19, 1909 [A. H. Clark, 1911] (1, U.S.N.M., 35670).

Albatross station 5519; in the vicinity of northern Mindanao; Point Tagolo Light bearing S. 71° W., 8.7 miles distant (lat. 8°47′00″ N., long. 123°31′15″ E.); 333 meters; temperature 12.39° C.; globigerina and sand; August 9, 1909 [A. H. Clark, 1911] (4, U.S.N.M., 27507, 35669). Type locality.

Between Cebu and Leyte, Philippines (lat. 11°07′ N., long. 124°06′ E.); 282 meters [A. H. Clark, 1929] (1, B.M.).

Geographical range.—From Flores northward to Negros and northern Mindanao, Philippines.

Bathymetrical range.—From the shore line down to 510 meters.

Thermal range.—From the temperature of the tropical reefs down to 11.95° C.

History.—This species was first secured by the *Siboga* among the Dutch East Indies and the Philippines in 1899, but was first described from specimens dredged by the *Albatross* in the Philippines in 1909.

Shortly after the publication of the original description in 1911 the *Siboga* collections were sent to me and among them I found what I considered to be a new species of this genus; it was described under the name of *T. purpurea* in 1912, but there can be little doubt that *T. purpurea* is only the fully developed form of *T. paupera.*

In 1929 I recorded a specimen from the Philippines in the British Museum collection.

Genus DOROMETRA A. H. Clark

Antedon (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 204, and following authors.

Iridometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131.

Dorometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (referred to the Antedoninae), p. 128 (type species *Antedon nana* Hartlaub, 1890; diagnosis; range; included species); No. 16, p. 506 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 214 (key to the included species).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 133.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 47; Echinoderm fauna of Australia, 1946, p. 60 (in key), p. 62 (type species; range; key to Australian species).

Diagnosis.—A genus of Antedoninae in which P_3 is much the longest and stoutest pinnule on the arm; there are rarely over XL cirri, of which the segments, not over 17 in number, have produced distal ends that overlap the proximal ends of those succeeding; the outer cirrus segments, except sometimes the distalmost, are much longer than their proximal width; the brachials have smooth, or only very finely spinous distal edges; and the arms are not known to exceed 60 mm., and are rarely 50 mm. in length.

Type species.—*Antedon nana* Hartlaub, 1890.

Geographical range.—From southern Japan and the Bonin Islands to the Tonga Islands and northern Australia and westward to the eastern coast of Africa, from Mauritius and Madagascar to Suez.

Bathymetrical range.—From the shore line down to 728 meters.

Thermal range.—From the temperature of the tropical littoral down to 16.72° C.

History.—The first known species of *Dorometra* (*parvicirra*) was described by P. H. Carpenter in 1888 under the generic name *Antedon*, the second (*nana*) was described by Hartlaub under the same generic name in 1890, and the third (*briseis*) was also described as an *Antedon* by the present writer in 1907. In 1908 Chadwick mentioned a fourth species which, however, he did not distinguish from Carpenter's *parvicirra*.

In my first revision of the comatulids (1907) the species *parvicirra*, *nana* and *briseis* were left in the genus *Antedon*; but in the second revision (1908) they were removed, together with [*Argyrometra*] *crispa*, [*Andrometra*] *psyche* and [*Annametra*] *minuta* to *Iridometra*, of which *Antedon adrestine* A. H. Clark, 1907, was the type species. Here they remained until 1917 when, in a revision of the Antedonidae, the genus *Dorometra* was proposed, with the species *nana*, *mauritiana*, *gracilis*, *briseis*, *parvicirra*, *aegyptica* and *clymene*. In 1936 the species *andromacha* A. H. Clark was added and in 1940 *gracilis* was reduced to the synonymy of *nana* by Dr. T. Gislén.

[Note by A.M.C.] As explained on p. 77, I believe that *Eumetra aphrodite* will prove to be congeneric with *Dorometra nana* rather than with *E. chamberlaini*. If that is so, then its position within the genus *Dorometra* is close to *aegyptica* and *parvicirra*.

KEY TO THE SPECIES OF DOROMETRA

[Modified by A.M.C.]

a^1. P_2 intermediate in size and in number of segments between P_1 and P_3.

b^1. Cirri not especially slender, with up to 16 segments of which the longest are not more than about twice as long as the diameter of the expanded ends; P_3 with more numerous segments than P_2.

c^1. Cirri up to 10 mm. long when the arms are 40 mm. long (Bonin and Philippine Islands to Singapore and Queensland; 0–164 meters) ---------- **parvicirra** (p. 63)

c^2. Cirri up to 13 mm. long when the arms are 40 mm. long (Suez Bay; 18 meters). **aegyptica** (p. 67)

b^2. Cirri with 11–12 excessively slender and delicate segments, the earlier ones about four times a long as the diameter of their expanded ends, the penultimate twice as long as broad; P_3 with few, if any, more segments than P_2 (Moluccas; 95 meters) ---------- **clymene** (p. 68)

a^2. P_2 Resembling P_1 in size, or smaller.

b^1. P_3 with more than 18 segments.

c^1. P_1 3.5 mm. long when the arms are up to 45 mm.; P_2 about three-quarters that length (Madagascar and Mauritius to the Maldive Islands; littoral) ---------------- mauritiana (p. 69)

c^2. P_1 10 mm. long when the arms are 40 mm.; P_2 less than half as long (Celebes). andromacha (p. 71)

b^2. P_3 with up to 16 segments.

c^1. P_3 more than twice as long as P_1 and P_2, with about twice as many segments; 10–14 (usually 10–12) cirrus segments (Philippine, Bonin, and Tonga Islands to northern Australia and westward to the Andaman and Nicobar Islands; 0–54 meters) -------------- nana (p. 71)

c^2. P_3 not more than a third again as long as P_1 and P_2, with not more than a third again as many segments; 9–17 (usually 11–14) cirrus segments (south and southwestern Japan; 108–728 meters) --- briseis (p. 75)

DOROMETRA PARVICIRRA (P. H. Carpenter)

[See vol. 1, pt. 2, fig. 789, p. 366]

Antedon parvicirra P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 204 (description; *Challenger* Sta. 208), pl. 36, figs. 7, 8.—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 352 (belongs with the *A. bifida* type), p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 34 (=*Iridometra parvicirra*).

Iridometra parvicirra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 218 (compared with *I.* [*Argyrometra*] *crispa*); vol. 39, 1911, p. 559 (*Albatross* Sta. 5355); vol. 40, 1911, p. 42 (cirri compared with those of *I. aegyptica*) Crinoids of the Indian Ocean, 1912, p. 34 (=*A. parvicirra* P. H. Carpenter, 1888), p. 231 (synonymy; localities); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 54 (comparison with *aegyptica*).

Iridometra scita A. H. CLARK, Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 232 (Philippines); Crinoids of the Indian Ocean, 1912, p. 231 (synonymy; Philippines; Billiton); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 54 (Billiton; Macclesfield Bank, 35–41 fms.).—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank).

Iridometra sp. A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 232 (Albany Passage, Queensland).

Dorometra parvicirra A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 215 (in key), p. 216 (synonymy; notes; Sta. 99), p. 272 (listed); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 18 (ambulacral deposits).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 5, p. 137 (localities; notes), p. 182 (listed); figs. 125–127, p. 134; Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 4 (Macclesfield Bank).—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 46 (Darwin); Echinoderm fauna of Australia, 1946, p. 62 (in key; references; distribution).

Diagnostic features.—P_2 is intermediate in size and in the number of its component segments between P_1 and P_3; the cirri have up to 17 segments and are not especially slender, their longest segments being not more than twice as long as the width of the expanded ends; P_1 has 10 to 15, P_2 13 or 14 or more, and P_3 17 to 19 segments. The size is large for a species of this genus, the arms being from 50 to 60 mm. in length, and the general habitus is robust.

Description of the holotype [from Carpenter, modified by A.M.C.].—The centrodorsal is flattened hemispherical, 1.9 mm. in diameter, with a few small papillae around the flat dorsal pole. There are about XL cirrus sockets. A peripheral cirrus 8 mm. long has 13 segments most of which are constricted centrally and flared at the ends, particularly the distal ends. The longest segments are two and a half times as long as their median widths and the antepenultimate segment is one and a half times as long as wide. The opposing spine is slender and prominent.

The division series are widely separated laterally.

The 10 arms are about 50 mm. long, with about 80 brachials finely spinous along their distal edges. The distal intersyzygial interval is three or four muscular articulations. The width at the first syzygy (3+4) is 1.0 mm. and the length from the proximal edge of the IBr_1 to the second syzygy (9+10) is 5.5 mm.

P_1 has up to 15 segments and is 3.5–3.8 mm. long.

P_2 is larger with 15+ segments and is over 5 mm. long.

P_3 is larger still with 18 segments and measures 8 mm. It bears an elongate gonad.

The color when freshly preserved was purplish red with frequent intervals of white on the arms. The type specimen of *Iridometra scita* was purple with darker blotches.

Notes.—By some curious mischance the relative sizes of the proximal pinnules were wrongly given in the original description of *Iridometra scita*, which was said to come nearest to *Andrometra psyche* and to have P_2 much the largest and longest pinnule on the arm.

In the type specimen of *Iridometra scita* the cirri are about XXXV, 13–15, 10 mm. long; the longest segments (the third and fourth) are twice as long as the diameter of their expanded ends; the last two before the penultimate are only slightly longer than broad.

The 10 arms are 60 mm. long.

P_1 is 3.2 mm. long with 10 or 11 segments. P_2 is 6 mm. long with 13 or 14 segments, proportionately stouter than P_1. P_3 is from 9 to 10 mm. long with from 17 to 19 segments, and is the longest and stoutest pinnule on the arm. P_4 is 4.5 mm. in length, with 13 segments. P_5 is 4.5 mm. long with 12 segments, slightly stouter than P_4 and bearing a gonad.

There can be no doubt that *Iridometra scita* and Carpenter's *Antedon parvicirra* represent the same species.

Dr. T. Gislén gave in detail the characters of two of the three specimens from the Bonin Islands studied by him; the specimens differ from the preceding only in being smaller.

The centrodorsal is hemispherical to dome shaped with the dorsal pole papillated; the cirrus sockets are arranged in two or three irregular rows.

The cirri are about XXV–XXX, 11–14, from 2.5 to 7 mm. long; the third to sixth segments, which are the longest, are from two to two and a half times as long as broad, slightly constricted centrally; the antepenultimate segment is twice as broad as long; the height of the opposing spine, which is directed obliquely forward, is from a half to two-thirds the width of the penultimate segment; the terminal claw is slender, sharp, slightly curved, and as long as the penultimate segment.

The radials are almost concealed by the centrodorsal. The IBr_1 have an anterolateral tubercular extension. The axillaries are rhombic, as long as broad, the lateral angles with slight tubercles.

The arms are from 20 to 35 mm. long. The first brachials are twice as long exteriorly as interiorly, and in contact with their neighbors interiorly. The first 10 brachials are more or less oblong, the ends of those following becoming oblique.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

The disk is smooth, without granules.

P_1 is from 2 to 2.7 mm. long with 8 or 9 segments of which the first is short, the second is as long as broad, the third is half again as long as broad, and the outer are from three to three and a half times as long as broad. P_2 is from 2.5 to 3.5 mm. long with 8 to 10 segments. P_3 is from 4 to 5.5 mm. long, with 10 to 14 segments having slightly swollen articulations. P_4 is from 2 to 2.5 mm. long, with 7 to 9 segments. P_5 is 3 mm. long with about 9 segments. P_a is from 1.5 to 2 mm. long, with 7 segments. The distal pinnules are 5 mm. long with 15 to 16 segments of which the longest are about four times as long as broad.

The color in alcohol is brown.

[Note by A.M.C.] The two specimens in the British Museum from Billiton, named *Iridometra scita* by Mr. Clark in 1913 have been re-examined. The larger had arms exceeding 60 mm. in length, the breadth at the first syzygy is 1.5 mm. The longest cirri are 13 mm. long with 17 segments which are hardly at all constricted in the middle; the longest segments are about twice as long as their median widths. P_1 has 16 or 17 segments and measures 6.5 mm. P_2 with 17 or 18 segments measures 8 or 9 mm. P_3 with 23 segments measures 14 mm. The smaller specimen has the arms 60 mm. long and the breadth at the first syzygy is 1.1 mm. The longest cirri are 11 mm. with 15 segments which are moderately constricted in the middle, this effect being heightened by a band of darker color in the middle of each segment. P_1 has 12 or 13 segments and measures 3.5 to 4.5 mm. P_2 with 14 or 15 segments measures 5 mm. P_3 with 20 segments measures 9 to 10 mm.

The larger of these two approaches *Toxometra* in the small degree of flaring of the distal ends of the cirrus segments. However, the brachials are quite smooth unlike those of *T. paupera*, also known from the East Indies. The length of the cirri in the larger specimen is equal to that in the type of *D. aegyptica* where the arm length is only 40 mm. There appears to be little else besides the proportion of the cirrus to arm length to distinguish between *parvicirra* and *aegyptica*.

Localities.—Dr. Sixten Bock's station 47; Bonin Islands, east of the Channel; 146 meters; August 1, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 53; Bonin Islands, 2 miles east of Higashijima; 164 meters; sand and broken shells; August 7, 1914 [Gislén, 1922].

Macclesfield Bank, between Luzon and Annam; 64–75 meters [A. H. Clark, 1912, 1913] (1, B.M.).

Philippine Islands [A. H. Clark, 1908, 1912] (1, U.S.N.M., 25451).

Challenger station 208; east of Panay, Philippines (lat. 11°37′ N., long. 123°31′ E.); 33 meters; blue mud; January 17, 1875 [P. H. Carpenter, 1888] (1, B.M.). Type locality.

Albatross station 5355; North Balabac Strait; Balabac Light bearing S. 61° W., 16.6 miles distant (lat. 8°08′10″N., long. 117°19′15″ E.); 80 meters; coral and sand; January 5, 1909 [A. H. Clark, 1911] (1, U.S.N.M., 35689).

Siboga station 99; anchorage off North Ubian (lat. 6°07′30″ N., long. 120°26′ E.); 16–23 meters; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Singapore (9, U.S.N.M., E. 3202; C.M.).

Billiton, between Borneo and Sumatra [A. H. Clark, 1912, 1913] (2, B.M.).

Albany Passage, Queensland [A. H. Clark, 1912] (1, Australian M.).

Danish Expedition to the Kei Islands; station 14; 40 meters; April 10, 1922 (4, C.M.; 2, U.S.N.M., E. 3164).

Danish Expedition to the Kei Islands; station 18; 40 meters; April 12, 1922 (10, C.M.; 9, U.S.N.M., E. 3194).

Danish Expedition to the Kei Islands; station 20; 50 meters; April 14, 1922 (3, C.M.).

Danish Expedition to the Kei Islands; station 26; 90 meters; April 16, 1922 (1, C.M.).

Danish Expedition to the Kei Islands; station 31; 50 meters; April 18, 1922 (3, C.M.).

Danish Expedition to the Kei Islands; station 36; 35 meters; April 23, 1922 (6, C.M.).

Danish Expedition to the Kei Islands; station 38; 35 meters; April 24, 1922 (5, C.M.; 4, U.S.N.M., E. 3141).

Danish Expedition to the Kei Islands; station 54; 85 meters; May 9, 1922 (1, C.M.).

Dr. Th. Mortensen's Pacific Expedition; Jolo, Philippines; 27 and 36–55 meters; March 19 and 21, 1914 (1, C.M.). [Note by A.M.C.]: This record and those of the Kei Islands Expedition were obtained from the typescript of an unpublished report by Mr. Clark, for the loan of which I am indebted to Dr. F. Jensenius Madsen. Most of the 51 specimens are lodged in the Zoological Museum, Copenhagen (C.M.).

Queensland; Eagle Island, Great Barrier Reef, north of Cooktown; T. T. Flynn [H. L. Clark, 1938].

Northern Territory, Australia; Darwin, near Shell Islands; 5–11 meters; H. L. Clark, July 1929 [H. L. Clark, 1938].

Darwin, near Leper Station; 5–9 meters; bottom, coralline algae, broken coral, sponges and alcyonarians; H. L. Clark, May 25, 1932 [H. L. Clark, 1938].

Geographical range.—From the Bonin, Philippine, and Kei Islands southwards to northern Australia and Queensland.

Bathymetrical range.—From the shore line down to 164 meters.

History.—*Dorometra parvicirra* was first discovered in the Philippines by the *Challenger* in 1875 and first described by P. H. Carpenter in 1888. It was again recorded from the Philippines, from examples dredged by the *Albatross* in 1907 and 1909, by the present author in 1908 and 1911. In 1912 a specimen given as *Iridometra* sp. was recorded from the Albany Passage, Queensland, which since has proved to be this form. In 1913 examples from the Macclesfield Bank and from the Island of Billiton in the collection of the British Museum were listed, in 1918 an individual which had been taken in the Philippines by the *Siboga* in 1899 was mentioned, and in 1922 Gislén recorded this form from among the collections made by Dr. Sixten Bock in the Bonin Islands.

The first *Albatross* specimen from the Philippines was not recognized as belonging to this species, but was described (1908) as a new type under the name of *Iridometra scita;* and furthermore, by some curious accident, the relationships of its lower pinnules were wrongly given in the diagnosis. The specimens in the British Museum from Billiton and the Macclesfield Bank were also (1913) recorded under this name. The error came to light during the revision of the species of this genus in the preparation of the *Siboga* report (1918) in which it was corrected and the pinnulation of the type specimen of *scita* was redescribed.

In 1938, Dr. H. L. Clark recorded the species from Darwin in northern Australia as well as from the Great Barrier Reef. He gave some notes on the color in life, which is apparently very variable, from "a handsome light brown and white" to "fine black, white and cream-color" with finely variegated arms, or "dull blackish with not very evident yellowish markings on pinnules and arms."

DOROMETRA AEGYPTICA (A. H. Clark)

Antedon parvicirra (not of P. H. Carpenter, 1888) CHADWICK, Journ. Linn. Soc. (Zool.), vol. 31, 1908, p. 45 (Suez Bay, 10 fms.).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 5 (=*Iridometra* [*Dorometra*] *aegyptica*).

Iridometra parvicirra A. H. CLARK, Amer. Nat., vol. 43, 1909, p. 255 (discussion of Chadwick's specimen).

Iridometra aegyptica A. H. CLARK, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 5 (=*Antedon parvicirra* Chadwick), p. 9 (northeastern coast of Africa), p. 42 (synonymy; description; localities); Crinoids of the Indian Ocean, 1912, p. 41 (=*A. parvicirra* of Chadwick), p. 231 (synonymy; localities); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 53 (description; comparisons).

Iridiometra aegyptica A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 53 (typographical error).

Dorometra aegyptica A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 215 (in key; range), p. 217 (references); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 102 (range), p. 104 (listed).

Diagnostic features.—P_2 is intermediate in size and in the number of its component segments between P_1 and P_3; the cirri are not especially slender, the longest segments being not more than about twice as long as the diameter of the expanded ends; they are very much larger than the cirri of *D. parvicirra*, from 10 to 13 mm. long when the arm length is 40 mm., comparatively stout with usually 15 or 16 segments; and P_1 has 8, P_2 12, and P_3 18 to 20 segments.

This is the only species of the genus at present known from the Red Sea area.

Description.—The cirri are XXV, 14–16 (usually 15–16), from 10 to 13 mm. long, and comparatively stout. The first segment is short, the second is about as long as broad, and the fourth or fifth is the longest, about two and a half times as long as the median diameter. The following segments slowly decrease in length, so that the antepenultimate is about one third again as long as broad. The opposing spine is prominent, terminal, and directed obliquely forward. The longer proximal segments are constricted centrally, with enlarged distal ends, and the cirri as a whole are rather strongly compressed laterally.

The 10 arms, which were probably about 40 mm. long, resemble those of *D. nana.*

P_1 is short, evenly tapering from the base to the tip, about 5 mm. long and composed of 8 segments which become twice as long as broad distally. P_2 is considerably larger and much longer, but evenly tapering and becoming very slender distally, 9.5 mm. long with 12 segments which become much elongated in the outer portion. P_3 is larger than P_2, much the longest and largest pinnule on the arm, but becoming very slender distally, 13 mm. long with 18 to 20 segments of which the distal are much elongated, three times as long as broad; the ends of the segments are slightly swollen, but there are no spinous projecting borders. P_4 is small and weak, from 4.5 mm. to 5 mm. long, its outer segments much elongated and with somewhat swollen ends. P_5 is slightly longer. The following pinnules are similar, becoming more slender and increasing in length distally.

Locality.—Suez Bay; 18 meters; mud; Cyril Crossland [Chadwick, 1908; A. H. Clark, 1911, 1912, 1913] (1, B.M.; could not be found, 1958).

History.—This species was found by Mr. Cyril Crossland in the course of his collecting in the Red Sea and was recorded under the name of *Antedon parvicirra* by Chadwick in 1908. In a review, published in 1909, of Mr. Chadwick's paper, I called attention to the relatively large number of cirrus segments in the specimen as described by him and suggested that it might find its place rather with the *nana* group of species than with *parvicirra*, a supposition which subsequently proved erroneous.

Only a single individual was discovered which I examined in the British Museum in 1910. It seemed so different from any of the related species that I described it as a new form under the name of *Iridometra aegyptica* in 1911 (redescribing it in 1913), which name in 1917 was changed to *Dorometra aegyptica*.

DOROMETRA CLYMENE A. H. Clark

Figure 3, *a–c*

Dorometra clymene A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 215 (in key; range), p. 217 (description; Sta. 167), p. 273 (listed).

Diagnostic features.—P_2 is intermediate in length between P_1 and P_3, all three of these pinnules having 8 or 9 segments, and the cirri are excessively slender and delicate, the longer segments being about four times as long as the width of the expanded ends.

Description [modified by A.M.C.].—The centrodorsal is obscured from view by the cirri which appear to have a tendency towards arrangement in vertical columns each of about two cirri. As the arms are curled up dorsally a lateral view of the centrodorsal is difficult. The cirri are long and slender, those nearer the apex being very much more slender than the peripheral ones which have up to 12 segments and may be 9 mm. long. The second segment is already over twice as long as its median (minimum) breadth and the next three or four segments are five to six times their median widths. The distal segments shorten relatively but the penultimate is still twice as long as broad; it has no opposing spine. The terminal claw is long, very slender and slightly curved.

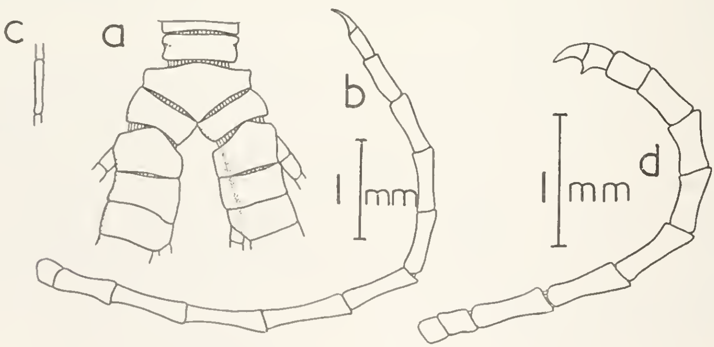


FIGURE 3.—*Dorometra clymene* A. H. Clark, holotype: *a*, Proximal part of postradial series; *b*, cirrus of second row from periphery; *c*, segment of apical cirrus. *d*, *Dorometra nana* (Hartlaub) from *Siboga* station 250, peripheral cirrus.

The adjacent division series are separated by the projecting radials. The IBr_1 are rectangular and a little broadened at the articulations. The short axillaries are much wider, with short straight sides, a very obtuse distal angle, and a barely perceptible proximal angle hardly indenting the distal edge of the IBr_1. Similarly the first brachials are not much incised by the small proximal angle of the second ones. The second to fourth brachials have a distinct lateral flange on their inner sides as far as the base of P_a.

The 10 arms are about 40 mm. long. The width at the first syzygy is 0.7 mm. and the length from the beginning of the division series to the second syzygy at 9+10 is 5.5 mm.

P_1 is 2 mm. long, with 8 segments; P_2 is 3.5 mm. long, with 8 or 9 segments; P_3 is 4.5 mm. long with 9 segments; P_4 is shorter and smaller than P_3. The pinnule segments are mostly very long and slightly expanded at the joints.

Locality.—Siboga station 167; Ceram Sea (lat. 2°35′30″ S., long. 131°26.2′ E.); 95 meters; August 22, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

DOROMETRA MAURITIANA (A. H. Clark)

Species of the *I. nana* group A. H. Clark, Amer. Nat., vol. 43, 1909, p. 255 (Mauritius).

Iridometra mauritiana A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 8 (southeastern coast of Africa), p. 40 (description; Mauritius; Madagascar; differential characters); Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 257 (Madagascar); Proc. U.S. Nat. Mus., vol. 43, 1912, p. 382 (cotypes from Mauritius in U.S.N.M.), p. 384 (original reference), p. 405 (Fouquet I., Mauritius; compared with *I. nana*); Crinoids of the Indian Ocean, 1912, p. 230 (synonymy; Mauritius and Madagascar; littoral).—Hartmeyer, Mitt. Zool. Mus. Berlin, vol. 8, No. 2, 1916, p. 236 (catalogue numbers of the original specimens).

Iridometra nana (not of Hartlaub, 1890) A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 54 (Male, Maldives).

Dorometra mauritiana A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 215 (in key; range), p. 216 (references); John Murray Exped., 1933–34, Sci. Reports, vol. 4, No. 4, 1937, pp. 102, 104.

Diagnostic features.—P_2 is slightly smaller than P_1, which is about half as long as P_3, the last having 18 to 20 segments; and the cirrus segments are relatively short, the longest being about two and a half times as long as broad and the antepenultimate and penultimate not more than a third again as long as broad.

This is the only species of the genus known from the central and southwest Indian Ocean.

Description.—The centrodorsal is low hemispherical, the slightly concave dorsal pole 1 mm. in diameter. The cirrus sockets are arranged in approximately four closely crowded alternating rows, the most proximal with about four cirrus sockets to each radial area.

The cirri are XXX–XLV, 10–13 (usually 11–12), from 9 to 11 mm. in length. The first segment is short, the second is not quite so long as broad, the third is twice as long as broad, the fourth is about two and a half times as long as the proximal diameter, and the following gradually decrease in length so that the penultimate is less than one third again as long as broad; the opposing spine is prominent, though small, sharp, subterminal, and more or less erect; the terminal claw is slightly longer than the penultimate segment, rather stout and rather strongly curved. The elongated lower segments are slightly constricted centrally, and the cirri are rather strongly flattened laterally in the distal half.

The distal borders of the radials are even with the edge of the centrodorsal. The IBr_1 are exceedingly short and bandlike. The IBr_2 (axillaries) are triangular, twice as broad as long, with the anterior angle sharp, the middle of the posterior margin somewhat produced proximally, and the lateral angles extending considerably beyond the anterolateral angles of the IBr_1.

The 10 arms are from 30 mm. to 45 mm. long. The first brachial is very short, somewhat shorter interiorly than exteriorly, the two of each arm pair united basally. The second brachial is much larger, irregularly quadrate. The third and fourth brachials together form a syzygial pair somewhat longer interiorly than exteriorly and about twice as broad as the interior length. The following four brachials are approximately oblong, about three times as broad as long, those succeeding soon becoming triangular, about as long as broad, and in the outer part of the arm wedge-shaped and longer than broad.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is small and slender, but somewhat stiffened, tapering evenly and rather rapidly, 3.5 mm. long, with 12 segments, most of which are considerably elongated. P_2 is similar, but somewhat smaller and more slender, 2.7 mm. long, with 11 segments. P_3 is from 6 to 7 mm. long, with 18 to 20 segments, slender and almost flagellate. P_4 is 4 mm. long, with 13 segments which are shorter than those of P_3. The following pinnules slowly increase in length, the distal pinnules being from 6 to 7 mm. in length and exceedingly slender.

Notes [by A.M.C.].—In checking the identity of the British Museum's specimens of *Dorometra* I found that those from the Maldives named *D. nana* by Mr. A. H. Clark in 1913 have P_3 much larger and with more numerous segments than any specimens of *nana* described.

The largest Maldive specimen has the arm length just over 60 mm. P_1 and P_2 have 10 or 11 segments and measure between 3.5 and 4.5 mm., P_1 being slightly the longer, while P_3 has 21 to 25 segments and measures 9 or 10 mm. Two other specimens with arm length, respectively, about 50 and 45 mm. have P_3 with 23+ segments, 10 mm. long, and 21 segments, 9 mm. long. In *D. nana* the segments of P_3 have not been recorded as exceeding 16 in number, although specimens with arm length up to 60 mm. have been described. The types of *mauritiana*, with arm length up to 45 mm., have P_3 with 18 to 20 segments. The proportions of the cirrus segments appear to be similar in both species, but the characters of P_3 alone serve to ally these Maldive specimens with the species from Mauritius.

Localities.—Mauritius; on the reef near Port Louis; Capt. Nicholas Pike [A. H. Clark, 1911].

Mauritius; Fouquet Island reef; Prof. K. Möbius [A. H. Clark, 1911, 1912; Hartmeyer, 1916] (34, U.S.N.M., 35693; Berl. M., 6376 [type], 6377). Type locality.

Madagascar; Grandidier, 1905 [A. H. Clark, 1911, 1912] (1, P.M.).

Hulule, Male, Maldives; S. Gardiner [A. H. Clark, 1913] (5, B.M.).

History.—For some time before I was able to examine any specimens I had been aware of the occurrence of some species of this genus at Mauritius, and indeed in reviewing Mr. Chadwick's paper upon Mr. Crossland's Red Sea collection I mentioned that a species related to *D. nana* was found there.

While at the Museum of Comparative Zoology at Cambridge, Massachusetts in, the summer of 1908, Mr. Samuel Henshaw most kindly permitted me to look over the letters sent to Prof. Louis Agassiz by Capt. Nicholas Pike at the time when he was United States consul at Mauritius. In one of these letters Captain Pike in his usual charming style described a little crinoid which he found on the reef near Port Louis about the year 1867, but which broke all to pieces so that he was unable to preserve it. However he made a color sketch of it and this I was able to recognize as representing a species near *D. nana*.

In a review of Chadwick's paper on Mr. Cyril Crossland's Red Sea crinoids published in 1909, I mentioned the occurrence of a species of the *D. nana* group at Mauritius, and when Professor Möbius' collection of crinoids from that island was sent me through the kindness of the Berlin Museum I found in it a number of specimens of this species; these served as the basis of my description of *Iridometra mauritiana* published in 1911. With these specimens from Mauritius I recorded another from Madagascar which had been collected by M. Grandidier in 1905 and which I had found in the Paris Museum; this was again mentioned in the following year.

In my account of the crinoids of the Berlin Museum published in 1912 Professor Möbius' specimens were again mentioned, and a comparison was given between this species and *D. nana*.

In 1917 this species was removed from the genus *Iridometra* and placed in *Dorometra*.

DOROMETRA ANDROMACHA A. H. Clark

Dorometra andromacha A. H. Clark, Temminckia, vol. 1, 1936, p. 295 (listed), pp. 316–317 (description; locality—Celebes).

Diagnosis.—The third to fifth cirrus segments are the longest, being about three times as long as their median width. P_1 is 10 mm. long with 13 segments; P_2 is 3.5 mm. long, with 10 segments and P_3 has 20 segments. [Note by A.M.C.] The length of the first pinnule is surprising and comment would be expected if it really is 10 mm. long.

Description.—The cirri are about XL, 12–14, 10 mm. long. The longest segments, the third to fifth, are about three times as long as the median width, with the distal ends moderately flaring. The antepenultimate segment is about one third again as long as broad.

The arms are about 40 mm. long.

P_1 is 10 mm. long with 13 segments. P_2 is 3.5 mm. long with 10 segments. P_3 has 20 segments.

The color in alcohol is black.

Locality. *Willebrord Snellius;* Lembeh Strait, Celebes; September 25, 1930 [A. H. Clark, 1936] (1 broken specimen, Leyden M.).

DOROMETRA NANA (Hartlaub)

Figure 3,*d*

[See also vol. 1, pt. 2, figs. 574–575 (p. 298), 751 (p. 349)]

Antedon nana Hartlaub, Nachr. Ges. Göttingen, May 1890, pp. 168, 170 (description; Amboina; Tonga Is.); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 89 (more detailed description and comparisons), pl. 5, figs. 57, 58; Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 143 (range).—

A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 84 (compared with *A. briseis*); Smithsonian Misc. Coll., vol. 50, 1907, pt. 3, p. 337 (representative of a small group characteristic of the East Indian region), p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. Clark, Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 241 (relation to *A. psyche*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (of Hartlaub, 1890, 1891 = *Iridometra nana*); Crinoids of the Indian Ocean, 1912, p. 37 (same).

Antedon macropygus (Lütken, MS.) Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 89 (name identified).—A. H. Clark, Vid. Medd. Nat. Foren. København, 1909, p. 117 (same).

Iridometra nana A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); vol. 22, 1909, p. 87 (record of a specimen swimming about a submerged electric light); Vid. Medd. Nat. Foren. København, 1909, p. 192 (Nicobar Is.; Singapore); Proc. U.S. Nat. Mus., vol. 36, 1909, p. 362 (resemblance to *Comatilia iridometriformis*); vol. 40, 1911, p. 41 (compared with *I. mauritiana*); vol. 43, 1912, p. 405 (compared with *I. mauritiana*); Notes Leyden Mus., vol. 34, 1912, p. 138 (compared with *I. gracilis*); Crinoids of the Indian Ocean, 1912, p. 25 (range of this and related types), p. 37 (= *A. nana* Hartlaub, 1890), p. 231 (synonymy; Andaman Is.; Male, Maldives); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (= *A. nana* Hartlaub, 1890, 1891), p. 32 (Tonga Is.); vol. 61, No. 15, 1913, p. 53 (arms compared with those of *I. aegyptica*); (non *I. nana*, p. 54 = *D. mauritiana*, A.M.C.).—H. L. Clark, Carnegie Inst. Washington, Publ. 212, 1915, p. 106 (Maër; notes).

Iridometra gracilis A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 138 (description; *Siboga* Sta. 220).

Ten-armed specimens, H. L. Clark, Carnegie Inst. Washington, Publ. 212, 1915, p. 110 (mechanism of swimming).

Dorometra nana A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 215 (in key; range), p. 216 (synonymy; Stas. 144, 250), pp. 273, 274 (listed); Smithsonian Misc. Coll., vol. 72, 1921, No. 7, p. 24 (swimming).—H. L. Clark, The echinoderm fauna of Torres Strait, 1921, p. 25 (Mer; notes).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 5, p. 133 (locality; notes), p. 182 (listed); figs. 123, 124, p. 134; Ark. Zool., vol. 19A, No. 32, 1928, p. 10 (notes); Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, p. 5.—A. H. Clark, Temminckia, vol. 1, 1936, p. 317 (Kera, near Timor and Beo, Talaud Islands); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 102 (range), p. 103.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 18, No. 10, 1940, p. 15 (Marshall Is.; *gracilis* a synonym), pl. 2, figs. 9–11.—H. L. Clark, Echinoderm fauna of Australia, 1946, p. 62 (in key; references; distribution).

Dorometra gracilis A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 215 (in key; range; references; description; Sta. 220), p. 274.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 18, No. 10, 1940, p. 15 (a synonym of *D. nana*).

Diagnostic features.—P_1 and P_2 are similar, with usually 8 to 10 segments, only half as long as P_3, which has 13 to 16 segments; the cirri have 10 to 14 (usually 10 to 12) segments of which the longest, the fourth to seventh, are from two to three times as long as broad with much expanded ends, and the antepenultimate is half as long again as broad. The arms are from 25 to 60 mm. (usually between 30 and 45 mm.) and the cirri are from 4 to 9 mm. in length.

Description.—The centrodorsal is moderately large, low hemispherical to almost discoidal, with the cirrus sockets arranged in three irregular rows. The dorsal pole is flat, 0.5 mm. in diameter.

The cirri are XXX–LI, 10–14 (usually 10–12), from 4 to 9 mm. (usually from 6 to 8 mm.) in length, and very delicate. The first segment is short, the second is about as long as broad, the third is from half again to twice as long as broad, and the fourth to seventh, which are the longest, are from two to three times as long as broad; the following segments become shorter, so that the antepenultimate is half again as long as broad, and the penultimate is a third again as long as broad. The last bears a sharp opposing spine which rises to a height of half the width of the segment. The terminal claw is curved, and somewhat longer than the penultimate segment.

The radials and more or less, sometimes nearly all, of the IBr_1 are concealed by the centrodorsal. The IBr_2 (axillaries) are rhombic, entirely free laterally, a third again as broad as long, rising on their posterior border to a slight synarthrial tubercle.

The 10 arms are from 25 to 60 mm. (usually between 30 and 45 mm.) in length, with a smooth dorsal profile. The first brachials are very short and not at all, or only just, in contact with the ones on the adjacent arms interiorly. The second brachials are considerably larger, irregularly quadrate in form, rising on the proximal border to a small posteriorly directed synarthrial tubercle. The distance between the inner edges of the second brachials of each arm pair equals half the width of the arms. The first syzygial pairs (composed of the third and fourth brachials) and the following five brachials are approximately oblong. The succeeding brachials are almost triangular, usually not much longer than broad, and on the longer side slightly overlap the bases of those following. The outer brachials become more wedge-shaped and then oblong and finally elongated. The syzygial pairs are long.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 and P_2 are similar, very short, from 2.5 mm. to 3.0 mm. long, composed of 8–11 (usually 8 or 9) segments of which the first two are usually about as long as broad and the remainder are much elongated. These two pinnules are usually of the same length, but P_2 may be slightly shorter than P_1. P_a is similar, but usually slightly smaller. P_b is commonly similar to P_a, but may be slightly longer. P_3 and P_c are much longer and stouter than the preceding pinnules, from 5 to 7 mm. in length, composed of 13 to 16 segments and bearing a well developed gonad. P_4 is much shorter than P_3, about 3.7 mm. in length with 12 segments. The distal pinnules are from 5 mm. to almost 7 mm. in length, with 15 to 17 segments. The proximal pinnules are almost smooth.

The disk is pentagonal, 5 mm. in diameter, without visible calcareous concretions. Sacculi are present on the disk, arms and pinnules, crowded on the last mentioned.

The color in life is recorded as light brown, or purplish black with light brown cirri.

The color in alcohol is given as (*a*) white, banded across the base of each brachial and pinnular with dark purple, the cirri faintly pinkish with a narrow band of light purple at the base of each segment; (*b*) nearly white, the articulations of the brachials, pinnulars and cirrals banded with dark brown; (*c*) white, with crowded small spots of violet brown, the soft parts olive brown; similar, with smaller spots so that the individual appears lighter; (*d*) whitish, with broad transverse bands on the brachials and white cirri; (*e*) violet, the cirri white becoming purple distally; (*f*) dark brown with the brachial articulations whitish and an obscure longitudinal stripe on the dorsal surface of the arms; (*g*) uniform dingy grayish brown.

Localities.—Investigator; Andaman Islands; surf line [A. H. Clark, 1912] (1, I.M.).

Nicobar Islands [A. H. Clark, 1909, 1912] (1, C.M.).

Singapore [A. H. Clark, 1909, 1912] (7, C.M.).

Siboga station 144; anchorage north of Salomakiëe (Damar) Island, Anambas archipelago; 45 meters; coral bottom and lithothamnion; August 7–9, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Albatross; Jolo anchorage, Jolo, Philippines; surface; night of February 13, 1908 [A. H. Clark, 1909, 1912] (1, U.S.N.M., 36219).

Dr. Sixten Bock's station 41; Bonin Islands; Taki Ura; coral bottom; diver; July 28, 1914 [Gislén, 1922].

Siboga station 250; anchorage off Kilsuin, western coast of Kur Island; 20–45 meters; coral and lithothamnion; December 6–7, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Amboina [Hartlaub, 1890, 1891; A. H. Clark, 1912] (3, Göttingen M.).

Mer Island, Torres Strait; southwestern reef; October 10 and 27, 1913 [H. L. Clark, 1915, 1921].

Tonga Islands [Hartlaub, 1890, 1891; A. H. Clark, 1912] (1, H.M.).

Siboga station 220; anchorage off Pasir Pandjang, western coast of Binongka; 54 meters; November 1–3, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.).

Danish Expedition to the Kei Islands; Sebesi, Sunda Strait; under stones in shallow water; July 31, 1922 [MS. record] (1, ? C.M.).

Danish Expedition to the Kei Islands; Banda; c. 10 meters; sand; June 15, 1922 (number not given).

Marshall Islands, Ebon, N.W. lagoon strand; September 21, 1917 [Gislén, 1940].

Marshall Islands, Jaluit, W. of S.E. entrance; October 1917 [Gislén, 1940].

Marshall Islands, Jaluit, S.W. of S.E. entrance; November 1–2, 1917 [Gislén, 1940].

Willebrord Snellius; Kera, near Timor; November 11–13, 1929 [A. H. Clark, 1936] (3, Leyden M.).

Willebrord Snellius; Beo, Talaud Islands; 6–10 meters; June 14–21, 1930 (3, Leyden M.).

Geographical range.—From the Andaman and Nicobar Islands to the Philippine, Bonin, Marshall, and Tonga Islands, and Torres Strait.

Bathymetrical range.—From the shore line down to 54 meters.

Type locality.—The types (apparently syntypes) of this species were three specimens from Amboina in the Göttingen Museum and one from the Tonga Islands in the Hamburg Museum. If the type locality is to be restricted, then Amboina is to be preferred, provided the specimens are still in existence, especially as it is the more central in the geographical range of the species as known at present.

History.—About 20 years before this species was described a specimen of it had been received by the Godeffroy Museum at Hamburg where it had received the manuscript name of *Antedon macropygus* from Professor Lütken.

While determining the collection of comatulids obtained by Dr. J. Brock at Amboina in 1884–85, Hartlaub found this form which he recognized as representing a new type, describing it in his preliminary report (1890) under the very appropriate name of *Antedon nana.* In the Hamburg Museum he found another specimen of this species from the Tonga Islands bearing Lütken's name *macropygus.* This locality he mentioned in the preliminary report, giving the data regarding the origin of the example—it had formed part of the Godeffroy Museum collection—in his final memoir (1891).

For 19 years nothing further was published regarding this interesting form until in 1909 the present author recorded it from Singapore where it had been collected in 1906 and 1907 by Mr. Svend Gad, the Danish Consul at that port, and from the Nicobar Islands where it had been found by the *Galathea* expedition; and in another paper from Jolo in the Philippines.

In 1910 I examined the specimen from Tonga in the Hamburg Museum, and later (1912) published a confirmation of Hartlaub's identification of it. In 1912 also *nana* was recorded from the Andamans where it had been found by the *Investigator*.

In 1915 Dr. H. L. Clark recorded it from Mer Island in Torres Straits and described its swimming movements, publishing additional notes upon it in 1921.

In 1918 it was recorded from two new localities where it had been found by the *Siboga*, and in 1922 Dr. Torsten Gislén recorded it from the Bonin Islands and gave copious notes regarding the structure of the specimens.

Antedon nana was removed to *Iridometra* at the time of the creation of that genus in 1908, and was made the type of the genus *Dorometra* in 1917.

In 1940 Dr. T. Gislén decided that *Dorometra gracilis* A. H. Clark, of which only a single specimen was known, came within the range of variation of *D. nana*. [Note by A.M.C.] In the absence of any directive from Mr. Clark on this point, I have followed Gislén in regarding *gracilis* as a synonym.

Remarks.—Dr. H. L. Clark (1915) stated that this is a very active species, in contrast to most of the other comatulids which he collected at Mer. The account quoted from him of the swimming of 10-armed specimens (part 2, p. 603) refers to this species, though he gave no indication of this in his original paper.

While the *Albatross* was anchored off Sulu a young individual of this species about half the adult size was captured at the surface while swimming about a submerged electric light. It was said to have been swimming entirely by means of its cirri, with the arms widely extended.

This is probably a common species throughout the Indo-Malayan region; the infrequency of the records may result from its being very generally overlooked because of its small size.

DOROMETRA BRISEIS (A. H. Clark)

Antedon briseis A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 83 (*Albatross* Sta. 4876; description), p. 84 (compared with *A.* [*Dorometra*] *nana*); Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 341 (comparison with *A. minuta*) p. 353 (listed); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 241 (relation to *A. psyche*).—Sowerby, The Naturalist in Manchuria, Tientsin, vol. 5, 1930, p. 79.

Iridometra briseis A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (Japan); Crinoids of the Indian Ocean, 1912, p. 231 (synonymy; southern Japan, 59 fms.); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese species; bathymetrical and thermal ranges and their significance).

Dorometra briseis A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (listed); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 215 (in key; range), p. 216 (references).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 5 (listed; depth; Sagami Bay), p. 135 (localities; notes), p. 181 (listed), figs. 120–122, p. 134.

Diagnostic features.—P_3 is much less than twice as long as P_1 and P_2, and P_2 is slightly shorter than P_1; the cirri have usually 11 to 14 segments of which the longest, the third to fifth, are from three to three and a half times as long as broad with much expanded ends. The arms are from 20 to 45 mm. and the cirri are from 7 to 11 mm. (usually about 8 mm.) in length.

Description.—The centrodorsal is discoidal or low hemispherical, the dorsal pole papillose; the cirrus sockets are arranged in two or three irregular marginal rows.

The cirri are XX–XLVII, 9–17 (usually 11–14), the longest from 7 to 11 mm. (usually about 8 mm.) in length. The first segment is about as long as broad, the second is twice as long as broad, and the third to fifth, which are the longest, are from three to three and a half times as long as broad. The segments are somewhat constricted centrally and the ends, especially the distal, are enlarged.

The radials are just visible beyond the edge of the centrodorsal, or concealed except in the interradial angles. The IBr_1 are very short, from four to six times as broad as long, more or less concealed in the median line by the posterior process from the axillary, laterally free, and with a small lateral tubercle on either side. The IBr_2 (axillaries) are rhombic, from as long as broad to one third broader than long, with all the sides, especially the two anterior, concave, and a strong posterior process which incises the IBr_1 and rises to a prominent synarthrial tubercle with it.

The 10 arms are from 20 to 45 mm. in length. The first brachials have a short inner and a long outer side and are deeply incised by the posterior projection of the second brachials, which are irregularly quadrate in shape, with the two proximal sides very concave, and rise to a prominent synarthrial tubercle with the first. The first syzygial pair (composed of the third and fourth brachials) is about as long as broad. The following brachials are roughly oblong, at first broader than long, but becoming wedge-shaped and longer than broad after the tenth and elongate distally.

Syzygies occur between brachials 3+4, 9+10, 14+15 (exceptionally 16+17) and distally at intervals of 3 (exceptionally 4) muscular articulations.

The disk is 5 mm. in diameter.

P_1 is from 2.2 to 3.5 mm. long with 7 to 10 segments, of which the first two are about as long as broad and the remainder are much elongated. P_2 is similar to P_1 and is composed of the same number of segments, but it is slightly shorter. P_3 is from 2.9 to 5 mm. long with 9 to 13 segments. P_4 is 4.5 mm. long (in the largest specimen recorded) with 10 segments, and bears a gonad. The distal pinnules are from 4 to 6.5 mm. long, very slender, composed of 15 to 18 segments, all but the first two of which are greatly elongated.

The color in life is light yellowish brown with broad bands of darker yellow brown on the arms; or yellowish white with large transverse brownish red blotches.

Notes.—The preceding description is based upon all the known specimens of this species.

In the type specimen the cirri are about XX, 12–14, 8 mm. long; the arms are 23 mm. long; P_1 is 2.5 mm. long, with 7 segments; P_2 is similar, but very slightly shorter; P_3 is 2.9 mm. long, with 9 segments.

Localities.—*Albatross* station 4876; in the eastern channel of the Korean Straits, near the Oki Islands; Oki Shima bearing S. 29° W., 5.3 miles distant (lat. 34°20′ N., long. 130°10′ E.); 108 meters; temperature 16.72° C.; fine gray sand and broken shells; August 2, 1906 [A. H. Clark, 1907, 1918] (1, U.S.N.M., 22658). Type locality.

Dr. Sixten Bock's station 35; Sagami Bay, off Okinose; 728 meters; June 28, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 37; off Okinose; 728 meters; July 8, 1914 [Gislén, 1922].

Geographical range.—Southern Japan, from the Korean Straits to Sagami Bay.

Bathymetrical range.—From 108 to 728 meters.

Thermal range.—One record, 16.72° C.

History.—This species was described in 1907 from a single specimen dredged by the *Albatross* in 1906 in the Korean Straits. It was again found in Sagami Bay by Dr. Sixten Bock in 1914, his specimens being discussed by Dr. T. Gislén in 1922.

Genus EUMETRA A. H. Clark

Eumetra A. H. Clark, Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 230 (type species *E. chamberlaini*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 177 (referred to the Thysanometrinae); Crinoids of the Indian Ocean, 1912, p. 10 (absent from Japan; reason), p. 26 (range), p. 62 (in key), p. 242 (original reference; type); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Antedoninae); No. 16, p. 506 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 213 (key to the included species).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 231.

Iridometra (*Eumetra*) A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 137.

Diagnosis.—A genus of Antedoninae in which P_3 is much the longest and stoutest pinnule on the arm; there are rarely less than XL cirri of which the component segments, 16 to 33 in number, have produced distal ends overlapping the proximal ends of those succeeding; the outer cirrus segments are much longer than their proximal breadth; and the brachials have smooth or only very finely spinous distal ends. The arms are at least 75 mm. in length.

Type species.—*Eumetra chamberlaini* A. H. Clark, 1908.

Geographical range.—From the Lesser Sunda Islands to the Philippines and southern Japan.

Bathymetrical range.—From 69 to 146 meters.

Remarks [by A.M.C.].—I am doubtful about the inclusion of the species *aphrodite* in this genus. The differences between the description of it and those of the species of *Dorometra* with P_2 intermediate in size between P_1 and P_3, such as *aegyptica*, appear to be trivial and mainly due to the large size of the types of *aphrodite*. The very long cirri of *Eumetra chamberlaini* with almost twice as many segments as *aphrodite* and no opposing spine, mark it off very clearly from the latter species and indeed from the rest of the Antedoninae. There is a parallel with regard to cirrus elongation in the genus *Antedon*, which includes species with the longest cirrus segments less than twice as long as wide as well as others like *A. longicirra* where they may be six times as long as wide. But in *Antedon* the number of segments is not considerably augmented at the same time as the segments are elongated, unlike *Eumetra chamberlaini*.

KEY TO THE SPECIES OF EUMETRA

a^1. Cirri very long and slender, their length equal to from one third to one half the length of the arms, composed of 25–33 (usually 25–26) much elongated segments of which the longest are about five times as long as the proximal breadth and the last three or four are about two and a half or three times as long as broad; no opposing spine; terminal claw very slightly curved (Philippine Islands; 142–146 meters)________________chamberlaini (p. 77)

a^2. Cirri shorter and less slender, their length equal to about one quarter of the arm length, composed of 16–18 segments which are not especially long, the longest (fifth-seventh) being nearly or quite three times as long as broad proximally, and the last three or four less than twice as long as the distal breadth; a prominent opposing spine; terminal claw strongly curved (Lesser Sunda Islands; 69–73 meters)________________aphrodite (p. 80)

EUMETRA CHAMBERLAINI A. H. Clark

Eumetra chamberlaini A. H. Clark, Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 231 (description; *Albatross* Sta. 5178); Proc. U.S. Nat. Mus., vol. 39, 1911, p. 563 (*Albatross* Sta. 5277); Crinoids of the Indian Ocean, 1912, p. 242 (Philippine Is.; 78–80 fms.); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 213 (in key; range; references).

Iridometra (*Eumetra*) *chamberlaini* A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 137 (compared with *E. aphrodite*).

Diagnostic features.—The cirri are very long and slender, from a third to half the length of the arms, composed of 25 to 33 (usually 25 or 26) much elongated segments of which the longest are about five times as long as the proximal width and the last three or four are from two and a half to three times as long as broad; there is no opposing spine and the terminal claw is very slightly curved. The arms are up to 80 mm. and the cirri between 30 and 40 mm. in length.

Description.—The centrodorsal is hemispherical, rather low; the cirrus sockets are arranged in four or five closely crowded alternating rows.

The cirri are XL–LX, 25–33 (usually 26), from 30 to 40 mm. long. The first segment is very short, the second is about as long as broad, the third is about half again as long as broad, the fourth is nearly four times as long as its proximal diameter, and the fifth and following are about five times as long as their proximal diameter; the terminal ten to twelve segments decrease very slightly in length, so that the last three or four are only about two and a half times as long as broad. The penultimate segment is slightly over twice as long as its proximal diameter, decreasing slightly in width distally. There is no opposing spine. The terminal claw is about three-quarters the length of the penultimate segment, slender, evenly tapering, and very slightly curved. The cirri are rather strongly compressed laterally throughout, and the distal half of each segment slightly and very gradually increases in diameter so that the distal edge is prominent.

The distal borders of the radials are even with the edge of the centrodorsal. The IBr_1 are extremely short, almost divided in the median line by a posterior projection from the axillaries, with a more or less prominent rounded tubercle in each anterolateral angle. The IBr_2 are rhombic, about half again as broad as long, with the sides strongly concave and the anterior angle sharp and somewhat produced. The elements of the IBr series and the first two brachials are in close lateral apposition with their neighbors. The synarthrial tubercles on the articulations between the elements of the IBr series and the first two brachials are very prominent.

The 10 arms are 80 mm. in length. The first brachials are about twice as long exteriorly as interiorly, and are deeply incised in the median line; the bases of adjacent first brachials just meet over the anterior angles of the axillaries. The second brachials are much larger, irregularly quadrate, with a strong posterior process incising the first brachials. The first syzygial pairs (composed of the third and fourth brachials) are rather more than twice as broad as long in the median line, and rather longer inwardly than outwardly. The next four brachials and the second syzygial pair (composed of the ninth and tenth brachials) are slightly wedge-shaped, and about twice as broad as long. The succeeding brachials become triangular, at first not so long as broad, soon becoming as long as broad, and distally wedge-shaped again and, in the terminal portion of the arms, elongate. The brachials are smooth and do not overlap.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of in one specimen 3 and in another 4 muscular articulations.

P_1 is 6 mm. long, somewhat stiff, slightly compressed, tapering evenly from the base to the tip, composed of 12 segments of which the first is not so long as broad, the third is slightly longer than broad, the fourth is about half again as long as broad, and the remainder are about twice as long as broad. P_2 is half as long again as P_1, 9 mm. in length, stouter and stiffer than P_1, with about 16 segments, of which the first is about

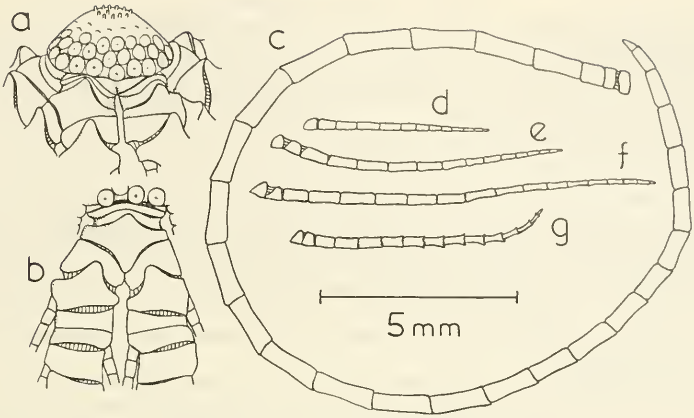


FIGURE 4.—*Eumetra chamberlaini* A. H. Clark, U.S.N.M., 35927: *a*, Laterodorsal view of centrodorsal; *b*, proximal part of postradial series; *c*, peripheral cirrus; *d*, P_1; *e*, P_2; *f*, P_3; *g*, P_7.

twice as broad as long, the second is about as long as broad, the third is rather longer than broad, and the remainder are about twice as long as broad.

P_3 is the longest and stiffest pinnule, 13 mm. long with 20 to 22 segments, of which the first is short, the second about as long as broad, and the following increase in length, so that the fifth and those succeeding are about twice as long as broad, becoming slightly longer distally. P_4 and P_5 resemble P_2. The distal pinnules are 9 mm. long with 18 or 19 segments, of which the first is very short, the second is about as long as its proximal breadth, slightly trapezoidal, and the third and following are greatly elongated and very slender with slightly expanded articulations.

The color in alcohol is (*a*) yellow, the cirri white, and the perisome brown, or (*b*) brownish yellow, the cirri and pinnules blotched with purple.

Localities.—Albatross station 5277; China Sea, off southern Luzon; Malavatuan Island (N.) bearing S. 56° E., 8 miles distant (lat. 13° 56′ 55″ N., long. 120°13′ 45″ E.); 146 meters; temperature 14.78° C.; fine sand; July 17, 1908 [A. H. Clark, 1911] (1, U.S.N.M., 35690).

Albatross station 5178; in the vicinity of Romblon; Point Origon (N.) bearing S. 5° E., 2.3 miles distant (lat. 12°43′ N., long. 122°06′ 15″ E.); 142 meters; fine sand; March 25, 1908 [A. H. Clark, 1908] (2, U.S.N.M., 25450, 35927). Type locality.

Geographical range.—Only known from the north central Philippines, from southern Luzon to Romblon.

Bathymetrical range.—From 142 to 146 meters.

Thermal range.—One record, 14.78° C.

EUMETRA APHRODITE (A. H. Clark)

Iridometra (Eumetra) aphrodite A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 137 (description; *Siboga* Sta. 294).

Eumetra aphrodite A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 213 (in key; range; references; detailed description; Stas. 49*a*, 294), pp. 271, 275 (listed), pl. 25, fig. 76.—GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (Sta. 21), pp. 45, 46 (Sta. 21; notes), p. 69 (listed); figs. 38, 39, p. 44.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, No. 249, 1929, p. 660 (Macclesfield Bank, 35–41 fathoms).—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., vol. 7, No. 1, 1936, pp. 4, 6 (range).

**Diagnostic features*.—The cirri are about a quarter of the arm length, composed of 16 to 18 segments which are not especially long, the longest being nearly or quite three times as long as broad proximally and the last three or four less than twice as long as the distal breadth; there is a prominent opposing spine and the terminal claw is strongly curved. The arms are about 75 mm. and the cirri from 16 to 18 mm. in length.

Description.—Centrodorsal low hemispherical, about 2.9 mm. in diameter at the base, almost completely covered with cirrus sockets; the small dorsal pole is papillose, as in *E. chamberlaini*.

Cirri XXXV–L, 16–18, from 16 to 18 mm. long; first segment very short, second about twice as broad as long, third nearly or quite as long as the proximal diameter, fourth from two to two and a half times as long as the proximal diameter, fifth to seventh the longest, nearly or quite three times as long as the proximal diameter; following very gradually decreasing in length so that the antepenultimate is from a third to half again as long as broad; the cirri are not especially slender; they become moderately compressed laterally in the distal half; the longer earlier segments have a slight central constriction, and the shorter distal have the proximal dorsal angle cut away so that the distal dorsal angle of the preceding appears prominent; all the segments have prominently overlapping distal ends; the cirri do not taper distally.

Division series and arm bases resembling those of *E. chamberlaini*. Arms 10, about 75 mm. long.

The distal intersyzygial interval is three muscular articulations.

P_1 is 5.5 mm. long, composed of 11 or 12 segments, of which the first is not quite so long as broad, the second is about as long as broad, the third is half again as long as broad, and the remainder are about twice as long as broad; the pinnule is slightly stiffened, and tapers evenly from the base to the tip; P_2 is 7 mm. long, with 15 segments of which the first is twice as broad as long, the second is nearly as long as broad, the third is half again as long as broad, and the remainder are about twice as long as broad; the pinnule is proportionately stouter than P_1, and the outer segments have slightly prominent distal angles and slightly spinous distal edges; P_3 is 10 mm. long, with 19 segments, resembling P_2 but tapering slightly less rapidly and with the outer segments relatively longer; P_4 is from 4.5 to 5.5 mm. long, with 10 to 13 segments, smaller than P_2, though similar to it; P_5 is 6.5 mm. long, with 14 segments; distal pinnules extremely slender, 8 mm. long, with 17 segments.

Notes.—Gislén has described a specimen from the Sagami Sea area which differs in some small details from the above description. It has the cirri about LV, with 12 to 17 segments and 5 to 13 mm. long. The fifth and sixth segments are the longest, being twice as long as broad.

* Utinomi and Kogo (see Addenda for 1965) figure a cirrus with 20 segments, also P_1, P_2, and P_3, with 7, 10 or 11, and 24 segments respectively.

The arms are over 50 mm. long.

P_I has 12 to 13 segments and is 6 mm. long; P_2 has 14 to 16 segments and is 8 mm. long; P_3 has 18 or 19 segments and is 11.5 mm. long; P_4 has 14 segments and is 7.2 mm. long; and P_5 has 15 segments and is 5.5 mm. long.

The color is violet-red dorsally; the cirri, disk, proximal pinnules and spots on the arms are white.

Localities.—*Siboga* station 49*a*; Sapeh Strait, between Sumbava and Komodo (lat. 8°23′30″ S., long. 119°04′36″ E.); 69 meters; bottom, coral and shells; April 14, 1899 [A. H. Clark, 1918] (7, Amsterdam M.).

Siboga station 294; east of Rotti Strait, between Timor and Rotti (lat. 10°12′12″ S., long. 124°27′18″ E.); 73 meters; soft mud with very fine sand; January 23, 1900 [A. H. Clark, 1912, 1918] (35, U.S.N.M., E. 452; Amsterdam M.). Type locality.

Dr. Th. Mortensen's station 21, Sagami Bay area; 36–144 meters [Gislén, 1927] (1, C.M.).

Macclesfield Bank, South China Sea; 64–75 meters [A. H. Clark, 1929] (1, B.M.; not to be found, 1958).

Geographical distribution.—From Sumbava and Timor to Sagami Bay, Japan.

Bathymetrical distribution.—From 69 to 144 meters.

Genus ANDROMETRA A. H. Clark

Antedon (part) A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353.

Iridometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131.

Eumetra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 84.

Andrometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (referred to the Antedoninae), p. 128 (type species *Antedon psyche* A. H. Clark, 1908; diagnosis; range; included species); No. 16, p. 506 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 210 (key to the included species).—Gislén Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 130; Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 15.

Toxometra (part) Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 129.

Diagnosis.—A genus of Antedoninae in which P_2 is much longer than P_1 and also longer than P_3 though similar to the latter.

Type species.—*Antedon psyche* A. H. Clark, 1908.

Geographical range.—Andaman Islands and southern Japan.

Bathymetrical range.—From 55 to 274 meters.

Thermal range.—Recorded from 11.61° C.

KEY TO THE SPECIES OF ANDROMETRA

a^1. Centrodorsal low hemispherical to almost columnar; cirri not more than XXXV; P_2 with 10–13 segments; P_3 with 10–11 segments (southern and southwestern Japan; 55–274 meters). psyche (p. 81)

a^2. Centrodorsal conical, as high as broad at the base; cirri over L; P_2 and P_3 with 15 segments; (Andaman Islands; 205 meters) indica (p. 84)

ANDROMETRA PSYCHE (A. H. Clark)

Figure 5

Antedon psyche A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed; nomen nudum); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 241 (description; vicinity of Tokyo or Sagami Bay), pl. 1, figs. 2, 3.

Iridometra psyche A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 317 (Sagami Bay, 30 fms.); Crinoids of the Indian Ocean, 1912, p. 231 (synonymy; southern Japan, 30 fms.); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese species; range and its significance).—Tortonese, Natura, Milano, vol. 24, 1933, p. 166.

Andrometra psyche A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 210 (in key; range; references).

Toxometra aequipinna Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 5, 129 (description; locality), p. 180 (listed); figs. 114–116, p. 122, pl. 2, fig. 11.

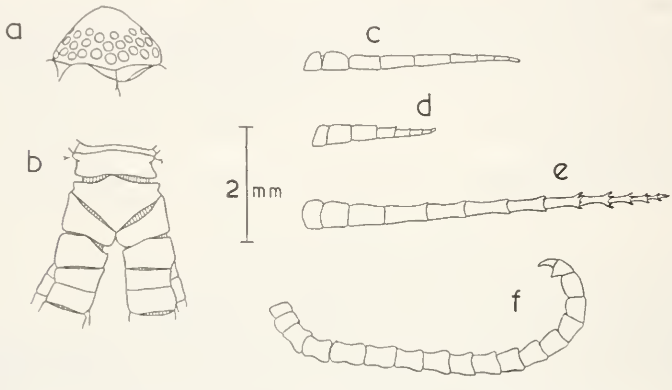


Figure 5.—*Andrometra psyche* (A. H. Clark), U.S.N.M., 35694: *a*, Centrodorsal; *b*, proximal part of postradial series; *c*, P_1; *d*, P_a; *e*, P_2; *f*, cirrus of second row from periphery.

Diagnostic features.—The centrodorsal is low hemispherical to almost columnar; P_2 has 10 to 13 segments and P_a 10 or 11; the brachials may have strongly everted and spinous distal ends and the outer are more or less strongly constricted centrally.

Description.—The centrodorsal is low hemispherical to almost discoidal, with the broad bare dorsal pole about 1 mm. in diameter. The cirrus sockets are arranged in two or two and a partial third alternating rows.

The cirri are XXVIII–XXXV, 10–18, from 5 to 7 mm. long. The first segment is twice as broad as long, the second is about as long as broad, and the remainder are from a third to half again as long as the median breadth, except for the penultimate, which is as long as broad. The ends of the cirrus segments are somewhat enlarged. The opposing spine is prominent, its height equaling about a third of the width of the penultimate segment. The terminal claw, which is moderately curved, is slightly longer than the penultimate segment.

The radials may be just visible beyond the edge of the centrodorsal, or only evident as low interradial triangles. The IBr_1 are low and broad, about five times as broad as long, more or less deeply incised by the posterior process from the axillary, with a more or less prominent anterolateral tubercle and with a rounded median elevation which is continued onto the proximal two-thirds of the axillary. The IBr_2 (axillaries) are a third again as broad as long, produced posteriorly where they rise into a more or less marked rounded synarthrial tubercle, and with the borders more or less strongly everted. The elements of the IBr series are in lateral contact, but are not laterally flattened.

The 10 arms are from 55 to 65 mm. long. The first brachials are longer exteriorly than interiorly, with the inner edges basally united. The second brachials are irregularly quadrate, proximally rising to a synarthrial tubercle. The syzygial pair formed by the third and fourth brachials is about as long as broad.

The two following brachials are roughly oblong, the succeeding wedgeshaped and then triangular, longer than broad after the ninth, wedgeshaped again at about the middle of the arm, and much elongated and centrally constricted distally. All the brachials have the distal edges strongly everted and finely spinous.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is from 3 to 4 mm. long with 8 to 10 segments of which the first is about as long as broad and the remainder elongated, the third and fourth, which are the longest, being twice as long as broad or longer. P_2 is from 4 to 7 mm. in length, at the base about as stout as P_1 but becoming almost flagellate distally, with 11 to 13 segments of which the first is broader than long, the second is longer than broad, and the remainder are elongated; the outer segments have the distal borders beset with fine spines. P_3 with 10 or 11 segments resembles P_2 but is shorter, and P_4 is shorter still and more slender, about as long as P_1 or even shorter, with about 9 segments of which the fourth to sixth bear a gonad. The following pinnules become more slender and gradually increase in length, the distal pinnules being from 6.5 to 7 mm. long with 15 to 18 segments, of which those beyond the third are from three to four times as long as broad.

The color in alcohol is (*a*) white with the perisome and the outer part of the arms light pinkish; (*b*) light brown with the disk darker; or (*c*) white, the arms crossed at the second syzygy by a purplish band 2 mm. broad and by two narrower additional purple bands distally.

Notes.—In the type specimen of *Toxometra aequipinna* the first three pinnules have respectively 8 or 9, 11, and 10 segments, and are 3, 4, and 3.3 mm. long. The arm length is 65 mm.

A smaller specimen with an arm length of 40 mm. taken with the preceding has the cirri XIV, 10–11, from 4 to 5 mm. long; the synarthrial tubercle between the elements of the IBr series is much less marked. P_1 is 2.2 mm. long, with 8 segments; P_2 is 2.7 mm. long, with 9 or 10 segments; P_3 is 2 mm. long, with 8 segments; P_a is 2 mm. long, with 6 segments; and the distal pinnules are 5 mm. long.

This individual was attached to a calcareous sponge.

[Note by A.M.C.] The *Golden Hind* specimen (U.S.N.M., 35694) has been examined by me. It has the low centrodorsal 1.8 mm. in diameter by 1.0 mm. vertical height. The single cirrus remaining is in the second row up from the periphery. It has 18 segments, of which the third to fifth are markedly constricted in the middle, this modification gradually disappearing on the following segments. The longest segments are just over half again as long as their median width. The relative length decreases distally so that the three segments before the penultimate are about as wide as long. The cirrus is about 7 mm. long.

In contrast to the holotype the brachials are smooth.

556–622—67——7

The breadth of the arms at the first syzygy is 0.8 mm. and the length from the edge of the centrodorsal to the second syzygy at 9+10 is 6.0 mm.

P_1 is about 3.5 mm. long and has 8 or 9 segments. All of them appear to have lost one, if not more, terminal segments. They are smooth and taper evenly from the base.

P_2 is much larger, about 6.5 mm. long with 13 segments which are more elongated than those of P_1 and have markedly spinous, flaring distal ends.

P_3 with about 10 segments 5 mm. in total length has even more conspicuously flared distal ends to the segments and this is carried further in P_4 which is shorter with 8 segments and 2.5 mm. long.

P_a is notably smaller than the other proximal pinnules, only 2.0 mm. long, with the 8 fairly smooth segments tapering much more than those of P_1.

This is the specimen with the arms banded at the second syzygy (*c* in the description).

Localities.—*Albatross* station 4903; Eastern Sea, near the Goto Islands; Ose Saki Light bearing N. 22° E., 6 miles distant (lat. 32°31′10″ N., long. 128°33′20″ E.); 195–254 meters; temperature 11.61° C.; gray sand and broken shells; August 10, 1906 (1, U.S.N.M., 35695).

Golden Hind; Sagami Bay (lat. 35°06′ N., long. 139°42′ E.); 55 meters; Alan Owston, April 24, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 35694).

Golden Hind; Tokyo or Sagami Bays; Alan Owston [A. H. Clark, 1908] (1, M.C.Z., 252). Type locality.

Dr. Sixten Bock's station 4; Sagami Bay, off Misaki, on the *Metacrinus* shoal; 274 meters; May 5, 1914 [Gislén, 1922].

Geographical range.—Southern Japan from the Goto Islands to Sagami Bay.

Bathymetrical range.—From 55 to 274 meters.

Thermal range.—One record, 11.61° C.

History.—This species was originally described in January 1908, from a specimen from Sagami or Tokyo Bay collected by Mr. Alan Owston in the collection of the Museum of Comparative Zoölogy.

In 1907 Mr. Frank Springer purchased and presented to the U.S. National Museum all the crinoids at that time remaining in the possession of Mr. Owston, and among them was a second specimen of this species with definite data and bearing the original number 7215 which I recorded in July 1908. I suspect that these two were captured at the same time, though there is no evidence to prove it.

In his investigations in Sagami Bay in 1914 Dr. Sixten Bock dredged two crinoids which were described and figured by Dr. T. Gislén in 1922 under the name of *Toxometra aequipinna*. They appear, however, undoubtedly to represent this species, for I cannot see that they differ from the three previously known in any significant way.

ANDROMETRA INDICA (A. H. Clark)

[See vol. 1, pt. 2, figs. 572, 573, p. 298]

Eumetra indica A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 84 (description; Port Blair, Andaman Is.); Crinoids of the Indian Ocean, 1912, p. 242 (synonymy; detailed description; off Port Blair, 112 fms.); fig. 46, p. 243.

Andrometra indica A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 210 (in key; range; references).

Diagnostic features.—The centrodorsal is conical, as high as broad at the base; P_2 and P_3 have about 15 segments; the distal edges of the brachials are not strongly everted.

Description.—The centrodorsal is conical, 3 mm. broad at the base and 3 mm. high; the cirrus sockets are arranged in six closely crowded alternating rows. As a whole the centrodorsal resembles closely that of the species of *Hathrometra.*

The cirri are about LXX; but none are present in the only known specimen.

The radials extend slightly beyond the edge of the centrodorsal, and are separated by a narrow V in the interradial angles. The IBr_1 are about three times as broad as long, not in contact basally, with the lateral edges converging distally. The IBr_2 (axillaries) are rhombic with the free lateral edges rather longer than those of the IBr_1 with which they form somewhat more than a right angle. There is a moderately developed synarthrial tubercle on the articulation between these ossicles.

The 10 arms are about 60 mm. long. The first brachials are longer exteriorly than interiorly, slightly incised by the second brachials, with their inner edges entirely free and diverging at approximately a right angle. The second brachials are nearly twice as large as the first, irregularly quadrate in form, with a rounded posterior process incising the first. The third and fourth brachials (the first syzygial pair) are together about as long as broad. The following eight or nine brachials are slightly wedge-shaped, half again as broad as long, the following becoming almost or quite triangular, about as long as broad, and further out on the arm wedge-shaped again and longer than broad.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is about 6 mm. long, very slender and delicate, somewhat stiffened, composed of about 9 segments of which the first is about as long as, or slightly longer than, broad, the second and third are twice as long as broad, and the following gradually increase in length, becoming exceedingly elongated distally. P_2 is about 10 mm. long, proportionately stouter than P_1 and stiffer, with 15 segments, of which the first is about as long as broad, the second is slightly longer than broad, the third is twice as long as broad, and the remainder are from three to four times as long as broad. P_3 is 8 mm. long with 15 segments, similar to P_2 but shorter and slightly less stout. P_4 resembles P_3. P_5 is 5 mm. long, slightly more slender than P_4, with 10 segments which have slightly everted and spinous distal ends. The following pinnules are similar. The distal pinnules are lacking.

The color in alcohol is light brownish yellow with traces of a broad median dorsal line of purple.

Locality.—*Investigator* station 15; north of Port Blair, Andaman Islands; 205 meters; dark mud; November 29, 1888 [A. H. Clark, 1909, 1912] (1, I.M.).

Remarks [by A.M.C.].—The high conical centrodorsal of this species marks it off from *A. psyche* and from all the other species of the Antedoninae, since the removal of *Hybometra* to the Zenometrinae. Specimens complete with cirri may indicate its removal from the genus, or even the subfamily. However, the small number of segments in P_1 distinguishes it from the Bathymetrinae, the larger P_2 from the Perometrinae, and the alternating cirrus sockets from the Zenometrinae, which are the only other subfamilies of the Antedonidae to which it might possibly be referred.

Genus IRIDOMETRA A. H. Clark

Antedon (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 340.

Iridometra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130 (diagnosis; type species *Antedon adrestine* A. H. Clark, 1907), p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 212 (occurs in Japan and Hawaii [the latter refers to *Argyrometra*]); Geogr. Journ., vol. 32, No. 6, 1908, p. 602 (characteristic of the Indo-Pacific-Japanese region); Amer. Nat., vol. 42, No. 500, 1908, p. 541 (only known from the Indo-Pacific-Japanese area); No. 503, p. 725 (color); vol. 43, 1909, p. 254 (represented in the Red Sea [refers to *Dorometra*]); Proc. U.S. Nat. Mus., vol. 36, 1909, pp. 362, 366, (comparison with *Comatilia*), p. 365 (single opposing spine); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Antedoninae); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Crinoids of the Indian Ocean, 1912, p. 9 (absent from Australia), p. 12 (represented in the Red Sea and southeast African region [both refer to *Dorometra*]), p. 25 (range), p. 63 (in key), p. 230 (original reference; type); Zittel-Eastman's Paleontology, 1913, p. 237 (in the Antedonidae); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Antedoninae); No. 16, p. 506 (in key; geographical and bathymetrical range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 212 (key to the included species).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 130, 131, 132; Zool. Bidrag Uppsala, vol. 9, 1924, p. 36.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, pp. 659, 660 (*I. maxima* sp. nov.).

Diagnosis.—A genus of Antedoninae in which P_1, P_2, and P_3 are similar and of approximately equal length, longer than the genital pinnules, and composed of at least 13 segments; the pinnules are not especially stiffened and their component segments do not bear prominent spines on their distal ends; the centrodorsal is low hemispherical.

Type species.—*Antedon adrestine* A. H. Clark, 1907.

Geographical range.—From southern Japan southward to Hong Kong, Timor, and (?) the Admiralty Islands.

Bathymetrical range.—From 80 to 731 meters.

KEY TO THE SPECIES OF IRIDOMETRA

a^1. P_1 with 14–20 segments when the arms are not more than 55 mm. long (Korean Strait and Japan to Hong Kong; 80–731 meters) .... **adrestine** (p. 86)

a^2. P_1 with not more than 14 segments, even when the arms are 95 mm. in length (Timor; 183 meters; (?) Admiralty Is.; 274 meters) .... **maxima** (p. 90)

IRIDOMETRA ADRESTINE (A. H. Clark)

[See vol. 1, pt. 2, figs. 301 (p. 221), and 328 (p. 227)]

Antedon adrestine A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 340 (description; *Albatross* Sta. 3713), p. 353 (listed); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 241 (relationship to *A.* [*Andrometra*] *psyche*).

Iridometra adrestine A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (Japan); vol. 39, 1911, p. 559 (compared with *I. melpomene*); Crinoids of the Indian Ocean, 1912, p. 230 (synonymy; southern Japan, 45–48 fms.); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japan species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 212 (in key; range; references).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922; pp. 132, 133 (comparison with *I. melpomene*); Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (Mortensen's Stas. 19, 21, 25; 36–216 meters), p. 46 (Stas.; notes), p. 69 (listed).

Iridometra melpomene A. H. CLARK, Proc. U.S. Nat. Mus., vol. 39, 1911, p. 559 (*Albatross* Sta. 5311); Crinoids of the Indian Ocean, 1912, p. 230 (synonymy; Philippines; 88 fms.); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 212 (in key; range; references; parasitic amphipod).—SHOEMAKER, Proc. Biol. Soc. Washington, vol. 32, 1919, p. 245 (description of *Laphystiopsis iridometrae*, a new parasitic amphipod from this species).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 5 (Sagami Bay, 182–728 m.), p. 132 (localities; notes), p. 181 (listed);

figs. 117–119, p. 134; Vid. Medd. Nat. Foren. København, vol. 83, 1927, pp. 46, 47 (synonym of *I. adrestine*).—Tortonese, Natura, Milano, vol. 24, 1933, p. 165.

Diagnostic features.—The first three pinnules on the outer and usually the first two on the inner side of each arm are similar, elongate, longer than their successors, moderately slender, evenly tapering, and somewhat stiffened so that in preserved specimens they are usually (but not always) nearly straight. They have 13 to 20 segments.

The arms are from 35 mm. to 55 mm. and the cirri from 10 mm. to 14 mm. in length.

Description.—The centrodorsal is low rounded conical with a small more or less prominently papillose polar area. The cirrus sockets are arranged in from three to four closely crowded, regularly alternating, rows of which the peripheral has four sockets in each radial area; they have rather prominent rims.

The cirri are XXXII–L, 10–19 (usually 15–18), up to 14 mm. long. The first segment is very short, the second is about twice as broad as long, the third is slightly longer than broad, and the following increase in length to the sixth which, with those succeeding, is about three times as long as broad. On the last six segments the length gradually decreases so that the antepenultimate is only about a third again as long as broad. The penultimate segment is smaller than the preceding, slightly longer than broad, and bears a stout opposing spine rising from nearly the whole of the dorsal surface to a height almost equal to its distal breadth. The terminal claw is stout basally, rather strongly curved, and as long as, or longer than, the penultimate segment. The cirri are rather strongly compressed laterally and are of practically the same width throughout. The ventral profile of the longer segments is concave, the depth of the concavity moving gradually toward the proximal end, but the profile of the shorter outer segments becomes straight or slightly convex; the dorsal profile of all the segments is almost or quite straight.

The radials are concealed by the centrodorsal, or their distal angles are just visible interradially as narrow prostrate triangles. The IBr_1 are very short and very deeply incised by the posterior processes of the axillaries which in a view perpendicular to the dorsoventral axis completely divide them; their anterior borders are slightly swollen; their lateral borders are somewhat abruptly produced so that they are in contact with their neighbors. The strongly convex main portion of the IBr_1 narrows anteriorly and this lateral production fills the gap which otherwise would be left; its surface is abruptly marked off from that of the main portion, and usually somewhat raised. The IBr_2 (axillaries) are broader than long, with all the sides very concave; beneath the sharp lateral angles they are extended proximally by a production which meets the similar production of the sides of the IBr_1 and is in contact with that of the adjacent axillaries. Thanks to these lateral extensions the elements of the IBr series and the first two brachials are in close lateral apposition.

The 10 arms are from 35 to 55 mm. long. The first brachials are from two to three times as long exteriorly as interiorly, and very deeply incised in the median line; their outer border is somewhat abruptly extended laterally, and the outer edge is straight; the inner edge is in contact with that of the adjacent first brachial for the basal half or two-thirds, the two edges thence diverging at approximately a right angle. The second brachials are irregularly quadrate, about as long as broad, with the two proximal sides strongly concave and a posterior process deeply incising the first brachials. The first syzygial pairs, composed of the third and fourth brachials, are longer inwardly than outwardly, about twice as broad as the median length, with the proximal and distal edges concave.

The next six or seven brachials are wedge-shaped with concave ends, about twice as broad as the median length, the following ones then becoming almost or quite triangular, about as long as broad, and later gradually wedge-shaped again and terminally elongate and more or less constricted centrally. The ends of the brachials are smooth and not produced.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is from 8.5 to 10 mm. long, with 14 to 20 segments, and resembles P_2. P_2 is from 9 to 10.5 mm. long, with 15 to 18 segments, of which the first is broader than long, the second is slightly longer than broad, and the remainder are greatly elongated. P_3 is from 8.5 to 11 mm. long with 14 to 20 segments which are proportionately slightly shorter than those of P_2; this pinnule resembles P_2 but tapers very slightly less rapidly and therefore appears very slightly stouter. P_a is similar to P_1. The distal pinnules are from 7 to 9 mm. long with 16 or 17 segments which beyond the second are greatly elongated with finely spinous distal edges.

The color in alcohol is white or whitish with a broad median band of yellowish, reddish or purplish brown on the division series and arms which commonly breaks up into narrow transverse bands distally; there are sometimes large blotches of purplish brown on the pinnules, and the perisome may be brown or dark purple. Some specimens are almost uniform whitish.

TABLE 2.—*Details of some specimens of* Iridometra adrestine *from published records*

Specimen	*Arm length (mm.)*	*Cirri*			P_1		P_2		P_3	
		No.	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*
Holotype	35	XL	12–15	10–12	19	10	18	10+	20	11
"*I. melpomene*"	—	XXX–L	15–19	10–14	16	7. 5	16	8	13	6
Gislén, 1922 (1)	40	XXXII	10–18	9–11	14–15	5. 5–6	14–15	6–6. 5	13	6
Gislén, 1922 (2)	37	XXXVIII	10–16	3–8	12	5. 5	11	5	10	5
Gislén, 1927 (1)	c.30	c.XXIII	9–14	2. 5–5. 7	12	6	11	5	9	4. 5
Gislén, 1927 (2)	35	—	14	6. 5	—	—	11	5. 2	—	—
Gislén, 1927 (3)	55	c.XXV	13–18	6–11	15	7	15–17	6. 5–7	15	7
Gislén, 1927 (4)	35	—	13–16	—	13	5. 6	13	5. 5	10	4. 7
Gislén, 1927 (5)	—	—	15–16	5–7	14	5. 2	13	5	11	4

Notes [BY A.M.C.].—In studying Dr. Mortensen's Japanese collection, Gislén (1927) had five specimens, of which three were immature and had P_3 relatively smaller than in the larger specimens, where it tended to be the same size as P_1 and P_2. He concluded from this that *I. melpomene* is nothing more than the young of *adrestine*. Mr. A. H. Clark seems to have decided independently of Gislén that these two are synonymous, since this part of the typescript was written about 1923.

In 1928 Gislén named a specimen in the British Museum from the *Challenger* collections *Iridometra adrestine*, though it was taken at station 219 in the Admiralty Islands, north of New Guinea, well beyond the known range of this species. The specimen is small with arms only about 20 mm. long, but has XL cirri and P_3 is as long as P_2 and slightly longer than P_1, which has only 10 segments. In my opinion this specimen is more likely to be a young *Iridometra maxima*.

Localities.—Dr. Th. Mortensen's station 19; off Misaki, Japan; 146–220 meters; sand; June 10, 1914 [Gislén, 1927] (2, C.M.).

Dr. Th. Mortensen's station 21; off Sunosaki, Japan; 36–146 meters; hard bottom; June 12, 1914 [Gislén, 1927] (2, C.M.).

Dr. Th. Mortensen's station 25; Sagami Sea, Okinose, Japan; 183 meters; hard bottom; June 26, 1914 [Gislén, 1927] (1, C.M.)

Albatross station 3707; Sagami Bay, Japan; Ose Zaki bearing S. 53° W., 2.25 miles distant; 115–137 meters; volcanic sand and gravel; May 8, 1900 (3, U.S.N.M., 35697).

Albatross station 3713; Sagami Bay; Ose Zaki bearing S. 81° W., 4.2 miles distant; 82–86 meters; volcanic sand, shells and rock; May 11, 1900 [A. H. Clark, 1907] (1, U.S.N.M., 22659). Type locality.

Albatross station 3764; Sagami Bay; Suno Saki bearing S. 64° E., 2.8 miles distant; 80–91 meters; fine gravel and broken shells; May 22, 1900 (1, U.S.N.M., 35698).

Dr. Sixten Bock's station 32; off Okinose, Sagami Bay; 183 meters; June 26, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 37; off Okinose; 731 meters; July 8, 1914 [Gislén, 1922].

Albatross station 4903; Eastern Sea, near the Goto Islands; Ose Saki light bearing N. 22° E., 6 miles distant (lat. 32°31′10″ N., long. 128°33′20″ E.); 195–254 meters; gray sand and broken shells; August 10, 1906 (1, U.S.N.M., 36225).

Albatross station 5310; China Sea, near Hong Kong (lat. 21°33′ N., long. 116°13′ E.); 183 meters; temperature 18.61° C.; sand and shells; November 4, 1908 (3, U.S.N.M., 36015).

Albatross station 5311; China Sea, near Hong Kong (lat. 21°33′ N., long. 116°15′ E.); 161 meters; coarse sand and shells; November 4, 1908 (6, U.S.N.M., 27506, 35691, 35989).

Geographical range.—From Sagami Bay, Japan, and the Korean Straits southward to Hong Kong.

Bathymetrical range.—From 80 to 731 meters.

Thermal range.—One record, 18.61° C.

History.—During a visit to the Museum of Comparative Zoology in the summer of 1907 Dr. H. L. Clark showed me the crinoids which had been collected by the *Albatross* in southern Japan in 1900 and subsequently turned over to him for study. He had already gone over them more or less in detail and had made preliminary determinations of the species; but finding that I was engaged in work upon the very much larger collection which I had personally brought together in 1906 he most generously handed over to me all the material which had been sent to him, together with his notes.

Among the new species he had distinguished was this form which I had not found in the 1906 collection. I immediately wrote a description of it which was published on October 29 of the same year.

During the course of the Philippine investigations the *Albatross* dredged in 1908 near Hong Kong several specimens of a form which was evidently close to *I. adrestine*, but which appeared to differ from it. This I described in 1911 under the name of *I. melpomene.*

A curious amphipod parasite was found partially embedded in the disks of some of these specimens which I gave to Mr. Clarence R. Shoemaker who described them in 1919 under the name of *Laphystiopsis iridometrae* (see part 2, pp. 633, 634).

In 1922 Dr. T. Gislén in his memoir on the crinoids collected by Dr. Sixten Bock suggested that the examination of more ample material would probably show that *Iridometra adrestine* and *I. melpomene* are really identical, and a reexamination of the specimens at hand leaves no doubt in my mind that this supposition is correct as Dr. Gislén himself concluded in 1927.

Remarks [BY A.M.C.].—In 1918 Mr. A. H. Clark included his own *Antedon minuta* in the synonymy of *adrestine* but without comment. In 1922 Gislén challenged this on the grounds of the large number of segments in the much smaller P_1 of *minuta*. In spite of this Gislén in 1927 still included *minuta* in the synonymy of *adrestine*, while Mr. Clark, at about the same time, appears to have reconsidered, as he maintains *minuta* as a valid species in the genus *Annametra* on the grounds of the cirri, the longest segments of which are only a third again as long as wide while in *adrestine* of similar size (arm length about 30 mm.) they are two to two and a half times as long as wide (Gislén, 1927).

IRIDOMETRA MAXIMA A. H. Clark

Iridometra maxima A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 635 (listed), pp. 659–660 (locality; diagnosis; description), pl. 43, figs. 12, 13; Proc. Biol. Soc. Washington, vol. 47, 1934, p. 10.

? *Iridometra adrestine* (not of A. H. Clark) GISLÉN, Ark. Zool. vol. 19, No. 32, 1928, p. 10 (*Challenger* station 219; notes).

Diagnostic features.—A very large and robust species of *Iridometra* in which the centrodorsal is large and hemispherical, with a deeply concave dorsal pole; the arms are up to 95 mm. long, at which size the cirri are L–LV; P_1 is 12 mm. long, with 13 or 14 segments; P_2 is 13 mm. long, with 13 or 14 segments; and P_3 is from 11 to 14 mm. long, with 15 or 16 segments.

Description.—The centrodorsal is hemispherical, 5 mm. in diameter at the base and 3 mm. high, with a deeply sunken papillose dorsal pole, about 2 mm. in diameter. The cirrus sockets are arranged in four, and a partial fifth, closely crowded, alternating rows, the size of the sockets decreasing gradually from the proximal to the apical rows.

There are between L and LV cirrus sockets. All the cirri are lost.

The radials are short, from four to six times as broad as long; their anterolateral angles are separated by a notch. The diameter of the radial ring is slightly less than that of the centrodorsal, so that the latter has a knoblike appearance. The IBr_1 are short, five or six times as broad as long in the median line, trapezoidal, with the lateral borders converging slightly distally. The IBr_2 (axillaries) are broadly pentagonal, half again as broad as long. The lateral sides are short, shorter than those of the IBr_1, and make with these a broadly obtuse angle. The anterior angle is approximately a right angle, and the anterior sides are only slightly concave.

The 10 arms are about 95 mm. long. The first brachial is short, twice as long exteriorly as interiorly, interiorly united in the proximal half, the distal half of the inner border making with the proximal half a right angle, so that the distal halves of the inner edges of two adjacent first brachials lie in the same straight line. The second brachials are usually nearly twice as large as the first, and are irregularly quadrate in shape. The first syzygial pair (composed of brachials 3+4) is wedge-shaped, almost twice as long interiorly as exteriorly and twice as broad as the median length. The next four brachials are very short, twice as broad as the maximum and four times as broad as the median length, wedge-shaped, with concave proximal and distal ends. After the second syzygy, the brachials soon become triangular with gently concave distal borders, and about one-third broader than long. After the proximal third of the arm, the brachials gradually become wedge-shaped, at about the middle of the arm becoming about as long as broad and terminally elongate.

Syzygies occur usually between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 2 to 5, most commonly 3 or 4, muscular articulations. The second syzygy is sometimes omitted, and the position of the third is subject to some irregularity. The width of the first syzygy is 2.0 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 10.0 mm.

P_1 is 12 mm. long with 13 or 14 segments, and is considerably stiffened. The first segment is about as long as broad, the second is slightly trapezoidal, from half again to nearly twice as long as the width of the narrower distal end, the third is twice as long as broad or slightly longer, very slightly constricted centrally, the fourth is three times as long as broad, the sixth and seventh are the longest, from three to four times as long as broad, and the remainder are slightly shorter. The earlier segments are entirely smooth. On the sixth there is a slight eversion of the distal edge which on the eighth and following becomes a conspicuous strongly dentate overlapping frill. P_2 is 13 mm. long, with 13 or 14 segments, resembling P_1 but tapering more gradually and hence slightly stouter. P_3 on some arms is 14 mm. long, with 16 segments, slightly stouter than P_2, but on other arms it is 11 mm. long, with 15 segments and slightly less stout than P_2. P_4 is 9 mm. long, with 14 segments, on some arms resembling the preceding pinnules, but less stiffened and much more slender, and on other arms resembling P_5. The next two pinnules are similar in length and number of segments to P_4, but are slightly stouter basally, less stiffened, and have the ends of the outer segments less conspicuously everted. The distal pinnules are 12 mm. long with 17 or 18 segments, which in the outer portion become about four times as long as broad.

Remarks.—In its general appearance this species may be described as having the brachial structure of a very large species of *Antedon*, with a centrodorsal resembling that of *Heliometra*.

Its much larger size and more robust build give it an appearance quite different from that of *Iridometra adrestine*, but the agreement in structure is so very close that it would scarcely be advisable to create another genus for it.

Locality.—C. S. *Cable*; Rotti Strait, Timor; 183 meters; on the cable. [A. H. Clark, 1929] (1, B.M.).

[NOTE BY A.M.C.] The specimen from *Challenger* station 219 (Admiralty Islands, off New Guinea (lat. 1°50′ S., long. 146°42′ E.); 274 meters; mud), which was named *Iridometra adrestine* by Gislén in 1928, may prove to be the young of *maxima*. Though the arms are only about 20 mm. long there are already XL cirri, whereas in *adrestine* with arms 40 mm. long there may be only XXXII cirri; also P_1 has about 14, as opposed to 10, segments.

Genus ANNAMETRA A. H. Clark

Antedon (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 341.
Iridometra (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131.
Cominia (part) A. H. CLARK, Die Crinoiden der Antarktis, 1915, p. 104.

Annametra A. H. Clark, U.S. Nat. Mus. Bull. 82, vol. 1, pt. 2, 1921, pp. 618, 647, 648, 681, 723; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range), p. 52 (in key); Proc. U.S. Nat. Mus., vol. 83, 1936, p. 247 (diagnosis; type species *Cominia occidentalis* A. H. Clark, 1915).

Diagnosis.—A genus of Antedoninae in which P_3 is of the same length and character as the succeeding pinnules; P_1 and P_2 have 18–35 segments; P_1 is shorter than P_2, though similar to it; and the cirri are short and stout, strongly recurved distally, resembling the cirri of *Antedon petasus*, with 10–19 segments.

Type species.—*Cominia occidentalis* A. H. Clark, 1915.

Geographical range.—Known only from southern Japan and South Africa.

Bathymetrical range.—From the shore line down to 47 meters.

Remarks [by A.M.C.].—I am doubtful whether the Japanese *minuta* can be considered as congeneric with the South African *occidentalis.* The former does have similar short cirrus segments, but so also do two other Japanese species of the Antedoninae, *Andrometra psyche* and *Antedon* (formerly *Compsometra*) *serrata.* Also, in genera such as *Antedon,* the included species show a wide range of proportions of the longest cirrus segments from one and a half times to six times as long as broad. This character is therefore of little significance in determining the genus. The rather short segments of P_1, however, may be of more importance in allying *minuta* and *occidentalis.* Those of *minuta* (18 in the holotype) are about half again as long as wide but in *occidentalis* the 30 to 35 segments are unique in the Antedoninae in not being longer than wide (fig. 6*b*, p. 95). In some species of *Antedon* and *Mastigometra,* however, the pinnule segments are little longer than they are in *minuta.* I also consider the geographical separation of the two species to be another factor against their being congeneric.

KEY TO THE SPECIES OF ANNAMETRA

a^1. P_1 and P_2 with about 18 segments, the longest about half again as long as wide (southern Japan; 24–47 meters) ---------- **minuta** (p. 92)

a^2. P_1 and P_2 with 30–35 segments, not longer than broad (South Africa; 0–26 meters). **occidentalis** (p. 94)

ANNAMETRA MINUTA (A. H. Clark)

Antedon minuta A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 341 (description; *Albatross* Sta. 3725), p. 353 (listed); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 241 (relation to *A.* [*Andrometra*] *psyche*).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 133 (cannot be synonymous with *adrestine*).

Iridometra minuta A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 218 (compared with *Iridometra* [*Argyrometra*] *crispa*), p. 318 (Japan); Crinoids of the Indian Ocean, 1912, p. 232 (synonymy, southern Japan, 13 fms.).—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 46 (synonym of *I. adrestine*).

Iridometra adrestine (part) A. H. Clark, Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 212 (in synonymy).

Annametra minuta A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 247 (noted); John Murray Exped., 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 105.

Diagnostic features.—P_1 and P_2 have about 18 segments. The arms are about 30 mm. and the cirri are about 5 mm. in length.

This is the only Japanese comatulid in which the cirri are of the kind characteristic of *Antedon petasus.*

Description.—The centrodorsal is low hemispherical, nearly covered with from 15 to 20 cirrus sockets which are closely crowded in from 2 to 3 alternating rows and have very prominent rims.

The cirri are XV–XX, 10–15, about 5 mm. long, strongly recurved in the outer half and resembling those of *Antedon petasus*. The first segment is very short, the second is about twice as broad as long, the third is slightly longer than broad, and the fourth and fifth and following are about a third again as long as the median breadth. The third to fifth are strongly and rather abruptly constricted centrally, but the seventh and following have the dorsal and ventral profiles almost straight and hence appear broader in lateral view. On the outer cirrus segments the distal border runs from the ventral edge downward to a rather sharp angle about one third the distance to the dorsal edge, then curves proximally and then downward, joining the dorsal edge perpendicularly. The opposing spine is prominent, though small.

The radials are just visible in the midradial line beyond the edge of the centrodorsal; their interradial angles are slightly divergent, so that the bases of the IBr_1 are well separated. The IBr_1 are about twice as broad as long with the lateral borders slightly convergent. The IBr_2 (axillaries) are pentagonal, about as long as broad, with unusually long sides, about as long as those of the IBr_1, with which they make a very obtuse angle. The IBr series are narrow and very widely separated.

The 10 arms are about 30 mm. long, with about 50 brachials, which are relatively long and somewhat constricted centrally with spinous ends.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 3 mm. long and is composed of about 18 segments. It decreases rather rapidly in width to the fourth segment and is slender from that point onward. The first four segments are broader than long with the corners cut away, and the remainder are relatively short, not over twice as long as broad. The lower segments have spinous distal ends. P_2 is similar but slightly longer and tapering more gradually. P_3 and the following pinnules appear to be slightly longer than P_2 and as they taper more gradually they appear stouter.

The color in alcohol is pinkish, light brownish, or dull white, with the perisome brown.

Localities.—*Albatross* station 3725; Sagami Bay; Noma Saki bearing N. 18° E., 8.8 miles distant; 24 meters; sand, shells and gravel; May 15, 1900 [A. H. Clark, 1907] (6, U.S.N.M., 22661, 35701). Type locality.

Albatross station 3726; Sagami Bay; Takamatsu Zaki bearing N. 5° W., 5.7 miles distant; 47 meters; gray volcanic sand; May 15, 1900 (4, U.S.N.M., 35696).

Geographical range.—Known only from the Sagami Bay area, Japan.

Bathymetrical range.—From 24 to 47 meters.

History.—This species was dredged by the *Albatross* in 1900 and was represented in the collections from that cruise which were sent to Dr. H. L. Clark and subsequently turned over to me by him. He had already recognized it as a new type, and I found the specimens labeled *Antedon minuta* H. L. Clark, a name which from its appropriateness I adopted when I described the species in 1907.

Upon the creation of the genus *Iridometra* in 1908 I placed this species in it, and in 1918 I reduced it to the synonymy of *Iridometra adrestine*.

Dr. T. Gislén pointed out in 1922 that this disposition was certainly incorrect on the grounds of the characters of P_1. A reexamination of the material showed that while the specimen I had studied when I had assigned this species to the synonymy of *I. adrestine* was undoubtedly a young example of that form, the type specimen was very different, and was at once distinguishable from all other Japanese comatulids by its characteristic cirri of relatively short segments.

Further investigation showed this species to be most nearly related to the South African species originally described, through a misconception of its characters, under the name of *Cominia occidentalis*.

In ignorance of this decision, Gislén in 1927 included *minuta* in the synonymy of *Iridometra adrestinc.* In the two specimens for which he cited the proportions of the longest cirrus segments both had them from two to three times as long as wide. Presumably the rest were similar in this respect and none could have been referable to *minuta*.

ANNAMETRA OCCIDENTALIS (A. H. Clark)

FIGURE 6

Cominia occidentalis A. H. CLARK, Die Crinoiden der Antarktis, 1915, p. 104 (collected by the *Gauss* at Simon's Bay), p. 164 (detailed description; localities: parasitized by *Eulima capensis*), p. 165 (description with figure of *Eulima capensis*, by Thiele), pl. 10, figs. 1–5.—H. L. CLARK, Ann. South African Mus., vol. 13, 1923, p. 228 (in key), p. 231 (station; remarks).

'Comium' PELSENEER, Bull. Soc. Zool. France, vol. 53, 1928, p. 172 (parasitized by *Eulima capensis*).

'Capillaster capensis' PELSENEER, as above.

Annametra occidentalis A. H. CLARK, U.S. Nat. Mus. Bull. 82, vol. 1, pt. 2, 1921, pp. 647, 648, 681, 723; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range); Journ. Linn. Soc. (Zool), vol. 36, 1929, p. 659 (locality); Proc. U.S. Nat. Mus., vol. 83, 1936, p. 247 (type species of *Annametra*); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 102 (range), p. 105.—GISLÉN, Kungl. Svenska Vet-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4 (listed), pp. 20–21 (supplementary description; history); text-figs. 18–26, p. 19.—A. M. CLARK, Trans. Roy. Soc. South Africa, vol. 33, pt. 2, 1952, p. 203 (Cape Town University stations).

Diagnostic features.—P_1 and P_2 have up to 35 very short segments. The arms are about 50 mm. long in the adult and the longest cirri measure up to 15 mm.

There is little danger of mistaking this species for any other member of the family, for its general appearance and the character of the first two pinnules give it a very strong resemblance to one of the 10-armed species of the Comasteridae with which it was at first confused.

Description.—The centrodorsal is small, thin discoidal. Its bare dorsal pole is flat or slightly convex and measures 1 mm. in diameter. The cirrus sockets are arranged in three closely crowded, irregular marginal rows.

The cirri are XXXV–XL, 14–19, and the longer ones measure up to 15 mm. in length. The first segment is shorter than the second, which is half again as broad as long, the third is about as long as broad or slightly longer than broad, the fourth or fourth and fifth are the longest, one third to half again as long as the median diameter, and the following ones gradually decrease in relative length so that the six outermost are about as long as the median diameter. The longer proximal segments are slightly constricted centrally and in lateral view appear comparatively slender; as the segments distally become shorter and laterally compressed they also become broader in lateral view so that the short outer segments may be nearly or quite twice as broad as the longer proximal. All the segments have a perfectly straight and smooth dorsal profile, and the outer also have a straight ventral profile. The opposing spine is minute and terminal in position. The terminal claw is somewhat longer than the penultimate segment, moderately stout and moderately curved. The cirri in general suggest those of *Antedon petasus*.

The disk is from 8 to 9 mm. in diameter; the dorsal interradial perisome is more or less abundantly plated.

The ends of the basal rays are prominent as large rounded triangles in the angles of the calyx.

The distal edges of the radials are just visible beyond the border of the centrodorsal, and just meet in the angles of the calyx over the ends of the basal rays. The IBr_1 are oblong, about four times as broad as long, with straight lateral borders, those of two adjacent ossicles making with each other a wide angle of about 80°. The IBr_2 (axillaries) are triangular, half again as long as broad with all the sides practically straight and the anterior angle slightly and narrowly produced; they are widely separated from each other laterally.

The 10 arms are about 50 mm. long in the adult. The brachials have slightly projecting and very finely spinous distal edges. Syzygies occur with an interval of usually 4 (–6) muscular articulations. The brachials proximally are short, with the length about half the breadth. There are about 24 articulations per centimeter (including the syzygies).

P_1 is up to 8.5 mm. long, with 30 to 35 segments all of which are relatively short but the fifth to the twelfth are as long as broad. On about the third to the eighth segments there is a knob on the dorsal side distally, which produces a saw-like profile to the pinnule. This feature continues out to the pinnules on the middle part of the arm. The middle part of P_1 is fairly smooth but toward the tip of the pinnule a slight swelling on the middle of each segment may become more marked so as to produce the effect of a rudimentary comb. The development of this feature is apparently variable since Dr. H. L. Clark could distinguish no trace of any kind of comb in the specimens that he studied.

P_2 has 32 to 35 segments and measures up to 9 mm. in length.

P_3 has 25 to 33 segments and is 8 to 11 mm. long, it bears the first gonad on the third to tenth segments and is stouter than the first two pinnules.

The following pinnules are similar; the gonads extend as far as the eleventh or twelfth, but rapidly decrease in size after the eighth or ninth. The distal pinnules are very slender, 5.5 mm. in length and composed of 14 or 15 segments.

The color in life is brownish yellow and there may be olive green spots.

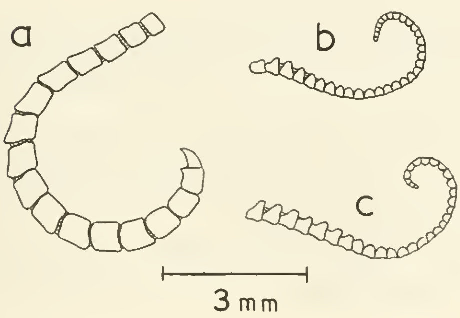


FIGURE 6.—*Annametra occidentalis* (A. H. Clark), B.M., 1949.9.27. 48, Table Bay: *a*, Peripheral cirrus; *b*, P_1; *c*, P_2.

Remarks.—The foregoing description is a compound of the original one with the supplementary comments of H. L. Clark (1923) and Gislén (1938).

Localities.—*Gauss;* Simon's Bay, Cape of Good Hope; July 16, 1903; July 29, 1903 [A. H. Clark, 1915] (4, U.S.N.M., E. 386; Berl. M.). Type locality.

Pieter Faure; No. 14905; Saldanha Bay, west side of Cape Province; 18–25 meters; sand and mussel beds [H. L. Clark, 1923; Gislén, 1938]; (1, M.C.Z.; 15, S. Afr. M.; 1, C.M.?).

Table Bay; 18–26 meters; Prof. O. Carlgren, Oct. 8, 1935 [Gislén, 1938].

Table Bay, off Blaauberg; 9 meters; sand and rock; Cape Town University Ecological Survey [A. M. Clark, 1952] (3, B.M.).

Table Bay (lat. 33°49′ S., long. 18°27′30″ E.); 15 meters; sand and rock; Cape Town University Survey [A. M. Clark, 1952] (9, B.M.; 3, C.T. Univ.).

Table Bay; Cape Town University Survey [A. M. Clark, 1952] (3, B.M.; 1, C.T. Univ.).

False Bay (lat. 34°09′ S., long. 18°27′ E.); 22 meters; sand; Cape Town University Survey [A. M. Clark, 1952] (6, B.M.).

False Bay, Fishock Bay; 8 meters; sand; Cape Town University Survey [A. M. Clark, 1952] (1, B.M.).

Durban [A. H. Clark, 1929] (1, B.M.).

Geographical distribution.—Known from South Africa, from Saldanha Bay on the west coast of Cape Province to Durban.

Bathymetrical distribution.—From the shore down to 26 meters.

History.—This species was originally described in 1915 as a 10-armed member of the family Comasteridae in the genus *Cominia.* Its general appearance, in all the specimens I have seen, is quite unlike that of any other member of the Antedonidae. In 1938 Gislén confirmed its inclusion in the family Antedonidae after examining the articular facets of the radials and centrodorsals of two specimens. He agreed also that the genus *Annametra* is best placed in the subfamily Antedoninae, its similarities to the Heliometrinae being probably attributable to convergence.

In 1952 it was recorded by A. M. Clark from several stations of the Cape Town University Ecological Survey in Table Bay and False Bay.

Genus ARGYROMETRA A. H. Clark

Iridometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131.

Compsometra (part) A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 229.

Argyrometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Antedoninae), p. 128 (diagnosis; type species *Iridometra crispa* A. H. Clark, 1908; range; included species); No. 16, p. 505 (in key; range).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 130.

Diagnosis.—A genus of Antedoninae in which the cirri are LX–LXXX; P_3 is of the same length and character as the succeeding pinnules, and P_1 and P_2, which are similar though of different lengths, have about 10 to 14 segments, most of which are greatly elongated.

Type species.—*Iridometra crispa* A. H. Clark, 1908.

Geographical range.—From the Philippine Islands to northern New Zealand and the Hawaiian Islands.

Bathymetrical range.—From 62 to 298 meters.

Thermal range.—One record, 15.72° C.

Remarks [by A.M.C.].—As explained in the discussion of the subfamily (p. 49), the differentiation of *Argyrometra* and *Euantedon* by a small difference in the number of segments in P_1 seems to me very unsatisfactory, particularly in view of the wide range shown by other genera or even species of the Antedoninae (notably *Antedon serrata* with 12 to 28 segments). If *Argyrometra* is to be retained at all there seems to be only the very large number of cirri, LX–LXXX in *crispa* and *mortenseni*, to distinguish it from *Euantedon* with less than L cirri.

Another doubtful point is whether even *crispa* and *mortenseni* are congeneric. Elsewhere in this subfamily Mr. Clark has used the different proportions of the first three pinnules as diagnostic of genera, although in *Dorometra* he includes species with P_2 both larger and smaller than P_1, but in these two species the sizes of all three pinnules are in inverse order—P_2 and P_3 progressively smaller than P_1 in *crispa* but larger in *mortenseni*. Perhaps *mortenseni* should be segregated in a distinct genus on this account, but without seeing examples of it I cannot take the step of creating a new genus.

KEY TO THE SPECIES OF ARGYROMETRA

a^1. P_1 longer than P_2, which is longer than P_3; 10–12 cirrus segments, the longest not much elongated and with little or no expansion of the distal ends (Hawaiian Islands; 270–298 meters).
crispa (p. 97)

a^2. P_1 shorter than P_2, which is shorter than P_3; about 17 elongate cirrus segments (northern New Zealand; 110–175 meters) ---------- mortenseni (p. 98)

ARGYROMETRA CRISPA (A. H. Clark)

FIGURE 7

Iridometra crispa A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed; *nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 213 (in key), p. 218 (description; *Albatross* Sta. 3938).

Compsometra crispa A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 229 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 210 (not a *Compsometra;* closely related to the species of *Andrometra*).

Argyrometra crispa A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (listed), p. 129 (comparison with *A. mortenseni*).

Argyrometra (*Compsometra*) *crispa* GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 130.

Diagnostic features.—P_1 is longer than P_2, which is longer than P_3; the pinnule segments have rather prominently everted and spinous distal ends; there are 10 to 12 cirrus segments of which the longest are not much elongated, with little or no expansion of the distal ends.

The arms are about 30 mm. in the unique holotype and the cirri are 4 mm. in length.

Description.—The centrodorsal is hemispherical, bearing about 70 cirrus sockets which have no definite arrangement.

The cirri are LXX, 10–12, 4 mm. long. The first segment is short, and the remainder are longer than broad, the third, fourth and fifth being the longest. The opposing spine is represented by a small tubercle.

The radials are almost entirely concealed. The IBr_1 are short, narrowing rapidly distally, and very deeply incised in the median line, well rounded dorsally and widely separated. The IBr_2 are rhombic with all the sides concave, and about as long as broad.

The 10 arms are about 30 mm. long.

P_1 is 6 mm. long, composed of 12 or 13 segments of which the first is about as long as broad, the second is about twice as long as broad, the third is about three times as long as broad, and the remainder are somewhat longer. P_2 is 4.5 mm. long, similar to P_1 and with the same number of slightly shorter segments. P_3 and the following pinnules are shorter and slightly stouter with the distal edges of their segments everted and serrate, and with gonads. Distally the pinnules become very slender and increase somewhat in length.

The color in alcohol is yellowish brown with the pinnules, cirri, and interambulacral areas of the disk white.

Locality.—*Albatross* station 3938; Hawaiian Islands; Laysan Island Light bearing S. 88°30′ E., 7.8 miles distant; 270–298 meters; temperature 15.72° C.; white sand and broken shells; May 16, 1902 [A. H. Clark, 1908, 1912, 1917, 1918] (1, U.S.N.M., 22692).

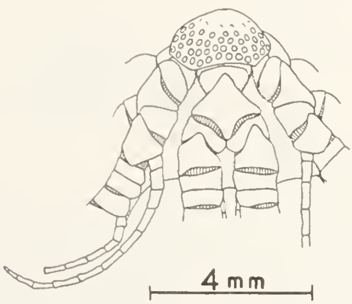


FIGURE 7.—*Argyrometra crispa* (A. H. Clark), holotype, laterodorsal view.

ARGYROMETRA MORTENSENI A. H. Clark

Argyrometra mortenseni A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (listed), p. 129 (diagnosis; comparison with *A. crispa;* locality); Proc. Biol. Soc. Washington, vol. 31, 1917, p. 41 (listed).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 130.—MORTENSEN, Vid. Medd. Nat. Foren. København, vol. 79, 1925, p. 386, p. 389 (localities; notes), fig. 66 (calyx and arm bases), p. 397 (listed).—FELL, New Zealand Science Congress, 1947, p. 210 (listed); Tuatara, Wellington, New Zealand, vol. 3, No. 2, 1950, p. 79, text fig. 3 (calyx and arm bases), p. 84 (in key).

Diagnostic features.—P_1 is shorter than P_2, which is shorter than P_3; there are 12 to 17 cirrus segments. The arms are about 30 mm. long in the holotype.

Description.—The cirri have up to 17 segments, of which the longest are from four to six times as long as their distal diameter. The distal ends of the segments are much more expanded than in *A. crispa* in which their dorsal and ventral profiles are everywhere practically parallel.

The 10 arms are about 30 mm. long.

P_1 is 3.3 mm. long, slender and evenly tapering, composed of 12 segments, of which the first is slightly broader than long, the second and third are very slightly longer than broad, and the following become progressively elongated, being between four and five times as long as broad distally. The segments are cylindrical and smooth, with little or no development of spines on the distal edges. P_2 is 4 mm. long, very slightly stouter than P_1, composed of 12 segments, of which the distal are more elongated than those of P_1. P_3 is 5 mm. long, with about 12 segments, about as stout basally as P_2 but tapering more slowly and hence appearing stouter, with relatively shorter segments which beyond the third have prominently overlapping and finely spinous distal ends. The pinnules immediately following resemble P_3.

Notes [BY A.M.C.].—The above description is of the type specimen, which was the only one known until in 1925 Dr. Mortensen published remarks about seven additional specimens from off the northern tip of New Zealand. The cirri of these have 12 to 16 segments rather than 17 and the number of segments in the first pinnules also tends to be smaller, 8 segments in P_1 and 10 in P_2. Judging from Mortensen's figure the centrodorsal is rounded conical. Unfortunately neither he nor Mr. A. H. Clark gave the number of cirri, but in the latter's diagnosis of *Argyrometra*, including also *A. crispa* (1917, p. 128), the number is given as LX–LXXX. Fell also gives this number but may be quoting from Mr. Clark.

Localities.—North Cape, New Zealand; 110 meters; Dr. Th. Mortensen [A. H. Clark, 1917] (1, U.S.N.M.). Type locality.

Off North Cape; 110 meters; Capt. Bollons [Mortensen, 1925].

Off Three Kings Islands; 175 meters; Capt. Bollons [Mortensen, 1925].

Genus EUANTEDON A. H. Clark

Iridometra (part) A. H. Clark, Proc. U.S. Nat. Mus., vol. 36, 1909, p. 408 (*I. exquisita* sp. nov.).

Antedon (part) A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 139.

Euantedon A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 31 (diagnosis and comparison with related genera; type species *Antedon moluccana* A. H. Clark, 1912); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, p. 5 (represents in part *Antedon* in the east; range); *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, Echinod., II, Crinoidea, 1914, p. 313 (closely related to *Antedon;* species; range); Die Crinoïden der Antarktis, 1915, p. 181 (range; represents in part *Antedon* in the east); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Antedoninae); No. 16, p. 505 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovered by the *Siboga;* with *Mastigometra* represents *Antedon* in the east), p. 197 (in key; range), p. 200 (key to the included species).—H. L. CLARK, Rec. South Australian Mus., vol. 3, No. 4, 1928, p. 369.—COTTON and GODFREY, Rec. South Australian Mus., vol. 7, 1942, p. 232.—H. L. CLARK, Echinoderm fauna of Australia, 1946, p. 60 (in key), p. 61 (type species; distribution).

Diagnosis.—A genus of Antedoninae in which the cirri are XXV–L; P_1, though elongated, is shorter than the cirri, more or less stiffened, and composed of less than 25 segments; P_2 is of the same character as P_1, but shorter; P_3 is shorter still and is of the same length and character as the succeeding pinnules.

Type species.—*Antedon moluccana* A. H. Clark, 1912.

Geographical range.—From the Philippines and Moluccas to China, eastward to the Society Islands and south to St. Vincent Gulf, South Australia.

Bathymetrical range.—From the shore line down to 397 meters.

Remarks [by A.M.C.].—As stated in the discussion of this subfamily on p. 50, the diagnosis of this genus has had to be modified with regard to the limitation in the number of segments in P_1 in order to accommodate the species *Euantedon paucicirra* H. L. Clark, 1928. The wide range of other genera and even species with regard to the number of segments in P_1 makes it unlikely that the difference between 12 and 18 segments in P_1 is sufficient on its own to debar *paucicirra* and *moluccana* from being congeneric. At the same time the species *Iridometra exquisita* can be referred to *Euantedon*. Mr. Clark (MS) had included it in *Argyrometra* but I think that its relatively long cirri ally it with the species of this genus.

KEY TO THE SPECIES OF EUANTEDON

a^1. Cirrus segments up to about 25.
- b^1. Cirri about XL when the arm length is 100 mm. (Tahiti)........ **tahitiensis** (p. 100)
- b^2. Cirri about XXV when the arm length is 40 mm. (South Australia)....... **paucicirra** (p. 101)

a^2. Not more than 17 cirrus segments.
- b^1. Longest cirrus segments about four times as long as their median widths or longer.
  - c^1. Cirrus segments hardly at all expanded at their distal ends (Moluccas; 397 meters). **moluccana** (p. 102)
  - c^2. Cirrus segments markedly expanded at their distal ends (Philippines; 62–142 meters). **exquisita** (p. 103)
- b^2. Longest cirrus segments from two to two and a half times as long as broad; antepenultimate not so much shorter.
  - c^1. Cirrus segments with each end thickened and prominent; the longest cirri 13–15 mm. long when the arms are 60 mm. (?China; deep)........ **sinensis** (p. 105)
  - c^2. Cirrus segments not prominently swollen at the ends; cirri 8–10 mm. long when the arms are 80 mm. (East Indies; 2–15 meters)........ **polytes** (p. 106)

EUANTEDON TAHITIENSIS A. H. Clark

Euantedon tahitiensis A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationship with *E. moluccana*), p. 200 (in key; range; description; Tahiti).—H. L. Clark, Rec. South Australian Mus., vol. 3, No. 4, 1928, p. 370 (comparison with *E. paucicirra*).

Diagnostic features.—There are about XL cirri with up to 25 segments of which the longest are from two and a half to three times as long as broad. The arms are about 100 mm. long in the two known specimens.

Description.—Centrodorsal very low, with a relatively large, slightly convex dorsal pole 1.5 mm. in diameter; cirrus sockets arranged in about three closely crowded more or less irregular alternating rows.

Cirri XL, 22–25, from 15 mm. to 20 mm. long; first segment very short, second about twice as broad as long, third about as long as broad, fourth not quite twice as long as the median diameter, fifth slightly longer, sixth and seventh the longest, between two and two and a half times as long as the median diameter; the following decrease very slowly in length, the fourteenth or fifteenth and those succeeding being usually from a third to a half again as long as the median diameter, though sometimes only slightly longer than broad; the segment preceding the antepenultimate and the antepenultimate itself become longer again, about twice as long as broad; on the segments as far as the eighth, both the dorsal and ventral profiles are equally concave, so that the articulations are prominent; from this point onward the dorsal profile becomes progressively more and more concave, and the ventral less and less, the segments beyond the twelfth or thirteenth thus have the ventral profile approximately straight, and the dorsal very strongly and narrowly concave so that both ends of the segments on the dorsal side appear very prominent; opposing spine very small, terminal or subterminal, directed obliquely forward; terminal claw slightly shorter than the penultimate segment, moderately curved.

The distal border of the radials projects slightly beyond the rim of the centrodorsal.

When viewed at right angles to the plane of their dorsal surface the IBr_1 appear oblong, about four times as broad as long; when viewed at right angles to the dorsoventral axis of the animal the median length appears to be about one third less than the lateral; IBr_2 (axillaries) rhombic, half again as broad as long, the anterior angle sharp, the posterior process very broad and obtuse; the anterior borders are moderately concave; the proximal borders are straight except just before they reach the lateral border, where they turn to a horizontal direction and then curve slightly downward, fitting snugly around the rounded distal angles of the IBr_1; the elements of the IBr series and the first two brachials are in very close lateral apposition, and are more or less sharply flattened against their neighbors.

Arms 10, 100 mm. long; first brachial wedge-shaped, three times as long exteriorly as interiorly, the inner border in close contact with that of its fellow; second brachial nearly of the same size and shape, slightly larger and more irregular; first syzygial pair (composed of the third and fourth brachials) slightly longer interiorly than exteriorly, twice as broad as long; following brachials as far as the second syzygy irregularly wedge-shaped, about three times as broad as long, those beyond the second syzygy triangular, somewhat broader than long, soon becoming wedge-shaped, slightly broader than long, and distally wedge-shaped, about as long as broad, and terminally longer than broad.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of three muscular articulations.

P_1 is 7.5 mm. long, composed of 10+ segments, of which the first is twice as broad as long, the second is slightly longer than broad, the third is half again as long as broad, and the following are twice as long as broad, becoming three times as long as broad distally; the third and following have rather prominent distal ends armed with fine spines, at first only on the distal border (away from the ventral surface), later all around; the pinnule is markedly stouter than those succeeding, and somewhat stiffened; P_2 is 6 mm. long, with 10 segments, resembling P_1 but more slender and with proportionately longer segments distally; P_3 is 4.5 mm. long, with 11 segments, smaller, more delicate and less stiffened than P_2; distal pinnules from 8 to 9 mm. long and very delicate, with 20 or 21 segments.

Locality.—Tahiti, Society Islands [A. H. Clark, 1918] (2, Munich M.).

EUANTEDON PAUCICIRRA H. L. Clark

Euantedon paucicirra H. L. Clark, Rec. South Australian Mus., vol. 3, No. 4, 1928, pp. 369–370 (description; locality); fig. 109, p. 370.—Cotton and Godfrey, Rec. South Australian Mus., vol. 7, 1942, p. 232 (distribution).—H. L. Clark, Echinoderm fauna of Australia, 1946, p. 61 (size and color).

Diagnostic features.—Cirri XXV, 17–26 (usually about 20), the longest segments about twice as long as broad; arms about 40 mm. long in the holotype.

Description.—The centrodorsal is low, hemispherical, about 2.5 mm. in diameter and slightly convex, with the cirrus sockets closely crowded, arranged roughly in two or three irregularly horizontal series. Cirri XXV, 17–26 (usually about 20), 10 mm. in length; the three basal segments are broader than long but the rest are longer than broad, the sixth to tenth being the longest and up to twice as long as their median thickness. In profile all but the first and last few segments are concave on the dorsal side and less so on the ventral. The distal margin of the longer segments is oblique, the ventral side being longer than the dorsal. The cirri are compressed distally. The terminal claw is short, curved and very sharp; the opposing spine is small, but sharp and conspicuous.

The radials are nearly or quite concealed by the centrodorsal. The IBr_1 are oblong, about four times as wide as long, the lateral edges straight, parallel and a trifle everted. The IBr_2 are low, twice as broad as long, pentagonal with the lateral margins about half as long as those of the IBr_1. The distal angle is a right angle.

The 10 arms are about 40 mm. long. The first brachial is wedge shaped, twice as long externally as internally, just in contact internally with its fellow of the adjacent arm. The first syzygies are between brachials 3+4, 9+10, 14+15, and then at intervals of three muscular articulations.

P_1 is 5 to 7 mm. long. It is rather stiff and tapering, much stouter than the succeeding pinnules, and has 10 to 12 segments, of which the second is longer than broad, the following ones twice and distally three times as long as broad. The third and following segments have the distal edge on the outer side rather prominent. P_2 is 3.5 mm. long, with 7 segments, slightly more elongate than those of P_1, with rather more prominent ends. P_3 is slightly shorter than P_2, somewhat more slender, less stiffened and with a gonad.

Localities.—St. Vincent's Gulf, South Australia [H. L. Clark, 1928] (2, S. Austr. M.). Type locality.

Marino, South Australia; on reef [Cotton and Godfrey, 1942].

EUANTEDON MOLUCCANA (A. H. Clark)

Antedon moluccana A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 129 (description; *Siboga* Sta. 139).

Euantedon moluccana A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 32 (comparison with *E. sinensis*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationships with *E. tahitiensis* and *E. sinensis*), p. 200 (in key; range), p. 201 (references; detailed description; Sta. 139), p. 273 (listed), pl. 25, figs. 72, 73.

Diagnostic features.—There are 15 to 17 cirrus segments of which the longest are about 4 times as long as the median diameter and the distal decrease in length so that the antepenultimate is little, if at all, longer than broad; the cirrus segments have a straight dorsal and ventral profile, and their ends are not enlarged.

Description.—Centrodorsal low hemispherical, the bare dorsal pole 1.5 mm. in diameter and very slightly convex with an obscure broad median tubercle surrounded by obsolete cirrus sockets.

Cirri about XXX, 15–17 (usually 17), slender and delicate, the longest about 18 mm. long; first segment very short, second from half again to twice as long as the median diameter, third from two and a half to three times as long as the median diameter, fourth and following about four times as long as the median diameter; segments after the eighth slowly become shorter so that the antepenultimate is little, if at all, longer than broad; penultimate segment small, wedge-shaped, about half the size of the antepenultimate; opposing spine small and subterminal; longer earlier segments moderately constricted centrally, with expanded and slightly overlapping ends; shorter terminal segments with straighter dorsal and ventral profiles, so that in lateral view the cirri appear to broaden just at the tip; there may be a slightly marked transition segment at about the eighth.

Distal borders of the radials even with the rim of the centrodorsal.

IBr_1 very short, about four times as broad as the lateral length, which is about twice the median length; the lateral edges are concave; the ossicles are just in apposition basally, but diverge from each other in the interradial angles at an obtuse angle of about 120°; IBr_2 (axillaries) slightly broader than long, very widely separated; the lateral edges are about as long as those of the IBr_1, concave, diverging outward at approximately a right angle with each other; the anterior sides are approximately at right angles to each other, nearly straight; the anterior angle is only very slightly and broadly produced; a rounded median posterior projection incises the IBr_1.

The 10 arms are all broken; the size appears to be about that of an average *Antedon mediterranea*. First brachial very short, twice as long exteriorly as interiorly, the median length about the same as the internal; proximal third of the inner border united with that of its fellow, but the distal two thirds diverge almost in a straight line; second brachial much larger, irregularly quadrate. The structure of the arms is essentially the same as that of *Antedon mediterranea*. The width of the first syzygy is 1.3 mm. and the length from the proximal edge of the IBr_1 to 9+10 about 8 mm.

P_1 is from 13.5 to 16.0 mm. long, composed of from 18 to 21 segments, moderately slender and tapering evenly from the base to the delicate tip; first segment not quite so long as broad, second decreases slightly in diameter distally and about as long as its proximal diameter; third between two and a half and three times as long as broad, the following somewhat over three times as long as broad, becoming more elongate distally; the segments have the whole surface very finely spinous, and the outer have very finely spinous distal ends; the articulations are very slightly swollen; P_a is similar to P_1, but not quite so long; P_2 is 7 mm. long, with 14 or 15 segments, much more slender than P_1 but otherwise similar; P_3 is 5 mm. long, with 11 segments, slender and weak, all but the two basal segments much elongated; P_4 is 5 mm. long, with 10 segments, slender and weak like P_3, but more slender beyond the third segment; P_5 is 6 mm. long, with 13 segments, slightly stouter than P_4 with slightly shorter segments; P_6 is 7.5 mm. long, with 14 segments, similar to P_5 but the component segments slightly shorter and with more expanded ends.

Locality.—*Siboga* station 139; Molucca Passage, north of Batjan (lat. 0°11′ S., long. 127°25′ E.); 397 meters; mud, stones and coral; August 4, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.).

EUANTEDON EXQUISITA (A. H. Clark)

Iridometra exquisita A. H. Clark, Proc. U.S. Nat. Mus., vol. 36, 1909, p. 408 (description; *Albatross* Sta. 5178); vol. 39, 1911, p. 559 (*Albatross* Sta. 5483); Crinoids of the Indian Ocean, 1912, p. 232 (synonymy; Philippine Is., 74–78 fms.); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 212 (in key; range), p. 213 (references; notes).

Diagnostic features.—The XL–L cirri have up to 15 greatly elongated segments, up to 6 times as long as the median width, with much expanded distal ends; the antepenultimate is over twice as long as wide.

The arms are from 40 to 50 mm., and the cirri are from 10 to 12 mm. in length in the four known specimens.

Description.—The centrodorsal is low rounded conical with a very small papillose polar area; the cirrus sockets are arranged in four or five closely crowded alternating rows and have rather prominent margins. There are four or five sockets along the edge of the centrodorsal in each radial area. The cirrus sockets decrease regularly in size from the marginal to those about the dorsal pole.

The cirri are XL–L, 14–15, from 10 to 12 mm. long. The first segment is short, the second is from half again to twice as long as broad, and the third to eighth are greatly elongated, from four to six times as long as the median width or even longer; the following segments gradually decrease in length so that the antepenultimate is from two to three times as long as broad and the penultimate is of about the same length or shorter, sometimes tapering distally and without an opposing spine, but usually not tapering and bearing a small opposing spine. The longer cirrus segments are more or less strongly constricted centrally with expanded ends.

The distal edge of the radials is even with the margin of the centrodorsal in the median line, rising slightly toward the interradial angles. The IBr_1 are very short and bandlike, depressed in the median line where they are incised by the posterior process of the axillaries, in lateral contact or free basally. The IBr_2 (axillaries) are rhombic, half again to twice as broad as long, with all the sides strongly concave and the anterior angle produced.

The 10 arms are from 40 to 50 mm. long. The first brachial is more than twice as long exteriorly as interiorly, with the two sides converging rather strongly, and is deeply incised by the posterior process of the second; interiorly adjacent first brachials are just in contact basally over the anterior angle of the axillary, and their interior borders diverge at somewhat more than a right angle. The second brachials are about as long as broad, irregularly quadrate, with the two proximal sides rather strongly concave. The first syzygial pair, composed of the third and fourth brachials, is slightly longer interiorly than exteriorly, and about as broad as long exteriorly. The next four brachials are oblong, about twice as broad as long, the following becoming triangular and about as long as broad, after the end of the proximal third of the arm obliquely wedge-shaped and rather longer than broad, and very gradually increasing in length distally.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 6 mm. long, moderately stout basally but evenly tapering and becoming slender distally, composed of 12 to 14 segments, of which the first is twice as broad as long, the second is half again as long as broad, and the third and following are from three to three and a half times as long as broad, becoming slightly shorter again terminally. P_2 is similar, from 3 to 5 mm. long with 9 to 11 segments, of which the first is twice as broad as long, the second is slightly longer than broad, the third is twice as long as broad, and the remainder are much elongated. The distal ends of the segments of these pinnules are rather prominently spinous.

P_3 resembles the succeeding pinnules; it is from 2 to 4 mm. long with 8 or 9 segments; it does not taper so rapidly as P_2 and the segments are less elongated so that it appears somewhat stouter; it bears a small gonad in the distal portion, and the segments have slightly overlapping and spinous distal ends. P_4 resembles P_3. P_5 is usually slightly longer with one or two more segments. The distal pinnules are about 6 mm. long.

The color in alcohol is white with blotches of brown on the arms and pinnules; the perisome is brown.

Localities.—*Albatross* station 5178; Philippine Islands, in the vicinity of Romblon; Port Origon (N.) bearing S. 5° E., 2.3 miles distant (lat. 12°43′00″ N., long. 122°06′15″ E.); 142 meters; fine sand; March 25, 1908 [A. H. Clark, 1909] (1, U.S.N.M., 25371). Type locality.

Albatross station 5483; in the vicinity of Surigao Strait, between Samar and Leyte; Cabugan Grande Island (N.) bearing N. 88° W., 5.7 miles distant (lat. 10°27′30″ N., long. 125°19′15″ E.); 135 meters; sand and broken shells; July 30, 1909 [A. H. Clark, 1911] (2, U.S.N.M., 36024).

Albatross station 5152; Tawi Tawi group, Sulu (Jolo) archipelago; Pajumajan Island (W.) bearing S. 2° W., 2 miles distant (lat. 5°22′55″ N., long. 120°15′45″ E.); 62 meters; white sand; February 18, 1908 (1, U.S.N.M., 57656).

Geographical range.—Only known from the Philippine Islands.

Bathymetrical range.—From 62 to 142 meters.

Remarks [by A.M.C.].—The limitation of *Iridometra* to species in which the first three pinnules are approximately equal has necessitated the removal of this species. Mr. Clark had included it in *Argyrometra* in the typescript, but the smaller number of cirri distinguish it from the two species of that genus. The rediagnosis of *Euantedon* to include species with less than 18 segments in P_1 allows the inclusion of *exquisita* in this genus.

EUANTEDON SINENSIS A. H. Clark

Euantedon sinensis A. H. Clark, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 31 (description; ?coast of China; comparison with species of *Antedon*), p. 32 (comparison with *E. moluccana*); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationship with *E. moluccana*), p. 200 (in key; range), p. 203 (references); Temminckia, vol. 1, 1936, p. 316 (comparison with *E. polytes*).

Diagnostic features.—There are 15 to 17 cirrus segments of which the longest are from two to two and a half times as long as broad, and the distal are only very slightly shorter; in the outer portions of the cirri the proximal and distal ends of the segments dorsally are slightly thickened; as a whole the cirri recall those of *Antedon mediterranea* or of *A. adriatica*.

The arms are about 60 mm. and the cirri are from 13 to 15 mm. in length.

Description.—The cirri are about XXX, 15–17, the longest probably from 13 to 15 mm. long; the longest segments in the proximal portion are from two to two and a half times as long as broad; the distal segments are only very slightly shorter. The cirri in general appearance resemble those of *Antedon adriatica*; the dorsal proximal and distal edges of the segments are slightly thickened in the outer portion of the cirri as in *Antedon mediterranea* and in *A. adriatica*.

The 10 arms are about 60 mm. long, and resemble those of *A. adriatica*.

The distal intersyzygial interval is 3 muscular articulations.

P_1 is broken in all cases; but it is longer and stouter than P_2. The first segment is short, the second is slightly longer than broad, the third is slightly over twice as long as broad, and the following are about three times as long as broad. The distal edges of the third and following segments are slightly produced. P_2 is from 6.0 to 6.5 mm. in length composed of 9 or 10 segments, of which the second is about as long as broad, the third is nearly twice as long as broad, and the following increase in length so that the outer are about four times as long as the median diameter; the third and following segments have slightly produced and finely spinous distal edges. The following pinnules are small and weak.

Locality.—?Coast of China; "very deep water" [A. H. Clark, 1912, 1913, 1915, 1918] (1, H.M.).

EUANTEDON POLYTES A. H. Clark

Euantedon polytes A. H. Clark, Temminckia, vol. 1, 1936, p. 295 (listed), pp. 315, 316 (description), pl. 7, fig. 5, pl. 8, fig. 6.

Diagnostic features.—Cirri XXX, 13–14, 8 to 10 mm. long; the longest cirrus segments are about twice as long as broad; P_1 is 11 to 15 mm. long with 17 to at least 20 segments.

Description.—Cirri about XXX, 13–14 (usually 13), 8 to 10 mm. in length. The longest cirrus segments are about twice as long as broad; the antepenultimate is as long as broad, or only very slightly longer than broad, and that preceding is only slightly longer. The longest segments have a slightly concave ventral profile and a still more slightly concave dorsal profile, so that their ends do not appear swollen. In lateral view the cirri are half again as broad in the compressed distal portion as proximally. The cirri are, in general, like those of *Antedon bifida*.

The arms number 10 and are 70 to 80 mm. long. Together with the division series they resemble those of *E. sinensis*.

P_1 in the holotype is 11 mm. long, with 17 or 18 segments. In the paratype it is 15 mm. long, with over 19 segments. The second segment is as long as broad, the third is half again as long as broad and those following gradually increase in length, so that the thirteenth and succeeding segments are about four times as long as broad. The segments in the proximal half are very slightly constricted centrally, but the distal ends are scarcely, if at all, produced.

P_2 is 7.5 mm. long in the holotype, with 14 segments, similar to P_1 but proportionally more slender. P_3 is shorter than P_2 and resembles the succeeding pinnules.

In the paratype P_2 is 13 mm. long, with 23 segments (probably about as many as, or slightly fewer than, P_1) resembling P_1 but very slightly more slender and with the distal segments more elongated. P_3 is 6.5 mm. long with 12 segments, about as stout basally as P_2, but tapering more rapidly. The following pinnules are similar.

The color of one specimen is light yellow brown, mottled with lighter, and of the other brown regularly banded with white, the syzygial pairs being white and the other brachials brown.

Localities.—*Willebrord Snellius*; Tanah Djampea, south of Celebes; 2–3 meters; February 21–22, 1930 [A. H. Clark, 1936] (1, Leyden Mus.). Type locality.

Willebrord Snellius; near Koepang (Timor), East Indies; 10–15 meters; December 2, 1929 [A. H. Clark, 1936] (1, Leyden Mus. ?).

Geographical range.—Known only from the East Indies.

Bathymetrical range.—From 2 to 15 meters.

Genus MASTIGOMETRA A. H. Clark

Mastigometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 229 (type *M. flagellifera*); vol. 22, 1909, p. 176 (referred to the Antedoninae); Vid. Medd. Nat. Foren. København, 1909, p. 128 (East Indian representative of *Antedon*), p. 190 (most closely related to *Antedon*; comparisons); Proc. U.S. Nat. Mus., vol. 38, 1910, p. 331 (represents *Antedon* in the Indian Ocean;

less specialized than *Antedon*); vol. 40, 1911, p. 10 (closely related to the Atlantic *Antedon*), p. 14 (not known from the Arabian Sea, but possibly exists there); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 449 (barely separable from *Antedon*); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia), p. 726 (closely related to *Antedon*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 31 (compared with *Euantedon*); Crinoids of the Indian Ocean, 1912, p. 9 (does not occur in the area of maximum intensity of the East Indian fauna; absent from Australia), p. 10 (absent from Japan; reason), p. 11 (represented at Ceylon), p. 13 (relation to *Antedon*), p. 25 (range), p. 63 (in key), p. 227 (reference; type); Internat. Revue gesamt. Hydrobiol. und Hydrogr., 1914, p. 5 (eastern representative of *Antedon*; range); *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 313 (relation to *Antedon*; has 2 species; range); Die Crinoiden der Antarktis, 1915, p. 181 (range; represents, in part, *Antedon* of the Atlantic); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, p. 16 (phylogenetic study); Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (referred to the Antedoninae); No. 16, p. 505 (in key; range); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. viii (with *Euantedon* represents *Antedon* in the east), p. 197 (in key), p. 198 (key to the included species).

Diagnosis.—A genus of Antedoninae in which P_1 is very long, becoming very slender and flagellate distally, composed of 30 to 40 segments; P_2 resembles P_1 and is about two-thirds as long (and a third again as long as P_3), with at least four-fifths as many segments; P_3 is of the same length and character as the succeeding pinnules; the segments of the lower and middle pinnules have unmodified distal edges.

Type species.—*Mastigometra flagellifera* A. H. Clark, 1908.

Geographical range.—From Ceylon eastward to the Society Islands.

Bathymetrical range.—From the shore line down to 48 meters.

[Note by A.M.C.] Though this genus may be the Indo-West Pacific counterpart of the North Atlantic *Antedon* it has been collected very seldom. Of the three species only one, *M. micropoda*, is known from more than a single specimen and but five specimens of that have been recorded. This rarity is probably due in part to the competition in the littoral Indo-West Pacific with the numerous species of Oligophreata.

KEY TO THE SPECIES OF MASTIGOMETRA

[modified by A. M. C.]

a^1. Cirri very numerous, at least L, centrodorsal low hemispherical.
- b^1. P_1 about 25 mm. long, P_2 about 16 mm. (locality unknown) .... **flagellifera** (p. 107)
- b^2. P_1 about 15 mm. long, P_2 about 9 mm. (Ceylon; 0–47 meters) .... **micropoda** (p. 109)

a^2. Cirri less than L, centrodorsal almost discoidal (Tahiti; littoral) .... **pacifica** (p. 110)

MASTIGOMETRA FLAGELLIFERA A. H. Clark

[See vol. 1, pt. 2, fig. 750, p. 349]

Mastigometra flagellifera A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 229 (description; locality unknown); Vid. Medd. Nat. Foren. København, 1909, p. 128 (relationships), p. 191 (probably East Indian); Crinoids of the Indian Ocean, 1912, p. 227; Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range; references).

Antedon flagellifera A. H. Clark, Vid. Medd. Nat. Foren. København, 1909, p. 117 (unpublished ms. name of Lütken).

Diagnostic features.—The L–LXXX cirri have about 15 segments of which the distal are from a third to half again as long as broad; P_1 is 25 mm. long, with 40 segments; P_2 is 16 mm. long, with 35 segments; P_3 is from 10 to 12 mm. long, with 25 segments.

The arms are about 120 mm. and the cirri are from 12 to 14 mm. in length in the unique holotype.

Description.—The centrodorsal is hemispherical, with a rather small convex bare polar area.

The cirri are L LXXX, 15, about 12 mm. long. The first two segments are short, about twice as broad as long, the third is about a third again as long as broad, the fourth and fifth, which are the longest, are about half again as long as broad, and the following decrease gradually in length to the one preceding the antepenultimate which is about a third again as long as broad, the last two being about half again as long as broad. The opposing spine is represented by a very small terminally situated tubercle which, however, may be absent. The fourth and fifth segments are very slightly constricted centrally, but the remainder have almost straight edges. Up to about the sixth segment the cirri are circular in cross section; from that point onward they are somewhat compressed laterally and appear somewhat broader in lateral view.

The distal border of the radials is even with the edge of the centrodorsal. The IBr_1 are very short, about five times as broad as long in the median line, narrowing rapidly anteriorly, not in apposition basally. The IBr_2 (axillaries) are triangular, about half again as broad as long, as broad basally as the distal ends of the radials and consequently overhanging on either side the narrow distal ends of the IBr_1.

The 10 arms are probably about 120 mm. long. The first brachial is very obliquely wedge-shaped or almost triangular, much longer exteriorly than interiorly, just in contact with that of the adjoining arm basally, the free inner borders of the two diverging practically in a straight line. The second brachial is irregularly quadrate, about as long as the outer border of the first. The first two brachials and the IBr_2 have a somewhat produced and thickened border. The synarthrial articulation between the elements of the IBr series and the first two brachials rises to a moderate tubercle. The first syzygial pair (composed of the third and fourth brachials) is about half again as long interiorly as exteriorly, and half again as broad as the greater length. The next four brachials are oblong, about twice as broad as long, the following becoming wedge-shaped and after the second syzygial pair triangular and about twice as broad as long, later wedge-shaped again and somewhat longer. The distal portion of the arms is lacking.

Syzygies occur between brachials 3+4, 9+10, and 14+15 to 16+17, and distally at intervals of from 3 to 7 (usually 3) muscular articulations. The distal ends of the brachials following the first syzygial pair are rather prominent.

P_1 is 25 mm. long, moderately stout at the base but gradually tapering and in the distal half very slender and flagellate, composed of 40 segments, of which the first is about as long as broad, the following gradually increase in length, and the tenth and those succeeding are about half again as long as broad. The first five segments are slightly constricted centrally. P_2 is 16 mm. long, similar to P_1 but not so stout basally, with about 35 segments. P_3 is from 10 to 12 mm. long, about as stout basally as P_2 but less slender and flagellate distally, tapering more evenly from the base to the tip, with 20 segments which resemble those of P_1 and P_2; it bears a long gonad. P_4 and the following pinnules are similar to P_3. The gonad disappears at about the twelfth pinnule, after which the pinnules are about 15 mm. long, exceedingly slender, with about 35 segments, of which the first is short and crescentic, the second is irregularly quadrate, about as long as its distal diameter, the third is squarish, and the following gradually increase in length, in the distal half being about twice as long as broad.

The color in alcohol is brownish yellow.

Locality.—Unknown [A. H. Clark, 1908, 1909, 1912, 1918] (1, C.M.).

MASTIGOMETRA MICROPODA A. H. Clark

Figure 8

[See also vol. 1, pt. 2, figs. 570, 571, p. 298]

Mastigometra micropoda A. H. Clark, Proc. U.S. Nat. Mus., vol. 36, 1909, p. 649 (description; ?India); Vid. Medd. Nat. Foren. København, 1909, p. 128 (closely related to *M. flagellifera* and to the species of *Antedon;* Indian Ocean and Ceylon); Crinoids of the Indian Ocean, 1912, p. 227 (detailed description; ?India; Ceylon); fig. 42, p. 228.—H. L. Clark, Spolia Zeylanica, vol. 10, pt. 37, 1915, p. 93 (occurs at Ceylon).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 200 (references).

Diagnostic features.—The L–XC cirri have about 16 segments, of which the sixth and following are about as long as broad; P_1 is 15 mm. and P_2 is 9 mm. long.

The arms are about 80 mm. and the cirri about 10 mm. in length in the holotype.

Description.—The centrodorsal is low hemispherical, 4 mm. in diameter at the base, the polar area slightly convex, or flattened; the cirrus sockets are very numerous and are arranged in four or five closely crowded alternating rows.

Cirri L–XC, 16, about 10 mm. long; the first two segments are short, rather over twice as broad as long, the third is from as long as broad to a third again as long as broad, and the fourth and fifth are slightly longer; the following segments are subequal, about as long as broad; the third to sixth segments are slightly constricted centrally, the remaining segments having the ventral surface practically straight and the dorsal with a slight median concavity. The cirri become somewhat compressed laterally in the distal two thirds and therefore appear very slightly broader in lateral view. The opposing spine is represented by a slight terminally situated tubercle which may be obsolete.

Scattered calcareous granules are present along the ambulacral grooves of the disk and perisomic interradials may be present between the IBr_1 as in *Antedon bifida.*

The distal borders of the radials are even with the edge of the centrodorsal. The IBr_1 are very short, five or six times as broad as long, of uniform height, not quite in apposition basally, the lateral edges of adjacent plates diverging distally. The IBr_2 are triangular, about half again as broad as long, the distal angle somewhat produced, the proximal border as long as the proximal border of the IBr_1.

The 10 arms are probably about 80 mm. long, and resemble in structure those of *M. flagellifera.*

The distal intersyzygial interval is 3 muscular articulations.

P_1 is 15 mm. long, much stouter basally than the succeeding, though tapering evenly to an exceedingly slender and delicate flagellate tip. P_2 is 9 mm. long. The following pinnules gradually decrease in length. The pinnules are of the same proportions and structure as are those of *M. flagellifera.*

The color in alcohol is brownish white.

Localities.—?India [A. H. Clark, 1909, 1912, 1918] (4, U.S.N.M., 35655 [17H], 35656 [16H]; the holotype, I.M.). Type locality.

Off the Colombo Light House, Ceylon; 48 meters [A. H. Clark, 1909, 1912, 1918] (1, I.M.).

Remarks.—The five known specimens of this species were all collected by the *Investigator;* only one of them bears a definite locality.

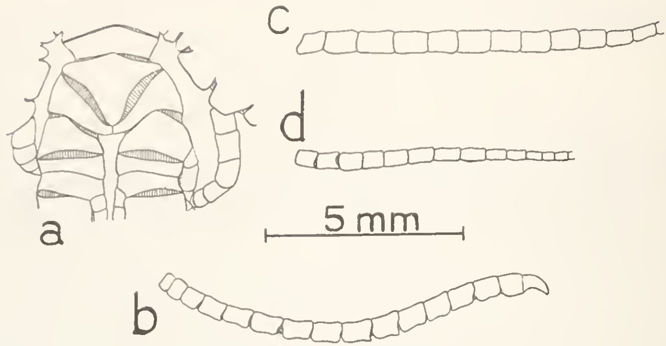


FIGURE 8.—*Mastigometra micropoda* A. H. Clark, U.S.N.M., 35656: *a*, Part of postradial series; *b*, cirrus; *c* and *d*, proximal parts of P_1 and P_2.

[NOTE BY A.M.C.] The specimen U.S.N.M. 35656 differs slightly from the one described above in the proportions of the cirrus segments, most of which on the peripheral cirri are longer than broad. The arms are notably constricted at the syzygies. The breadth at the first is 1.5 mm. and the length from the IBr_1 to the second syzygy is 9.0 mm. The longest cirrus has 16 segments and measures 11 mm., a shorter detached one has 18 segments. The proximal pinnules are all broken.

MASTIGOMETRA PACIFICA A. H. Clark

Mastigometra pacifica A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 199 (description; Tahiti).

Diagnostic features.—The cirri are about XXXV with 12–16 segments, of which the distal are from a third to half again as long as broad; P_1 is 15 mm. long, with 30 segments; P_2 is 10 mm. long, with 24 segments; P_3 is 7 mm. long, with 13 to 15 segments.

The arms are 105 mm. and the cirri from 12 to 14 mm. in length in the unique holotype.

Description.—The centrodorsal is very flat, almost discoidal, with a large flat dorsal pole 2 mm. in diameter; the cirrus sockets are arranged in two and a partial third alternating marginal rows.

The cirri are about XXXV, 12–16 (the longest usually 14–16), 12 to 14 mm. long, in general appearance strongly suggesting those of *Antedon petasus*. The first segment is very short, the second about twice as broad as long, third nearly as long as broad, fourth slightly longer than broad, fifth the longest, from a third to half again as long as the median diameter, the following have about the same proportions; from the fourth or fifth segment onward the cirrus in lateral view increases slowly in diameter so that the outer portion, which is rather strongly recurved, is nearly twice as broad as the proximal. The opposing spine is minute; the terminal claw is nearly as long as the penultimate segment, stout and strongly curved. The earlier cirrus segments have a slight central constriction; the outer in lateral view have a quite straight dorsal, and a nearly straight ventral, profile.

The distal border of the radials is even with the rim of the centrodorsal.

The IBr_1 are very short, from five to six times as broad as long, with the distal and proximal edges parallel and the lateral edges slightly convergent, making an angle of about 90° with those of the adjacent IBr_1, the perisomic area thus exposed being entirely covered by a conspicuous group of perisomic interradials. The IBr_2 (axillaries) are triangular, half again as broad as long, with the anterior angle somewhat produced.

The 10 arms are 105 mm. long, becoming extremely slender and attenuated distally; the brachials resemble those of the other species of the genus; their distal edges are slightly produced and finely spinous.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of 3 muscular articulations.

P_1 is 15 mm. long, composed of 30 segments, of which the first is broader than long, the second half again as long as broad, and the third and following twice as long as broad, becoming longer in the distal half; from about the fifth onward the segments have overlapping and prominently spinous distal ends; the pinnule is considerably stouter basally than P_2 and the succeeding pinnules, but becomes exceedingly attenuated and flexible in the distal half. P_2 is 10 mm. long, with 24 segments, more slender than P_1 and with relatively longer segments, which have more prominently spinous distal ends. P_3 is 7 mm. long, with from 13 to 15 segments, tapering more gradually than P_2 and hence appearing stouter, and without the long flagellate tip. P_4 apparently resembles P_3, but is somewhat shorter.

Locality.—Tahiti, Society Islands [A. H. Clark, 1918] (1, Munich M.).

Genus ANTEDON de Freminville*

Δεκάκνημος Linck, De Stellis marinis, Leipzig, 1733, p. 55.—Leuckart, Zeitschr. organ. physik, vol. 3, 1829, p. 377.—W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 678 (history).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 2 (history).

Asterias (part) Linnaeus, Systema Naturae, ed. 10, vol. 2, 1758, p. 663; ed. 12, 1767, p. 1098.—Pennant, British zoology, vol. 4, 1777, p. 55.—Retzius, Kungl. Svenska Vet.-Akad. Handl., 1783, vol. 4, p. 241.—Olivi, Zoologia adriatica, Bassano, 1792, p. 66.—Nemnich, Allgemeines Polyglotten-Lexicon der Naturgeschichte, vol. 1, 1793, pp. 1172, 1490.—Retzius, Dissertatio sistens species cognitas asteriarum, Lundae, 1805, pp. 33–35.—Treviranus, Biologie, Göttingen, vol. 3, 1805, p. 44.—Rafinesque, Principes fondamentaux de somiologie, Palermo, 1814, p. 24.—Tiedemann, Anatomie der Rohren Holothurie, Landshut, 1816, p. 36.—Griffith, Cuvier's Animal Kingdom, 1835, p. cx.—W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 680.—P. H. Carpenter, Trans. Linn. Soc. (Zool), ser. 2, vol. 2, 1879, p. 2.

Asteria (part) Brunnich, Zoologiae fundamenta, Copenhagen & Leipzig, 1772, p. 230.

Antedon de Freminville, Bull. Soc. Philom. Paris, vol. 2, 1811, p. 349.—Rafinesque, Analyse de la nature, Palermo, 1815, p. 153.—[Bosc], Nouveau Dictionnaire d'Histoire Naturelle, vol. 2, 1816, p. 136; vol. 7, 1817, p. 399.—de Blainville, Dict. Sci. Nat., vol. 10, 1818, p. 107.—Lamouroux, Encyclopédie méthodique, vol. 2, 1824, p. 204.—de Blainville, Dict. Sci. Nat., vol. 60, 1830, p. 230.—[Gervais], Dictionnaire universel d'histoire naturelle, vol. 4, 1844, p. 130.—Gray, List of British animals in the British Museum, pt. 1, Centroniae or radiated animals, 1848, p. 28.—Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 192.—Carus, Handbuch der Zoologie, vol. 2, 1863, p. 515.—Norman, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 101.—Wyville Thomson, Phil. Trans. Roy. Soc., vol. 155, 1865, pp. 513–544.—Böhlsche,

*See also Addenda (pp. 835–837) under 1956, 1957, 1962, 1963, 1965.

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Repometra A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 93 (diagnosis, type species *R. arabica* sp. nov.).

Diagnosis.—A genus of Antedoninae in which P_3 resembles the succeeding pinnules and bears a gonad; P_2 is usually about half as long as P_1 and resembles P_3, and may or may not bear a gonad; sometimes P_2 resembles P_1, when that pinnule is composed of more than 25 segments, but then it is always less than two-thirds as long with less than four-fifths as many segments.

Type species.—*Antedon gorgonia* de Freminville, 1811, a synonym of *A. bifida* (see p. 127).

Geographical range.—From Iceland and about lat. 70° N. in Norway to the West Indies, Rio de Janeiro, the Gulf of Guinea and the Mediterranean, also from the Arabian sea to the East Indian region, China and Japan, and the coasts of Australia.

Bathymetrical range.— From tide pools and floating objects down to 932 meters; but most abundant between 15 and 150 meters.

Specific interrelationships within the genus.—Llhuyd (1699) noted that if Columna's form were really different from his *Decempeda cornubiensium* the differences were very slight.

Linck (1733) recognized three species in his Δεκάκνημος, which is the exact equivalent of *Antedon*, namely *crocea* (based on the *Crocea zaffarana Neapolitanorum* of Columna, often a foot in diameter), *rosacea* (which he figures, based on the *Decempeda cornubiensium* of Llhuyd, distinguished by its smaller size, from 6 to 7 inches in diameter), and *barbata* (which he also figures, the *fimbriata* of Barrelier, whose description he quotes).

Linnaeus (1758) placed all the comatulids with the other brachiate echinoderms in the genus *Asterias*, and evidently intended to designate by the name of *Asterias pectinata* all the species now included in *Antedon*. But the specimen which he had before him, and which he thought was the same form as those described by Llhuyd, Columna, and Barrelier, came from the Indian Ocean, which he mentions as the habitat, and is an example of the species now called *Comatula pectinata*.

Pennant (1777) recognized two British species: *bifida* (based upon the *rosacea* of Linck, which itself was based upon the *Decempeda cornubiensium* of Llhuyd); and *decacnemus*, from the western coasts of Scotland, which he considered the same as Linck's *barbata*, the *fimbriata* of Barrelier.

Fleming (1828), following Pennant, also recognized two British species: *rosacea*, the equivalent of Linck's *rosacea;* and Pennant's *bifida*, which he described as having 30 cirri, and *barbata*, which is the same as Linck's *barbata* (or so assumed by him) and Pennant's *decacnemus*, with only 10 cirri.

Dujardin in 1837 recognized two species: *mediterranea* (including *rosacea* Linck, *bifida* Pennant, *fimbriata* Miller, and *rosacea* de Blainville), and *barbata* (including *barbata* Linck, *decaoeros* [sic] Pennant, and *pectinata* Adams); he also mentions *Comatula decacnemos* as the adult of *Pentacrinus europaeus*, evidently adopting inadvertently the name used by J. V. Thompson.

The Scandinavian form of this genus, which when first discovered had been considered as identical with the Mediterranean form, was described as a distinct species under the name [*Alecto*] *petasus* by Düben and Koren in 1846.

In his monograph J. Müller (1849) admitted three species in the genus *Antedon* as now understood: *mediterranea*, *petasus* and *milleri*, the last being the equivalent of the *Comatula fimbriata* described by J. S. Miller in 1821, which is not the *Comatula fimbriata* of Lamarck, 1816.

In his earlier work Edward Forbes (1841) had considered the British animal identical with the Mediterranean and Scandinavian, recognizing only the single species which he called *rosacea*; but in his last contribution (1851) he lists *petasus* and *europaea* in addition, and gives various localities on the Scottish coast as inhabited by a new species which he did not name. But in Forbes and Godwin-Austen's account of the natural history of the European seas published after his death all these forms are again united under the name *rosacea*.

Dujardin in 1862 recognized *petasus*, from the coasts of Norway, and *mediterranea*, from the Mediterranean and the western coasts of Europe which are warmed by the Gulf Stream.

Two British species were admitted by Norman (1865) on the authority of Sir Wyville Thomson; the characters of these were given as follows:

rosaceus	*milleri*
Perisome of the disk naked, or with scattered tubercles containing groups of radiating calcareous spicules.	Perisome of the disk with scattered warts, supported by groups of diverging spicules.
Centrodorsal convex, flattened at the apex, its sides covered with cirri, but the central flattened portion, of greater or lesser extent, naked.	Centrodorsal uniformly convex, and entirely covered with cirri.
Cirri with 14–18 short segments, the longest but little longer than broad; terminal claw sharp and curved; penultimate segment with a short pointed opposing tubercle, which is not developed into a claw.	Cirri with 15–18 segments, the longest half again as long as broad; terminal claw curved and acute; no trace of an opposing spine.
Proximal pair of pinnules at least twice as long as those succeeding.	Proximal pinnules greatly longer than those succeeding them.
Ovaries short and rounded.	Ovaries long and narrow, extending over more than half the length of the pinnules.
Usually, when mature, without any trace of interradial plates; frequently, however, with groups of usually 3 perisomic interradial plates in the spaces between the IBr axillaries.	Groups of interradial plates occupying the spaces between the IBr axillaries.
Crimson, scarlet, or mottled.	Rich brown or reddish tawny.
Average diameter 4½ inches.	Average diameter 11 inches.

W. B. Carpenter wrote (1866) that none of these characters seemed to him sufficient for the differentiation of the two species to which they are respectively assigned, save the form of the ovaries which, as he was assured by Wyville Thomson, constitute a strongly marked feature in each, and is not liable to gradational variations like size, color, the form and relative abundance of the perisomic plates, or to variations connected with grade of development. He was in doubt as to the proper disposition of the various forms which from time to time had been distinguished. Regarding these he says that he is not able to speak with the positiveness he could desire, since his investigations, though prosecuted over a considerable geographical range, had not yet satisfied him as to the limits of variation within this species. In this, as in many similar cases, points of difference which seem extremely well marked when the most divergent examples from remote localities are compared are found to present gradational modifications which go far to destroy their value as specific characters when a sufficiently large number of examples from intermediate localities are examined.

He remarks that this will be found especially to be the case with those which rest on degree of development. Thus he can attach little value to the flattening of the centrodorsal in one form and its convexity in another, or to the nakedness of the flattened portion in the former while the whole surface is covered with cirri in the latter, when he finds that in the early stage of both the centrodorsal is uniformly convex and entirely covered with cirri so that young specimens of the two could not be differentiated. Nor can he adopt as characters of specific value such variations in the number of the cirri, the number of their segments, the proportion of the length of these segments to their breadth, and the form of the terminal claw as he occasionally meets with among the cirri of specimens from the same locality resembling each other in all other respects, the shedding and renewal of these cirri continuing, in his opinion, through the whole life of the animal, and the several cirri of the same individual often presenting very marked differences in size and in proportions. Even a character which in the first instance appeared so definite as the presence of interradial plates in one form (as in J. S. Miller's *fimbriata*) and their entire absence in another (*rosacea* of Fleming and Forbes, *decameros* of Gray, and *rosaceus* of Norman and Wyville Thomson and as understood by himself) he finds has proved unreliable.

Thus he is led to suspect that the range of variation in this genus is very wide, and that the more extended the comparison of specimens from different localities and from different depths, the more reason there will appear for assigning only a varietal rank to several of what are at present accounted different species.

His disposition of the described species is as follows:

The *rosacea* of Linck (the *Decempeda cornubiensium* of Llhuyd): There can be no reasonable doubt that this is identical with the form from Arran.

The *barbata* of Linck (the *fimbriata* of Barrelier): This he is disposed to consider, with Edward Forbes, as specifically identical with *rosacea*, although Fleming, Lamarck (in the second edition) and de Blainville rank it as distinct.

The *crocea* of Linck (the *Crocea zaffarana Neapolitanorum* of Columna): He says that it is impossible to say with certainty whether this is anything more than a larger form of *rosacea*, and it may not improbably be the *Antedon milleri* of Norman and Wyville Thomson.

The *bifida* and *decacnemos* of Pennant, and Adams' *Asterias pectinata*, he considers, with Forbes, as belonging to the same specific type as Linck's *crocea*, though Lamarck identified Pennant's *decacnemos* and Adams' *Asterias pectinata* with *barbata* (*Comatula barbata* as given by him).

The *europaea* of Leach he says is undoubtedly the same as *rosacea*.

The *mediterranea* of Lamarck is unquestionably the same as *rosacea*.

The *milleri* of J. Müller (the *fimbriata* of J. S. Miller renamed) is scarcely anything else than the variety of *rosacea* which is characterized by the presence of interradial plates; it is probably identical with the *milleri* of Norman and Wyville Thomson.

The *adeonae* of Delle Chiaje (not of Lamarck) he is disposed to identify with *rosacea*.

The *petasus* of Düben and Koren is probably identical with *rosacea*.

Summing up, he gives as undoubted synonyms the following:

rosacea Linck
bifida Pennant
decacnemos Pennant
pectinata Adams
europaea Leach
mediterranea Lamarck
rosacea Fleming
decacnemos J. V. Thompson
petasus Düben and Koren
decameros Gray

and lists with a mark of interrogation:

barbata Linck
barbata Lamarck
milleri J. Müller
fimbriata J. S. Miller
adeonae Delle Chiaje

Also in 1866 Böhlsche described *Antedon dübenii* from Rio de Janeiro. This name is now emended to *duebeni* under the rules of nomenclature.

P. H. Carpenter in 1879 considered the British and the Mediterranean Antedons as specifically identical, but conceded the existence of local varieties. Thus he says that Columna's *Crocea zaffarana Neapolitanorum*, the *crocea* of Linck, is the Neapolitan variety, the *fimbriata* of Barrelier, or the *barbata* of Linck, another variety from the mouth of the Tiber, and the *Decempeda cornubiensium*, or the *rosacea* of Linck, the variety found at Cornwall.

In 1881 he again discussed the interrelationships of the species of *Antedon*. Of *Antedon milleri*, recognized by Wyville Thomson and by Norman, he says that the chief distinction between it and *A. rosacea* is in the length of the ovaries, which are short and rounded in *A. rosacea* but long in *A. milleri*, extending over more than half the length of the pinnules as in *Heliometra glacialis*.

He had examined a few specimens of *milleri*, and was inclined to think the distinction a good one, and that others were correlated with it. So far as he could see at the time the common Mediterranean form is that with the long ovaries; but a very few specimens with short ovaries were obtained by the *Porcupine* in the Bay of Bizerta and on the Skerki Bank.

Antedon petasus he finds entirely distinct from *A. rosacea*, with more numerous cirri composed of slightly longer segments, and more quadrate axillaries, longer brachials, and more nearly equal P_1 and P_a.

In the *Challenger* report (1888) he designates *mediterranea* as a synonym of *rosacea*, while he admits as distinct from the latter *dübeni* and *petasus*, as well as *milleri;* but he says "I have no doubt whatever that some of the following are not good species, *Antedon dübeni*, * * * *Antedon milleri*, *Antedon petasus* and *Antedon rosacea*."

His last discussion of the question appeared in 1891. Here he wrote that specimens from Madeira are unquestionably identical with those from Brazil; but he found great difficulty in making up his mind as to whether the numerous varieties ranging from the Faroe Channel to Madeira, or even further, should all be referred to one species. Such a species seemed to him to be even more variable than *Tropiometra carinata* (which in his view included all the small species of *Tropiometra*) and *Comanthus parvicirra*, which, as he admitted, is saying a good deal; but he was inclined to think that further study would confirm his impression that all these forms represent but one specific type, to which the following names have been applied at different times:

adeonae Delle Chiaje
annulata Risso
barbata Linck
bicolor Delle Chiaje
bifida Pennant
coralina Risso
decacnemos Pennant
decameros Gray
dübeni Böhlsche
europaea Leach
fimbriata Barrelier
fimbriata Dujardin
fimbriata Miller
?*gorgonia* de Freminville
mediterranea Lamarck
milleri J. Müller
pectinata Linné
petasus Düben and Koren
rosacea Linck

It is thus clear that he considered the genus *Antedon* as now restricted to include but a single species.

In working on the embryology of *Antedon* at Naples, Bury (1888) found that his material differed in many details from that described by Wyville Thomson, details which could not be ascribed to differences in technique or observation, and he therefore considered that he was dealing with a distinct varietal form, though he included both under the same specific name.

In 1890 Hartlaub described *Antedon hupferi* from the Ivory Coast.

Seeliger (1892), working at Trieste, found that his material differed both from that of Bury and Barrois, and from that of Thomson, and he was inclined to consider each form as a distinct variety of the species (*rosacea*).

In 1893 Bell and in 1903 Nichols doubted the specific distinctness of *milleri*.

In 1908 the present author recognized three European species in the genus *Antedon*, *A. mediterranea*, *A. bifida*, and *A. petasus*, and in 1910 he described *A. adriatica*. In 1914 he published a synopsis of the genus and a key to the species in which the following forms were admitted as valid:

adriatica A. H. Clark
bifida Pennant
dübenii Böhlsche
hupferi Hartlaub
mediterranea Lamarck
moroccana, sp. nov.
petasus Düben and Koren

Dr. Th. Mortensen, in 1920 discussed the interrelationships of the species of *Antedon*. At first he was inclined to consider *petasus* as generically distinct from *adriatica*, *mediterranea*, and *bifida*, on account of its freely discharged eggs, the hatching of the embryo before the appearance of the ciliated bands, and because of very remarkable differences in the enterocoele vessels and in the endoderm of the embryos. But the adults of *petasus*, he finds, lend no support to such a disposition, and he suggests that it would really seem more natural to distinguish as separate genera or subgenera the group including *adriatica* and *mediterranea*, and that comprising the remaining species.

Prof. René Koehler in 1921 admitted the distinctness of *bifida* and *mediterranea*, and also recognized *moroccana*, although he says that it is extremely close to *bifida*, and scarcely merits specific differentiation, though it might be made a variety of that species.

[Notes by A.M.C.] In 1937 Kolosvary described a new species of *Antedon* from the Adriatic which he named *petasoides*. Most of the characters upon which he distinguished it were such as are generally considered to be of no taxonomic significance in determining species, as Gislén pointed out in the same year when he made *petasoides* a synonym of *adriatica*. However, Kolosvary in 1938 still maintained that *petasoides* is distinct, even if only as a forma of *adriatica*.

In 1955, after comparison of some specimens from Algeria with others from the English Channel and Scotland, Prof. E. Tortonese came to the conclusion that *moroccana* is indistinguishable from *bifida*.

However, Gislén in the same year, after studying the *Atlantide* and other collections from West Africa, concluded that only a single species occurs off northwest and West Africa and that this is not distinct from the west Atlantic *duebeni*. Consequently he reduced both *moroccana* and *hupferi* to the synonymy of the little-known *duebeni*.

Gislén's paper was only received by me after this typescript was completed. From the material available, I had concluded that two distinct forms exist in northwest and West Africa: a more northern one with the cirri distally expanded, ranging from just south of Cape Verde to the Azores and into the western Mediterranean, namely *moroccana*, which is not more than subspecifically distinct from *bifida*, and a southern one, *hupferi*, from Sierra Leone round into the Gulf of Guinea, with cirri more like those of *A. petasus*. I had not speculated on their relationship with *duebeni* beyond commenting that, from the data available, the latter seems to have cirri of the expanded *moroccana*-type.

Gislén believed that the shape of the profile of the cirri is too variable in any one specimen to be used as a specific character and gave photographs of cirri from specimens of *petasus*, *bifida*, and two from West Africa which he called *dübenii*, in support of this. There is indeed some variation in the shapes of the individual cirri of each specimen, but it is clear that the form depends on the maturity of the cirrus. The younger, more apical (or possibly regenerated) ones are consistently less expanded distally than the mature, peripheral ones and in Gislén's figures 1 (*petasus*) and 4 (which I should call *hupferi*) there is obviously a paedomorphic tendency with the peripheral cirri retaining to some extent their juvenile form, unlike those of his figures 2 (*bifida*) and 3 (which I should call *bifida moroccana*). In fact I think that Gislén's figures only support my contention that two distinct species exist off West Africa.

[1961. I have recently been able to examine some of the *Atlantide* specimens in the Zoological Museum, Copenhagen. Most of them fall into two groups: those with relatively narrow cirri (*hupferi*) from stations south and east of Liberia and those with distally widened cirri from stations to the west and north (*moroccana*), but I must admit that some specimens are intermediate in this respect. However, when there are several specimens from a single station, they all have cirri of similar shape and the range of variation in any one area is clearly limited.]

In an attempt to clarify the position of *moroccana* with regard to *bifida*, I measured the median widths of the fourth segments from the base and the fourth from the tip of mature peripheral cirri of a number of specimens of *Antedon*. Of these, 10 from the Azores, 3 from Goree, just south of Cape Verde (named *hupferi* by Mr. A. H. Clark in 1911 before he distinguished *moroccana*), and 2 from Algiers very kindly sent by Prof. Tortonese at my request, I believe are referable to *moroccana*. Other specimens measured were a number of *bifida* from various parts of the British Isles and 8 which I believe represent *hupferi*, from off Sierra Leone and Ghana. The details of these are given in tables 3 and 6 on pp. 155 and 229–230 but, to sum up, the ratio of distal to proximal width varied in the 15 specimens of *moroccano* from 1.33 to 1.80:1, averaging 1.57:1 (though only the two from Algiers and one of those from Goree, all of which are relatively small, have the value less than 1.5:1). In 40 specimens of *bifida* the range was from 1.09 to 1.67:1, averaging 1.43:1. The specimens of *bifida* with values over 1.5:1 were all associated with others in which the ratio is lower, there being no marked tendency in *bifida* from any one locality to show a consistently high level. As for *hupferi*, the range was from 1.25 to 1.50:1, averaging 1.36:1, and in none of the specimens was the distal enlargement of the cirri so marked as in the adult specimens of *moroccana*. The cirri shown in Gislén's figure 4 of a specimen (which he called *dübenii*) from off Nigeria agree with those of the specimens I have called *hupferi*, while those in his figure 3, from one taken off Portuguese Guinea, north of Sierra Leone, agree with *moroccana*. I think his decision to synonymize *moroccana* (and *hupferi*) with the west Atlantic *duebeni* is premature in view of the very scanty material of the latter known at present.

It is unfortunate that Gislén gave no details of the proportions of the cirri in his various West African specimens since he discounted this character. Despite his greater range of material I cannot agree with his conclusions with regard to these species. It seems to me that all the Atlantic species of *Antedon* tend to intergrade with one another on their geographical borderlines and much more material, particularly from the north of Scotland, the western Mediterranean and from off Senegambia is needed to clarify their limits.

At the same time Gislén decided that the character by which Mr. A. H. Clark distinguished *Compsometra* from *Antedon*, namely the very spinous distal edges of the pinnule segments in the species of *Compsometra*, is not sufficient to justify the retention of two genera as it is somewhat variable in *Antedon* and *A. bifida* particularly may have a similar spinous condition well developed.

Of the seven species which Mr. Clark had included in *Compsometra*, six, namely *loveni, incommoda, serrata, iris, longicirra* and *parviflora* are from the Indo-West Pacific while the seventh, *nuttingi*, is from deep water in the West Indies. However, *nuttingi* cannot be confused with the other Atlantic species of *Antedon*, since, besides the depth at which it is found, the cirrus segments are greatly elongated, up to five times as long as broad, and also P_2 is a genital pinnule. (In fact, the last character, together with the apparent absence of the species from shallow water, makes me doubt whether it should have been included in *Compsometra* in the first place and whether it can now be placed in *Antedon*.) *Compsometra longicirra, parviflora* and to a lesser extent also *iris*, have the cirrus segments also more or less elongated, but the remaining species have them short and similar in proportions to those hitherto included in *Antedon*, the length not exceeding two and a half times their width.

I had myself referred another species to *Compsometra* which must now be termed *Antedon*, namely *Repometra arabica* A. H. Clark, 1937.

The genus *Repometra*, of which *arabica* was the type and only species, was included by Mr. Clark in the subfamily Thysanometrinae, on account of the short segments of P_1, but the stout cirri are quite unlike the delicate ones of the Thysanometrin species, most of which also come from deeper water than does *arabica*.

A final addition to the genus *Antedon* is a new subspecies of *A.* (formerly *Compsometra*) *incommoda* from the Dampier Archipelago, northwest of Australia, which I am calling *austini*. The type specimens were recorded by Mr. Clark in 1911 as "*Compsometra* sp." but in this typescript were included by him under the heading of *C. iris*. I found that their cirri are more like those of *incommoda* and their centrodorsals are much flattened, approximating in form to the discoidal ones found in the types of *incommoda* from Port Phillip. Dr. H. L. Clark has recorded *incommoda* from Western Australia as far north as Geraldton and it may be that his specimens are intermediate with, or even referable to, *austini*.

With regard to the validity of the species of *Antedon* in the former sense (i.e. excluding those of *Compsometra*) Mr. A. H. Clark had a number of comments, of which those not disproved by recent work follow here [end of notes by A.M.C.].

The two species called *mediterranea* and *adriatica* seem to stand well apart from the others. Though when typically developed quite different from each other and easily recognizable at a glance, they are very closely related and undoubtedly intergrade.

Antedon petasus, so far as I have seen, exhibits relatively little variability, in marked contrast to *A. bifida*, which is exceedingly variable.

Along the west coast of Scotland and in deep water in the Irish Sea a form occurs which is scarcely, if at all, separable from true *petasus*. Either true *petasus* occurs under suitable conditions for some distance southward along the coasts of Scotland and England and in deep water in the Irish Sea, or it is merely one of the numerous varieties of *bifida* stabilized by the relatively uniform conditions of temperature, salinity, etc., under which it lives in deep water and to the northward.

As Koehler says, *moroccana* is probably only a southern variety of *bifida*. Stunted English specimens sometimes approach it very closely. Where the dividing line should fall, if in fact there be one, remains to be determined.

It may well be that *duebeni* and *moroccana* are identical, as affirmed by P. H. Carpenter; they are certainly very close to each other.

History.—Linné in 1758 included the species of *Antedon*, together with the other comatulids known to him and the starfishes and ophiurans in the genus *Asterias*.

In 1811 de Freminville created the genus *Antedon*, the type species, *A. gorgonia*, being based on a specimen which he found on the bottom of a ship at Havre. Though this species is not now known from Havre it undoubtedly occurred there in de Freminville's day, and there is no reason whatever for considering *Antedon gorgonia* anything else than the species now known as *bifida*. Indeed Bosc wrote in 1816 that *Antedon* "a pour type l'étoile rosacée de Linck, tab. 37, fig. 66, qui est la Comatule méditerranéene de Lamarck." But Lamarck thought otherwise, and in the same year without any comment or explanation he placed *A. gorgonia* in the synonymy of *Comatula carinata*, a new species which he described from Mauritius. P. H. Carpenter accepted this determination, believing that the individual might have been brought to Havre on the bottom of the ship, which is in the highest degree improbable.

In 1815 Dr. W. E. Leach created the genus *Alecto* (type species *A. horrida*, indeterminable) to which he assigned all the comatulids known to him. The forms which he knew of, and which are now grouped in *Antedon*, were included in his *Alecto europaea*.

In 1816 Lamarck erected the genus *Comatula* (type *C. solaris*), which, like Leach's genus *Alecto*, included all the comatulids with which he was acquainted.

For many years the names *Alecto* or *Comatula*, more frequently the latter, were used to designate all comatulids, and *Antedon* was entirely forgotten until it was resurrected by Lütken and by Norman in the 1860's, and thenceforth gradually came into general use.

The reinstatement of the generic name *Antedon* raised a question as to its origin; this was settled by Mr. T. R. R. Stebbing in 1877 who at the same time suggested the emendation "Anthedon."

The first revision of the genus *Antedon*, considered as the equivalent of *Alecto* or *Comatula*, that is, as including all the unstalked crinoids, was published by P. H. Carpenter in 1879. He removed from the genus all those species in which the mouth is excentric and which have a terminal comb on the oral pinnules, placing these in the genus *Actinometra* (J. Müller, 1841, type species *A. imperialis*=*Comatula solaris* Lamarck, 1816, which is the type of *Comatula*) and leaving in *Antedon* those forms with a central mouth and no comb on the oral pinnules.

Antedon was not further restricted until 1907. Other comatulid genera were described by Semper (*Ophiocrinus*, 1868) and by P. H. Carpenter (*Promachocrinus*, 1879; *Atelecrinus*, 1881; *Eudiocrinus*, 1882 [replacing *Ophiocrinus* Semper, preoccupied]; and *Thaumatocrinus*, 1884), but all these were based upon new species considered as falling beyond the scope of *Antedon*.

In 1907 the present author restricted *Antedon* to practically the equivalent of Carpenter's "Tenella group," and still further restricted it by the segregation of additional genera in 1908 and in 1914.

A few generic names, synonyms of *Antedon*, have been proposed based upon misconceptions. J. V. Thompson's *Pentacrinus europaeus*, described in 1827, which is the young of *Antedon bifida*, was made by Fleming in 1828 the type of the genus *Hibernula*, for which the substitute name *Phytocrinus* was proposed by de Blainville in 1830. In 1834 J. E. Gray described a detached centrodorsal of *Antedon bifida* under the name of *Ganymeda pulchella*, considering it as representing a new kind of echinoderm.

Linck's generic name, dating from 1733, appeared in post-Linnean time in various forms, *Decacnemos*, *Decaenemus*, *Decaenimos*, *Decameros*, etc., but all these are of later date than *Antedon*.*

Acknowledgments.—For assistance in the preparation of the following pages dealing with the various species of *Antedon* I am under heavy obligations to a number of my colleagues.

The manuscript of the section pertaining to *A. petasus* was examined for me by Dr. James A. Grieg of the Bergen Museum, who went to a very great deal of trouble in identifying localities and in checking up my statements. It is not too much to say that Dr. Grieg deserves to be regarded as a co-author of this section, for without the information which he placed at my disposal, accumulated through years of personal contact with this species in life, my account of it would have been quite inadequate.

The manuscript of the section dealing with *A. bifida* was read for me by Sir Sidney Harmer and by Dr. F. A. Bather of the British Museum; by Dr. E. J. Allen and Dr. J. H. Orton of the Marine Biological Association at Plymouth; and by Sir William Herdman of Liverpool. To all these gentlemen I am most deeply indebted for criticism and advice, especially to Sir William Herdman and Dr. Orton, who were both so generous as to provide me with unpublished information for inclusion. To Mr. James Chumley of Glasgow and to Mr. Herbert C. Chadwick of Port Erin, Isle of Man, I am indebted for most excellent series of specimens, and to Mr. Chumley and to Mr. Richard Elmhirst of Millport, for detailed information regarding its occurrence in the Clyde area.

In the preparation of the account of *A. mediterranea* I have had the invaluable cooperation of Professors Rene Koehler and Clement Vaney of the University of Lyon, while Prof. William T. M. Forbes, formerly of Robert College, Constantinople (Istanbul), was so kind as to furnish me with unpublished information concerning the occurrence of this species near that city.

[Note by A.M.C.] In the key which follows, rewritten after receipt of Gislén's paper synonymizing *Compsometra* and *Antedon*, I have had to resort to a geographical distinction to support the separation of those species, formerly included in *Compsometra*, with relatively shorter cirrus segments, from the Atlantic species of *Antedon* of like case. A comparison of specimens of *loveni*, the type species of *Compsometra*, with similarly small ones of *Antedon bifida*, the type of *Antedon*, shows an extraordinary resemblance between the two and supports Gislén's proposal. The pinnule

*For validation of *Antedon* see 1957, in Addenda (p. 835).

segments of *bifida* are equally as spinous in some specimens as those of *loveni* and the number of segments in P_1 seems to be little higher in small examples of *bifida* than in *loveni* of similar size. A proper assessment of their relationships will have to await another occasion when more material of *loveni* and of the other species formerly included in *Compsometra* can be compared with precise details of the characters of Atlantic species in relation to size.

KEY TO THE SPECIES OF ANTEDON

[Modified by A.M.C.]

a^1. Cirrus segments not more than 18, rarely over 16.

b^1. P_2 intermediate in length between P_1 and P_3, though sometimes little longer than P_3; cirri usually XL or more (western Sweden and the coast of Norway north to about 70° and from the Faroes and south-west of Iceland; 27-326 meters)----------------**petasus** (p. 130)

b^2. P_2 similar in size to P_3, or smaller; cirri usually about XXX, rarely exceeding XL.

c^1. P_2 a genital pinnule and as much as two-thirds as long as P_1 (West Indies; 364–429 meters). **nuttingi** (p. 143)

c^2. P_2 rarely a genital pinnule and not more than half as long as P_1.

d^1. Cirrus segments more or less attenuate, the longest well over twice as long as their median width.

e^1. Cirri with 12–17 segments (the Moluccas to Flores; 0–95 meters)---**longicirra** (p.145)

e^2. Cirri with not more than 12 segments.

f^1. P_1 with 8–11 segments; arm length up to 35 mm. but rarely known to exceed 20 mm. (East Indies to the Bonin and Maldive Islands; 0–275 [?400] meters). **parviflora** (p. 147)

f^2. P_1 with about 17 segments; arm length up to at least 45 mm. (off Malaya to Queensland, Australia; 0–55 meters)------------------------------------**iris** (p. 151)

d^2. Cirrus segments not more than about twice as long as wide, usually shorter.

e^1. Cirri relatively long, equal to about a fourth the arm length, with up to 18, usually 16, segments, the longest about twice as long as their median width or slightly longer, the dorsoventral expansion towards the distal end not very well marked so that the median width of the widest segments is only about a third again that of the narrowest, more proximal, ones; cirri often preserved with the outer half uncurled (Sierra Leone to Gabon in the Gulf of Guinea; 0–120 meters)---------**hupferi** (p. 153)

e^2. Cirri short, usually equal to about a fifth the arm length, with rarely more than 16 segments, the longest usually less than twice as long as wide, the widest segments about half to two-thirds again as wide as the narrowest ones in most specimens; cirri usually preserved in a curled condition.

f^1. Rarely more than 14 cirrus segments; from the Indo-West Pacific.

g^1. Centrodorsal discoidal, dorsal pole flat; antepenultimate cirrus segment not longer than wide (south and west Australia)-------------------**incommoda** (p. 157)

h^1. Dorsal pole large, the sides of the centrodorsal nearly vertical (south-east [? to south-west] Australia; 0–68 meters)-------**incommoda incommoda** (p. 157)

h^2. Dorsal pole smaller (north-west Australia)----**incommoda austini** (p. 162)

g^2. Centrodorsal hemispherical to rounded conical, the dorsal pole more or less convex; antepenultimate cirrus segment usually longer than wide.

h^1. Cirrus segments up to 15 (rarely 16).

i^1. P_1 with 12–28 (rarely less than 15) rather short segments, the longest about twice as long as broad, often with markedly flared and spinous distal ends; opposing spine of cirri sometimes reduced (Fukien Province, China to southern Japan; 0–180 meters)----------------------------**serrata** (p. 163)

i^2. P_1 with 8–13 segments, the longest about three times as long as wide, moderately flared at the distal ends; opposing spine of cirri always acute (south-east Australia; 0–18 meters)-- ------------------------------**loveni** (p. 172)

h^2. Cirrus segments not more than 12 (Arabian Sea; 13 meters)----**arabica** (p. 176)

f^2. Up to 18 cirrus segments, usually 14–16; from the Atlantic.

g^1. Outer cirrus segments moderately expanded dorsoventrally, the median width of the fourth from the tip being rarely more than half again the width of the fourth from the base (British Isles, except the southern North Sea, to Portugal; 0–457 meters). **bifida bifida** (p. 179)

g^2. Outer cirrus segments strongly expanded, the fourth from the tip between half again and twice as wide as the fourth from the base, rarely less.

h^1. Centrodorsal discoidal, the large flat dorsal pole more than half the basal diameter (north-west Africa from Algeria to Senegal and Sierra Leone, the Canaries, Madeira and the Azores and [?] from Sicily and Corsica; 0–200 meters) ---------- **bifida moroccana** (p. 226)

h^2. Dorsal pole of centrodorsal small, not more than half the basal diameter* (Rio de Janeiro to the Caribbean; 0–168 meters) ---------- **duebeni** (p. 234)

a^2. Cirrus segments 20 or more.

b^1. Cirrus segments usually 20–23 (from Cape St. Vincent, Spain to the south of France, the west coast of Italy, east to Israel, south and west to Tunisia [? Algeria]; 0–220 meters). **mediterranea** (p. 236)

b^2. Cirrus segments usually over 25 (northern and eastern Adriatic, eastward to the Gulf of Ægina; 0–932 meters) ---------- **adriatica** (p. 258)

*[Note by A.M.C.] In view of the variation in the relative size of the dorsal pole in *bifida bifida*, I doubt whether this distinction of Mr. Clark's holds good. Gislén (1955) has reduced *moroccana* (together with *hupferi*) to the synonymy of *duebeni*, but without any additional information about the latter I think this must await confirmation.

ANTEDON PETASUS (Düben and Koren)

Figure 13,*a*

See also vol. 1, pt. 1, figs. 103 (p. 165), 280 (p. 261), pl. 1, fig. 521; pt. 2, figs. 78 (p. 53), 238 (p. 197), 281 (p. 215), 747 (p. 349), 784–786 (p. 366), pl. 56, fig. 1355.]

?*Asterias pectinata* Linnaeus, Museum Ludovicae Ulricae reginae Svecorum, Stockholm, 1764, p. 716.

Comatula mediterranea (not of Lamarck, 1816) M. Sars, Beskrivelser og Jagttagelser, Bergen, 1835, pp. 40, 42, pl. 8, fig. 19*a–g* (occurrence in Norway).—Loven, Kungl. Svenska Vet.-Akad. Handl., for 1840, 1842, p. 121 (western Sweden; locally abundant; myzostomes); Arch. Naturg., 1842, vol. 1. p. 314 (western Sweden; myzostomes).—von Graff, Das Genus *Myzostoma*, 1877, pp. 1–3 (myzostomes).

Comatula rosacea (not of Fleming, 1828) Forbes, History of British starfishes, 1841, p. xviii (Scandinavia), p. 17 (Norway).

Alecto petasus Düben and Koren, Kungl. Svenska Vet.-Akad. Handl. for 1844, 1846, p. 229, pl. 6, fig. 1 (near Fiskebäckskil in Bohuslän; Egersund; Sondefjord).—Lütken, Oversigt over Grönlands Echinodermata, 1857, p. 73 (Scandinavian species), p. 81 (characteristic of the Scandinavian-British region), p. 90 (northern), p. 107 (15–50 fms.).—M. Sars, Oversigt af Norges Echinodermer, 1861, p. 1 (localities; range).—Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 199 (listed).—W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 697 (probably identical with *rosaceus*).—Möbius, Jahresb. Komm. Unters. deutsch. Meere, No. 1, 1873, p. 149 (Arendal).—Storm, Kungl. Norske Vid. Selsk. Skr. for 1877, 1878, p. 246 (localities in Trondhjemsfjord); for 1878, 1879, p. 18 (same).—Kukenthal and Weissenborn, Jenaische Zeitschr., vol. 19, 1886, p. 779 (Bognestroem).—P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 69 (= *rosacea*).

Comatula (*Alecto*) *petasus* J. Müller, Abh. Preuss. Akad. Wiss. for 1847, 1849, p. 253 (description; Bohuslän).

Comatula petasus M. Sars, Bidrag til Kundskaben om Middelhavets Littoral-Fauna, Nyt. Mag. Naturvidensk., vol. 9, 1857, p. 72.—Dujardin and Hupé, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 199 (synonymy; description; coasts of Norway).—Marion, Rev. Sci. Nat., vol. 7, 1878, p. 141 (comparison with the Mediterranean species).

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Mus., vol. 38, 1910, p. 275 (cirri compared with those of *Compsometra lacertosa*), p. 330 (infrabasals possibly lost through acceleration of development; development compared with other species of *Antedon*).—MORTENSEN, *Danmark*—Expedition til Grønlands NE. kyst, vol. 5, No. 4, Medd. Grønland, vol. 45, 1910, p. 246 (orals of pentacrinoid compared with those of *Hathrometra prolixa*), p. 250 (description of a pentacrinoid), pl. 10, fig. 3 (pentacrinoid).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 9 (characteristic of the Atlantic division of the European faunal area); Bull. Mus. Hist. Nat. 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p. 55 (in key).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 11 (arm ending; abnormal P_1), p. 12 (abnormal arm; hexamerous specimen), pp. 20, 21, 27, 28, 29, 32, 39, p. 41 (measurements) pp. 42, 44, 46, 53, 73, 74, 76, 80, 194, 223, 271 (notes on biology), pp. 273, 275, 276 (food), pp 278, 279, 283, p. 285 (Kristineberg, Sweden; 30–40 meters; details), p. 286, figs. 6, 7, 19, 45, 56–58, 332–337.—MORTENSEN, Danmarks Fauna, No. 27, 1924, pp. 23, 24 (description; distribution), fig. 4 (pentacrinoid), fig. 10_2; Skr. Norske Vid. Selsk. Trondhjem for 1923, No. 3, 1925, pp. 16, 19.—KOEHLER, Les échinodermes des mers d'Europe, II, 1927, p. 123 (in key), pp. 125, 126 (references; description; distribution).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 13 (eggs and young larvae), p. 30 (diagnosis; habits; parasites; range; remarks); fig. 5, p. 15 (myzostomes); fig. 12, p. 27 (cirrus); fig. 13, p. 28 (part of arm); fig. 17, p. 31 (pentacrinoids).—MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, Lief. 12, 1928, p. viii. 4 (in key), p. viii. 55 (a boreo-lusitanian species), p. viii. 56 (range in detail), p. viii. 86 (food and feeding habits), p. viii. 87 (food), p. viii. 107 (free eggs; spawning period; size of eggs), p. viii. 124 (*Loxosoma*); fig. 2, 2, p. viii. 3 (cirrus); fig. 3A,C, p. viii. 4 (part of arm with genital pinnules); fig. 90, p. viii. 51 (distribution); fig. 114, p. viii. 112 (two pentacrinoids).—LIEBERKIND, Zoology of the Faroes, pt. 60, Echinoderma, 1929, p. 1 (localities).—LONNBERG and HELLSTRÖM, Ark. Zool., vol. 23, No. 15, 1932, p. 15 (carotenoid pigments).—DJAKONOV, Les Échinodermes des mers arctiques (in Russian), Leningrad, 1933, p. 22 (in key), p. 24 (characters; range), fig. 12A, p. 25.—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Förh., new ser., vol. 45, No. 11, 1934, p. 18.—LONNBERG, Ark. Zool., vol. 26, No. 7, 1934, pp. 10, 11 (pigments).—EKMAN, Tiergeographie des Meeres, 1935, p. 156.—KOLOSVARY, Folia zool. hydrobiol. Riga, vol. 9, 1936, p. 83 (in Hungarian National Museum).—MORTENSEN, Kongl. Danske Vid. Selsk. Skr., nat. math., ser. 9, vol. 7, No. 1, 1937, p. 61 (larva compared with that of *Tropiometra audouini*).—KOLOSVARY, Festschrift für Embrik Strand, vol. 2, 1937, p. 469; Zool. Anz., vol. 121, 1938, p. 47, fig. 2 (centrodorsal in side view).—TERSLIN, Vid. Medd. Nat. Foren. København, vol. 102, 1938, p. 15 (named by Heding; new record from southern Kattegat, first from Danish waters), p. 16, fig. 1 (cirrus).—GISLÉN, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 80.—LE DANOIS, Les profundeurs de la mer, Paris, 1948, pp. 115, 245.—CUÉNOT *in* Grassé, Traité de zoologie, vol. 11, 1948, p. 54.—EINARSSON, The zoology of Iceland, vol. 4, pt. 70, 1948, p. 4 (range; notes), p. 48 (member of boreal littoral-sublittoral fauna), p. 53 (lecithotrophic pelagic larvae), pp. 58, 61 (distribution).—MORTENSEN *in* Braestrup, Vort Lands Dyreliv, Copenhagen, vol. 2, 1950, p. 134.—TORTONESE, Atti Accad. Ligure, vol. 8, 1952, p. 9.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 46 (carotenoid pigment), p. 105 (temperature tolerance), p. 106 (food and feeding behaviour), p. 115 (occurrence in aggregations), fig. 42 (ciliary currents of disk).—GISLÉN, *Atlantide* Rep., No. 3, 1955, p. 89 (short description); pl. 1, fig. 1, pl. 2, fig. 5.

Antedon (*Alecto*) *pelasus* GRIEG, Bergens Mus. Aarsb. for 1888, No. 2, 1889, p. 3 (Moster).

Antedon rosacea (part) AURIVILLIUS, Bihang till k. Svensk. Akad. Handl., vol. 24, Afd. 4, No. 3, 1898, p. 11 (Kristineberg; breeding season).

Diagnostic features.—P_2 is intermediate in length between P_1 and P_3, and resembles P_1; there are not more than 18 cirrus segments, of which the outer are moderately compressed laterally and in lateral view are broader than the proximal; the longer proximal segments are about half again as long as broad, the sixth and following gradually decreasing in length to the last, which is about as long as broad; there are usually more than XL cirri; there are no interradial perisomic plates; the brachials are usually almost cylindrical, not markedly flared or convex in lateral view.

[NOTES BY A. M. C.] Judging from the few Scandinavian specimens in the British Museum, the relationship of P_1, P_2, and P_3 is not invariable, one specimen from Norway, at least, has P_2 the same size as, or not more than 0.5 mm. longer than, the corresponding P_3.

The British Museum specimens and Mortensen's figure (1924 and 1927) indicate that the dorsoventral widening of the cirri in their outer part is usually less marked than in *bifida* (see fig. 13*a*, p. 198).

Description.—The centrodorsal is low hemispherical with a rather large flattened dorsal pole from 1.5 to 2.5 mm. in diameter. The cirrus sockets are arranged in two or three closely crowded and irregular marginal rows.

The cirri are XXXV–LV, 13–17 (usually 16), from 6 to 13 mm. (the longest usually from 9 to 12 mm.) in length. In rare cases cirri with 18 segments may be found. The first segment is very short, about twice as broad as long, the third is about as long as broad, and the fourth and fifth are the longest, about half again as long as broad; the following very slowly decrease in length so that the penultimate is little longer than broad. In lateral view the cirri, slowly becoming laterally flattened, increase gradually in width so that the outer portion may be nearly half again as broad as the proximal. The opposing spine is small and inconspicuous, and occasionally absent. The terminal claw is usually about as long as the last segment, and is stout and strongly curved.

The disk may be naked, but is usually more or less thickly studded with calcareous nodules which are especially abundant along the ambulacral grooves, on and about the anal tube, and in the inner angles of the interambulacral areas.

The distal edges of the radials are even with the border of the centrodorsal in the radial line, but are visible as low triangles with the distal apices slightly separated in the interradial angles. The IBr_1 are short and more or less bandlike, four or five times as broad as long, slightly depressed in the median line beneath the proximal angle of the axillaries, with the lateral edges strongly convergent and not in contact basally with their neighbors. The IBr_2 (axillaries) are approximately triangular, nearly twice as broad as long, with a slight posteriorly directed angle in the median portion of the proximal edge, and with the lateral angles extending for some distance beyond the anterolateral angles of the IBr_1.

The 10 arms are up to 130 mm. in length. The first brachials are from two to three times as long exteriorly as interiorly, with the distal border broadly V-shaped and the inner sides of the two of each arm pair in contact basally, the portions beyond the point of contact lying usually in a straight line or making with each other a very wide angle. The second brachials are larger, irregularly quadrate, with a more or less developed posterior process incising the first. The first syzygial pairs (composed of the third and fourth brachials) are slightly longer interiorly than exteriorly, from a third to half again as broad as long in the median line. The next three or four brachials are slightly wedge-shaped, about twice as broad as the median length, after which the brachials become triangular and about as long as broad, after the proximal fourth of the arm very obliquely wedge-shaped, and then less and less obliquely wedge-shaped and terminally about twice as long as broad with only very slightly oblique ends. In side view the brachials are not convex or flared at their distal ends.

Syzygies occur normally between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations, but there is often considerable irregularity in individual specimens.

In an unusually fine specimen from Kristineberg, P_1 is 23 mm. long, with 49 segments, tapering evenly from a rather stout base to a long delicate and flagellate tip; all the segments are subequal, somewhat longer than broad, the longest, in the middle of the pinnule, being about half again as long as broad. The outer segments have finely spinous distal ends. In five specimens from the vicinity of Bergen, Grieg found

P_1 to be from 8.5 to 14 mm. (averaging 10 mm.) in length with 20 to 31 (averaging 26) segments.

In the Kristineberg specimen P_2 is 15 mm. long, with 36 segments, intermediate in character between P_1 and P_3, and without an ambulacral groove like P_1. In five specimens from Bergen, Grieg found P_2 to be from 6 to 8.5 mm. (averaging 7 mm.) in length, with 18 to 24 (averaging 21) segments.

In the Kristineberg example P_3 is 9.5 mm. long with 21 segments, about as stout basally as P_2 but tapering less rapidly and with a gonad on the fourth to ninth segments. Grieg found in his five specimens from Bergen that P_3 was from 5 to 6 mm. (usually about 6 mm.) in length with 14–16 (averaging 15) segments.

The following pinnules are similar to P_3; the gonads, which are larger on P_4 and P_5, persist to about the thirtieth pinnules, slowly decreasing in size after about the twelfth.

The distal pinnules are 13 mm. long, with about 30 segments of which all but the basal are twice as long as broad with slightly spinous distal ends, becoming slowly shorter and more delicate in the attenuate terminal portion of the arms.

Along the ambulacral grooves of the pinnules there are, as described by Grieg, irregular calcareous structures varying from thick rods with irregular ends, one or both of which may be expanded and perforated, to irregular cribriform plates usually broad basally where they adjoin the pinnular and abruptly narrower distally.

Gislén (1955) describes a medium-sized specimen, arm length about 70 mm., also from Kristineberg, as having the centrodorsal hemispherical, 2 mm. in diameter, and almost totally covered with cirri. The small dorsal pole is convex. The cirri are XL, 10–16, from 4 to 11 mm. long. The longest segment is only a third again as long as broad and the antepenultimate a fifth again as long as broad. The profile is not noticeably thickened in the distal part. The opposing spine is an indistinct knob. The arm profile is almost smooth dorsally with only slight notches at the articulations. P_1 with 28 segments is 12 mm. long; P_2 with 19 is 6.5 mm. and P_3 with 15 segments and bearing a gonad is 5.5 mm. long. All the pinnule segments are smooth, without thickened distal ends, the longest ones are a fifth again as long as wide.

According to M. Sars (1835) this species is light brown, the articulations with whitish transverse bands or dots, the upper surface and the arm tips lighter, and the cirri transparent yellowish white.

Düben and Koren (1846) give the color as varying from brownish red and deep bright red to yellow.

Greig (1913) says that the living specimens examined by him were white and red, the red, however, varying between brownish and bright red. The arms are often provided with alternating white and red bands, or they may be almost uniform white or red, with only the distal or the basal parts respectively red or white. The red color disappears very rapidly when the animal is placed in alcohol.

Abnormal specimens.—Mortensen (1920) has reported a number of interesting cases of aberrant arm structure in this species, all from Kristineberg, Sweden.

With eleven arms: Three individuals had 11 arms; in two of them the division occurred immediately after a syzygy. In one the epizygal is divided longitudinally. In the other one of the branches begins with a syzygial pair. In the third specimen the brachial below the division is split up somewhat irregularly and the branches have the two lowest segments coalesced.

With pinnules replaced by or transforming into arms: In one specimen, as described by Mortensen, the anterior and left anterior arms are quite normal. On the right anterior ray the anterior arm has P_1 and P_a transformed; P_a bears only two lateral branches near the tip; Mortensen remarks that it can scarcely be said that these represent true pinnules, since they suggest much more strongly simple branching; P_1 has developed into a true arm almost as large as the arm which bears it. The four lowest segments retain the character of pinnulars; on the fifth a pinnule is developed, and from this point on the segments assume the character of true brachials, carrying pinnules in the normal way. The portion beyond the sixth pinnule is lost. There are no syzygies in the part preserved. The two lowest pinnules have the character of oral pinnules; from the third onward tentacles are developed, but none of the pinnules preserved carry gonads. The posterior arm of the same ray (the right anterior) also has both P_1 and P_a transformed. P_1 has developed into a small but true arm with the pinnules beginning on the eighth segment. The tip is broken off; the portion remaining bears three pinnules on each side of which the second has the tentacles developed. P_a has developed into a true arm larger than that into which P_1 has become transformed, but distinctly more slender than the main arm. The pinnules begin on the fourth segment. The tip is broken. The preserved portion carries 5 pinnules on either side of which the lowest are developed as oral pinnules. In the right posterior radius the oral pinnules of the anterior arm are normal, while on the posterior arm P_a is developed into a small arm with the first pinnule on the eighth segment. The tip is broken. The preserved part carries four pinnules on either side of which the first is developed as an oral pinnule. In the left posterior radius both arms have both P_1 and P_a transformed into arms. On the posterior arm P_1 forms a small slender arm on which the first pinnule is on the eighth segment; this is followed by two segments without pinnules, then four with regularly alternating pinnules, another without a pinnule, one with a pinnule, the remainder forming a pinnule-like tip provided with tentacles like the other pinnules. P_a has developed into a large arm very nearly as stout as the main arm. The five proximal segments have the character of true pinnule segments; the sixth bears a pinnule on the distal side, the seventh has no pinnule, and the eighth bears a pinnule on the distal side; from this point onward the segments have the character of true brachials and carry pinnules in the normal way; syzygies occur between segments 9+10, 16+17, and then at intervals of 2 muscular articulations. The tip is broken off, the preserved portion carrying eight pinnules on either side, not counting that on the sixth segment. The lowest one on each side has the character of an oral pinnule, although this is not very pronounced. None of the pinnules bear gonads. On the anterior arm of the same ray (the left posterior) P_1 has very much the same character as P_1 on the right anterior ray, with only four branches or pinnules in the distal portion, the first occurring on the ninth segment. P_a is developed into a small arm, the pinnules beginning to appear on the fifth segment. The three lowest pinnules are all on the same (the proximal) side; after the third pinnule there are four segments without pinnules, then one with a pinnule on the distal side, after which the little arm ends in a pinnule-like tip bearing tentacles like the usual pinnules. The lowest pinnule on this arm bears tentacles and thus does not have the character of an oral pinnule.

In another specimen, P_1 on the anterior arm of the left posterior ray is developed into a small arm almost like that supplanting P_1 on the posterior arm of the left posterior ray in the preceding. The 3 lowest pinnules are on the distal side, the first on the sixth segment; these are followed by one on the proximal side beyond which is a simple pinnule tip. The ambulacral furrow is well developed throughout the whole length of this pinnule.

In a third specimen, P_3 on the posterior arm of the left anterior ray has in the proximal portion the character of a true genital pinnule, but beyond the eighth segment regularly alternating pinnules are developed as in a true arm, the segments of the main pinnule assuming a much more robust character than normal pinnulars, though they are not so robust as brachials. The fifteenth and sixteenth segments form a syzygial pair, and there is another syzygial pair after an interval of two muscular articulations. There are 6 pinnules on either side, all except the last on the distal side having the gonad highly developed. After the sixth pinnule the main axis continues and ends as a typical pinnule.

In a fourth specimen, P_3 on the anterior arm of the right anterior ray has developed into an arm. The four proximal segments have the character of true pinnulars, though they are somewhat more robust than usual. From the fifth segment regularly alternating pinnules are developed and the segments of the main axis assume the character of true brachials, the tenth and eleventh forming a syzygial pair. The tip of the arm is broken off. The portion preserved bears four pinnules on either side, all of which have the character of genital pinnules. The basal portion of the main pinnule does not carry a gonad as was the case in the preceding.

Mortensen points out that in the arms developed from the oral pinnules no genital organs are found, while in those developed from the genital pinnules all the pinnules, including the lowest, have these well developed. This is in accordance with the structural difference between oral and genital pinnules, the former not receiving a branch from the genital rhachis while possessing a water vessel so that in them the water vascular apparatus may become completely developed.

With forked pinnules: In one specimen, P_1 on each arm of the right anterior ray is forked. That on the anterior arm divides on the fourth, that on the posterior arm on the fifth segment. In both, the two derivatives are equally developed and retain their characteristic structure throughout.

Dr. T. Gislén (1924) has also described some abnormal specimens. In one of these, P_1 on one arm was developed like an arm with pinnulars 8 to 11 themselves bearing pinnules. A second specimen showed a similar abnormality and at the same time had another P_1 forked. A 6-rayed XII-armed specimen had a forked P_3 with a reduced gonad.

Early stages.—Dr. Th. Mortensen (1920) has given an account of the early stages of this species.

The fertilized eggs and young embryos are not attached to the pinnules as in the other species of the genus, but drop at once from the pinnules and fall to the bottom.

The fertilization membrane is covered with short spines, almost as in a *Callionymus* egg, and is very different from the nearly smooth membrane of the other species. Occasionally he saw the eggs floating and suggests that in nature the eggs do not lie on the bottom, the spinous membrane serving as a floating apparatus.

The eggs are about 0.15 mm. in diameter, yellowish red and opaque. The cleavage is total and regular. After about 20 hours the embryo begins to rotate within the egg membrane and soon afterwards, generally at about 24 hours, the embryo becomes free by breaking through a hole in the egg membrane. The empty membranes may easily be found in the dishes, and form very characteristic objects.

The newly hatched embryo is uniformly ciliated, with a tuft of longer cilia at the anterior end. In the course of the next day the ciliated bands, only 4 in number, become differentiated, the yellow cells appear in considerable numbers, and the larva, seen in diffused light, forms quite a striking object. The yellow cells are restricted to the interstices between the ciliated bands which appear as broad white lines; only very rarely may a yellow cell be seen lying in one of the bands. The vestibular invagination appears after about 3 days as a wide shallow depression much like that in the other species of the genus. There is no suctorial disk. The formation of the skeleton begins at the age of 6 days.

It was repeatedly observed that the embryos had considerable difficulty in rupturing the egg membrane. Mortensen supposed that the absence of motion in the water in the dishes containing the developing eggs was the chief cause of this, and this supposition was strengthened by the accidental observation that by sucking the embryos up with a pipette and then squirting them out again with some force they were greatly aided in rupturing the membrane and becoming free. The embryos which did not succeed in rupturing the egg membrane did not die at once but continued developing within the egg, the vibratile bands and the yellow cells appearing at the same age as in the free embryos. In such cases the embryos thus reached the same stage within the egg membrane as do normally the embryos of *A. mediterranea* and *A. bifida* before they become free. If not liberated in the way described above they gradually died; but some of them remained alive up to the age of 6 days.

Although excellent cultures of the larvae were repeatedly obtained both in 1918 and 1919 Mortensen never succeeded in rearing them through the metamorphosis. At about the time of the commencement of the formation of the vestibular invagination they became abnormal, with a median constriction, or with the anterior end swollen. They might live for many days in this condition, but ultimately died without attaching themselves. Only in relatively few cases did the vestibular invagination develop normally, but even these larvae did not attach themselves. The normal development of the crinoid skeleton within the larva was not observed; in some cases a few calcareous pieces were formed which could not with certainty be identified.

As soon as the blastula has formed, after about 6 hours, the formation of the mesenchyme begins, and the blastocoele cavity is soon filled with a dense mass of mesenchyme cells. The gastrular invagination does not occur until a much later stage, about the time when the embryo is about to leave the egg membrane, and the blastopore, which is very small, does not close until the embryo has become free. The invaginated portion is not a simple sac, but, while still remaining in open connection with the exterior, is flattened in the longitudinal axis. Mortensen was unable to trace with certainty the later subdivisions of the invaginated portion. He remarks that he intentionally does not refer to the invaginated portion as the archenteron, as he is not at all sure that the stomach is derived from this part. He believes that there are indications of more than one invagination taking place, in which case probably the enterocoele vesicles alone develop from the invagination described. The enterocoele vesicles do not alter their position in quite the same way as in *A. mediterranea* and in the other crinoids thus far studied; at the time of the formation of the vestibular invagination the two vesicles are still lying in their original positions on the right and left side of the embryo, the mesentery between them being in the posterior mid-line.

While in the course of normal development the egg undergoes total and regular cleavage, a curious abnormal mode of development was only too commonly observed in the cultures, the nuclei only, lying free in the egg substance which does not show any indication of cell limits, dividing, thus forming a syncytium. Quite a number of nuclei may be found lying in a fairly regular layer near the surface, and in the later stages also some in the inner part of the egg. The development does not proceed further.

Mortensen believes there can be no doubt but that this abnormal development is due to the unnatural conditions in the aquaria, probably to the high temperature.

A fairly complete series of the post-larval stages was obtained by examining the material dredged in the localities where the adults were common. They were found attached especially to hydroids, but also to polyzoans, worm tubes, and other objects.

A careful study of these revealed the presence of infrabasals, three in number, small and of equal size, forming a small ring lying wholly within the basals so that it is impossible to detect it on entire specimens.

Localities.—*Thor* station 171; south of western Iceland (lat. 63° 15′ N., long. 22° 23′ W.); 216–326 meters; 1903 (1, C.M.).

Triton station 3; Faroe Banks (lat. 60° 39′ 30″ N., long. 9° 06′ W.); 159 meters; temperature 9.44° C.; sand and shells; August 8, 1882 [P. H. Carpenter, 1884, 1888; von Graff, 1884; Bell, 1893].

Faroe Islands; 16 kilometers east by south from Nolsø (south point); about 146 meters; Th. Mortensen, June 20, 1899 [Lieberkind, 1929] (1, C.M.).

Faroe Islands; 101–183 meters (1, C.M.).

Scandinavia [Forbes, 1841].

Norway [Forbes, 1841; A. H. Clark, 1912, 1913] (10, B.M.; C.M.; Berl. M., 1039; H.M.).

Beian, at the entrance to Trondhjemsfjord (1, K.M.).

Trondhjemsfjord [M. Sars, 1861; A. H. Clark, 1912] (several, K.M.; Berl. M., 2887). Outer part of Trondhjemsfjord, from Galgenesset; 40–100 meters [Storm, 1878, 1879].

Aunø, Hitteren, at the entrance to Trondhjemsfjord [M. Sars, 1861].

Aure, between Trondhjem and Kristiansund (1, Berg. M.).

Four miles north of Kristiansund; 27–36 meters (1, Berg. M.).

Kristiansund, 91–128 meters [M. Sars, 1861] (several, K.M.).

Veblungsnes, Romsdalen [Nansen, 1885].

Storeggen (edge of the continental shelf, off Aalesund) (1, K.M.).

Vaagsfjord, leading out of the Nordfjord; 55–274 meters [Grieg, 1897].

Bryggen, Nordfjord (Berg.M.; courtesy of Dr. Grieg).

Søndfjord [Düben and Koren, 1846; Grieg, 1896] (6, Berg.M.). Askevold, Søndfjord (1, Berg. M.). Florø, Søndfjord [Nansen, 1885; A. H. Clark, 1912] (fragment, Berl. M., 1043).

Sognefjord [Grieg, 1896]. Husø, at the entrance to Sognefjord [Danielssen, 1892; Grieg, 1912].

Michael Sars; west of Sognefjord (lat. 60°55′ N., long. 8°56′ E.); 126 meters; temperature 9.33° C.; August 14, 1902 (1, C.M.).

Mangerfjord [Grieg, 1896].

Radøfjord [A. H. Clark, 1912; Hartmeyer, 1916] (Berl. M., 3618).

Bognestrøm, between Manger- and Radøfjord [Nansen, 1885; Kükenthal and Weissenborn, 1886].

Hjeltefjord [Grieg, 1896].

Herløfjord [Grieg, 1896].

Bergensfjord [M. Sars, 1835; Bell, 1893; Grieg, 1896, 1904; A. H. Clark, 1911, 1913] (5, B.M.; P.M.; Berg. M.).

Vatlestrømmen, southwest of Bergen (1, Berg. M.).

Bukken (2, K.M.; Berg. M.).

Korsfjord [Grieg, 1896].

Selbjørnfjord, Fitjar [Grieg, 1896].

Bjørnefjord, Godøsund; 40–50 meters [Grieg, 1896] (about 30, U.S.N.M., 35705; Berg. M.).

Loksund, between Bjørnefjord and Hardangerfjord [Grieg, 1896].

Hardangerfjord [Grieg, 1896, 1912]. Jondal [Grieg, 1913] (Berg. M.). Saelø, Tyrnes; 10–40 meters (Berg. M.). Mosterhavn [Grieg, 1889] (2, Berg. M.).

Three kilometers from the southwestern coast of Norway (lat. 58°23′ N., long. 5°55′ E.); 51–82 meters; Captain Örsted, May 5, 1898 (7, C.M.).

Southwest of Stavanger (lat. 58°12′ N., long. 4°00′ E.); 115 meters; Captain Örsted, April 19, 1901 (8, C.M.).

Southwest of Stavanger (lat. 58°12′ N., long. 4°00′ E.); 113 meters; Captain Örsted, May 13, 1908 (1, C.M.).

Egersund [Düben and Koren, 1846].

Arendal [Möbius, 1873; von Graff, 1884].

Langesund (several, K.M.).

Bollaeerne, west of the entrance to Christiania (Oslo) Fjord (1, K.M.).

Vallø, at the entrance to Christiania Fjord (1, K.M.).

Christiania Fjord (36–183 meters, stony bottom) and south to Bohuslän [M. Sars, 1861].

Western Sweden [Loven, 1840, 1842]. West coast of Sweden [von Graff, 1877].

Bohuslän [J. Müller, 1849; M. Sars, 1861; A. H. Clark, 1912; Jägerskiöld, 1917] (1, Berl. M., 1308).

Fiskebäckskil, in Bohuslän [Düben and Koren, 1846]. Type locality.

Kristineberg, Fiskebäckskil [Aurivillius, 1898; G. Retzius, 1904; Theodor Mortensen, 1910, 1920; Gislén, 1924] (11, U.S.N.M., 36126, 36192; C.M.).

8–10 miles N.W. of Gilleleje Flak lightship, southern Kattegat; 32 meters [Terslin, 1938].

Kattegat [von Graff, 1887].

Copenhagen; Loven, 1849 [A. H. Clark, 1911] (1, P.M.).

Baltic Sea, 1862 [A. H. Clark, 1911] (1, P.M.).

[Note by A. M. C.] Mr. Clark had included the last three records among the erroneous localities with the comment that they were more probably from Bohuslän. In face of Terslin's record from the southern Kattegat I have restored them to the list of valid records.

Erroneous localities.—Tromsø [A. H. Clark, 1912] (2, H.M.). Professor Grieg has assured me that this species does not occur at Tromsø, and Messrs. Dons and Schneider of the Tromsø Museum (at one time) in a letter to him stated that they never found it in that district. He suggested that Tromsø is probably a mistake for Tromø, near Arendal.

Helga sta. W. 5; Irish Fisheries, March 23, 1904; 5 miles SW. by W. of Great Skellig, County Kerry; 109–119 meters [A. H. Clark, 1913].=*Antedon bifida.*

Helga sta. S.R. 360; Irish Fisheries, August 8, 1906; west of Dingle Bay (lat. 52° 04′ N., long. 11°27′ W.); 198–220 meters [A. H. Clark, 1913].=*A. bifida.*

Pourquoi Pas? sta. 60; English Channel (lat. 49°51′ N., long. 2°21′ W.); 162 meters [Vaney, 1914].=*A. bifida.*

Geographical range.—From southwestern Iceland to the Faroe Islands and Scandinavia, where it ranges from Trondhjemsfjord (lat. 63°40′ N.) southward along the Norwegian and western Swedish coasts to Bohuslän and the Kattegat.

Bathymetrical range.—From 10 to 326 meters; most frequently recorded from between 90 and 150 meters.

Occurrence.—Prof. Michael Sars wrote in 1861 that this species is rather frequent in certain localities on the southern coast of Norway, as well as in the Kristianiafjord, at depths of from 36 to 183 meters on rocky bottom.

On the Bergen coast it is less common than *Hathrometra sarsi.* There he found small individuals frequently on a hard clay bottom in from 90 to 130 meters.

Prof. C. Boeck found it at Aunø, Hitteren; also in the Trondhjemsfjord, which was the northernmost locality known to Professor Sars, he found it almost as large as in the Kristianiafjord.

On the Norwegian coasts, generally speaking, this species is local, though often abundant, especially where there are sponges (Appelløf, 1905).

In 1896 Grieg noted that this species is very common in most of the localities from which he at that time reported it; that is, in Hardangerfjord, Selbøfjord, Korsfjord, Bjørnefjord, Hjeltefjord, Mangerfjord, Bergensfjord, Herløfjord, Sognefjord and Søndfjord.

Grieg (1898) has given a detailed account of the localities inhabited by this animal in Vaagsfjord.

From Bergsholmerne, the group of "holms" or small high islands which lie between Bergnakken and Vaagsvaagen, there extends a submarine plateau reaching down toward the Husvaagsholmerne. The outermost edge of this plateau, called Raaseskallen, lies approximately in the middle of the fjord, in from 73 to 109 meters. Both toward the south and toward the east, that is toward the inner part of the fjord, the plateau descends steeply to the depths of the fjord which is here from 183 to 274 meters deep. Toward the west, or toward the mouth of the fjord, the channel which cuts in from the Vaagsfjord toward the Vaagsvaagen, the plateau descends very gradually. The summit of the plateau consists of sand and gravel which in the shallowest places, toward the Bergsholmerne, is overgrown with *Laminaria.* The fauna is very rich and includes this species.

Along the steep declivity which extends from Halnaesvik over toward Saetenaes the conditions regarding depth are like those at Halnaesvik, but the bottom consists mainly of coarse gravel and loose rocks; only here and there are these interrupted by a few patches of sand. From Saetenaes eastward past the south side of Moldøens, Kletten, and Blaalilandet to Skavøen, there is only shell sand with a fauna which resembles that in the southern part of Ulvesund. The deeps slowly descend to 55 or 73 meters, where the bottom abruptly falls off to the depths of the fjord. The 73 meter line extends in an arc which follows the land from the Skavøskallen outside of Skavøen northward and westward past Kariskjaer to the channel which cuts into the western arm of the Ulvesund between Saetenaes and Moldøen. This descent is most abrupt at Kariskjaer and Skavøskallen, but nowhere is it as abrupt as at Slaaken. The formations remind one more of those at Matrog; there as here a steep descent alternates with smaller terraces covered with sand and gravel. Outside of Skavøskallen in a depth of from 183 to 219 meters on a mud bottom there is, on the bottom as well as on the declivities, a very rich and diversified fauna, which includes this form.

Inside of Skavøen lies Skavøpollen, the harbor of which place is much used as a refuge for small vessels. The inner part of the "pollen" near the estates Nygaard and Skavøpol is from 4 to 7 meters deep with a mud bottom. In the outer part the depth descends to 55 meters and the bottom consists of gravel or clay mixed with stones and dead shells. Here and there at the mouth of the "pollen" are also found patches of shell sand. Along the shore there is a very rich flora of *Zostera marina* and algae, and the fauna recalls that of Degnepollen, though it is much richer, which is probably due to the fact that the two entrances to Skavøpollen, one from the west and one from the south, give a more lively interchange of waters here.

On the southern side of Vaagsfjord only the plateau which extends eastward from Ramseviknaesset past Gaasholmen is of particular interest, in addition to the steep declivities at Slaaken and Stegene. At Ramsevik is located the outer edge of the plateau—Ramsevikskallen—about 550 meters from shore. But the further it extends the nearer it approaches the land. Thus at Gaasholmen the descent toward the depths of the fjord is found at a distance of about 90 meters. The summit of the plateau, which lies at a depth of from 18 to 55 meters, is covered with shell sand with its characteristic fauna. The animal life, particularly on the slopes and toward the inner part of the fjord is, generally speaking, rich and diversified.

In the Sognefjord, according to Grieg (1912), this animal occurs only at the entrance, not penetrating into the inner waters.

About Bergen it is less common than *Hathrometra sarsi* (M. Sars, 1861).

At Moster (Grieg, 1889) it is found on both sides of the fjord, but apparently it only occurs individually except at Hestholmen in from 55 to 90 meters where it was present in numbers.

In the Hardangerfjord in 1905 (Grieg, 1913) this species was only found singly and in a very few localities; but in subsequent years, especially in 1908, 1909, and 1912, it was very numerous, most so at Straumastein and Jonanes. It seems here to be chiefly an inhabitant of the *Laminaria* zone. Individuals were often secured attached to the stalks of *Laminaria saccharina*, though it could also be taken at depths of about 200 meters.

It is common in Jondalsbugt, leading out of the Hardangerfjord. Toward the north Jondalsbugt is bounded by steep land between Jonanes, Kirken and Urevik. From the deep water of the Hardangerfjord a deep channel cuts in along this part of the coast to Urevik, where close to the shore depths of from 100 to 200 meters are found. The lands falls away steeply toward the channel, and only here and there is the abrupt fall broken by small terraces. The sides of the cliffs and terraces support a rich and very varied fauna, and at one haul of the dredge half a score of this species can be secured.

According to Professor Sven Lovén (1840, 1842) it is abundant in certain localities on the western coast of Sweden; Kristineberg is one of these.

Aurivillius (1898) wrote that in March and April as well as at the end of October the spermatozoa of this species were found in the water at Kristineberg, but at that time the eggs were neither ripe, nor even partly ripe, so that he was unable to say anything definite regarding the breeding season. This was, however, later determined by Mortensen.

Occurrence of the pentacrinoids.—The first pentacrinoid of this species was found by Grieg (1895) at Loksund in September 1892, attached to the brachiopod *Waldheimia* (now *Macandrevia*) *cranium.*

At Kristineberg, Fiskebäckskil, Sweden, Dr. Th. Mortensen (1920) found that the breeding season of this form is chiefly in August and September, though in 1919 ripe specimens were found as early as July 23, and in January 1910 he collected a pentacrinoid not yet quite ready for detachment from a *Balanus* growing on a shell of *Pecten maximus*; this pentacrinoid he described in detail and figured in 1910.

History.—The commencement of the use of the naturalist's dredge on the Norwegian coast was immediately rewarded by the discovery of this species, which was first recorded by Prof. Michael Sars in 1835. He did not, however, distinguish it from the Mediterranean form. Seven years later it was reported (also under the name *mediterranea*) from the western coast of Sweden by Prof. Sven Loven, who mentioned it only incidentally as a host for myzostomes.

In 1846 it was described as a new species under the name of *Alecto petasus* by Profs. Düben and Koren, who had it from the Swedish coast near Fiskebäckskil, and also from Egersund and Søndfjord in Norway.

In 1861 Prof. Sars gave a detailed account of its occurrence on the Scandinavian coast, noting that it is less common than the other characteristic comatulid of this region, *Hathrometra sarsi.*

In 1866 Dr. W. B. Carpenter wrote that this form is probably identical with the species with which he was especially concerned, namely *A. bifida.*

In 1873 Prof. Möbius reported it from Arendal, and in 1878 and 1879 Dr. V. Storm recorded it from the outer part of the Trondhjemsfjord, beyond Galgenesset, in 40–100 meters.

In 1881 Dr. P. H. Carpenter stated that this species is entirely distinct from *A. bifida*, having more numerous cirri with slightly longer segments, relatively longer brachials, more quadrate axillaries, and the two lowest pinnules (P_1 and P_2) of more nearly equal length. In 1884 he recorded a specimen from *Triton* station 3, and in the same year Prof. Ludwig von Graff recorded another from Arendal, Norway, adding the Kattegat to the list of localities from which this form is known in 1887.

Dr. Fridtjof Nansen in 1885, in connection with his studies on the myzostomes, recorded it from several new localities, and in the following year Drs. W. Kükenthal and Weissenborn recorded it from Bognestrøm.

Further experience with the various forms of *Antedon* led P. H. Carpenter to doubt the distinctness of *bifida* and *petasus*; in the *Challenger* report in 1888 he was inclined to consider the two as identical, and bracketed their names together, though keeping them separate in his list of known species of comatulids.

In 1891 he decided that all the various forms of *Antedon* represent collectively but a single species.

Prof. D. C. Danielssen in 1892 noted that usually in *A. petasus* the rudimentary ovum is partially surrounded by the nearest adjacent epithelial cells which, as the egg grows, gradually form round it a half or entire membrane; but ova may be found which from their commencement to their full maturity have no such covering at all. He added Husøen, Sognefjord, where it had been dredged by the *Vøringen*, to the list of known localities.

Dr. James A. Grieg in 1895 recorded the first pentacrinoid to be observed, and in 1897 he gave its occurrence in detail on portions of the Norwegian coast. In 1904 he published detailed notes on its cirri and lower pinnules and described and figured the ambulacral plates, at the same time comparing it minutely with related species. In the same year Dr. G. Retzius described in detail the spermatozoa.

In 1910 Dr Th. Mortensen described and figured a pentacrinoid of this species which he had found at Kristineberg, Sweden; in 1912 and again in 1913 Dr. J. A. Grieg published additional detailed information regarding the occurrence of this form on the coast of Norway; in 1917 Jägerskiöld noted its occurrence in Bohuslän; and in 1921 Dr. Mortensen in two papers gave a detailed account of the eggs and larvae, described several aberrant specimens, and discussed the systematic position of the species.

More recently, Lieberkind (1929) and Einarsson (1948) have recorded the species again from Iceland and the Faroes respectively, and Terslin (1938) has established that it does occur in the southern Kattegat, his specimens having been identified by Dr. Svend Heding.

ANTEDON NUTTINGI (A. H. Clark)

Antedon hagenii (part) P. H. Carpenter, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, pp. 154–156 [pp. 4–6 of separate] (Dominica to Grenada; 75–291 fms.; Barbados; Grenada).—A. Agassiz, Bull. Mus. Comp. Zool., vol. 15, reprinted as "Three Cruises of the Blake," pt. 2, 1888, p. 124 (Dominica to Grenada; 75–291 fms.).

Antedon hageni (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 22, 54, 207, 367, 368, 373, 377 (Caribbean Islands).

Coccometra hagenii (part) A. H. Clark, Univ. Iowa Studies Nat. Hist., vol. 9, No. 5, 1921, p. 8 (obtained by the Barbados-Antigua Exped.), p. 26 (Sta. 15), p. 27 (listed).

Compsometra nuttingi A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 246 (description; references; Barbados); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140 (in key), p. 143 (*Atlantis* station 3412; notes).—H. L. Clark, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 11 (*Atlantis* station 3412; notes).— A. H. Clark, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—This species seems to be most closely related to *A. parviflora*, from which it is easily distinguished by having P_1 with 18 to 20 instead of 9 or 10 segments and P_2 stouter basally than P_1 and two-thirds rather than half the length of the latter. The cirri are about XXX with up to 11 segments, the longest up to five times as long as their median widths. It is larger than *A. parviflora*, the arms being up to 40 mm. in length.

Among the West Indian comatulids it is most likely to be confused with *Antedon duebeni*, in which the cirrus segments are shorter, P_1 is basally stouter than P_2 and the distal ends of the segments of the lower pinnules, of the brachials, and of the cirri are not produced; also with *Coccometra hageni*, in which P_1 is composed of much shorter segments and is of the same length as P_2, and the cirrals, pinnulars, and lower brachials do not have produced distal ends.

Description.—The centrodorsal is hemispherical or low and broadly rounded conical with a broad area free of cirri and covered with relatively large papillae from the center of which the low, rounded conical dorsal pole protrudes.

The cirri are XXV–XXX, 9–11, from 3.5 to 5 mm. long. The first segment is not so long as broad, the second is longer than broad, strongly constricted centrally with the distal end prominent, the third is about four times as long as the median width with the terminal fourth expanded, and the fourth is the longest, about five times as long as the median width; the fifth is about as long as the third; the sixth is about three times as long as the median width. The following segments decrease in length to the third before the last, which is twice as long as the median width, the antepenultimate, which is half again as long as broad, and the penultimate, which is slightly longer than broad and bears a blunt opposing spine. The distal ends of the third and following segments are expanded and produced all around into a thin transparent border that overlaps the base of the segments succeeding; this becomes less prominent on the short distal segments.

The 10 arms are up to 40 mm. in length. The earlier brachials have the central portion of the distal edge strongly produced and armed with several stout webbed spines. Beyond the second syzygy the brachials are constricted centrally and have produced and spinous distal ends. The distal brachials are much elongated and very strongly constricted centrally; the syzygial unions are also much swollen.

The distal intersyzygial interval is usually 2 muscular articulations.

P_1 is long and slender, evenly and gradually tapering and becoming very delicate distally. It is composed of 18 to 20 segments of which the first is about as long as broad, the second is slightly longer than broad, the third is twice as long as the median width, strongly constricted centrally, and the remainder are much elongated, 4 or 5 times as long as the median width, with swollen proximal ends and the distal ends strongly flaring and spinous.

P_2 is about two thirds as long as P_1 and is much stouter basally, though becoming very slender in the distal half. It is composed of 11 or 12 segments, of which the first is short, the second is longer than broad, and the third and following are much elongated with expanded and spinous distal ends. There is a long ovate gonad on the third and fourth or third to fifth segments. The subsequent pinnules are similar. The lower and middle pinnules have the distal ends of the segments strongly produced and armed with prominent spines. The distal pinnules are very slender.

Notes.—In the specimen from *Atlantis* station 3412 the arms are about 30 mm. long. P_1 is 5 mm. long, with 23 segments. P_2 is 3.5 mm., long with 9 segments and bears a long fusiform gonad on the third to sixth segments. The perisome of the pinnules contains short, straight, slightly curved or sinuous thorny spicules; the tentacles contain a broad band of similar though much smaller interlaced spicules. The cirri are about XXXV.

Localities.—*Albatross* station 2337; off Havana, Cuba (lat. 23°10′39″ N., long. 82°20′21″ W.); 364 meters; January 19, 1885 (1, U.S.N.M., 36213).

Atlantis station 3412; north of Punta Alegre, Camaguey Province, Cuba (lat. 22°49′ N., long. 78°48′ W.); 429 meters; April 29, 1939 [A. H. Clark, 1940; H. L. Clark, 1941] (1, M.C.Z.).

University of Iowa's Barbados-Antigua Expedition station 15; Barbados [A.H. Clark, 1921, 1936] (1, the holotype, U.S.N.M., E. 4289). Type locality.

Geographical range.—Northern Cuba to Barbados.

Bathymetrical range.—From 364 to 429 meters; it probably occurs also in shallower water.

History.—Presumably in his preliminary report on the *Blake* comatulids published in 1881 Dr. P. H. Carpenter included under the name of *Antedon hagenii* specimens of this species which he said had been obtained by the *Blake* at various stations between Dominica and Grenada at between 75 and 291 fathoms. He said that several individuals from Barbados and Grenada differed so much from specimens from off Sand Key and from one another that he was at first inclined to regard them as representing two new species; but a more careful examination did not confirm this impression.

Mr. Alexander Agassiz in 1888, quoting Carpenter, said that "*Antedon Hagenii*" occurred from Dominica to Grenada in 75–291 fathoms.

In his report on the comatulids of the *Challenger* Expedition published in 1888, Dr. Carpenter gave *Antedon hageni* as occurring among the Caribbean Islands and in the Straits of Florida in 82–242 fathoms, again presumably including some individuals of this species.

In 1921 I recorded as *Coccometra hagenii* four "small and young specimens" from the University of Iowa's Barbados-Antigua Expedition station 15, remarking that "the segments of P_1 are much longer than usual, probably owing to their small size." Reexamination of these specimens showed that they had nothing to do with *Coccometra hagenii*, and in 1936 I described them under the name of *Compsometra nuttingi*.

In 1940 I recorded as *Compsometra nuttingi* a specimen from *Atlantis* station 3412 and gave notes on it, and in 1941 Dr. H. L. Clark recorded the same specimen.

[Note by A.M.C.] Following Gislén (1955) this species (*nuttingi*) is now referred to *Antedon* together with the others formerly included in *Compsometra*, but its relatively elongate cirrus segments and the fact that P_2 is a genital pinnule mark it off sharply from the other Atlantic species of *Antedon*.

ANTEDON LONGICIRRA (A. H. Clark)

Figure 9,*a*

Compsometra longicirra A.H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 134 (description; *Siboga* Sta. 167); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga*), p. 204 (in key; range), p. 206 (synonymy; detailed description; *Siboga* Stas. 50, 167), pp. 271, 273 (listed), pl. 25, figs. 74, 75, 79.

Compsometra gracilipes A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 134 (compared with *C. longicirra*), p. 135 (description; *Siboga* Sta. 50, reef); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 206 (=*C. longicirra*), pl. 25, fig. 79.

Nomenclature [by A.M.C.].—The transfer of *Compsometra longicirra* to the genus *Antedon* renders it liable to confusion with *Antedon longicirra* Carpenter, 1888, of which it appears, at first sight, to be a junior homonym. However, Carpenter's species was transferred to *Ptilometra* by Mr. A. H. Clark in 1907 and thence to *Asterometra* in 1909. Under the International Code of Zoological Nomenclature, article 59b, it would only be necessary for me to find a replacement name for *Antedon longicirra* (A. H. Clark) if I consider the two species to be congeneric. Since this is not the case and is never likely to be, *Asterometra longicirra* (Carpenter) being a member of the Oligophreata, there is no need to alter the specific name of this species.

Diagnostic features.—A small species with the arms not over 40 mm. long, easily distinguished from all the others by the X-XX, very long cirri (more than a fourth the arm length) which are exceedingly slender and delicate, almost hairlike, very slightly recurved distally, with all the 12 to 17 segments much elongated, the earlier with greatly swollen articulations, the outer gradually decreasing in diameter so that the cirri end in a sharp point without an opposing spine; P_2 is less than half as long as P_1 but similar to P_3.

Description.—Centrodorsal flattened hemispherical, the dorsal pole more or less thickly covered with rounded tubercles, which become smaller centrally; cirrus sockets arranged in one or two irregular crowded rows.

Cirri X-XX, 12-17, from 7 to 11 mm. long, extremely slender, very slightly curved, and tapering gradually to a sharp point in the distal fourth, composed of extremely long segments with greatly swollen articulations, especially in the proximal portion; first segment very short, second nearly as long as broad, third from two and a half to three times as long as the diameter of the expanded distal end, and the following about four times as long as the diameter of the greatly expanded distal ends, or over six times the median width (see fig. 9,*a*, p. 149); beyond the fifth to eighth the expansion of the distal ends of the segments gradually decreases, and the lateral diameter of the segments after the tenth gradually decreases to the sharp tip; no opposing spine; terminal claw very slender, and straight.

Distal edge of the radials even with the rim of the centrodorsal, sometimes bearing a few tubercles toward the interradial angles of the calyx; distal interradial angles slightly separated.

IBr_1 very short, about four times as broad as long, twice as long laterally as in the median line; lateral edges parallel or slightly converging, making an angle of about 90° with the lateral edges of the adjacent IBr_1, and not in contact basally; proximal and distal edges broadly thickened, the proximal more broadly than the distal, and very finely spinous; as a result of this thickening of the proximal and distal edges the lateral borders have a rounded notch; IBr_2 (axillaries) rhombic, all the sides moderately concave, with truncated lateral angles, from half again to twice as broad as long; the lateral angles are slightly produced outward and downward in rounded latero-posterior processes; the truncated ends of the lateral angles are about as long as the median length of the IBr_1; all the borders are slightly everted and very finely spinous.

Arms 10, up to 40 mm. long, and exceedingly slender; brachials elongate, slightly constricted centrally, this condition increasing distally, their surfaces practically smooth, with no production of the distal edges.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 oblique muscular articulations. The arm width at the first syzygy is 0.7 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 4.5 mm.

P_1 is from 3.5 to 4.0 mm. long, tapering evenly from the base to the tip, composed of from 9 to 11 segments, of which the first is twice as broad as long, the second half again as long as broad, the third twice as long as broad, and the remainder from two and a half to three times as long as broad; third and following with produced and overlapping spinous distal edges which are most developed along the distal side. P_2 is from 1.5 to 1.7 mm. long, much smaller and more slender than P_1 though with similar segments, of which the first is short, the second slightly longer than broad, the third twice as long as broad, and the remainder elongated. P_3 is similar to P_2, but very slightly smaller, with only a very slight production of the distal dorsal edges of the segments. The distal pinnules are from 2 to 4 mm. long, and extremely slender.

Localities.—*Siboga* station 50; Bay of Badjo, western coast of Flores; reef; April 16–18, 1899 [A. H. Clark, 1912, 1918] (14, Amsterdam M.).

Siboga station 167; Ceram Sea, off northwestern New Guinea (lat. 2°35.5′ S., long. 131°26.2′ E.); 95 meters; August 22, 1899 [A. H. Clark, 1912, 1918] (6, U.S.N.M., E.449; Amsterdam M.). Type locality.

Remarks.—Originally I considered the specimens from station 167 as representing one species, which I called *Compsometra longicirra*, and those from station 50 as representing another, *C. gracilipes.*

Compsometra longicirra I believed to differ from *C. gracilipes* in having longer cirri (which does not appear to hold true) with more numerous segments (14–16 as against 12–13 in *gracilipes*), and P_1 proportionately more slender with more elongated segments which are fewer in number (9 or 10 as contrasted with 11 in *gracilipes*) and possess only a slight eversion of their distal ends.

But the largest specimens from station 167 have the arms from 30 to 40 mm. long, while those from station 50 are smaller, the maximum arm length being only 23 mm.; without doubt the difference in development accounts for the slight differences between them.

[NOTE BY A.M.C.] Following Gislén's synonymy of 1955, this species (*longicirra*) is now referred to *Antedon.*

ANTEDON PARVIFLORA (A. H. Clark)

FIGURE 9,*b*,*c*

Compsometra parviflora A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 133 (description; *Siboga* Sta. 50); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga*), p. 205 (in key; range), p. 207 (references; detailed description; Stas. 50, 65*a*, 99, 105, 125, 240, 289), pp. 271, 272, 273, 274, 275 (listed), pl. 25, figs. 80, 81.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 5, 124–126 (detailed notes; localities), pp. 182, 183 (listed); figs. 109–113, p. 122; Zool. Bidrag Uppsala, vol. 9, 1924, p. 283.—A. H. CLARK, Temminckia, vol. 1, 1936, p. 295, p. 316 (locality; notes); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, pp. 102, 103.

Diagnostic features.—A very small species with the arms up to only 35 mm. (but rarely over 20 mm.) in length, and the cirri about a fifth as long; the cirri are less than XL in the known specimens, slender and delicate with 8 to 11 greatly elongated segments, of which the longest are about four times as long as their median widths, the antepenultimate is about twice as long as broad, and the penultimate is from a third to half again as long as broad and bears a prominent opposing spine; all the cirrus segments have greatly expanded distal ends, this feature becoming less marked distally; P_2 is about half as long as P_1; the centrodorsal is flattened hemispherical.

Description.—Centrodorsal flattened hemispherical, very low, bearing two irregular rows of cirrus sockets.

Cirri XV–XXV, 8–9 (usually 8), 4 mm. long, exceedingly slender, the much elongated segments with greatly expanded ends; first segment about twice as broad as long, second from two to two and a half times as long as the diameter of the expanded distal end, third and fourth the longest, about three times as long as the diameter of the expanded distal ends or four times the median width; following segments decrease slowly in length so that the antepenultimate is about twice as long as the diameter of its expanded distal end, and the penultimate is from a third to half again as long as broad; the strong constriction of the middle of the segments decreases in amount distally; opposing spine terminal, prominent, in height reaching nearly half the distal diameter of the penultimate segment; terminal claw about as long as the penultimate segment, rather stout, strongly and evenly curved.

Distal borders of the radials even with the rim of the centrodorsal; their distal angles are slightly separated.

IBr_1 about three times as broad as the lateral length, which is twice the median length; lateral edges converge slightly, and widely separated from those of adjacent IBr_1; lateral portion of the proximal and distal edges sometimes slightly thickened; IBr_2 (axillaries) rhombic, with the lateral angles truncated, twice as broad as long, widely separated from their neighbors.

Arms 10, from 15 to 20 mm. long, and slender; brachials with somewhat prominent very finely spinous distal ends.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of 3 muscular articulations.

P_1 from 2.3 to 3.5 mm. long with 9 or 10 segments, of which the first is twice as broad as long, the second somewhat longer than broad, the third two and a half times as long as the proximal diameter, and the following three times as long as the proximal diameter; the third and following have prominently expanded and overlapping distal ends which are especially prominent on the distal side of the pinnule, where they are armed with long and prominent spines; P_2 about half as long as P_1, composed of 7 segments which are very long, with very strongly everted spinous distal ends, especially on the distal side; a large gonad extends from the base of the third to the base of the sixth segment; similar gonads occur on the following pinnules to and including P_5.

[Note by A.M.C.] The paratype from Banda (*Siboga* station 240), with arms about 35 mm. long, has the width at the first syzygy 0.6 mm. and the length from the proximal edge of the IBr_1 to the second syzygy about 4 mm.

Notes.—Dr. Gislén gives the following details for the specimens from the Bonin Islands.

No. 1 (station 46): The centrodorsal is about 1.4 mm. in diameter. The cirri are about XXXV, 9–10, from 2.0 to 2.5 mm. long, arranged in two closely crowded rows; the third to fifth segments are very strongly constricted centrally, from two and a half to three times as long as the distal diameter; the seventh segment is half again as long as broad; the outer segments are less constricted centrally. The IBr_2 (axillary) is twice as broad as long, rhombic, the proximal angle incising the IBr_1; it is broader than the IBr_1. The arms are 20+ mm. in length, but not very much longer; the first brachials are well separated interiorly. P_1 is 4 mm. long with 10 segments of which the sixth and following have everted and spinous distal ends. P_2 is 2 mm. long, with 7 segments and without a genital gland, P_3 is 2.0 mm. long, with 7 segments, of which the third to fifth carry a genital gland. P_8 is 4 mm. long, with 13 segments, of which the first two are short and the remainder elongated. The disk is 4 mm. in diameter; the anal tube is long.

No. 2 (station 47): The cirri are XXXVII, 8–11, from 2.0 to 4.5 mm. long; the fourth segment is the longest, from three to four times as long as broad. The radials are concealed. The IBr_2 are half again as broad as long with strongly concave distal borders. The first brachials are twice as long exteriorly as interiorly, twice as broad as the external length, and basally in contact interiorly. The arms are 25 mm. long. P_1 is 2 mm. long with 7 or 8 segments which, with the exception of the two first and the terminal, are from two to three times as long as broad. P_2 is 1.2 mm. long, with 6 segments. P_3 is 2.2 mm. long, with 8 segments and carries a genital gland. P_4 is 2.2 mm. long, with 8 segments. The distal pinnules are 4 mm. long, with 14 segments.

No. 3 (station 47): The cirri are XXXI, 9–10, from 2.5 to 3.5 mm. long. The IBr_2 are as in the preceding specimens. The arms are broken, but they were probably between 20 and 25 mm. long. P_1 is 3 mm. long, with 8 segments, of which the third is two and a half and the fourth three and a half times as long as broad. P_2 is from 1.2 to 1.5 mm. long, with 5 or 6 segments. P_3 is 2 mm. long, with 7 segments. The disk is 1.8 mm. in diameter.

No. 4 (station 45): The centrodorsal is hemispherical. The cirri are about XXV, in two rows, 9–11, from 2.0 to 4.5 mm. long. The segments are very markedly constricted centrally, those before the antepenultimate being twice as long as broad and the antepenultimate half again as long as broad. The cirri in the distal row have very much longer segments than the others, with relatively large opposing spines

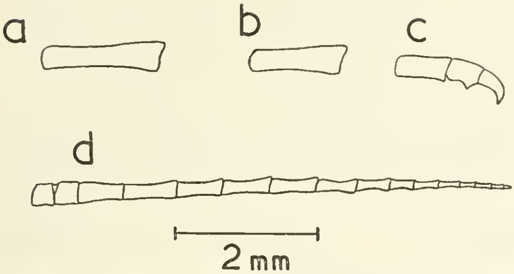

FIGURE 9.—*a*, *Antedon longicirra* (A. H. Clark), longest cirrus segment. *b*, *A. parviflora* (A. H. Clark), longest and *c*, distalmost cirrus segments. *d*, *A. iris* (A. H. Clark), P_1.

and terminal claws. The IBr_1 are six times as broad as long. The IBr_2 are rhombic, twice as broad as long, shorter and with sharper lateral angles than in the preceding specimens. The arms are 15+ mm. long, rather smooth; the first brachials are basally in contact interiorly. The distal intersyzygial interval is 3 muscular articulations. P_1 is 1.5 mm. long, with 8 segments. P_2 is 1.0 mm. long, with 6 segments. P_3 is 1.8 mm. long, with 7 or 8 segments and bearing a genital gland. The disk is 2.5 mm. in diameter and the anal tube is 1.3 mm. in height.

No. 5 (station 45): The cirri are about XXV, 10–11, from 2 to 3 mm. in length; the fourth segment is about four times as long as broad. The arms are about 15 mm. long. P_1 is 1.0 mm. long, with 6 segments. P_2 is 0.5 mm. long, with 4 segments, or lacking. The disk is 1 mm. in diameter.

No. 6 (station 44): The centrodorsal bears about XXV cirrus sockets. The IBr_1 is five times as broad as long, with a thickened rim against the radial. The IBr_2 is three times as broad as long, rhombic. P_1 is 1.2 mm. long, with 7 segments. P_2 is 0.8 mm. long, with 4 or 5 segments. P_3 is 1.2 mm. long, with 6 segments.

No. 7 (station 54): The centrodorsal is 0.5 mm. in diameter, low and rounded, with about XXXV cirrus sockets arranged in 3 rows. The center of the dorsal pole is occupied by a small rounded star with the scar left by the central canal of the stem. The distal borders of the radials are even with the edge of the centrodorsal. The IBr_1 are four times as broad as long, with the lateral borders converging distally. The

IBr_2 (axillaries) are twice as broad as long and rhombic. The arms are about 5 mm. long. The first brachials are twice as long exteriorly as interiorly, three times as broad as the exterior length. The second brachials proximally rise into a synarthrial tubercle. P_1 has 7 segments; P_2 is shorter, with 5 segments; P_3 is about as long as P_2, with 7 segments; P_4 is sometimes absent.

Gislén remarks that in his specimens from the Bonin Islands the cirrus segments are a little shorter than in those from the *Siboga* collection; but cirri can be found with the segments more elongated.

None of his 7 specimens had a genital gland on P_2 as did the type from *Siboga* station 50. From other *Siboga* stations, however, the specimens had the first genital gland on P_3 as was the case with his. He suggests that, as this is evidently not due to age, it may have varietal significance.

Of the three *Snellius* specimens noted by the author in 1936, one has the cirri 5.5 mm. long, with 10 segments. The dorsal pole of the centrodorsal is papillose. The elements of the division series and the first two brachials have their edges slightly thickened, with occasional tubercles on the edges and on the dorsal surface, and with a few long and widely separated spines on the edges. P_1 is 3 mm. long, with 11 segments. In another specimen P_1 is 7 mm. long, with 10 or 11 segments. On a detached arm about 30 mm. long, P_b is 5.7 mm. long, with 10 segments, and P_c is 4 mm. long with 9 segments and proportionally less stout. On another detached arm about 30 mm. long, P_b is 5.4 mm. long, with 10 segments and P_c is 3.8 mm. long, with 8 segments.

Localities.—*Siboga* station 240; Banda (south of Ceram); 9–36 meters; black sand and coral; November 22 to December 1, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 289; off eastern Timor (lat. 9° 0.3′ S., long. 126° 24.5′ E.); 112 meters; mud, sand and shells; January 20, 1900 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 50; Bay of Badjo, western coast of Flores; reef; April 16–18, 1899 [A. H. Clark, 1912, 1918] (42, U.S.N.M., E. 440; Amsterdam M.). Type locality.

Siboga station 65*a*; south of Saleyer (south of western Celebes) (lat. 7° 00′ S., long. 120° 34.5′ E.); 120–400 meters; pale gray mud changing during the haul to coral; May 6, 1899 [A. H. Clark, 1918] (3, Amsterdam M.).

Albatross station 5593; near Sibuko Bay, Borneo; Mt. Putri, Borneo, (sea tangent) bearing N. 52° W., 17.2 miles distant (lat. 4° 02′ 40″ N., long. 118° 11′ 20″ E.); 69 meters; fine sand; September 29, 1909 (1, U.S.N.M., 36017).

Siboga station 99; anchorage off North Ubian, between Borneo and Zamboanga (lat. 6° 7.5′ N., long. 120° 26′ E.); 16–23 meters; lithothamnion; June 28–30, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 105; Sulu (Jolo) archipelago (lat. 6° 08′ N., long. 121° 19′ E.); 275 meters; coral; July 4, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Jolo, East Indies; *c.* 36 meters; lithothamnion; Th. Mortensen, March 17, 1914 [MS. record] (1, ? C.M.).

Kombir, Banda; *c.* 75–90 meters; sand and stones; June 3, 1922 [MS.] (1).

Siboga station 125; anchorage off Sawan, Siau Island (between the northeastern end of Celebes and Mindanao); 27 meters; stone and some lithothamnion; July 18–19, 1899 [A. H. Clark, 1918] (2, Amsterdam M.).

Dr. Sixten Bock's station 44; Bonin Islands; northwest of Ototojima; 128 meters; July 31, 1914, [Gislén, 1922].

Dr. Sixten Bock's station 46; Bonin Islands; east of the Channel; 128 meters; August 1, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 47; Bonin Islands; east of the Channel; 146 meters; August 1, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 54; Bonin Islands; east of Chichijima; 128 meters; broken shells and sand; August 7, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 45; Bonin Islands; east of Chichijima; 146 meters; July 31, 1914 [Gislén, 1922].

Suvadiva atoll, Maldive Islands; lagoon; 80 meters or less; *Willebrord Snellius*, May 4, 1929 [A. H. Clark, 1936] (3, Leiden M.).

Geographical range.—From Banda, Timor and Flores northward to the southern Philippines and the Bonin Islands, and west to the Maldive Islands.

Bathymetrical range.—From the shore line down to 275, and possibly to 400, meters.

History.—This species was first described in 1912 from the collections of the *Siboga*, which met with it at a number of different localities. It was subsequently found to be rather common among the Bonin Islands by Dr. Sixten Bock, his specimens, collected in 1914, having been recorded by Dr. T. Gislén in 1922.

The known range was extended to the Maldive Islands by the collections of the *Snellius* expedition, reported by the author in 1936.

[Note by A.M.C.] Following Gislén's synonymy of 1955, this species is now referred to *Antedon*.

ANTEDON IRIS (A. H. Clark)

Figure 9,*d*

Compsometra loveni (not of *Bell*, 1882) A. H. Clark, Mem Australian Mus., vol. 4, 1911, p. 790 (part) (Claremont I., 11 fms.).—H. L. Clark, Biol. Results Fishing Exper. F.I.S. *Endeavour*, 1909–14, vol. 4, pt. 1, 1916, pp. 4, 26 (localities).

Compsometra iris A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 131 (description; *Siboga* Sta. 144); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga*), p. ix (relationship with *C. serrata*), p. 205 (in key; range), p. 208 (references; detailed description; Sta. 144), p. 273 (listed), pl. 25, figs. 77, 78; Temminckia, vol. 1, 1936, p. 295 (listed), p. 316 (locality).

Diagnostic features.—The cirri are about XXX, short (about a fifth the arm length), rather stout, and very strongly recurved in the outer three fourths, composed of 10 to 12 segments, of which the longest is about three times as long as the median width and the distal become shorter, the antepenultimate being as long as, or very slightly longer than, broad; P_1 has 16 to 18 segments and is about as long as the cirri; P_2 is only half as long as P_1; the eversion and production of the distal ends of the pinnule segments is moderately developed; the centrodorsal is flattened hemispherical.

The arms are 45 mm. and the cirri are 8 or 9 mm. in length in the type specimen.

Description.—Centrodorsal very low hemispherical, the bare polar area almost covered with pits representing obsolete cirrus sockets.

Cirri XXX, 10–12, from 8 to 9 mm. long, the outer portion strongly recurved; first segment very short, second about twice as long as the median diameter, third about three times as long as the median diameter, and fourth as long as the third;

the following gradually decreasing in length so that the antepenultimate is slightly longer than broad and the penultimate about as long as broad. The second and third segments strongly constricted centrally, with expanded ends, the following gradually losing this character and becoming laterally flattened and hence broader in lateral view, the outer segments being nearly or quite twice as broad dorsoventrally as the proximal; opposing spine large and prominent, triangular, arising from the entire dorsal surface of the penultimate segment, directed obliquely forward.

Distal borders of the radials even with the rim of the centrodorsal.

IBr_1 short, almost entirely divided in the median line by the posterior processes of the axillaries, well separated interradially and not in contact basally; IBr_2 (axillaries) rhombic, all the sides strongly concave, about as broad as long and widely separated from their neighbors.

Arms 10, 45 mm. long, resembling those of *A. serrata*, but the distal edges of the brachials, while overlapping and spinous, are much less conspicuously and more finely spinous, and lack the strongly marked longitudinal ridges running inward from each of the spinous processes.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations. The arm width at the first syzygy is 0.8 mm. and the length from IBr_1 to the second syzygy is 5.5 mm.

P_1 is 6.8 to 8.5 mm. long, moderately slender, composed of 16 to 18 segments of which the first two are broader than long, the third is about twice as long as the median breadth, and the remainder are approximately three times as long as broad, and somewhat longer distally; the third and following have slightly projecting and overlapping distal edges, this increasing distally (see fig. 9,*d*, p. 149). P_2 is much smaller and more slender than P_1, 4 mm. long and with 11 segments, of which the first two are short, the third is half again as long as broad, and the following rapidly become elongated; the segments have moderately produced spinous overlapping distal edges. P_3 is from 3.0 to 4.5 mm. long, with about 11 segments, tapering less rapidly than P_2 and thus appearing stouter, especially distally. P_4 is similar to P_3, but slightly longer and slightly stouter. The distal pinnules are very slender, 7 mm. long, with 16 or 17 segments which have slightly spinous distal edges.

Notes.—A specimen which I have examined and which appears to be referable to this species comes from 20 miles off Double Island Point, Queensland, in 55 meters; it was named *Compsometra loveni* by Dr. H. L. Clark. The cirri are about XV, 10–11 (usually 10); the arms are 35 mm. long; P_1 is 5.5 mm. long, with 20–23 segments.

Localities.—*Siboga* station 144; anchorage north of Salomakieë (Damar) Island, Anambas Islands, northeast of Singapore; 45 meters; coral bottom and lithothamnion; August 7–9, 1899 [A. H. Clark, 1912, 1918] (1, the holotype, Amsterdam M.). Type locality.

Claremont Island, northern Queensland (lat. 14°10′ S.); 20 meters [A. H. Clark, 1911] (1, U.S.N.M., 35678).

Endeavour; thirteen miles north by west of Double Island Point, Queensland (lat. 26°00′ S.); 46–47 meters [H. L. Clark, 1916].

Endeavour; twenty miles northnortheast of Double Island Point; 55 meters [H. L. Clark, 1916] (1, M.C.Z., 719).

Willebrord Snellius; Beo, Talaud Islands, East Indies; 6–10 meters; June 14–21, 1930 [A. H. Clark, 1936] (1, Leyden M.).

Geographical range.—From the Anambas Islands (northeast of Singapore) and the Talaud Islands to Double Island Point, southern Queensland (lat. 26°00′ S.).

Bathymetrical range.—From the shore line down to 55 meters.

History.—In the collection of the Australian Museum at Sydney I found a specimen from Claremont Island, Queensland, in 20 meters, which I identified (1911) as *Compsometra loveni.* Although Claremont Island is in a region in which only tropical forms would normally be assumed to occur, the only two species of what was then *Compsometra,* known at the time, were *loveni* from southeastern Australia and *serrata* from southern Japan, and I did not suspect the existence of additional species in the intermediate region.

When the *Siboga* collection was sent me, to my surprise I found in it a new species from the Malayan region which in 1912 I described under the name of *C. iris.*

The specimen from Claremont Island now proves to belong to this species, which superficially in many ways is very like *loveni.*

In 1916 Dr. H. L. Clark recorded *loveni* as *Compsometra* from two localities in southern Queensland. One of these is in the Museum of Comparative Zoology where I examined it in 1921 and identified it as *Compsometra iris.*

In 1936 I recorded this species from the collections of the *Willebrord Snellius* at the Talaud Islands in the East Indies.

[Note by A.M.C.] Following Gislén's synonymy of 1955, this species is now referred to *Antedon.*

ANTEDON HUPFERI Hartlaub

Figure 13, *d*

[See also vol. 1, pt. 2, figs. 568, 569, p. 298]

Antedon rosacea (part) R. Greeff, Zool. Anz., vol. 5, No. 107, 1882, p. 159 (Rolas).

Antedon hupferi Hartlaub, Nachr. Ges. Göttingen, May 1890, p. 171 (Wapoo, Ivory Coast, 21 fms., blue mud); Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 88, pl. 5, figs. 53, 59 (detailed description and comparison with *Hathrometra tenella*).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 3 (Greeff's specimens from Rolas possibly this species), p. 4 (history), p. 7 (occurs on the west coast of Africa), p. 12 (closely allied to *A. dubenii* from Rio; characteristic of the West African-South American faunal area), p. 39 (specimens from Madeira possibly referable to this species), p. 40 (synonymy; Rolas; Wapoo; Goree; Canary Is.; Madeira; discussion); *in* Michaelsen and Hartmeyer, Die Fauna Sudwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 449 (resembles *A. petasus* in its short arms); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 2 (of Hartlaub, 1890–91=*A. hupferi*), p. 30 (Wapu; redescription of the type specimen; Goree, 13 fms.); Crinoids of the Indian Ocean, 1912, p. 37 (listed; identity); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 52 (Goree); *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 307 (references; Wapoo; Rolas), p. 315 (in key), p. 316 (range), p. 317 (possibly only immature *moroccana*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 203 (in key; range).—Mortensen, Vid. Medd. Nat. Foren. København, vol. 72, 1920, p. 71 (discussion).—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range), p. 55 (in key).—(?) Mortensen, Bull. Soc. Sci. Nat. Maroc., vol. 5, Nos. 4, 5, 1925, pp. 179, 180, 183 (doubtful identity).—Kolosvary, Festschrift für Embrik Strand, vol. 2, 1937, p. 469.—Cadenat, Rev. Trav. Pêches Marit. Paris, vol. 11, 1938, p. 373 (*President-Theodore-Tissier* stations.).—(?) Vaney and John, Sci. Res. Voy. *Scotia,* 1902–04, vol. 59, pt. 3, 1939, p. 665 (Cape Verde Islands; remarks, like specimens from Goree).—Gislén, *Atlantide* Rep., No. 3, 1955, p. 84 (synonym of *A. dübenii*), p. 87 (spinous pinnule segments), p. 90 (synonymous with *moroccana* and *dübenii*).—Buchanan, Proc. Zool. Soc. London, vol. 130, pt. 1, 1958, p. 31 (off Accra; 40–60 fms.).

Antedon dübenii (part) Gislén, *Atlantide* Rep., No. 3, 1955, pp. 86–87 (most southern localities), pl. 1, fig. 4 (cirri), pl. 2, fig. 8 (pinnules).

Diagnostic features.—The arm length is up to about 50 mm. in the known specimens and the cirri up to XL, their length equal to about a quarter that of the arms, the peripheral ones with up to 18, usually 16, segments, of which the longer proximal are two to two and a half times as long as their median width and the distal are distinctly longer than wide as well as very little wider dorsoventrally than the proximal ones; P_1 has up to 25, usually 20, segments and is at least twice as long as P_2, which is similar to P_3; there are often calcareous patches in the perisome between the division series.

Description.—Centrodorsal discoidal, thin, the rather broad dorsal pole very slightly concave, 1 mm. in diameter. The cirrus sockets are arranged in two irregular rows.

Cirri XXVI, 14–16, from 12 to 14 mm. long, intermediate in character between those of *A. bifida* and those of *A. mediterranea*. The longest proximal segments are from two to two and a half times as long as the proximal diameter, slightly constricted centrally; the short outer segments are usually half again as long as broad, becoming slightly longer on the last three, with a perfectly straight dorsal profile. The opposing spine is minute, terminal, and sharp. The moderate central constriction of the longer earlier segments makes the outer ones, which are slightly flattened laterally, appear broader in lateral view; but the difference is relatively slight.

The perisomic areas between the IBr series are occupied by triangular masses of rather solid perisomic plates. The disk is 7 mm. in diameter, and bears a very few small calcareous nodules, more numerous on the base of the anal tube than elsewhere.

The 10 arms are 35 mm. long and have a fairly smooth dorsal profile. The first and second brachials are longer outwardly than inwardly; the first syzygial pair (composed of the third and fourth brachials) is wedge-shaped, slightly longer inwardly than outwardly. From about the tenth onward the brachials are triangular with a slight tendency toward an overlapping of their distal ends. From the twentieth onward they become wedge-shaped. The syzygial pairs are long.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 or 4 muscular articulations.

P_1 is very long, though not especially stout, about 10 mm. in length and composed of 18 to 20 segments, of which the first is about as broad as long, the second is slightly longer than broad, the third is slightly over twice as long as broad, and the remainder are three times as long as broad; the third and following have very slightly produced and very finely spinous distal ends.

P_a is similar, about 6 mm. long, with about 12 segments.

P_2 is usually about one-third as long as P_1, composed of about 8 segments, of which the three basal are broad and the remainder elongated. The immediately following pinnules are of the same length, after which the pinnules become elongated and more slender, reaching a length of 9 mm. distally.

The color in alcohol is dirty white.

Notes [BY A.M.C.].—A number of specimens from southwest of Sierra Leone, with arms probably up to about 50 or 55 mm. in length, all have the centrodorsal with sloping sides bearing about XL cirri and the small dorsal pole distinctly concave, measuring 0.7 to 0.9 mm. across when the total diameter of the centrodorsal is 2.5 to 3.0 mm. In two specimens from off Accra, the centrodorsal is more discoidal, the dorsal pole being 1.6 to 1.8 mm. across and the total diameter about 3.4 mm.; in one the dorsal pole is distinctly concave but in the other it is nearly flat. In all these specimens there are distinct lateral flanges on each first brachial leading from less marked flanges on the division series as in *A. mediterranea.* Between the adjacent IBr_1 are triangular calcareous patches on the perisome as in the specimens described above. P_1 is usually much stouter than the other pinnules, 10 to 12 mm. long and with 18 to 25, usually about 20, segments. P_2, with 11 or 12 segments, is about 5 mm. long. P_3 is similar in length but has 11 to 14 segments. The cirri are long and slender, mostly preserved in the extended condition in contrast to those of specimens of *A. bifida moroccana* and not markedly widened dorsoventrally in the distal part. Some measurements are given in the following tabulation for comparison with those of *Antedon bifida bifida* and *bifida moroccana* in table 6 on p. 95.

TABLE 3.—*Measurements of some of the peripheral cirri of one specimen of* A. hupferi *from off Accra and six from Sierra Leone (the largest have the length IBr_1 to Br_9 about 7 mm.)*

Width at 1st syzygy (mm.)	*Cirrus length (mm.)*	*Cirrus segments*	*Width of 4th from tip A (s.u.)* [1]	*Width of 4th from base B (s.u.)* [1]	*Length of 4th from tip (s.u.)* [1]	*Ratio A:B* [2]
1.25	9.5	14	12.5	9	14	1.39:1
1.4	12	15	12	8	19	1.50
1.2	12.5	17	12.5	9	19	1.39
1.4	12	16	10	7	16	1.42
1.2	13.5	17	12	9	20	1.33
1.25	12	16	10	8	16	1.25
1.2	12.5	16	10	8	16	1.25

[1] 22 s.u.=1 mm., as in table 6 on p. 95.
[2] Range of A:B in 7 specimens from 1.25–1.50:1, average 1.36:1.

The greatest number of cirrus segments found was 18, of which the longest proximal ones are two to two and a half times as long as their median width and the distal ones are also longer than wide. The cirri as a whole are more like those of *A. mediterranea* than of *A. bifida moroccana*, particularly those of the Sierra Leone specimens.

My conclusion that *moroccana* and *hupferi* are distinct is contrary to that of Gislén (1955), who had extensive material from the Canary Islands and from fourteen *Atlantide* stations and others round the Gulf of Guinea and off West Africa. In addition he examined the Copenhagen Museum specimens named *moroccana* by Mr. A. H. Clark. He concluded from these that only a single species is represented in the area and decided also that it is indistinguishable from the West Atlantic *Antedon duebeni.* Nevertheless I am not convinced that *hupferi*, with more slender and relatively longer cirri and coming from localities south and southeast of Sierra Leone, is untenable, whether or not *moroccana* is distinct from *duebeni.* Gislén's figures 3 and 4 show long slender cirri from a specimen from off Nigeria and short, distally broadened, ones from another off Gambia. However, the specimens shown in his figures 10 and 11 from a station off Freetown, Sierra Leone, also seem to have cirri of the *moroccana* type.

I have recently been able to examine some of these *Atlantide* specimens myself and still remain unconvinced by Gislén's contention concerning the identity of *hupferi* and *moroccana,* although the geographical limits between them are not sharply defined. In the vicinity of Sierra Leone and Liberia some of the specimens are intermediate with regard to the shape of the cirri and the profile of the arms (serrated or smooth, according to the degree of flaring of the brachials). The specimens from stations 68 and 85 (off the Ivory Coast and the eastern end of Ghana) are certainly referable to *hupferi*, their cirri being slender and hardly at all expanded distally and the brachials only very slightly flared, if at all. On the other hand, specimens from stations 147, 148, 153, and 163 (from stations to the north of Sierra Leone, 9+° N.) have expanded cirri and more or less flared brachials, as in *A. bifida moroccana*. However, six specimens from station 60 (off Liberia) and two from station 151 (due west of the northern end of Sierra Leone) are intermediate, though tending towards the form of *moroccana*, while three specimens from station 123 (off Gabon, 2° S., 9° E.) and one from station 116 (off Nigeria) are also intermediate, but tend towards *A. hupferi*.

Only more material and better descriptions can settle the limits of these Atlantic species of *Antedon*.

Localities.—Isla das Rolas (just south of São Thomé) (lat. 0°00′) [Greeff, 1882].

Atlantide station 123; off Gabon (lat. 2°03′ S., long. 9°05′ E.); mud; 50 meters [Gislén, 1955] (4 and 1 juvenile, C.M.).

Atlantide station 116; off Nigeria (lat. 4°01′ N., long. 7°56′ E.); mud; 66 meters [Gislén, 1955] (1, C.M.).

Atlantide station 85; off the eastern end of Ghana (lat. 5°37′ N., long. 0°38′ E.); mud; 28–40 meters [Gislén, 1955] (1, C.M.).

Atlantide station 68; off the Ivory Coast (lat. 4°38′ N., long. 6°18′ W.); mud; 90 meters [Gislén, 1955] (2, C.M.).

Off Accra, Ghana; 70–110 meters [J. B. Buchanan, 1958] (2, B.M.).

Wappou (Wapoo or Wapu), Ivory Coast (about 7°15′ W.); 38 meters; Captain Hupfer, December 5, 1887 [Hartlaub, 1890, 1891; A. H. Clark, 1911, 1912, 1914, 1918] (1, H.M.). Type locality.

President-Theodore-Tissier, fifth cruise; station 722; west of Sierra Leone (lat. 9°14′ N., long. 15°31′ W.); 120 meters; May 19, 1936 [Cadenat, 1938].

President-Theodore-Tissier, fifth cruise; station 728; west of Sierra Leone (lat. 9° 25′ N., long. 13°48′ W.); depth not given; bottom greenish sand; May 25, 1936 [Cadenat, 1938].

Off Sierra Leone (lat. 6°54′ N., long. 11°54′ W.); 72 meters; West African Fisheries Research Institute, A. R. Longhurst (20, B.M.).

Doubtful localities.—St. Vincent, Cape Verde Islands; shore [Vaney and John, 1939] (1, Royal Scottish Museum).

Vanneau stations 37 and 46 (1924); Atlantic coast of Morocco [Mortensen, 1925]. [Note by A.M.C.] Both these are probably *A. bifida moroccana* like those from Goree, Senegal.

Geographical range.—West Africa, from Sierra Leone to Gabon in the Gulf of Guinea.

Bathymetrical range.—From the shore line down to 120 meters.

Occurrence.—Professor Greeff says that he found only a few specimens at Rolas, on the shore cliffs at the lowest tide.

History.—It is probably to this species that the specimens collected by Prof. R. Greeff at Rolas, on the equator in the Gulf of Guinea, and recorded as *Antedon rosacea*, should be assigned.

This form was described by Dr. Clemens Hartlaub in 1890 from a specimen he found in the Hamburg Museum, from Wappou, on the Ivory Coast, collected by Captain Hupfer. He described it in greater detail and figured it in the following year, but his account of it is misleading in that he compared it only with *Hathrometra sarsi*, quite overlooking its affinities with the other species of *Antedon* as now understood. In 1910 I reexamined Hartlaub's type at Hamburg, thanks to the courtesy of Prof. Georg Pfeffer, and found there another from Goree, Senegal, which had also been collected by Capt. Hupfer. Later I found three more from Goree in the British Museum. In 1911 I gave Goree among the localities from which this species is known, in the following year describing the type in detail and listing the specimen from Goree in the Hamburg Museum. In 1913 I recorded those from Goree in the British Museum.

[Notes by A.M.C.] In 1914, however, Mr. A. H. Clark included Goree among the localities for his new species *moroccana* and certainly this change is supported by the British Museum specimens which have the short, curled, distally expanded cirri typical of *moroccana*.

In 1925 Dr. Th. Mortensen gave the name *hupferi* to some specimens of *Antedon* collected off the Atlantic coast of Morocco by the *Vanneau*. It seems more likely that these too are *moroccana*.

In 1938 Cadenat recorded *A. hupferi* from the dredgings of the *President-Theodore-Tissier* to the west of Sierra Leone, the depth of one station being 120 meters.

The following year Dr. D. Dilwyn John recorded under this name a single specimen lacking the cirri, taken on the shore at St. Vincent, Cape Verde Islands, by the Scottish Antarctic Expedition en route. He reckoned it belongs to the same species as the three from Goree which had been labeled *hupferi* by Mr. Clark (though since referred to *moroccana*).

Gislén (1955) has recorded specimens from a number of West African stations under the name of *A. dübenii* of which nearly all those that I have seen from localities south of Sierra Leone prove to be distinct as *A. hupferi*.

ANTEDON INCOMMODA INCOMMODA (Bell)

FIGURE 10,*a*

[See also vol. 1, pt. 1, fig. 107, p. 173]

Antedon incommoda Bell, Ann. Mag. Nat. Hist., ser. 6, vol. 2, 1888, pp. 402, 404 (Port Phillip; description); vol. 3, 1889, p. 292.—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1580 (listed).

Antedon, sp. nov. P. H. Carpenter, Proc. Roy. Soc. Victoria, new ser., vol. 1, for 1889, 1890, p. 135 (Port Phillip).

? *Compsometra lacertosa* A. H. Clark, Proc. U.S. Nat. Mus., vol. 38, 1910, p. 275 (Port Jackson); Mem. Australian Mus., vol. 4, 1911, p. 718 (=*Antedon*, sp. nov. Carpenter, 1890), p. 790 (compared with *loveni*).

Compsometra incommoda A. H. Clark *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, pp. 442, 443, 444, 464, 465 (detailed discussion; localities; comparisons); Mem. Australian Mus., vol. 4, 1911, pp. 722, 735, 792 (detailed account; localities); Proc. U.S. Nat. Mus., vol. 43, 1912, pp. 382, 405; Crinoids of the Indian Ocean, 1912, pp. 10, 229 (localities; discussion); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 52 (specimens in the British Museum); Die Crinoiden der Antarktis, 1915, p. 124 (exhibits the same features as *Solanometra antarctica*), p. 167 (range); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, p. 227 (distribution).—H. L. Clark, Biol. Results Fishing Exper. F.I.S. *Endeavour*, 1909–14, vol. 4, 1916, pt. 1, pp. 5, 26 (range; locality).—Hartmeyer, Mitt. Zool. Mus. Berlin, vol. 8, No. 2, 1916, p. 236 (southwestern Australia; No. 5958).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 31, 1918, p. 42 (listed from Tasmania); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 205 (in key; range), p. 208 (synonymy); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 12, fig. 48.—H. L. Clark, Rec. South Australian Mus., vol. 3, No. 4, 1928, p. 362 (listed), p. 369 (two specimens, locality unknown; notes); Mem. Mus. Comp. Zool., vol. 55, 1938, p. 44

(associations), p. 45 (various localities in Western Australia; notes).—COTTON and GODFREY, Rec. South Australian Mus., vol. 7, 1942, p. 232 (type locality; distribution).—H. L. CLARK, Echinoderm fauna of Australia, 1946, p. 60 (distribution in Australia, Port Jackson record needs confirmation).

Diagnostic features [by A.M.C.].—The centrodorsal is discoidal, with the dorsal pole quite flat although variable in width, the cirrus sockets sometimes encroaching on it; the cirri have up to 13 (rarely 14) segments, of which the longest are not more than half again as long as their median width and the antepenultimate is about as long as broad, but may be broader; the distal half of the cirrus is expanded dorsoventrally; in length the cirri are about a fifth the arm length when that is about 35 mm. (a ninth when the arm length is about 60 mm. in the types of *Compsometra lacertosa* from Port Jackson); there are XX–XXX cirri when the arm length is up to 50 mm. (XXXV in larger Port Jackson specimens); P_1 has 15 to 24 segments in Port Phillip specimens of arm length up to 50 mm. (30 to 32 in larger Port Jackson ones) and P_2 is less than half as long with nearly half as many segments; P_3 is similar in size to P_2 but bears a gonad.

Remarks [by A.M.C.].—Mr. A. H. Clark had left his description of the types of *lacertosa* from Port Jackson to cover this species. As there is an element of doubt about the identity of *lacertosa* and *incommoda* I am inserting here a description based on the type material of *incommoda* from Port Phillip.

Description [by A.M.C.].—The centrodorsal is discoidal, with the dorsal pole quite flat and the cirrus sockets crowded round the margin in about two irregular rows. In some specimens the sockets encroach considerably on the dorsal pole, which, as a result, varies in diameter from 0.8 to 1.6 mm. in 20 specimens, averaging 1.2 mm.

The cirri are XXIII–XXX in five syntypes with arm length 25 to c.50 mm., with up to 13 segments except in the largest which may have 14, and up to 8.0 mm. long. The segments are laterally compressed, but dorsoventrally expanded in the distal half particularly. The longer segments have the length to median width in lateral view about 1.5 : 1; they are somewhat constricted in the middle and expanded at the distal ends. The antepenultimate segment is not longer than wide. The opposing spine is well developed and the terminal claw strong and curved, particularly towards its base.

The arms are 25 to 50 mm. long in the five syntypes examined. The width at the first syzygy is 0.7 to 1.1 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 5.0 to 6.0 mm. The brachials are slightly flared towards their distal ends.

P_1 has 15 to 24 segments which are slightly flared and spinous at their distal ends. The fourth segment is about twice as long as wide and the following ones become at least twice as long again. The total length is usually little less than the cirrus length, 5.5 to 6.0 mm., but in the largest specimen it may exceed the cirrus length and measure 10 mm.

P_2 is much shorter with 8 to 12 stouter, more markedly flared and more spiny segments. It is 2.0 to 5.0 mm. long.

P_3 is the first genital pinnule. It has 11 to 13 segments and measures 3.0 to 4.0 mm. The segments are still more markedly flared and spinous.

In some specimens the gonads are considerably expanded and in the females the eggs can be seen through the transparent wall.

The sacculi are numerous and conspicuous.

TABLE 4.—*Measurements of some specimens of* Antedon incommoda, *respectively three syntypes of* A. incommoda austini *from northwest Australia, five syntypes and three other specimens of* A. incommoda incommoda *from Port Phillip, Victoria, and the types of* Compsometra lacertosa *from Port Jackson summarized for comparison*

Arm length (mm.)	*Breadth at 3+4 (mm.)*	*IBr₁ to 9+10 (mm.)*	*Cirri*			*P₁*		*P₂*	
			No.	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*
33	0. 7	4. 4	XXV	13	6. 5	17	6. 0	8, 9	3. 0
c. 30	0. 7	4. 3	XXV	14	7. 0	20	6. 5	8	2. 0
30	0. 7	5. 0	XXV	13	7. 0	19	6. 5	7	2. 0
c. 50	1. 1	6. 0	XXX	14	8. 0	24	c. 10	12	4. 5
c. 30	0. 9	5. 5	XXVIII	13	6. 5	16	c. 6	9	2. 3
c. 25	0. 9	5. 5	XXVIII	13	7. 0	broken		9	2. 3
c. 35	0. 9	6. 0	XXIII	13	7. 5	16	6. 0	9	2. 5
30	0. 7	5. 0	XXIII	12	6. 0	17	5. 5	8	2. 0
c. 50	1. 0	5. 5	XXVIII	14	8. 0	17	6. 5	9	3. 0
35	0. 9	5. 5	XXVII	13	7. 0	16	4. 5	8	2. 0
40	0. 9	5. 5	XXVIII	13	7. 0	15	—	8	2. 2
60–65	—	—	XXXIV–XXXVI	9–12	7. 0	30–32	11. 0	16–20	5. 0

Description of the types of lacertosa.—Centrodorsal discoidal, rather thin, with a broad flat polar area nearly or quite 2 mm. in diameter; cirrus sockets arranged in two very closely crowded more or less irregular marginal rows.

Cirri XXXIV–XXXVI, 9–12 (usually 10), 7 mm. long; first segment very short, second nearly or quite as long as broad, fourth and fifth the longest, about half again as long as the median diameter; following segments gradually decrease in length, so that the last two are about as long as broad; opposing spine minute, slender, subterminal, directed slightly forward; terminal claw long, nearly twice as long as the penultimate segment, evenly tapering and moderately and evenly curved; second and following segments slightly constricted centrally, this character gradually disappearing distally as the segments become shorter; longer proximal segments rounded in cross section and comparatively narrow in lateral view, the shorter outer segments becoming laterally flattened and therefore appearing broader in lateral view.

Distal edge of radials even with the border of the centrodorsal.

IBr_1 very short, about four times as broad as long, slightly trapezoidal. The IBr_2 (axillaries) are almost triangular, the lateral edges, which are slightly shorter than those of the IBr_1, making with the sides of that ossicle almost a right angle; in shape they are about as broad as long, with the distal angle considerably produced.

Arms 10, from 60 to 65 mm. long, rather stout in the basal third but becoming exceedingly slender distally; first brachial short, almost oblong, from two to two and a half times as broad as long in the median line, barely in contact basally interiorly, the diverging interior edges making a very broadly obtuse angle; second brachial much larger, almost triangular, about as broad as the greatest length; first syzygial pair (third and fourth brachials) wedge-shaped, twice as long interiorly as exteriorly, about as broad as the interior length; following three brachials about twice as broad as the median length, slightly wedge-shaped, the brachials then become very obliquely wedge-shaped, almost triangular, about as broad as long, further out on the arm less oblique, and in the terminal portion much elongated and centrally constricted, twice as long as broad or even longer; fifth and following brachials with rather strongly overlapping spinous distal edges, this feature becoming less marked in the outer portion of the arm.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 11 mm. long, slender and flagellate, with from 30 to 32 segments, of which the first is short, the following three or four about as long as broad, then rapidly becoming elongated and after three or four more about twice as long as broad, and somewhat longer distally; second and two or three following segments with the distal edges strongly produced, overlapping and finely spinous, but this gradually dies away as the segments become elongated, so that most of the pinnule is smooth; the elongated segments have slightly expanded ends. P_2 is 5 mm. long, slightly less stout basally than P_1, with from 16 to 20 segments, of which the first is exceedingly short, the next two are about as long as broad, and the following become elongated and about twice as long as broad distally; second, third, and fourth segments with strongly overlapping distal dorsal ends, this feature dying away on the three or four following segments. P_3 is about 5 mm. long with about 15 segments, of which the proximal have much more strongly produced and overlapping distal ends than those of P_2, which it otherwise resembles, and this character is prominent on all the segments almost to the tip of the pinnule; the third to twelfth segments bear a large rounded gonad. The following pinnules are similar to P_3 but slightly longer, 5.5 mm., with somewhat larger genital glands; after P_{10} the gonads slowly decrease in size, finally disappearing on P_{16}. The distal pinnules are exceedingly slender, about 4 mm. long, their perisome with large, conspicuous and thickly set sacculi.

Each of the ambulacral lappets contains a minute short straight rod.

The disc is as in *Antedon loveni*; the sacculi are rather small, but very numerous along the ambulacra of the disc, arms and pinnules.

The color in alcohol is a dull greenish gray.

[NOTES BY A.M.C.] It can be seen from the foregoing descriptions and table that the types of *lacertosa* are very similar to those of *incommoda*. The most important difference seems to lie in the proportions of the cirri and number of segments, the larger specimens of *lacertosa* with arm length about 65 mm. having cirri not more than 7 mm. long, with up to 12 segments, while Port Phillip specimens with arm length about 50 mm. have the cirri 8 mm. long, with 14 segments. The larger number of segments in P_1 of *lacertosa* (30 to 32) is not so much greater than the 24 found in one of the largest Port Phillip specimens, especially considering the very wide range with regard to this character shown by Gislén to occur in *Antedon serrata* which has from 12 to 28 segments in P_1 in different specimens.

Also included in the preceding table are details of three of the 11 specimens of *Antedon* from Lewis Island in the Dampier Archipelago, just east of the northwest cape of Australia. In retrospect Mr. A. H. Clark included these in *A. iris* in this typescript but the cirrus segments are relatively much shorter than in the type of that species and they approach the types of *incommoda* much more closely. The only significant difference appears to be that the centrodorsal of the Dampier Archipelago specimens is less markedly discoidal than in the Port Phillip specimens, with the cirrus sockets encroaching further onto the dorsal pole, so that its diameter is not more than 0.9 mm. and may be as little as 0.4 mm., though averaging 0.7 in the 11 specimens. This difference warrants a subspecific distinction for these northwest Australian specimens for which I propose the name *austini*. *A. incommoda* has previously been recorded from as far north as Geraldton in Western Australia but I have seen no specimens other than those from Port Phillip, so cannot define the range of this new subspecies.

An interesting discovery made while measuring the centrodorsals of all the Port Phillip specimens, was that among those registered in the 1890s, some of which specimens had been through P. H. Carpenter's hands, were six examples of *Antedon loveni*. These were all smaller than the majority of the specimens of *incommoda* taken with them. They were distinguished at first by the convex centrodorsal and by the more slender cirri. An examination of the pinnules showed P_1 to be much shorter than in *incommoda* with only about 8 segments. Carpenter was therefore justified in thinking there are two related species in Port Phillip Bay.

As *Antedon loveni* and *A. incommoda* do occur together at Port Phillip it is not so unlikely that both can be found at Port Jackson.

Localities.—Port Jackson, New South Wales [A.H. Clark, 1910, 1911] (5, U.S.N.M. 35680; Australian M.). Type locality of *Compsometra lacertosa*.

Endeavour; southeast of Flinders Island (north of eastern Tasmania); 68 meters [H.L. Clark, 1916] (1, M.C.Z., 718).

Port Phillip, Victoria, outer part of the harbor and outside the Heads [Bell, 1888; P. H. Carpenter, 1890; A. H. Clark, 1911, 1913] (43, B.M.). Type locality.

Encounter Bay, off the mouth of the Murray River, South Australia [A. H. Clark, 1911].

Hamburg Southwest Australian Expedition, 1905, station 56; Koombana Bay, 6–7 miles southwest of Bunbury, Western Australia; 14.5–18 meters; rocky bottom with a few plantlike organisms; July 28, 1905 [A. H. Clark, 1911, 1912; Hartmeyer, 1916] (3, U.S.N.M., 35675; Berl. M.; H.M.).

Western Australia: Geraldton; tide pool N. of jetty. Dongarra. Cottesloe, North Beach. Off Garden Island, Fremantle; 13 meters. Bunbury, Koombana Bay; 9–15 meters; Basalt Reef. East of C. Naturaliste, Bunkers Bay. Albany; below low water [H. L. Clark, 1938].

Geographical range of Antedon incommoda.—South and west coasts of Australia from Port Phillip, Victoria, and probably Port Jackson, New South Wales, to the Dampier Archipelago in the northwest (subspecies *austini*).

Bathymetrical range.—From shallow water down to 68 meters.

History.—Prof. F. Jeffrey Bell in 1888 published a report upon a number of echinoderms which had from time to time been sent to the British Museum by Mr. J. Bracebridge Wilson, who had been conducting dredging operations at Port Phillip, Victoria. In this collection were two comatulids taken in the summer of 1887–88 in the outer part of the harbor of Port Phillip and outside the Heads; these Professor Bell took to represent a new species which he described under the name of *Antedon incommoda*, remarking that it appeared to be common at Port Phillip, as several specimens had been sent to him. In his description, brief and unsatisfactory, he compares his new species only with *Antedon* [*Oligometrides*] *bidens*.

In the following year Professor Bell published a short note in which he mentioned that in the *Alert* report he had stated that P_2 in *Antedon pumila* (i.e., *A. loveni*) is longer than P_1 whereas as a matter of fact it is P_1 that is longer than P_2, and that this had led him to institute a new species, *A. incommoda*, based on examples of what are really *A. pumila*.

These specimens were also submitted to P. H. Carpenter, and in 1890 his report upon them appeared. Referring to them under the designation of *Antedon*, sp. nov., he said that he believed them to represent a new species, but remarked that this may turn out to be only a strongly marked variety of *A. pumila* (*A. loveni*). He intended to draw up a diagnosis of this new form, but was never able to do this.

In 1902 Sayce recorded specimens of *loveni* (as *Antedon pumila*) from the entrance to Port Phillip in 11 to 16 meters. In all probability these were mostly or entirely of this species, though I (A.H.C.) have given him the benefit of the doubt and entered them under *loveni* which, unless a specimen in the British Museum is erroneously labeled, also occurs there.

When I examined the magnificent collection of comatulids belonging to the Australian Museum I found nearly 800 specimens of *Antedon loveni* from various localities in it, and with them several examples of a species which, though allied to it, was quite distinct and showed no evidence of intergradation. This I assumed was the *Antedon*, sp. nov., referred to by P. H. Carpenter in 1890, and in 1910 I described it, on the basis of 5 specimens from Port Jackson, New South Wales, under the name of *Compsometra lacertosa*.

Shortly after this paper was published I visited the British Museum and was greatly surprised to find that the types of Bell's *Antedon incommoda* included two specimens of the form I had just described and one of *Ptilometra macronema*, but none of *Antedon pumila* (*loveni*) in the synonymy of which he had unhesitatingly placed it. I was fortunately able to make the situation clear in my memoir on the recent crinoids of Australia in 1911.

In 1911, I published a detailed discussion of the comatulids of Australia based upon the collections made by the Hamburg Southwest Australian Expedition, under Drs. W. Michaelsen and R. Hartmeyer, in 1905, in which this species was recorded from two new localities.

In 1916, Dr. H. L. Clark recorded it from Flinders Island, where it had been dredged by the *Endeavour*.

In 1928, Dr. H. L. Clark named two small specimens in the South Australian Museum *Compsometra incommoda*. Their locality was unfortunately unknown. The larger had arms about 25 mm. long and XXVIII cirri. In the smaller the cirri were only XX, with about 10 segments.

In 1938, Dr. Clark recorded this species from a number of localities in southwestern Australia, extending the range northwards as far as Geraldton (north of Fremantle).

In 1946, he queried the occurrence of the species in Port Jackson.

[NOTE BY A.M.C.] Following Gislén's synonymy of 1955, this species is now referred back to *Antedon*.

ANTEDON INCOMMODA AUSTINI subsp. nov., A. M. Clark

FIGURE 10,*b–e*

Compsometra, sp. A. H. CLARK, *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 466 (Lewis Island); Mem. Australian Mus., vol. 4, 1911, p. 797 (same); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 71 (same).

Diagnostic features.—This subspecies differs from *incommoda incommoda* only in the relatively smaller dorsal pole of the centrodorsal, of which the center may be very slightly convex. The eleven specimens have the dorsal pole from 0.4 to 0.9 mm. in diameter, averaging 0.7 mm. The sides of the centrodorsal bearing the cirri are more sloping than in most specimens from Port Phillip, where they are usually, but not always, nearly vertical. In 20 specimens from Port Phillip the dorsal pole varied from 0.8 to 1.6 mm. across, averaging 1.2 mm. There is then an overlap with regard to this character which does not permit more than an infraspecific distinction of the two sets of specimens.

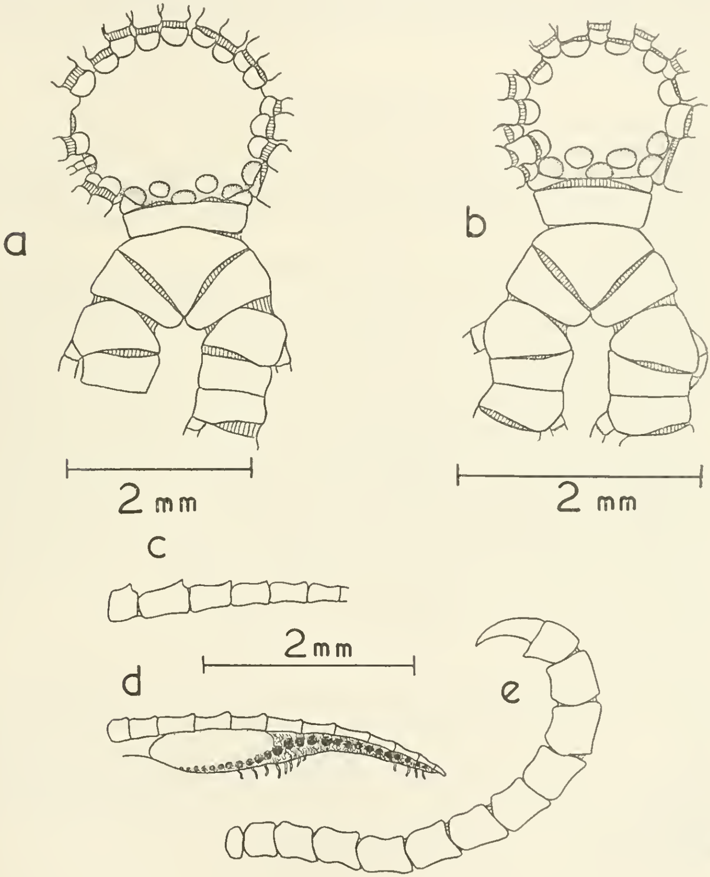

FIGURE 10.—*a*, *Antedon incommoda incommoda* (Bell), B.M., 93.7.8.2–5, Port Phillip, dorsal view of centrodorsal and part of postradial series. *b*, *A. incommoda austini* sp. nov., B.M. 86.2.25.4–9, dorsal and slightly lateral view of centrodorsal and part of postradial series; *c*, same, base of P_1; *d*, P_3; *e*, peripheral cirrus.

Some numerical details of three of the specimens of *austini* are included in table 4, on p. 159.

The geographical limits of this subspecies cannot be determined without an examination of material from the west coast of Australia. Possibly all the specimens recorded as *incommoda* by Dr. H. L. Clark from Western Australia are referable to *austini*, the Great Australian Bight forming the dividing line between the subspecies.

Locality.—Lewis Island, Dampier Archipelago, northwest Australia [A. H. Clark, 1911, 1913] (11, B.M.).

ANTEDON SERRATA A. H. Clark*

FIGURE 11,*a,b*

[See also vol. 1, pt. 1, fig. 373 (p. 299); pt. 2, figs. 296 (p. 221, 335) (p. 227, and 342) (p. 229)]

Antedon serrata A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed; *nomen nudum*); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 240, pl. 1, fig. 4 (description; Tokyo Bay, 8–12 fms.); Crinoids of the Indian Ocean, 1912, p. 229, footnote (of Örsted, MS.=*Stylometra spinifera*).

Compsometra serrata A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 316 (Tokyo Bay, 8–12 fms.; cotype); Vid. Medd. Nat. Foren. København, 1909, p. 192 (Formosa Channel, 35 fms.); Notes Leyden Mus., vol. 34, 1912, pp. 131, 132 (compared with *C. iris*); Crinoids of the Indian Ocean, 1912, p. 229 (synonymy; Formosa to southern Japan: 8–35 fms.); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationship with *C. iris*), p. 205 (in key; range), p. 209 (references).—MORTENSEN, Studies in the development of crinoids, 1920, pp. 13, 16, 22 (development compared with that of *Tropiometra*), pp. 23–30 (embryology), p. 64 (discussion of the embryology), text-figs. 5, 6, pls. 11–13.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 5, 126 (localities; notes); figs. 105–108, p. 122; Zool. Bidrag Uppsala, vol. 9, 1924, p. 28, footnote 1, p. 82 (syzygial faces), p. 194 (larva), p. 223 (gonads), fig. 83, p. 81; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (stations 1, 3, 10, 22, 23, 25; 0–180 meters), p. 43 (stations; notes), pp. 68, 69.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 658 (locality).—CHANG, Contr. Inst. Zool. Nat. Acad. Peiping, vol. 4, 1948, p. 34 (listed), pp. 88–90 (references; description; type locality), p. 91 (bathymetrical range), fig. 24, pl. 9, figs. 7–9.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 87 (doliolaria larva).

Iridometra serrata A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 219 (compared with *I.* [*Argyrometra*] *crispa*).

Diagnostic features.—The arms are up to 70 mm. long; in the largest specimens the cirri are about one-eighth as long as the arms but in the smaller ones may be up to a quarter as long; the cirri are XX–LV when the arms exceed 20 mm., with up to 16, usually 13 or 14 segments, of which the longest are about twice as long as their median widths and the antepenultimate is about half again as long as wide; P_1 has 12 to 28 segments; P_2 is about half as long as P_1 or even shorter; P_3 is slightly larger than P_2 and bears a gonad; the brachials may be prominently spinous as well as the pinnule segments; the centrodorsal is flattened hemispherical.

Description.—The centrodorsal is low-hemispherical.

The cirri are about XXX, 11–14, from 7 to 8 mm. long. The longest segments are about twice as long as their median widths. Those in the proximal half of the cirri are more or less constricted centrally. The opposing spine is minute.

*See also Addenda (p. 838) under 1965.

The radials are just visible as small interradial triangles. The IBr_1 are very short. The IBr_2 (axillaries) are triangular, about twice as broad as long.

The 10 arms are 45 mm. long. The first two brachials are wedge-shaped, longer outwardly than inwardly; the first syzygial pair (composed of the third and fourth brachials) is wedge-shaped, slightly longer interiorly than exteriorly; the next three brachials are oblong, and the following become wedge-shaped, at first short, but after the eleventh about as long as broad and after the middle of the arm elongate.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 5 mm. long, composed of 15 segments, of which the first is very short, the second is slightly longer than broad, and the remainder are elongated; the ends of the segments are turned outward and produced dorsally and armed with very fine spines. The five following pinnules are similar to P_1 but considerably shorter with the distal eversion of the segments more marked, the dorsal projection being equal to from half to nearly the whole length of the segment. The remaining pinnules become longer and more slender and the eversion of the distal ends of the segments gradually dies away.

The color in alcohol is brownish, the arms narrowly banded on about every third brachial with darker brown.

Notes [BY A.M.C.].—The preceding description was drawn up from the type specimen in the Museum of Comparative Zoology.

Dr. Torsten Gislén has given details of 18 specimens secured by Dr. Sixten Bock in southern Japan in 1914. These form the first half of the table below.

The first one has the centrodorsal hemispherical; the cirri are arranged in a single or double row; the fourth and following segments are slightly constricted centrally and are half again as long as the distal diameter; the antepenultimate segment is one fifth longer than broad; the penultimate has a very inconspicuous opposing spine; the terminal claw is narrow, curved, and somewhat longer than the preceding segment.

The radials are concealed. The IBr_1 are three times as broad as long, almost free laterally. The IBr_2 (axillaries) are triangular, from two to three times as broad as long.

The arms are about 25 mm. in length. The first brachials are interiorly united and are twice as long exteriorly as interiorly. The second brachials are twice as long exteriorly as interiorly and the inner borders are rather widely separated. The first 8 brachials are oblong, the articulations then becoming oblique. The arms are rather smooth.

P_1 has the first two segments short and the remainder from two to two and a half times as long as broad with the distal ends everted and spinous. P_3, P_4 and P_5 have the first 6 segments with strongly spinous distal ends like the proximal segments of P_2. P_3 and the following pinnules bear a large genital gland. The genital pinnules are 4 mm. long with 13 to 15 segments. The expansion of the distal ends of the proximal pinnule segments continues at least to P_{10}, then becomes more indistinct.

The disk is 3 mm. in diameter, and is without granules.

The disk is white; the arms are darker; each cirral has a dark spot proximally.

In the other specimens the intersyzygial interval is 3, sometimes 4, muscular articulations. The cirri are arranged in from one to three more or less complete rows. The larger segments of the proximal pinnules may have prominent spiny frills at their distal ends.

The color varies considerably from browns and grays to reds and violets and may be patterned with lighter bands on the brachials and cirrus segments or longitudinal light bands on the arms or a generally paler calyx.

Of two juvenile specimens with the arm length 3.2 mm. and 5 mm. respectively, the former has a gap in the pinnulation after P_1, the basals are visible in the interradii and remnants of the orals are present. The latter has lost the orals and P_2 and P_3 are in process of development.

In 14 individuals where the first genital pinnule was noted, it was P_3 in 9, P_4 in 2, P_3 or P_4 in 2, and P_2 or P_3 in 1.

The specimens from San-Tu in the following tabulation appear to differ from the rest in having more numerous cirrus segments, 15 or even 16, than in most other specimens of comparable size. The brachials are not conspicuously spinous and the cirrus segments are not markedly flared. However, Gislén (1922, fig. 107) has illustrated a comparable cirrus and the arms of some of his specimens are also smooth. The spec-

TABLE 5.—*Range of variation in cirri and proximal pinnules of* Antedon serrata

[Only the maxima of the cirrus counts were used in assessing the ranges]

Arm length (mm.)	*Cirri*			P_1		P_2		P_3		*Remarks*
	Number	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	
25	XXIII	12–15	7	15	c. 5	9	2 3	11	3.5	Collected by
20	XXIII	9–12	3.5–4.5	12	3.5	6	1.5	–	–	Sixten Bock,
35	XXVI	12–15	6.5–7.5	23–28	8–10	9	2.5	12	3.5	mostly in the
35	XXXVIII	12–14	4–8	23	10	8	3	10	4	vicinity of
40	XLV	11–14	6–7	21	9	10	3	11	4	Misaki, Japan
35	XLI	11–14	4–7	28	11	9	3	12	4	
15	XVIII	11–12	4–5	16	5	8	2.2	10	3.5	
30	XXXI	11–14	4–7	c. 20	6	7	2	9	2.5	
20	XXVII	11–13	5	c. 18	5	6	1	8	2	
25	XXXII	11–13	c. 5	17	4	9	2	9	2.2	
30	XXV	11–13	7	13–15	4.5	9	2.5	11	c. 4	
25	XXII	12–13	5–6	20	6.5	8	2.5	11	3.5	
27	XXIV	11–13	–	15–20	4–6.5	7	2	9	c. 3	
c. 20	XXXII	11–13	5–6.5	16	6	8	2.2	–	–	
25	–	12	5	12–16	3–4	8	1.3	–	–	
25	–	12	5	17	4.5	8	2	–	–	
3.2	XII	9	1.2	–	–	–	–	–	–	
5	XIX	9–10	1.5	–	–	–	–	–	–	
45	–	12–14	5–7	20	7	9	2.5	–	–	Collected by
32	–	11–12	c. 5	c. 15	4	–	1.5	–	–	Mortensen,
30	–	9–13	3–5	–	–	–	–	–	–	mostly near
25	XXIII	8–13	2.3–4	13–15	4.5	5	1.0	8	1.8	Misaki
70	XLIII	11–15	4–8	c. 25	12	9	3.7	c. 12	4.5	
c. 15	–	8–10	3.5	7	1.2	5	0.6	9	1.6	
30–65	XL–LV	10–14	8	18–25	10–12	8–10	3–4	–	–	Tsingtao, China
35	XXII	16	9	21	8	8	2.2	10	3.5	San-Tu, China
c. 30	XXV	15	8	–	–	9	2.3	11	3.7	
25	XXII	15	–	–	–	8	1.8	9	2.0	
15–70	XVIII–LV	12–16	4.5–9	12–28	1.2–12	5–10	1–3 (4)	8–12	2–4.5	Ranges of specimens with arms 15+ mm.

imen from Cape Sima, Japan, though small, seems to be much more like the type, with the brachials and pinnule segments spinous and the cirrus segments flared. The opposing spine is quite well developed (fig. 11a, p. 175) as compared with the San-Tu specimens cirri (fig. 11b).

In 1948, Feng-Ying Chang gave a full description of some specimens from Tsingtao, China. These have the centrodorsal hemispherical, with XL to LV cirri, about 8 mm. long, arranged in two or three irregular whorls, leaving a small naked dorsal pole. Each cirrus consists of 10 to 14 segments, the first two of which are very short. The fourth and following segments are a little constricted in the middle; the distal ends of the segments are slightly expanded and a little produced ventrally. Their surface is smooth. The terminal claw is narrow, curved, about equal in length to the preceding segment.

The radials are concealed. The axillaries are triangular, about twice as wide as long.

The ten arms are smooth, 30 to 65 mm. long.

P_1 is very variable in length (10 to 12 mm.) and in number of segments (18 to 25); the first two segments are very short but the following ones become two to three times as long as wide. The distal ends of the segments are slightly widened, turned outwards, produced dorsally and provided with fine spines. The surface of the segments is very rough.

P_2 is similar to P_1 but considerably shorter (3 or 4 mm. long), consisting usually of 8 to 10 segments.

From the middle of the arm distally, the pinnules become more slender and the projections on the distal ends of the segments gradually disappear.

P_3 and the following pinnules bear gonads.

The disk is about 3 mm. in diameter.

The color in alcohol is yellowish brown, the arms and pinnules often banded darker and the cirri whitish.

Localities.—Golden Hind; Tokyo Bay; 15–22 meters; October 22, 1899 [A. H. Clark, 1908] (2, U.S.N.M., 35635 [Owston coll. 5361]; M.C.Z. 254, the holotype, [Owston coll. 5363]). Type locality.

Misaki, Sagami Bay; from about low tide mark to somewhat deeper water [Mortensen, 1920] (1).

Dr. Sixten Bock's station 3; Misaki; on the shore at low tide; May 5, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 21; Misaki; on the shore at low tide; May 28, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 25; Misaki; on the shore at low tide; June 13, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 26; Misaki; on the shore at low tide, on corallines; June 14, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 23; Misaki; on corallines; June 5, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 22; Misaki; 0–2 meters; May 28, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 2; Aburazubo, Sagami Bay; 2–3 meters; April 19, 1914 [Gislén, 1922].

Dr. Sixten Bock's station 1; Shimonoseki; on the shore at low tide; March 30, 1914 [Gislén, 1922].

Formosa Channel; 64 meters; Captain Suensson, November 23, 1901 [A. H. Clark, 1909] (1. U.S.N.M., 35636).

Dr. Mortensen's station 1; Biological station, Misaki, Japan; shore; April 23, 1914 [Gislén, 1927] (4, C.M.).

Dr. Mortensen's station 3; Misaki; shore; April 29, 1914 [Gislén, 1927] (1, C.M.).

Dr. Mortensen's station 10; off Kiu-Shiu, Japan (lat. 33°41′ N., long. 128°50′ E.); 137 meters; sand; May 17, 1914 [Gislén, 1927] (1, C.M.).

Dr. Mortensen's station 22; Misaki, Japan; 0–4 meters; rocky; June 16, 1914 [Gislén, 1927] (3, C.M.).

Dr. Mortensen's station 23; Misaki; 2–4 meters; on roots of Laminariacea; June 19, 1914 [Gislén, 1927] (5, C.M.).

Dr. Mortensen's station 25; Okinose, Sagami Sea, Japan; 183 meters; hard bottom; June 26, 1914 [Gislén, 1927] (2, C.M.).

Cape Sima, Japan; Dr. G. Jeffreys [A. H. Clark, 1929] (1, B.M.).

Tsingtao, China: entrance to Kiaochow Bay and around Takungtao and Siaokungtao; 15–65 meters; rock, stones and broken shells [Chang, 1948].

Off Amoy, Fukien Province, China (lat. 24°06′ N., long. 118°25′ E.); 36 meters; bottom temperature 24.5° C.; H. Christensen; August 10, 1912 (C.M.).

San-Tu, Fukien Province, China; Dr. Cheng (3, B.M.).

Geographical range.—From Fukien Province, China, and the Formosa Channel to Tsingtao on the Yellow Sea eastward to Tokyo Bay in Japan.

Bathymetrical range.—From the low tide mark and just above it down to 180 meters.

Occurrence.—Dr. Th. Mortensen found this species to be fairly common on the rocky shores near the biological station at Misaki from about low tide mark to somewhat deeper water. It was often found on the under side of rocks which one could turn over and also among the roots of laminarians and other algae.

Early stages.—On his return to Copenhagen Dr. Mortensen found that a few of the specimens of this species which he had collected at Misaki carried a considerable number of embryos on the pinnules. These proved to represent only two stages, showing that in this species, as in the other species of *Antedon*, the eggs are extruded contemporaneously, apparently as a result of the stimulating effect of the sperm from some male.

Judging from the ripe eggs within the pinnules of the preserved specimens the eggs are rather small, only about 0.25 mm. in diameter. They remain attached in clusters to the pinnules about the opening through which they were extruded. The egg membrane does not appear to have any structural peculiarities, but is simple, as in other species of *Antedon*, serving only as a means of attachment and not as a floating apparatus as in *Tropiometra*. It appears to be very spacious, affording ample room, so that the embryo is not globular, as is usual in *Antedon*, but while still lying within the membrane has its natural elongate shape.

Dr. Mortensen says that from the material at hand it is evident that the embryos remain within the egg membrane until fully formed and ready to attach themselves and transform into pentacrinoids. It may thus be concluded with a fair degree of certainty that they have only a very short free swimming period, and this supposition is strengthened by the fact that the pentacrinoids were found very close to the localities where the adults were secured.

The cleavage, the formation of the archenteron, and the formation of the enterocoele and hydrocoele sacs was not observed.

In the youngest stage observed by Dr. Mortensen the hydrocoele has occupied its place on the ventral side and the parietal canal is about to separate from it. The two enterocoele vesicles have separated completely from one another and occupied their usual position, the left at the posterior end, the right at the dorsal side of the endoderm. Unfortunately this stage is too far advanced to show whether the endoderm sends out posterior prolongations to embrace the central part of the enterocoele vesicle as it does in other species of *Antedon*, but not in *Tropiometra*. The walls of the anterior end of the right enterocoele are thicker than those of the rest of the vesicle, and it would appear that this has something to do with the formation of the chambered organ. Dr. Mortensen was at first inclined to believe that in this case the parietal canal might be forming from the right enterocoele vesicle instead of from the hydrocoele, but the question was settled by the oblique sections which showed that the formation of the parietal canal is in conformity with what obtains in other species of *Antedon* and in *Tropiometra*.

The vestibulary invagination and the suctorial disk have begun to form, and the ciliated bands have begun to develop as is evident from the arrangement of the cells in the ectoderm. There are no glandular cells in the ectoderm. The apical pit Dr. Mortensen did not find distinct. As in *Tropiometra* the nuclei of the ectoderm cells are distinctly smaller than those of the rest of the embryo.

The next stage represented is the fully formed larva. The length is only about 0.3 mm.; the shape is elongate, with the posterior end slightly pointed. The vestibulary invagination is broadly oval. The suctorial disk is distinct, as is sometimes also the apical pit. There are 5 ciliated bands, but the anterior is rudimentary and is visible only on the dorsal side. The third band appears to be interrupted by the vestibular invagination; it is only slightly bent downward. Dr. Mortensen was unable to trace its continuation within the border of the vestibular invagination. The fourth band is scarcely bent downward on the ventral side, and neither is the band at the anterior end of the vestibular invagination bent upward.

The internal organization of the larva shows considerable progress. The hydrocoele has given off the 5 lobes representing the 5 primary tentacles; the parietal canal, which is large with a conspicuous anterior prolongation, communicates with the exterior through the pore canal which opens between the third and fourth ciliated bands. The outer end of the pore canal is somewhat broadened. The shape and arrangement of the two enterocoele vesicles appears from a comparison of the transverse with the longitudinal sections. The chambered organ is seen to continue toward the anterior end. The stomach may be either a large sac or flattened, so that the lumen can scarcely be discerned. The nervous system is very well developed, and as usual it continues as a distinct nerve along each border of the vestibular invagination. In the ectoderm, glandular cells are numerous in the anterior end, in the region of the apical pit; they are also fairly well developed in the vestibular invagination, although very much less so than in *Tropiometra*. In the rest of the ectoderm glandular cells are hardly present at all. The nuclei of the cells of the ciliated bands are beautifully arranged in arcs, the surface showing a corresponding concavity, more or less distinct.

Dr. Mortensen figures a young pentacrinoid, decalcified. In it the pore canal is remarkably short and its outer opening apparently closed. He remarks that this seems to be in conformity with Russo's observation that the hydropore of the larva of *Antedon mediterranea* disappears and a new secondary pore develops in its place. He does not venture definitely to assert that this is the case in *A. serrata*, since the material, having been preserved in alcohol, does not show such minute histological details with sufficient distinctness. The pore really appears to be closed, but this may perhaps be due to contraction; in any case this point deserves closer investigation.

The stone canal appears to have the form indicated by Russo, but it could not be made out with certainty. The inner half of the parietal canal has thicker walls than the other part. On the inner side of the parietal canal is a small body which apparently represents the primary gonad. The axial organ was found to be only slightly developed.

In the earlier stage the elements of the skeleton are just beginning to form. As in other species of *Antedon* and in *Tropiometra* the orals and basals do not lie exactly opposite one another. At this stage there are 8 to 10 columnals. A single very small plate, just a small grain lying within the circlet of basals, represents the first rudiment of the infrabasals.

In the next stage the skeletal elements have enlarged considerably and have the usual fenestrated structure. In this stage within the basals there are to be seen 4 plates much smaller than they and with only one or a few holes. These are the infrabasals. Usually there are 4 of them, but sometimes only 3, or more rarely 2; in no case were 5 found. They are about equal in size and there is no indication that any one of them might be a double plate so that the real number would be 5. There are about 18 columnals at this stage.

Pentacrinoid.—Dr. Mortensen found the pentacrinoids of this species attached to corallines growing on the rocks in the same localities where the adults lived.

In the youngest pentacrinoids he secured, the basals enclose the proximal ends of the orals; the latter are distinctly concave along the middle line, the edges being prominent. The infrabasals can no longer be seen distinctly, but on dissociating the calyx very carefully they are seen lying within the basals about the proximal columnals where they are found on the succeeding pentacrinoid stages. There are still only 18 columnals of which the distalmost three to four are very short, nearly spherical, and the middle ones more elongate; in all of them the primitive annulus is very prominent.

In the next stage the radials have appeared; the radianal, which appears shortly before the radials, lies almost in the mid-radial line, the corresponding radial lying almost in the middle of the region between the orals and basals. The orals are no longer embraced by the basals, and their proximal ends are beginning to turn outward. A couple of small newly formed columnals are seen at the proximal end of the stem, which is now composed of 20 columnals.

In the next stage the orals have become separated from the basals so that a strip of naked perisome is seen between the adjoining ends of the plates. The radials have enlarged and a prominent knob has appeared on their distal border to which the IBr_1 are attached; beyond the IBr_1 the IBr_2 have appeared. The small columnals at the proximal end of the stem have broadened somewhat, but have not increased in length; apparently no new columnals have been formed.

The pentacrinoid of this species, according to Dr. Mortensen, is especially characterized by its tentacles, which are long and slender and provided with calcareous spicules—thin, bow-shaped, finely spinous structures which are usually arranged in a single series in each tentacle. In specimens mounted in Canada balsam these serially arranged spicules are very conspicuous and curious objects. They are found equally well developed in the tentacles of the adults.

In a slightly more advanced stage the IBr_2 is distinctly bilobed, and the IBr_1 is more elongate. The radianal is seen to encroach upon the oral, the proximal part of which has been partly resorbed and is partly covered by the radianal. The radial to the right of the radianal is asymmetrical, the side adjoining the latter being less developed.

In the next stage represented, the arms have grown to some length and consist of some 5 or 6 brachials; the exact number of brachials can not be made out distinctly because they are somewhat overlapping and have no such prominent central ridge as the columnals. The radials, which are still widely separated from each other, have assumed a characteristic cordate shape, while the IBr series remain slender. The orals are widely separated from the basals; they have a very characteristic shape, with a deep furrow down the middle line, the sides being gracefully bent outward, as is also the basal portion. The stem is now composed of 27 columnals. The 5 proximal columnals are very short, but wider than the rest, with a prominent central annulus; then follow 2 equally short, but much narrower, columnals. The eighth is slightly longer, the next about twice as long, and from the tenth onward they have assumed their definitive shape.

In the fully developed pentacrinoid the orals have, as a result of the expansion of the disk, shifted their position so that they now lie entirely on its ventral side separated from the calyx proper. The anal cone has developed in the space between the radianal and the adjoining oral so that there is now a large plate both on the outer and on the inner side of the anal cone. The radials have enlarged considerably, and are in contact by their lateral edges. The IBr_1 has broadened, and the IBr_2 has assumed its characteristic shape with the two oblique articulating surfaces. The brachials are short and broad, somewhat thickened at the ends. The first pinnule to appear is on the twelfth brachial.

In the younger of the two pentacrinoids at this stage the stem consists of 29 columnals, in the larger of 33. As the cirri are forming on the proximal columnal of the younger, it is evident that no more columnals will be formed. Some of the proximal columnals, from three to five, are broader than the remainder and apparently remain quite short. While in the columnals of the young pentacrinoids the central annulus is wider than the rest of the ossicle and thus appears as a prominent ring about its center, the fully formed columnals are slightly constricted centrally and the central annulus appears only as a more or less distinct line about the middle. The ends of the columnals are a little broadened. The articulating surfaces are alternating, giving the impression that the columnals are united in pairs, but sometimes the surfaces at either end of a columnal may lie in the same plane. The columnals are smooth and short, the longest only about 0.25 mm. in length.

The terminal stem plate is small and slightly lobed.

Dr. Mortensen says that both the brachials and pinnulars begin as a simple transverse rod from which extensions grow out on each side very soon uniting to form a cribriform plate in which the original rod may be distinguished for some time, although it is not nearly so conspicuous as the median annulus of the columnals.

The first cirri are radial in position, as in *Hathrometra sarsi* and in *Tropiometra picta* (i.e., *carinata carinata*). Dr. Mortensen maintains, in opposition to Dr. W. B. Carpenter, that in *Antedon bifida* the first cirri are also radial.

Dr. Mortensen found a detached individual with only two pinnules developed and a third just forming. There are only 8 cirri, the 5 of the primary whorl and 3 of the second, one of which is about as long as the primary ones, the second is half as long, and the third is quite short. The orals and the radianal are quite distinct but resorption has begun. That this specimen has only just been detached is evident from the existence of a small hole in the middle of the centrodorsal.

In a recently detached young with from 6 to 7 pinnules the oral pinnules are just beginning to develop; the fifth to sixth pinnules are the largest, while the second to fourth are much smaller. Usually the fourth would seem to be the last to develop, but on one arm this is slightly larger than P_2 and P_3. P_7 and P_8 have not yet appeared, which is the more remarkable as later these become larger than the other proximal pinnules except P_1. In the adults the four lowest pinnules have no tentacles. In this specimen the orals and the radianal have disappeared.

History.—This species was first mentioned, as a *nomen nudum*, in the list of species retained in the genus *Antedon* in my first revision of the comatulids in 1907. It was described and figured in the following year from a specimen in the Museum of Comparative Zoology collected by Mr. Alan Owston in Tokyo Bay in 8 to 12 fathoms on October 22, 1899, and soon afterwards removed to the new genus *Compsometra.*

In the collection of crinoids purchased from Mr. Owston by Mr. Frank Springer and given to the U.S. National Museum in 1907 I found another specimen of this species bearing the same data as the type, which I recorded in 1908. In the following year I recorded a third specimen from the Formosa Channel in 35 fathoms where it had been secured by Captain Suensson.

In 1908 before I had definitely determined the limits of the genus *Compsometra,* which I was about to propose, I mentioned this form under the name of *Iridometra serrata,* when comparing it with the new species *I.* [*Argyrometra*] *crispa.*

Dr. Th. Mortensen in 1920 described the early stages and the pentacrinoids of this species and gave an account of its occurrence about Misaki, and in 1922 Dr. T. Gislén described in detail a number of specimens which had been obtained at and near Misaki by Dr. Sixten Bock in 1914.

In 1927, Dr. Gislén gave notes on some further specimens from the Sagami Bay area of Japan, including one with arms 70 mm. long.

The range of the species was extended to Tsingtao on the Shantung Peninsula of central China by Chang (1948) who gave a description of his material, which included specimens of up to 65 mm. arm length and with LV cirri.

[Note by A.M.C.] Following Gislén's synonymy of 1955, this species is now referred back to *Antedon.*

ANTEDON LOVENI Bell

Figure 11,*e–g*

[See also vol. 1, pt. 1, figs. 108 (p. 174), 282 (p. 261), 371 (p. 299), 410 (p. 317), 497 (p. 369), pl. 4, fig. 547; pt. 2, fig. 81, p. 53]

?*Kallispongia archeri* Wright, Proc. Roy. Irish Acad., ser. 2, vol. 2, 1877, p. 754.

Antedon loveni Bell, Proc. Zool. Soc. London, 1882, p. 534 (specific formula).—P. H. Carpenter, Proc. Zool. Soc. London, for 1882, 1883, p. 746 (corrected specific formula).—von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 4 (*Antedon insignis* of earlier report altered by Bell to *A. loveni* in the *Alert* report).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 56, No. 3 (Bell's transfer of the name).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 481 (history of the name); Mem. Australian Museum, vol. 4, 1911, p. 713 (history of the name).

Antedon pumila BELL, Rep. Zool. Coll. H.M.S. *Alert*, 1884, p. 155 (specific formula), p. 157 (detailed description; Port Jackson, 0–5 fms.; Nelson's Bay), pl. 10, figs. B, *a-b;* Proc. Linn. Soc. New South Wales, vol. 9, for 1884, 1885, p. 498 (Nelson's Bay, Port Stephens).—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 54, 56, 193, 206, 366, 378.—BELL, Ann. Mag. Nat. Hist., ser. 6, vol. 3, 1889, p. 292.—P.H. CARPENTER, Proc. Roy. Soc. Victoria, new ser., vol. 2, 1890, p. 135 (Port Phillip).—RAMSAY, Rec. Australian Mus., vol. 1, 1890, p. 84 (Port Jackson).—WHITELEGGE, Journ. Roy. Soc. New South Wales, vol. 23, for 1889, 1890, pt. 2, p. 197 [p. 35 of separate] (correction of Bell; occurrence; pentacrinoids).—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 113 (in Göttingen Mus.).—SAYCE, Victorian Naturalist, vol. 18, No. 10, Feb. 6, 1902, p. 153 (entrance to Port Phillip, 6–9 fms.).—BELL, Victorian Naturalist, vol. 18, No. 10, Feb. 6, 1902, p. 153.—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 342 (compared with *A. orientalis*), p. 352 (obviously belongs with the *A. bifida* type), p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pp. 1579, 1580 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, pp. 481, 490 (synonym of *A. loveni* Bell, 1882); vol. 38, 1910, p. 275; Mem. Australian Mus., vol. 4, 1911, p. 714 (of *Alert* report=*C. loveni*), p. 715 (of Bell, 1885=the same), p. 716 (credited to Australia by Carpenter; synonym of *A. loveni* Bell, 1882), Crinoids of the Indian Ocean, 1912, p. 31 (of Bell, 1884=*C. loveni*), p. 34 (of Carpenter, 1888=the same); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 86 (of Bell, 1889=*C. incommoda*+*C. loveni*).—HARRISON, Proc. Pan-Pacific Sci. Congress, Melbourne, vol. 2, 1924, p. 13.

Compsometra loveni A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (listed); Proc. U.S. Nat. Mus., vol. 38, 1910, p. 275 (nearly 800 in the Australian Mus. from various localities; compared with *C. lacertosa*); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 442 (south Australia to Dampier archipelago and Claremont I.), p. 443 (range on east coast), p. 444 (range on west coast); Mem. Australian Mus., vol. 4, 1911, p. 717 (known to Carpenter from Australia), p. 718 (original notes by Whitelegge; recorded by Carpenter, 1890, and by Ramsay, 1890), p. 722 (confined to south Australia; range), p. 735 (in key), p. 790 (annotated synonymy; characters; localities); Crinoids of the Indian Ocean, 1912, p. 10 (confined to south Australia), p. 31 (=*A. pumila* Bell, 1884), p. 34 (=*A. pumila* P. H. Carpenter, 1888), p. 229 (synonymy; south Australia, 0–5 fms.); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 53 (published references to specimens in the B.M.; localities); Die Crinoïden der Antarktis, 1915, p. 167 (range); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1915, p. 227 (detailed account of the distribution); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 205 (in key; range), p. 209 (synonymy).—MORTENSEN, Studies in the development of crinoids, 1920, p. 30 (comparison of the pentacrinoid with that of *C. serrata*).—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 46 (Port Jackson).—POPE, Proc. Linn. Soc. New South Wales, vol. 68, 1943, p. 246 (habitat).—H. L. CLARK, Echinoderm fauna of Australia, 1946, p. 61 (distribution; Port Phillip record needs confirmation).

Diagnostic features.—The XV–XXX cirri are short (usually about a fifth of the arm length) with the outer portion gently recurved and somewhat flattened, so that they increase slightly in dorsoventral width distally; they are composed of 12 to 14 segments, of which the longest are about twice as long as the median breadth, the distal decreasing to about half again as long as broad on the antepenultimate; P_1 has 10 to 13 segments; P_2 with 7 to 10 is only about half as long; P_3 is larger than P_2; the centrodorsal is hemispherical, more or less flattened, with a fairly large convex polar area; the arm bases make less than a right angle with the dorsoventral axis, at least when the arms are not fully extended.

The arms are from 20 to 70 mm. (usually from 30 to 35 mm.) and the cirri from 7 to 8 mm. in length.

The relatively longer cirri, which are not strongly flattened and recurved distally and have longer distal segments, the more or less hemispherical centrodorsal, the smaller P_1 with fewer segments and the absence of the characteristic flattened appearance distinguish this species from the other south Australian form, *A. incommoda.*

Description.—The centrodorsal is hemispherical, rather low, with a comparatively large bare polar area, and bears from 20 to 30 cirrus sockets in two or three irregular marginal rows.

The cirri are XV–XXX (usually about XXV), 12–14, from 7 to 8 mm. in length. The first segment is short, the second about as long as broad, the third about half again as long as broad, and the fourth about twice as long as its median diameter; the following segments become very gradually shorter, the antepenultimate being about half again as long as broad, or even rather shorter, and the penultimate about as long as broad. The segments have somewhat expanded distal ends which overlap the proximal ends of those succeeding; the earlier also have swollen proximal ends. The cirri are very slender proximally but increase somewhat in dorsoventral diameter distally and become slightly compressed laterally after the first few segments. The opposing spine is always present, though apparently variable in size. The terminal claw is rather large, usually about half again as long as the penultimate segment, stout, and strongly curved.

The distal borders of the radials are even with the edge of the centrodorsal. The IBr_1 are oblong, about twice as broad as long, rounded laterally and widely separated, the anterior border concave to receive a slight posterior projection from the IBr_2 (axillary) which is broadly pentagonal, not quite half again as broad as long, and may rise into a very slight rounded tubercle on the articulation with the IBr_1.

The 10 arms are usually from 30 to 35 mm. long, rarely longer, though individuals occur with an arm length of as much as 70 mm., while sexual maturity may have been reached in animals with an arm length of only 20 mm. The first brachials are short, longer outwardly than inwardly, the anterior border incised by a slight backward projection from the larger and irregularly quadrate second brachial. The first syzygial pair (composed of the third and fourth brachials) is about as long inwardly as broad, slightly shorter outwardly, the epizygal being oblong and the hypozygal wedge-shaped or almost triangular with the apex outward. The fifth to eighth brachials are oblong or slightly wedge-shaped, about twice as broad as long. The following brachials are wedge-shaped, at first not quite so long as broad, but soon becoming as long as broad and distally longer and gradually less obliquely wedge-shaped, the terminal brachials being practically oblong, half again to twice as long as broad, but cylindrical with no trace of a central constriction.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 4 mm. long, composed of 10 segments, moderately stout and tapering evenly from the base to the delicate tip. The first segment is very short, about three times as broad as long, the second is about as long as broad, the third is about half again as long as broad, and the following become gradually more and more elongated. The third and following segments have the distal edges prominently everted dorsally and laterally (but not ventrally) so that the dorsal profile of the pinnule is strongly serrate. P_2 is about half as long as P_1, but similar to it. It is almost equally stout at the base, but tapers more rapidly and its 7 or 8 segments are proportionately shorter than the segments of P_1, but show the same eversion of the distal edges. P_3 is intermediate in length between P_1 and P_2, composed of 10 segments which resemble those of P_1, but the third to sixth carry a gonad. The following pinnules to the sixteenth are similar, but the eversion of the distal ends of the segments gradually becomes less and less and dies away entirely after about the tenth. The distal pinnules are about 5 mm. long, moderately slender, the first segment rather less than half as long as broad, the second about as long as broad, the third about twice as long as broad, and the following becoming gradually elongate. The two first segments are scarcely broader than those following, and the outer segments have moderately expanded articulations.

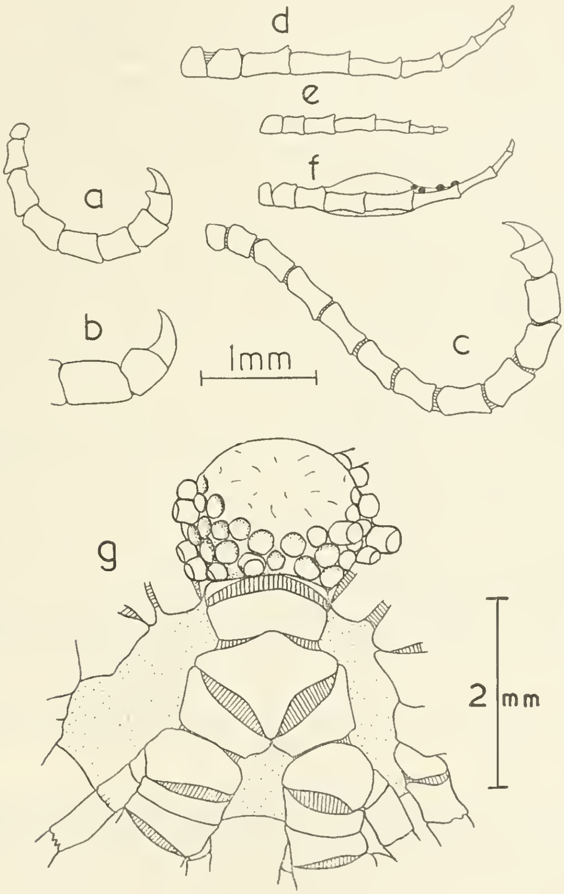

FIGURE 11.—*a, b. Antedon serrata* A. H. Clark: *a*, B.M., 73.5.1.13, Cape Sima, cirrus; *b*, B.M., 1954.11.2.11, San-Tu, cirrus tip. *c, A. loveni* Bell syntypes, B.M., 83.12.9.69–70, cirrus; *d*, P_1; *e*, P_2; *f*, P_3. *g, A. loveni*, B.M. 81.10.1.23, type of *Antedon pumila* Bell, laterodorsal view of calyx and postradial series.

In color the great majority of preserved specimens are dull grayish yellow tinged with brown, the cirri and the proximal portions of the arms being lighter than the rest of the animal. About 10 percent of those which I have examined are a rather dark brown or purple with light yellowish cirri and arm bases. Seven have each segment of the arms, pinnules, and cirri deep purple in the center, the borders being white, giving them a beautiful and striking "pepper and salt" appearance.

Notes [BY A.M.C.].—The four syntypes of *loveni* in the British Museum are all small with the arm length about 18 mm. One has the arm width at the first syzygy 0.65 mm. and the length from IBr_1 to the second syzygy 4.0 mm. The cirri have up to 13 segments and may be 5.5 mm. long. P_1 is about 3.5 mm. long, with 9 or 10 segments; P_2, with 7 segments, is 1.8 mm. and P_3, with 9 segments, is 2.3 mm. long. The holotype of *Antedon pumila* Bell from Port Jackson has P_1 6.5 mm. long, with 13 segments; P_2 2.7 mm., with 10 segments and P_3 3.5 mm., with 12 segments. The arm width at the first syzygy is 0.9 mm.

An interesting discovery among the material of *Antedon incommoda* from Port Phillip in the British Museum, was six specimens of *A. loveni*, thus confirming Carpenter's idea that there is a species distinct from *incommoda* to be found in that harbor. These specimens are smaller than the majority of examples of *incommoda* taken with them but were easily distinguished by the convex dorsal pole of the centrodorsal, the more slender cirri and the consistently smaller number of segments in P_1 and P_2.

Localities.—Port Phillip, Victoria [P. H. Carpenter, 1890] (6, B.M.). Entrance to Port Phillip, 11–16 meters [Sayce, 1902].

Port Jackson, New South Wales [Ramsey, 1890; A. H. Clark, 1911] (656, U.S.N.M., 17864, 35679, 36236; M.C.Z., 47; Australian M.). Same, 0–9 meters Bell, 1884] (1, B.M.). Same, 10–18 meters (1, U.S.N.M., 35676). Same, deep water [Whitelegge, 1890]. Same, Bottle and Glass rocks [A. H. Clark, 1911] (34, Australian M.). Same, near Middle Head, 7–9 meters [H. L. Clark, 1938].

Broughton Island, New South Wales [A. H. Clark, 1911] (8, U.S.N.M., 35672; Australian M.).

Port Halliday [A. H. Clark, 1911] (fragments, Australian M.).

Nelson's Bay, Port Stephens, New South Wales [Bell, 1884, 1885; A. H. Clark, 1911] (4, B.M., 83.12.9.69–70, labeled as the types of *loveni* though registered in 1883 as *Antedon pumila;* Australian M.). Same, 5–9 meters (9, U.S.N.M., 35677). Type locality.

'Australia' [Wright, 1877; A. H. Clark, 1911] (28, Australian M.).

Long Reef, New South Wales, sublittoral, on lower side of rocks [Pope, 1943].

Geographical range.—From Port Stephens, New South Wales (lat. 32°40′ S.) to Port Phillip, Victoria.

Bathymetrical range.—From the shore line down to 18 meters.

Occurrence.—Whitelegge (1890) says that this species is very common at Port Jackson in deep water, and is occasionally found under stones. He mentions it specifically from Taylor Bay and Watson's Bay.

He says that the pentacrinoids are often found attached to seaweeds in August and September.

History.—It is probable that this is the species upon which Prof. E. Perceval Wright in 1877 based the supposed new genus and species of sponge which he called *Kallispongia archeri.* Mr. Stuart O. Ridley in entering Professor Wright's paper in the

Zoological Record noted the crinoidlike form of the organism and remarked that it was doubtful whether it was a sponge.

In 1882 Professor F. Jeffrey Bell in a list of names of comatulids included *Antedon loveni* followed by a so-called specific formula, but with no other data; this specific formula was modified by P. H. Carpenter in the following year.

In the *Alert* report published in 1884 Professor Bell described this species in detail and figured it under the name of *Antedon pumila,* transferring the original name *loveni* to the species he had listed as *Antedon insignis* in 1882. The description given by Bell in the *Alert* report is deceptive, for the number of cirrus segments is too small, and their shape is inaccurately described, and furthermore P_2 is said to be longer than P_1, and on the figure P_1 is represented as arising from the first brachial. On plate 10 there are two figures lettered "B"; the present species is the lower figure "B", the upper being an error for "C" and representing *Colobometra perspinosa,* the *A. loveni* of this report, which is the *A. insignis,* not the *A. loveni,* of the list published in 1882.

In 1887 von Graff, on the authority of P. H. Carpenter, explained the transference of the name *loveni* by Bell from this species to *Colobometra perspinosa* (the *Antedon insignis* of Bell, 1882) and Carpenter himself discussed it in the following year.

In 1888 Bell described *Antedon incommoda* (see p. 161), and in 1889 he discovered that he had erred in describing P_1 in *A. pumila* as shorter than P_2. But in correcting this error he made another, for he reduced *incommoda* to the synonymy of *pumila* whereas in reality the two represent distinct species.

In 1890 Whitelegge published an account of its local occurrence at the same time correcting Bell's error regarding the relative length of P_1 and P_2, Ramsay recorded it from Port Jackson and P. H. Carpenter from Port Phillip.

In 1902 Sayce again recorded it from Port Phillip, and in 1911 the present author listed it from several new localities.

In 1938 Dr. H. L. Clark noted that 79 specimens were taken near Middle Head, Port Jackson, so the species is evidently very abundant there.

Miss Elizabeth Pope, 1943, found *A. loveni* on the underside of rocks in the sublittoral of Long Reef, New South Wales, when making an ecological survey of the area.

In 1946, Dr. Clark commented that there were no reliable records of the species from south of Port Jackson or north of Port Stephens, the Claremont Island and Port Phillip records needing confirmation. (The Claremont Island record is here considered by A. H. Clark to be of *Antedon iris*).

[Note by A.M.C.] Following Gislén's synonymy of 1955, this species is now referred back to *Antedon.*

ANTEDON ARABICA (A. H. Clark)

Figure 12

Repometra arabica A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 87 (listed), p.93 (*Mabahiss* sta. 53; description), pp. 102, 104, 105, pl. 1, figs. 3, 3a.

Diagnostic features.—The centrodorsal is flattened hemispherical, with about XXX cirri in three crowded marginal rows; none of the 10 to 12 cirrus segments are more than twice as long as their median width, the antepenultimate is distinctly longer than wide and the distal part of the cirrus is markedly expanded dorsoventrally; in the type P_1 is 3 mm. long, with about 20 short segments; P_2 is 1.7 mm. long, with 12 segments; and P_3 is 2 mm. long, with about 13 segments; the following pinnules are like

P_a. This, the only known specimen, is small with the length IBr_1 to Br_9 (inclusive) 4.25 mm.

Description.—The centrodorsal is flattened hemispherical, about three times as broad as high, 1.9 mm. broad at the base, with the wide flat polar area measuring 1.3 mm. in diameter. The cirrus sockets are arranged in three closely-crowded alternating marginal rows.

The cirri are about XXX, 10–12, from 3.7 to 5.0 mm. long. The first two segments are about twice as broad as long, the third is from a third to half again as long as the median width, and the fourth is about twice as long as the median width. The segments following become gradually shorter, so that the antepenultimate is from a third to half again as long as broad, and the penultimate is about as long as broad. The opposing spine is moderate in size, terminal and directed outward. The terminal claw is slightly longer than the penultimate segment, rather stout and rather strongly curved, most strongly curved in the shorter cirri. The longer proximal cirrus segments are slightly constricted centrally. The distal halves of the cirri are laterally flattened and dorsoventrally expanded, so that in side view the outer half of the cirrus is about twice as broad as the proximal half. The cirrus segments are all broadly rounded dorsally.

The radials are even with the edge of the centrodorsal. The IBr_1 are very short, seven or eight times as broad as long, with the proximal and distal edges parallel and the lateral edges strongly convergent and somewhat convex. The IBr_2 (axillaries) are triangular, from a third to half again as broad as long, with the proximal border forming almost a straight line, the two distal sides concave and the distal angle narrow and rounded at the apex. The lateral angles of the IBr_2 are separated from those of their neighbors by a distance almost equal to the entire width of the ossicle.

The 10 arms are all broken off near the base. The first brachials are wedge-shaped, about three times as long exteriorly as interiorly. The second brachials are irregularly quadrate, more than twice as broad as the median length; they are somewhat larger than the first brachials. The first syzygial pair (composed of brachials 3+4) is broader than long, and is longer interiorly than exteriorly. The next two brachials are oblong, half again as broad as long, and those following are obliquely wedge-shaped, nearly as long as broad. The brachials beyond the fourth have prominent and very finely serrate distal ends.

Syzygies occur between brachials 3+4 and 9+10. The width at 3+4 is 0.7 mm. and the length from IBr_1 to the second syzygy is 4.25 mm.

P_1 is 3 mm. long with about 20 short segments, which are flared at their distal ends dorsally; the outer ones become about twice as long as broad. P_2 is about 1.7 mm. long, with 12 segments. P_3 is 2 mm. long, with about 13 relatively longer segments, of which the first, second, and third have a triangular dorsal process armed with spines directed obliquely distally, and the second to the sixth bear a fusiform gonad. The following pinnules resemble P_3.

The color is pale dull purplish, with a median white band on the division series and arms. The centrodorsal and cirri are white, the latter with broad light purple saddles on the segments and a dark purple interrupted midventral line.

Locality. *Mabahiss* station 53; south coast of Arabia (lat. 19°22′36″ N., long. 57°53′ E.); 13.5 meters; rock, shingle, shells and lithothamnion; November 2, 1933; water temperature 22.79° C. [A. H. Clark, 1937] (1, B.M., 1937.2.25.24).

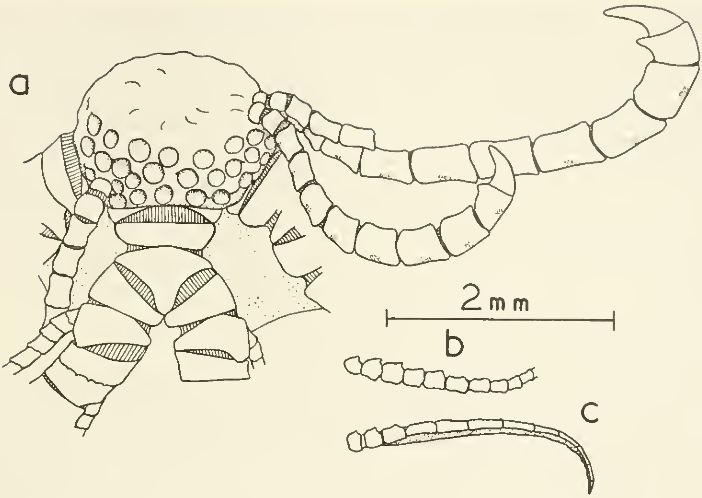

FIGURE 12.—*Antedon arabica* (A. H. Clark), holotype: *a*, Laterodorsal view of calyx and part of a postradial series; *b*, P_1; *c*, P_3.

Remarks [by A.M.C.].—As *Repometra arabica* this species was originally included by Mr. Clark in the subfamily Thysanometrinae, of which the species are mostly from deeper water. On attempting to place it in the keys left by Mr. Clark I found that its characters, particularly those afforded by the cirri, have greater affinity for the characters of the Antedoninae, especially those species of the now merged *Compsometra* and *Antedon* which have stouter cirri and flared pinnule segments, such as *loveni*, *serrata*, *bifida moroccana* and *duebeni* (if the last two are distinct).

ANTEDON BIFIDA BIFIDA (Pennant)

Rosy Feather Star, La Comatule Rose

FIGURE 13,*b*,*g*,*h*

[See also vol. 1, pt. 1, figs. 20 (p. 69), 104 (p. 167), 283 (p. 261), 312 (p. 271), 428–429 (p. 321), 496 (p. 369, pl. 1, fig. 518, pl. 4, fig. 543, pl. 5, figs. 553–556, pl. 9, fig. 576, pl. 10, figs. 577, 578, pl. 11, fig 579, pl. 12, figs. 580–586, pl. 13, figs. 587–588, pl. 14, figs. 589–591, pl. 15, figs. 592–593, pl. 16, figs. 594, 596, 597, pl. 17, figs. 598–602; pt. 2, figs. 549–564 (p. 295), 565 (p. 298), 748 (p. 349), pl. 4, figs. 994–996, pl. 12, fig. 1044, pl. 16, fig. 1071, pl. 18, figs. 1083–1097, pl. 19, figs. 1098–1109, pl. 20, figs. 1110–1122, pl. 23, figs. 1145, 1146, pl. 26, fig. 1162, pl. 27, fig. 1173, pl. 28, figs. 1176–1181, pl. 29, figs. 1186–1189, pl. 30, figs. 1191–1193, pl. 31, fig. 1195, pl. 32, figs. 1201–1203, pl. 33, figs. 1204–1206, pl. 44, figs. 1305–1307, pl. 45, figs. 1309, 1310, 1312, 1314, pl. 47, figs. 1323, 1325, pl. 48, figs. 1326, 1327, pl. 50, figs. 1333–1336]

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Antedon (*bifida*) *rosacea* MEEK, Rep. Dove Marine Lab., new ser. vol. 13, 1924, p. 110 (stations off Northumberland).

Antedon roseus [ANONYMOUS] Encyclopaedia Brittanica, ed. 14, vol. 6, 1929, p. 722.

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Diagnostic features.—P_2 is of the same length as P_3 and resembles it, though it does not bear a gonad; P_1 is about twice as long as these and is composed of more than 25 segments; there are not more than 18 (usually 14 to 16) cirrus segments of which the outer are moderately compressed laterally, shorter than the proximal, and slightly longer than broad; on average the wider distal segments are half again as wide as the narrower proximal ones; the cirri rarely exceed XL in number; interradial perisomic plates are frequently (but not always) present; the IBr_1 are very short, especially in larger specimens, and their slightly converging lateral edges form distinct angles with the projecting lateral corners of the axillaries.

Description.—Centrodorsal low truncated conical or flattened hemispherical, bearing cirrus sockets in two or three crowded and irregular more or less alternating rows; the bare polar area is of moderate size, slightly convex, flat, or slightly concave, smooth, or more or less covered with shallow pits.

Cirri XX–XXXV (exceptionally as many as XLVI), 10–18 (usually 14–16), from 9 to 12 mm. long; first segment short, second about twice as broad as long, third slightly longer, fifth the longest, from one third to one half again as long as broad; the remaining segments gradually decrease in length, the distal being only very slightly longer than broad; the penultimate segment bears a small subterminal opposing spine or tubercle. The cirri are basally almost circular in cross section, becoming gradually flattened distally, thus when viewed from the side appearing slowly to increase in diameter. The segments in the proximal half have slightly expanded articulations, this feature dying

* See also Addenda (pp. 835, 836) under 1957, 1962.

away distally. The profile of the dorsal edges of the segments is slightly concave or almost straight. (Some details of proportions of the cirri are given in table 6 (pp. 229–230) for comparison with *A. bifida moroccana*.)

Radials even with the edge of the centrodorsal in the median line, but visible in the angles of the calyx.

A compact group of 3 to 7 or more (usually 3 or 4) small plates is frequently present in the interradial perisome between the ossicles of the IBr series. W. B. Carpenter states that there is no trace of these plates in specimens from the Clyde, Strangford Lough, or Kirkwall Bay, but he found them in specimens from Ilfracombe and from Plymouth Sound; they are described and figured by J. S. Miller (1821) in specimens from Milford Haven, and in a specimen from Shetland dredged by Mr. Barlee and sent to Sir Wyville Thomson (W. B. Carpenter, 1866) they were present in three of the angles and absent from the other two. Sir Wyville Thomson (quoted by Norman, 1865) says that mature individuals usually have no trace of these plates, but frequently there are groups usually of three in the spaces between the IBr axillaries. They are given as present without comment in the specimens from Arran and the mouth of the Mersey listed under *A. milleri*. Disk naked, or with scattered tubercles containing groups of radiating spicules.

IBr_1 very short, bandlike, usually over four times as broad as long, decreasing rapidly in diameter distally, proximally just in contact at their bases, the sides of adjacent ones rapidly diverging from this point. IBr_2 triangular, rather broader than long, the anterior angle somewhat produced, and with a rounded posterior process incising the IBr_1 with which it rises into a rounded moderately prominent tubercle; proximally the IBr_2 are as broad as the bases of the IBr_1 so that their posterior edges overhang on each side the narrowed distal borders of the IBr_1 (see fig. 13,g,*h*).

The ten arms, which are composed of about 140 brachials, are usually between 50 and 65 mm. in length; the first brachial is wedge-shaped, much longer outwardly than inwardly, incised in the median line by a posterior projection from the second; interiorly the bases of adjacent first brachials meet above the apex of the IBr axillary, their inner sides thence diverging at right angles to the line of contact between them; exteriorly the first brachials are produced into a narrow ventrolateral ridge; the second brachials are irregularly quadrate; the third and fourth form a syzygial pair which is somewhat longer inwardly than outwardly and about twice as broad as its outer side; the fifth to the eighth brachials are wedge-shaped, though the ends are not especially oblique, about twice as broad as their median length; the ninth and tenth, forming the second syzygial pair, are more obliquely wedge-shaped; the following are triangular, not quite so long as broad, after the proximal third of the arm becoming wedge-shaped, slightly broader than long, the proportion of length to breadth gradually increasing distally while at the same time the ends of the brachials become less and less oblique so that in the distal portion of the arm they are about twice as long as broad with the ends only slightly oblique and with the articulations somewhat swollen. At about the second syzygy the distal edges of the brachials develop a finely dentate border which begins gradually to disappear after the middle of the arm. The synarthry between the first and second brachials rises to a broad tubercle resembling the one on the line between the two elements of the IBr series, and the articulations between the following three or four brachials are usually somewhat swollen over the ends of the apposed fulcral ridges.

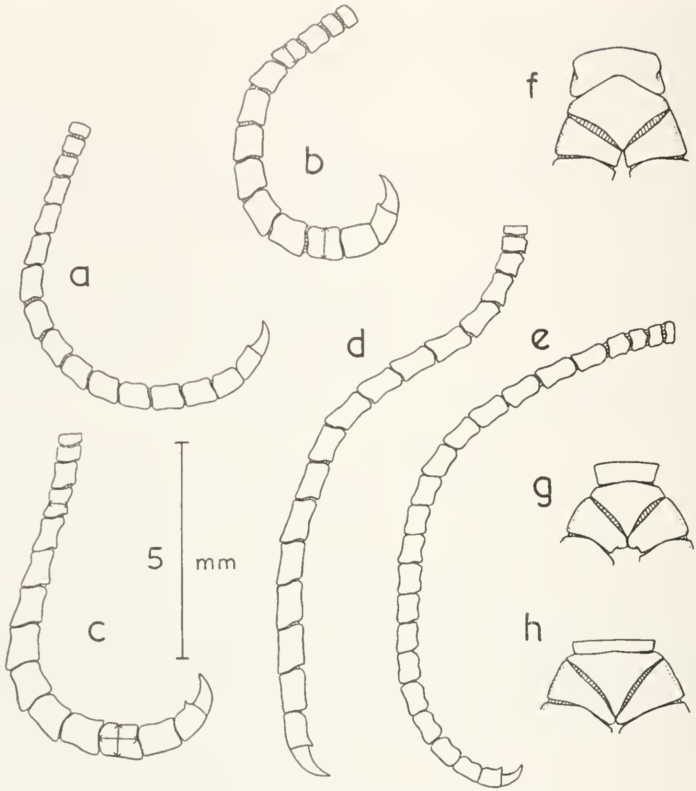

FIGURE 13.—Peripheral cirri of: *a*, *Antedon petasus* (Düben and Koren); *b*, *A. bifida* (Pennant); *c*, *A. bifida moroccana* A. H. Clark; *d*, *A. hupferi* Hartlaub; *e*, *A. mediterranea* (Lamarck). *f*, Division series and first brachials of *A. mediterranea;* *g* and *h*, same of *A. bifida*, small and large. (The arrows on *b* and *c* indicate the measurements taken.)

Syzygies occur between the third and fourth, ninth and tenth, and fourteenth and fifteenth brachials and distally at intervals of three muscular articulations.

There are about 35 pairs of pinnules. P_1 is from 12 to 15 mm. long, composed of from 30 to 45 (most commonly about 35, rarely over 40) segments of which the first is not quite so long as broad and the remainder are fairly uniform, about half again as long as broad; it is much stouter basally than P_2 and tapers gradually to a delicate and flagellate tip. P_2 is about half as long as P_1, or very slightly longer, and much less stout, composed of from 20 to 25 (usually about 20) segments of which the first is about as long as broad and the following become progressively elongated distally reaching a length of about twice their breadth. P_3 is similar to P_2 but very slightly stouter and bearing a genital gland. The following pinnules increase very slightly in length and in the number of their component segments, at the same time becoming gradually more slender; after the tenth, the genital glands, which may be short and well rounded or long and fusiform, gradually decrease in size, disappearing entirely at the twentieth to twenty-sixth (rarely as late as the thirtieth). The distal pinnules are from 12 to 15 mm. long, very slender, composed of about 30 segments of which the first is very short, trapezoidal or crescentic, the second is about as long as its distal width, trapezoidal, the third is somewhat longer than broad, and the following become progressively elongated with slightly enlarged articulations, reaching a length of about two and a half times the width distally. The distal pinnules remain very uniform until near the end of the arms when they rather rapidly decrease in length. The segments of all the pinnules have more or less overlapping and finely spinous distal borders. W. B. Carpenter (1866) says that in the middle of the arm the number of segments in the pinnules may average 18, and in the terminal portion this rapidly diminishes from 16 to half that number.

Notes.—The size of the Rosy Feather Star varies greatly, the arm length ranging from 20 to 200 mm.

In the Orkneys, Dalyell (1851) says that the average arm length is about 65 mm.

Parkes (1891) gives the arm length of specimens from Lamlash Bay, Arran, as from 50 to 90 mm. W. B. Carpenter (1866), speaking presumably of the same region, says that the usual arm length is from 50 to 65 mm., though specimens exceeding this are by no means uncommon, and he occasionally met with individuals with an arm length of as much as 115 mm.

According to Mr. Elmhirst (in a letter), around Millport the full size is about 125 mm. in diameter (with an arm length of about 63 mm.), and specimens 150 mm. in diameter (with an arm length of 75 mm.) are rare. He wrote that these full sized examples are probably in the second year.

Chumley records a specimen from the mouth of Loch Strivan in the Clyde area which had an arm length of 200 mm.

Norman (1865) gives an average arm length of 57 mm. in shallow water, and of 140 mm. in deeper water.

Hornell (1895), speaking of this species in Jersey, says that the arms are often 90 mm. in length.

Greeff (1882) says that those which he found near Lisbon had an arm length of from 20 to 30 mm., but they were not sexually mature. Two which I examined from Cezimbra, Portugal, had an arm length of about 80 mm.

Professor W. B. Carpenter wrote (1866) that the color of this species as he found it at Lamlash Bay varies greatly. Commonly it is that which its trivial name *rosaceus* implies; but the crimson frequently deepens to a rich damask hue, especially during the breeding season, while it very frequently gives place to white on portions of the disk and arms so that the animal has a beautifully variegated aspect. Sometimes, again, the predominant hue is a rich orange, and this may be variegated with white or crimson, or with a bright sulphur yellow.

Dr. Grieve, speaking of material from the Clyde region (1868), says that it is usually of a fine rose color, but sometimes tinted with yellow.

Fleming (1828) gives the color as deep red, Dalyell (1851) as tile red to crimson, Forbes (1841) as deep rose, Wyville Thomson (1864) as crimson, and Norman (1865) as crimson, scarlet or mottled, the large ones from deep water being rich brown or reddish tawny.

About the Isle of Man, says Chadwick (1907), some are uniform deep reddish purple, but the majority are clouded and spotted with rose, orange and yellow, while Herdman (1886) gives the color as yellow, tawny, orange and crimson. Of those from deep water off the cliffs (Herdman, 1906) some were deep red, but most were dirty yellow, more or less mottled with rose.

Lewes (1860) says that one which he found at St. Mary's, Scilly Islands, was pink and white.

Gosse (1863) describes one from Petit Tor on the Devonshire coast as having bands and patches of crimson and yellow, not very regular, the yellow studded with red dots.

At Guernsey, Sharp (1908) says the color is variable, generally red, but sometimes yellow, old gold, or banded.

At La Hougue, Malard (1892) states that this species occurs in three distinct colors, more or less deep violet red, orange yellow inclining toward saturn red, and alternate white and red, with whitish pinnules.

Mr. Elmhirst writes that about Millport the color is variable, brick red to reddish purple, either plain or marbled with white, yellow, or yellow-orange, and occasionally yellow, plain or marbled with white, orange or red.

The extruded eggs are bright orange (Wyville Thomson, 1864).

Carpenter (1866) says that bright sulphur yellow is often the first color assumed by the pentacrinoid larvae when not far from the termination of their pedunculate stage.

Hassall (1842) writes that the markings and coloring of very young specimens obtained off Kingstown harbor, Ireland, are very beautiful and delicate, very different from the coarse red color which distinguishes them in their mature condition.

Several authors (as Forbes, 1841; W. B. Carpenter, 1866; Colgan, 1905, etc.) have remarked that the coloring matter is readily soluble in fresh water and in alcohol.

Abeloos and Teissier (1926) found that there are two pigments present, one red and one yellow. According to Karrer and Solmssen, (1935) and Lederer (1938) the pigments are not carotenoids. However, Dimelow (1958) has analyzed the following carotenoids from the arms and pinnules of *A. bifida*, β-carotene, esterified astaxanthin, astaxanthin, and xanthophyll.

Covering plates.—Dr. Th. Mortensen finds that, although they appear to be lacking in the majority of specimens, side and covering plates resembling those figured by Grieg in *A. mediterranea* occur in some individuals of this species.

Formation of the pinnulars.—Dr. Mortensen (1920) has shown that in the pinnules the segments are formed successively from the first outward, the terminal hook being the last to appear. All of the segments are formed within a very brief time, while the pinnule is still very short. They are all present in the third pinnule from the tip of the arm, the further growth of the pinnule depending upon their increase in length.

Formation of the cirrals.—According to Dr. Mortensen (1920) the cirrus segments, like the pinnulars, are developed successively from the first outward, the terminal claw being the last to form. They appear first as simple rounded fenestrated plates with no central perforation, this arising later through the resorption of the central part.

Radianal and infrabasals.—Dr. Mortensen (1920), while studying the larvae of this species in connection with his work on those of other crinoids, finds that the radianal appears before the right posterior radial, which forms to the right of it, in exactly the same way in which these two plates appear in *Promachocrinus*. Its formation therefore is not delayed until the appearance of the elements of the IBr series as was supposed by Sir Wyville Thomson.

Furthermore, Dr. Mortensen (1920) calls attention to the fact that Professor MacBride (1914) had correctly identified as infrabasals a plate Thomson designated as the centrodorsal in a reproduction of one of his figures, though Thomson had made no mention of them in his text. Mortensen also states that infrabasals are constantly present in this species, usually two larger and one smaller, lying in the usual place about the topmost columnal.

Abnormal specimens.—With four rays: P. H. Carpenter (1888) records a 4-rayed specimen in his collection, the anterior ray being absent; and Chadwick (1907) has observed several 4-rayed individuals, presumably from the vicinity of Port Erin.

With nine arms: W. B. Carpenter (1866) described and figured a 9-armed specimen in which on one of the rays the IBr_2 is absent so that the first brachial immediately follows the IBr_1, which is of about twice the normal length.

With eleven arms: W. B. Carpenter (1866) described and figured an individual with one IIBr series of 2 segments and 11 arms.

With twelve arms: Dendy (1886) described in great detail and figured a specimen with two IIBr series of 2 segments and 12 arms; one of the IIBr series was on the posterior side of the left anterior ray, the other being on the anterior side of the right posterior ray. The individual, which is preserved in the British Museum, is unusually large.

With palmate arms: Professor William Bateson secured a specimen with palmate arms which had been dredged in the Hamoaze, Plymouth, near Beggar's Island together with a number of other normal ones. This he turned over to P. H. Carpenter for description. The latter (1890) writes that the two abnormal arms of this remarkable specimen are symmetrically placed as regards the mouth and anus, being the posterior arms of the two anterolateral rays. The arm b_2 has been regenerated at the syzygy in its 15th brachial (i.e., at brachials 18+19 by modern terminology where syzygies are counted as two brachials), but the pinnule on the new epizygal is on the same side (the outer) as that on the preceding 14th brachial and not opposite to it as would normally be the case, so that there are two pinnules in succession on the same side of the arm. The next 12 pinnules alternate regularly on opposite sides, those of the 19th and 27th brachials having much enlarged basal joints. That on the 28th brachial is considerably larger than its predecessors, and more like a bifid armlet. It commences with five large segments, the last of which bears two pinnules, the one continuing the main axis being rather stouter than its fellow. The 29th brachial is syzygial, with an axillary epizygal. The outer facet bears an arm of which some 75 segments remain. It has pinnules on the 2nd and 4th, the latter being syzygial, but there is none on the 3rd, which would normally be syzygial and bear a pinnule on its epizygal. On the larger, internal, facet of the axillary 29th brachial is another axillary (30th brachial), but without a syzygy. One of its facets bears the continuation of the primary arm, on the next segment of which (the 31st brachial) is an abnormal trifid armlet with three enlarged basal segments, the second being syzygial with a pinnule stump on the epizygal, while the fourth bears two pinnules. The 32nd brachial is again axillary and syzygial, its epizygal bearing two subequal arms of some 60 segments each. The second segment of the left-hand one, which continues the primary arm, has a bifid pinnule with its basal segments enlarged, and the following pinnules alternate regularly on opposite sides. The arm borne on the right or inner facet of the axillary 32nd brachial has no pinnule until its third segment, which is not syzygial, though the fourth is; but in other respects the arm is normal. The second facet of the axillary 30th brachial bears a normal arm of about 60 segments with a pinnule on the second and a syzygy in the third. Thus the axillary 29th brachial of the primary arm b_2 gives rise to four well developed arms, two of which bear bifid or trifid armlets in addition to the larger bifid armlet on the 28th brachial. The primary arm e_1 does not seem to have undergone any regeneration and is normal to the 40th brachial. The 41st is syzygial, and the appendage of its epizygal is a short armlet of three segments, the second and third of which bear pinnules laterally, while its main axis is also continued on in the form of a pinnule. The 42nd brachial has a similar armlet, with but one lateral pinnule. The 43rd is axillary, without a syzygy, its inner branch being a normal arm with some 40 segments remaining, the second and fourth of which have pinnules, though the third has not. The 44th segment of the primary arm seems to be syzygial, and its epizygal, though not regularly axillary, supports an arm which has the first pinnule, as usual, on the second segment, but on the inner instead of on the outer side. The next five segments are all enlarged and bear bifid or trifid armlets, while the remainder of the arm is normal, with regularly alternating pinnules.

With a forked oral pinnule: W. B. Carpenter (1866) mentions a specimen with one of the P_1 bifurcating on the second segment so that two full sized pinnules take the place of the ordinary single pinnule.

With an abnormal disk: P. H. Carpenter (1884) records a specimen from Milford in which only four of the ambulacral grooves reach the mouth, the fifth (the left antero-lateral) having a second mouth all to itself.

With an ovary within the visceral mass: P. H. Carpenter (1884) describes a specimen in which he found a small but well developed ovary occupying the position of the genital plexus beneath the left posterior ambulacrum of the disk. The first traces of it appear in the sections which pass through the hinder part of the spongy organ, and it extends outward to the point where the primary radial groove divides into the two which proceed to the arms. It contains the nuclei of half a dozen ova in various stages of development, some with a germinal spot and some without.

Localities.—Shetland (Zetland) Islands. Shetland [Forbes, 1851; Norman, 1862, 1865] (6, U.S.N.M., 8793). Same, shallow water [A. H. Clark, 1913] (about 6, B.M.). Same, 13 meters [Forbes, 1851]. Same, 18 meters [Forbes, 1841]. Balta Sound [A. H. Clark, 1913] (19, B.M.). St. Magnus Bay, off Papa Stour (island); 46 meters; broken barnacles and serpulae; strong tideway [Forbes, 1851]. Bressay Sound; 9–13 meters [von Graff, 1884]. Same, about 18 meters; rocky; June 1875 [Mason, 1876]. Ling Bank; 90 meters; sand and stones [Forbes, 1851].

Orkney Islands. Orkneys [Busch, 1851; Dalyell, 1851; Parkes, 1891]. Same, 14–28 meters [Forbes, 1851]. Kirkwall Bay [Busch, 1849; Wyville Thomson, 1864; Norman, 1865]. Same, 11–15 meters [Busch, 1851].

Plateau northnorthwest of North Rona (lat. 59°12′ N., long. 5°57′ W.); 97 meters; rough ground; H.M.S. *Knight Errant*, 1880 [P. H. Carpenter, 1884, 1888].

North Atlantic Ocean [P. H. Carpenter, 1884; A. H. Clark, 1911] (1, L.M.). Northern seas [von Graff, 1877]. European seas [von Graff, 1884]. Celtic seas [Forbes, 1844].

Scotland [Busch, 1849; A. H. Clark, 1913] (13, B.M.).

Off Seaham; about 55 meters [Hodge, 1872].

North of Tynemouth (lat. 55°12′ N., long. 1°25′ W.); 44 meters (7, C.M.).

Coast of Northumberland [Hodge, 1865]. Off Dunstanborough Castle; about 46 meters [Hodge, 1872]. Embleton and Beadnal Bays [R. Embleton, in Hodge, 1872]. Cullercoats [J. Alder, in Hodge, 1872]. Off Cullercoats, 6 miles east of the Longstone; 73 meters [Storrow, 1913; Meek, 1924].

Aberdeen [Simpson, 1903]. Peterhead, Aberdeenshire [Peach, 1864].

Moray Firth (northeastern Scotland) [Gordon, 1852; Smith, 1891]. Moray Firth, Witch Ground, near Banff [Sim, 1886].

Wick, Caithness [Peach, 1864]. Staxigo [Peach, 1864].

Pentland Firth [Peach, 1864].

Western coasts of Scotland, England and Wales [P. H. Carpenter, 1881].

Western coasts of Scotland [Pennant, 1777; Fleming, 1828; Forbes, 1841; Busch, 1851].

Northwest province, Scotland; 15 meters [Forbes, 1851].

Hebrides [Forbes, 1851]. Same, 36–46 meters; gravel [Forbes, 1851]. Same, 55–73 meters, shell [Forbes, 1851]. Off Stornoway, island of Lewis; 15 meters [Forbes, 1851]. Sound of Scalpa; 55–73 meters [Forbes, 1851]. Off the Sound of Scalpa; 55–73 meters; stones and shells [Forbes, 1851]. The Minch, 10 miles northeast of the Shiant Isles; 91 meters; sand and gravel [Forbes, 1851]. North Uist, outer Hebrides; 11 meters [McIntosh, 1866]. Calway Channel (Loch Boisdale), southeastern part of South Uist, outer Hebrides [Scott, 1896].

Ross-shire [W. B. Carpenter, 1866]. The Gairloch, west Ross-shire [Scott, 1896].

Loch Hourn [Bell, 1892; A. H. Clark, 1913] (1, B.M.). Off Loch Laigh [Forbes, 1851].

Off Tobermory, Island of Mull; 55 meters [A. H. Clark, 1913] (2, B.M.). Loch Buy, Mull; deep water [Scott, 1896]. Ross of Mull [Forbes, 1851].

Loch Etive; 28–37 meters [Bell, 1892; A. H. Clark, 1913] (1, B.M.).

Firth of Lorn; 9–201 meters [A. H. Clark, 1913] (1, B.M.). Same, 37–55 meters [A. H. Clark, 1913] (2, B.M.). Same, 91 meters [Bell, 1892; A. H. Clark, 1913] (2, B.M.). Oban, Firth of Lorn [W. B. Carpenter, 1875; von Graff, 1887].

Loch Craignish, Argyll [Bell, 1892; A. H. Clark, 1913] (13, B.M.). Loch Fyne [Scott, 1897]. Loch Strivan; 36 meters [Chumley, 1918]. Same, 27–36 meters [Chumley, 1918].

Firth of Clyde [Sars, 1868; W. B. Carpenter, 1876; Dendy, 1886; Bell, 1892; McIntosh, 1904; A. H. Clark, 1913] (2, B.M.). Same, hard ground in 18–37 meters throughout the district [Henderson, 1887]. Off Roseneath Point [Henderson, 1887]. Below Gourock [Grieve, 1868]. Dunoon Basin; 55–73 meters [Hoyle, 1889]. Same, east side; 9–36 meters [Chumley, 1918]. Same, south end; 51–73 meters [Chumley, 1918]. Same, center; 18–36 meters [Chumley, 1918]. *Garland* station XII, April 20–21, 1896 [Scott, 1897].

Largs Channel, between Cumbrae and the mainland; 18–25 meters; March 30, 1923; Chumley and Elmhirst (29, U.S.N.M.).

Between Great Cumbrae and Wemyss Ground [Bell, 1892; A. H. Clark, 1913] (1, B.M.). The Cumbraes [Grieve, 1868; von Graff, 1887; Chopin, 1895]. Same, shore to 36 meters [Chumley, 1918]. Millport, Great Cumbrae [Dendy, 1886; A. H. Clark, 1913] (2, B.M.). Near Millport, between the Allans and Portloy [Chopin, 1895]. Off the northern end of Little Cumbrae; 9–18 meters; June 1861, and 1867 [Grieve, 1868]. Off the western side of Little Cumbrae [Henderson, 1887].

Off the southern end of the Island of Bute (Callum's Hole and Hank's Neb) [Henderson, 1887].

Arran Basin [Chumley, 1918]. Isle of Arran [Norman, 1865; W. B. Carpenter, 1866; P. H. Carpenter, 1884; Henderson, 1887; von Graff, 1887; Bell, 1892]. Lamlash Bay, east coast of Arran [Wyville Thomson, 1864; Grieve, 1868; W. B. Carpenter, 1876, 1884; Herdman, 1884; Parkes, 1891; A. H. Clark, 1913; Chumley, 1918] (7, B.M.). Same, 13 meters [A. H. Clark, 1913] (dry pentacrinoids, B.M.). Same, southern part, near King's Cross Point [Herdman, 1884]. Same, south entrance; 11 or 13 meters [Herdman, 1884]. ?Lamlash Bay [Bell, 1892]. Tan Buoy; 13 meters [Chumley, 1918].

Campbelltown Loch, Kintyre; 18–29 meters [Chumley, 1918].

Four miles southeast of Sanda (off the southeastern end of Kintyre); 55–70 meters [Bell, 1892; A. H. Clark, 1913] (4, B.M.). Between the island of Sanda and Ailsa Craig; 44 meters [Bell, 1892; A. H. Clark, 1913; Chumley, 1918] (1, B.M.).

Irish Sea [Herdman, 1896] (3, M.C.Z., 236, T. J. Moore). Same, 37 meters [Forbes, 1841].

Isle of Man [Forbes, 1835; von Graff, 1887]. Same, deep water off the cliffs [Herdman, 1902, 1906]. Same, southern end [Chadwick, 1907]. Around the Isle of Man; 45 meters [Forbes, 1851]. Manx coast [Forbes, 1839]. Same, deep water [Forbes, 1831]. One mile north of Fleshwick, a half mile off shore; 26 meters; fine gravel [Herdman, 1895]. West of South Barrule, 1 mile off shore; 22 meters; nullipores [Herdman, 1895]. From the north side of Port Erin Bay, just under Bradda Head, to the southern end of the Calf of Man [Herdman, 1889]. Port Erin Bay [Herdman, 1889]. Port Erin (38, U.S.N.M., 36125). Same, from the bottom of the buoy off the end of the breakwater [Herdman, 1894]. Close to Port Erin [Herdman, 1886, 1893]. Off Port Erin; 37 meters; May 1888 [Chadwick, 1889]. Same, 18–37 meters [Herdman, 1886]. Off the Castles (just outside the breakwater), Port Erin [Herdman, 1901]. Between Port Erin and the Calf of Man [Herdman, 1894]. Off Bay Fine; 33 meters [Herdman, 1901]. About Aldrick and Bay Fine; 28–37 meters [Herdman, 1894]. Calf of Man [Herdman, 1886; Bell, 1892; A. H. Clark, 1913] (1, B.M.). Off Port St. Mary [Herdman, 1886]. Twenty miles southeast of Port St. Mary; 48 meters [Herdman, 1893]. Twenty-five miles southeast of Port St. Mary; 42 meters [Herdman, 1893]. Off Spanish Head [Herdman, 1886]. Off Douglas Bay [Herdman, 1886]. Off Porthwen Bay; 31 meters [Herdman, 1890]. Same, 2 miles from shore; 37–40 meters [Herdman, 1890]. Same [Swainson, 1889]. Off Niarbyl Point, 1 mile off shore; 22 meters; rough hard ground [Herdman, 1895].

Mouth of the Mersey river [Norman, 1865; Bell, 1892].

Off Liverpool [Bell, 1892; A. H. Clark, 1913] (3, B.M.).

North coast of Anglesea. Off Bull Bay [Chadwick, 1889, 1907]. Cemmaes (Keumaes) Bay [von Graff, 1887]. Off Cemmaes Bay, 18 meters; *Hyena* expedition, 1886 [Chadwick, 1889, 1907].

Holyhead Island, Anglesea, near Rhoscolyn beacon [Herdman, 1891].

Wales [Fleming, 1828; Forbes, 1841]. Milford Haven [Adams, 1800; Miller, 1821; Fleming, 1828; Forbes, 1841; J. Müller, 1841, 1849; von Graff, 1887; Bell, 1892]. Same, 6–11 meters; mud [Forbes, 1851]. Tenby [Parkes, 1891; Hartmeyer, 1916]. Mew Stone, Skomer, Pembroke; intertidal [Bassindale, 1945].

Ilfracombe (south side of the entrance to the Bristol channel) [Norman, 1865; W. B. Carpenter, 1866].

Ireland [von Graff, 1877] (2 pentacrinoids, C.M.; from Sir Wyville Thomson). North, east and south Ireland [Wm. Thompson, 1844]. Fair Head to Downpatrick (embracing Belfast and Strangford Loughs, and parts of counties Down and Antrim); Downpatrick to Carnsore Point in County Wexford (embracing Dundrum, Dundalk and Dublin bays, and parts of counties Down, Louth, Meath, Dublin, Wicklow and Wexford); Carnsore Point to Cape Clear, County Cork, with harbors of Waterford, Dungarven, Youghal, Cork and Kinsale, and parts of counties Wexford, Waterford and Cork; Mizen Head to Kerry Head at the mouth of the River Shannon (embracing Bantry, Dingle and Tralee bays, the Kenmare River, and parts of counties Cork and Kerry); Loop Head, County Clare, to Erris Head on Mullet Island at the extreme northwest of Mayo (embracing Galway, Clare and Blacksod bays, the isles of Aran, Clare, Achill and Mullet, and parts of counties Clare, Galway and Mayo [Wright and Greene, 1859]. Generally distributed on the Irish coast; not recorded on the northwest coast between Erris Head and Malin Head, although probably occurring there [Nichols, 1903]. Larne Lough [Wm. Thompson, 1856]. Antrim [Forbes, 1841]. Belfast [Norman, 1865; Sars, 1868; Bell, 1893]. Belfast Lough [Wyville Thomson, 1864]. Belfast Bay [Wm. Thompson, 1856]. Down [Forbes, 1841]. Portaferry [Bell, 1892]. Ringhaddy Sound, Strangford Lough; L.W. extra spring tide [Williams, 1954]. Strangford Lough [Wm. Thompson, 1856; Wyville Thomson, 1864; Norman, 1865; W. B. Carpenter, 1876]. Entrance to Strangford Lough, October 1839 [Forbes, 1841]. County Dublin [Bell, 1892]. Dublin coast [Forbes, 1841]. Skerries, County Dublin; 24 and 25 meters [Colgan, 1905]. Ireland's Eye (near Dublin) [Forbes, 1841]. Off Ireland's Eye [Wm. Thompson, 1856]. Dublin [Forbes, 1841; Busch, 1849]. Dublin Bay [Anonymous, 1835]. Dublin Bay, channel between Dalkey Island and the mainland [Hassall, 1842]. Under Martello Tower, Dalkey Island, close to shore [Haddon, 1886]. Dalkey Sound [Wyville Thomson, 1864]. Off Kingstown Harbour [Hassall, 1842]. Greystones, County Wicklow [MacIntosh, 1884; Haddon, 1886]. Cork [Forbes, 1841; J. E. Gray, 1848]. Queenstown (Cobh, or Cove of Cork) [J. V. Thompson, 1827]. Courtmacsherrry Harbour [Wm. Thompson, 1856]. Long Island Sound (southwestern Ireland); 7 meters [Sladen, 1891]. *Flying Fox* station IV, off the southwest coast of Ireland; 457 meters [Bell, 1889, 1892; A. H. Clark, 1913] (4, B.M.). County Kerry, 45–60 miles W. ½ N. from Dursey Head; 457 meters [Kemp, 1905]. Kenmare River [Bell, 1892; A. H. Clark, 1913] (3, B.M.). Coastguard Bay, off Green Rocks, etc. [Kemp, 1905]. Off Freaghillaun [Kemp, 1905]. On bottom of hulks moored in Faby [Kemp, 1905]. South entrance to Ballynakill Harbour [Kemp, 1905]. County Kerry, 3–5 miles southwest by south from Great Skellig rock; 109 meters [Kemp, 1905]. Five to 8 miles west of Great Skellig rock; 128–146 meters [Haddon and Green, 1888; Kemp, 1905]. Valencia; ascidian ground, Knightstown area, Valencia Harbour; 5–13 meters [Beaumont, 1900]. *Helga* station W.5; five miles SW. by W. of Great Skellig, County Kerry; 109–119 meters [A. H. Clark, 1913] (1, Dublin M.)

Helga station S.R.360; west of Dingle Bay (lat. 52° 04′ N., long. 11° 27′ W.); 197–219 meters [A. H. Clark, 1913] (1, Dublin M.). Cleggan Bay, County Galway; 7–15 meters [Bell, 1893]. *Fingal* station 75; Cleggan Bay; 15–20 meters; July 15, 1890 [Bell, 1893; A. H. Clark, 1913] (1, B.M.). Roundstone [A. H. Clark, 1913] (about 40, and pentacrinoids, B.M.). Roundstone or Birterbuy Bay [Wm. Thompson, 1856]. Blacksod Bay, County Mayo [Bell, 1893]. Same, 7 meters [A. H. Clark, 1913] (6, B.M.). Ardelly Point; 9–15 meters; off Blacksod Light; 15–16 meters [Farran, 1915].

Rockall [Sladen, 1897; A. H. Clark, 1913] (1, B.M.). Rockall Bank; 110–238 meters [Kemp, 1905].

British Ocean [J. E. Gray, 1848; Bell, 1893; A. H. Clark, 1913] (1, B.M.). British Seas [Bell, 1893; A. H. Clark, 1913 (9, B.M.).

Scilly Isles. St. Mary's Island; from Laminaria roots [Lewes, 1860]; from a tide pool [Vallentin, 1904]. White Island [A. H. Clark, 1912] (2, H.M.).

Cornwall [Llhuyd, 1699; Pennant, 1777; Peach, 1864] (1, U.S.N.M., 19311; J. Alder). Penzance [Llhuyd, 1699; Fleming, 1828; Forbes, 1841] Type locality. Falmouth [Vallentin, 1898].

Devonshire coast [Parkes, 1891].

Rocks southwest of the Eddystone rocks (off Plymouth); 73 meters [Heape, 1888].

Plymouth and vicinity. Plymouth Sound [J. E. Gray, 1848; W. B. Carpenter, 1866]. Plymouth [Norman, 1865; W. B. Carpenter, 1876; P. H. Carpenter, 1887; Bell, 1892; Garstang, 1892, 1894; Sumner, 1895; Chubb, 1906; Woodland, 1907; A. H. Clark, 1913] (9 B.M.; U.S.N.M., 19311; H. W. Parritt). Millbay Channel, deepest part (Millbay Pit) [Pace, 1904; Plymouth Marine fauna, 1931, 1957]. Same, 26–42 meters [Pace, 1904]. Asia Shoal [Pace, 1904; Plymouth Marine fauna, 1931, 1957]. Mallard Shoal [Pace, 1904; Plymouth Marine fauna, 1931, 1957]. Off Mallard Buoy [Calderwood, 1889]. Inside the Bridge [Pace, 1904, Plymouth Marine fauna, 1957]. The Cattewater, off Turnchapel [Pace, 1904, Plymouth Marine fauna, 1957]. Mewstone ledge; 18–27 meters [Pace, 1904; Plymouth Marine fauna, 1931, 1957]. Rocks of Drake's Island, and off the Cobbler Buoy (in the Sound) [Heape, 1888]. In the Hamoaze, near Beggar's Island [P. H. Carpenter, 1890]. Midway between Mallard Buoy and Batten Breakwater; black mud with clinker [Plymouth Marine fauna, 1957]. Between Mount [St.] Edgecumbe and Dukes (?Drake's) Island; about 18 meters; rocky; June 1876 [Mason, 1876].

Salcombe; Castle Rocks, L. W. S. [Plymouth Marine fauna, 1931, 1957]. Salcombe; under Marine Hotel; L. W. S. and Salstone; E. L. W. S. [Plymouth Marine fauna, 1957]. Salcombe estuary, shallow water, among *Zostera marina* [Stebbing, 1876].

Between the Start and Exmouth [Todd, 1897].

Petit Tor, Devonshire Coast [Gosse, 1853].

South coast of Devon; about 7 meters [Allman, 1863, 1864].

Torquay [Gosse, 1864; Hughes, 1877; von Graff, 1887].

Torbay [Gosse, 1864; Hunt, 1876; Hughes, 1877; P. H. Carpenter, 1884; Bather, 1890; Burbidge, 1900]. Near Torbay; 22 meters; 15.0° C.; limestone bottom [Hughes, 1873]. Thatcher Rock, July 11, 1871 [Hunt, 1876]. Same, 1871 and 1872 [Stebbing, 1876]. Near Thatcher Rock, 1876 [Hunt, 1876]. Close to Thatcher Rock [Lang, 1876; Hunt, 1876]. Berry Head, Brixham; 15–18 meters; rough ground [Todd, 1897]. Berry Head; 24 meters [A. H. Clark, 1913] (5, B.M.). Berry Head [Hunt, 1876]. Off Berry Head, about 22 meters, very rocky, July 25, 1876 [Lang, 1876; Hunt, 1876].

Oithona station 6, on a line from Berry Head to Orestone, just outside the limit fixed by the Devon Sea Fisheries Committee; 15–18 meters; and on the rough ground at the Berry Head end of the station [Todd, 1903].

Entrance to the British Channel [Bell, 1893; A. H. Clark, 1913] (1, B.M.).

Coast of Kent [Gray, 1834, 1848].

Hastings [Parkes, 1891]. Folkestone [Parkes, 1891]. Dover [Parkes, 1891].

Great Britain (6, U.S.N.M., 35706; M.C.Z., 238). ?England (arms, M.C.Z., 240). No locality (3, B.M.).

European Ocean [Leach, 1815]. Western coasts of Europe which are warmed by the Gulf Stream [Dujardin and Hupé, 1862]. Atlantic coast of France [Koehler, 1921].

Wimereux-sur-mer (just north of Boulogne) [Schaxel, 1911].

Pont du Coll, Picardy [Parkes, 1891]. Le Havre [de Freminville, 1811]. Saint-Waast-la Hogue [Cuénot, 1894]. La Hogue, near Cherbourg [Malard, 1892, 1893].

Channel Islands [Koehler, 1885]. Guernsey [Sharp, 1908] (3, C.M., A. M. Norman). Bordeaux and Castle Cornet, Guernsey [Sharp, 1908]. Herm (east of Guernsey) [A. H. Clark, 1913] (4, B.M.). Same, tide mark [A. H. Clark, 1913] (3, B.M.). Jersey [Koehler, 1885; Hornell, 1895, but without mention of locality]. *Pourquoi Pas?* station 60; northwest of Alderney (lat. 49°51′ N., long. 2°21′ W.); 162 meters [Vaney, 1914].

Coasts of Brittany, in the second and third littoral zones [Pruvot, 1897].

St. Malo (1, W.M.).

Roscoff, Finisterre [Lacaze-Duthiers, 1869, 1870; E. Grube, 1872; Perrier, 1873, 1886; P. H. Carpenter, 1881; Cuénot, 1891, 1894; Pruvot, 1897; A. H. Clark, 1911] (many pentacrinoids, P.M.). Isle Vert and Isles Bourguignons, near Roscoff [Lacaze-Duthiers; Cherbonnier, 1951].

Men Cren, in the large rock pools [Th. Barrois, 1882].

Concarneau [Th. Barrois, 1882].

Huxley station 5; off Brittany (lat. 47°48′ N., long. 7°46′ W.); 200 meters; coarse sand and shells; August 1906 [de Morgan, 1913].

Princesse-Alice station 42, 1886; southwest of St. Nazaire (lat. 46°47′ N., long. 3°52′15″ W.); 136 meters; fine sand; July 18, 1886 [Koehler, 1909].

Charente Inferieur [Beltramieux, 1864].

La Rochelle, Charente Inferieure [Fischer, 1870].

Gironde [Fischer, 1870].

Arcachon, Gironde [Fischer, 1889].

Southwestern France [Fischer, 1870].

Spain [A. H. Clark, 1912] (2, H.M.). Santander [Aranda y Millán, 1908]. San Martin, Santander [Martin and Crehuet, 1948]. Vigo Bay [MacAndrew, 1851].

North Portugal. Leça da Palmeira; 18–37, and 55 meters [Nobre, 1903]. Póvoa de Varzim [Nobre, 1903]. Lexões; 55 meters [Nobre, 1903].

River Tejo, near Lisbon [R. Greeff, 1882]. Between Lisbon and Cazilhas; salinity 2.5 percent [Walther, 1894]. Between Lisbon and Cazilhas [R. Greeff, 1882]. Caes de Jodre [R. Greeff, 1882]. Under the Torre da Belem [R. Greeff, 1882]. Bathing establishment "Flor de Lisboa" opposite Caes de Jodre [R. Greeff, 1882].

Ancora e Povoa de Varzim; Leixoes; Foz do Douro, 12–50 meters; Tejo; Peniche;

Setubal; Costa da Gale, 60 meters; Sines [Nobre, 1938]. Vila do Conde, 20 meters; Boa Nova; Foz do Douro; Nevogilde [Elias da Costa, 1942].

Cliffs of Portinho [R. Greeff, 1882].

Cezimbra, January 18, 1880 [A. H. Clark, 1912] (3, H.M.). Same [Cumano, 1934].

Erroneous locality.—Prof. F. J. Bell (1893) mentioned this species as possibly occurring in Bengal. This is obviously a slip for Brazil, since it is clear that he had in mind Carpenter's reference (1891) of the Brazilian *A. duebeni* to this species.

Geographical range.—From the Shetland and Orkney Islands southward about the coasts of Scotland, Ireland, Wales and England (except the coast of the North Sea between Northumberland and the Straits of Dover), the Atlantic coasts of France (south of the Straits of Dover), northern Spain and most of Portugal.

To the northward it passes into *Antedon petasus*, to the southward into *A. bifida moroccana;* in the region of Cape St. Vincent it presumably passes into *A.mediterranea.*

Bathymetrical Range.—From the low tide level, and occasionally in tide pools and attached to floating objects such as buoys, hulks, etc., to 457 meters; but apparently most abundant between 15 and 40 meters.

Occurrence.—The rosy feather star is by no means evenly distributed throughout its range. Often extremely abundant in restricted areas of greater or lesser extent, in other regions, even perhaps closely adjacent, it may be rare or even quite absent. Furthermore, in some localities where continued observations have been carried on, its numbers have been found to vary greatly from year to year.

Professor Edward Forbes noted (1841) that the adult feather stars frequent both deep and shallow water. In deep water he found them always fully grown, and when dredging in such a situation he never saw a small one. He appears to refer especially to deep water in the Irish Sea where he found large ones at some distance from land in 37 meters.

In the *Laminaria* zone they abound in several localities and there all sizes are found in company with the stalked young. Forbes infers that they probably frequent those forests of seaweeds for breeding purposes at certain seasons and retire to the deep at other times.

Brady (1863) also mentions that the larger specimens occur in deeper water, and that this species appears to come up into groves of zoophytes and *Laminaria* to spawn.

Professor William B. Carpenter says that the usual habitat appears to be in water of depths from 18 to 37 meters, though it is found sometimes in shallower and sometimes in deeper water. His experience agrees with that of Professor Forbes, that the largest specimens are obtained from deep water. The animals are generally brought up by the dredge either actually clinging to seaweeds, usually *Laminaria*, or to zoophytes or polyzoans, or in such association with them as suggests the idea that their detachment was effected in the act of dredging.

Mr. Arthur Roope Hunt (1884) says that in the vicinity of Torbay the feather stars are found frequenting the clear water off rocky headlands where they are necessarily exposed to strong currents, both tidal and wave engendered. Here nothing will avail them but sheer strength in holding on; and this they possess in an eminent degree from the time they are first attached to a weed or a zoophyte in the early stages of growth to the time when, as fully grown adults, they are free to exercise their limited powers of locomotion.

Sir William Herdman (1894) once took 12 from the bottom of a buoy anchored off the end of the breakwater at Port Erin, Isle of Man, Mr. W. I. Beaumont (1900) reported it from the bottom of a hulk at Valencia, Ireland, Mr. S. Kemp (1905) found it on the bottom of hulks at Faby, and Mr. A. J. Smith , in company with Mr. Stephen Pace (1904) found several on the bottom of a coal hulk in the Cattewater, Plymouth.

While watching the picking up of the buoys in the district of La Hougue, near Cherbourg, Malard (1892, 1893) once saw the chain of one of them literally covered with feather stars.

Hornell (1895) mentions that one day when he was out lobster-potting with an old fisherman at Jersey, in the Channel Islands, the first pot pulled up was fairly encrusted with this species. Herdman (1906) and Chadwick (1907) say that at Port Erin it often occurs in considerable numbers clinging to the creels used by fishermen for catching crabs and lobsters, being found more abundantly after stormy weather.

At Roscoff feather stars, almost always of large size and of a very bright red carmine, are found beneath the stones of greater or lesser size which are turned over in the search for ascidians and other creatures (Perrier, 1873).

The Rev. George Gordon (1852; quoted by Peach, 1864) mentions having met with a very mutilated specimen from the stomach of a haddock taken in the Moray Firth in 1850, and Mr. W. Ramsey Smith (1891) records another as having been taken from a lemon sole (*Pleuronectes microcephalus*) caught in the Moray Firth in October, 1890. Mr. C. W. Peach (1864) found one in the stomach of a fish, kind not stated, at Wick, Caithness.

There are a few records of fragments of comatulids of other species having been taken from fish, but these are so rare, even in localities where feather stars are especially abundant, that it seems clear the fish swallowed them with other food or seized them unwittingly. It is perhaps significant that the instances cited above are all from a region where comatulids are very scarce and the fish therefore have little opportunity to become familiar with them. No crinoid is known to form a normal part of the diet of any fish or other large animal.

From the Shetlands we have no information regarding this species other than records of capture. Professor Forbes and Mr. Goodsir found several in 18 meters on Laminariae, while Mr. Philip B. Mason (1876) in June, 1875, dredged some in Bressay Sound on a rocky bottom, also in about 18 meters.

Sir John Dalyell (1851) speaks of this species as being less rare in the Orkneys than in most other parts of Scotland.

On the British shores of the North Sea the rosy feather star is for the most part rare or entirely absent. On the coast of Northumberland it is rare (Hodge, 1865). Messrs. Alder and Hancock obtained specimens from the Cullercoats fishing lines (Hodge, 1872), and in June 1913, two arms were dredged 6 miles east of the Longstone, off Cullercoats (Storrow, 1913). It has been taken in Embleton and Beadnel Bays (Hodge, 1872). When dredging off Dunstanborough Castle in July 1864, in company with the Rev. A. M. Norman and Mr. D. O. Drewett, Mr. G. Hodge obtained three specimens from a rocky ledge in about 46 meters. This, taken in connection with Mr. Embleton's remark that it is "not rare" led Mr. Hodge to suppose that it is local in its distribution; but he says (1872) that certainly it is VERY RARE on the Durham coast, for so far as he knew only one specimen had ever been captured there, by Mr. G. S. Brady and himself, off Seaham, in about 55 meters.

It does not occur at St. Andrews, in Fife (McIntosh, 1874), nor in the Firth of Forth (Leslie and Herdman, 1881), but it is common near Aberdeen, associated with hybrid zoophytes (Simpson, 1903).

During a residence of about three and a half years at Peterhead, in Aberdeenshire, Mr. Charles William Peach (1864) met with but a single example which he took from a fish. It occurs on the Witch Ground, near Banff (Sim, 1886), and it is sparingly distributed in the Moray Firth (Sim, 1886) where it has twice been recorded from fish (Gordon, 1852, repeated in Peach, 1864; W. R. Smith, 1891). For more than eight years while living at Wick, Caithness, Mr. Peach (1864) watched for this species, but secured only two, one of which he took from a fish, while the other he got out of a fishing boat at Staxigo.

A fine specimen of a sponge (*Halichondria palmata*) taken on a fisherman's line in the Pentland Firth (between the Orkneys and Caithness) in 1862 was given to Mr. Peach (1864) by Miss Miller, of Thurso. On it was a fine family of feather stars, two adults and eleven young, in different stages of growth. The adults were a short distance from each other, and near the top of the sponge; some of the young were sheltered under the arms of one of the old ones, while others were scattered singly about the sponge. In another spot a group of four or five were safely ensconsed in a nice nook, low down, where four branches took their rise. All of them were on the inner part of the branches of the sponge.

Regarding the occurrence of this species in the Clyde and vicinity Dr. John Grieve (1868) says that Lamlash Bay (Arran) alone has been considered their headquarters where they might readily be obtained in abundance. Though numerous at one time it does not follow that such is constantly the case, for much depends on the chance of the moment. Probably in some seasons they are more common than at others, or one's luck is greater at one time than another on such a narrow strip of the sea bottom as is touched by the dredge. On a dredging expedition in which Grieve participated, the first specimen was obtained below Gourock. On the coast of Bute they were never so fortunate as to find one, but off the Cumbrae one or two were secured at intervals. When off the north end of the Little Cumbrae, about the end of June 1861, the dredge was put overboard for a trial of the ground in from 9 to 18 meters. On hauling it in, one or two comatulids came up clinging to the rope, and though the net seemed empty, a few were found on the inside. Several hauls were made over the same ground, and each time the dredge brought up numbers. They appeared to have been crawling over the *Laminaria*, as they came up adhering to the outside as well as to the inside of the netting, and, by remaining at that spot, they could have been obtained in hundreds. In the month of September following, they went over again to the same ground, expecting to be equally fortunate, but not a single one came up, and after some half dozen hauls they gave up the attempt. Again in the following summer, on two different occasions, they dredged most zealously over the same spot, with no better success. Since then Mr. Robertson dredged in the same spot several times, but not until 1867 did the feather stars reappear, when they, together with their pentacrinoids, were abundant, one *Laminaria* frond being thickly covered with the latter.

Dr. Grieve remarks that these repeated failures where they had at first been so successful would appear to warrant the inference that this species may migrate in shoals and live in societies, one of which had obviously been met with when they came up clinging in such numbers to the netting. Their occurrence on the *Laminaria*, on which the pentacrinoids may be sought, he says, would serve further to point out the purpose for which this migration takes place.

Feather stars seem to be especially common in Lamlash Bay, occurring there in great numbers (Parkes, 1891).

Henderson (1887) says that this species is common on hard ground in 18 to 37 meters throughout the Clyde district, being especially common off the southern end of the island of Bute (Callum's Hole and Hank's Neb), off the western side of Little Cumbrae, and off Roseneath Point. Prof. W. E. Hoyle records it (1889) from 55 to 73 meters in the Dunoon Basin, which occupies the channel of the Clyde from the extremity of Great Cumbrae northward and extends up into the lower stretch of Loch Long. Mr. Thomas Scott (1897) says that it is common near the eastern shore of Loch Fyne.

Summarizing the data accumulated by Sir John Murray and his colleagues during the years from 1884 to 1892, Mr. James Chumley (1918) says that the feather star is very rare at the mouth of Loch Strivan; in the Dunoon Basin it is very common on the eastern side in 9 to 36 meters, moderately common at the southern end in 51 to 73 meters, but rare in the center in 18 to 36 meters; in the Arran basin it occurs at the Cumbraes from shore to 36 meters, and at Lamlash, and is rare at Tan Buoy in 13 meters; on the Plateau it was found in the Sanda-Ailsa region in 44 meters, and it is very rare in Campbelltown Loch in 18 to 29 meters. It has not yet been recorded from upper Loch Fyne, Loch Goil, or the Gareloch. One from the mouth of Loch Strivan had a diameter of about 400 mm.

Mr. Richard Elmhirst, when Superintendent of the Millport station, sent me detailed information regarding the distribution of this animal as known to him. He writes that it occurs in the seaward part of the Firth (Barrier), around Arran, Bute and the Cumbraes, and there is one record each for the East Kyles and Loch Strivan. But it does not seem to reach far into the landward lochs; there are no records for Lochs Fyne, Long, etc. It is very variable in color, and also variable in size, as in any catch specimens belonging to two year groups may be present.

About the Isle of Man it is not rare (Forbes, 1831, 1839). It is found in deep water off the cliffs (Herdman, 1906) and is abundant about the southern end of the island (Chadwick, 1907) and in 18 to 37 meters off Port Erin (Herdman, 1886).

Summarizing all the available information regarding its local distribution, Sir William Herdman wrote in 1886 that it occurs in deep water around the shores of the Isle of Man, and has been dredged by Mr. R. Garner off Douglas Bay, and near Port Erin and The Calf. It is also recorded by Forbes as having been taken off the Isle of Man in 46 meters. At least in 1885 it occurred in abundance in depths of from 18 to 37 meters off Port Erin, Port St. Mary, and Spanish Head, at the southern end of the Isle of Man. The specimens were of fair size, and showed the usual variations in color, yellow, tawny, orange and crimson individuals being obtained. The pentacrinoid larvae were obtained during the last week of July and first fortnight of August, attached to seaweed, in depths of from 18 to 37 meters off Port Erin.

A letter from Sir William Herdman (written probably about 1922) gives details of the occurrence of *Antedon bifida* in the vicinity of the Port Erin Biological Station. He writes that it is found off the rocky coast outside the breakwater at the southern side of the entrance to Port Erin Bay, frequently (occasionally in fair abundance) off Bay Fine, just south of Port Erin Bay, and in great abundance off the northern rocky coast of the Calf of Man on a rough bottom in from 18 to 36 meters. On occasions here the dredge has come up with the net covered both inside and out with hundreds of Antedons and their broken remains. They have also been obtained in large numbers from the crab and lobster pots ("creels") which the fishermen set in about 18 meters off the rocky coast of Bradda Head at the northern side of the entrance to Port Erin Bay. The locality nearest the Biological Station at which the species has actually been dredged (Station 60) is 600 feet west of the breakwater and 850 feet northwest of the Castles.

The feather star was found to be abundant near Rhoscolyn Beacon (Herdman, 1891), and was dredged in large numbers off Cemmaes Bay on the north coast of Anglesea during the *Hyena* expedition of 1886 (Chadwick, 1889, 1907).

At Milford Haven it is recorded as very common (Adams, 1800).

In Ireland it is recorded as abundant on the Dublin coast (Forbes, 1841 on the authority of Mr. R. Ball) and off Ireland's Eye (Wm. Thompson, 1856), and very abundant in Dublin Bay in the channel between Dalkey Island and the mainland (Hassall, 1842) and close to shore under the Martello Tower on Dalkey Island (Haddon, 1886). It is also abundant at the southern entrance to Ballynakill Harbour (Kemp, 1905) and in Queenstown harbor (J. V. Thompson, 1827). It is given as scarce at Greystones, County Wicklow (Haddon, 1886; MacIntosh, 1884) and quite rare at the Skerries, County Dublin (Colgan, 1905).

In the Scilly Islands Mr. Lewes (1860) found it at St. Mary's Island on *Laminaria* roots, and Mr. Rupert Vallentin (1904) found one at the same place in a tide pool; it also is known from White Island (A. H. Clark, 1912).

Mr. Vallentin says (1898) that when he first commenced dredging in Falmouth Harbour, Cornwall, this was one of the commonest forms to be met with in the deep water, but since then they have steadily decreased in numbers and one can scarcely now obtain a single specimen where in previous years they were so numerous.

In the 1870's a very interesting discussion took place regarding the abundance of the rosy feather star in the vicinity of Torbay.

The Birmingham Natural History and Microscopical Society went on a marine excursion to that district, and the president of the Society, Mr. W. R. Hughes, who reported upon the results of the excursion, wrote (October 2, 1873) that during the week beginning September 1, 1873, by far the most noteworthy capture was the feather star, two individuals of which were taken in the larval pedunculate condition attached near the base of a frond of *Laminaria* which was torn off by the dredge, and that five young in a free condition, the largest about an inch across, were also taken. They were captured in the vicinity of Torbay on Thursday, September 5, 1873, at a depth of 22 meters on a limestone bottom, the bottom temperature registering 15.0° C. A subsequent haul on the following day (September 6) in the same locality brought up three adults.

Three years later (October 12, 1876) Major Fred. H. Lang took exception to the idea that the feather star was rare about Torbay, and said that during the preceding month Mr. Arthur Roope Hunt and himself, dredging in Torbay in Mr. Hunt's handy little sailing vessel, had taken comatulids not by twos and threes but in the greatest abundance. In one haul off Berry Head there were certainly more than a hundred adults. On this occasion the dredge was brought on board crammed full of the commoner *Ophiothrix fragilis* (Abildgaard) of which there must have been many thousands, the comatulids forming only a small percentage. This haul was in about 22 meters on a very rocky bottom. They met with fairly similar results close to the Thatcher Rock. Major Lang remarks that it is evident the habitat of this species is strictly circumscribed, in comparatively deep water and among rocks. They never took a single specimen from sandy or shelly bottom.

On examining the few pieces of seaweed and zoophytes brought up at the same time they were found to be covered with the young pentacrinoids which were principally attached to *Bugula* and *Cellaria*. As he wrote, Major Lang had before him a small bottle of alcohol and water in which was a little spray of the latter about two inches in height to which were attached at least 70 specimens in every stage of development from the calcareous bud with its zoophyte-like tentacles to the perfect, but stalked, form; and on a single microscopical glass slide and cell he has mounted as many as a dozen specimens all growing on the same small piece of weed.

He observes that it is generally stated that both *Antedon* and *Ophiothrix* on leaving their native element break themselves into pieces, but his experience does not bear this out. It is true that, as they crawled about the deck in their own peculiar fashion, the *Ophiothrix*, especially, left an occasional arm behind, but as a rule he could take either of them up in the palm of his hand without their exhibiting any suicidal propensities. Presuming on this fact, he put about a hundred of the two sorts into a sponge bag; but this was asking too much of them, for on reaching home and emptying them out, he found that both feather stars and brittle stars had converted themselves into a mass of mincemeat, and it would have been difficult to find a single portion of an arm a quarter of an inch long.

To this Mr. Hughes replied (November 2, 1876) that the communication from Major Lang as to the abundant capture of the rosy feather star in Torbay by himself and Mr. Hunt with the dredge was a valuable contribution to the study of the question of the appearance and disappearance in certain localities of certain marine animals, respecting which we knew so little. It was especially interesting to the Birmingham Natural History and Microscopical Society, and as president of the Society and reporter during the marine excursion to Teignmouth in 1873 he read it with very great surprise and pleasure. His knowledge of the locality had extended over a period of about thirteen years, and during that time he had on several occasions dredged the ground mentioned by Major Lang, yet never once succeeded in taking an adult specimen, much less the more interesting pentacrinoid. He had not, however, dredged there since the marine excursion. He said that Mr. Gosse, whose experience was very large and who resided in the neighborhood, to whom he showed the mounted specimens, had never before seen the animal in that form, nor was there any mention made of the adult animal in any of his descriptive works except in "A Year at the Shore," where, on p. 182, he stated "We sometimes but very rarely find on this coast a very lovely form of this class of animals . . . *Comatula rosacea*, a fine specimen of which, taken by myself in a little cove near Torquay, I have delineated." This was written in 1864. In the previous year Professor Allman had dredged in the same locality and communicated to the Royal Society of Edinburgh a paper based upon a single specimen which he took on the occasion. Mr. Hughes said that it was a most remarkable circumstance, therefore, that in the space of about three years the species should have become numerous to the extent alluded to by Major Lang, more than a hundred being taken in one haul of the dredge, and in conclusion remarked that the marine naturalist who year by year found his favorite specimens disappearing on many parts of the coast would derive some consolation from Major Lang's communication as a set-off to disappointments elsewhere.

Taking exception both to Mr. Hughes' view of the supposed increase in abundance of this species and to Major Lang's statement that it is confined to comparatively deep water, where it lives among rocks, Mr. Thomas R. R. Stebbing, commented (November 16, 1876) on what he characterized as one or two rather hasty conclusions in these letters upon the rosy feather star. He wrote that although Major Lang argued from his experience in Torbay that its habitat is strictly defined as comparatively deep water and among rocks, he himself had taken it during the previous year in Salcombe Estuary, in shallow water, and not among rocks, but among the *Zostera marina* (eel-grass) to which numbers of the young stalked form were sticking. The well-known marine zoologist, Mr. Hincks, he said, told him that he had taken both the adult and the stalked forms in great abundance in the same locality more than twenty years earlier. The rapid increase in abundance of this animal since 1873 assumed by Mr. Hughes, said Mr. Stebbing, was imaginary, for dredgings in the two previous years had yielded the adult form by bucketsful from the neighborhood of the Thatcher Rock.

At the same time (November 16, 1876) Mr. Hunt, who had accompanied Major Lang on his dredging excursions, wrote that he did not think *Antedon* had been more abundant than usual during the year in that locality. An entry in an old notebook reminded him that a chance haul near the Thatcher Rock on July 11, 1871, brought up "plenty of feather stars," and since then, during the six years he had dredged in Torbay, *Antedon* had been a very ordinary capture while dredging for other objects of interest.

He said that the haul under Berry Head on July 25 alluded to by Major Lang was undoubtedly an unusually prolific one, but had it not been for the fortunate discovery by Major Lang of the pedunculate form the mere occurrence of an abundance of the adult feather stars would have made no impression on his mind and no notice would have been taken of it. Remembering that the Birmingham Natural History Society had taken the young, he mentioned the fact to Major Lang, adding that he had never seen them himself. Next morning he was gratified to hear from Lang that an examination at leisure of the proceeds of the haul had revealed them in quantity. This successful result induced Hunt to revisit the spot near the Thatcher after an interval of six years, and there, as he fully expected, *Antedon*, both adults and immature, was abundant. With this experience to guide him he later tried a third locality where, though the adults were less numerous, the stalked young, and every stage of growth up to about an inch in diameter, appeared to him to be even more numerous than at Berry Head or the Thatcher.

Mr. Walter Garstang (1892, 1894) mentions the rosy feather star as a constant element in the invertebrate fauna of Plymouth, and Mr. Stephen Pace (1904) has summarized the records brought together by the various investigators connected with the Marine Biological Association.

In the Plymouth district this species is extremely abundant in certain small areas, but is practically restricted to these.

The deepest part of Millbay Channel, which forms a deep pit or hole (Millbay Pit), is remarkable for the abundance of feather stars, the dredge often coming up half-full of them (S. Pace; R. A. Todd). It is occasionally found on Asia Shoal (R. A. Todd; S. Pace), and occurs on Mallard Shoal (G. C. Bourne, J. T. Cunningham, S. Pace) and inside the Bridge (S. Pace). It is occasional on Mewstone Ledge, in 18 to 27 meters (S. Pace; R. A. Todd), but has not been recorded from outside the Mewstone Ledge (Crawshay, 1912). Several specimens were taken from the bottom of a coal hulk in the Cattewater, off Turnchapel (A. J. Smith; S. Pace). Calderwood (1889) reported it as abundant off the Mallard Buoy, and Mason (1876) found it abundant between "Mount St. Edgecumbe and Dukes Island" (presumably Mount Edgecumbe and Drake's Island) in June 1876, on a rocky bottom in about 18 meters.

In a letter to me Dr. J. H. Orton wrote that on the gates of the Great Western docks at Millbay at depths of only a few meters below low water mark this species occurs in great abundance, and it is occasionally found on the piles of the western wharf, Millbay docks. Young individuals occur seasonally on the under surface of rafts, and in several seasons attained an arm length (measured from the attachment of the disk) of from 30 to 42 mm.

Among the Channel Islands this species is fairly common (Koehler, 1885) or even abundant (Hornell, 1895; Sharp, 1908) in deep water whence it is brought up by fishermen (Koehler, 1885). It has been recorded from Jersey (Koehler, 1885; Hornell, 1895), from Bordeaux and Castle Cornet, Guernsey (Sharp, 1908), and from Herm at the low tide mark (A. H. Clark, 1913).

On the Atlantic coast of France, says Professor René Koehler (1921), this species is found at low tide among the algae and beneath rocks.

It is recorded as abundant at Pont du Coll, in Picardy (Parkes, 1891), and it is common in the large pools in the rocks at Men Cren (Th. Barrois, 1882).

A detailed account of its occurrence about Roscoff, as described by Professor H. de Lacaze-Duthiers has already been given (part 2, pp. 599–601). In 1872 Professor E. Perrier found that the feather stars inhabited the whole region before Île Vert, between that island and the Île de Bas, both to the east and to the west. On the east they literally covered the bases of the seaweeds. That year he found them to the west, though somewhat less abundantly, a little to the left and almost opposite the black buoy of Per-Roch. In two tides he was able to obtain here nearly 300, without counting a quantity of young in all stages of development, including the youngest pentacrinoids. Only immediately below the *Himanthalia lorea* zone are they very abundant, attached to the large algae or to the brown and curled *Fucus* which abounds at their bases. At Roscoff there is great variation in the numoers of this species from year to year (Gravier).

In northern Portugal, Nobre (1903) says that it occurs at Povoa de Varzim, where it is brought up on the fishermen's nets. It is common between 18 and 37 meters at Leça da Palmeira, and was also found at 55 meters. Some years previously he took a specimen on one of the quays at Leixoes.

In the vicinity of Lisbon, Dr. R. Greeff (1882) found this species repeatedly at the bathing establishment opposite the Caes de Jodre among the tufts of hydroids and polyzoans encrusting the piling. He also found it in the Tejo under the Torre da Belem, at ebb tide, under stones at tide level. It is rare below the cliffs of the Portinho.

[NOTE BY A.M.C.] In the thirty or more years since this account was written, *Antedon bifida* has been recorded from many localities within the already known range, notable among them being Bassindale's from the island of Skomer, off the Pembrokeshire coast; Williams' from Strangford Lough in northeast Ireland; Cherbonnier's from the vicinity of the Roscoff Marine station, and those of Nobre and Elias da Costa from Portugal.

Throughout its range the rosy feather star is preeminently an inhabitant of rugged and rocky shores and of rough, hard and rocky bottoms, where it lives attached to seaweed, polyzoans, hydroids, sponges, etc., or even to the rocks themselves. At Cork it has been found clinging in numbers to stones below the low tide mark (Paddy from Cork, 1895).

In deep water, in from 37 to 90 meters and beyond, where the wave action is less strong than along the shores, it is more generally distributed, though usually less abundant than in favorable localities in shallow water. While rocky regions still remain the favorite habitat, a considerable variety of bottom is frequented. Here it has been recorded from gravel (Forbes, 1851, Herdman, 1895), sand and gravel, sand and stones, stones and shells, broken barnacles and serpulae, fine mud (Forbes, 1851), and clinging to nullipores (Herdman, 1895). It has once been reported from mud in 5 to 11 meters (Forbes, 1851).

Habits, etc.—During a visit to Roscoff, Dr. F. A. Bather made a series of careful observations on the habits and reactions of this species.

He says that, while swimming has been observed in both endocyclic and exocyclic comatulids kept in an aquarium, these animals as a rule remain attached by their cirri to rocks, to the bottom ooze, to seaweeds, or to other marine animals. In this position the arms are outspread, and the small branches or pinnules that line their sides are kept slightly waving. If the water be ruffled, the first impulse of the crinoid is to flatten its arms out suddenly and to hold on to the rock or other object with its pinnules. The pinnules of an *Antedon* can be bent in any direction, those near the extremity of the arm being especially active. If its extremity be touched by any irritating substance, the arm is erected at right angles to the upper surface of the animal and so removed from the other arms, while the pinnules move somewhat like the legs of a fly that is cleaning itself. If, however, this proves ineffectual, the arm bends over towards another on the opposite side, the pinnules of which then assist in the operation. The pinnules move in this manner to rid the arm of sizeable fragments of foreign matter; but the hooks at the end of the pinnules can catch and retain minute fragments which, as they decay, attract animalculae and so furnish food for the animal. If a stimulus be applied to any point on the under surface of the animal, the arms on the side from which it comes are simultaneously and forcibly pressed down, apparently to create a current that will wash away the irritant. An arm, if it be cut off, will continue to move for a short time. The crinoid, however, flattens its remaining arms, and remains immovable for half a minute, then slowly crawls in a direction away from the wound.

Antedon does not appear to like the light, and if placed on the surface of a stone in a glass vessel, always prefers to crawl to the under side, where it remains fixed by its cirri. If, however, a strong light be reflected on to the under side of the stone while the top is kept dark, the animal will crawl back to the top. It is by crawling that the crinoid usually moves from place to place. The arms on the side towards which it intends to move are stretched out; the pinnules are curved back towards the body, like so many grappling hooks; and the arms are then curved up in S-fashion, thus dragging the animal along. Meanwhile the arms of the opposite side move in the converse way, and their pinnules are directed away from the body so that they push instead of pull. Nicols (1960) made a fine study of the histology of the tube feet and their role in feeding behavior.

Occurrence of the pentacrinoid young.—As yet the pentacrinoid young of the rosy feather star have only been reported from a portion of the localities from which the adults are known.

They are recorded from the Orkneys (Busch, 1851); the east coast of Ireland (Forbes, 1841); Belfast (Sars, 1868); Dublin Bay and off Ireland's Eye (Forbes, 1841, on information from Messrs. R. Ball and Wm. Thompson); Cove of Cork (J. V. Thompson, 1827); Firth of Clyde (Sars, 1868); off the north end of the Little Cumbrae, 9–18 meters (Grieve, 1868); Millport (Dendy, 1886); Lamlash Bay, Arran (Wyville Thomson, 1865; W. B. Carpenter, 1866; Herdman, 1884); off Port Erin, Isle of Man, in 18–37 meters (Herdman, 1881, 1886); near Rhoscolyn beacon (Herdman, 1891); Ilfracombe (W. B. Carpenter, 1866); Cornwall (Peach, 1864); Torbay, 22 meters (Hughes, 1873); off Berry Head, about 22 meters (Lang, 1877; Hunt, 1876); near Thatcher Rock (Hunt, 1876); Petit Tor, 7 meters (Allman, 1863, 1864); Salcombe estuary, in shallow water (Stebbing, 1876); Plymouth (Garstang, 1894; Pace, 1904); Jersey (Hornell, 1895; Sharp, 1908); and Roscoff (Lacaze-Duthiers, 1869, 1870; Perrier, 1873, 1886; Pruvot, 1897).

In the Orkneys Busch (1851) first found the larvae in the last days of July, and at Cork J. V. Thompson (1835) found the eggs first in July.

Mr. Elmhirst has written me that at Millport the gonads are ripe in June and July, and the pentacrinoid stage occurs in August, September, and October. In these three months young are found with an arm length of from 13 to 25 mm.; in December and January the arm length is about 38 mm., in March 50 mm. and in May 75 mm., the individuals becoming mature 100-mm. specimens in the summer.

At Millport Dendy (1886) found that the height of the breeding season appeared to be in July, and at Lamlash Bay Sir Wyville Thomson (1865) found that the spawning season commences at the end of May or the beginning of June.

The best idea of the occurrence of pentacrinoids in Lamlash Bay is gained from the following observations by Sir William Herdman and Dr. W. B. Carpenter.

Herdman wrote (1884) that he was somewhat surprised in the summer of 1884 at finding *Antedon bifida* in the pentacrinoid stage readily obtainable in Lamlash Bay up to the end of September. The adults are abundant here, and young specimens in the pentacrinoid stage are common on *Laminaria* in the earlier part of the summer; but he had always found the pentacrinoids rare or absent during August, and certainly never before found one in September. He found that Sir Wyville Thomson stated that the ova are mature toward the end of May or the beginning of June, and that, although the time spent in the larval stages may be to a certain extent shortened or prolonged by surrounding conditions, the disengagement from the stalk constantly occurs between the middle of August and the middle of September. From this one would not expect to find any specimens in the pentacrinoid stage after the middle of September. In 1884, however, while dredging chiefly in the southern part of the bay near King's Cross Point, he obtained young stalked Antedons nearly every day between September 15 and 25. He generally got one, two, or three specimens in a forenoon's dredging (usually four or five hauls of the dredge). On September 27, the last day he dredged, he found on some *Fucus* brought up from 11 to 13 meters at the south entrance to the bay upwards of twenty specimens of pentacrinoids of all sizes from 3 up to 10 mm. in length of stalk. The last were evidently just ready to be set free, and in fact several of them became disengaged from their stalks while he was watching them in a glass dish during the afternoon. The smaller specimens obtained that day were, from their structure, evidently very much younger and could not have become free for a considerable time.

In compliance with Sir William's request, Professor Carpenter stated that his experience, acquired during seven years' consecutive dredging in Lamlash Bay (1855–1861) was in entire accordance with his own. Although the most active period of reproduction is undoubtedly (as given by Sir Wyville Thomson) the *early* part of the summer, so that the pentacrinoids which spring from the ova then matured and fertilized are ready to drop off their stems in the succeeding autumn, yet he never failed to obtain pentacrinoids in all stages, as well as adults still "in fruit" throughout the months of August and September.

A peculiarity of the occurrence of the rosy feather star on the Manx coast is the rarity in that region of the pentacrinoid young. In 1839 Forbes wrote that the adults were not rare here, but that he had never found the pentacrinoids, though they are abundant on the opposite shores of Ireland. Sir William Herdman (1886) once dredged pentacrinoids off Port Erin in 18 to 37 meters during the first week in July and the first fortnight in August, and this appears to be the only record. During the preparation of his memoir on *Antedon* (1907) Mr. Chadwick was obliged to get his larval material from Naples. He states that sexual maturity occurs in the months of May and June around the Isle of Man, the time differing a little according to geographical position; but he was never able to secure pentacrinoids.

The mooring for Sir William's yacht at Port Erin was inside the breakwater and distant about 350 feet from it. He wrote to me saying that, in the periodical clearing of the thick mooring rope from the growth of *Laminaria* and other coarse seaweeds, pentacrinoids were several times found attached to the *Laminaria* fronds.

At Torbay they have been recorded from 22 meters on September 5 (Hughes, 1873), and from Berry Head in 22 meters on July 25 (Lang, 1877; Hunt, 1877).

At Plymouth pentacrinoids have been found in February (A. J. Smith), July (R. A. Todd; S. Pace), August, abundant at all stages (E. W. L. Holt), September (W. Garstang, 1894) and October (W. Garstang, 1894), while the ovaries were found to contain ova in October (T. V. Hodgson).

Dr. J. H. Orton informed me that at Plymouth the barrel-shaped larvae may occur from about July to about November. He also stated that the animals produce larvae at the age of 14 months when the arm length is 67 mm. measured from the attachment of the disk.

At Jersey, Hornell (1895) found the pentacrinoids in summer, but the months were not recorded.

At Roscoff pentacrinoids can only be found with certainty in the summer months; they become less common in September, and do not occur in October, at least along the shore (Lacaze-Duthiers, 1870). Their local distribution in this region has already been mentioned (part 2, p. 601).

The nature of the objects to which the pentacrinoid young attach themselves, as noticed by W. B. Carpenter (1866), varies with the locality. Brady (1863) remarked that they always occur on zoophytes or seaweeds, never on stones or shells, and the exceptions to this statement have been found to be very few. Astonished at the limited range of the objects upon which he found the pentacrinoids, J. V. Thompson (1835) suspected that the adult was gifted with the power of placing them in appropriate situations, as otherwise they would be found indiscriminately on such objects as fuci, shells, or stones.

Off Ireland's Eye the pentacrinoids are always found growing on *Delesseria sanguinea* (Forbes, 1841, on the authority of Messrs. R. Ball and Wm. Thompson). In the Bay of Cork they are found attached to the various species of *Sertularia* and *Flustracea*, which occur in the deeper parts of the harbor of Queenstown, in 13 to 18 meters (J. V. Thompson, 1827).

In Lamlash Bay, Professor Carpenter (1866) never found them affixed to anything else than the fronds of *Laminaria*, to which the adults habitually cling, or to Polyzoa or Spirorbes growing on these. Herdman (1904) also noted that here the young occur on *Laminaria*, and on *Fucus*, and Grieve (1868) found them on *Laminaria* off the Little Cumbrae.

Sir Wyville Thomson, however, found clusters of pentacrinoids attached to the inner surface of a dead valve of *Modiola modiolus*.

At Port Erin the pentacrinoids attach themselves to seaweeds (Herdman, 1886), chiefly *Laminaria* fronds (Herdman, 1881). But at Ilfracombe, where *Laminaria* is much less abundant, and the polyzoan *Cellaria* grows in great luxuriance in the habitat of *Antedon*, they are found adherent to its stony polyzoary (W. B. Carpenter, 1866).

Mr. Peach (1864) frequently met with the pentacrinoids when he lived in Cornwall. In 1844, as he found on referring to his diary, he noticed many moored on the stones used to sink the crab-pots, and also on the rods of which the pots were made.

At Torbay, Mr. Hughes (1873) found them attached to a *Laminaria* frond, while Major Lang (1877) found them in abundance on seaweeds and zoophytes, principally on *Bugula* and *Cellaria*; he says that there were at least 70 on a zoophyte 2 inches long.

In the Salcombe estuary Mr. Stebbing (1877) found them on eel-grass (*Zostera marina*).

At Plymouth the pentacrinoids occur chiefly on *Cellaria* (E. W. L. Holt, in Pace, 1904).

At Roscoff pentacrinoids seem to choose a greater variety of objects for attachment than anywhere in the British Isles, for Perrier (1873) found them growing either on the pinnules of the mother, or on various submerged objects such as *Laminaria* and other algae, the polyps of polyzoans or of hydroids, annelid tubes, etc.

Whenever found, pentacrinoids are usually abundant. Lacaze-Duthiers (1869, 1870), Lang (1877), Hunt (1877) and others have especially noted this, indeed the fact has been frequently remarked by many naturalists from J. V. Thompson (1827) and Forbes (1841) onward. J. V. Thompson wrote that the great abundance of comatulids in the places they inhabit is not to be wondered at when we are aware how exceedingly prolific they are; thus each arm may be estimated to bear 30 fruitful ovaries, each producing about 100 ova, and as there are 10 arms, this gives 30,000 as the amount of ova produced by a single individual.

Grieve (1868) mentions a *Laminaria* frond brought up from 9 to 18 meters off Little Cumbrae being thickly covered with pentacrinoids, and W. B. Carpenter (1866) states that they are generally scattered over the surfaces of these so as not to be in any near proximity to each other.

But sometimes (W. B. Carpenter, 1866) there is found a group of several pentacrinoids very close together so as to present in one view all the stages in development represented on plate 33, part 2. He had in his possession one sample in which more than 70 pentacrinoids, all nearly in the same stage of development, were attached to the surface of a patch of *Membranipora* that was encrusting a frond of *Laminaria;* and in another, which he owed to the kindness of Sir Wyville Thomson, 35 pentacrinoids in the prebrachial stage were so closely clustered together that the discoidal bases of their stems had come into mutual contact and had acquired a polygonal form. This was bred in an aquarium, and the circumstances under which it was formed are thus described. An early embryo when losing its power of locomotion was frequently seen floating in such a manner that its incipient discoidal base spread itself out, often in a stellate form, on the surface of the water, while the stem and body of the rudimentary pentacrinoid hung downward from this; and it sometimes happened that by the approximation of a number of individuals in the same condition the stellate extensions of the disks became mutually adherent. Similar clusters were found by Sir Wyville attached to the inner surface of a dead valve of *Modiola modiolus*.

History.—The main features of the history of this species from the systematic and from the anatomical viewpoint have already been given (part 1, pp. 21–58, 118–125).

First recorded from Penzance in Cornwall by Llhuyd in 1699, it was next reported from the western coast of Scotland by Pennant in 1777, and later from Milford Haven by Adams in 1800.

It was first noticed on the French coast at Havre by de Freminville in 1811, and ten years later was again recorded from Milford Haven by J. S. Miller, who was unaware of the previous notice of its occurrence there.

J. V. Thompson's description in 1827 of the pentacrinoid young, which at the time he did not recognize as such, based upon specimens from Queenstown ("Cove of Cork"), was the first record for Ireland. Soon after this, in 1834, J. E. Gray described from the coast of Kent an entirely new type of echinoderm which subsequently proved to be merely a detached centrodorsal. The announcement, made by J. V. Thompson in 1835, of the discovery that the *Pentacrinus europaeus* found at Queenstown was merely the young of this species was accompanied by an interesting account of its occurrence and habits.

The use of the dredge in zoological investigations, begun by O. F. Müller in 1799, was introduced into England by Prof. Edward Forbes in 1831. This implement opened up entirely new fields of work, and shed an entirely new light on the whole subject of marine biology. For twenty years Professor Forbes worked along the west coast of England and Scotland, among the Hebrides, on the east coast of Ireland, and in the Shetlands, and even extended his operations as far as Norway and the Cyclades. This work of Forbes was the inception of the intensive study of the distribution of marine animals, and was the starting point for the whole science of biological oceanography, at least as concerns bottom-living animals. The results obtained by Forbes and his friend Dr. John Goodsir on a dredging trip to the Shetlands in 1839 were so interesting, and were so well presented by Forbes, that a committee for researches with the dredge, with a view to the investigation of the marine zoology of Great Britain, was formed by the British Association, including Messrs. Forbes, J. E. Gray, John Goodsir, William Thompson, and Robert Ball, and a grant of £60 was set aside for its use.

As a result of his studies, published in a long series of contributions (1831, 1835, 1839, 1841, 1844, and 1851), of which the most noteworthy in this connection are his "History of British Starfishes" (1841) and the detailed summary of his results (1851), Forbes determined the main features of the distribution of the rosy feather star about the coasts of the Irish Sea and northward to the Shetlands.

During this period Forbes' work in England was supplemented by that of Messrs. William Thompson and Robert Ball on the opposite shores of Ireland. Forbes related that when dredging in Dublin Bay in August 1840, in company with these two gentlemen, numbers of pentacrinoids were found more advanced than any seen before, so advanced, in fact, that they saw the creature drop from its stem and swim about, a true comatulid. William Thompson published a note on the occurrence of this species in Ireland in 1844, and a list of localities, with notes, in 1856.

As a result of this work, the British Association in 1857 appointed a committee to investigate the marine zoology of the southern and western coasts of Ireland. The intention was to draw up a report upon the marine fauna of Ireland which should be entitled to serve as a second part to that by Professor Forbes on the British marine fauna. In 1859 Dr. E. Perceval Wright and Prof. J. Reay Greene published a preliminary report in which the presence of the rosy feather star in each of five districts was indicated, but no detailed report ever appeared.

During this period of intensive faunal work, inspired and to a large extent personally carried out by Edward Forbes, others were not idle. Hassall (1842) published notes on some very young specimens which he dredged in Dublin Bay, J. E. Gray (1848) first recorded the species from Plymouth Sound, Busch (1849, 1851) investigated the very early stages and as a result of his search for material added some new localities to its known range, MacAndrew (1851) recorded it from Vigo Bay (and *A. mediterranea* from Malaga), Gordon (1852) reported it from the stomach of a fish in the Moray Firth, Lewes (1860) found it at the Scilly Isles, and Sir John Dalyell (1851) and Mr. Edmund Gosse (1853, 1855, 1865) first introduced it to other than professional naturalists.

While the waters about the British Isles were being so thoroughly studied by Professor Forbes and his colleagues and contemporaries, it happened that the microscope was being vastly improved and increased in power, largely through the work of Messrs. Ross, Pavell and James Smith, along lines suggested by Mr. J. J. Lister. It is therefore easy to see why it was that in the decade between 1860 and 1870 the outstanding work on *Antedon bifida* should have been centered upon the embryology and development.

The epoch-making and classical contributions of Professor George Allman (1863, 1864), Sir C. Wyville Thomson (1863, 1864, 1865), Dr. William B. Carpenter (1865, 1866, and continued into the next decade) and Prof. Michael Sars (1868) laid the foundation for all our modern knowledge of the early stages of this animal, and such a firm foundation that their work never has been revised or repeated, at least in its essential features.

So rapidly had facts been accumulated in the preceding years that the need for the presentation of the data in accessible form was keenly felt. Brady (1863) and Sir Wyville Thomson (1864) published popular accounts of the rosy feather star, the Rev. A. M. Norman (1865) presented a more technical account, bringing out some features hitherto overlooked, and Dr. W. B. Carpenter in his memoir on the later developmental stages (1866) gave a detailed history of it in a memoir which is really remarkable for its completeness and its accuracy.

While the main interest in this decade centered about the early stages, dredging operations were by no means neglected. Thomson, Brady, Carpenter and Norman all used this method of collecting, all adding new localities to the known range and the first three also copious notes on its habits. Mr. C. W. Peach (1864) gave instances of its occurrence in northeastern Scotland, Dr. John Grieve (1868) published an account of its occurrence in the Clyde, and McIntosh found it at North Uist, in the outer Hebrides (1866). On the French coast it was reported from Charente-Inferieure by Beltramieux (1864) and from Roscoff by Prof. H. de Lacaze-Duthiers (1869).

The decade beginning in 1868 saw the extension into deep water, with the assistance of ocean-going steamers, of the dredging operations begun by Edward Forbes in 1831 and by Michael Sars in 1835. Due mainly to the energy and enthusiasm of Sir Wyville Thomson and Dr. W. B. Carpenter, the British government, through the influence of the Royal Society, was induced to place at the disposal of a committee of scientific experts, for the purpose of exploring the deep sea, first the small surveying steamer *Lightning* in 1868, and in 1869 and 1870 the more efficient steamer *Porcupine*. These expeditions did little, however, to add to the knowledge of this particular species; such information as was gained was published by Wyville Thomson (1872) and, in more detail, by P. H. Carpenter (1884, 1888).

During this decade interest in the anatomy, skeletal structures, and embryology of this form and of the closely related *A. mediterranea*, which for the most part was considered identical with it, became general, resulting in a considerable number of original contributions and some rather acrimonious controversies. The writings of W. B. Carpenter (1870, 1875, 1876), Baudelot (1872), Perrier (1873), Greeff (1876), Ludwig (1876, 1877, 1878, 1879), Götte (1876), and no less than five articles by W. B. Carpenter's son, P. H. Carpenter (1876, 1877, 1878, 1879), served to throw much light on hitherto obscure points.

For the region about Plymouth the only records were Gray's mention of a specimen in the British Museum and the notices of Allman and Gosse, both of whom looked upon the rosy feather star as rare in that locality. This view again being expressed by Mr. W. R. Hughes (1873), a flood of evidence tending to show that it was in reality abundant, at least locally, was immediately unloosed (Lang, 1876; Hughes, 1876; Stebbing, 1877; Hunt, 1877; Mason, 1877). Mason (1877) also recorded it again from the Shetlands, and McIntosh reported it as absent from St. Andrews in eastern Scotland.

On the French coast its occurrence was still further detailed for the region about Roscoff by Lacaze-Duthiers (1870, 1872), E. Grube (1872), and Perrier (1873), and for southwestern France by Fischer (1870). W. B. Carpenter in 1866 had explained in great detail the nomenclatorial history of this species, including that of the Mediterranean form which he considered identical with it. Some of the points involved were further discussed by his son (1877), Pascoe (1877) and Stebbing (1877), while in 1879 P. H. Carpenter treated exhaustively the nomenclature of all the comatulids. The relationships of this species were also explained by him (1877, 1879).

The curious myzostome parasites, always associated with crinoids and almost exclusively confined to them, first noticed by J. V. Thompson in 1835, first described by Leuckart, and independently named by J. Müller, formed the subject of a comprehensive monograph by Ludwig von Graff in 1877.

In the 1880's and 1890's the outstanding feature of biological investigation was the concentration of work at definite localities determined by the establishment of marine biological stations offering superior facilities for intensive distributional studies and for minute investigations. These biological stations were the natural outgrowth of summer visits and excursions of individuals and societies to seaside places where the marine flora and fauna could be studied to best advantage. It was in the late 1830's and early 1840's that such visits had first become general, and they gradually tended to concentrate on certain areas.

The general trend all over Europe is well illustrated by the work of Forbes, covering the coasts of the Irish Sea and northward, which was followed by that of Sir Wyville Thomson and Dr. W. B. Carpenter, centered mainly on the Isle of Arran, visited year after year, and the marine excursions of the Birmingham Natural History Society to the Torbay region.

The first of the marine laboratories in Europe was that at Concarneau founded by Prof. J. J. Coste in 1859. Although the rosy feather star is common there (Th. Barrois, 1882), no important work has ever been done on it, nor has its local distribution been determined in detail.

In 1866 the movement was begun, largely through the efforts of Professors Bert and Fischer, which resulted in the establishment of the laboratory at Arcachon, Gironde, in 1883. Here again, though the rosy feather star occurs (Fischer, 1889), it has never been the subject of extended investigations.

The Franco-Prussian war of 1870 occurred just at the time when the movement for the creation of permanent marine biological stations was at its height, and its demoralizing effect on the social structure of the time, not only in France but elsewhere, served to delay matters for many years. At the outbreak of this war, Prof. Henri de Lacaze-Duthiers had become greatly interested in the wonderful marine fauna in the vicinity of Roscoff, and had prepared a detailed account of the occurrence of the feather star in that district. In 1872 he established a temporary station there, which was converted into a permanent one in 1876 and annexed to the Sorbonne in 1881. At no biological station has more been done to elucidate the local distribution as well as the anatomy and development of this species, and the papers based partly or entirely upon material secured there are unusually numerous and important (Lacaze-Duthiers, 1869, 1879; Perrier, 1873, 1884, 1885, 1886, 1889; Joliet, 1886; Cuénot, 1891, 1894; Pruvot, 1897).

Two other French stations have contributed largely to our knowledge of this species, that at Saint Vaast-la-Hougue, near Cherbourg (Cuénot, 1894; Malard, 1892, 1893), and that at Wimereux (Schaxel, 1911).

In England the 1880's witnessed the establishment of two biological stations which are of especial importance in connection with the history of this species. Just as the French station at Arcachon was the outcome of the International Exposition of Fisheries and Aquiculture held there in 1866, so the laboratory of the Marine Biological Association at Plymouth was indirectly the outgrowth of the International Fisheries Exhibition held in London in 1883. Mentioning only those who have published upon the crinoids, we find in the original provisional council the names of Thomas H. Huxley, Sir E. Ray Lankester, A. M. Marshall, Adam Sedgwick, W. Percy Sladen, A. M. Norman, and Sir John Murray.

The information on this species resulting from work done at this station since its formal establishment in 1887 has been of the greatest importance. The local distribution and the data concerning the breeding season have been worked out in great detail by Messrs. W. Heape (1888), W. L. Calderwood (1889), Walter Garstang (1892, 1894), J. C. Sumner (1895), R. A. Todd (1897), G. C. Bourne, J. T. Cunningham,

E. W. L. Holt, A. J. Smith, T. V. Hodgson, and Stephen Pace (Pace, 1904). Besides this, intensive work on the pigments (MacMunn, 1889), the spicules (Woodland, 1907) and the development of the oöcyte (Chubb, 1906) has also been done here.

The other British biological station noteworthy for the output of information regarding this species as a result of local studies is that at Port Erin, Isle of Man, originally under the direction of the Liverpool Marine Biology Committee. This committee, organized in March 1885 through the efforts of Professor Sir William A. Herdman of the University of Liverpool, immediately began a detailed study of the fauna and flora of the region. A station was opened on Puffin Island, a small island off the north coast of Anglesea, which served as a base of operations for five years. Then, in 1892, the first station at Port Erin was established, to be superseded by the present station at the same place in 1902.

Known from the Isle of Man since 1831 (Forbes, 1831, 1835), the local distribution of feather stars in this region was worked out in great detail by Professor Herdman (1881, 1884, 1886, 1889, 1890, 1891, 1893, 1894, 1895, 1896, 1901, 1902, 1906) and by Mr. Herbert C. Chadwick (1889, 1907).

The investigations of Forbes, and especially those of his successors Sir Wyville Thomson and Dr. W. B. Carpenter, supplemented by the records of Dr. John Grieve and others, had indicated that the rosy feather star was unusually abundant in the Clyde region. Here lived Dr. David Robertson, the "Cumbrae naturalist," known for many years as a student and collector of the marine life on the shores of his island home. Sir John Murray, who had served on the *Challenger* expedition, became actively interested in the region in 1884, and in collaboration with Dr. Robertson and Dr. H. R. Mill prosecuted biological investigations for several years, using two small boats, the *Medusa* and the *Ark*.

The enthusiastic work of these men soon attracted attention, and finally resulted in the establishment in 1897 of the Millport station on land secured for a merely nominal rental from the Marquess of Bute. In addition to giving the use of his land for the station, Lord Bute did a great deal in other ways to further biological investigation here. His family name of Stuart is familiar to all American biologists through the dedication of the genus *Stewartia* (Ternstroemiaceae) to one of his antecedents.

One of the naval officers on the *Challenger* was Lieut. Lord George Granville Campbell, a son of the eighth Duke of Argyll. The Duke took a great interest in various branches of science, and especially in Sir John Murray's work on the Clyde, and occasionally accompanied him for a cruise when that work took the *Medusa* to the neighborhood of Inveraray where he resided.

Information regarding the occurrence of the rosy feather star in this area, published when the Millport station was represented by the floating laboratory *Ark* (1885–1900), from which the work was carried on, is given by Dendy (1886), Henderson (1887), Hoyle (1889) and Chopin (1895), while a most excellent summary of its local distribution, based on the records accumulated by Sir John Murray and his associates between 1884 and 1892, was published by Chumley (1918).

From two other British biological stations has come information regarding the rosy feather star. For many years Mr. James Hornell maintained a private marine laboratory in a magnificent location in the island of Jersey (1893), but this was discontinued when he took up the fisheries work in Ceylon in 1902. The Dove Marine Laboratory founded by Prof. Alexander Meek at Cullercoats, near Newcastle, is in a most unpromising region so far as this species is concerned; yet feather stars were recorded from there by Storrow in 1913.

In addition to and apart from the work emanating from the biological stations, there were in the 1880's more numerous and more important contributions to the study of the recent crinoids, including many species, both stalked and unstalked, than have ever appeared in any decade before or since. This decade witnessed the high tide in the interest in these animals, which ebbed appreciably in the 1890's, and subsequently has fallen to below the level of the decades 1830–1850.

Local dredging operations were carried on in the Moray Firth (Sim, 1886) and on the coast of Ireland, both in deep (Bell, 1889) and shallow water (MacIntosh, 1884; Haddon, and Haddon and Bell, 1886), and the species was reported from the Channel Islands (Koehler, 1885), and from various localities on the Portuguese coast (R. Greeff, 1882). Additional information regarding the occurrence of the pentacrinoids at Arran (Herdman, 1884; W. B. Carpenter, 1884) and of the adults in the Torbay region (Hunt, 1884) appeared.

The systematic status, distribution, anatomy and morphology were discussed by P. H. Carpenter (1880, 1881, 1883, 1888), the embryology by Balfour (1880), the homologies of the apical plates by Sladen (1884), and the Myzostome parasites by von Graff (1884, 1885, 1887).

In the 1890's many new records of occurrence appeared, for the Moray Firth (W. R. Smith, 1891), the Clyde area (Parkes, 1891; Bell, 1893; Chopin, 1895; T. Scott, 1896), Ireland (Sladen, 1891; Bell, 1893; Paddy from Cork, 1895); Rockall (Sladen, 1897), Anglesey (Herdman, 1891), Wales (Parkes, 1891), Cornwall (Vallentin, 1898), the region about Plymouth (P. H. Carpenter, 1890; Parkes, 1891), and the English Channel (Parkes, 1891; Malard, 1892, 1893; and especially Pruvot, 1897).

P. H. Carpenter (1891) announced his final conclusions regarding the systematic status of the species and its relation to other species, and Prof. F. Jeffrey Bell (1893) published a monographic account of this form in British waters, adding many new records based upon material in the British Museum. Various points connected with the anatomy and the comparative embryology were discussed (Cuénot, 1890, 1891, 1892; MacBride, 1894), and some very interesting parasites (Cuénot, 1891, 1894) and commensals (Malard, 1892, 1893) were described. The zonal distribution of the species about Roscoff was worked out by Pruvot (1897).

Since 1900, the rapid multiplication of data in all branches of zoology, the great improvement in microscopical technique, and the intensive cultivation of new and attractive fields, especially the study of plankton, animal ecology, and various forms of experimental zoology, have given rise to an ever increasing number of "specialists" who, in contrast to the old time "naturalists," have understandably interested themselves along lines in which relatively little work had previously been done. So much had already been published regarding this species, and so widely had it been advertised in textbooks and popular writings that it was only natural that interest in it should wane and attention should be attracted to other animals hitherto more or less neglected or misunderstood.

Since 1900, however, very considerable additions to the knowledge of details of local distribution were made. Storrow (1913) and Meek (1924) recorded it from Cullercoats, in Northumberland; Simpson (1903) discussed its occurrence about Aberdeen; MacIntosh (1904) spoke of it in the Clyde, for which region Chumley

(1918) has given a complete list of all the localities where it had been found by Sir John Murray and his collaborators; Beaumont (1900), Kemp (1905), Colgan (1905), Farran (1915) and Williams (1954) gave new records for Ireland, while Nichols (1903) summarized its distribution on the Irish coasts; Vallentin (1904) recorded it again from the Scilly Isles, and Todd (1903) added new localities in the Plymouth region for which area Pace (1904) summarized all previous records and gave many new ones, which are also included in the Plymouth Marine Fauna List (1931). Details of its occurrence about Guernsey were given by Sharp (1908) and on the Portuguese coast by Nobre (1903, 1904, 1931, and 1938) and Elias da Costa (1942). The myzostomes infesting it were mentioned by Allen (1904) and Chadwick (1907).

Comparisons between this and allied species were given by Grieg (1904), who at the same time described the ambulacral deposits, while much new information regarding the larval stages, including the discovery of infrabasals, was given by Mortensen (1920).

The outstanding contributions from the cytological point of view were the memoirs on the oöcyte by Chubb (1906) and Schaxel (1911), and more recently by Vannini and Urbani (1949 to 1955). The significance of the intercostal plates was considered by Springer (1906), the fixation was described by Perrier (1902), and excellent popular accounts were given by Fowler (1912), Koehler (1921 and 1927) and Mortensen (1927). Detailed accounts of the anatomy and embryology, as well as other features of the biology of the species, have been covered in the recent textbooks of Cuénot (1948) and Hyman (1955) and Nichols (1960) has dealt with the tube feet.

ANTEDON BIFIDA MOROCCANA (A. H. Clark)*

FIGURE 13,*c*

[See also vol. 1, pt. 2, figs. 566, 567, p. 298]

Antedon rosaceus (part) WYVILLE THOMSON, Proc. Roy. Soc. Edinburgh, vol. 7, 1872, p. 765 (many specimens dredged in the Mediterranean off the coast of Africa by the *Porcupine*).—MARION, Ann. Mus. Hist. Nat. Marseille (Zool.), vol. 1, Mem. No. 2, 1883, p. 24 (vicinity of Marseille). [I do not believe either of these is *moroccana*—A.M.C.]

Comatula mediterranea (part) MARION, Rev. Sci. Nat., vol. 7, 1878, p. 141 (Algiers; description).

Antedon rosacea (part) P. H. CARPENTER, Zool. Anz., vol. 4, 1881, p. 521 (Skerki Bank) [?*moroccana*—A.M.C.].—R. GREEFF, Zool. Anz., vol. 5, No. 105, 1882, p. 116 (Lanzarote, Canary Is.).—P. H. CARPENTER, Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 360 (*Porcupine* localities) [?*moroccana*—A.M.C.].—CARUS, Prodromus Faunae mediterraneae, pt. 1, 1884, p. 85 (Algiers).—PERRIER, Nouv. Arch. Mus. Hist. Nat., Paris, ser. 2, vol. 9, 1886, pp. 53, 166, 171 (development and anatomy; Algiers); Mémoire sur l'organisation et la developpement de la comatule de la Méditérranée, p. 1.—TH. BARROIS, Rev. Biol. Nord France, vol. 1, No. 1, 1888, p. 32 (listed), p. 33 (common in Azores on rocky bottoms below mean tide level; abundant at Bay of San Pedro).—(?) LO BIANCO, Mitt. Zool. Stat. Neapel, vol. 13, 1899, p. 469 (occurrence at Naples).—PALLARY, Bull. Soc. Hist. Nat. Afrique Nord, vol. 26*b*, 1935, p. 49 (listed).

Comatula (part) PERRIER, Compt. Rend. Acad. Sci., vol. 98, 1884, pp. 444–446 (Algiers; development); Ann. Mag. nat. Hist., ser. 5, vol. 13, No. 76, 1884, pp. 310–312 (same).

Pentacrinus europaeus (part) PERRIER, Nouv. Arch. Mus. Hist. Nat., Paris, ser. 2, vol. 9, 1886, p. 63 (history).

Antedon SIMROTH, Arch. Naturg., Jahrg. 54, vol. 1, 1889, p. 231 (Punta Delgada, Azores).

Antedon dübeni (not of Böhlsche, 1866) P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 68 (Madeira; identity).

Antedon bifida (part) A. H. CLARK, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 38 (Algiers, Tangier, Mo-

* See also Addenda (p. 838) under 1965.

rocco, Madeira and the Azores; description of specimens from Tangier and Algiers; notes); Bull. Mus. Hist. Nat. Paris, No. 4, 1911, p. 256 (coast of Morocco; Algiers; notes).—CHAPMAN, Ann. Mag. Nat. Hist., ser. 12, vol. 8, 1955, p. 398 (Azores).—TORTONESE, Bull. Stat. Aquic. Pêche, Castiglione, new ser., No. 7, 1955, pp. 203–209 (*moroccana* a synonym; relationship with *mediterranea* and *adriatica*); Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182 (part); Publ. Hydrobiol. Res. Inst. Univ. Istanbul, vol. 5, pts. 1, 2, 1960, p. 34 (replaces *A. mediterranea* off Algeria).

Antedon moroccana A. H. CLARK, *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 307 (references; Senegal, Goree, Ajaccio, Messina, Algiers, Tangier, Azores, Madeira and Lanzarote, Canary Is.; possibly specimens from the Bay of Benzert are this species), p. 312 (represents an extreme type of the genus), p. 315 (in key), p. 316 (range), p. 317 (*hupferi* from Goree probably this species; possibly this is only fully developed *hupferi*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 204 (in key; range).—MORTENSEN, Vid. Medd. Nat. Foren. København, vol. 72, 1921, p. 71 (discussion).—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range); p. 55 (in key).—MORTENSEN, Bull. Soc. Sci. Nat. Maroc, vol. 5, Nos. 4, 5, 1925, p. 179 (listed); Handbook of the echinoderms of the British Isles, 1927, p. 27 (range).—KOLOSVARY, Festschrift für Embrik Strand, vol. 2, 1937, p. 469.

Antedon maroccana A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 124 (exhibits same features as *Solanometra antarctica*), p. 190 (occurrence in the Mediterranean).—KOEHLER, Faune de France, 1, Échinodermes, 1921, p. 194 (in key), p. 197 (differential characters; distribution); Les échinodermes des mers d'Europe, vol. 2, 1927, p. 123 (in key), p. 125 (references, hardly different specifically from *A. bifida*).—RIVERA, Bol. Pesc. Madrid, vol. 14, 1929, p. 50 (could be a variety of *bifida*).—TORTONESE, Natura, Milano, vol. 24, 1933, pp. 164, 165; Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, 1935, pp. 223, 264; Atti. Soc. Ital. Sci. Nat., vol. 75, 1936, p. 280; Bull. Stat. Aquic. Pêche, Castiglione, new ser., No. 7, 1955, p. 208 (synonym of *bifida*).—CHERBONNIER, Bull. Stat. Océanogr. Salammbo, No. 53, 1956, pp. 7–8 (probably a synonym of *bifida*).

Antedon mediterranea (not of Lamarck) RANSON *in* Le Danois, Office scientifique et technique des pêches maritimes. Mémoires (série speciale) No. 3, 1925, pt. 2, Recherches sur les fonds chalutable des côtes d'Algerie, pp. 30, 36, 38, p. 54 (*Tanche* Stas. 812, 820). Also published in the Ann. Stat. Oceanogr. Salammbo, vol. 1, 1925.—PALLARY, Bull. Soc. Hist. Nat. Afrique Nord, vol. 26, pt. 2, 1935, pp. 49, 58 (Gulf of Oran).

?*Antedon hupferi* (non Hartlaub) MORTENSEN, Bull. Soc. Sci. Nat. Maroc, vol. 5, Nos. 4, 5, 1925, p. 183 (*Vanneau* Stas. 37 and 46, Morocco).—VANEY and JOHN, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, p. 665 (C. Verde Is.).

Antedon bifida var. *maroccana* PALLARY, Bull. Soc. Hist. Nat. Afrique Nord, vol. 26, pt. 2, 1935, p. 58.

Antedon dübenii, (part) Gislén, *Atlantide* Rep., No. 3, 1955, pp. 84–91 (*moroccana* a synonym of *dübenii*), pl. 1, fig. 3 (cirri), pl. 2, fig. 7 (pinnules), pl. 3, figs. 10, 11.

Diagnostic features. The outer cirrus segments are strongly compressed laterally, so that in lateral view the cirri are nearly or quite twice as broad distally as proximally; the longer proximal segments are from half again to twice as long as the median width, and the shorter distal segments are as long dorsally as broad proximally.

Description.—Centrodorsal flattened hemispherical to almost discoidal, with a rather large bare dorsal pole about 3 mm. in diameter. (See p. 235, under *duebeni*, for notes on variation in the relative size of the dorsal pole.)

Cirri XXIV–XXXV, 12–16 (usually 13–15), from 10 to 13 mm. long. In lateral view the cirri are twice as broad distally as proximally, and the distal half is strongly recurved. In the outer part of the cirri the segments are about as broad as long dorsally, becoming terminally slightly longer, about one third again as long as broad. The dorsal profile of the distal segments is perfectly straight, there being no trace of a bidentate appearance.

There is a conspicuous group of perisomic interradials in each interradius.

The IBr series are very short and well separated laterally.

The 10 arms are from 55 to 65 mm. (usually 60 mm.) in length, stout and rugged, resembling those of small stout specimens of *A. bifida bifida*.

P_1 is 12 mm. long, with 25 segments and relatively less stout than the same pinnule in *A. mediterranea*. P_2 is 5 mm. long, with 16 segments. The production of the distal ends of the segments of the proximal pinnules is marked.

Notes on the specimens.—In the larger example from Messina, Sicily, which has the arms 65 mm. long, the cirri are not so strongly recurved in the distal half as in those from Tangier; the outer cirrus segments are very slightly longer than the lateral diameter, becoming about one third again as long as broad terminally; the dorsal profile of the distal cirrus segments is slightly concave. In a second specimen from Messina, with the arms 55 mm. long, the outer cirrus segments have a straight dorsal profile. The others from Messina are small, and their cirri are more like those of *A. mediterranea*, the outer segments having a somewhat concave dorsal profile. The larger specimen from Ajaccio, Corsica, in which the arms are 45 mm. in length, resembles the young individuals from Messina.

[Note by A.M.C.] In some specimens from the Azores P_1 measures up to 15 mm., with 30 to 35 segments while P_2 with 12 to 21 segments is 4 to 7 mm. long.

Abnormal specimen.—An example from Tangier with the arms 60 mm. long and the cirri XXX, 14–16, has 11 arms, the right posterior IBr axillary bearing on the right (i.e., anterior) side a single axillary ossicle.

Remarks [by A.M.C.].—Since Mr. A. H. Clark first compiled this typescript, the status of *moroccana* has been questioned by several authorities, notably Koehler (1927), who thought it only a variety of *bifida*, Tortonese (1955), who thought it a synonym of *bifida* and Gislén (also 1955), who thought it, together with *Antedon hupferi* from the Gulf of Guinea, a synonym of the West Atlantic *duebeni*. I do not find convincing Gislén's evidence for the existence of only a single species of *Antedon* throughout northwest and west Africa and I think he was premature in synonymizing *moroccana* and *hupferi* with *duebeni* on the present inadequate material of the latter. Considering the variability of *bifida* and probably of some of the other species of *Antedon* also, a number of specimens from related localities are needed before the characters of any one form can be appreciated.

There are 18 specimens in the British Museum which I believe may be referred to *moroccana*, 13 from the Azores, 3 from Goree in Senegal and 2 from Algiers, for the last of which I am indebted to Professor Tortonese. The table given here includes measurements of peripheral cirri of 15 of these, the arm width at the first syzygy being included as a criterion of size since complete arms are rare. The largest specimen had an arm length of about 80 mm. Comparable measurements of 40 specimens of *bifida* from various parts of the British Isles are given also for comparison. The ratio used to express distal expansion of the cirri dorsoventrally is taken from the median widths of the fourth segments from each end of the cirrus and is less than that which would be obtained by taking the maximum and minimum widths, owing to the tendency of the distal segments to exhibit some degree of flaring. Such a ratio would be about 2:1 (as Mr. Clark gives for *moroccana*) as opposed to about 1.8:1 when the median widths are used. The median length of the fourth segment from the tip is also given for comparison with the width, appearing to be rarely much greater in *moroccana* but varying from equal to the width to a third again as long in *bifida*, though this result may be only due to the small sample of *moroccana*, for which much more data is needed to supplement the figures given here.

Gislén does not think that cirrus shape is sufficiently constant to provide useful characters for distinguishing the species of *Antedon* but I disagree provided it is always mature peripheral cirri which are described.

Mr. A. H. Clark put forward no other character by which to distinguish between *bifida* and *moroccana* and, judging from the variability in cirrus shape shown by *bifida* in the table, this is of less than specific value. Nevertheless, the tendency for distal enlargement of the cirri to occur in specimens from northwest Africa and the off-lying islands is sufficiently constant for the specimens from this area to be recognized as a subspecies *moroccana* of *A. bifida*.

Even apart from its doubtful distinction from *bifida*, the status of *moroccana* is unsatisfactory. When named in 1914 it was distinguished only in a key, though brief descriptions of specimens from Tangier, one of the several localities listed for it, had been given in 1911 under the name of *bifida*. This was technically sufficient to establish it. The description given above was probably expanded from that of 1911 and so the three specimens from Tangier may be considered as syntypes, Tangier being loosely included in Morocco. The specimens are in the Copenhagen Museum and have more recently been renamed as *Antedon dübenii* by Dr. Gislén, together with the specimens, which Mr. Clark had also included in *moroccana*, from Messina and Ajaccio.

TABLE 6.—*Proportions of the cirrus segments in some specimens of* Antedon bifida moroccana (*first five lots*) *and* A. bifida bifida (*below*)

Specimens (BM Nos.)	*Width at 1st syzygy (mm.)*	*Cirrus length (mm.)*	*Cirrus segments*	*Width 4th from tip A (S.u.)* [1]	*Width 4th from base B (S.u.)* [1]	*Length 4th from tip (S.u.)* [1]	*Ratio A:B (:1)*
1956. 5. 29. 32–33, Azores	1. 4	10	15	14	9	15	1. 56
	1. 1	10	16	14	9	14	1. 56
	1. 5	12	16	18	11	18	1. 64
	1. 5	10	14	14	9	15	1. 56
	1. 5	12	15	14	8	19	1. 75
1956. 5. 29. 34–36, Azores	1. 4	9	14	14	9	15	1. 56
	1. 4	10	16	16	10	15	1. 60
	1. 3	9	13	14	9	16	1. 56
	1. 5	9	15	15	9. 5	15	1. 58
1956. 5. 29. 37, Azores	1. 2	8	15	14	9	14	1. 56
81. 7. 30. 7–8, Goree	1. 1	–	14	12	9	–	1. 33
	0. 9	c. 7	14	10	6	–	1. 67
	0. 8	–	13	9	5	–	1. 80
1958. 5. 2. 29, Algiers	1. 1	6. 5	14	11	8	12	1. 38
	0. 8	5. 5	13	9	6	11	1. 50
65. 2. 11. 14, Scotland	1. 25	10	16	13	10	15	1. 30
	1. 2	10	15	15	10	17	1. 50
	1. 4	11	16	15	10	18	1. 50
	1. 5	10	16	12	8	14	1. 50
	1. 2	11	15	13	8	18	1. 63

See footnote at end of table.

TABLE 6.—*Proportions of the cirrus segments in some specimens of* Antedon bifida bifida—Continued

Specimens (BM Nos.)	*Width at 1st syzygy (mm.)*	*Cirrus length (mm.)*	*Cirrus segments*	*Width 4th from tip A (S.u.)* [1]	*Width 4th from base B (S.u.)* [1]	*Length 4th from tip (S.u.)* [1]	*Ratio A:B (:1)*
1947. 9. 22. 1–4, Channel	1. 6	8	15	14	8. 5	15	1. 65
	1. 65	11	17	17	11	18	1. 55
	1. 8	11	16	17	12	18	1. 42
	1. 4	11	15	15	10	15	1. 50
	1. 6	10	16	16	11	16	1. 45
1936. 10. 12. 36–45, Wales	1. 1	11	16	13	8	17	1. 63
	1. 6	11	16	13	9	17	1. 45
	1. 1	11	15	13	9	18	1. 45
	1. 2	11	16	14	11	18	1. 27
	1. 1	11	16	13	8. 5	15	1. 53
	1. 7	13	18	14	11	18	1. 27
	1. 6	13	18	15	11	19	1. 36
	1. 4	11	16	15	9	16	1. 67
	1. 2	11	14	14	10	16	1. 40
	1. 25	11	16	14	9	17	1. 56
	1. 3	10	15	14	9	15	1. 56
88. 2. 10. 7, Clyde	1. 7	11	18	12	11	15	1. 09
	0. 9	7	14	12	8. 5	13	1. 41
	1. 5	10	15	15	12	16	1. 25
89. 12. 3. 1–3, Liverpool	1. 7	16	17	16	12	21	1. 33
	1. 6	13	16	15	11	19	1. 36
	1. 7	16	17	16	11	20	1. 46
	1. 55	16	18	15	12	20	1. 25
93. 8. 23. 23–25, S. Devon	1. 5	11	16	15	12	16	1. 25
	1. 75	12	16	19	13	19	1. 46
	1. 1	7. 5	14	13	9	13	1. 45
98. 5. 3. 1142–9, Shetland	1. 2	10	15	12	8	14	1. 50
	0. 9	–	15	9	7	12	1. 29
	1. 0	6	14	11	8	12	1. 375
	1. 2	9	14	12	8. 5	15	1. 41
	0. 8	8	14	11	8	13	1. 375
1948. 2. 17. 1, Salcombe	1. 5	10	14	14	10	18	1. 40
	1. 7	9	14	16	11	16	1. 45
98. 5. 4. 1014–20, Ireland	0. 8	9	14	11	7	14	1. 57
	1. 0	9	14	14	10	16	1. 40

Range of A:B in 15 specimens of *moroccana*, 1.33—1.80:1, average 1.57:1
in 40 specimens of *bifida* 1.09—1.67:1, average 1.43:1

[1] S.u. for the finer measurements signifies the scale units of my microscope eyepiece, of which 22 equal one millimeter. For the purposes of the ratios it did not seem worthwhile to convert them.

Localities.—Azores [Barrois, 1888; A. H. Clark, 1911]. San Miguel, Punta Delgada [Simroth, 1889]. Bay of San Pedro [Barrois, 1888; A. H. Clark, 1911]. Horta and Almoxarife, Fayal, Azores; Queen Mary College Exped., 1952 [Chapman, 1955] (18, B.M.).

Canary Islands; Lanzarote [Greeff, 1882; A. H. Clark, 1914].

Madeira [P. H. Carpenter, 1891; A. H. Clark, 1911, 1914].

Goree (just south of Cape Verde), Senegal [A. H. Clark, 1911, 1913, 1914, 1918] (3, B.M.). Same, 24 meters; Captain Hupfer, May 1891 [A. H. Clark, 1912] (1, H.M.).

Atlantide station 60; off Liberia (lat. 5°06′ N., long. 9°34′ W.); sandy mud; 78 meters [Gislén, 1955] (10, C.M.).

Atlantide station 147; off (former French) Guinea (lat. 9°28′ N., long. 14°58′ W.), shells and Foraminifera; 45 meters [Gislén, 1955] (12, C.M.).

Atlantide station 148; off Guinea (lat. 9°57′ N., long. 15°22′ W.); shells and hydroids; 25 meters [Gislén, 1955] (1, C.M.).

Atlantide station 151; off Portuguese Guinea (lat. 10°40′ N., long. 16°44′ W.); coarse sand; 65 meters [Gislén, 1955] (2, C.M.).

Atlantide station 153; off Portuguese Guinea (lat. 10°49′ N., long. 16°39′ W.), coarse sand; 42 meters [Gislén, 1955] (35, C.M.).

Atlantide station 163; off Gambia (lat. 13°43′ N., long. 17°23′ W.); 65–89 meters [Gislén, 1955] (1, C.M.).

(?)St. Vincent, Cape Verde Islands; shore [Vaney and John, 1939] (1, Royal Scottish M.).

Coast of Morocco, September 9, 1902 [A. H. Clark, 1911, 1914] (8, P.M.). Same, M. Buchet, 1903 (1, U.S.N.M., 35682).

Vanneau stations 37 and 46, 1924, off Morocco [Mortensen, 1925]

Tangier; Feldstrup, March 5, 1891 [A. H. Clark, 1911, 1914] (3, C.M.). Here designated as the type locality.

Algiers [Marion, 1878; Perrier, 1884, 1886; Carus, 1884; A. H. Clark, 1911, 1914] (5 and many pentacrinoids, P.M.). Same, Exped. scientifique de l'Algerie (1, U.S. N.M., 35683). Same; 7–10 meters [Tortonese, 1955, 1956] (Tortonese coll., Genoa; 2, B.M.)

Bou Haroun, Algeria; 100–120 meters [Tortonese, 1955, 1956] (Tortonese coll.).

Tanche station 812; coast of Algeria (lat. 36°50′ N., long 3°05′ E.); 200 (120–300) meters; June 22, 1924 [Ranson, 1925]. *Tanche* station 820; coast of Algeria (lat. 35°58′ N., long. 0°00′); 75 meters; June 24, 1924 [Ranson, 1925]. [Note BY A.M.C.] It is not certain whether these specimens are *moroccana* or *mediterranea*. They were given the latter name by Ranson, together with other specimens collected by the *Tanche* off Tunisia. A confirmation of identification by an authority, if the specimens have been preserved, would provide valuable information as to the geographical limits of these two forms.

Gulf of Oran [Pallary, 1935].

?Messina; 18–37 meters; H. J. Hansen, May 1–10, 1893 [A. H. Clark, 1914] (10, C.M.).

?Ajaccio, Corsica; Bøgesen, February 3, 1898 [A. H. Clark, 1914] (2, C.M.).

Geographical range.—From west of Sierra Leone and Liberia north to Morocco, the Canary Islands, Azores and Madeira and east in the Mediterranean to Algeria, doubtfully from Tunisia, Sicily and Corsica.

[NOTES BY A.M.C.] In 1914 Mr. Clark listed *moroccana* as from Ajaccio (Corsica), Messina (Sicily), Algiers, Tangier, the coasts of Morocco, Goree in Senegal, Madeira, Lanzarote in the Canaries and the Bay of San Pedro in the Azores. In 1911 and 1914 he commented that he had not seen the *Porcupine* specimens from Bizerta (Tunisia) but they were more likely to be of *A. mediterranea*. Nevertheless in the typescript of this monograph he had included Tunisian records of *Antedon* under *moroccana* and referred records from the Azores back to *A. bifida*. It is likely that he had not himself examined specimens from the Azores but was quoting the record of Barrois (1888). Certainly the specimens collected by the Queen Mary College expedition to Fayal in the Azores all have the markedly expanded cirri characteristic of *moroccana*. As for Tunisia, Cherbonnier (1956) and Tortonese (1935) among others have recorded as *mediterranea* numerous specimens from Tunisia; also Tortonese commented that none of his specimens from Gerba (Djerba) off southeast Tunisia have the cirri with their outer segments strongly compressed. I am therefore arbitrarily referring all the Tunisian records to *mediterranea* and the Algerian ones to *moroccana*. The specimens Ranson (1925) named *mediterranea*, if they have been preserved, should help to show the geographical limits of these two forms. Tortonese (1955) has suggested that at least the Algerian specimens of Ranson are really *bifida* (i.e., *moroccana* which he thought to be synonymous).

As for the records from Ajaccio and Messina, Gislén renamed the specimens as *A. dübenii* like others from Tangier, so it is unlikely that they could be *mediterranea*.

There are two other possible localities. Lo Bianco (1899) stated that a small variety of *Antedon* occurs in the Bay of Naples in the *Posidonia* fields in 10 to 15 meters, which may prove to have been *moroccana* and Marion (1883) wrote that in the vicinity of Marseilles on the muddy gravel south of the island of Rion and Planier in 100 to 200 meters *Leptometra phalangium* is found together with very small Antedons, which appear stunted. It is possible that the latter were *moroccana*, not *mediterranea*, as he supposed.

Finally, there are a number of localities from West Africa given by Gislén in his *Atlantide* Report (1955) under the name of *dübenii* in addition to those included in the locality list (the specimens from which I have personally examined). At least the more northern of these, such as the stations north of about 8° N., and also Mortensen's records and *Dana* station 4015 from the Canaries probably yielded *A. bifida moroccana* rather than *A. hupferi*.

Bathymetrical range.—From the shore line down to 200 [?380] meters.

History.—In 1878 Professor A. F. Marion, recording the feather star for the first time from Algiers, noted that there it differed considerably from typical *A. mediterranea* and approached *A. petasus;* he compared it in some detail with both of these. Speaking of the fauna of Algiers, he said that the feather star, of which he had many specimens, recalls the form which occurs on the coasts of Provence, on the deep muddy bottoms, and which, in spite of its large size and its long pinnules, perhaps only represents a variety of *A. mediterranea*. In the specimens from Algiers, according to Professor Marion, the bare dorsal pole of the centrodorsal is very small. The cirri are rather short and stout, XXVI or XXVII, or even XXVIII, in number; their segments are strongly compressed laterally and, in the longest, number 14, 15, or 16, while in the shortest there are only 12 or 13; the penultimate segment bears a small opposing spine. He says that in specimens of *A. petasus* from the coasts of Norway, obtained through the kindness of Professor Loven, the cirri are much shorter and much stouter than those of typical *A. mediterranea*, and their segments number 12 to 15, whereas there are usually 20 in *A. mediterranea.*

On the French coast, on the muddy bottoms in 40, 50, and 80 meters, there occur ambiguous feather stars often scarcely different from *A, mediterranea*, but on the other hand sometimes close to *A. petasus*. Sometimes in these P_1 is very long and filiform, and sometimes it is not notably different from the following pinnules. The cirri show similar variations, so that it becomes difficult to fix the systematic position of these crinoids. The specimens from Algiers are among those which most resemble *A. petasus*.

The form recorded by R. Greeff (1882) from the Canary Islands I assume to be this species, though it has never been described in detail and I have seen no specimens from that locality. The stunted Antedons mentioned by Marion in 1883 are those with which he compared specimens from Algiers in 1878

Perrier's early work (1884) upon the larval stages of *Antedon* was based on material from Algiers, but in his later work (1886) it is impossible to separate the observations made on this form from those made on *A. bifida* from Roscoff and on *A. mediterranea* as he did not distinguish between these species and did not give in detail the origin of his specimens. It is a reasonable guess, however, that what he says about the larvae and the pentacrinoids refers to *A. bifida moroccana*, while his notes on the anatomy of the adults refer to *A. bifida bifida*.

From what Carpenter (1891) wrote about his examples from Madeira it seems clear that he had *moroccana*. The assumption that Lo Bianco's (1899) small specimens from the Bay of Naples are this form rests upon a probable analogy with conditions at Marseille and the identification of *moroccana* at Messina and Ajaccio.

When I first had occasion to discuss this form (1911) on the basis of specimens from Algiers, Tangier and Morocco in the Paris and Copenhagen Museums, I referred it to *A. bifida*, in contrast to *A. mediterranea* of the northern coast of the Mediterranean. But a further study led me in 1914 to separate *moroccana* from *A. bifida*.

In 1920 Mortensen suggested the creation of a special genus to include *A. petasus*, leaving all the other species in *Antedon*. At the same time he made the alternative suggestion that *A. mediterranea* and *A. adriatica* be considered as a new genus or subgenus, all the other forms remaining in *Antedon*.

In 1921 Professor Koehler remarked that *moroccana* is extremely close to *bifida* and scarcely deserves specific separation; but it may be considered as a variety of *bifida* differing from the typical form through having the outer cirrus segments strongly compressed laterally.

[Notes by A.M.C.] This suggestion was adopted by Pallary in 1935 but Tortonese (1955) went further and reduced *moroccana* to the synonymy of *A. bifida*.

In 1925 Ranson recorded *Antedon mediterranea* from Tunisia and Algeria in the *Tanche* collections. It is presumed that the latter specimens at least are of *moroccana*.

Also in 1925 some specimens from off Morocco, collected by the *Vanneau*, were recorded by Mortensen as *Antedon hupferi*. It is most probable that these are referable to *moroccana*. They were in poor condition.

ANTEDON DUEBENI Böhlsche

[See vol. 1, pt. 2, pl. 7, fig. 1018, pl. 12, fig. 1040]

Antedon dübenii BÖHLSCHE, Arch. Naturg., 1866, vol. 1, p. 92, fig. (description; Rio de Janeiro).—VERRILL, Trans. Connecticut Acad. Sci., vol. 1, 1867, p. 341 (from Böhlsche).—P. H. CARPENTER, Nature, vol. 15, 1877, p. 197 (ossicles between the IBr series possibly external basals); Journ. Linn. Soc. (Zool.), vol. 13, 1877, p. 456 (possible resemblance to *Comaster* [of Müller, 1840]); Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*).—RATHBUN, Trans. Connecticut Acad. Sci., vol. 5, 1879, p. 157 (Rio de Janeiro; from Böhlsche).—LUDWIG, Mém. Cour. Acad. Roy. Sci. Belgique, vol. 44, 1882, p. 6.—P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 69 (=*rosacea* [*bifida*]).—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 113 (in the Göttingen Mus.).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 469 (determined as the young of *Comatula carinata* Lam.); vol. 40, p. 2 (history; *Challenger* specimen a young *Tropiometra picta*, but the type is a species of *Antedon*), p. 3 (Greeff's specimens from Rolas thought by P. H. Carpenter possibly to be this species), p. 12 (closely allied to *A. hupferi* of the west coast of Africa.—*in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 315 (in key), p. 316 (range), p. 317 (known only from Rio de Janeiro and St. Thomas; Verrill's record from Brazil and the *Challenger* specimen from Bahia are *Tropiometra picta*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 204 (in key; range).—H. L. CLARK, Carnegie Inst. Washington Publ. 281, 1919, p. 53 (range).—A. H. CLARK, Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 7 (St. Thomas and Brazil; littoral); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range), p. 55 (in key).—H. L. CLARK, Scientific Survey Porto Rico and the Virgin Islands, vol. 16, pt. 1, 1933, p. 8 (bathymetrical range; quoted from A.H.C.; West Indies in less than 10 fms.), p. 9 (in key), p. 12 (occurrence in West Indies).—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140 (in key), p. 143 (references).—GISLÉN, *Atlantide* Rep., No. 3, 1955, p. 90 (notes on type and St. Thomas specimen), pl. 3, fig. 9. [Probably *dübenii* of pp. 84–87=*moroccana* and *hupferi*.]

Antedon dübeni POURTALÈS, Bull. Mus. Comp. Zool., vol. 5, No. 9, 1878, p. 214 (not in the M.C.Z. from Brazil).—P. H. CARPENTER, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386 (sacculi abundant); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 181 (part), pp. 182, 183 (description; discussion); pl. 37, figs. 2, 3 [but not fig. 1, which is *Tropiometra picta*]; Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 68 (Madeira; Canaries [=*moroccana*]; Rolas [=*hupferi*]; intercostal plates present; suggested identity with *rosacea* [i.e. *bifida*]).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 125 (identified as young of *Tropiometra carinata* [*picta*]); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 82 (of P. H. Carpenter, 1888=*Tropiometra picta*).—MORTENSEN, Vid. Medd. Nat. Foren. København, vol. 72, 1920, p. 71 (discussion).

Antedan dubeni BELL, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—P. H. CARPENTER, Proc. Zool. Soc. London for 1882, 1883, p. 746 (corrected specific formula).—SPRINGER, Mem. Mus. Comp. Zool., vol. 25, No. 1, 1901, p. 88 (both sides of the Atlantic).

Antedon duebeni BELL, Catalogue of British echinoderms in the British Museum, 1893, p. 56 (probably a synonym of *A. bifida;* off Bengal).

Antedon liarthra HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (in *Blake* collection), pp. 399–402 (*Blake* Sta. 262; detailed description and discussion), pl. 7, figs. 8–10, pl. 15, fig. 1.

Antedon antillensis (Lütken, MS.) A. H CLARK, *in* Michaelsen and Hartmeyer, Beiträge zur Kentniss der Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 317 (St. Thomas).

Diagnostic features.—There are not more than XXXV cirri, which have not over 17 (rarely more than 15) segments, of which the outer are strongly compressed laterally, so that in lateral view the cirri are nearly twice as broad distally as proximally; the longer proximal segments are from half again to twice as long as the median width, and the shorter distal segments are as long dorsally as broad proximally; P_2 and P_3 are both about half the size of P_1; the centrodorsal is very low, evenly convex, with very sloping sides and a relatively small dorsal pole, the diameter of which is from one third to one half that of the centrodorsal; conspicuous perisomic interradials are present.

Remarks [by A.M.C.].—In my opinion the above diagnosis does not afford any reliable character by which *A. duebeni* can be distinguished from *A. bifida* and more particularly from *A. bifida moroccana*. The degree of enlargement of the cirri distally is variable in *bifida* (see table 6, p. 229) and in 10 specimens from the Azores which I take to be *bifida moroccana*, the ratio of the diameter of the dorsal pole to that of the base of the centrodorsal varies from 0.47 to 0.64:1, averaging 0.55. In two small specimens from Algiers the dorsal pole is 0.64 and 0.45 of the total diameter. In Carpenter's figure of *duebeni* the ratio appears to be about 0.5:1. With only three specimens known from the western tropical Atlantic little idea can be obtained of the range of variation.

The preceding paragraph was written without knowledge of Gislén's *Atlantide* report in which he reduced *moroccana*, together with *hupferi*, to the synonymy of *A. duebeni*. He may well be right about *moroccana* and *duebeni* but I believe much more precise information is needed before the relationships between both of these and *A. bifida* can properly be appreciated and that it is premature to synonymize two of them without more reference to the third, especially when so little is known of the West Atlantic form.

Description.—The centrodorsal is pentagonal, 2.5 mm. broad and 1 mm. high, the bare dorsal pole 1 mm. in diameter.

The cirri are XXX–XL, 12–15; the segments in the middle of the cirri are broader than long and somewhat compressed laterally.

The disk is 7 mm. in diameter.

A cluster of perisomic interradials lies between the ends of the IBr_1.

The radials are almost entirely concealed. The IBr_1 are very short, oblong, not united laterally. The IBr_2 (axillaries) are acutely triangular.

The 10 arms are about 45 mm. long. The first two brachials are approximately similar in shape, oblong or subtriangular, the second being rather the longer. A few brachials after the second syzygy may be triangular, but they soon become wedge-shaped with the articulations but little inclined so as to be somewhat squarish in outline, and distally elongated. The lower and middle brachials may overlap more or less, but the distal parts of the arms are almost smooth.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of from 2 to 7 muscular articulations.

P_1 reaches over 10 mm. in length and is composed of 24 to 30 elongated and overlapping segments. P_2 and the following pinnules are about half as long with 12 to 14 segments which are much longer than broad. The distal pinnules are very long and slender.

According to Böhlsche the whole surface of the brachials and pinnule segments is covered with fine longitudinal striations which end at the distal borders in fine spinules.

The color in alcohol is brown.

Notes on a second specimen.—The cirri are about XXX, 12, about 7 mm. long. In lateral view the outer cirrus segments are twice as broad as the proximal, strongly flattened and with a straight dorsal profile.

The arms are about 30 mm. long.

P_1 is about 9 mm. long with 21 segments which have spinous distal borders. P_2 is about 4 mm. long.

The arms and pinnules resemble those of *A. bifida moroccana,* and there are prominent clusters of perisomic interradials in each interradius.

Localities.—Rio de Janeiro, Brazil [Böhlsche, 1866; P. H. Carpenter, 1888] (1, presumably Göttingen Museum, A.M.C.). Type locality.

Blake station 262; off Grenada (lat. 12°01′45″ N., long. 61°47′25″ W.); 168 meters; temperature 16.67° C.; fine sand; March 1, 1879 [Hartlaub, 1912].

St. Thomas, Virgin Islands; H. Koch, 1860 (1, C.M.).

Geographical range.—From Rio de Janeiro, Brazil, northward to St. Thomas.

Bathymetrical range.—From the shore line down to 168 meters.

Thermal range.—One record, 16.67° C.

History.—This species was first described by Dr. Wilhelm Böhlsche from a single specimen taken at Rio de Janeiro; but previous to this, in 1860, an example had been collected by Mr. H. Koch at St. Thomas and sent to the Copenhagen Museum where it had received the manuscript name of *Antedon antillensis* from Prof. C. F. Lütken.

In 1888 Dr. P. H. Carpenter redescribed and refigured Böhlsche's type specimen, which was sent him from Göttingen through the kindness of Dr. Otto Hamann; but his account of the species is somewhat obscured by the fact that he identified with it a young example of *Tropiometra carinata,* which the *Challenger* had obtained at Bahia, Brazil, in 36 meters.

In 1891 Carpenter decided that this species is synonymous with *Antedon bifida.*

It is most probable that the very poor specimen described by Hartlaub in 1912 under the name of *Antedon liathra* represents this species.

In 1914 the specimen collected by Mr. Koch at St. Thomas was first recorded.

Considering the great amount of collecting that has been done along the shores of the West Indian islands it is certainly surprising that this species has not been more frequently taken.

ANTEDON MEDITERRANEA (Lamarck)*

Mediterranean Feather Star. La Comatule de la Mediterranée

FIGURE 13,*e,f*

[See also vol. 1, pt. 1, figs. 105 (p. 169), 281 (p. 261), 313 (p. 271), pl. 3, fig. 533, pl. 4, fig. 546, pl. 7, figs. 569–571; pt. 2, fig. 79 (p. 53), pl. 28, figs. 1182–1185, pl. 29, fig. 1190, pl. 30, fig. 1194, pl. 31, figs. 1196–1200, pl. 44, fig. 1308, pl. 46, figs. 1315–1321, pl. 51, figs. 1337–1340]

Stella Δεκαδασυακτινοειδης COLUMNA, Φυτοβασανος, sive Plantarum aliquot Historia, Naples, 1592, appendix, Piscium aliquot plantarumque novarum historia, p. 12, plate (coasts of Italy; coloration; detachment of visceral mass); Φυτοβασανος, ed. 2, Florence, 1744, p. 109, pl. 29 (as above).—W. B. CARPENTER, Phil. Trans. Roy. Soc., vol. 156, 1866, pp. 673, 678 (identity).—P. H. CARPENTER, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 2 (identity).

Stella marina ALDROVANDUS, De animalibus insectis, Bologna, 1602, p. 756, fig. (from Columna).—COLUMNA, Minus cognitarum Stirpium aliquot, ac etiam rariorum nostro coelo orientium εκφρασις, Rome, 1606, Observationes III, p. v (coloration; solubility of coloring matter in fresh water); another edition, 1616 (same).—JONSTONUS, Historiae naturalis de Quadrupedibus, liber 3, Frankfurt and Mainz, 1653, pl. 26, fourth row from top (from Columna, through Aldrovandus);

* See also Addenda (pp. 835–838) under 1958, 1959, 1965.

another edition, liber 2, Amsterdam, 1657, p. 146, second column; pl. 28, fourth row from top, second from left (same).—Ruysch, (edition of Jonstonus), Theatrum universale omnium Animalium, pt. 5, liber 3, 1718, p. 144, pl. 28 (opposite p. 146) (as above).—Valmont de Bomare, Dictionnaire raisonné universel d'histoire naturelle, vol. 2, Paris, 1765, p. 642; ed. 4, vol. 3, Lyon, 1791, p. 281 (compilation).

Stella decem radiorum Aldrovandus, De animalibus insectis, Bologna, Liber 7, 1618 ed., p. 296 (middle figure in lower row), p. 297 (from Columna).—Llhuyd, (Llwyd), Praelectio de Stellis marinis Oceano Britannici, Oxford, 1703, section 18 (comparison with *Decempeda cornubiensium*); republished as an appendix to Linck, 1733, p. 81.—Baier, Monumenta rerum petrificatarum, Nuremburg, 1757, pl. 7, fig. 1 (after Aldrovandus).

Δεκακνημος fimbriata Barrelier, Plantae per Galliam, Hispaniam, et Italiam observatae, Paris, 1714, p. 131, No. 1282 (mouth of the Tiber; color).—W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 678 (identity).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 2 (history); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 69 (identity).

Δεκακνημος crocea zaffarana Neapolitanorum Linck, De Stellis marinis, Leipzig, 1733, p. 53 (based on the δεκαδασυακτινοειδης of Columna).—Columna, Φυτοβασανος, sive Plantarum aliquot Historia, 2, Florence, 1744, p. 109.—W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 678 (history and identity).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 2 (history and identity).

Δεκακνημος barbata Linck, De Stellis marinis, Leipzig, 1733, p. 55, pl. 37, fig. 64 (based on the *Δεκακνημος fimbriata* of Barrelier). — W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 678 (history and identity).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 2 (history and identity); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 69 (identity).

The Sea Comet Hill, A general natural history, vol. 3, An history of animals, London, 1752, p. 91, pl. 5 (opposite p. 91), lowest row (compilation; "entrochi" derived from astrophytons*).—Millar, Natural history, London, 1785, fig., pl. [20], "Naked Insects," opposite p. 283.—Walcott, A new and complete natural history [1795], pl. [21].

Asterias pectinata Linnaeus, Systema Naturae, ed. 10, vol. 1, 1758, p. 663 (in part; references to Columna and Barrelier and part of Linck); ed. 12, vol. 1, 1762, pt. 2, p. 1101, No. 14 (as in ed. 10, with additional references to Seba which do not concern this species).—? Linnaeus, Museum Ludovicae Ulricae reginae Svecorum, Stockholm, 1764, p. 716 [may refer to *petasus*].—P. L. S. Müller, Linné's Natursystem, Nuremburg, 1775, vol. 6, p. 140 (summary; correction of the habitat given by Linnaeus).—Barbut, Genera vermium, London, 1783, p. 87, pl. 10, fig. 11 (from Linnaeus).—Nemnich, Allgemeines Polyglotten-Lexicon der Naturgeschichte, vol. 1, 1793, p. 521 (vernacular name).—? Meyer, Museum Meyerianum, 1802, p. 30 (listed).—Leuckart, Zeitschr. organ. Physik, vol. 3, 1833, p. 376 (includes *Comatula mediterranea* and is the same as the *Δεκακνημος* of Linck).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 11 (footnote); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 69.

Decacnimos Schulze, Betrachtung der versteinerten Seesterne, Warsaw and Dresden, 1760, p. 53 (based on *Δεκακνημος* Linck).

Asterias radiata, etc. Gronovius, Zoophylacium Gronovianum, Leiden, 1781, p. 250 (a composite of all known species).

Unnamed figure, Brugiere, Vers intestines, Encyclopédie méthodique, 1792,** Tableau, pt. 124, fig. 6.

Asterias (*Euryale*) *pectinata* Oken, Lehrb. Naturg., Leipzig and Jena, pt. 3, 1815, p. 356 (in part, compilation).

Comatula mediterranea Lamarck, Histoire naturelle des animaux sans vertèbres, vol. 2, 1816, p. 535 (description; Mediterranean; refers to Encyclopédie méthodique, pl. 124, fig. 6; *Stella rosacea* Linck included as a synonym).—De Blainville, Dict. Sci. Nat., vol. 10, 1818, p. 108 (listed).—

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* From Rosinus, Tentaminis de Lithozoi ac Lithophytis olim marinis, jam vero subterraneis Prodromus; sive de Stellis marinis quondam, nunc fossilibus Disquisitio, Hamburg, 1719, in which work fossil crinoids are compared with recent sea-stars, particularly with ophiurans.

** This date is given by Sherborn and Woodward, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 581; the title page is dated 1827, but since these figures were referred to by Lamarck, 1816, it is obvious that the plates were actually published some time previous to the captions and corresponding text. A.M.C.

Meckel, Arch. Anat. Physiol., vol. 8, 1823, heft 3, p. 470 (mouth and anus).—Lamouroux, Encyclopédie méthodique, vol. 2, 1824, p. 206 (from Lamarck).—Heusinger, Arch. Anat. Physiol., 1826, No. 3, p. 317 (digestive system), pl. 4.—Risso, Histoire des principales productions de l'Europe meridionale, Paris and Strassbourg, 1826, vol. 5, p. 275 (vicinity of Nice, in coral; April and May; color).—Leuckart, Versuch einer naturgemässen Eintheilung der Helminthen, Heidelburg and Leipzig, 1827, p. 24 (myzostomes).—Brugiere, Vers intestines, Encyclopédie méthodique, vol. 1, 1827, p. 206.—Heusinger, Zeitschr. organ. Physik, vol. 2, 1828, Heft 1, p. 55, pl. 5, pl. 6, figs. 1, 2 (discussion of *Pentacrinus europeus*).—Eichwald, Zoologia specialis, 1829, p. 226.—Delle Chiaje, Instituzioni de Anatomia e Fisiologia comparativa, vol. 1, 1832, p. 19 (anatomy), p. 205 (mouth; stomach).—Goldfuss, Petrefacta Germaniae, vol. 1, 1832, p. 201, pl. 61, figs. 1, *a l* (structure of hard parts).—Heusinger, Zeitschr. organ. Physik, vol. 3, 1833, p. 366, pls. 10, 11, figs. 1–16 (one folding plate) (anatomy; fig. 1 of the whole animal is colored; fig. 2 of the disk is colored; figs. 10 and 11 are of cirri, the rest are anatomical figures).—Leuckart, Zeitschr. organ. Physik, vol. 3, 1833, p. 375 (vicinity of Cette; XXXVIII–XL cirri; structure; comparison with ophiurans, astrophytons and starfishes), p. 376 (=*Asterias pectinata* Linnaeus and Δεκακνημος Linck), p. 389 (includes *Comatula europea* or *pectinata;* found not only in the Mediterranean but also in the Adriatic and North Seas, and without doubt also in the Atlantic).—Burmeister, Zoologischer Hand-Atlas, Berlin, 1835, pl. 37, fig. 6.—Dujardin, L'Institut, vol. 3, No. 119, 1835, p. 268 (Toulon; eggs borne on the pinnules, not internally).—L. Agassiz, Mem. Soc. Sci. Nat. Neuchatel, vol. 1, for 1835, 1836, p. 193 (example of the genus *Comatilia*).—Dujardin, *in* Deshayes and Milne-Edwards, Lamarck, Histoire naturelle des animaux sans vertèbres, ed. 3, vol. 1, 1837, p. 471; ed. 2, vol. 3, 1840, p. 210 (additional references).—von Meyer, Abh. Mus. Senckenbergianum, vol. 2, 1837, pl. 16, fig. 11 (arm).—Grube, Actinien, Echinodermen und Würmer des Adriatischen und Mittelmeeres, Koningsberg, 1840, p. 14 (Naples, Palermo; solubility of coloring matter in fresh water; sacculi; measurements).—J. Müller, Monatsb. Preuss. Akad. Wiss., April 1840, p. 91 (structure); Arch. Naturg., 1840, vol. 1, p. 307 (same).—Delle Chiaje, Descrizione e notomia degli animali invertebrati della Sicilia citeriore, vol. 4, 1841, pl. 134, fig. 13 (centrodorsal and part of an arm).—E. Forbes, History of British starfishes, 1841, p. 17 (synonym of *rosacea* [*bifida*]).—Leuckart, Zool. Bruchstücke, vol. 3, Helminthologie Beiträge, Programm zur Eröffnung der Winterworks in Freiburg, pt. 1, Helmstadt, 1842, pp. 10, 12.—J. Müller, Abh. Preuss. Akad. Wiss. for 1841, 1843, pp. 178, 179, pl. 1, figs. 4–6, pl. 2, figs. 9, 11–13, pl. 4, figs. 12, 14, pl. 5, figs. 7–13, 17, 17′, pl. 6, figs. 4–12 (elaboration of J. 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Also published in the Ann. Sta. Océanogr. Salammbo, vol. 1, 1925.—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 122 (in key), pp. 123, 124 (references; description; distribution), pl. xi, fig. 7; *in* Faune et Flore Méditerranée, Paris, 1929 (pages not numbered) (replaces *bifida* in the Mediterranean).—Zirpolo, Bol. Soc. Nat. Napoli, vol. 40, 1929, pp. 52–56, figs. 1–4 (bifurcating arms).—Carvalho, Mem. Est. Mus. Zool. Univ. Coimbra, ser. 1, No. 36, 1929, p. 9 (catalogue of Zool. Mus. Coimbra collection).—Rivera, Bol. Pesc. Madrid, vol. 14, 1929, p. 50 (in key), figs. 2, 4.—Runnström, Arch. Entwicklungsmechanik, vol. 121, 1930, pp. 714–725 (metamorphosis).—Boone, Bull. Vanderbilt Mar. Mus., vol. 4, 1933, p. 70.—Tortonese, Natura, Milano, vol. 24, 1933, pp. 164, 165.—Djakonov, Les échinodermes des mers arctiques (in Russian), Leningrad, 1933, fig. 4, p. 17, fig. 6, p. 19.—Buen, Bol. Soc. Esp. Hist. Nat. Madrid, vol. 34, 1934, pp. 442, 443; Trab. Inst. Esp. Oceanogr. Madrid, No. 6, 1934, p. 22 (Majorca).—Rivera, Trab. Inst. Esp. Oceanogr. Madrid, No. 10, 1934, p. 83 (*Xauen* stas.).—Ekman, Tiergeographie des Meeres, 1935, p. 120.—Chalaux, Bull. Soc. Sci. Bretagne, vol. 11, 1935, pp. 91–93 (specimen with 12 arms from Banyuls); figs. 1–3.—Tortonese, Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, 1935, p. 222 (limited to Mediterranean), pp. 264–265 (size; cirri; range); Atti Soc. Ital. Sci. Nat., vol. 75, 1936, p. 280.—Perrier, La faune de la France, vol. IA, Paris, 1936, p. 95 (key to the French species of *Antedon*; color; size).—Mortensen and Steuer, Notes Hydrobiol. Fish. Directorate, Egypt, No. 21, 1937, The fishery grounds near Alexandria. XIII. Echinoderma, p. 28 (local distribution), pp. 28–29.—KOLOSVARY, Festschrift für Embrik Strand, vol. 2, 1937, p. 469 (comparison with *A. adriatica*).—TORTONESE, Boll. Mus. Zool. Univ. Torino, vol. 46, ser. 3, No. 82, 1938, p. 5 (listed), pp. 44–45 (synonymy; material; color); Boll. Zool., year 9, Nos. 5–6, 1938, p. 267, p. 269 (occurrence off Tripolitania).—BRUUN, Bull. Stat. Océanogr. Salammbo, No. 40, 1940, p. 17 (listed).—TORTONESE, Ann. Mag. Nat. Hist., ser. 11, vol. 13, 1946, p. 715 (habitat; color variations).—BACCI, Pubbl. Staz. Zool. Napoli, vol. 20, 1947, p. 171 (Gulf of Naples; bottom communities), p. 172.—VATOVA, Pubbl. Staz. Zool. Napoli, vol. 21, 1947, p. 60.—CUÉNOT *in* Grassé, Traité de zoologie, vol. 11, 1948, pp. 45, 71.—DAWYDOFF *in* Grassé, Traité de zoologie, vol. 11, 1948, fig. 357 (larva).—TORTONESE, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4 (bathymetrical range), p. 15 (listed).—MÜLLEGER, Aquar. Terrar. Z. Stuttgart, vol. 4, 1951, p. 18, fig. 4 (photograph of live specimen standing on the arm tips; elementary description; color), pp. 18–19 (developmental stages).—TORTONESE, Atti Accad. Ligure, vol. 8, 1952, p. 168 (in table of habitat), pp. 169–172 (occurrence in Ligurian Sea; color; cirri), fig. 2; Bull. Inst. Zool. Univ. Torino, vol. 4, No. 4, 1954, pp. 9, 10 (Israel); Bull. Stat. Aquicult. Pêche, Castiglione, new ser., No. 7, 1955, pp. 207–209.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, pp. 62, 63 (nervous system), p. 73 (spawning time), p. 103 (response to mechanical stimulation), p. 108 (regenerative powers), fig. 30B and C.—CHERBONNIER, Les échinodermes, Monte Carlo, 1955, p. 93; Bull. Stat. Océanogr. Salammbo, No. 53, 1956, p. 4 (listed), p. 7 (stations off Tunisia).—TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 181 (localities of Tortonese collection specimens); Bull. Res. Council Israel, vol. 6B, Nos. 3–4, 1957, pp. 189, 190 (small size in Israel).—GAUTIER-MICHAZ, Ann. Inst. Océanogr., Paris, new ser., vol. 34, 1958, pp. 146, 147 (*Calypso* stations), p. 155.—KERNEIS, Vie et Milieu, vol. 11, No. 2, 1960, p. 171.—COSTA, Vie et Milieu, vol. 11, No. 1, 1960, p. 22 (off Marseille), p. 50.—TORTONESE and DEMIR, Publ. Hydrobiol. Res. Inst. Univ. Istanbul, vol. 5, pts. 1, 2, 1960, p. 9 (Aegean Sea, Sea of Marmara, Bosphorus).—COGNETTI and SANTARELLI, Boll. Pesca, Piscic., Idrobiol., new ser., vol. 14, p. 13 (Gulf of Naples).—TORTONESE, Publ. Hydrobiol. Res. Inst. Univ. Istanbul, vol. 5, pts. 1, 2, 1960, p. 34 (replaced by *A. bifida* [i.e. *A. bifida moroccana*] along shores of Algeria).—ZAVODNIK, Biol. Vestnik, Ljubljana, vol. 8, 1961, p. 49.—TORTONESE, Thalassia Jonica, vol. 4, 1961, p. 190 (Ionian Sea).

Antedon roseum (Hamburg Mus., MS) A. H. CLARK, Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 30.

Diagnostic features [modified by A.M.C.].—There are 18 to 30 (usually 20 to 23) cirrus segments, all of which but the first two or three are longer than wide and centrally constricted; the distal only differ slightly from the proximal; the outer halves of the cirri are only slightly, if at all, curled in dorsally in preserved specimens, and in lateral view are not noticeably wider than the basal halves; the IBr_1 are relatively long, not more than three times as broad as long, regularly oblong or slightly trapezoidal, the lateral edges usually making a straight line, or a very wide angle with those of the axillary; P_1 is stout but tapers rapidly, with less than 20 (usually 13 to 15) segments; the disk is naked interbrachially.

[NOTE BY A.M.C.] I cannot account for Koehler's description of 35 to 45 segments for P_1 (1921 and 1927); possibly it was derived from earlier descriptions of "*rosacea*" including *bifida*. None of the specimens in the British Museum (from the south of France and Naples) has more than about 15 segments in P_1. Koehler apparently checked this section of the typescript but left unmodified Mr. Clark's description of P_1 as having up to 18 segments.

Description.—The centrodorsal is low hemispherical, the bare polar area small and more or less convex. The cirrus sockets are arranged in two, or in two and a partial third, more or less alternating and irregular crowded marginal rows.

The cirri are XX–XXXVI (usually about XXV), 17–25 (usually 20–23), from 15 to 20 mm. long; the first segment is short, the second about half again as broad as long;

the third longer than broad, and the fourth about half again as long as broad; the remaining segments are all of about the same proportions; the opposing spine is always prominent, but small, terminal or subterminal in position, directed obliquely forward; the terminal claw is about the length of the penultimate segment, moderately stout and moderately curved. The segments in the proximal two-thirds of the cirri have markedly swollen articulations, this feature dying away distally on the ventral surface of the cirri but persisting to the end on the dorsal surface so that in a lateral view the later segments have a flat or slightly convex ventral profile and a rather strongly concave dorsal profile, which in some specimens is so marked as to give the appearance of two dorsal spines, one proximal and one distal, on each segment. The cirri are well rounded in cross section basally, but become somewhat compressed laterally in the distal half. (See fig. 13,*e*, p. 198.)

The edge of the radials in the mid-radial line is usually even with the edge of the centrodorsal, but often projects slightly.

The IBr_1 are oblong, about twice as broad as long, the sides more or less parallel and furnished with a rounded ventrolateral projection in the distal half (fig. 13,*f*, p. 198). The IBr_2 are rhombic, slightly broader than long, with the distal angle rather low and with the middle of the proximal border raised into a slight broad rounded tubercle in the formation of which the distal border of the IBr_1 is also involved.

Ten slender arms up to 110 mm. long; first brachial wedge-shaped, about twice as long outwardly as inwardly, exteriorly provided with a thin flangelike ventrolateral border continuing a similar border on the IBr_2 and the anterior half of the IBr_1, the two on each ray interiorly united for about half their length, their inner edges forming a right angle with each other beyond their union; the interior anterolateral angles of the first brachials are furnished with a thin rounded projection; second brachials wedge-shaped, longer outwardly than inwardly, somewhat larger than the first; their shape may become more or less irregularly quadrate owing to the greater or lesser development of a rounded posterior process incising the first brachials, and the central portion of the proximal border usually rises to a more or less evident tubercle with the distal border of those ossicles; third and fourth brachials (forming the first syzygial pair) nearly oblong, but very slightly longer inwardly than outwardly, about half again as broad as long; next four segments wedge-shaped, but with the ends not especially oblique, about twice as broad as their median length; ninth and tenth brachials (second syzygial pair) similar, though slightly longer; following brachials more obliquely wedge-shaped, about as long as broad, very gradually becoming more and more elongated with the ends less and less oblique, the terminal ones being about two and a half times as long as broad with somewhat swollen articulations.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of usually three muscular articulations.

P_1 is from 8 to 11 mm. long, with 13 to 18 segments; P_2 is from 5.5 to 7 mm. long with 10 to 12 segments; P_3 is 5 mm. long with 8 to 11 segments. The pinnules are similar to those of *A. bifida*, but the denticulation of the distal edges of the segments is not so pronounced and the component segments of the lower are somewhat and of the distal much longer.

In a specimen from Naples Professor James A. Grieg found well-developed deposits along the ambulacral grooves, consisting of rough, straight or slightly curved, rods alternating with the sacculi and extending from the ambulacral lappets downward nearly to the brachials, alternating with small, delicate, and very irregular fenestrated plates lying above the sacculi.

The color of specimens at Rhodes is given by Tortonese, 1946, as varying from yellow, coral red, chocolate brown, to whitish with brown spots and rings. Mülleger, 1951, says that it may be anything from uniform white to dark red or brown.

Notes.—In the specimens collected by the *Washington* in northern Sardinia, Baldelli found the number of the cirrus segments to range from 17 to 30; the average of numerous counts was 23.

He gives the arrangement of the syzygial pairs on 9 arms in which this was irregular, as follows:

Regular disposition

Brachials 3+4, 9+10, 14+15, 18+19, 22+23, . . .

Irregular disposition

Brachials 3+4, 7+8, 11+12, 15+16, 19+20, 23+24.
" 3+4, 9+10, 16+17, 20+21, 24+25.
" 3+4, 9+10, 14+15, 22+23.
" 3+4, 9+10, 15+16, 19+20.
" 3+4, 9+10, 13+14, 46+47.
" 3+4, 9+10, 18+19.
" 3+4, 11+12, 16+17.
" 3+4, 12+13, 16+17, 20+21, 24+25.
" 3+4, 9+10, 11+12, 16+17.

Tortonese (1935) has recorded some specimens from the Gulf of Genoa with up to 29 cirrus segments but comments that there are rarely more than 20.

Abnormal specimen.—With two disks: In a specimen of this species from Naples Mr. Herbert C. Chadwick found a supernumerary disk.

The true disk, which measured 7.5 mm. in diameter, was in all respects quite normal except for the displacement of one of the ambulacral grooves. On its oro-lateral border it bore a small rounded body roughly spherical in shape and about 3 mm. in diameter, which was attached to the normal disk by a sort of stalk which gradually narrowed from the oral to the aboral surface. Near the center of its oral surface was a well developed mouth, fringed with tentacles, from which 5 ambulacral grooves radiated just as they do in the disk of a normal *Antedon;* of these 4 could with little difficulty be traced outward to the aboral surface. The remaining one ran along the stalk of attachment to the normal disk and joined the ambulacral grooves of the pair of arms nearest to it, immediately after crossing the line of junction of the two disks. On the aboral surface the anus appeared as a minute crescent-shaped aperture close to which was a minute scarcely distinguishable pore, another rather large aperture appearing on the summit of the funnel-shaped projection.

The body cavities of the two disks intercommunicated freely through the stalk uniting them, but their alimentary canals were quite distinct. The alimentary canal of the supernumerary disk was well developed and contained food. The ambulacral system was well marked, and presented a feature of special interest. The minute pore close to the anus opened into a canal-like space which traversed the body wall for a distance equal to the thickness of 17 sections and again communicated with the exterior through the funnel-shaped projection already described. That this canal was a modified ambulacral groove was shown by the epithelial cells that lined it, which were precisely similar to those that line the ordinary ambulacral grooves; and further evidence in the same direction was afforded by the presence in its walls of numbers of the deeply staining problematical bodies which are invariably seen in sections through the ambulacral groove of this species. Beneath the epithelium of the ambulacral grooves the nerve band can be recognized without difficulty on most sections. The circular water vessel and radial water vessels were also present, and from the former a considerable number of water tubes depended into the body cavity. Water pores traversed the body wall in all the sections. But the skeletal and axial nervous systems present in the normal disk and the central plexus were entirely absent in the supernumerary one.

Mr. Chadwick, adopting a suggestion from Prof. A. Milnes Marshall, supposed this condition to have arisen from incomplete evisceration.

Parasites.—In addition to the parasites already given for *Antedon mediterranea* (vol. 1, part 2, p. 684) Vogt and Yung (1887) mention an undescribed (?) copepod which lives embedded in the tissues of specimens from Naples. This is probably similar to the crustacean reported by P. H. Carpenter as found embedded in the disk of *Heliometra glacialis* (vol. 1, part 2, p. 440).

Localities.—Mediterranean Sea [Lamarck, 1816, and many succeeding authors] (13, C.M.; L.M.; P.M.; H.M.) Type locality.

Palma (Huelva), on the Bay of Cadiz [Aranda y Millan, 1908].

Near Gibraltar [von Graff, 1887].

Southern and eastern Spain. Málaga [Busch, 1849; MacAndrew, 1851] (2, C.M.). Valencia [Aranda y Millan, 1908]. Machina [Aranda y Millan, 1908]. Barcelona [Aranda y Millan, 1908]. Blanes [Aranda y Millan, 1908]. Between Blanes and San Féliu de Guixols; 94 meters [Pruvot, 1901]. North of Cape San Sebastian, Province of Gerona; 142–116 meters [Pruvot, 1901]. Rosas [Lacaze-Duthiers, 1891]. ?Minorca, Balearic Islands [Braun, 1886]. Majorca; *Xauen* stas. X 2, lat. 39°31′ N., long. 8°44′ E., X 8, lat. 39°18′ N., long. 9°5′ E.; 55 meters [Rivera, 1934].

France. Coast of France (16, P.M.). Banyuls-sur-Mer [Pruvot, 1891, 1895, 1897; Aranda y Millan 1908; Bohn, 1911; Chalaux, 1935; Tortonese, 1956]. Roches Cannalots, near Banyuls [Pruvot, 1895]. Port Vendres (just north of Banyuls) [Baudelot, 1872; Lacaze-Duthiers, 1891]. Cette [Leuckart, 1833; Koehler, 1894; A. H. Clark, 1911] (8, M.C.Z., 242; P.M., one from P. Gervais). Cette, Frontignan jetty [Lacaze-Duthiers, 1891]. Gulf of Lyon [Pruvot, 1897]. Marseille [Marion, 1878, 1883; Ludwig, 1879; Carus, 1884; A. H. Clark, 1911] (about 50, P.M., M. Deshayes, 1874). Bay of Marseille [A. H. Clark, 1913] (4, B.M.). Same, 60–80 meters [A. H. Clark, 1913] (1, B.M.). West side, Gulf of Marseille; 3–36 meters; bottom, *Zostera* and algae [Vayssière, 1919]. Vicinity of Marseille; Bassin national, 0–2 meters; at the head of the gulf, at Pharo, Madrague, Cape Janet, Mouripiano, Point Rouge de Montredon, and Fond des Calanques; off Mejeau; south of Rion and Planier, 100–200 meters [Marion, 1883]. La Ciotat [Koehler, 1894]. Toulon [Dujardin, 1835, 1862; J. Barrois, 1888; Bonnet, 1928]. Hyeres [A. H. Clark, 1911] (1, P.M.). Nice (Nizza) [Risso, 1826, and many succeeding authors] (4, M.C.Z., 241; B.M.; H.M.). Villefranche (Villafranca) [J. Barrois, 1888]. Same, 80 meters [Koehler and Vaney, 1910].

Principality of Monaco [Tortonese, 1956]. Harbor of Monaco (8, M.O.M.). Near Cape Martin (1, M.O.M.). Near the tip of Cape Martin, 45–60 meters (1, M.O.M.). *Eider* station 0289; about 600 meters from the tip of Cape Martin, between Monte Carlo and Menton (Mentone); 46–60 meters; Feb. 28, 1908 (1, M.O.M.). *Eider* station 0212; off Roquebrune (Roccabruna) Bay; 17–37 meters; Feb. 4, 1908 (1, M.O.M.).

Sardinia (Sardegna). *Washington* station II, haul 4; off Porto Torres, Gulf of Asinara, northern Sardinia (lat. 41°02′58′′07′′′ and 41°05′01′′ N., long. 8°32′20′′09′′′ and 8°32′23′′01′′′ E.); 420 and 370 meters; madrepores; August 3, 1881 [Giglioli, 1884; Baldelli, 1914]. Porto Camicie (Maddalena), northeastern Sardinia; *Washington*, 1881 [Baldelli, 1914].

Italy (13, M.C.Z., 239). Gulf of Genoa (Genova) [Verany, 1846]. Same, 150–300 meters [Tortonese, 1938, 1952, 1956]. Portofino, Gulf of Rapallo [Marchisio, 1896, Tortonese, 1938, 1952]. Spezia (Spezzia) [Metschnikoff, 1871; A. H. Clark, 1913] (1, B.M.). Gulf of Spezia [Bronn, 1860]. Levanto [Tortonese, 1938, 1952]. Levanto; Elba; Monterosso; Livorno, 100–250 meters; Riviera di Ponente, 150–300 meters [Tortonese, 1952]. Rome (5, U.S.N.M., 35699). Mouth of the Tiber [Barrelier, 1714]. Naples [Columna, 1592, and many succeeding authors] (numerous examples, both living and preserved, S.Z.; U.S.N.M., 35700; M.C.Z., 41, 237, 402; C.M.; B.M.; H.M.; L.M.; Berg. M.; R.T.J.). Bay of Naples (1, U.S.N.M., 21651). Gulf of Naples; 14–100 meters [Parenzan, 1940]. Same, Secca di Gajola [Giesbrecht, 1901]. Taranto, as a fossil in the pleistocene marly clays [Bassani, 1905]. Taranto [Tortonese, 1956]. Secca Amendolara, Calabria, 44 meters [Tortonese, 1956]. Mar Piccolo and Mar Grande, Ionian Sea, 15–22 meters [Tortonese, 1961].

Sicily [A. H. Clark, 1912] (1, H.M.). Messina [M. Sars, 1857; Ludwig, 1879; Carus, 1884]. Mondrazone [Delle Chiaje, 1841]. Pozzuoli [Delle Chiaje, 1841]. Palermo [Grube, 1840; Ludwig, 1879; Carus, 1884]. Taormina, January 7, 1909 (2, C.M.). *Thor* station 9, off Taormina, December 14, 1908 (1, C.M.). Milazzo, 50–60 meters [Tortonese, 1956].

Aegean Sea, among the Cyclades; 37–55 meters [Forbes, 1844]. Aegean archipelago, 55 meters (1, Berg. M.). Cyclades, 17–73 meters [Carus, 1884]. Cum Burnu, Rhodes [Tortonese, 1946]. Aegean Sea, Marmara, Bosphorus, 15–60 meters [Tortonese and Demir, 1960].

Sea of Marmara [Tortonese, 1956]. Same, *Selanik* station 31; 85 meters; September 24, 1894. Station 35; 72–77 meters; September 25, 1894. Station 36; 53 meters; September 26, 1894. Station 61, 32–43 meters; October 8, 1894 [Ostroumoff, 1896]. Istanbul; between the Tour de Leandre and Top-Hane; 40–42 meters; muddy gravel and broken shells [Marion, 1898]. Bebek and Rumili Hissar [W.T.M. Forbes]. Bosphorus [Tortonese, 1956].

Israel. Zib, near Rosh-Hanikrah; Atlith, 72 meters; Caesarea, 72 meters; Nathania, 54 meters and 90 meters; Tel Aviv, 72, 90 and 54 meters; Vitkin, 90 meters [Tortonese, 1954 and 1956]. Haifa Bay, 38 and 70 meters [Tortonese, 1957].

Alexandria; 39–45 meters [Mortensen and Steuer, 1937].

Violante; 2 miles east of the NE. point of Malta; 80 meters; September 1, 1879 [Tortonese, 1935] (Genoa M.). *Thor* station 142; east of Malta (lat. 35°44′ N., long. 15°07′ E.); 98 meters; July 22, 1910 (3, C.M.).

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Violante; off Tripolitania, 17 miles east of the Gerba (Djerba) Islands; 50 meters; September 7, 1879 [Tortonese, 1935, 1938] (Genoa M.).

Tanche station 780; east of Gabès, Tunisia (lat. 35°55′ N., long. 10°20′ E.); 25 meters; May 1924. *Tanche* station 781, NE. of Gabès (lat. 34°07′ N., long. 10°28′ E.); 23 meters; May 25, 1924. *Tanche* station 768; North of Kuriat Island (lat. 36°30′N., long. 11°17′–11°14′ E.); 110–115 meters; May 18, 1924. *Tanche* station 788, E. of La Galite Island (lat. 37°27′–37°24′ N., long. 9°38′–9°35′ E.); 180 meters; June 3, 1924. *Tanche* station 793; NW. of Tabarca (lat. 37°06′–37°08′ N., long. 8°47′–8°42′ E.); 190 meters; June 5, 1924 [Ranson, 1925]. *Thor* station 137, NE. of Zemba Island, east side of the entrance to the Gulf of Tunis (lat. 37°17′ N., long. 10°56′ E.); 190 meters; July 19, 1910 (5, C.M.). Station Océanographique Salammbo, April 30, 1955; 250 meters. Station 4; E. of Hergla (lat. 36°02′ N., long. 10°45′ E.); 70–90 meters; sand; August 4, 1955. Station 6; between Plane Island and Cape Zebib; 50 meters; sand; August 9, 1955. Station 7; W. of the Gulf of Tunis; 50 meters; August 9, 1955 [Cherbonnier, 1956]. *Porcupine;* Skerki (? Banc des Esquerquis) Bank; 55–220 meters [P. H. Carpenter, 1881, 1884]. *Porcupine*; Bay of Benzert (Bizerta); 91–183 meters and 91–220 meters [P. H. Carpenter, 1881, 1884; A. H. Clark, 1911]. *Calypso* stations 513, 542, 545, and 549, between Sicily and Tunisia; 45–70 meters [Gautier-Michaz, 1958].

[NOTE BY A.M.C.] It is possible that some or all of these Tunisian records may be of *A. bifida moroccana* rather than of *A. mediterranea*; the two must approximate in this area.

Geographical range.—From Cape St. Vincent, SW. Spain, eastward around the whole Mediterranean except in the Adriatic and off Algeria and Morocco.

Bathymetrical range.—From the shore line down to 420 meters.

Occurrence.—At Malaga, MacAndrew (1851) found this species abundant.

At Valencia, Professor Aranda y Millan (1908) found it in the littoral region on rocks covered with algae and on coralline bottoms, and in the coastal (deep littoral) region on sandy bottoms.

North of Cape San Sebastian, in the province of Gerona, Pruvot (1901) found the bottom in 116 to 142 meters to be characterized by an extreme abundance of comatulids, this species together with *Leptometra phalangium*, the former, however, markedly predominant.

About Banyuls the feather stars occur in the higher, middle and lower sections of the littoral zone (Pruvot, 1897), in the first two on rocks covered with algae, in the last on coralline bottom. They are also found in the sandy section of the coastal region, as at Valencia.

Pruvot (1895) has given a very detailed account of their occurrence here. They are found in the third faunal zone, of coastal mud, and in the fourth zone in broad sandy areas they are still very common locally, associated with at least an equal quantity of *Leptometra phalangium*.

The Roches Cannalots, near Banyuls, are remarkable for the extreme abundance of echinoderms and pennatulids (Pruvot, 1895); in a single haul taken here in 90 meters there were 1500 of this species and 170 of *Leptometra phalangium*.

Lacaze-Duthiers (1891) found this species along the quay at Port Vendres, and on the Frontignan jetty at Cette. Sabatier (1889) says that in the old port at Cette

Antedon is often very abundant, but as Professor van Beneden told him he had noticed when he was working at Cette, there are times when comatulids disappear entirely, reappearing again later.

Regarding the occurrence of this comatulid in the vicinity of Marseille, Professor Marion (1883) says that all the stones forming the foundations of the jetty in the places protected from the sun's rays down to a depth of 6 or 7 meters are covered by a veritable forest of feather stars; it is rare, indeed, that a naturalist is enabled to see such a profusion of crinoids.

In the Bassin National in November 1882, a very few were dredged almost in the center on a bottom of black ill-smelling mud. They had here decreased in quantity over past years, and the mud on the bottom had increased in amount and had become more ill-smelling.

In the submerged zone, in 0 to 2 meters, they occur at the head of the gulf at Pharo, Madrague, Cape Janet, Mourepiano, Point Rouge de Montredon, and Fond des Calanques. These several localities, subject to the influence of invasions of fresh water, have certain features in common. They are the most favorable for the growth of Ulvae. At certain times various animals, more particularly certain mollusks—Aplysias and nudibranchs—are abundant, only to disappear again later. Here feather stars are found rarely among the algae.

They occur on the broad muddy stretches in the northeastern part of the gulf. On the muddy bottoms off Mejeau they are found associated with *Leptometra phalangium*, represented by individuals of large size with an exceptionally strong opposing spine. On the muddy sand south of the island of Maire also feather stars of very large size occur in 65 to 70 meters which similarly have a very prominent opposing spine.

This is especially interesting when considered in connection with the occurrence in deep water in the Irish Sea of a comparable large variety of *Antedon bifida*, as remarked by Forbes, Norman, and others.

On the muddy gravel south of the island of Rion and Planier in 100 to 200 meters this species gives place to *Leptometra phalangium*, together with which are found only very small individuals appearing stunted.

At La Ciotat, Koehler (1894) found it at very different stations and depths, from the littoral patches of *Zostera* down to muddy bottoms off shore at depths of more than 100 meters. In these greater depths it is associated with *Leptometra phalangium*, and the two together seem to form an actual carpet on the bottom, judging from the numbers of individuals brought up by the dredge.

J. Barrois (1888) says that at Toulon it is abundant along the quays and may here be taken by hand in very large numbers. He notes certain differences between specimens from Villefranche and others from Toulon. At Villefranche the individuals are all spotted, showing gray and white speckles on a red background. At Toulon they are much more variable, uniform red or orange, or of the same colors mixed. The Villefranche variety is a little more slender than that at Toulon, and lives at some depth, with the result that it is usually collected with the dredge, while at Toulon the animals are abundant along the quays and may be taken by hand.

It is found generally among algae on quays and jetties in the south of France (Koehler, 1921).

Tortonese has recorded it from many places round the Ligurian Sea.

It is very common in the Bay of Naples (Lo Bianco, 1888, 1899), living by preference on bottoms of detritus and on coralline banks at depths from 20 to more than 100 meters. A smaller variety occurs in the *Posidonia* fields in 10 to 15 meters.

When at the Naples Station in 1910, I was told that it was then quite rare.

In the Aegean Sea among the Cyclades, Forbes (1844) found it to be local on weedy ground in 37 to 55 meters.

In the Sea of Marmara, as elsewhere, it appears to be locally abundant. In the four dredge hauls of the *Selanik* at which it occurred (Ostroumoff, 1896) there were found 1 (Stations 31, in 85 meters, and 36, in 53 meters), 2 (Station 35, in 72 to 77 meters), and 683 (Station 61, in 32 to 43 meters) individuals.

Dr. William T. M. Forbes has told me that it is abundant locally near Istanbul. He himself has found it at Bebek and Rumili Hissar, and quantities are picked up by the nets of the fishermen operating from Istanbul in various localities in the adjacent waters.

In the Bosphorus at Istanbul, between the Tour de Leandre and Top-Hane, Marion (1898) dredged numerous large specimens with robust arms and with the opposing spine only slightly developed; he remarked that the slender specimens of littoral localities were not observed. He said that these cannot be distinguished except as a variety of the form extending from the *Zostera* fields to the muddy sand of great depths on the coast of Provence.

Dr. E. Tortonese, 1954 and 1957, recorded the species from a number of localities along the coast of Israel, where it was collected by members of the Hebrew University in Jerusalem. In Egypt the species has only been reported from Alexandria by Mortensen and Steuer, 1937. Tortonese (1935) has also recorded *mediterranea* from Malta and from off the western end of Tripolitania. There are numerous records of *Antedon* from off Tunisia, notably by Cherbonnier (1956), P. H. Carpenter (1884) and Ranson (1925), which are now assumed to be of *mediterranea*, but some of those from the north coast at least may be of *bifida moroccana*. Alternatively *mediterranea* may extend into eastern Algeria.

Gourret (1893) has found the arms of this species in a *Labrus mixtus* taken in the Gulf of Marseille in 1892; but this occurrence was undoubtedly accidental as there is no evidence that crinoids form any part of the normal food of fishes.

This species occurs as a fossil in the Pleistocene marly clays at Taranto (Bassani, 1905).

Occurrence of the pentacrinoids.—Professor de Lacaze-Duthiers (1891) says that at Rosas the breeding period set in at the beginning of April; shortly afterwards the glass and the stones of the aquarium and the stems of sponges were covered with innumerable larvae in all stages of development. After an interval of two days the pentacrinoids were formed and with a lens their arms and pinnules could be observed.

He remembers having found carpets of pentacrinoids under the stones of the Frontignan jetty at Cette in August and September.

In the echinoderm tank in the aquarium at Naples, almost always attached to the walls or to old branches of gorgonians or antipatharians, there may be seen the pentacrinoids of this species in various stages up to a length of about 7 mm., beyond which size they do not develop, perhaps because of lack of food (Lo Bianco, 1888).

For further details regarding the breeding season see vol. 1, part 2, p. 373.

History.—In 1592 Fabius Columna published the first account of this species, together with a very excellent figure. He had found it abundantly at Naples, and gave a very accurate description of its arms and cirri (W. B. Carpenter, 1866); the latter he assumed were used to seize the food and to draw it to the mouth, which he supposed to be at the central point from which they radiate, after the manner of the octopus. He described the visceral mass and noted that it is very easily detached. He originally described the animal as "subrubens," but in 1606 he called it "croceum," stating further "reperiuntur frequenter vario colore distinctae veluti maculosae; partes quidem lutescentes, aliae pullo colore"; and he also notes, quoting observations by Bartholinus, that if these animals be placed while yet alive in fresh water they impart their color to it while still living.

His figure and his account were republished by Aldrovandus in 1602 and again in 1618, and a majority of the following seventeenth century authors contented themselves with reproducing the figure and more or less of the information given by Aldrovandus.

In 1714 this species was redescribed by Barrelier from the mouth of the Tiber.

Linck in 1733 recognized as distinct both Columna's form which he called *crocea*, and Barrelier's, which he called *barbata*, in addition to that described by Llhuyd, which he named *rosacea* (=*bifida*); but Linnaeus in 1758 united all three, together with an Indian Ocean species (*Comatula pectinata*) under the name of *Asterias pectinata*.

For more than a hundred years after the appearance of Barrelier's memoir no original contributions regarding this animal were published. In 1816 Lamarck bestowed upon it the name of *Comatula mediterranea*, and ten years later Risso, giving it the additional names of *Comatula annulata* and *C. coralina*, recorded it from Nice and mentioned various facts concerning the time of its occurrence and its local habits.

The anatomy of this species began to attract attention in 1823, in which year Meckel described the mouth and anus, twenty-three years after these orifices had been pointed out by Adams in *A. bifida*. In 1826 Heusinger further described the digestive system. In 1827 Leuckart described, under the name *Myzostomum*, the curious parasitic worms almost invariably found on this species, for which he used Leach's name *europaea*.

The structure and anatomy were now taken up more seriously, forming the subject of more or less extended observations by Heusinger (1828, 1833), who gave colored figures of the entire animal and of dissections, Delle Chiaje (1832) and Leuckart (1833), while Goldfuss (1832) compared the skeleton with that of fossil types. Leuckart's account was quite detailed, including a discussion of the range and history; he also recorded it for the first time from Cette.

From studies made at Toulon, Dujardin in 1835 determined the fact that the eggs are extruded and carried on the pinnules, and he added other points of interest regarding its habits; for the first time he found the pentacrinoid young.

In 1840 Grube published a monographic account of the Mediterranean echinoderms, recording this species from Naples and Palermo. In the following year Delle Chiaje recorded it under the name *bicolor* from two new localities in Sicily, while J. Müller pointed out that the madreporite previously described in this species by Delle Chiaje was in reality nothing more than a myzostome parasite. In the same year Forbes reasserted the identity of this and the English form.

A further account of the myzostome parasites was given by Leuckart in 1842, and in the next year J. Müller described the structure of the skeleton in very great detail. In 1844 Edward Forbes announced that in his dredging operations among the Cyclades he had found this species locally distributed, in 1846 Verany recorded it from the Gulf of Genoa, and in 1849 Busch mentioned its occurrence at Malaga and discussed its structure, Dujardin publishing the second colored figure in the same year.

During the next twenty years little new information was brought out. MacAndrew again recorded it from Malaga in 1851, and Schmarda again from Nice in 1853. In 1857 M. Sars added Messina to the list of known localities, in 1859 Forbes gave as its habitat the entire Mediterranean Sea, and in 1860 Bronn reported it from Spezia.

New colored figures were given by Dujardin and Hupé in their monograph on the echinoderms published in 1862, and at the same time a pentacrinoid which the former had captured at Toulon in 1835 was figured. Metschnikoff brought out additional information concerning the myzostomes in 1866.

In his epoch-making memoir, published in 1866, W. B. Carpenter considered this form as conspecific with *bifida*, but as representing a more or less marked variety of it. The detailed history he gives covers both species equally, but he specifically describes the cirri and certain other features of *mediterranea*.

The classical memoirs of Wyville Thomson (1865) and W. B. Carpenter (1866) naturally served to attract especial attention to the comatulids, with the result that the following decade witnessed a flood of anatomical contributions by various continental writers, Metschnikoff (1871), Grimm (1872), Baudelot (1872), Semper (1875), Götte (1876), Teuscher (1876), Ludwig (1876, 1877, 1879), Lang (1876) and Greeff (1876), with comments by Carpenter (1875, 1876).

Metschnikoff's material came from Spezia, and Baudelot's from Port Vendres, a new locality. In 1872 Wyville Thomson recorded that the *Porcupine* had dredged many specimens off the north coast of Africa.

The Naples station was opened in 1874, and the station at Marseille came to the fore, under the able guidance of Prof. A. F. Marion, in 1876. As a result of the centering of effort in these places, Schmidtlein published (1879) a detailed account of the breeding season at Naples as he was able to determine it with the assistance of Drs. Dohrn and Spengel; Ludwig gave a monographic account of the type, though without adding any new information regarding its distribution; and Marion (1883) described in great detail its occurrence about Marseille.

In 1875 von Graff described from this species a curious molluscan parasite which he called *Stylina comatulicola*, and in 1877 there appeared his monograph on the myzostomes.

The relations of this to fossil species were discussed by Quenstedt in 1876, and its history and various details of its structure were considered by P. H. Carpenter in 1879.

In the 1880's the superior facilities offered at the Naples station, added to the accessibility and the natural attractions of the city, resulted in focussing here almost all the anatomical and embryological work upon the recent crinoids. The papers prepared as a result of studies here, or with the aid of material secured from the station, were very numerous, contributions appearing by Ludwig (1880), Götte (1880), de Gasparis (1882), Krukenberg (1882), Weinberg (1883), Beard (1884), A. M. Marshall (1884, 1886), Dendy (1886), Vogt and Yung (1887), Bury (1888, 1889), and Korschelt (1889), while in addition, much information gained from specimens from Naples was incorporated in various text books without any indication as to its origin. W. B. Carpenter (1884) and his son P. H. Carpenter (1881, 1884, 1887, 1888) also contributed much to the knowledge of this species, though their work always was based mainly upon *A. bifida*. The outstanding memoirs of this decade were those on the embryology and early development by H. Bury (1888, 1889) and Jules Barrois (1886, 1888), the former working at Naples and the latter on material from Toulon and Villefranche. Since the publication of Wyville Thomson's original contribution on the embryology of *A. bifida* in 1865, histological technique had been so perfected as to give these memoirs practically the value of original treatises.

The local distribution of this species about Marseille was discussed by Professor Marion (1883), and its general distribution in the Mediterranean by Carus (1884). Perrier (1882) mentioned that it had been obtained by the *Travailleur*, but gave no details. The myzostomes were treated in great detail by von Graff (1884, 1887).

The lines of work characteristic of the eighties were continued into the nineties. From the Naples station appeared contributions on anatomical, histological and physiological points by Ludwig (1890), Frenzel (1892), Nagel (1892, 1894), Chadwick (1893), Crety (1894), Field (1895) and Russo (1899), with studies on the myzostomes by Beard (1894, 1897), Wheeler (1894, 1895, 1898, 1899), Driesch (1896) and Konstanecki (1898), an account of the details of the local occurrence and of the breeding season by Lo Bianco (1899), and a description of the best way to preserve specimens, also by Lo Bianco (1890; translated into many languages).

Professor de Lacaze-Duthiers, the founder of the biological station at Roscoff, had interested himself in establishing another station in the Mediterranean, where the winter storms prevalent at Roscoff would not interfere with work. Port Vendres was his first choice, but no location could be secured here because of possible requirements for naval purposes in case of war, so he decided upon Banyuls-sur-Mer, near the Spanish border. The station was built in 1881, but its scope was greatly enlarged in 1893 through the gift by Prince Roland Bonaparte of a sum of money sufficient for the purchase of a small but adequate steamer.

Professor de Lacaze-Duthiers had recorded (1891) this species from Banyuls, Port Vendres, Rosas and Cette; the intensive work on deeper water made possible by the steamer *Roland* enabled Prof. G. Pruvot (1895, 1897) to determine its local distribution about Banyuls with great precision. Pruho (1895) recorded the myzostomes found here, while some of the material described in the various papers by Cuénot came from this locality.

Prof. Rene Koehler described the occurrence of this form at Cette (1894) and at La Ciotat (1894), and Marchisio (1896) recorded it from Portofino on the Gulf of Rapallo. In the Sea of Marmara, Ostroumoff (1896) recorded it from a number of stations as the result of the work of the Russian steamer *Selanik*, and from the Bosphorus it was dredged in abundance by Marion (1898).

In 1891 P. H. Carpenter announced the results of his investigations into the systematic interrelationships of the various forms of *Antedon*, based on a study covering about 25 years.

Since 1900 this species has formed the subject of a large number of studies on interesting details connected with oogenesis, spermatogenesis, various phases of minute anatomy and histology, and experimental zoology, while research into the broader zoological aspects of its natural history has dwindled to almost nothing.

In 1900 Bosshard described the minute structure of the articulations, Russo traced the origin of the sexual elements, and Giesbrecht gave a monographic account of a curious parasitic copepod which had previously been found on *A. adriatica* by Rosoll (1888). In 1901 Przibram published the results of his studies on the regeneration of this species, Riggenbach discussed the autotomy, Russo contributed additional information regarding the primitive gonad and the primitive stone canal, Kelly worked out the chemical composition of the skeleton, Pruvot gave new records for various localities on the eastern Spanish coast, and Giesbrecht described a new copepod parasitic in the intestinal canal. In 1902 Buller described the fertilization of the eggs, and W. S. Marshall the male gonopores. In 1904 Ludwig discussed the retention of the eggs on the pinnules of the females, and Grieg compared *mediterranea* in detail with related species. In 1905 Godlewski gave the results of his experiments in hybridizing this species with echinoids, Minckert published a long account of the regeneration, first indicating the way in which comatulids with more than 10 arms pass from the young 10-armed to the adult multibrachiate stage, and Bassani recorded this form as a fossil. In 1906 Lo Bianco described the effect on the comatulids in the Bay of Naples of the rain of cinders from the eruption of Vesuvius in April of that year, and there were further contributions by Przibram on regeneration and by Bassani. Chadwick's detailed account (1907) of the early stages of *Antedon* was based upon material of this species sent to him from Naples. In 1908 August Reichensperger described certain glandular structures, and Aranda y Millan recorded this species from various localities on the Spanish coast. In 1910 Koehler mentioned this form as represented in the collections of the *Travailleur* or *Talisman*, and Prof. Charles A. Kofoid published the first photograph of it from living examples, taken in the aquarium of the Naples station.

In 1911 Cotronei and Schaxel described the finer structure of the oocyte, and Bohn certain reactions to physical stimuli. The early development was considered by Mortensen in 1920 in connection with his work on other comatulids, and the metamorphosis was studied by Runnstrom (1930).

Koehler, in 1921 and 1927, gave details of the distribution of the species and Tortonese, in several papers from 1935 onwards, provided further instances of its occurrence, especially in the Ligurian and Ionian Seas, at Rhodes in the Aegean, in the vicinity of Istanbul and along the coast of Israel. He also described the variations of the color in life. Other new localities were provided by Rivera, 1934 (Majorca), Mortensen and Steuer, 1937 (Alexandria), Ranson, 1925 and Cherbonnier, 1956 (Tunisia), though some of the latter might be referable to *A. bifida moroccana*.

ANTEDON ADRIATICA A. H. Clark*

Adriatic Feather Star. La Comatula

[See vol. 1, pt. 1, figs. 1 (p. 60), 106 (p. 171); pt. 2, figs. 80 (p. 53), 757 (p. 349)]

Asterias pectinata (not of Linnaeus, 1758) OLIVI, Zoologica adriatica, Bassano, 1792, p. 66 (common, occurring on seaweed, especially *Zostera* and *Fucus*).

Comatula mediterranea (not of Lamarck, 1816) HEUSINGER, Zeitschr. organ. Physik, vol. 3, 1833, p. 366 (Trieste; the description and anatomy refer to *mediterranea*).—LEUCKART, Zeitschr. organ. Physik, vol. 3, 1833, p. 389 (Adriatic).—GRUBE, Actinien, Echinodermen und Würmer der

*Zavodnik (1960) and Tortonese (1965) regard *A. adriatica* as a synonym of *A. mediterranea*. See Addenda for 1963.

Adriatischen und Mittelmeeres, Koningsberg, 1840, p. 14 (Trieste).—J. Müller, Monatsb., Preuss. Akad. Wiss., 1841, p. 189 (in part); Abh. Preuss. Akad. Wiss. for 1841, 1843, p. 59 (description of spermatozoa).—Heller, Sitz. Akad. Wiss. Wien, math.-nat., vol. 46 for 1862, pt. 1, 1863, p. 444 (Lissa, Lésina, Ragusa; 10–35 fms.).—Grube, Die Insel Lussin und ihre Meeresfauna, Breslau, 1864, p. 103 (Neresine, 9 fms.; Lussinpiccolo, in the harbor near the Bocca grande, 15 fms.; Crivizza, 30 fms.; Lussingrande, 37 fms.).—Heller, Die Zoophyten und Echinodermen des Adriatischen Meeres, Verh. Kk. Zool.-bot. Ges.,Wein, vol. 18, suppl., 1868, p. 51 (common along the whole east coast in 10–40 fms.; Trieste, Quarnero, Lesina, Lissa, Curzola, Ragusa; most of the specimens infested with *Myzostomum glabrum*), p. 84 (listed).—Stossish, Boll. Soc. Adriat. Sci. Nat. Trieste, vol. 2, 1876, p. 354.—von Graff, Das Genus *Myzostoma*, 1877, pp. 10, 11, 21, 22 (Cattaro; myzostomes).—Stossish, Boll. Soc. Adriat. Sci. Nat. Trieste, vol. 8, 1883, p. 110 (summary of localities).—Jickeli, Zool. Anz., vol. 7, No. 170, 1884, pp. 346–349 (nervous system and sense organs; Trieste); No. 171, 1884, pp. 366–370 (anatomy; reactions); No. 174, 1884, pp. 448–449 (copulation).—Rosoll, Sitz. Akad. Wiss., Wien, math.-nat. vol. 97 for 1888, pt. 1, 1889, p. 188 (Trieste; description of *Ascomyzon comatulae*, a new parasitic copepod).—König, Sitz. Akad. Wiss., Wien, math.-nat., vol. 103, pt. 1, 1894, p. 55 (description of *Hemispeiropsis comatulae*, a new urceolarid parasite).

Comatula europaea (not of Leach, 1815) von Siebold, Arch. Naturg., 1843, vol. 2, p. 299 (Cattaro; myzostomes).—M. Sars, Nyt Mag. Naturvidensk., vol. 10, 1857, p. 16 [Bidrag til Kundskaben om Middelhavets Littoral-Fauna, p. 72] (Trieste, 10–40 fms.).

Comatula (Alecto) mediterranea J. Müller, Abh. Preuss. Akad. Wiss. for 1847, 1849, p. 252 (in part; Trieste).

Alecto europaea (not of Leach, 1815) Grube, Ein Ausflug nach Triest und dem Quarnero, Berlin, 1861, p. 131 (Quarnero); Die Insel Lussin und ihre Meeresfauna, Breslau, 1864, p. 10 (harbor of Lussinpiccolo), p. 19 (outside the harbor of Lussingrande; 25–37 and 17–20 fms.), p. 23 (near Ossero, 20–29 fms.), p. 24 (occurrence in shallow water), p. 29 (Crivizza, 4½ fms.), p. 103 (Neresine, 9 fms.; Lussinpiccolo, in the harbor near the Bocca grande, 15 fms.; Crivizza, 30 fms.; Lussingrande, 37 fms.).—Faber, Fisheries of the Adriatic, 1883, p. 147 (found in the fish markets on the Istro-Dalmatian coast).

Antedon rosacea (not of Pennant, 1777) Ludwig, Mitt. Zool. Stat. Neapel, vol. 1, 1879, p. 536 (references; Trieste, Neresine, Lussingrande, Lussinpiccolo, Crivizza, Zaole, Martinsica, Lesina, Lissa, Curzola, Ragusa).—E. Graeffe, Arbeit Zool. Inst., Wien, vol. 3, Heft 3, 1881, pp. 334, 339 (details of occurrence about Trieste).—Kruckenberg, Vergleichende physiologische Studien, 2 Reihe, 3 Abth., 1882, p. 88 (coloring matter; occurrence of chlorophyll).—Carus, Prodromus faunae Mediterraneae, pt. 1, 1884, p. 85 (summary of localities).—von Wagner, Zool. Anz., vol. 10, 1887, p. 363 (common at Lesina and near Clemente I., south of Lesina; myzostomes).—Hamann, Jenaische Zeitschr., vol. 23 (neue Folge 16), 1889, pp. 289 and following (Trieste; anatomy in detail; histology; the original observations refer to this species, those quoted to *mediterranea* and *bifida*).—Seeliger, Zool. Jahrb., Anat. Ontog., vol. 6, 1892, p. 161 (Trieste; detailed account of the embryology and early development), p. 422 (bibliography), pls. 12–22; Zool. Anz., vol. 15, No. 404, 1892, pp. 391–393 (embryology); Ann. Mag. Nat. Hist., ser. 6, vol. 10, No. 60, December 1892, pp. 481, 482 (embryology).—von Marenzeller, Denkschr. Akad. Wiss., Wien, math.-nat., vol. 60 [Bericht der Commission für Erforschung des ostlichen Mittelmeeres] for 1893, 1894, p. 3 (south of Cape S. Maria di Leuca; data); Denkschr. Akad. Wiss., Wien, math.-nat. 1895, Zool. Ergebnisse 5, Echinodermen, p. 23 (details of a number of stations in the Adriatic).—von Fürth, Vergleichende chemische physiologie der niederen Tiere, 1903, p. 519 (coloring matter; after Kruckenberg).—Grave, Biol. Bull. Woods Hole, vol. 5, No. 3, August 1903, p. 172 (significance of the larva).—E. Graeffe, Arbeit. Zool. Inst., Wien. vol. 15, Heft 3, 1905, p. 15 [331] (Trieste; occurrence and breeding season of myzostomes).—Zimmermann, Zeitschr. Naturwiss., vol. 78, 1906, p. 304 (Rovigno, 23–28 meters), p. 310 (Rovigno).—Sterzinger, Zeitschr. Wiss. Zool., vol. 88, 1907, pp. 378, 380 (slime glands on the tentacles possibly of significance in procuring food).—Vatova, Mem. Com. Talassogr. Ital., vol. 143, 1928, p. 362 (many stations in the Rovigno area, 12–38 meters).

Comatula (Alecto) mediterranea Faber, Fisheries of the Adriatic, 1883, p. 21 (Lussin; Veglia; 20–30 fms.; occurrence).

Antedon bifida (not of Pennant, 1777) Grieg, Bergens Mus. Aarb. for 1904, No. 5, p. 23 (Trieste; measurements), p. 25 (number of cirrus segments and length of cirri), p. 29 (intersyzygial interval).

Antedon adriatica A. H. CLARK, Proc. U.S. Nat. Mus., vol. 38, 1910, p. 331 (description; Trieste); vol. 40, 1911, p. 9 (characteristic of the Mediterranean division of the European faunal area), p. 40 (may be the species occurring in the Bay of Benzert); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, 1911, p. 449 (no shortening of the arm as in *petasus*); Mem. Australian Mus., vol. 4, 1911, p. 709 (embryology studied by Seeliger); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 31 (compared with *Euantedon*, and with *E. sinensis*); Proc. U.S. Nat. Mus., vol. 43, 1912, p. 382 (specimens from Trieste in U.S.N.M.), p. 384 (specimens of *Comatula* [*Alecto*] *mediterranea* recorded by J. Müller, 1849, from Trieste are this species), p. 404 (Trieste; description); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 52 (Trieste).—SPRINGER and CLARK, Zittel-Eastman's Paleontology, 1913, p. 181 (ontogeny).—A. H. CLARK, *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 314 (in key), p. 315 (range); Die Crinoïden der Antarktis, 1915, p. 190 (occurrence in the Adriatic Sea).—HARTMEYER, Mitt. Zool. Mus. Berlin, vol. 8, No. 2, 1916, p. 236 (Trieste, No. 4342; Trieste, J. Müller, No. 3033).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 203 (in key; range).—MORTENSEN, Vid. Medd. Nat. Foren. København, vol. 71, 1920, p. 155 (comparison of early stages with *A. petasus*); vol. 72, 1920, pp. 70, 71 (notes on structure and development); Studies in the development of crinoids, 1920, pp. 8, 11 (development compared with that of *Tropiometra carinata* [*picta*], pp. 59 and following (discussion of the embryology).—BATHER, Nature, vol. 107, March 31, 1921, p. 133 (infrabasals).—A. H. CLARK, Smithsonian Misc. Coll., vol. 72, 1921, No. 7, p. 10 (development), p. 23 (food), p. 40 (economic value), pl. 1, fig. 1, pl. 11, fig. 47; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range), p. 55 (in key).—KOEHLER, Les echinodermes des mers d'Europe, vol. 2, 1927, pp. 124, 125 (form of *mediterranea*; diagnosis).—TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, 1935, p. 264 (var. of *mediterranea*, agrees with Koehler).—KOLOSVARY, Folia zool. hydrobiol. Riga, vol. 9, 1936, p. 83 (in Hungarian National Museum); Festschrift für Embrik Strand, vol. 2, 1937, p. 468 (description; Adriatic localities), p. 469, pl. 9, figs. 56, 57.—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Forh., vol. 8, No. 1, 1937, pp. 2–4 (comparison with *A. petasoides* which becomes a synonym).—KOLOSVARY, Zool. Anz., vol. 121, 1938, p. 48, fig. 1 (centrodorsal in side view).—ZEI, Arch. Oceanogr. Limnol. Roma, vol. 2, 1942, p. 190 (listed), p. 193 (Narenta channel, northeast Adriatic).—TORTONESE, Atti Accad. Ligure, vol. 8, 1952, p. 170 (not a variety of *Antedon mediterranea*), p. 171 (comparison).—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 73 (spawning time), pp. 75–83 (development), fig. 30D (doliolaria larva), 31–33.—TORTONESE, Bull. Stat. Aquic. Pêche, Castiglione, new ser., vol. 7, 1955, pp. 207, 208, p. 209 (valid species), Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182.—CHERBONNIER, Bull. Stat. Océanogr. Salammbo, No. 53, 1956, p. 4 (listed).

Antedon sp. LEIDENFROST, Alatt. Kozlem, Budapest, vol. 16, 1917, p. 12 (*Najade* Exped. stations in the Adriatic).

Antedon mediterranea var. *adriatica* TORTONESE, Natura, Milano, vol. 24, 1933, p. 164.

Antedon mediterranea adriatica TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, 1935, p. 223.—ZAVODNIK, Biol. Vestnik, Ljubljana, vol. 8, 1961, p. 49.

Antedon mediterranea (not of Lamarck) TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, 1935, p. 264 (Molkovich, Cattaro).—VATOVA, Nova Thalassia, vol. 1, No. 3, 1950, pp. 23, 24, 30, 90 (ecology), Tables 25, 35, 37 (stations).

Antedon petasoides KOLOSVARY, Festschrift für Embrik Strand, vol. 2, 1937, p. 468 (description, Adriatic localities), p. 469, pl. 9, figs. 55 and 58.—GISLÉN, Kungl. Fysiogr. Sällsk. Lund Forh., vol. 8, No. 1, 1937, pp. 1–4 (comparison with *A. adriatica*, of which it is a synonym).—KOLOSVARY, Zool. Anz., vol. 121, 1938, pp. 47–48 (reduced to a form of *adriatica*).

Antedon adriatica adriatica KOLOSVARY, Zool. Anz., vol. 121, 1938, p. 48.—KOLOSVARY, Folia zool. hydrobiol. Riga, vol. 10, No. 2, 1940, p. 377 (range), p. 380.

Antedon adriatica forma *petasoides* KOLOSVARY, Zool. Anz., vol. 121, 1938, p. 48, fig. 3 (centrodorsal in side view).—ZEI, Arch. Oceanogr. Limnol. Roma, vol. 2, 1942, p. 190 (listed).

Antedon adriatica petasoides KOLOSVARY, Folia zool. hydrobiol. Riga, vol. 10, No. 2, 1940, p. 377 (range), p. 380.

Diagnostic features.—There are 22 to 30 (usually 24 to 28) cirrus segments, of which the distal only differ slightly from the proximal; the distal portion of the cirri is only slightly if at all recurved, and in lateral view is not wider than the proximal; the IBr_1

are relatively long, not more than three times as broad as long, regularly oblong or slightly trapezoidal, the lateral edges usually making a straight line, more rarely a broadly obtuse angle, with those of the axillary.

Description.—The centrodorsal is flattened hemispherical, about 4 mm. in diameter at the base, the bare dorsal pole flat, about 1.5 mm. in diameter; the cirrus sockets are arranged approximately in three closely crowded alternating rows, of which the uppermost includes about four sockets in each radial area.

The cirri are XXV–XL (usually XXX–XXXV), 22–30 (usually 24–28) 20 to 27 mm. in length, long, slender, and of uniform thickness throughout their length; the first segment is very short, the second about half again as broad as long, the third about as long as broad, the fourth half again as long as the width of its expanded ends, the fifth and following about twice as long as the width of the distal ends, the proportions remaining practically the same to the end of the cirrus, though the distal segments may be a trifle shorter than those nearer the base; the penultimate segment is nearly or quite twice as long as broad, with a prominent, slender and sharp opposing spine which is subterminal in position, directed slightly forward or nearly erect, and equal to about half the distal diameter of the penultimate segment in height; the terminal claw is slender, evenly tapering, moderately and uniformly curved, about equal to the penultimate segment in length. The fourth and following segments are moderately constricted centrally, so that the ends are prominent; this feature slowly diminishes in intensity in the distal half of the cirri. The cirri are nearly circular in basal section, but gradually become slightly compressed laterally and are moderately compressed in the distal portion; this lateral compression is very gradual, and is not accompanied by an increase in the lateral diameter of the cirrus as in *A. bifida.* In a lateral view, the dorsal profile of the segments is seen to be slightly more concave than the ventral, especially distally, making the proximal and distal dorsal ends of the segments somewhat prominent.

The disk resembles that of *A. mediterranea.* It is usually naked, but sometimes has more or fewer calcareous particles in the inner portion of the interambulacral areas. Sacculi are abundant along the ambulacra, but small and irregularly arranged in one, two or three rows, becoming more definitely arranged in a single row along the brachial ambulacra.

The radials in the median line are even with, or extending very slightly beyond, the edge of the centrodorsal, rising in the interradial angles of the calyx into a low triangle.

The IBr_1 are oblong or slightly trapezoidal, two and a half to three times as broad as long, the lateral edges slightly produced and swollen; a shallow groove usually borders this swollen edge interiorly, which may be reduced to a small rounded pit just proximal to the median horizontal diameter of the ossicle. The IBr_2 (axillary) is roughly a right-angled triangle, the apex rather sharp; the lateral edges, which are about half the length of those of the IBr_1, are somewhat swollen and produced.

The ten slender arms are up to 110 mm. long; the first brachial is wedge-shaped, twice as long exteriorly as interiorly, about half again as broad as the exterior length, interiorly just in contact basally; the exterior margin is swollen and slightly produced; the second brachial is irregularly quadrate, larger than the first, though of about the same length exteriorly; synarthrial tubercles are sometimes slightly prominent, but usually not marked; the third and fourth brachials (syzygial pair) are slightly longer interiorly than exteriorly, about half again as broad as long in the median line; the fifth brachial is slightly wedge-shaped, about twice as broad as long in the median line, the following becoming more obliquely wedge-shaped, and after the second syzygy triangular, about as long as broad, soon becoming somewhat less oblique and wedge-shaped again and very slowly increasing in length, being very long terminally.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of three muscular articulations.

P_1 is from 11 to 13 mm. long with 17 or 18 segments of which the first is about as long as broad and the remainder are about twice as long as broad, becoming somewhat longer distally; the pinnule is much stouter than those succeeding and tapers very gradually to the tip; it is not so slender distally as the corresponding pinnule in *A. bifida*; the third and following segments have the distal outer edge produced and finely spinous, this feature gradually increasing in intensity and becoming prominent in the outer half of the pinnule. P_2 is from 7 to 8 mm. long with 12 segments, the first about twice as broad as long, the second about as long as broad, the remainder about twice as long as broad, becoming terminally about three times as long as broad; the third and following develop projecting and spinous distal outer edges which are quite prominent. P_3 and the following pinnules are similar to P_2. The distal pinnules are from 10 to 12 mm. long, exceedingly slender, with about 20 segments, the first longer than broad, the remainder greatly elongated with swollen articulations.

Remarks [by A.M.C.].—There has been some controversy as to the rank of *adriatica*. Koehler (1927) regarded it as a form of *A. mediterranea* but Tortonese (1952), on second thought, maintains that it is a distinct species.* Since the larger number of cirrus segments does occur, though rarely, outside the Adriatic, this character is not absolutely diagnostic and I am inclined to consider *adriatica* as a subspecies of *mediterranea*.

Localities.—Adriatic Sea [Olivi, 1792] (several, G.M.). Entire east coast of the Adriatic, 18–73 meters [Heller, 1868].

Trieste (Triest) [Heusinger, 1833; Leuckart, 1833; Grube, 1840, 1864; J. Müller, 1849; M. Sars, 1857; Heller, 1868; Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884; Jickeli, 1884; Rosoll, 1888; Hamann, 1889; Seeliger, 1892; König, 1894; Grieg, 1904; E. Graeffe, 1905; Sterzinger, 1907; A. H. Clark, 1912; Hartmeyer, 1916; Tortonese, 1952, 1956] (102+ U.S.N.M., 35685, 35686, M.C.Z., 243; C.M.; B.M.; G.M.; Berg. M.; Berl. M.; 3033, 4342; V.M., 812, 813, 815; Tortonese collection). Type locality.

Rovigno [A. H. Clark, 1912; Vatova, 1928, 1950]. Same, 23–28 meters [Zimmermann, 1906].

Neresine [Stossish, 1876, 1883; Ludwig, 1879]. Same, 17 meters [Grube, 1864].

Narenta channel [Zei, 1942].

Crivizza [Stossish, 1876, 1883; Ludwig, 1879]. Same, 8 meters [Grube, 1864] and 55 meters [Grube, 1864; Carus, 1884].

Fiume [Kolosvary, 1937].

Zaole [Ludwig, 1879; Carus, 1884].

Martinsica (Martinschizza) [Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884].

Quarnero [Grube, 1861; Heller, 1868].

Veglia, 37–55 meters [Faber, 1883].

Near Ossero (island of Cherso), 37–53 meters [Grube, 1864].

Island of Lussin (Lossini). Lussin, 37–55 meters [Faber, 1883]. Lussingrande

* See Addenda (p. 838) under 1965.

[Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884]. Same, 68 meters [Grube, 1864]. Outside the harbor of Lussingrande, 31–37 meters, and 46–68 meters [Grube, 1864]. Lussinpiccolo [Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884]. Harbor of Lussinpiccolo [Grube, 1864]. Same, near the Bocca Grande, 27 meters [Grube, 1864].

Najade Expedition, 1913–1914 to Istria and Dalmatia. Sta. N. II, B. 10, Busi, (lat. 42°58′ N., long. 16°2′ E.); 98–100 meters [Leidenfrost, 1917; Kolosvary, 1937]. Sta. N. II, B. 11, Busi-Andrea (lat. 43° N., long. 15°59′ E.); 100 meters [Leidenfrost, 1917; Kolosvary, 1937]. Sta. N. II, B. 25; 77 meters [Kolosvary, 1937]. Sta. N. I, B. 14, Busi; Sta. N. I, B. 26, Corsia and Zara channel. Stas. N. (trial trip), B. 9 and B. 13, Basin of Pomo and Zara; B. 11, Incoronata Kurva-Vela; 77–240 meters [Kolosvary, 1937].

Lissa (Vis) [Heller, 1863, 1868; Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884]. Same, 18–64 meters [Heller, 1863].

Between Lissa and S. Andrea (lat. 42°58′20″ N., long. 15°43′10″ E.); 133 meters; fine sand [von Marenzeller, 1895].

Between Comisa (Komiža), on the island of Lissa (Vis) and Bursi (lat. 43°02′24″ N., long. 16°00′10″ E.); 94 meters; fine sand and broken shells [von Marenzeller, 1895].

Lesina (Hvar) [Heller, 1863, 1868; Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884; von Wagner, 1887]. Same, 18–64 meters [Heller, 1863].

Near Clemente Island, south of Lesina [von Wagner, 1887].

Cúrzola (Korčula or Karkar) [Heller, 1868, Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884].

Lagosta [Stossish, 1883].

Near Lagosta (lat. 42°09′00″ N., long. 15°22′37″ E.); 117 meters; sandy mud [von Marenzeller, 1895].

Not far from Pelagosa (lat. 42°36′34″ N., long. 16°12′20″ E.); 179 meters; thick mud [von Marenzeller, 1895].

Near Pelagosa (lat. 42°34′18″ N., long. 16°09′15″ E.); 176 meters; loose mud [von Marenzeller, 1895].

Off Pelagosa (lat. 42°23′24″ N., long. 16°01′42″ E.); 129 meters; fine sand [von Marenzeller, 1895].

Near Pelagosa (lat. 42°23′08″ N., long. 16°12′42″ E.); 101 meters; sand and a few algae [von Marenzeller, 1895].

Near Pianosa (lat. 42°13′20″ N., long. 15°50′42″ E.); 111 meters; yellow-gray mud [von Marenzeller, 1895].

On a line between Pianosa and the Isole dei Tremiti (lat. 42°11′40″ N., long. 15°40′50″ E.); 103 meters; gray-yellow mud [von Marenzeller, 1895].

Near the Isole dei Tremiti (lat. 42°02′00″ N., long. 15°27′07″ E.); 112 meters; gray-yellow mud [von Marenzeller, 1895].

Ragusa (Dubrovnik) [Heller, 1863, 1868; Stossish, 1876, 1883; Ludwig, 1879; Carus, 1884]. Same, 18–64 meters [Heller, 1863].

Cattoro (Kotor) [von Siebold, 1843; von Graff, 1877].

Violante; Molkovich, mouth of Cattoro, Dalmatia; July 25, 1880 [Tortonese, 1935] (Genoa M.).

Near the entrance to the harbor of Avlona (Válona or Vliona) (lat. 40°13′10″ N., long. 19°03′40″ E.); 932 meters; thick tenacious mud [von Marenzeller, 1895].

South of Cape Santa Maria di Leuca (the southeasternmost point of Italy) (lat. 39°54′24″ N., long. 18°40′ E.); 136 meters; sandy yellow mud with many shells; August 19, 1892 [von Marenzeller, 1894].

Thor station 17; off the island of Salamis (Kolouri), near Piraeus, Greece (lat. 37°49′ N., long. 23°27′ E.); 55 meters; December 30, 1908 (2, C.M.).

Geographical range.—Adriatic Sea (absent from the Italian coast between Istria and Apulia) and eastward to the Gulf of Aegina. It probably passes into *mediterranea* south of Italy and Greece and among the Cyclades.

Bathymetrical range.—From the low tide mark to 932 meters; most frequently recorded from between 15 and 70 meters; only once recorded beyond 179 meters.

Occurrence.—This species is common at Trieste (M. Sars, 1857) and along the entire eastern shore of the Adriatic in 18 to 73 meters (Heller, 1868).

In the Gulf of Trieste (E. Graeffe, 1881) it is to be found throughout the year in large numbers everywhere in depths of 11 meters and over. On the stony banks it occurs in numerous color varieties.

On the bottoms of gravel and scattered fragments of shells, stones or nullipores which form the bed of the sea in 37 to 55 meters in a wide circle around the island of Lussin and partly also around the island of Veglia, and which occur less extensively in other parts, swarms of *Antedon adriatica* are quite a characteristic feature (Faber, 1883).

Grube (1864) says that in shallow places about Lussin in a depth of about 2.5 meters there are found on a rocky bottom smaller and larger rounded, fragile, marly calcareous boulders and nullipore balls white or rose-red in color, upon and within which live these Feather Stars. He also notes that all the specimens which he dredged at Lussingrande in 68 meters were variegated in color.

The frequent occurrence of this form in water down to 179 meters and its existence even at 932 meters on mud and fine sand as reported by von Marenzeller (1894, 1895) is especially interesting.

Occurrence of the early stages.—Prof. E. Graeffe (1881) wrote that the pentacrinoids are attached to stones and other objects, but in the sea are very difficult to find. To obtain them it is easier to raise them in an aquarium in which a number of sexually mature individuals have been placed.

He said that the duration of the developmental stages is a few weeks; but he was unable to determine the duration of the pentacrinoid stage, since he kept the pentacrinoids in an aquarium for only a few weeks, during which time they did not become appreciably larger.

History.—First recorded from the Adriatic Sea in 1792 by Olivi, this species was reported from Trieste (as *mediterranea*) by Heusinger in 1833 and from Cattoro (as *europaea*) by von Siebold in 1843. M. Sars again listed it as common at Trieste in 1857.

Beginning especially with the founding of the Austrian Lloyd steamship company in 1836, and the resulting increased facilities for travel between Trieste and points on the Dalmatian coast, this region, remarkable for the natural beauty of its rugged and broken shore line, began to attract the attention of the Austrians and Germans. For naturalists this coast is an especially interesting one, as the extraordinarily rich fauna of the Quarnero, then but little known, includes a number of conspicuous northern species, such as *Nephrops norvegicus* and *Aporrhais pes-pelecani*, not elsewhere occurring in the Mediterranean area.

In 1864 A. E. Grube, who had earlier recorded *Antedon* from Trieste in 1840, published a detailed account of its occurrence about the islands of Lossini and Cherso, while in 1863 and 1868 C. Heller published the results of his investigations further to the southward, about Ragusa and the islands of Lesina, Lissa and Curzola.

The marked hostility of the inhabitants of Dalmatia toward the Austrians culminated in the insurrection of 1869, and for a considerable time interest in the study of the east Adriatic fauna ceased entirely.

The opening of the two railways to Fiume (Rieka) in 1873 and the enlargement and extension of the Porto Nuovo in 1878 rapidly brought that city into the foreground as a rival of Trieste. The British Vice-Consul here at this time, Mr. G. L. Faber, was an enthusiastic naturalist and prosecuted extensive investigations touching all phases of the marine resources of the region. His comprehensive account of the fisheries of this district (1883) includes a discussion of the local distribution of this *Antedon*.

In 1870 the Berlin Aquarium opened a station at Trieste for the collection and shipment of marine plants and animals to that city (subsequently removed to Rovigno in 1892), and in 1874 the Naples Zoological Station was founded, followed by the Royal Zoological Station at Trieste in 1875.

These establishments, by providing preserved material of all the local species at small cost, removed one of the chief incentives for further exploration, while at the same time they diverted attention toward problems in anatomy, histology, embryology, etc., which can only be studied with the aid of more or less elaborate equipment.

The Naples Station took upon itself the cataloging of the fauna and flora of the Mediterranean and Adriatic, and in 1879 Ludwig, in his prodromus of a monograph on the Mediterranean echinoderms, added two new localities to the known range of the Adriatic species, Zaole and Martinsica. No additional localities were given by Carus in his prodromus in 1884.

So far as the crinoids are concerned the Zoological Station at Trieste has been second to none in the value of the work produced, either at the station itself or from material supplied by it. Mention should be made of the papers by Jickeli (1884), Hamann (1889), Seeliger (1892) and Sterzinger (1907).

In 1890–92 a survey was made of the deeper waters of the Adriatic by the Austrian steamer *Pola*, and our only information touching the occurrence of this species other than along the shores results from the work of this expedition (von Marenzeller, 1894, 1895).

In 1904 Grieg gave a comparative account of this form based upon a specimen from Trieste in the Bergen Museum, and in 1906 Zimmermann mentioned it incidentally from Rovigno whence a considerable amount of unrecorded material had already been distributed to various museums.

It was not formally separated from *mediterranea* until 1910, though Seeliger in 1892 noticed that the animal he was studying at Trieste appeared to differ somewhat from that studied by Bury at Naples.

The only collections of any note in recent years to include this species, were those of the *Najade* in 1913 and 1914, mainly around the islands off the coast of Dalmatia. These were reported on by Kolosvary in 1937.

Subfamily THYSANOMETRINAE

Thysanometrinae A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Eumetra*, *Thysanometra* and *Coccometra*); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); The crinoids of the Indian Ocean, 1912, p. 6 (table of distribution of East Indian genera and species in that and other regions), p. 9 (absent from Australia), p. 26 (range in detail), p. 61 (in key); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (temperature relations); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, p. 6 and following (Atlantic and corresponding Indo-Pacific genera); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559-563 (correlation of geographic and bathymetrical ranges); No. 20, p. 582 (relation to temperature of habitat); vol. 5, No. 4, 1915, pp. 126-134 (bathymetrical range; phylogenetic and palaeontological significance); Amer. Journ. Sci., vol. 40, 1915, p. 68 (detailed philosophical discussion of bathymetrical range); Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (includes *Thysanometra* and *Coccometra*); No. 16, 1917, p. 504 (in key), p. 506 (key to the included genera); Unstalked crinoids of the *Siboga*-Exped., 1918, p. vii (not represented in *Siboga* collections; occurrence), p. viii (a single specimen of one species collected by the *Albatross* in the East Indies), p. 196 (in key), p. 217 (key to the included species); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 2; Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (represented in the West Indies), p. 26.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 139; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 91, 101, 232.—EKMAN, Zoogeographica, vol. 2, No. 3, 1934, pp. 328, 343; Tiergeographie des Meeres, 1935, p. 66.—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 47.—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 141 (in key).—GISLÉN, Lunds Univ. Arsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54, footnote 1; Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (one species found deeper than 1,000 meters).

Diagnosis.—A subfamily of Antedonidae in which the centrodorsal is usually hemispherical, rarely subconical or almost discoidal, with the cirrus sockets irregularly arranged in crowded transverse rows and a relatively large bare polar area; the cirri are delicate, of very variable length, with the distal segments entirely without dorsal processes except for the occasional occurrence of a small opposing spine; the IBr series and arm bases make a very wide angle with the dorsoventral axis; P_1 is long and flagellate, usually very flexible, composed of 30 to 40 segments, which are mostly or almost entirely about as long as broad with the corners cut away; P_2 is of the same length as, or slightly shorter than, P_1 but is usually composed of only half as many segments or even fewer, most of which are much elongated; and the following pinnules resemble P_2. The segments of the genital pinnules are never expanded.

Geographical range.—From the Admiralty and Philippine Islands northward to southern Japan; in the Atlantic from the Caribbean Sea northward to North Carolina.

Bathymetrical range.—From 14 to 1046 meters.

Thermal range.—From 5.11° C. to 27.0° C.

Remarks.—The species of this subfamily, like those of the Perometrinae, are characteristic of water from 100 to 400 meters in depth, and with a rather high temperature.

Characters.—The centrodorsal in the Thysanometrinae shows little variation. It is usually a flattened hemisphere with a rather large bare dorsal pole, but varies from low rounded conical, rarely more sharply conical, to almost discoidal. The cirrus sockets are irregular in position, closely crowded, and arranged roughly in 3 or 4 rows.

The cirri show considerable variation. They are usually from 10 to 35 mm. in length, or from 20 to 40 per cent of the arm length, averaging 30 per cent.

The number of the cirri varies from XXX to LXX, but is usually from XXX to XL; no species has less than XXX.

The number of segments in the fully developed cirri runs from 15 to 28; in 4 species it varies from 15 to 25, in the fifth from 24 to 28.

The difference in size between the peripheral and apical cirri is never very strongly marked.

The cirri are delicate and slender, strongly compressed laterally, and weakly attached to the centrodorsal. They are composed of one or two short basal segments, after which the segments rapidly become more elongated, remaining long to the end of the cirrus or decreasing more or less in length distally.

The distal ends of the cirrus segments are unmodified, or if the outer segments are short their ends may be slightly produced. The longest segments, the fourth or fifth, and those immediately following, are from 3 to 5 (usually 4) times as long as broad, and are somewhat constricted centrally. The segments may remain similarly elongated to the end of the cirrus, with the penultimate segment half as long as those preceding, tapering, and followed by a perfectly straight terminal claw; they may decrease slightly in relative length but remain elongate; they may decrease to less than twice as long as broad by the antepenultimate; or the terminal 6 or 8 may be about as long as broad.

The dorsal surface of the cirrus segments is always rounded, and there are no dorsal processes nor opposing spines.

Basal rays are not developed.

The radials are usually visible at least in the angles of the calyx where their apposed anterolateral angles form low triangles; their distal border is rarely visible beyond the rim of the centrodorsal.

In the largest species there is a small narrow subradial cleft.

The IBr_1 are short, much broader than long. They may narrow rapidly from the proximal to the distal edge, or the sides may be nearly parallel. They are more or less deeply excavated distally by the obtuse angle formed by the proximal border of the axillary which, because of their shortness, sometimes completely conceals them in the median line.

The IBr_2 (axillaries) vary from much broader than long to somewhat longer than broad, and from triangular with the proximal border slightly convex to rhombic with a marked proximal process. The lateral angles extend more or less, sometimes very considerably, beyond the anterolateral angles of the IBr_1. The distal sides vary from slightly to strongly concave, and the distal angle may be more or less produced.

In one species (*Coccometra nigrolineata*) the IBr series are just in apposition laterally, though they are not flattened against each other; but usually the IBr_1 are considerably narrowed distally. Moderate synarthrial tubercles are usually present. The sides of the elements of the IBr series bear no processes of any kind, the proximal and distal edges are unmodified, and there is never any ornamentation on the dorsal surface.

The division series and arm bases lie in planes making a relatively large angle with the dorsoventral axis.

The arms are invariably 10 in number. They vary in length in mature individuals from 40 to 120 mm., and are usually between 50 and 100 mm. The average length for all the species is about 60 mm.

In structure the arms closely resemble those of the Antedoninae, with the exception of a single species. The first brachials are usually wedge-shaped, longer outwardly than inwardly, with the inner sides in contact or united basally, or sometimes for as much as their proximal half; but they may be so deeply incised by the second brachials that the inner half is almost bandlike and the outer triangular.

The second brachials vary from slightly to considerably larger than the first, irregularly quadrate in form, with the middle of the proximal border more or less depressed into an obtuse angle entering the concavity on the distal border of the first.

The first syzygial pair is oblong, from as long as broad to almost twice as broad as long, or much longer interiorly than exteriorly, with the hypozygal (third brachial) wedge-shaped or triangular and the epizygal oblong.

The following brachials are oblong or slightly wedge-shaped, from about as long as broad to half again as long as broad, after the eighth to twelfth becoming very obliquely wedge-shaped or triangular, about as long as, or rather longer than, broad, and distally less and less obliquely wedge-shaped and terminally oblong and elongate.

In *Thysanometra tenelloides* the shape of the brachials is quite unique, recalling that of the brachials in *Amphimetra*. Those following the first syzygial pair are wedge-shaped, about twice as broad as long, gradually becoming more and more nearly oblong, and at length quite oblong, not quite twice as broad as long, after about the end of the proximal third of the arm. Distally the brachials gradually become more elongate, at the end of the arm being twice as long as broad or even slightly longer.

Syzygies occur between brachials 3+4, 9+10 and 14+15, and distally at intervals of from 2 to 6 (usually 2 or 3) muscular articulations.

In *Coccometra nigrolineata* the edges of the elements of the IBr series and of the lower brachials are everted, prominent, and very spiny; in *C. hageni* 2 or 3 of the brachials following the second syzygial pair have a group of small spines in the central portion of the distal end. In the other species the ends of the brachials are quite smooth.

A curious feature in this group is the occurrence of characteristic and definite black markings on two species. In *Coccometra nigrolineata* there is a conspicuous median line of black on the IBr series and the lower portion of the arms beyond which each syzygial pair bears a transverse black band or large black spot. In *C. guttata* there is a large black spot on either side of each syzygial pair, and the inner half of the articular faces of the syzygies is also black. There are no black markings in any of the other species known.

The oral pinnules show little diversity. P_1 is composed of 31 to 40 segments of which at least those in the proximal half are barely, if at all, longer than broad. The pinnule is slender and highly flexible, the corners of the short segments being truncated, though sometimes more or less swollen dorsally.

P_2 may be longer than P_1, but is usually somewhat shorter and may be not much more than half as long. It is stouter and stiffer than P_1 and is composed of 12 to 20 segments, of which the first 2 or 3 are about as long as broad and those following become elongated. It may bear a gonad. The following pinnules resemble P_2.

The distal pinnules are slender with much elongated segments, longer or shorter than P_1.

The deposits along the sides of the ambulacral grooves of the pinnules in *Coccometra* consist of long slender uniform rods, straight or slightly bent in the middle, and pointed at each end or slightly roughened at the distal end. In *Thysanometra* there is a narrow but very conspicuous calcareous band 2 or 3 meshes wide, rarely wider, which runs from the borders of the pinnulars into each of the ambulacral lappets, where, toward the inner edge, it gradually broadens and forks so that its end is Y-shaped, the proximal arm of the Y being as broad as the original band and making only a slight angle with it, while the distal arm is smaller and narrower, making with the main stem a considerably greater angle. Occasionally there is only a spatulate expansion of the outer end of the band.

In *Coccometra hageni* minute spicules have on occasion been detected in the tentacles; none have been found in the other species.

[NOTES BY A.M.C.] In his John Murray Expedition report of 1937 Mr. Austin Clark described a new species and genus, *Repometra arabica*, which he placed in the Thysanometrinae. In trying to match this genus to the diagnosis of this subfamily so many differences appeared, particularly with regard to the cirri, that a possible relationship with the other subfamilies of Antedonidae was sought. The low hemispherical centrodorsal with irregularly alternating cirrus sockets ruled out relationship with the Zenometrinae. The short, rather heavy cirri with no dorsal processes eliminated the Perometrinae and Bathymetrinae but suggested affinity with the Antedoninae. The Key to the genera of Antedoninae unfortunately relies largely on the characters of the pinnules which are in very poor condition in the unique specimen of *Repometra arabica*. However, this species appears to run down to the genus *Antedon* and further to *A. iris*, known from off Malaya to northwest Australia. No species of *Antedon* has been recorded from the western Indian Ocean. *A. serrata* from China and Japan has the segments of P_1 rather short, approaching those of *arabica* and *A. incommoda* has cirri which are practically identical in form and proportions. I am therefore transferring *arabica* to the subfamily Antedoninae and considering *Repometra* as a synonym of *Antedon*.

KEY TO THE GENERA OF THYSANOMETRINAE

a^1. Distal pinnules longer than the proximal ones; P_2 with the third segment as long as, or longer than, broad, and the following segments markedly longer than broad; radial facets oblong, broader than long (Admiralty and Philippine Islands northward to southern Japan; 128–548 meters)........**Thysanometra** (p. 269)

a^2. Distal pinnules shorter than the proximal ones; P_2 with the third segment broader than long and the fourth broader than long or about as long as broad; radial faces wedge-shaped, elongate (Caribbean Sea northward to North Carolina; 14–1046 meters)........**Coccometra** (p. 275)

Genus THYSANOMETRA A. H. Clark

Antedon (part) P. H. CARPENTER, Proc. Roy. Soc., vol. 28, 1879, p. 384, and following authors.

Thysanometra A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (diagnosis; type species *Antedon tenelloides* A. H. Clark, 1907); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 246 (same); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Antedonidae, restricted), p. 212 (occurs in Japan); Amer. Nat., vol. 42, No. 500, 1908, p. 541 (only known from Indo-Pacific-Japanese area); No. 503, p. 725 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 602 (characteristic of the Indo-Japanese region); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 136 (referred to Antedonidae); vol. 22, 1909, p. 177 (referred to Thysanometrinae); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 10 (represented in West Indies by *Coccometra*); Crinoids of the Indian Ocean, 1912, p. 11 (absent from the west coast of the Malay peninsula, the Andamans, and from farther west), p. 14 (corresponds to the West Indian *Coccometra*), p. 26 (range; relation to *Coccometra*), p. 62 (in key), p. 244 (original reference; type); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1914, pp. 6 and following (represents *Coccometra* in the Indo-Pacific; range); Die crinoïden der Antarktis, 1915, p. 182 (range; represented in the Atlantic by *Coccometra*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Thysanometrinae); No. 16, p. 506 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 217 (in key; range), p. 218 (key to the included species); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 94.—H. L. CLARK, Mem. Mus. Comp. Zool., vol. 55, 1938, p.47.

Diagnosis.—A genus of Thysanometrinae in which the radial facets are oblong, broader than long, the muscular fossae large, transversely rounded-oblong, separated from the interarticular ligament fossae by horizontal ridges, the exterior ends of which are more or less curved downwards; the centrodorsal is hemispherical as a rule, but varies from conical to discoidal; the distal pinnules tend to be longer than the proximal ones.

Type species.—*Antedon tenelloides* A. H. Clark, 1907.

Geographical range.—Known from southern Japan to the Philippines, Kei, and Admiralty Islands.

Bathymetrical range.—From 128 to 548 meters.

KEY TO THE SPECIES OF THYSANOMETRA

a^1. Brachials following the second syzygy wedge-shaped, twice as broad as long, soon becoming oblong, much broader than long; P_1 nearly half again as long as P_2; 15–17 cirrus segments (southern Japan; 128–360 meters) .... **tenelloides** (p. 270)

a^2. Brachials beyond the second syzygy triangular, as long as broad, in the outer part of the arm becoming very obliquely wedge-shaped and longer than broad; P_1 about the same length as P_2, or shorter, 15–25+ cirrus segments (north of the Admiralty Islands, Philippines; 225–548 meters) .... **tenuicirra** (p. 272)

THYSANOMETRA TENELLOIDES (A. H. Clark)

[See vol. 1, pt. 1, figs. 285 (p. 261), 372 (p. 299), 498 (p. 369); pt. 2, figs. 89–90 (p. 62), 282 (p. 215), 752 (p. 349)]

Antedon tenelloides A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 73 (description; *Albatross* Sta. 5092).

Thysanometra tenelloides A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 319 (Japan); Crinoids of the Indian Ocean, 1912, p. 244 (synonymy; southern Japan, 70 fms.); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 64 (comparison with *Th. tenuicirra*); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga*-Exped. 1918, p. 218 (in key; range; references).

Diagnostic features.—The brachials following the second syzygy are wedge-shaped, twice as broad as long, soon becoming oblong, much broader than long; when the arms are 110 mm. long, the cirri are LX–LXX, 15–17, 35 mm. long. P_1 is 14 mm. long with 35 to 40 short segments and P_2 is 10 mm. long with 20 segments of which all but the basal 3 or 4 are much elongated.

Description.—The centrodorsal is low hemispherical or more or less discoidal, always with a large bare polar area with a more or less pronounced tubercle in the center surrounded by numerous shallow pits. The cirrus sockets are very numerous and closely crowded, irregular in position, but arranged roughly in about three rows.

The cirri are LX–LXX, 15–17 (usually 15–16), 35 mm. long, from one quarter to one third the length of the arms, slender, strongly compressed laterally, with no trace of dorsal processes. The first segment is about as long as broad, the second is about twice as long as broad, with its ends somewhat enlarged, the third is about three times as long as broad, practically oblong, and the fourth is intermediate between the third and the fifth, which is about four times as long as broad. The segments immediately following resemble the fifth; after the eighth or ninth they gradually become proportionately shorter, the third from the tip being about three times as long as broad; the two terminal segments are of about the same proportions, but decrease slightly in breadth. The terminal claw is slender and almost straight, about half the length of the penultimate segment.

The anterolateral angles of the radials are just visible interradially. The IBr_1 are very short, narrowing rapidly from the proximal to the distal edge, and widely separated laterally; beneath them is a small narrow transverse cleft; their dorsal surface is almost flat, but in the distal portion of the median line rises to a slight tubercle with the IBr_2 (axillaries) which are pentagonal, somewhat broader than long, widening rapidly from the proximal edge to the lateral angles; the distal sides are slightly concave, and the proximal border slightly convex in the median line where it rises to a slight tubercle with the IBr_1.

The 10 arms are from 110 to 120 mm. long. The first brachials are wedge-shaped, slightly longer on the outer than on the inner side, united interiorly for their basal half, the free portions of their inner sides standing at right angles to the united basal portions. The second brachials are irregularly quadrate with a slight posterior convexity slightly incising the first brachials. The first syzygial pair (composed of the third and fourth brachials) is oblong, not quite twice as broad as long. The following brachials are wedge-shaped, about twice as broad as long, the succeeding gradually becoming more and more nearly oblong, and quite oblong, not quite twice as broad as long, after about the thirty-fifth or fortieth, that is, after about the end of the proximal third of the arm. Distally the brachials gradually become more elongate, at the end of the arm being twice as long as broad or even slightly longer.

Syzygies occur between brachials 3+4, 9+10 and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is about 14 mm. long, tapering evenly from the base to the slender and flagellate tip, and slightly compressed laterally; it is composed of 35 to 40 segments, all of which are about as long as broad; the distal corners of the segments are somewhat prominent, giving the pinnule a somewhat serrate dorsal profile, which becomes more pronounced distally. P_2 is shorter than P_1, 10 mm. long, composed of about 20 segments, of which the first is not so long as broad, the second and third are about as long as broad, and the following become progressively elongated, and very long and slender distally; the pinnule is about as stout basally as P_1. P_3 is 8 mm. long with 15 segments, basally about as stout as the two preceding but tapering less gradually; the first segment is not so long as broad, the next two are about as long as broad, and the remainder gradually become elongated and distally very long and slender; there is a large gonad on the third or fourth to the eighth or ninth segments. The following pinnules to about the thirteenth are similar, but gradually become shorter. The distal pinnules are 20 mm. long, very slender, composed of 25 to 30 segments, of which the first is very short, the second is wedge-shaped, not quite so long as broad, the third is about as long as, or slightly longer than, broad, and those following become progressively elongated.

Localities.—*Albatross* station 3698; Sagami Bay, Japan; Manazuru Light bearing N. 8° W., 4.5 miles distant; 279 meters; temperature 18.33° C.; green mud, volcanic ash, and sand; May 5, 1900 (1, U.S.N.M., 35960).

Albatross station 5091; Uraga Straits, at the entrance to Tokyo Gulf (lat. 35°04′10″ N., long. 139°38′12″ E.); Joga Shima Light bearing N. 15° W., 4.2 miles distant; 360 meters; bottom temperature 8.67° C.; green mud, coarse black sand, and pebbles; October 26, 1906 (1, U.S.N.M, 35932).

Albatross station 5092; Uraga Straits (lat. 35°04′50″ N., long. 139°38′18″ E.); Joga Shima Light bearing N. 19° W., 3.5 miles distant; 128 meters; bottom temperature

13.5° C.; coarse black sand; October 26, 1906 [A. H. Clark, 1907] (5, U.S.N.M. 22607, 35931, 36231). Type locality.

Geographical range.—Only known from Sagami and Tokyo Bays, southern Japan.

Bathymetrical range.—From 128 to 360 meters; the average of three records is 256 meters.

Thermal range.—From 8.67° to 18.33° C.; the average of three records is 13.5° C.

THYSANOMETRA TENUICIRRA (P. H. Carpenter)

Antedon, sp. P. H. CARPENTER, Proc. Roy. Soc., vol. 28, 1879, p. 384.

Antedon tenuicirra P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 186 (description; *Challenger* Sta. 219), pl. 30, figs. 4–8, pl. 33, figs. 4, 5.—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 125 (really belongs in *Thysanometra;* possibly young of *Th. tenelloides*); Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888 = *Thysanometra tenuicirra*).

Antedon notata P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 187 (in text), pl. 33, figs. 4, 5.

Antedon tennicirra HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).

Thysanometra tenuicirra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 125 (*tenuicirra* referred to *Thysanometra*); Crinoids of the Indian Ocean, 1912, p. 244 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, 1913, No. 15, p. 64 (published references to specimens in B.M.; *Challenger* Sta. 219; characters, and comparison with *Th. tenelloides*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 218 (in key; range; references; *Albatross* Sta. 5221).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 10 (notes).

Diagnostic features.—The brachials beyond the second syzygy are triangular, as long as broad, in the outer part of the arm becoming very obliquely wedge-shaped and longer than broad; when the arms are 55 mm. long the cirri are XXX–XL, 15–25; P_2 is about the same length as, or longer than, P_1 and composed of stouter and more elongate segments.

Carpenter's description of the type specimen.—The centrodorsal is hemispherical.

The cirri are XXX or more, long and slender, with 15–25 or more segments of which the first three are very short and the rest much elongated.

Radials just visible. The IBr_1 are short, rounded and oblong, free laterally, and scarcely incised by the axillaries, which are widely rhombic with open proximal angles.

The 10 arms are 55 mm. long, and are composed of smooth obliquely quadrate brachials.

Syzygies occur between brachials 3+4 and 9+10, and distally at intervals of from 3 to 6 muscular articulations.

The pinnules of the first pair (P_1 and P_a) are long, slender and delicate, composed of numerous segments which are but little longer than broad. Those of the second pair (P_2 and P_b) are of about the same length, but are composed, like their successors, of stouter and more elongate segments, which become slender again in the distal pinnules.

The disk and ambulacra are naked. Sacculi are moderately abundant.

Carpenter's notes on a second specimen from the same station.—Besides the mutilated individual just described, *Challenger* station 219 also yielded another which Carpenter at first regarded as representing a distinct species (*notata*), but later considered would be better interpreted as a varietal form of *tenuicirra*, although, according to Carpenter, it presents some not unimportant differences.

The cirri are both more numerous and have a larger number of segments than in the type, though the latter have the same smooth elongated character in both.

Although of larger size, more of the radials are visible, while the axillaries have sharper proximal angles and the IBr_1 are therefore more incised.

There are slight indications of lateral flattening upon the 4 lower brachials.

The segments of P_1 are relatively longer than in the type.

Notes.—Thanks to the courtesy of Prof. F. Jeffrey Bell, I was able to examine both these specimens in the British Museum. After a study of the larger example I decided that this form is closely related to *Th. tenelloides*, but it is a smaller species with longer brachials which are not so nearly oblong. There is the same short segmented P_1; P_2 and P_3 are large and stiffened; P_2 is slightly larger and longer than P_3; P_4 is smaller than P_2 and P_3.

In the smaller individual there are 15 cirrus segments of which the proximal are very long. P_1 is short with comparatively few long segments; P_2 and P_3 are large.

This last is the specimen figured by Carpenter under the name *notata;* but his notes on *notata* evidently refer to the individual figured as *tenuicirra*, except in regard to the number of the cirri, the incision of the IBr_1, and the character of P_1. [Note by A.M.C.] The type specimen of *notata* is not now (1958) to be found in the British Museum. The type of *tenuicirra* is in very poor condition, the centrodorsal broken and the radials separated. The cirri are detached but a few remain in the jar. One with 16 segments has the third segment already over twice as long as broad and the fourth and fifth are about six times as long as broad. No complete P_1 remains but the basal six or seven segments are about as long as broad. P_2 has 14 segments and is 5 mm. long. Only the first two segments are not longer than broad.

Some further specimens of this species were obtained by the Danish Expedition to the Kei Islands in 1922, about which nothing has been published. Since they show some differences from the types, a full description is given here.

The centrodorsal is rather sharply conical, nearly twice as broad basally as it is high, with the sides almost completely covered with closely crowded cirrus sockets which decrease slowly in size towards the apex.

The cirri are XL, 22–24, 25–30 mm. in length. They are very slender, nearly straight, tapering gradually from the base to an attenuate and very pointed tip. The first segment is very short, three times as broad as long, the second is half again as broad as long, the third is usually slightly longer than broad but may be slightly broader than long, the fourth is from two to three times as long as broad, and those following are much elongated, in the central portion of the cirri being five or six times as long as the median width with slightly swollen ends and distally about four times as long as broad with the dorsal and ventral profiles nearly straight. The antepenultimate and penultimate segments are perfectly straight and taper gradually, the latter being exceedingly slender and ending almost in a point, which bears the extremely small conical terminal claw.

The distal portion of the radials is visible as a very narrow band beyond the rim of the centrodorsal. The IBr_1 are nearly or quite four times as broad as long in the median line, somewhat incised in the median line by a proximal process from the axillary. The lateral borders are in contact basally. The IBr_2 (axillaries) are about half again as broad as long. The distal sides are slightly curved and are at right angles to each other. The distal apex is slightly produced. There is a slight, well-rounded proximal median projection.

The first brachials are twice as broad as their outer length, which is about twice the inner length. The distal border runs inward and downward from the outer angle to the median line of the arm and then curves to run parallel to the proximal border to the inner edge. The second brachials are much larger than the first and are irregularly quadrate. The first syzygial pair (brachials 3+4) is somewhat longer interiorly than exteriorly and is nearly twice as broad as the median length. The next four brachials are slightly wedge-shaped, about three times as broad as their median length. The second syzygial pair is oblong, half again as broad as long. The following brachials are obliquely wedge-shaped, about as long as broad, soon becoming less obliquely wedge-shaped. Syzygies occur at brachials 3+4, 9+10, 14+15, and distally at intervals of three or four muscular articulations.

P_1 is 8 mm. long with 31 to 33 segments, remaining about the same width for the first six segments then tapering gradually, the distal portion being excessively slender and hairlike. The first two segments are about as long as broad with their angles only rounded. The third to the sixth or seventh segments are broader than long, with their angles truncated. The following segments increase rather rapidly in length, becoming about twice as long as broad on the thirteenth and four or five times as long as broad terminally. The sixth to ninth segments have a rounded notch in the proximal border, the edges of this notch on either side being slightly swollen.

P_2 is about 11 mm. long with 20 segments. It is half again as broad basally as P_1, and tapers gradually to a very delicate tip. It is thus much stouter than P_1. The first segment is broader than long, the second and third are about as long as broad and those following increase in length becoming about three times as long as broad on the tenth and somewhat longer distally.

P_3 and P_4 resemble P_2; P_3 is of about the same length but very slightly more slender distally. P_4 is slightly shorter and is still more slender distally.

The color is white with a series of small but conspicuous brown spots along the ventral surface of the arms, usually at about every third pinnule.

Localities.—*Challenger* station 219; north of the Admiralty Islands (lat. 1°54′00″ S., long. 136°49′40″ E.); 274 meters; coral mud; March 10, 1875 [P. H. Carpenter, 1879, 1888; A. H. Clark, 1913] (1, B.M.). Type locality.

Albatross station 5221; between Marinduque and Luzon, Philippines; San Andreas Island (W.) bearing S. 27° E., 5.50 miles distant (lat. 13°38′15″ N., long. 121°48′15″ E.); 353 meters; bottom temperature 11.56° C.; bottom density 1.02447; green mud; April 24, 1908 [A. H. Clark, 1918] (1, U.S.N.M., 36012).

Dr. Th. Mortensen's Pacific Expedition, 1914–16; 3 miles SW of Tucuran, Mindanao, Philippines; c. 548 meters; March 10, 1914 (2, C.M.).

Danish Expedition to the Kei Islands; station 42; 225 meters; bottom, stones; April 26, 1922 (3, C.M.).

Danish Expedition to the Kei Islands; station 58; 290 meters; May 12, 1922 (1, C.M.).

Geographical range.—From the Admiralty, Kei, and Philippine Islands.

Bathymetrical range.—From 225 to 548 meters.

Thermal range.—One record, 11.56° C.

Remarks [by A.M.C.].—Unfortunately, though Mr. Clark left a description of one of the Kei Islands specimens, he added no comments on the light thrown by these on the interrelationship between *T. tenelloides* and *tenuicirra*. It seems to me that the shape of the brachials is dependent more on the magnitude of the specimen but that the greater number of cirrus segments in *tenuicirra* and the different proportions of the first two pinnules do provide reliable characters for the distinction of the two species.

Genus COCCOMETRA A. H. Clark

Comatula (part) Pourtalès, Bull. Mus. Comp. Zool., vol. 1, No. 6, 1868, p. 105.

Comatula (*Alecto*) (part) Pourtalès, Bull. Mus. Comp. Zool., vol. 1, No. 6, 1868, p. 111.

Antedon (part) Pourtalès, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 355, and following authors.

Coccometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (diagnosis; type species *Comatula hagenii* Pourtalès, 1868), p. 136 (referred to Antedonidae, restricted); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Antedonidae, restricted), p. 212 (occurs in the West Indies); Amer. Nat., vol. 42, No. 503, 1908, p. 724 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 606 (color); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 177 (referred to Thysanometrinae); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 10 (represents the East Indian *Thysanometra* in the West Indies); Amer. Journ. Sci., ser. 4, vol. 32 (whole number 182), 1911, p. 129 (characteristic of the West Indian fauna; significance); Crinoids of the Indian Ocean, 1912, p. 14 (corresponds to the East Indian *Thysanometra*), p. 26 (related to *Thysanometra*); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (represents in the Atlantic *Thysanometra* of the Indo-Pacific; range and its significance); Die Crinoïden der Antarktis, 1915, p. 182 (range; represented in the Indo-Pacific by *Thysanometra*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to Thysanometrinae); No. 16, p. 507 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 217 (in key; range), p. 218 (key to the included species); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (confined to the West Indies), p. 17 (in key); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range; included species).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 238.—H. L. Clark, Mem. Mus. Comp. Zool., vol. 55, 1938, p. 47.—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (one species occurs below 1,000 meters).

Cocometra H. L. Clark, Univ. Iowa Monographs, ser. 1, No. 15; Bull. Lab. Nat. Hist. Univ. Iowa, vol. 7, No. 5, April 1918, p. 12 (emendation).

Diagnosis.—A genus of Thysanometrinae in which the radial facets have long narrow triangular muscular fossae, separated from the interarticular ligament fossae by strongly diagonal and straight ridges; the centrodorsal is hemispherical or subconical; the distal pinnules tend to be shorter than the proximal ones. The color pattern is apparently characteristic of the species.

Type species.—Comatula hagenii Pourtalès, 1869.

Geographical range.—From North Carolina to Yucatan, Cuba, Jamaica, and Porto Rico.

Bathymetrical range.—From 14 to 1046 meters.

KEY TO THE SPECIES OF COCCOMETRA

a^1. Cirrus segments 24–28; cirri very slender, with the fourth and following segments greatly elongated, 4 to 5 or more times as long as broad; terminal claw straight, tapering to a sharp point; arms 60–70 mm. long in the unique holotype; a large black spot on either side of each syzygial pair; P_1 9 mm. long with 35–40 segments; P_2 5 mm. long with 12–15 segments (southeast of Santiago de Cuba; 464 meters) **guttata** (p. 278)

a^2. Not more than 25 cirrus segments, of which the distalmost are much shorter than the elongate proximal, the penultimate being about as long as broad and the antepenultimate and at least one of those immediately preceding being less than twice as long as broad; terminal claw recurved.

b^1. Segments in the distal half of P_1 becoming elongated, twice as long as broad, with very spinous distal edges; division series and proximal portion of the arms with a prominent black median line; remainder of arms with a large median black spot on each syzygial pair; elements of the division series and brachials with prominently everted and very spinous borders; cirri with the antepenultimate and several of the preceding segments very slightly, if at all, longer than broad; cirri 16–18 mm. long with 17–23 segments; arms probably 50–60 mm. long (Yucatan to Porto Rico and Jamaica; 42–987 meters)........................**nigrolineata** (p. 276)

b^2. Segments in the distal half of P_1 short, like those in the proximal half; no black markings; elements of the IBr series and lower brachials with less conspicuously spinous borders; cirri with the antepenultimate and preceding segments markedly longer than broad; cirri 10–15 mm. long with 17–25 segments; arms 40–100 mm. long (Cape Lookout, N.C., to Cuba and Yucatan; 14–1046 meters)..**hageni** (p. 279)

COCCOMETRA NIGROLINEATA A. H. Clark

[See vol. 1, pt. 1, fig. 374, p. 299]

Antedon hagenii (not of Pourtalès), H. L. Clark, Bull. U.S. Fish Comm., vol. 20, for 1900, pt. 2, 1902, p. 235 (in key; *Fish Hawk* Sta. 6067).

Coccometra nigrolineata A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 129 (listed; nomen nudum; new name for *Antedon hagenii* H. L. Clark, 1902, not *Comatula hagenii* Pourtalès, 1869).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 389 (nomen nudum; according to Clark, fig. 13, pl. 9, represents this species).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 219 (in key; range), p. 220 (synonymy; detailed description; *Albatross* Stas. 2138, 2327, 2335, 2341, 2354; off Havana; *Fish Hawk* Sta. 6067); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 142 (in key), p. 144 (references); Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

?*Antedon cubensis* (not of Pourtalès), Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 389, pl. 9, fig. 13, pl. 15, fig. 3.

Diagnostic features.—The elements of the IBr series and the arm bases have a broad and conspicuous black mediodorsal line; in the outer part of the arms there is a single large median black spot on each syzygial pair; the segments in the distal half of P_1 are elongated, twice as long as broad, with very spinous distal edges; and the cirri have 17 to 23 segments of which the antepenultimate and several of the preceding are only very slightly, if at all, longer than broad.

Description.—The centrodorsal is hemispherical or subconical, the polar area finely papillose with a rounded tubercle at the apex.

The cirri are XXX–XL, 17–23 (usually 21–22), from 16 to 18 mm. long. The first two segments are short, about twice as broad as long, the third is about twice as long as broad, the fourth to eighth or ninth are greatly elongated, four or five times as long as broad, and the following rapidly decrease in length so that the terminal 6 to 8 are about as long as broad. The elongate proximal segments are somewhat constricted centrally with swollen articulations. The shorter distal segments increase gradually in width from the proximal to the distal ends, the latter slightly overlapping the bases of the succeeding segments. On the distal part of the dorsal side of the penultimate segment there is a very small opposing spine which in height does not reach a third of the width of the segment. The terminal claw is about as long as the penultimate segment, and is moderately curved.

The radials are only visible in the interradial angles. The IBr_1 are very short, with a concave distal border which in the median line nearly reaches the straight posterior border. The IBr_2 (axillaries) are roughly rhombic with a rounded posterior prolongation; the anterior angle is sharp and greatly produced. The IBr series are normally just in apposition laterally, but are not laterally flattened.

The 10 arms are probably between 50 and 60 mm. long. The first brachial is exteriorly about half as long as broad but becomes reduced almost to a point interiorly;

it is deeply incised in the median line by the considerably larger irregular second brachial. The first syzygial pair (composed of the third and fourth brachials) is wedge-shaped and much longer interiorly than exteriorly. The following brachials are rather short, after the twelfth becoming more triangular and about as long as broad. The proximal brachials as far as the eighth have slight alternating lateral tubercles. The edges of the elements of the IBr series and of the lower brachials are everted, prominent, and very spiny.

Syzygies occur between brachials 3+4, 9+10 and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is 7.5 mm. long, slender, composed of 35 or more short segments of which those in the proximal half are about as long as broad with the corners cut away and those in the distal half become gradually somewhat elongated, the very slender terminal segments being about three times as long as broad. P_2 is 7 mm. long, considerably stouter and less flexible than P_1, with about 15 segments of which the first three are about as long as broad and the following become elongated, the sixth being over twice as long as broad and the terminal ones four or five times as long as broad. The following pinnules as far as P_7 are similar; beyond that point the pinnules become longer and more slender with the first two segments slightly enlarged, the first short and the second about as long as broad, and the remainder elongated.

Color.—The color in alcohol is white with a conspicuous median line of black on the IBr series and the lower portion of the arms beyond which each syzygial pair bears a transverse black band or large black spot.

Ventrally the disk is black, and the perisome of the arms is yellowish banded with black.

Localities.—*Albatross* station 2354; off the eastern coast of Yucatan (lat. 20°59′30″ N., long. 86°23′45″ W.); 237 meters; coral; January 22, 1885 [A. H. Clark, 1918] (1, U.S.N.M., 36290).

Albatross station 2335; off Havana, Cuba (lat. 23°10′39″ N., long. 82°20′21″ W.); 373 meters; January 19, 1885 [A. H. Clark, 1918] (1, U.S.N.M., 36296).

Albatross station 2341; off Havana, Cuba (lat. 23°11′00″ N., long. 82°19′06″ W.); 261 meters; coral; January 19, 1885 [A. H. Clark, 1918] (1, U.S.N.M., 36295).

Albatross station 2327; off Havana, Cuba (lat. 23°11′45″ N., long. 82°17′54″ W.); 333 meters; fine brown sand; January 17, 1885 [A. H. Clark, 1918] (1, U.S.N.M., 22674). Type locality.

Bibb station 139P (in bulletin, 1); off Cojima, near Havana, Cuba; 987 meters; March 4, 1869 [Hartlaub, 1912].

Albatross; off Havana, Cuba, without further data [A. H. Clark, 1918] (1, U.S.N.M., 36294).

Fish Hawk station 6067; Mayaguez Harbor, Porto Rico; Point del Algarrobo bearing E. ½ N. (magnetic), 5.75 miles distant; 175–216 meters [H. L. Clark, 1902] (1, U.S.N.M., 21467).

Albatross station 2138; southeast of the southeastern point of Jamaica (lat. 17°44′05″ N., long. 75°39′00″ W.); 42 meters; coral and broken shells; February 29, 1884 [A. H. Clark, 1918] (fragments, U.S.N.M., 7110).

Geographical range.—From Yucatan to Porto Rico and Jamaica.

Bathymetrical range.—From 42 to 987 meters; but all except 2 of the records are from between 216 (?175) and 373 meters. The average of the 7 records is 328 meters or, omitting the 2 extremes, 266 meters.

History.—The first mention of a specimen of this species was in 1902 by Dr. Hubert Lyman Clark who recorded a very badly broken individual from the *Fish Hawk* investigations about Porto Rico under the name of *Antedon hagenii.*

In looking over the comatulids collected by the *Albatross* in the West Indian region, I found a number of examples of this form which I recognized as new; and on comparison it was at once evident that Dr. Clark's mutilated specimen was conspecific with them. This was indicated in the list of species assigned to *Coccometra* at the time that genus was established in 1908.

In the *Blake* material turned over to him after Carpenter's death, Hartlaub found a fragmentary specimen labeled *Antedon cubensis* which differed markedly from the other two so labeled. He sent me the plate with the figure of this on it, and I wrote him that it appeared to represent my *Coccometra nigrolineata* from Cuba and Porto Rico. This information he published in 1912.

In 1918, just 10 years after the name was first published, this species was finally described and a summary of its range given.

COCCOMETRA GUTTATA A. H. Clark

[See vol. 1, pt. 1, figs. 376, p. 299; pt. 2, fig. 755, p. 349]

Coccometra guttata A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 218 (in key; range), p. 219 (detailed description; *Albatross* Sta. 2134); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 141 (in key), p. 144 (references); Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—There is a large black spot on either side of each syzygia pair; the cirri have 24 to 28 segments of which the fourth and following are greatly elongated, 4 to 5 or more times as long as broad, and the terminal claw is straight.

Description.—The centrodorsal is small, hemispherical or subconical, with the polar area rather small and papillose.

The cirri are XXX–XL, 24–28, very slender, 25 mm. long. The first two segments are short, the third is about half again as long as broad, and the remainder are four or five times as long as broad, or even longer. The antepenultimate segment tapers slightly from the proximal to the distal end. The penultimate segment is about half as long as the antepenultimate, and tapers to the base of the terminal claw, which itself is about half as long as the penultimate segment, perfectly straight, and tapers to a sharp point. The cirri are perfectly smooth with no trace of dorsal processes on the distal segments, nor of an opposing spine.

The radials are just visible beyond the edge of the centrodorsal in the mid-radial line, and extend upward in the interradial angles in the form of a triangle. The IBr_1 are oblong, about two and a half times as broad as long, and are widely separated laterally. The IBr_2 (axillaries) are almost triangular, with the posterior edge slightly convex and the anterior angle long and acute; they are somewhat broader than the IBr_1.

The 10 arms are from 60 to 70 mm. long. The first brachial is wedge-shaped, longer outwardly than inwardly, the inner sides in apposition basally. The second brachial is similar, but rather larger and more irregular in shape. The first syzygial pair (composed of the third and fourth brachials) is approximately as long as broad. The following brachials to the eighth are slightly wedge-shaped, not quite so long as broad. The second syzygial pair (comprising the ninth and tenth brachials) is not quite twice as long as broad. The succeeding brachials are obliquely wedge-shaped, about as long as, or rather longer than, broad, becoming less and less obliquely wedge-shaped distally, and finally oblong and elongate. All the brachials are perfectly smooth, with no ornamentation of any kind.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is 9 mm. long, very flexible and slender, composed of 35 to 40 short segments most of which are about as long as broad with all the angles cut away and hence appearing rounded, those in the terminal third becoming slightly elongated; the articulations are enlarged, and the whole pinnule suggests a string of small beads. P_2 is 5 mm. long with 12 to 15 segments, of which the first two are about as long as broad and the fourth and following rapidly become elongated and the distal very slender; the fifth, sixth and seventh segments bear a large rounded gonad. The following pinnules to P_8 are similar, but the gonad gradually moves nearer the base of the pinnule, on P_8 extending from the third to the sixth segment. The distal pinnules are 12 mm. long with 20 segments of which the first is very short, almost bandlike, the second is almost triangular, the third is about half again as long as broad, the fourth is about twice as long as broad, and the remainder become progressively elongated.

Color.—The color in alcohol is yellowish white with a large black spot on either side of each syzygial pair; the inner half of the articular faces of the syzygies is also black.

Locality.—*Albatross* station 2134; off Santiago de Cuba (lat. 19°56′06″ N., long. 75°47′32″ W.); 464 meters; February 27, 1884 [A. H. Clark, 1918] (1, U.S.N.M., 22675).

COCCOMETRA HAGENI (Pourtalès)

FIGURE 14

[See also vol. 1, pt. 1, figs. 284 (p. 261), 375 (p. 299), 499 (p. 369); pt. 2, figs. 112–113 (p. 67), 298 (p. 221), 331 (p. 227), 756 (p. 349), pl. 12, fig. 1042, pl. 13, figs. 1047–1049, pl. 14, figs. 1056, 1063, 1064]

Comatula hagenii POURTALÈS, Bull. Mus. Comp. Zool., vol. 1, No. 6, 1868, p. 105 (about 5 miles SSW. of Sand Key; 90–100 fms.; calcareous mud; *nomen nudum*); No. 7, 1869, p. 125 (taken by the *Bibb* in the Florida Straits).

Comatula (Alecto) hagenii POURTALÈS, Bull. Mus. Comp. Zool., vol. 1, No. 6, 1868, p. 111 (description; off Sand Key, 100 fms.; abundance; color).—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, 1905, p. 167, footnote (syzygies).

Antedon hagenii POURTALÈS, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 355 (coasts of Florida and Cuba; 94–195 fms.); vol. 5, No. 9, 1878, p. 214 (*Blake* localities; color of young).—P. H. CARPENTER, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*); Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, pp. 154–156 (discussion).—VON GRAFF, Bull. Mus. Comp. Zool., vol. 9, No. 7, 1883, p. 132 (myzostomes).—H. L. CLARK, Bull. U.S. Fish. Comm. for 1900, vol. 20, pt. 2, 1902, p. 235 (remarks and measurements but not specimen recorded).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 337 (representative of a group characteristic of the Caribbean Sea).

Antedon hageni BELL, Proc. Zool. Soc. London, 1882, p. 533 (listed).—P. H. CARPENTER, Proc. Zool. Soc. London for 1882, 1883, p. 746 (specific formula).—VON GRAFF, Bull. Mus. Comp. Zool., vol. 11, No. 7, 1883, pp. 128, 129 (Alligator reef, 96 fms.; off Sand Key, 100 fms.; off Bahia Honda, 100 fms.; 23°32′ N., 88°05′ W., 95 fms.; myzostomes); *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, p. 18 (myzostomes), p. 47 (*Bibb*, near Bahia Honda, 100 fms.; *Blake* Sta. 32), p. 50 (Alligator Reef, 96 fms.), p. 59 (off Sand Key).—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 22, 54, 207, 367, 368, 373, 377 (Caribbean Islands and Straits of Florida, 82–242 fms.).—A. AGASSIZ, Bull. Mus. Comp. Zool., vol. 15, reprinted as "Three Cruises of the

Blake," pt. 2, 1888, p. 124 (part) (Yucatan Bank; various stations between Dominica and Grenada, 75–291 fms.; Straits of Florida), p. 127 (myzostomes).—BRAUN, Centralbl. Bakteriol. und Parasitenk., vol. 3, 1888, p. 186 (myzostomes; after von Graff).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (listed), pp. 389–394 (synonymy; Sand Key, possibly *Corwin* position 1; detailed description and discussion), pl. 8, figs. 1–12, pl. 15, figs. 2, 6.

Crinoids NUTTING, Bull. Lab. Nat. Hist., Univ. Iowa, vol. 3, Nos. 1, 2, January 1895, pp. 164, 165 (Sand Key Light bearing N. by W. ½ W., 15 miles distant; 120 fms.; abundance).

Coccometra hagenii A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 129 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (published references to specimens in B.M.; off Sombrero [Florida Keys], 105 fms.); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 219 (in key; range), p. 221 (synonymy); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range).—PELSENEER, Bull. Soc. Zool. France, vol. 53, 1928, p. 173 (parasitized by *Eulima* sp.).—H. L. CLARK, Scientific Survey of Porto Rico and the Virgin Islands, vol. 16, pt. 1, 1933, p. 8 (West Indies in less than 10 fathoms), p. 9 (in key), p. 12 (occurrence).—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 141 (in key), p. 144 (references); Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Cocometra hageni H. L. CLARK, Univ. Iowa Monographs, ser. 1, No. 15; Bull. Lab. Nat. Hist., vol. 7, No. 5, April 1918, p. 12 (Bahama Exped. Stas. 27, 33, 48, 54, 57, 58, 62, 64; no loc.; discussion).

Diagnostic features.—There are no black markings; P_2 is nearly or quite as long as P_1; P_1 has the segments in the distal half short, like those in the proximal half; the cirri have 17 to 25 segments of which the antepenultimate and preceding are markedly longer than broad; and the terminal claw is strongly curved.

[NOTE BY A.M.C.] Mr. Clark gave the number of cirrus segments as 17 to 20 in this typescript but there are up to 25 in the four specimens from *Bibb* station 6P in the British Museum.

Description.—The centrodorsal is low hemispherical with a moderate to rather large area at the dorsal pole free of cirri and usually papillose. The cirrus sockets are closely crowded and irregular in arrangement.

The cirri are XXX–L, 17–20, from 10 to 15 mm. long, delicate and rather slender, usually becoming laterally compressed and increasing slightly in dorsoventral diameter in the terminal fourth. The first segment is very short, the second is about as long as broad, the third is about twice as long as broad, the fourth is longer still, and the fifth, which is usually the longest, is about three times as long as broad; from this point onward the segments gradually decrease in length so that the antepenultimate is rather less than twice as long as broad and the penultimate is about as long as broad. The opposing spine is obsolete. The terminal claw is rather longer than the penultimate segment and strongly curved. On the last 3 or 4 segments the median portion of the distal border may be slightly produced. There is no overlapping of the distal ends of the segments, and the longer earlier segments are only slightly constricted centrally.

The radials are concealed by the centrodorsal, or are just visible as low triangles in the interradial angles. The IBr_1 are short, broader proximally than distally, almost obscured in the median line by a posterior projection from the IBr_2 which are longer than broad with the anterior angle much produced, the distal sides very concave, and a strong rounded posterior process. The IBr_2 are much broader than the distal ends of the IBr_1, so that each IBr series appears much constricted at the articulation.

The 10 arms are from 40 to 100 mm. long. The first brachial is very short with the inner half almost bandlike and the outer half triangular. The second brachial is irregularly quadrate with a posterior prolongation deeply incising the first brachial. The third brachial (forming the hypozygal of the first syzygial pair) is triangular with

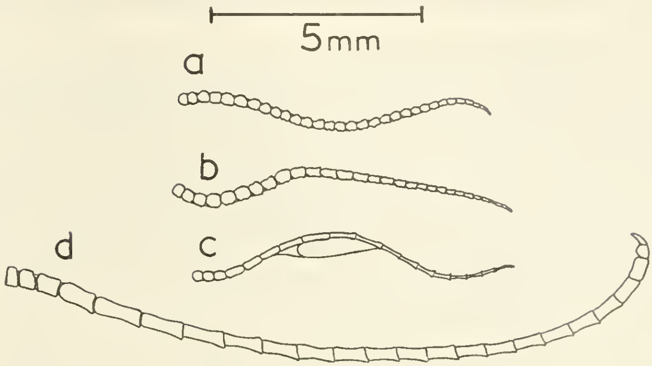

FIGURE 14.—*Coccometra hageni* (Pourtalès), B.M., 1907.3.26.1–3, Sombrero Key: *a*, P_1; *b*, nongenital P_2; *c*, genital P_2 of a second specimen; *d*, cirrus.

the apex outward, and the inner edge about half as long as the width. The fourth brachial (forming the epizygal of the first syzygial pair) is oblong, twice or three times as broad as long. The following brachials as far as the second syzygial pair are slightly wedge-shaped with somewhat concave ends, and about half again as broad as long; the central portion of their distal ends is finely spinous. The brachials following the second syzygial pair are very obliquely wedge-shaped and about as long as broad, distally becoming less and less obliquely wedge-shaped and at the arm tip elongated. Two or three of the brachials following the second syzygial pair have a group of small spines in the central portion of the distal end, but the following brachials have the ends smooth and not produced.

Syzygies occur between brachials 3+4, 9+10 and 14+15 (the last 2 occasionally irregular) and distally at intervals of 2 or 3 muscular articulations.

P_1 is about 10 mm. long, slender and very flexible, composed of 40 segments of which the basal 5 or 6 are broader than long, the twelfth and following are about as broad as long, and the terminal are rather longer than broad. The short proximal segments have their corners rounded off, and the middle and distal are centrally constricted with prominent articulations.

P_2 is of about the same length as P_1 or slightly shorter; it is stiffer than P_1 and is composed of 20 segments of which the first 3 are about as long as broad and the remainder become progressively elongated; a large gonad occurs on the eighth to thirteenth segments. The following pinnules are similar, but gradually decrease in length to about the eighth after which they do not bear gonads, becoming rather more slender and increasing in length. The distal pinnules are 7 mm. long, with the first 2 segments expanded and trapezoidal and the remainder elongate, though not markedly so.

Color in life.—Pourtalès says that this species is pale greenish, and that the young are marked with dark brown spots arranged in pairs on the beginnings of the arms, but becoming confluent toward their ends; in the adults the spots are hardly apparent.

Nutting refers to the color as brownish.

Notes [BY A.M.C.].—There are four specimens in the British Museum from off Sombrero Key received from the Museum of Comparative Zoology. These are presumably some of those from *Bibb* station 6P. The peripheral cirri usually have about 20 segments but the largest has up to 25, though the proportions of the segments are similar to those in the above description (fig. 14,d). Another difference is that the form of P_2 varies. In one or two cases it is very like P_1 with short numerous (about 30) segments (fig. 14,b) but usually it is a genital pinnule and the segments are reduced in number to about 15 to 20 and are much more elongated, varying to the other extreme shown in fig. 14,c.

Localities.—Fish Hawk station 7302; off Cape Lookout, North Carolina; Cape Lookout Light House bearing E. by N. ⅛ N., 1¾ miles distant; 14 meters; temperature 27° C.; July 24, 1902 (1, U.S.N.M., 35888).

Albatross station 2415; between Savannah, Georgia, and Cape Charles (lat. 30°44′00″ N., long. 79°26′00″ W.); 805 meters; temperature 7.56° C.; April 1, 1885 (1, U.S.N.M., 36292).

Albatross station 2656; between the Bahamas and Cape Fear, North Carolina (lat. 27°58′30″ N., long. 78°24′00″ W.); 1046 meters; temperature 5.11° C.; May 3, 1886 (1, U.S.N.M., 14705).

Bibb station 6P (in bulletin, 3); Florida Keys, off Sombrero; 210 meters; April 23, 1868 [Pourtalès, 1869; A. H. Clark, 1913] (7+, U.S.N.M., 34622; M.C.Z., 44*; B.M.).

University of Iowa's Bahamas Expedition station 57; Pourtalès Plateau, south of Bahia Honda (lat. 24°18′00″ N., long. 81°18′00″ W.); 366–411 meters; June 27, 1893 [H. L. Clark, 1918] (366, U.I.M.; U.S.N.M., 36124).

Bibb station 20P (on charts and in record books, 10D; in bulletin, 10); Florida Keys, off Bahia Honda (lat. 24°19′40″ N., long. 81°07′00″ W.); 234 meters; May 4, 1868 [Pourtalès, 1869] (3, M.C.Z., 45).

University of Iowa's Bahamas Expedition station 58; Pourtalès Plateau, south of Bahia Honda (lat. 24°19′00″ N., long. 81°19′00″ W.); about 402–411 meters; 1893 [H. L. Clark, 1918] (275, U.I.M.).

Bibb station 18P (on charts and in record books, 7D); Florida Keys, off Bahia Honda (lat. 24°26′30″ N., long. 81°14′30″ W.); 183 meters; rocky bottom; May 4, 1868 [Pourtalès, 1869; von Graff, 1883, 1884].

University of Iowa's Bahamas Expedition station 54; about 10 miles southeast of American Shoal Light; about 238 meters; 1893 [H. L. Clark, 1918] (185, U.I.M.).

University of Iowa's Bahamas Expedition station 64; Florida Keys, about 8 miles southeast of American Shoal Light; about 201 meters [H. L. Clark, 1918] (95, U.I.M.).

University of Iowa's Bahamas Expedition station 62; Florida Keys, off American Shoal Light; 126–144 meters; 1893 [H. L. Clark, 1918] (205, U.I.M.).

Bibb station 31P (on charts and in record books, 9E; in bulletin, 9); Florida Keys, off American Shoal (lat. 24°25′20″ N., long. 81°27′00″ W.); 183 meters; May 6, 1868 [Pourtalès, 1869] (47, M.C.Z., 246).

Bibb station 40P (on charts and in record books, 9G); Florida Keys, off the

*Included under Cat. No. 44, M.C.Z., are 10 specimens from *Bibb* stations 6P, 56P and 127P.

Samboes; 175 meters; mud; May 9, 1868 [Pourtalès, 1869; von Graff, as "Alligator reef," 1883, 1884].

Eolis; off the Samboes; 247 meters; J. B. Henderson (2, U.S.N.M.).

Eolis; off the Samboes; 209 meters; J. B. Henderson (14, U.S.N.M.).

Eolis; off the Samboes; 220 meters; J. B. Henderson (1, U.S.N.M.).

Fish Hawk station 7298; Florida Keys, off Key West (lat. 24°19′00″ N., long. 81°39′45″ W.); 220 meters; temperature 18.5° C.; February 26, 1902 (2, U.S.N.M., 36217).

Fish Hawk station 7297; near Key West (lat. 24°15′45″ N., long. 81°41′30″ W.); 267 meters; temperature 16.5° C.; February 26, 1902 (1, U.S.N.M., 34640).

Fish Hawk station 7296; near Key West (lat. 24°21′45″ N., long. 81°47′45″ W.); 223 meters; temperature 12.22° C.; February 26, 1902 (5, U.S.N.M., 35711).

University of Iowa's Bahamas Expedition station 27; south of Key West; 91–110 meters; 1893 [H. L. Clark, 1918] (5, U.I.M.).

University of Iowa's Bahamas Expedition station 48; southwest of Key West; about 146 meters; 1893 [H. L. Clark, 1918] (6, U.I.M.).

Bibb station 56P (on charts and in record books, 10H; in bulletin, 6); Florida Keys, off Sand Key (lat. 24°22′50″ N., long. 81°46′20″ W.); 172 meters; May 11, 1868 [Pourtalès, 1869] (9+, U.S.N.M., 34647; M.C.Z., 44).

Bibb stations 69P–73P (in bulletin 1, 3–6); nearly south of Sand Key; 183 meters; May 15, 1868 [Pourtalès, 1869] (10, U.S.N.M., 34643; M.C.Z., 247).

University of Iowa's Bahamas Expedition station 33; about 6 miles south of Sand Key Light; about 192 meters; 1893 [H. L. Clark, 1918] (1, U.I.M.).

University of Iowa's Bahamas Expedition; off Sand Key; Sand Key Light bearing N. by W. ½ W., 15 miles distant; 220 meters [Nutting, 1895] (6, U.S.N.M., 36123).

Eolis; off Sand Key; 220 meters; J. B. Henderson (32, U.S.N.M.).

Eolis; off Western Dry Rock, Sand Key; 263 meters; J. B. Henderson (5, U.S.N.M.).

Corwin station 1P; about 5 miles Southsouthwest of Sand Key; 164–183 meters; calcareous mud; May 17, 1867 [Pourtalès, 1868; von Graff, 1883, 1884; Hartlaub, 1912] (1, M.C.Z., 7). Type locality.

Bibb station 127P (in bulletin, 4); Florida Keys, off Boca Grande; 229 meters; February 15, 1869 [Pourtalès, 1869] (1+, M.C.Z., 44).

University of Iowa's Bahamas Expedition; Florida Keys, without further data (110, U.I.M.).

Coasts of Florida and Cuba; 172–356 meters [Pourtalès, 1869].

Blake station 32Ag.; northern part of the Yucatan Bank (lat. 23°32′00″ N., long. 88°05′00″ W.); 174 meters [Pourtalès, 1878; P. H. Carpenter, 1881; von Graff, 1883, 1884; A. Agassiz, 1888].

Albatross station 2335; off Havana, Cuba (lat. 23°10′39″ N., long. 82°20′21″ W.); 373 meters; January 19, 1885 (1, U.S.N.M., 36293).

Blake station 53Ag.; off Havana, Cuba (lat. 23°09′30″ N., long. 82°21′30″ W.); 442 meters [Pourtalès, 1878].

Blake station 57Ag.; off Havana, Cuba (lat. 23°09′15″ N., long. 82°21′00″ W.); 323 meters [Pourtalès, 1878].

Straits of Florida [P. H. Carpenter, 1888].

Doubtful localities.—Dominica to Grenada; 137–532 meters [P. H. Carpenter, 1881].

Barbados [P. H. Carpenter, 1881].

656-622—67——20

Grenada [P. H. Carpenter, 1881].

Caribbean Islands [P. H. Carpenter, 1888].

Erroneous locality.—University of Iowa's Barbados-Antigua Expedition station 15; Barbados [A. H. Clark, 1921] (3, U.I.M.; U.S.N.M.).

Geographical range.—From Cape Lookout, North Carolina, southward to the Florida Keys and northern Cuba, thence westward to the Yucatan Bank. This species is especially abundant along the Florida Keys.

Bathymetrical range.—From 14 to 1046 meters; but almost two-thirds of the records are from between 100 and 250 meters.

The average of 34 records is 264 meters; or, omitting the two extremes, 251 meters.

About the Florida Keys the 26 records range between 110 (?91) and 402 (?411) meters, with an average of 221 meters.

The 3 records from the Cuban coast range from 323 to 442 meters, the average being 379 meters; but little work has been done here in shallow water.

Thermal range.—The 6 records vary from 5.11° C. to 27.0° C., the average being 11.15° C.

Occurrence.—From the coast of North Carolina southward and westward to the western end of the Florida Keys this species is very abundant wherever it is found, and it appears to be very generally distributed. Outside of this area there are but three records for northern Cuba and one for the northern part of the Yucatan Bank, and in none of these four localities was it found in numbers.

In the original account published in 1868, Pourtalès recorded it as "quite abundant" about 5 miles southsouthwest of Sand Key in 183 meters.

In the following year Pourtalès reported on the work of the *Bibb*, which in the spring of 1868 had continued the work of exploring the Gulf Stream begun by the *Corwin* in 1867. He divides the sea bottom here into 3 regions of which the second extends in the form of a band from 10 to 20 miles broad parallel to the reef beginning at a depth of about 164 meters and extending downward to about 548, the slope being much less inclined than in the region further inshore, the area in fact deserving in a great part of its extent the name of a submarine plateau. The bottom is rocky, rather rough, and consists of a recent limestone continually though slowly increasing from the accumulation of the calcareous debris of the numerous small corals, echinoderms and mollusks living on its surface. This debris is consolidated by the tubes of serpulas, the interstices filled up by foraminifera and further smoothed out by nullipores.

In this region the *Bibb* found this species in great abundance, but the details of its occurrence were not published.

In summing up the occurrence of the crinoids obtained on the coasts of Florida and Cuba in 1867, 1868 and 1869 Pourtalès gives this species as ranging from 172 to 356 meters.

In 1881 P. H. Carpenter wrote that this species has the widest range of any endocyclic comatulid in the Caribbean Sea. It was obtained by the *Blake* on the Yucatan Bank and at various stations between Dominica and Grenada in from 137 to 532 meters, while Pourtalès dredged it in great abundance at several localities in the Florida Straits. Carpenter's account was republished by Mr. Alexander Agassiz in 1888.

Carpenter remarked that the original specimens from Sand Key differ greatly from others from Barbados and Grenada, and these from each other.

The only small antedonids from Barbados which I have ever seen are three specimens of *Compsometra* (now *Antedon*) *nuttingi*. These I at first mistook for this species, and so recorded them. I have a suspicion that Carpenter may have done the same thing, and I therefore tentatively regard his records from Dominica, Barbados and Grenada as referring to *Antedon nuttingi* and not to *Coccometra hageni*.

In the narrative of the University of Iowa's Bahama Expedition published in 1895 Prof. C. C. Nutting wrote that on the Pourtalès Plateau great numbers of crinoids were collected, but the species were comparatively few. That there are portions of the sea bottom covered with as dense a growth of crinoids as any that flourished in paleozoic seas has been proved more than once by recent deep sea explorations. He had ample demonstration of this fact on several occasions, notably when the tangles came up after a haul at a depth of 219 meters. The bearing of this spot, as nearly as could be determined, was Sand Key Light bearing N. by W. ½ W., 15 miles distant. As the tangle bar neared the surface and the tangles themselves could be seen rising through the blue water, he noticed that a stream of brownish objects was trailing after it, as if innumerable mossy bits were floating away from the hemp strands. When the tangles came on board he found them literally covered with a mass of crinoids, all of one kind and quite small (without any doubt *C. hageni*). He estimated that at least 500 specimens came up in that haul, and it was evident that hundreds or thousands had washed off during the ascent of the tangles from the sea bottom. He says that this was probably the greatest number of individuals of any one species obtained at a single haul during the entire cruise; the bottom must have been actually packed with them in spots.

In 1902 Dr. H. L. Clark said that "this has been called the commonest crinoid of the West Indies;" undoubtedly he referred to the statement that it is the most widespread.

Associates.—Dr. P. H. Carpenter wrote in 1881 that there are 3 distinct species besides this to which he has seen the name *hageni* applied.

The specimens sent to the museums at Edinburgh and Copenhagen under this specific name are varietal forms of *Comactinia echinoptera*.

Among the large number of individuals of *C. hageni* from the Florida Straits which he examined he found a few examples of two entirely different, and at that time new, species.

One of these he notes is distinguished by having enormous lancet-like processes on the lower segments of its oral pinnules. This is the form described by Hartlaub in 1912 under the name of *Actinometra cristata* (P. H. Carpenter, MS.), now known as *Comatonia cristata*. It is frequently associated with *C. hageni* from which it is easily distinguished by its somewhat larger size and more robust build, as well as lighter color.

The other has no pinnules at all upon the second and fourth brachials, though those of the following brachials are developed as usual. Carpenter subsequently referred to this as *Antedon defecta;* it is now known as *Hypalometra defecta*.

Subfamily HELIOMETRINAE

Heliometrinae A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Promachocrinus, Heliometra, Trichometra, Hathrometra,* and *Isometra*); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Crinoids of the Indian Ocean, 1912, p. 5 (the East Indian *Cyclometra* gave rise to *Solanometra* and *Promachocrinus* of the Antarctic; the East Indian *Trichometra* is represented in the Atlantic by other species of *Trichometra* and by *Hathrometra*), p. 6 (number of East Indian genera; number of genera also found in the Atlantic; genera represented by closely allied forms in the Atlantic; number of genera confined exclusively to the East Indies; number of East Indian species), p. 9 (absent from Australia), p. 14 (certain of the genera are characteristic of the Intermediate fauna), p. 26 (range in detail; 107–1,200 fathoms), p. 61 (in key); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (temperature relations); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges); No. 20, 1914, p. 582 (relation to temperature of habitat); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (Atlantic and corresponding Indo-Pacific genera); Die Crinoïden der Antarktis, 1915, p. 119 (synonymy; diagnosis; geological, geographical, and bathymetrical range), p. 132 (covering plates); Amer. Journ. Sci., vol. 40, 1915, p. 68 (detailed discussion of bathymetrical range); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 29 and following (phylogenetical study); Amer. Nat., vol. 49, 1915, p. 525 (bathymetrical and thermal range; asymmetrical genera and their bathymetrical and thermal ranges), p. 526 (*Promachocrinus* probably the most specialized genus in the subfamily; this the largest and most universally distributed subfamily of the Antedonidae), p. 539 (genus with asymmetrical disk), p. 542 (genus with more than 5 rays); Journ. Washington Acad. Sci., vol. 5, No. 4, 1915, pp. 126–134 (bathymetric range; phylogenetic and paleontological significance); vol. 7, No. 5, 1917, p. 127 (includes *Heliometra*, *Promachocrinus*, *Anthometra*, *Solanometra*, *Florometra*, and *Cyclometra*); vol. 7, No. 16, 1917, p. 504 (in key), p. 507 (key to the included genera); Unstalked crinoids of the *Siboga*-Exped., 1918, p. vii (not in the *Siboga* collection; occurrence in the Indo-Pacific; not found by the *Albatross* in the East Indies), p. 196 (in key), p. 239 (key to the included genera); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pp. 2, 13; The Danish *Ingolf*-Exped., vol. 4, no. 5, Crinoidea, 1923, p. 49 (in key), p. 52 (key to the Atlantic genera).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 85, 91, 101, 229, footnote 1, 230, 231, 232, 288, 290.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, pp. 26, 35.—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 662; John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 103.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 21.—John, *Discovery* Reports, vol. 18, 1938, pp. 123, 124, 130, 133; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 196.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.

Heliometrés A. H. Clark, Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 257.

Heliometrinen A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 147 (the species of Bathymetrinae in certain ways resemble the young of the species of this subfamily), p. 168 (shallow water Antarctic species), p. 192 (certain genera of this subfamily are especially characteristic of the Intermediate fauna).

Diagnosis.—A subfamily of Antedonidae in which the cirrus sockets are arranged in usually closely crowded and more or less regularly alternating transverse rows on a flattened hemispherical to sharply conical centrodorsal; the cirri are very numerous, XXXV–CC (usually about LXX), long and stout, with up to 90 (usually 40–55) segments of which the outer are shorter than the proximal and bear a more or less prominent dorsal spine, rarely absent; P_1 is long and flagellate, composed of very numerous, 30–82 (usually 50–60) short segments, none of which are longer than broad and all of which have their angles more or less cut away; and one or more of the following pinnules usually resembles P_1, being of similar length, slightly longer or slightly shorter, though P_2 rarely, P_3 more frequently, and P_4 usually is shorter than P_1 and composed of fewer but longer segments.

Geographical range.—Shores of the Antarctic continent, South Georgia, Kerguelen, Gough, Bouvet, Campbell, the Antipodes and Heard Islands and northward along the western coast of South and North America to the Bering Sea, westward along the Aleutian Islands, and southward to eastern and southern Japan; western shores of the Japanese and Okhotsk seas from the Korean Straits northward; Arctic seas and southward to Hudson Bay, Cape Cod, the Faeroes, northern Norway, and Siberia.

Bathymetrical range.—From shallow water, 11 meters and probably less, down to 1574 meters.

Thermal range.—From −1.90° C. to +13.50° C.; only *Florometra* occurs in water above 5.80° C., and only *Florometra* and, rarely, *Heliometra* occur in water above 3.00° C.

Characters.—The centrodorsal in the Heliometrinae is most commonly flattened hemispherical with the small bare dorsal pole plane or more or less excavated, often so much so as to form a deep pit; but in *Solanometra* it may be rounded conical while in *Anthometra* it is usually, and in *Promachocrinus* it is always, sharply conical with a considerable apical portion of the cone bare of cirrus sockets. The cirrus sockets are numerous, completely covering the sides of the centrodorsal from the ventral rim to the edge of the bare polar area or polar pit, and are usually arranged in from 4 to 7 closely crowded transverse rows; those of the succeeding rows decreasing very slightly in size toward the pole; less frequently they are more or less isolated or less regular in arrangement.

The cirri in the various species of this subfamily are singularly uniform in structure, and present almost no features by which genera or even species may be differentiated; the cirri of *Anthometra* alone seem to be distinctive, though not very different from the cirri of the other types, and the cirri of *Promachocrinus* possibly, on the average, could be identified as such.

The length of the cirri ranges from about 25 to 130 mm. or from 21 to 50 percent of the length of the arms. They are shortest in *Solanometra* and longest in *Anthometra* and *Promachocrinus* though John (1938) has shown that the relative length of the cirrus segments and hence of the cirri is very variable in *P. kerguelensis*. In *Heliometra* and *Florometra* they measure about one third of the arm length. The relative length of the cirri and arms in *Promachocrinus* is really not strictly comparable to the same feature in *Anthometra*, since each arm of the latter equals two of the former.

The number of the cirri varies from XXX–XXXV to L–CC, and in nearly all the species is L–LXXX. *Anthometra*, in which the cirri are very long, has the fewest, but the number of the cirri in the other genera is remarkably uniform.

The number of segments in the fully developed cirri varies from 25 to 90, with the greatest frequency between 40 and 55, the small apical cirri usually have about half as many segments as the peripheral.

In form the cirri vary but little; they are large and stout, strongly compressed laterally and strongly recurved, excepting in *Anthometra*, in which genus they are more elongated than elsewhere, more slender, and much less curved. About the margin of the centrodorsal there are frequently seen very long and nearly straight cirri which seem to function as tactile organs. The cirri about the dorsal pole are usually about half as long as the peripheral, and the intergradation between the two types is complete.

The longest cirrus segments are from half again to three times as long as broad, or slightly longer, and are very slightly constricted centrally; the outer are shorter, usually about as long as broad. As the segments begin to shorten, the median portion of the distal border usually begins to project slightly, forming a more or less obvious terminal dorsal spine. The segments of the small apical cirri are much more uniform in size than those of the longer cirri.

Low and broadly rounded tubercles may represent the ends of rudimentary basal rays in the interradial angles, but are not often present.

The distal edges of the radials are even with the rim of the centrodorsal in the median line and are only slightly concave so that in the interradial angles the apposed distal angles of two adjacent basals form only very low triangles.

In *Promachocrinus*, besides the 5 normal radials there are 5 additional similar radials interpolated between them; as there are only 5 basals in the young the rosette is 5-rayed, so that each of the interpolated radials is situated interradially directly over a basal ray. The interradial radials do not appear in the young until after the true radials have come into contact and reached a considerable size; they then become evident as narrow interradials which, growing rapidly, give rise to IBr series and gradually acquire all the characteristics of true radials. But it is not until the animal is nearly of full size that the radial and interradial radials become quite similar (See vol. 1, part 2, pp. 550, 551 [Nos. 41, 42], 555; and figs. 931–937, p. 549).

The disk is not at all or only slightly concave in the interradial areas; it is naked, or bears prominent calcareous nodules of various sizes, especially near the ambulacral grooves.

Sacculi are abundant and conspicuous, and regularly distributed.

The profile of the proximal portion of the animals when the arms are folded inward is broadly rounded except in *Anthometra* and, to a somewhat lesser degree, in *Promachocrinus* in which the IBr series and arm bases lie in almost a straight line.

The IBr series and arm bases show relatively little variation. They are robust, rounded dorsally, and well separated, with prominent or thickened and usually spinous borders and a greater or lesser development of spines on the dorsal surface, except in *Anthometra*, in which the sides of the IBr series are almost straight and nearly in contact and each of the ossicles of the IBr series and lower brachials bears a high, more or less sharp, median carination with a finely spinous crest, a structure frequently seen indicated on the IBr series and first two brachials of the young in other genera, though never in the fully grown adult.

The IBr_1 are not quite in contact basally; their sides are very strongly convergent, except in *Anthometra* in which they are parallel. The axillaries are usually rhombic with concave sides and the distal angle often truncated and grooved in the center, about as broad as long, with a more or less developed rounded posterior process incising the IBr_1; in large specimens they are usually broader than long, and in young individuals much longer than broad with a long posterior process which is sometimes so well developed (in *Promachocrinus, Florometra asperrima*, etc.) as to suggest the process in the larger species of *Psathyrometra*. The posterior portion of the axillary usually rises into a broadly rounded synarthrial tubercle.

The arms vary in length in adult individuals from 100 to 350 mm; in most species they are between 150 and 200 mm. long.

The arms are fairly uniform in structure, rather broad and strongly rounded dorsally except in *Anthometra* in which they are slightly compressed and each brachial rises to a sharp median crest. Between the first and second syzygies the brachials are wedge-shaped to almost oblong, usually about twice as broad as the median length but often shorter, with the proximal and distal edges somewhat concave; they then become more obliquely wedge-shaped to triangular, usually somewhat broader than long, more rarely much broader than long or as long as broad, distally becoming less obliquely wedge-shaped again and gradually increasing in length. The distal ends of the brachials are always prominent, rarely smooth but usually sharply serrate or spinous, sometimes conspicuously so, with the spinosity on the outer brachials tending to spread over the dorsal surface in the form of a triangle with the apex proximal.

The number of brachials to each arm in a large specimen of *Florometra asperrima* is 330, and P. H. Carpenter gives "more than 300" for large individuals of *Heliometra glacialis;* there are half as many, or something over 150, in large specimens of *Promachocrinus kerguelensis* in which there are twice as many arms.

Syzygies occur between brachials 3+4, 9+10, 14+15 or 16+17, and distally at intervals of normally 3 or 4 muscular articulations, this number being quite irregular in *Promachocrinus* as is usual in multibrachiate types.

Except in *Promachocrinus kerguelensis*, in which the number of arms varies from 10 to 23 (23, 22, 20, 19, 18, 17, 16, 12 and 10 having been recorded) but is almost invariably 20 in fully developed individuals, any departure from the normal number of 10 arms is exceedingly rare. Only *Florometra serratissima* has been found with 11 arms as the result of the occurrence of a single IIBr 2 series, while another specimen of the same species has been taken with a IIBr 2 series, the distal element of which was not axillary. Individuals with 9 arms pathological in character have been reported in *Heliometra glacialis* and in *Florometra serratissima.*

Throughout this subfamily the proximal pinnules are singularly uniform in structure. P_1 is always long and flagellate, composed of 30 to 82 (usually 50 to 60) segments which are basally broader than long, then about as long as broad, with the corners cut away giving flexibility, and the dorsal edge in the outer portion swollen or produced resulting in a serrate profile which may be so marked as to suggest the combs of the Comasteridae. P_2 usually resembles P_1 and is of about the same length or very slightly longer with somewhat fewer but slightly longer segments; in *Anthometra*, however, it is only about half as long as P_1 with less than half as many elongated segments and this condition may be approached in *Promachocrinus.* P_3 is almost always shorter and slightly stouter than P_1 and P_2 with fewer and more elongated segments; but in well developed examples of *Heliometra glacialis* or of *Florometra asperrima* it may be similar to P_2 or even longer. P_4 is usually shorter than P_1 and P_2 with fewer, more elongated segments, resembling P_3 unless P_3 resembles P_2; but in exceptionally fine specimens of *Florometra asperrima* it may be similar to P_1, P_2 and P_3, and longer than any of them. P_5 resembles P_4 and is usually shorter; in the most developed specimens of *Florometra asperrima* it is slightly shorter than P_1.

Briefly stated, in this subfamily the oral pinnules are long and flagellate, composed of very numerous short segments which are not longer than broad. P_1 may be the only oral pinnule, as in *Anthometra* and sometimes in *Promachocrinus*, but usually P_1 and P_2 are modified as oral pinnules and are similar, with P_3 shorter and composed of much longer segments. Rarely, in the largest species, P_3 is also an oral pinnule, and it may be even longer than P_1 and P_2, while very exceptionally P_4 may also be an oral pinnule.

The middle and distal pinnules show little variation. The distal pinnules are slender, very nearly as long as the oral pinnules and composed of about half as many segments, most of which are usually about twice as long as broad with the distal ends fringed with spines.

The gonads are very long and fusiform.

The deposits along the ambulacral grooves of the pinnules in *Florometra* consist of slender to stout rods, straight or slightly curved, with the ends usually roughened or more or less expanded; in *F. mawsoni* some fenestrated plates may be present near the tips of the pinnules. In *Heliometra* the deposits may be similar, with the ends of the rods, especially the inner, expanded and pierced with one or two holes, the rods in some specimens broadening out into irregular plates, or even transforming into well marked covering plates or partially differentiated covering and side plates. In *Anthometra* the lateral perisome of the pinnules is completely enclosed in a continuous distally imbricating series of highly developed plates. In *Promachocrinus* similar plates may occur, or the perisome may be quite without calcareous deposits (see vol. 1, part 2, pp. 268–271; also John, *Discovery* Reports, 1938, pp. 143–144).

In *Promachocrinus* the tentacles contain a conspicuous continuous band of fine interlaced spicules which runs along the outer side nearly to the tip, and irregular spicules are occasionally to be found in the tentacles of *Heliometra* and *Florometra*.

Relationships of the genera.—It is possible to arrange the 5 genera included in the Heliometrinae in a linear series on the basis of the relative degree of specialization of the oral pinnules, the centrodorsal and the brachials.

The minimum amount of specialization in the oral pinnules is found in *Anthometra*, in which only P_1 is a typical oral pinnule, P_2 being about half as long with less than half as many elongated segments. The centrodorsal of *Anthometra* also retains the original conical form only slightly, if at all, modified. The carination of the elements of the IBr series and first two brachials more or less characteristic of the young of all the other genera is retained throughout life in *Anthometra* and becomes greatly accentuated, being carried out onto all the brachials, which have slightly serrate or spinous distal ends. *Anthometra* is further peculiar in being of rather slender build, with the arm bases making a relatively small angle with the dorsoventral axis, and in having relatively few very long, rather slender, and only slightly curved cirri, the longest of which, however, have a very large number of segments. Although *Anthometra* is emphatically a member of the Heliometrinae, it is the least characteristic of all the genera, and shows the nearest approach to the Bathymetrinae.

In *Promachocrinus* the relative shortness of the arms, which have half the number of brachials common to the other types, and the irregular distribution and relative infrequency of the syzygies, are features correlated with the occurrence of 10 instead of 5 arm pairs, if we may judge from comparison with other multibrachiate types. The possession of 5 additional radials interpolated between the 5 normal "radial radials" gives the species of this genus an entirely different appearance from that of all the other genera; but this apparent isolation is not supported by any other features, and the 10- or 12-armed individuals of *Promachocrinus kerguelensis* which are sometimes found are most difficult of determination.

Sometimes in *Promachocrinus* P_1 is the only oral pinnule, as in *Anthometra*, though P_2 may be similar to it and is usually but little shorter. The centrodorsal is always sharply conical. The arm bases make a relatively small angle with the dorsoventral axis as in *Anthometra*, and the brachials always have spinous distal ends. The cirri of *Promachocrinus* are rather slender, and are little curved.

In spite of the utterly different appearance it is impossible not to recognize the fundamental similarities between this genus and *Anthometra*, over which it represents a relatively slight advance in the direction of pinnule specialization.

In *Solanometra*, *Heliometra* and *Florometra*, fully developed individuals have at least P_1, P_2 and P_3 modified as typical oral pinnules. *Solanometra*, with a hemispherical or low rounded conical centrodorsal, the distal edges of the brachials and pinnulars spinous, the third syzygy situated between brachials 14+15, P_4 markedly shorter than P_3, and relatively few, not more than 41, cirrus segments, seems to be somewhat less specialized than the other two.

In *Heliometra* the brachials beyond the third syzygy, which is between brachials 14+15, are triangular and about as long as broad with smooth distal ends, the dorsal pole of the centrodorsal is flat or slightly concave, and P_4 and even P_5 may be as long as P_3, with P_6 much shorter.

In *Florometra* the brachials just beyond the third syzygy, which is often displaced distally to between brachials 16+17, are more or less wedge-shaped and very rarely so long as broad, usually markedly broader than long, with spinous ends, the dorsal pole of the centrodorsal is deeply excavated, and all the pinnules from P_1 to P_6 may be modified as oral pinnules. In this genus only is there a tendency toward the development of IIBr series, though a specimen of *Heliometra glacialis maxima* has been reported with an axillary radial.

The frequent distal displacement of the third syzygy, the shortness of the brachials, the greater number of oral pinnules in fully developed individuals, the excavation of the dorsal pole of the centrodorsal, and the tendency toward a development of IIBr series seem to indicate that *Florometra* represents a higher degree of specialization than *Heliometra.*

[NOTE BY A.M.C.] In checking Mr. Clark's key to the genera of Heliometrinae following the introduction of several new species of *Florometra*, several alterations were found to be necessary, particularly with regard to *Florometra*, *Heliometra* and *Solanometra.* Measurements of the proximal brachials of specimens of all three genera suggested that *Heliometra* is intermediate between the other two in the thickness of the arms as well as in the proportions of the pinnule and cirrus segments. These three genera are very closely related and can only be recognized by a combination of minor characters, some of which tend to vary according to the size.

KEY TO THE GENERA OF HELIOMETRINAE

[Modified by A.M.C.]

a^1. 5 radials and 10 arms.

b^1. Arms rounded dorsally, sometimes with a transverse spinous crest but never carinate; P_2 similar in size to P_1.

c^1. Arms relatively narrow, the width at the first syzygy about 2.5 mm. when the length of the division series and first nine brachials together is about 15 mm.; segments of the middle and distal pinnules longer than broad, often quite elongated; the longest cirrus segments may be over twice as long as broad; division series and brachials usually more or less spinous (Korean Straits and Japan, north to the Bering Sea, south along the west coast of the Americas to the Cape Horn area and the Southern Ocean; 11–1574 meters). Florometra (p. 292)

c^2. Arms moderate in width, the first syzygy being usually 2.8 to 3.0 mm. wide when the length of the division series and the first nine brachials together is about 15 mm.; segments of the middle and distal pinnules not much longer than broad; the longest cirrus segments rarely as much as twice as long as broad; in specimens of arm length less than 100 mm. the division series and first few brachials may be finely spinous but larger specimens are always smooth (Arctic Seas south to Cape Cod, Iceland, the Faroes, northern Norway and off the northern Siberian coast, also in the Pacific from the Okhotsk Sea to the Korean Straits; 14–1358 meters) Heliometra (p. 340)

c^3. Arms thick, the width at the first syzygy over 3 mm. when the length of the division series and the first nine brachials is about 15 mm.; segments of the middle and distal pinnules short, mostly not much longer than broad; the longest cirrus segments rarely as much as twice as long as broad (off Heard Island, Southern Ocean and (?) off Adelie Land, Antarctica; 137–645 meters)--**Solanometra** (p. 419)

b^2. Arms narrow and strongly carinate or with a large median tubercle on each brachial in the midline; P_1 twice as long as P_2 (shores of the Antarctic continent; 130–914 meters).
Anthometra (p. 448)

a^2. Normally 10 radials and 20 arms (Southern Ocean; 20–1080 meters)--**Promachocrinus** (p. 428)

Genus FLOROMETRA A. H. Clark*

Antedon (part) Bell, Proc. Zool. Soc. London, 1882, p. 651, and following authors.

Comatula (part) Chierchia, Rivista Marittima, vol. 18, 1885, p. 9.—A. Agassiz, Bull. Mus. Comp. Zool., vol. 21, No. 4, 1891, p. 197; vol. 23, No. 1, 1892, pp. 80, 82.

Heliometra (part) A. H. Clark, Smithsonian Misc. Coll., vol, 50, pt. 3, 1907, p. 351.

Solanometra (part) A. H. Clark, Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 128 (*nomen nudum*, the remarks refer to this genus), p. 129 (characteristic antarctic genus; significance); Mem. Australian Mus., vol. 4, 1911, p. 727 (type species *Antedon antarctica*; as here understood includes the species now assigned to *Florometra*); Crinoids of the Indian Ocean, 1912, pp. 5, 6, 26 (same).—Vaney, Bull. Mus. Hist. Nat., Paris, vol. 19, 1913, p. 33 (same).—A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 61 (restricted by the separation of *Florometra* from it).

Florometra A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 62 (subgenus of *Promachocrinus;* no diagnosis; name used in combination with [*Antedon eschrichti* var.] *magellanica* Bell); Bull. Inst. Océanogr. Monaco, No. 285, 1914, p. 3 (type species *Antedon mariae* A. H. Clark, 1907; subgenus of *Promachocrinus;* includes *Antedon asperrima, hondoensis, inexpectata, laodice, magellanica, mariae, perplexa, rathbuni, serratissima* and *tanneri;* range considered in detail); Die Crinoïden der Antarktis, 1915, p. 132 (covering plates), p. 137 (synonymy; diagnosis; type *Antedon mariae* A. H. Clark, 1907; range; list of records; table of depths and temperatures in different regions), p. 190 (discussion), p. 194 (distribution in detail and its oceanographic significance).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 90–L, 1915, p. 195 (inorganic constituents of the skeleton); Prof. Paper 102, 1917, pp. 23 and following (same).—A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (referred to the Heliometrinae); No. 16, p. 508 (in key; range; best considered as a subgenus of *Promachocrinus*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 240 (in key; range; best considered as a subgenus of *Promachocrinus;* key to the included species).—Bather, Nature, vol. 107, March 31, 1921, p. 133.—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 124, 1922, p. 20 (inorganic constituents of the skeleton).—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 52 (in key; treated as a genus).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 288; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 51 (color).—Ekman, Tiergeographie des Meeres, 1935, p. 319.—A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (species very variable, limits not clear), p. 218 (in key) (in Russian), pp. 222, 224 (in English version); Sci. Rep. Australasian Antarctic Exped., 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 10, p. 14 (range).—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (two species in the Antarctic; 10 additional species); *Discovery* Reports, vol. 18, 1938, p. 130 (two Antarctic species);—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 21; John, Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, Ser. B, vol. 4, pt. 6, 1939, p. 198.—Vaney and John, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, pp. 667, 668 (pinnules; range).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool. No. 4, 1951, p. 55.—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 97 (Pacific distribution).

Promachocrinus (*Florometra*) A. H. Clark, Die Crinoïden der Antarktis, 1915, pp. 105, 106, 142.

Diagnosis.—A genus of Heliometrinae in which the arms are rounded dorsally; the brachials are nearly or quite as long as broad and, like the elements of the division series, have more or less spinous borders and commonly a greater or lesser development

*See also Addenda (pp. 836, 837) under 1962 and 1963.

of spines on the dorsal surface though this may be less prominent on large specimens; the proximal pinnules have the distal segments produced on the outer side, suggesting a rudimentary terminal comb; the middle and distal pinnules have more or less elongated segments; the centrodorsal is rounded conical or flattened hemispherical, sometimes with a deep pit at the apex; the longest cirrus segments are often over twice as long as wide; and there are 5 radials and 10 arms.

Type species [by A.M.C.].—In 1914 Mr. Austin Clark named *Antedon mariae* A. H. Clark, 1907, as the type species of *Florometra* (then considered to rank as a subgenus of the genus *Promachocrinus*) and listed a number of other species including *magellanica* (Bell), 1882, as consubgeneric. This disposition was repeated in 1915, when a diagnosis for *Florometra* was added. However, in 1913, at the very first mention in print of the name *Florometra*, Mr. Clark only gave it in connection with the species-group name *magellanica*. Under the rules of nomenclature, where publications before 1931 are concerned, the inclusion under a new generic (or subgeneric) name of a valid species is sufficient indication to establish the new generic name with that species as the type. The fact that *Florometra* was first mentioned as a subgenus is immaterial. *Florometra* therefore dates from 1913 and *Antedon eschrichti* var. *magellanica* Bell, 1882, is its type species, by monotypy. The subsequent designation of another species as type was unnecessary and has no validity.

Geographical range.—From the Southern Ocean and Cape Horn northward along the western coast of South and North America to the southern Bering Sea, thence westward to the western end of the Aleutian chain, and southward along the eastern and southern coasts of Japan to the Korean Straits.

Bathymetrical range.—From 11 to 1574 meters.

Thermal range.—From −1.85° to 13.50° C.

Specific interrelationships within the genus [modified by A.M.C.].—The question of which characters provide specific distinctions within this genus is still an open one, particularly with regard to the four North Pacific species in which the centrodorsal, cirri, arms and pinnules are singularly uniform in structure, and the only differential characters seem to be found in the position of the third syzygy, the relative length of the brachials, and the relative development of a dorsal extension of the basal segments of the proximal pinnules, none of which features are of any special value in any other comatulid group.

The relative proportions of the proximal pinnules, a constant and reliable character among most of the comatulids, is here less reliable for systematic purposes, for all the species show to a greater or lesser extent the same diversity seen in *Heliometra glacialis*. However, when size is also taken into account the number of pinnule segments may be of significance.

The proportions of the cirrus segments may also be of use, but bearing in mind the variation found in the related genus *Promachocrinus* by John (1938) may not prove reliable unless used in conjunction with other characters. The size of the dorsal spines on the cirri can also be used in some cases, *F. goughi* exhibiting a minimum development of these.

At the other extreme, *F. mawsoni* has very prominent dorsal processes on the distal cirrus segments like those of *Solanometra antarctica* which it also resembles in the relatively short segments of the middle and distal pinnules, most of which are only a little longer than broad. As discussed on pp. 340 and 419 I [A.M.C.] think it probable that *mawsoni* will prove to be congeneric with *Solanometra antarctica* rather than with *Florometra magellanica.*

History.—The first known species of this genus, *Florometra magellanica*, was described under the comprehensive name of *Antedon* and was also mentioned under the generic name *Comatula*, used as a synonym of *Antedon.*

On the creation of the genus *Heliometra* in 1907 all the known species now referred to *Florometra* which had then been described were transferred to it from *Antedon.*

In 1911 *Heliometra* was restricted to include *H. glacialis* only, and *Solanometra* was suggested to cover all the other species, now included in that genus and in *Florometra.* This conception of *Solanometra* was never actually stated, though it may readily be inferred from the earlier references to the name.

The name *Florometra* first appeared, as a subgenus of *Promachocrinus*, with no diagnosis, in 1913, one species, listed as *Florometra magellanica*, being given under it. In 1914 *Florometra* was mentioned again as a subgenus of *Promachocrinus* and *Antedon mariae* was given as the type species; *Antedon asperrima, A. hondoensis, A. inexpectata, A. laodice, A. magellanica, A. mariae, A. perplexa, A. rathbuni, A. serratissima* and *A. tanneri* were assigned to it. In 1915 a diagnosis was published and the type species was again given as *A. mariae;* it was regarded as a subgenus of *Promachocrinus.* The species assigned to it in 1914 were again mentioned, this time with *Florometra* instead of *Antedon* as the generic name.

[Note by A.M.C.] In recent years the working up of the many collections taken in the Antarctic and Southern Ocean has produced a number of new species attributed to this genus. The first of these was *F. mawsoni* described in 1937 by A. H. Clark from the Australasian Antarctic Expedition collection. In 1938 and 1939 Dr. Dilwyn John described *Florometra antarctica, spinulifera* and *goughi* from the *Discovery*, Banzare and *Scotia* collections respectively. In 1939 he acknowledged *antarctica* as a synonym of *mawsoni. F. spinulifera* has oral pinnules with distal segments several times longer than wide quite unlike the species of this subfamily and although it is just possible that this is attributable to the relatively small size of the unique type, I am transferring it to the genus *Tonrometra* in the subfamily Bathymetrinae. A new species from later *Discovery* collections is described here by me under the name *Florometra austini.*

KEY TO THE SPECIES OF FLOROMETRA

[Modified by A.M.C.]

a^1. Third syzygy usually between brachials 16+17, sometimes 15+16.

b^1. Basal segments of the oral pinnules markedly carinate and appearing much broader than the rest of the pinnule especially in lateral view.

c^1. Longest cirrus segments two and a half to three times as long as broad (Cape Horn north almost to Valparaiso, Chile; 22–594 meters)......magellanica (p. 295)

c^2. Longest cirrus segments not more than twice as long as wide.

d^1. Brachials short, the longest in the proximal part of the arm being distinctly broader than long (Lower California to the Alaska peninsula; 11–1252 meters)..serratissima (p. 299)

d^2. Brachials longer, the longest being about as broad as long (southeastern and southern Japan; 128–1073 meters)......mariae (p. 309)

b^2. No carinate process on the proximal segments of the oral pinnules (Panama Bay northward to the Tres Marias Islands; 523–1429 meters)......tanneri (p. 313)

a^2. Third syzygy usually between brachials 14+15.

b^1. Third syzygy as often between brachials 16+17 or 15+16 as 14+15, even in the same specimen; cirri XXX–L (southeastern and southern Japan; 128–1073 meters)......mariae (p. 309)

b^2. Third syzygy rarely beyond brachials 14+15; cirri often more than L.

c^1. P_1 with about 60 or more segments.

d^1. Cirri L–LXXX, the longest segments of the peripheral ones about twice as long as their proximal widths; axillary with distal angle truncated; size up to 230 mm. arm length (Monterey Bay to the Bering and Okhotsk Seas and northern Japan; 79–1574 meters). asperrima (p. 318)

d^2. Cirri L–LCV, the longest segments about two and a half times as long as their proximal widths; axillary with distal angle acute; size up to 130 mm. (Southern Ocean to the south of New Zealand; 159–163 meters)------austini (p. 324)

c^2. P_1 rarely with more than 50 segments.

d^1. No dorsal spines on the cirri, opposing spine very blunt; cirri XC to over C (vicinity of Gough Island, South Atlantic; 183–472 meters)------goughi (p. 328)

d^2. Prominent dorsal spines present on the cirrus segments and the opposing spine very acute; cirri XL–LXXVII------mawsoni (p. 331)

FLOROMETRA MAGELLANICA (Bell)

[See vol. 1, pt. 2, figs. 580–581 (p. 298), 588–591 (p. 303)]

Antedon eschrichti var. *magellanica* BELL, Proc. Zool. Soc. London, 1882, p. 651 (Straits of Magellan; comparison with [*Heliometra*] *eschrichti* [*glacialis*]; remarks); fig. b, p. 651 (P_2).—P. H. CARPENTER, Bijdr. Dierkunde, vol. 13, 1886, p. 4 (a distinct species; differential characters).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 470 (cannot be separated from *rhomboidea* on the basis of the characters given by Carpenter).

Comatula, sp. CHIERCHIA, Rivista Marittima, vol. 18, 1885, p. 9 (*Vettor Pisani*, Desolation I.).

Antedon magellanica P. H. CARPENTER, Bijdr. Dierkunde, vol. 13, 1886, p. 4 (a distinct species; differential characters); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 138 (in key), p. 149 (notes).—HAMANN, Jenaische Zeitschr., vol. 23, neue Folge 16, 1889, p. 234 (anatomy).—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 137 (range).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 404 (antarctic representative of the *Eschrichti* group).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Die Crinoïden der Antarktis, 1915, pp. 120–122 (systematic and structural relationships).

Antedon rhomboidea P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 148 (description; *Challenger* Sta. 308; comparisons), pl. 12, figs. 1, 2, pl. 24, figs. 1–3.—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 137 (range, in part), p. 138 (Smyth's Channel, Dr. Rehberg; the *Albatross* specimens described as this species are *Florometra tanneri*).—ORTMANN, Amer. Nat., vol. 33, No. 391, July 1899, p. 588 (bearing on bipolarity).—LUDWIG, Hamburger Magalhaenische Sammelreise, Crinoïden, 1899, p. 1 (Puerto Bueno, Smyth Channel; 30 meters or less).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 404 (antarctic representative of the *Eschrichti* group).—HAMANN, Bronn's Klassen und Ordungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 287 (synonym of *F. magellanica*).

Heliometra magellanica A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed); Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 257 (Mission sci. du Cap Horn Stas. 100, 103, 121), p. 258 (Stas. 165, 177, 179, 182; description of the specimens; same as *Antedon australis* and *A. rhomboidea* Carpenter); fig. 2, p. 258 (distal part of a proximal pinnule).

Heliometra rhomboïdea A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Florometra magellanica A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 62 (references to specimens in the B.M.; Swallow Bay, 12 fms.; *Challenger* Sta. 308; Tom Bay; *rhomboidea* is a synonym of this species); Bull. Inst. Océanogr. Monaco, No. 285, 1914, p. 9 (range); Journ. Washington Acad. Sci., vol. 5, No. 3, 1915, p. 81 (Antarctic; range); Die Crinoïden der Antarktis, 1915, p. 107 (in key to antarctic crinoids), p. 124 (discussion of the type), p. 168 (a shallow-water Antarctic species; a Magellanic form); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 242 (in key; range; references), p. 244 (discussion).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 287; Ark. Zool., vol. 19, No. 32, 1928, p. 11 (B.M. specimen from near Cape Providence, Magellan Strait).—EKMAN, Tiergeographie des Meeres, 1935, p. 319.

Promachocrinus (Florometra) magellanica A. H. Clark, Die Crinoiden der Antarktis, 1915, p. 105 (collected by the *Challenger*, recorded as *rhomboidea*), p. 106 (collected by the *Alert* and *Vettor Pisani*), p. 142 (synonymy; summary of previous records; range), pl. 8, figs. 1–5.

Diagnostic features [by A.M.C.].—A species of *Florometra* with the basal segments of the pinnules enlarged and carinate; P_1 and P_2 are similar in length and number of segments and their relative proportions seem to be more constant than in most species of the genus; the third syzygy is usually between brachials 16+17; the cirri are LX-C, the longest with 40 to 65 segments and measuring up to 65 mm. in length when the breadth at the first syzygy is 2.5 mm.; the size can be large with the arms up to 200 mm. in length.

Description.—The centrodorsal is hemispherical, rather large, with a deep pit about 2 mm. in diameter at the dorsal pole; the sides up to this pit are entirely covered with cirrus sockets, the distal slightly smaller than the peripheral, arranged in alternating rows.

The cirri are LX–LXX, 30–50 (usually 40–50), resembling those of the other species of the genus; the longest cirrus segments are about three times as long as broad in the longest cirri, about twice as long as broad in the shorter.

The distal edges of the radials are even with the margin of the centrodorsal and are only visible as very low triangles in the interradial angles. The IBr_1 are very short, with the lateral edges not quite in contact basally and strongly convergent, making an angle with each other of nearly 90°, and the distal border more or less strongly depressed by a rounded posterior projection from the axillaries which may meet the centrodorsal, excluding the IBr_1 from view in the median line. The lateral borders are somewhat concave. The ventrolateral edges are extended laterally in a triangular flangelike process the proximal apex of which lies beneath the proximal lateral angles. The IBr_2 (axillaries) are almost triangular, about as long as broad, with the distal angle produced, truncated, and notched, the anterior sides nearly straight, slightly everted and finely spinous, and the proximal border with a broadly rounded process incising the IBr_1.

The 10 arms are about 190 mm. long. The first brachials are about four times as long exteriorly as interiorly, very obliquely wedge-shaped, with the distal border slightly depressed in the middle by a process from the second brachial, and the short inner sides, which are not in contact basally, making a very broad angle, almost a straight line, with each other; the outer side is somewhat produced, the production being markedly flattened and studded with very fine spines. The second brachials are somewhat larger than the first, irregularly quadrate, with the somewhat prominent distal edge and the portion beneath the pinnule socket finely spinous. The first syzygial pair (composed of brachials 3+4) is from half again to about twice as long interiorly as exteriorly, wedge-shaped, with the distal border rather prominent and, like the syzygial line, finely serrate. The following 7 or 8 brachials are slightly wedge-shaped, about twice as broad as the median length, with prominent and finely serrate distal ends, after which the brachials become almost or quite triangular, about as long as broad, with serrate ends which increase in prominence as the brachials become wedge-shaped again distally.

Syzygies occur between brachials 3+4, 9+10, 16+17, and distally at intervals of 3 muscular articulations.

P_1 is from 20 to 22 mm. long, slender and flagellate, tapering rather rapidly on the first 6 segments, much more gradually from that point onward, composed of 50 segments, of which the first is rather large, about twice as broad as long, the second is much shorter, the third is of about the same proportions as the second, and the following gradually increase in length so that those following the eighth are about as long as broad. In the distal third of the pinnule the segments have the outer side somewhat produced into a rounded or bluntly angular swelling giving the outer profile a scalloped or serrate appearance which, when well-developed, suggests a rudimentary terminal comb.

P_2 is of the same length as P_1 and resembles it; the segments number 45 and are relatively slightly longer.

P_3 is from 15 to 20 mm. long, tapering more gradually than the preceding pinnules, with 27 segments of which the outer become twice as long as broad and lack the production of the outer side. P_4 is 12 mm. long with 23 segments, resembling P_3 but with the segments slightly longer. P_5 is 12 mm. long with 20 segments, resembling P_4 but with the outer segments still more elongate, nearly 3 times as long as broad. The following pinnules are of about the same length, but taper still more gradually and thus appear stouter.

The distal pinnules are slender, 18 mm. long with 24 segments which become twice as long as broad on the sixth or seventh and 3 times as long as broad terminally.

The preceding description is based mainly upon the specimens collected by the Mission scientifique du Cap Horn, in the Paris Museum.

Notes.—A small specimen from Sta. 100, Mission scientifique du Cap Horn, does not differ essentially from the adults. The axillaries are more rhombic with the anterior angles less produced, and the brachials are relatively longer, the first syzygial pair being about as long as broad. The relationships between P_1 and P_2 are the same as in the adults.

[NOTES BY A.M.C.] The type specimen in the British Museum also has a deep pit at the apex of the centrodorsal. The cirri are about LXXV, 45 and about 45 mm. long. The arms were probably about 150 mm. long and are 2.5 mm. wide at the first syzygy. The length from the proximal edge of the IBr_1 to the second syzygy (9+10) is 15.5 mm. Not one P_1 remains intact; the longest remaining one has 49 segments, and probably had at least a dozen more; P_2 has about 47 segments and measures 21 mm.

One of the two specimens from the Valparaiso-Concepción cable has the arms over 180 mm. long. The centrodorsal is 7.0 mm. in basal diameter and 3.5 mm. in height. The width of the arms at the first syzygy is 2.6 mm. and the length from IBr_1 to the second syzygy 16.0 mm. The cirri number about XC, the longest have 65 segments and are 65 mm. in length. P_1 has about 46 segments and measures 21 mm. and P_2 is the same. The *Sylvia* specimen though somewhat smaller (IBr_1 to the second syzygy measuring 13.5 mm.) has about 100 cirri, the longest of them with about 48 segments; the centrodorsal is 6.5 mm. by 4.5 mm.

Localities.—*Challenger* station 308; off Tom Bay, Patagonia (lat. 50°08′30″ S., long. 74°41′00″ W.); 320 meters; blue mud; January 5, 1876 [P. H. Carpenter, 1888; A. H. Clark, 1913] (1, B.M.).

Challenger; Tom Bay, Patagonia [P. H. Carpenter, 1888; A. H. Clark, 1913] (1, B.M.).

Smyth Channel, Straits of Magellan; Dr. H. Rehberg [Hartlaub, 1895; A. H. Clark, 1912] (1, H.M.).

Puerto Bueno, Smyth Channel; 30 meters or less; Capt. R. Paessler; October 25, 1893 [Ludwig, 1899; A. H. Clark, 1912] (1, H.M.).

Swallow Bay, Straits of Magellan; 22 meters; mud and rock; H.M.S. *Alert* [Bell, 1882; A. H. Clark, 1913] (1, B.M.). Type locality.

Near Cape Providence, Straits of Magellan; H.M.S. *Sylvia* [A. H. Clark, 1913; Gislén, 1928] (1, B.M.).

Desolation Island; *Vettor Pisani* [Chierchia, 1885].

Mission scientifique du Cap Horn station 100; southeast of Port Famine, Straits of Magellan; 326 meters [A. H. Clark, 1911] (11, U.S.N.M., 35970; P.M.).

Mission scientifique du Cap Horn station 103; Punta Arenas [A. H. Clark, 1911] (1, P.M.).

Mission scientifique du Cap Horn station 121; New Year Sound, in the extreme south of the Cape Horn archipelago, south of Tierra del Fuego [A. H. Clark, 1911] (3, P.M.).

Mission scientifique du Cap Horn station 165; northwest of Vauverlandt Island, Ponsonby Sound, south of Navarin Island; 143 meters; temperature 6.4° C. [A. H. Clark, 1911] (2, P.M.).

Mission scientifique du Cap Horn station 177; between Navarin and Hoste Islands, south of Tierra del Fuego; 270 meters; temperature 7.7° C. [A. H. Clark, 1911] (4, P.M.).

Mission scientifique du Cap Horn station 179; Murray Narrows; 200 meters [A. H. Clark, 1911] (9, P.M.).

Mission scientifique du Cap Horn station 182; Etroit de Siege, south of Diego; 120 meters [A. H. Clark, 1911] (4, P.M.).

Off Constitución, Chile (lat. 35°18′ S., long. 72°47′ W.); 594 meters; off the Valparaiso-Concepción cable; cable ship *Retriever* (2, B.M.).

Geographical range.—From the Cape Horn archipelago northward on the Pacific side of southern South America nearly to the latitude of Valparaiso (35° N.).

Bathymetrical range.—From 22 to 594 meters.

Thermal range.—From 6.4° C. to 7.7° C.

History.—Although first dredged by the *Challenger* on January 5, 1876, this species was first described by Prof. F. Jeffrey Bell in 1882 from a specimen collected by Dr. R. W. Coppinger of the *Alert* at Swallow Bay in 1878. Professor Bell considered this form as a variety of the arctic *Heliometra glacialis.*

In 1885 it was mentioned, under the name of *Comatula*, sp., by Lieutenant Chierchia of the Italian ship *Vettor Pisani* as having been found at Desolation Island. The specimens from this expedition were turned over to Dr. P. H. Carpenter for description, but he published nothing upon them and they seem to have disappeared.

In 1886 Dr. Carpenter compared Bell's supposed variety with arctic *glacialis* and stated that the two represented entirely distinct species. In 1888 he described in detail and figured the single individual which had been dredged by the *Challenger* under the name of *Antedon rhomboidea*, and mentioned that several examples of what he regarded as true *magellanica* had been obtained by the corvette *Vettor Pisani* which he hoped soon to be able to describe at length.

Dr. Clemens Hartlaub in 1895 under the name *rhomboidea* recorded a specimen which had been obtained in Smyth's Channel by Dr. Rehberg, and gave the same name to some others which had been dredged by the *Albatross* off the Central American coast; these last represent *F. tanneri*. Prof. Hubert Ludwig in 1899 recorded another from Puerto Bueno, in Smyth's Channel.

In 1910 I recorded a number of specimens in the Paris Museum from various stations of the Mission scientifique du Cap Horn in 1882–1883, giving notes upon them, and reducing *rhomboidea* to the synonymy of *magellanica;* by an error *Antedon australis* (a synonym of *Solanometra antarctica*) was said also to be a synonym of *magellanica.* In 1912 I mentioned Dr. Rehberg's example, saying that it resembled others at hand from the vicinity of Cape Horn, those referred to being the ones from Mission scientifique du Cap Horn station 100 in the collection of the U.S. National Museum; and I also listed the specimen recorded by Professor Ludwig, which had been collected by Captain Paessler of the Kosmos Line. The latter I had seen in Hamburg, and the former had been sent to me for more detailed study. In 1913 I recorded a specimen from Tom Bay, and another from near Cape Providence where it had been collected by the *Sylvia*, both in the British Museum, giving notes on them and at the same time reaffirming the identity of *rhomboidea* with *magellanica.*

A summary of our knowledge of this species was published in 1915, and in 1918 I stated that *magellanica* was confined to southern South America, the records from the western coast of Central America having reference to a different species.

FLOROMETRA SERRATISSIMA (A. H. Clark)

[See vol. 1, pt. 1, fig. 296 (p. 263); pt. 2, figs. 95–96 (p. 62), 131 (p. 79), 590 (p. 303), 774 (p. 362), pl. 5, figs. 1009–1014, pl. 13, fig. 1053]

Antedon, sp. Ritter, Science, new ser., vol. 15, No. 367, Jan. 10, 1902, p. 62 (off San Diego, about 100 fms.).—McClendon, Bull. Amer. Mus. Nat. Hist., vol. 23, 1906, p. 125 (off Pacific Grove; myzostomes).

Antedon perplexa A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 74 (description; *Albatross* Sta. 3070).

Antedon serratissima A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 77 (description; *Albatross* Sta. 3464).

Heliometra perplexa A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliometra serratissima A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliometra tanneri (not of Hartlaub, 1895) A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 267, fig. 4 (description of a specimen with a IIBr series); vol. 35, 1908, p. 125 (specimen with a IIBr series illustrates the arm structure of *Uintacrinus*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 226 (arm structure of the specimen with a IIBr series compared with that of *Cyllometra anomalus* [*manca*]).

Florometra asperrima (not of A. H. Clark 1907) F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 90–D, 1914, pp. 33 and following (inorganic constituents of the skeleton); Prof. Paper 102, 1917, pp. 20 and following (same); Prof. Paper 124, 1922, p. 17 (same).

Florometra tanneri A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 123 (specimen with a IIBr series).

Florometra perplexa A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 140 (*Albatross* Sta. 3070); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 241 (in key; range), p. 243 (references), p. 244 (discussion).—Ziesenhenne, Zoologica, New York, vol. 22, pt. 3, 1937, pp. 209, 211 (off San Jose Point, Lower California, 45 fms.; notes).

Florometra serratissima A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 140 (*Albatross* Sta. 3464), p. 142 (Nanaimo, B.C.; description of occurrence by C. McLean Fraser); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 242 (in key; range), p. 243 (references), p. 244 (discussion).—Fraser, Trans. Roy. Soc. Canada, ser. 3, vol. 12, 1918, p. 142 (larvae attached to the adult; a sedentary type).—Mortensen, Studies in the development of crinoids, 1920, pp. 54–55 (description of pentacrinoids, Nanaimo, B.C.), pp. 66 and following (discussion of the embryology), pl. 27.

Florometra seratissima Berkeley, Contr. Canadian Biol., new ser., vol. 6, 1931, No. 5, p. 75 (p. 11 of separate) (Ruxton Passage, B. C.; with *Myzostoma*).

Diagnostic features.—This species appears to differ from *asperrima*, only in having the third syzygy usually between brachials 16+17, sometimes between brachials 15+16, and in having generally a greater development of spines on the edges and dorsal surfaces of the ossicles of the division series and proximal brachials.

It appears to differ from *tanneri* in having the distal edge of the proximal segments of the oral pinnules produced into a more or less carinate process, which makes the pinnule bases appear much stouter; and from *mariae* in having shorter brachials, the longest of these being broader than long.

In the southern part of its range *Fariometra parvula* is found associated with this species, to the young of which it bears a close superficial resemblance. In *Fariometra parvula*, however, the centrodorsal is sharply conical, the third syzygy is between brachials 14+15, and the distal intersyzygial interval is 2 muscular articulations.

Notes.—As the detailed description of *asperrima* (excepting for the position of the third syzygy, which in *serratissima* occurs usually between brachials 16+17) applies almost equally well to this species, there seems to be no necessity for repeating it.

The development of spines on the edges, and often also on the dorsal surface of the ossicles of the division series and the proximal brachials, reaches a much greater extreme in *serratissima* than in *asperrima*, and the average spinosity is also greater. But in both species individuals occur in which the arm bases are almost smooth.

The maximum arm length in this species is slightly less than that of *asperrima*, though the average is about the same. The arm length in fully developed individuals is usually between 150 and 200 mm.

The maximum development of spines occurs in specimens from *Albatross* sta. 3461, in Puget Sound. In these the borders of the ossicles of the division series and lower brachials are frilled with irregular long spines, and the dorsal surface of the division series and first two brachials usually bears scattered spines which may become so numerous as completely to cover them. Sometimes these spines are simple, and sometimes they are branched or tufted, rising from a conical base. Occasionally the second brachial and the axillary may show a more or less regular row of conical tufted spines in the median line. Other extremely spiny specimens are from stas. 2877 and 2459, at the entrance to Puget Sound, from sta. 3109, off San Mateo County, California, and from sta. 2959, off southern California. The depth at these stations ranges from 73 to 225 meters, and the temperature from 6.89° C. to 11.05° C.

Specimens varying from very spiny to only slightly spiny, or even almost entirely without spines, are at hand from stas. 2893, 2956, 4555, 4543, 4518, 3129, 3672, 3078, 3789, 3449, 3454 and 3452, representing localities from Puget Sound to the Santa Barbara Islands in from 95 to 265 meters, with temperatures from 6.78° C. to 9.44° C.

Moderately spiny individuals only were dredged at stas. 4384, 4375, 2952, 2954, 2955, 4554, 4535, 4553, 4460, 3350, 3446, 3464 and 4245, representing localities from southeastern Alaska to San Diego, California, in from 73 to 254 meters, with temperatures ranging from 6.95° C. to 9.39° C.

Moderately to only slightly spiny specimens were dredged at stas. 3119, 4552, 4471, 4463, 4461, 3108, 3163, 3051 and 3445, and were sent me by Prof. McLean Fraser from Nanaimo. These localities range from Puget Sound to Santa Cruz, California, the depths being from 79 to 652 meters and the temperatures from 6.67° C. to 10.50° C.

Slightly spiny individuals only were found at stas. 4361, 4534, 3205, 2866, 3343 and 3458, from Puget Sound to San Diego in from 166 to 943 meters, the temperatures ranging from 6.22° C. to 7.44° C.

Almost smooth specimens only were dredged at stas. 3347, 3071, 3070, and at Loring, Alaska. The localities are from Washington to Loring, Alaska, in shallow water to 1251 meters, the temperatures ranging from 3.28° C. to 4.95° C.

Apparently the tendency to develop spines increases with the increasing temperature of the habitat.

In the type specimen of *serratissima*, from *Albatross* sta. 3464, the centrodorsal is hemispherical.

The cirri are XL–L, about 36, 30 mm. long; the segments show a tendency to overlap, and almost all of them bear strong dorsal spines.

The radials are concealed. The IBr_1 are barely visible. The IBr_2 (axillaries) are very short and broad.

The 10 arms are 105 mm. in length. The ossicles of the IBr series and proximal brachials are thickly set with small sharp spines; the brachials have overlapping distal edges set with numerous small sharp teeth.

Syzygies occur between brachials 3+4, 9+10, 16+17, and distally at intervals of 3 muscular articulations.

P_1 is from 17 to 21 mm. long with 45 to 60 short segments, and bears a long comb distally. P_2 is longer than P_1, from 18 to 22 mm. in length with 45 to 60 segments. P_3 may be 20 mm. long with 36 segments resembling P_2, or it may be 12 mm. long with elongated segments like P_4. The distal pinnules are long and slender, the segments with overlapping spinous distal edges.

In the very brief original description *Antedon perplexa* was merely said to be in general similar to *asperrima* but more slender with the brachials longer and wedge-shaped, the axillary considerably wider than the IBr_1, and the third syzygy almost invariably between brachials 16+17, rarely between brachials 15+16, and never between brachials 14+15.

Ziesenhenne (1937) gives the color in life of *serratissima* as reddish brown, the pinnules dark brown to black, the cirri light brown.

Abnormal specimens.—With 9 arms: A specimen labeled merely as from the western coast of North America (U.S.N.M., 35827) has 9 arms. The arms are about 150 mm. long. On one ray the two elements of the IBr series are slightly smaller than on the others and are followed by two first brachials and each of these by a second brachial which, though smaller than those on the other rays, are normal. The two second brachials are followed by a single first syzygial pair of the normal size in the shape of an inverted axillary, which is succeeded by a normal undivided arm. The two first brachials are just in contact over the anterior angle of the axillary, and the second brachials are more broadly in contact beneath the angle of the inverted axillary. A small pore passes in between the fused portions of the two first and two second brachials.

The conditions in this individual are very similar to those in the 9-armed specimen of *Heliometra glacialis* described by Lëvinsen (vol. 1, part 2, pl. 37, fig. 1231); but the elements following the two second brachials are single and the arm base is not so much enlarged.

With the first pair of brachials repeated: A specimen from off San Diego, California, in 183 meters collected by Prof. William E. Ritter is peculiar in having an additional first and second brachial inserted between a IBr axillary and the normal first brachial of its left derivative (vol. 1, part 2, fig. 131, p. 79; U.S.N.M., 36299). This interpolated pair of brachials is further interesting in being of the kind normal to a right derivative from a IBr axillary though it occurs on a left, and the outer element of the pair bears a pinnule on its inner side. The next two brachials are normal first and second brachials of a left arm with the characters of the two preceding just reversed.

With 11 arms: A specimen from *Albatross* station 3051 (U.S.N.M., 36042) has 11 arms, one IIBr 2 series being developed on the left side of a IBr axillary. On the left (outer) derivative from the IIBr axillary the first syzygy is between brachials 4+5; on the right (inner) derivative it is between brachials 1+2.

Pentacrinoid young.—Dr. Th. Mortensen has described in detail the pentacrinoids of this species.

In the youngest stage studied by him the oral valves have opened and the primary tentacles are beginning to protrude. The calyx consists only of the basals and orals. The basals are peculiar in having a rather broad unfenestrated lateral border. The orals are deeply depressed along the median line, the sides being bent gracefully outwards. There are no infrabasals. Dr. Mortensen says that while the radials are not yet formed the IBr_2 (axillary) has already appeared, lying as a small fenestrated plate about midway on the primary tentacle beyond the first sacculus, which is also distinct. In another specimen of the same stage the axillary was only a small spicule not yet fenestrated. He remarks that, so far as he knows, this is the first case recorded where the axillary appears before the radials. That this plate is really the axillary is shown beyond doubt, he says, by a slightly older stage in which the radial plate has been formed and there is, below the first formed plate in the tentacle, a small plate that can only represent the IBr_1. The radianal is large and rounded, encroaching upon the adjoining basals. It is the first plate to appear after the basals and orals, the order of appearance of the various plates being, according to Mortensen, (1) the basals and orals, (2) the radianal, (3) the IBr_2, (4) the radials, and (5) the IBr_1.

In this slightly older specimen the IBr_1 had appeared only in one radius, that to the left of the anal radius; "the radial plate was also found to diminish in size the same way round, and partly also the axillary, which latter was, however, found to be largest in the anal radius."

In this example the column consists of 16 segments, the 4 topmost being quite short, the central long and cylindrical, and the 3 lowest quite short; the terminal stem plate is irregularly lobed.

In another specimen the radials have just been formed while the IBr_1 has not as yet appeared. Some meshwork is beginning to develop on the orals, and a growth zone can be observed in the lower part of the orals and the upper part of the basals. Because of the large size of the radianal the adjoining radial lies to the right of the median line; resorption of the lower edge of the oral has begun.

In a slightly older specimen one of the basals was abnormal, smaller and shorter than the others and reaching only halfway down so as not to meet the upper end of the stalk. There are 19 columnals, the central ones being very elongate and slender.

In the oldest stage studied by Mortensen the radials have grown considerably and nearly join each other, separating the orals from the basals. The IBr_1 and IBr_2 have lengthened and now have the appearance of a small arm. The radianal apparently has not grown, and has now been pushed out from its original position in the mid-radial line so as to lie wholly in its own interradius between the basal and oral, while the radial has occupied its final position in the mid-radial line, though it is not yet quite symmetrical, the side adjoining the radianal being somewhat narrower. Some meshwork has developed in the depression in the orals. The column in this specimen is incomplete; but in another only slightly younger there are 23 columnals. The terminal stem plate remains small and without lobes.

So far as can be ascertained without sectioning, the outer pore of the pore canal is closed in this stage. The primary gonad is very small and indistinct.

Localities.—*Albatross* station 5688; off Lower California; west tangent, Natividad Island, bearing N. 15° E., and Breaker Point bearing N. 72° E. (lat. 27°38′45″ N., long. 115°17′40″ W.); 960 meters; temperature 4.39° C.; density 1.02482; green mud and globigerinae; April 23, 1911 (1, U.S.N.M., E. 1104).

Albatross station 2987; northwest of Cedros Island, Lower California (lat. 28°54′15″ N., long. 118°18′00″ W.); 312 meters; temperature 7.95° C.; gray sand with black specks and gravel; February 28, 1889 (1, U.S.N.M., 35800).

Templeton Crocker Expedition, station 175: D–1; west of San Jose Point, Lower California; 82 meters; bottom, shaley [Ziesenhenne, 1937].

Albatross station 4383; off San Diego, California; north point of North Coronado Island bearing S. 79° E., 2.3 miles distant; 525–722 meters; temperature 5.28° C.; March 18, 1904 (1, U.S.N.M., 35846).

Albatross station 4341; off San Diego; south point of South Coronado Island bearing N. 79° E., 3.3 miles distant; 216–590 meters; temperature 7.78°–5.56° C.; gray sand and black specks; March 11, 1904 (1, U.S.N.M., 35845).

Albatross station 2936; off San Diego (lat. 32°49′00″ N., long. 117°27′30″ W.); 656 meters; temperature 9.44° C.; mud; February 4, 1889 (2, U.S.N.M., 35841).

Albatross station 5695; off San Diego (lat. 33°33′00″ N., long. 120°17′30″ W.); 976 meters; temperature 3.83° C.; density 1.02466; green sand and globigerinae; April 26, 1911 (4, U.S.N.M., E. 1103).

Albatross station 4384; near San Diego; Point Loma Light House bearing N. 68° E., 7.7 miles distant; 254 meters; gray sand and rock; March 21, 1904 (7, U.S.N.M., 35839).

Dr. Th. Mortensen's Pacific Expedition, 1914–16; La Jolla, California; 110 meters (1, C.M.).

Albatross station 4372; near San Diego; Point Loma Light House bearing N. 82°30′ E., 9.8 miles distant; 159–186 meters; gray sand and rock; March 16, 1904 (1, U.S.N.M., 35843).

Albatross station 4361; near San Diego; Point Loma Light House bearing N. 87° E., 9.9 miles distant; 166–177 meters; gray sand with black specks, mud, and rock; March 15, 1904 (2, U.S.N.M., 35848).

Albatross station 4375; near San Diego; Point Loma Light House bearing N. 81° E., 10.1 miles distant; 157–161 meters; coarse sand, shells and rock; March 17, 1904 (6, U.S.N.M., 35842).

Albatross station 4363; near San Diego; Point Loma Light House bearing N. 81° E., 11.1 miles distant; 378–636 meters; temperature 6.00° C.; green mud; March 15, 1904 (2, U.S.N.M., 35844).

Off San Diego; about 183 meters; W. E. Ritter [Ritter, 1902; A. H. Clark, 1908, 1915] (2, U.S.N.M., 36299, 36300).

Albatross station 2952; south of the Santa Cruz channel, between Santa Cruz and Santa Rosa, Santa Barbara Islands (lat. 33°50′00″ N., long. 119°57′00″ W.); 104 meters; broken shells and rock; February 8, 1889 (139, U.S.N.M., 35731, 35854).

Albatross station 2954; southwest of San Nicolas, Santa Barbara Islands (lat. 33°42′30″ N., long. 119°59′30″ W.); 119 meters; gravel, shells and rock; February 8, 1889 (14, U.S.N.M., 35730).

Albatross station 2955; southwest of San Nicolas, Santa Barbara Islands (lat. 33°48′00″ N., long. 120°03′15″ W.); 221 meters; temperature 9.00° C.; fine gray sand and broken shells; February 8, 1889 (1, U.S.N.M., 35809).

Albatross station 2959; San Miguel Passage, between Santa Rosa and San Miguel, Santa Barbara Islands (lat. 34°06′45″ N., long. 120°18′00″ W.); 100 meters; temperature 11.05° C.; green mud, gray sand, and broken shells; February 9, 1889 (23, U.S.N.M., 35802).

Albatross station 2956; southwest of San Nicolas, Santa Barbara Islands (lat. 33°57′30″ N., long. 120°18′30″ W.); 95 meters; fine gray sand and rock; February 8, 1889 (43, U.S.N.M., 35855).

Albatross station 2893; south of Point Conception, Santa Barbara County, California (lat. 34°12′30″ N., long. 120°32′30″ W.); 265 meters; temperature 9.22° C.; fine gray sand and mud; January 5, 1889 (16, U.S.N.M., 35804).

Albatross station 4554; Monterey Bay, California; Point Pinos Light House bearing S. 76° E., 3 miles distant; 109–146 meters; green mud and rock; June 9, 1904 (80, U.S.N.M., 35735, 35813).

Albatross station 4555; Monterey Bay; Point Pinos Light House bearing S. 63° E., 3.4 miles distant; 121–126 meters; green mud and rock; June 9, 1904 (17, U.S.N.M., 35850).

Albatross station 4535; Monterey Bay; Point Pinos Light House bearing N. 86° E., 3.7 miles distant; 99–130 meters; hard gray sand; May 28, 1904 (18, U.S.N.M., 35815).

Albatross station 4553; Monterey Bay; Point Pinos Light House bearing S. 67° E., 3.7 miles distant; 119–135 meters; rock; June 9, 1904 (56, U.S.N.M., 35849).

Albatross station 4534; Monterey Bay; Point Pinos Light House bearing S. 80° E., 4 miles distant; 139–157 meters; hard gray sand; May 28, 1904 (17, U.S.N.M., 35803, 35829).

Albatross station 4552; Monterey Bay; Point Pinos Light House bearing S. 73° E., 4 miles distant; 121–133 meters; green mud and rock; June 9, 1904 (29, U.S.N.M., 35816, 35837).

Albatross station 4471; Monterey Bay; Point Pinos Light House bearing S. 33° E., 5.3 miles distant; 119–263 meters; gray sand; May 14, 1904 (3, U.S.N.M., 35819).

Albatross station 4543; Monterey Bay; Point Pinos Light House bearing S. 25° E., 5.4 miles distant; 97–170 meters; hard sand and rock; June 1, 1904 (3, U.S.N.M., 35818).

Albatross station 4518; Monterey Bay; Point Pinos Light House bearing S. 42° E., 5.7 miles distant; 121–139 meters; hard sand; May 24, 1904 (6, U.S.N.M., 35812).

Albatross station 4463; Monterey Bay; Point Pinos Light House bearing S. 17° W., 8 miles distant; 88–203 meters; rocky; May 13, 1904 (11, U.S.N.M., 35817).

Albatross station 4461; Monterey Bay; Point Pinos Light House bearing S. 3° E., 9.3 miles distant; 521–652 meters; green mud; May 12, 1904 (5, U.S.N.M., 35737).

Albatross station 4460; Monterey Bay; Point Pinos Light House bearing S. 12° E., 10.8 miles distant; 100–122+ meters; green mud and gravel; May 12, 1904 (17, U.S.N.M., 35811, 35826).

Albatross station 3129; off Pacific Grove, California (lat. 36°39′40″ N., long. 122°01′00″ W.); 373 meters; temperature 8.50° C.; sand and mud; March 13, 1890 (45, U.S.N.M., 35810).

Off Pacific Grove, California [McClendon, 1906].

Albatross station 3205; off Santa Cruz, California (lat. 36°55′10″ N., long. 122°23′50″ W.); 439 meters; temperature 6.50° C.; black sand and rocks; April 12, 1890 (1, U.S.N.M., 35805).

About 14 miles west of Santa Cruz, California; 731 meters; crumbly shale bottom; April 13, 1925; Pacific Biological Laboratories (5, U.S.N.M., E. 1236).

Albatross station 3119; off Santa Cruz, California (lat. 36°56′30″ N., long. 122°17′40″ W.); 99 meters; temperature 10.50° C.; March 12, 1890 (7, U.S.N.M., 35808, 35840).

Albatross station 3109; off central California (lat. 37°18′30″ N., long. 122°35′00″ W.); 73 meters; temperature 10.44° C.; rocky; March 11, 1890 (11, U.S.N.M., 35833).

Albatross station 3108; off San Mateo County, California (lat. 37°19′00″ N., long. 122°36′00″ W.); 79 meters; temperature 10.44° C.; rocks and broken shells; March 11, 1890 (7, U.S.N.M., 35834).

Albatross station 3672; off San Mateo County, California (lat. 37°37′00″ N., long. 123°02′00″ W.); 124 meters; temperature 9.44° C.; sand, coral, and rock; April 24, 1897 (31, U.S.N.M., 35814).

Albatross station 3163; off Marin County, California (lat. 37°56′40″ N., long. 123°25′30″ W.); 126 meters; temperature 9.17° C.; fine gray sand; March 22, 1890 (20, U.S.N.M., 35807).

Albatross station 3349; off northern California (lat. 38°57′45″ N., long. 124°03′05″ W.); 437 meters; temperature 6.72° C.; black sand; September 25, 1890 (3, U.S.N.M., 35789).

Albatross station 3350; off Point Arena, California (lat. 38°58′10″ N., long. 123°57′05″ W.); 137 meters; temperature 9.11° C.; fine sand and mud; September 25, 1890 (48, U.S.N.M., 21701, 35794, 35797; Vassar College M.).

Albatross station 3051; off Florence, Oregon (lat. 43°59′15″ N., long. 124°58′30′ W.); 108 meters; coral, broken shells and rock; June 8, 1889 (70, U.S.N.M., 35733, 35832, 35969, 36042).

Albatross station 3078; off Florence, Oregon (lat. 43°59′15″ N., long. 124°46′00″ W.); 124 meters; temperature 7.61° C.; green mud; September 1, 1889 (40, U.S.N.M., 35791).

Albatross station H.5377; Heceta Head Light (lat. 44°30′ N.) bearing N. 78.5° E., 31.5 miles distant; 161 meters; shale, rocks, granular material, black sand and gravel; April 29, 1914 (1, U.S.N.M., E.1101).

Albatross station H.5447; Heceta Head Light bearing S. 74° E., 29.2 miles distant; 111 meters; shale, granular material and fine gravel; May 4, 1914 (2, U.S.N.M., E.1102).

Albatross station 3347; off Nestucca Bay, Washington (lat. 45°09′35″ N., long. 124°45′00″ W.); 631 meters; temperature 4.95° C.; mud; September 22, 1890 (9, U.S.N.M., 35830).

Albatross station 3071; off Clearwater, Washington (lat. 47°29′00″ N., long. 125°33′30″ W.); 1252 meters; temperature 3.33° C.; green mud; June 28, 1889 (53, U.S.N.M., 35796).

Albatross station 3070; off Clearwater, Washington (lat. 47°29′30″ N., long. 125°43′00″ W.); 1163 meters; temperature 3.28° C.; green mud; June 28, 1889 [A. H. Clark, 1907, 1915] (35, U.S.N.M., 22611, 35795).

Albatross station 3343; west of Destruction Island, Washington (lat. 47°40′40″ N., long. 125°20′00″ W.); 943 meters; temperature 3.44° C.; green mud; September 21, 1890 (112, U.S.N.M., 35831, 36253).

Albatross station 2866; off Clallam County, Washington (lat. 48°09′00″ N., long. 125°03′00″ W.); 312 meters; temperature 6.22° C.; gray sand; September 20, 1888 (4, U.S.N.M., 35801).

Albatross station 3789; Tatoosh Island Light bearing N. 73° E., 5.7 miles distant (lat. 48°21′45″ N., long. 124°52′30″ W.); 210 meters; coarse gray sand and gravel; April 30, 1901 (6, U.S.N.M., 36203).

Albatross; off Washington (fragments, U.S.N.M., 36253).

Albatross; western coast of North America (12, U.S.N.M., 35827, 35828, 35851).

Albatross station 2877; entrance to the Straits of Fuca (lat. 48°33′00″ N., long. 124°53′00″ W.); 108 meters; black sand and mud; September 25, 1888 (1, U.S.N.M., 35806).

Albatross station 3454; entrance to the Straits of Fuca (lat. 48°27′50″ N., long. 124°42′40″ W.); 278 meters; temperature 6.78° C.; gray sand and rocks; September 1, 1891 (5, U.S.N.M., 35790).

Albatross station 3449; entrance to the Straits of Fuca (lat. 48°29′40″ N., long. 124°40′10″ W.); 247 meters; gray sand and gravel: August 28, 1891 (5, U.S.N.M., 21706).

Albatross station 3459; entrance to the Straits of Fuca (lat. 48°24′20″ N., long. 124°24′40″ W.); 225 meters; temperature 6.95° C.; gray sand and pebbles; September 2, 1891 (1, U.S.N.M., 35788).

Albatross station 3451; entrance to the Straits of Fuca (lat. 48°25′10″ N., long. 124°37′50″ W.); 194 meters; 7.22° C.; gravel and stones; August 28, 1891 (1, U.S.N.M., 36218).

Albatross station 3452; entrance to the Straits of Fuca (lat. 48°24′40″ N., long. 124°29′10″ W.); 228 meters; temperature 6.95° C.; rocky, with black gravel; August 29, 1891 (8, U.S.N.M., 35793).

Albatross station 3458; entrance to the Straits of Fuca (lat. 48°21′50″ N., long. 124°24′00″ W.); 210 meters; dark sand and stones; September 2, 1891 (2, U.S.N.M., 36137).

Albatross station 3461; off Pillar Point, Washington (lat. 48°17′20″ N., long. 124°07′25″ W.); 208 meters; temperature 6.89° C.; gray sand, gravel and rocks; September 2, 1891 (127, U.S.N.M., 35902, 35905).

Albatross station 3446; east of Pillar Point, Washington (lat. 48°18′50″ N., long. 123°58′20″ W.); 183 meters; temperature 6.95° C.; blue mud; August 27, 1891 (1, U.S.N.M., 35987).

Albatross station 3445; west of Port Angeles, Washington (lat. 48°16′ N., long. 123°45′05″ W.); 183 meters; temperature 6.67° C.; bottom rocky; August 27, 1891 (4, U.S.N.M., 35792).

Albatross station 3464; northeast of Port Angeles, Washington (lat. 48°14′ N., long. 123°20′40″ W.); 73 meters; temperature 8.78° C.; bottom, gray sand and pebbles; September 4, 1891 [A. H. Clark, 1907, 1915] (1, U.S.N.M., 22612). Type locality.

Nanaimo; Ruxton Passage; about 46 meters [Berkeley, 1931].

Nanaimo; between Round Island and Mudge Island; about 46 meters [Berkeley, 1931].

Dr. Th. Mortensen's Pacific Expedition 1914–16; Pylades Channel, Strait of Georgia, 37 meters; July 6, 1915 (1, C.M.).

Dr. Th. Mortensen's Pacific Expedition 1914–16; Strait of Georgia; about 90 meters; July 7, 1915 (1, C.M.)

Nanaimo, British Columbia [A. H. Clark, 1915; Fraser, 1918; Mortensen, 1920] (2, U.S.N.M., 35857).

Albatross station 4245; Kasaan Bay, Prince of Wales Island, southeastern Alaska; center of Round Island bearing S. 10° W., 0.4 mile distant; 173–179 meters; temperature 9.39° C.; dark green mud, sand, shells and rock; July 11, 1903 (1, U.S.N.M., 35838).

Loring, Revilla Gigedo Island, southeastern Alaska; shallow water; *Albatross;* July 1, 1897 (1, U.S.N.M., 35836).

Loring, Alaska; deep bay, on a dogfish trawl; about 46 meters; *Albatross;* July 1, 1903 (3, U.S.N.M., E. 1105).

Southeastern side of Etolin Island, Alaska; 11 meters; Dan Brown; 1911 (1, U.S.N.M., 36154).

Albatross station 4265; off Sitka Sound, Alaska; Cape Edgecumbe bearing N. 69° E., 11 miles distant; 1078 meters; temperature 3.44° C.; rocky, with green mud; July 31, 1903 (2, U.S.N.M., 36204).

Albatross station 3338; southeast of the Shumagin Islands, Alaska (lat. 54°19′00″ N., long. 159°40′00″ W.); 1142 meters; green mud and sand; August 28, 1890 (34, U.S.N.M., 35835).

Albatross station 3210; south of Sannak Island, Alaska (lat. 54°00′00″ N., long. 162°40′30″ W.); 883 meters; temperature 3.61° C.; sand and green mud; May 21, 1890 (2, U.S.N.M., 36028).

Geographical range.—From Natividad Island, Lower California (lat. 27°38′45″ N.), northward to the Shumagins and Sannak Island, Alaska.

Bathymetrical range.— From shallow water (the shallowest record is 11 meters) down to 1252 meters; the average of 67 records is 285 meters.

Thermal range.—From 3.28° C. to 11.05° C.; the average of 35 records is 7.13° C.

Occurrence.—Judging from the great numbers sometimes brought up by the dredge this species must be locally very abundant, after the manner of *Heliometra glacialis.*

Prof. C. McLean Fraser wrote to me that, in the vicinity of the Pacific Coast Biological Station at Nanaimo, the area so far explored in which this species is found extends on both sides of the de Courcy Islands, a group of five of six islands running southeast from Dodd's Narrows for a distance of several miles. They are apparently more abundant on the southwestern side, and at the entrance to the passages between the islands. The point nearest to Nanaimo at which they have been found is about 6 miles away, and about 9 miles from the Station. Most of them have been obtained in water of from 27 to 55 meters in depth. There must be many acres, if not miles, pretty well covered with them.

In June and July, 1915, Dr. Th. Mortensen found this species to be fairly common near Nanaimo in a place near Ruxton passage at a depth of about 27 to 46 meters.

He observed this form swimming actively after the usual manner of comatulids.

Occurrence of the pentacrinoids.—Professor Fraser wrote (1918) that the larvae of this species become attached to the adults, and Dr. Mortensen (1920) from among over 200 specimens took 10 pentacrinoids attached to the cirri.

History.—Prof. William E. Ritter in a note published in 1902 first called attention to the existence of comatulids on the west American coast; he had obtained a few specimens by dredging off San Diego in about 183 meters (100 fathoms). But many years before, on January 5, 1889 (Sta. 2893) the *Albatross* had first secured this species among the Santa Barbara Islands, dredging it in abundance on February 8 (Stas. 2952, 2954–2956) and 9 (Sta. 2959) of the same year. On all her subsequent cruises on the west coast she met with this species in local abundance everywhere, but always in fairly deep water.

Dredging operations carried on at Pacific Grove, near Monterey, had yielded this form, and the myzostomes on some of the specimens secured were described by Prof. Jesse F. McClendon in 1906.

From the material which had been accumulating in the U.S. National Museum as a result of the work of the *Albatross*, I described in 1907 *Antedon perplexa* and *A. serratissima*, both from the coast of Washington. I learned later that Mr. Cloudsley Rutter, the naturalist of the *Albatross*, at the time of his death had been especially interested in the crinoids, and had conferred upon this species the MS. name of *Antedon asper*.

Professor Ritter now sent me the comatulids which he had dredged off San Diego and recorded in 1902. These did not seem to agree either with my *perplexa* or with my *serratissima*. It seemed to me at the time most probable that they represented Hartlaub's *tanneri*, described from somewhat further south, and under that name I recorded them in 1908, at the same time mentioning the occurrence of a reduplicated first brachial pair in one of them.

In 1911 Mr. Dan Brown, of Wrangel, Alaska, while fishing on the southeastern side of Etolin Island, brought up a specimen from a depth of 11 meters, the only one that has ever been obtained other than by dredging.

The late Prof. C. McLean Fraser found comatulids to be abundant in the vicinity of the Biological Station at Nanaimo, when he was director, and was kind enough to send me some of them with notes on their occurrence in that region, which notes I published in 1915. He brought out some additional information and noted the occurrence of the pentacrinoid young in 1918.

After a reexamination of all the material available, I remarked in 1918 that *serratissima* is probably only a spinous form of *perplexa;* but I included with the latter the specimens which had been recorded from Panama and the western coast of Central America by Hartlaub in 1895 and by myself in 1908 under the name of *rhomboidea*. These are here considered as *tanneri*.

During a visit to the station at Nanaimo, Dr. Th. Mortensen secured a number of pentacrinoids which he described in great detail in 1920.

[NOTE BY A.M.C.] In Mr. Austin Clark's paper of 1907, the name *Antedon perplexa* has page priority over *A. serratissima*, but, in view of the very brief description of *perplexa* in the form of a comparison with *asperrima*, I do not dispute the use of the name *serratissima* for this species.

FLOROMETRA MARIAE (A. H. Clark)

FIGURE 15

[See also vol. 1, pt. 1, fig. 311 (p. 269); pt. 2, figs. 292–293 (p. 221), 770 (p. 362)]

Antedon mariae A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 77 (description; *Albatross* sta. 5092); Bull. Inst. Océanogr., Monaco, No. 285, 1914, p. 3, footnote (type of *Florometra*).

Antedon hondoensis A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 78 (description; *Albatross* sta. 5048); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 243 (=*F. mariae*).

Antedon laodice A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 75 (description; *Albatross* sta. 4969).

Heliometra hondoensis A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed); Bull. Mus. Comp. Zool., vol. 51, No. 8, January 1908, p. 240 (compared with *H. juvenalis* [*glacialis*]).

Heliometra laodice A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (Japan).

Heliometra mariae A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (Japan).

Florometra mariae A. H. CLARK, Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (antarctic type; range and its significance); Die Crinoïden der Antarktis, 1915, p. 141 (*Albatross* stas. 5092, 3706), p. 142 (entrance to Tokyo Bay, 600 m.; Professor Doflein); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 241 (in key; range), p. 242 (in key; range), p. 243 (synonymy), p. 244 (discussion).—GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (Dr. Mortensen's sta. 15; 720 meters), p. 49 (notes), p. 68 (listed), figs. 43, 44, p. 44.

Florometra hondoensis A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 141 (*Albatross* stas. 5047, 5048).

Florometra laodice A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 141 (*Albatross* sta. 4969); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 241 (in key; range), p. 243 (synonymy), p. 244 (discussion).

Diagnostic features.—The length of the brachials, those following the third syzygy being about as long as broad instead of markedly broader than long, separates this species from *serratissima* to which, however, it is very closely related; the position of the third syzygy is very irregular but it is often between brachials 16+17 instead of between brachials 14+15, which separates it from *asperrima;* the occurrence of dorsal processes on the proximal segments of the oral pinnules separates it from *tanneri*, while the bases of these pinnules are not broadened as in *magellanica*.

Descriptions of the known specimens.—In the type of *mariae* the centrodorsal has a conspicuous bare polar area which is not sunken.

The cirri are about L, 60, 60 mm. in length; the earlier segments are elongate, the distal short with faintly indicated terminal dorsal spines. The cirri about the dorsal pole are 35 mm. in length and are composed of about 30 segments.

The radials are concealed by the centrodorsal except for a narrow border. The IBr_1 are short, about 4 times as broad as long. The IBr_2 (axillaries) are about as long as, or somewhat longer than, broad, triangular, with the middle of the proximal border raised into a slight tubercle and the proximal edge and distal sides, like the borders of the IBr_1, set with fine teeth.

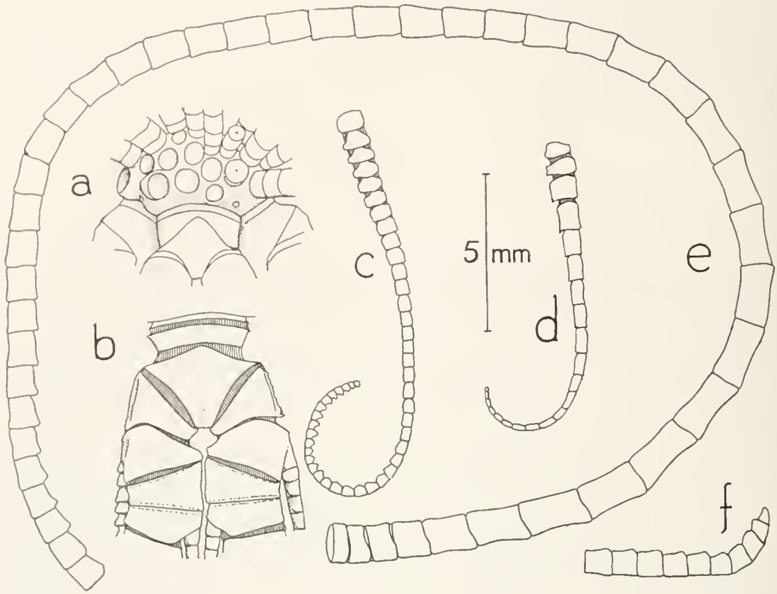

FIGURE 15.—*Florometra mariae* (A. H. Clark), holotype: *a*, Lateral view of centrodorsal, division series foreshortened; *b*, perpendicular view of proximal part of postradial series; *c*, P_1; *d*, P_4; *e*, peripheral cirrus lacking the tip; *f*, tip of another cirrus.

The width of the arm at the first syzygy is 2.3 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 14.5 mm.

The third syzygy occurs 3 times between brachials 15+16, 3 times between brachials 14+15, and once between brachials 16+17. The distal intersyzygial interval is 3 muscular articulations.

P_1 is 22 mm. long, slender and flagellate, composed of 60 segments, most of which are broader than long, the terminal 25 or 30 forming a rudimentary comb. P_2 is 19 mm. long with about 40 segments which are relatively longer than those of P_1. P_3 is 16 mm. long with 40 segments and, like P_2, with a rudimentary terminal comb. The following pinnules are much shorter with fewer and longer segments and no terminal comb. The pinnule on the twenty-sixth brachial is 12 mm. long, slender, with 20 elongated segments. The lower segments of the proximal pinnules have rather high narrow carinate processes with spinous crests.

In the type of *laodice* the cirri are about XL, 40, 40 mm. long; the segments in the proximal half are longer than broad, those in the distal short and furnished with small spines.

The third syzygy occurs 5 times between brachials 14+15, and 4 times between brachials 15+16. The distal intersyzygial interval is almost invariably 4 muscular articulations. The distal edges of the brachials are almost entirely smooth.

P_1 and P_2 are 20 mm. long, slender and flagellate, with 50 very short segments. P_3 is 22 mm. long with 46 segments. P_4 is somewhat shorter. P_5 and P_6 are much shorter with the component segments more elongate. The first 4 pinnules bear rudimentary terminal combs.

In the type of *hondoensis* the cirri are XXX–L, 35–40, 40 mm. long. The articulations are rather prominent, and the segments in the distal half bear dorsal spines.

The IBr_2 (axillaries) are somewhat broader than long.

The 10 arms are 140 mm. long; the brachials following the proximal oblong series are as long as, or longer than, wide.

P_1 and P_2 are 24 mm. long, composed of short and broad segments which become as long as broad after the first 5 or 6; the basal 5 or 6 segments bear high, but short, dentate dorsal processes, those on the different segments being separated from each other by deep notches. P_3 is 14 mm. long with rather elongated segments. P_5 bears a small gonad which increases in size on the following pinnules. The distal pinnules are long and slender, the component segments with the distal borders set with small spines.

The position of the third syzygy is very irregular, between brachials 16+17, 15+16, or 14+15. The distal intersyzygial interval is 3 muscular articulations.

A very fine nearly perfect specimen collected at the entrance to Tokyo Bay in 600 meters on October 27, 1904, by Prof. Franz Doflein has the cirri composed of 40 to 48 segments, from 55 to 60 mm. in length.

The 10 arms are about 175 mm. in length. The distal edges of the brachials are rather strongly produced and very spinous, and the edges of the elements of the IBr series and the lower brachials are everted and spinous.

Syzygies occur between brachials 3+4, 9+10 and 16+17, and distally at intervals of 3 muscular articulations.

P_1 is 25 mm. long and is composed of 65 very short segments of which the first 6 have the dorsal edge produced into a high thin carination, straight or bilobed, while those in the outer half of the pinnule have the dorsal surface strongly produced, forming a prominent comb. P_2 is 26 mm. long with 70 segments, resembling P_1. P_3 is 18 mm. long with 41 segments which are proportionately longer than those of the preceding pinnules, while the carination of the basal segments is slightly less marked and the distal comb is shorter. P_4 is 16 mm. long with 38 segments which are proportionately slightly longer than those of P_3; the carination of the basal segments is slightly less marked than in P_3, and the distal comb is slightly shorter. P_5 is 11 mm. long with 19 segments, and is slightly stouter and less flagellate than the preceding pinnules, with slightly longer segments; the distal comb is only slightly developed. P_6 and the following pinnules are similar to P_5, but very slightly stouter. P_6 is 11 mm., P_7 is 10 mm., and P_8 is 10 mm. in length. The distal pinnules are very slender, 18 mm. long with 31 segments.

Gislén, 1927, gave the following details of the specimens obtained by Dr. Th. Mortensen in the Sagami Sea.

Specimen 1. Centrodorsal hemispherical, 2 mm. in height, the dorsal pole slightly flattened, measuring 3 mm. across. Cirri about L, with 28 to 46 segments, measuring 13 to 40 mm. and arranged in alternating whorls. There are no dorsal or opposing spines. The longest segments are usually a quarter again as long as wide except for the small dorsal cirri, which may have segments as much as twice as long as wide.

The radials are visible in the corners. The IBr_2 (axillaries) have a moderate synarthrial tubercle and almost no backward projection. The arms are about 95 mm. long. The arm bases are somewhat knobby but otherwise smooth, only the middle and distal brachials having spinous distal borders. Syzygies occur at brachials 3+4, 9+10, 13+14, or 14+15, or 15+16, or 17+18, and distally with an interval of 3–4 muscular articulations.

P_1 has 66 segments and measures about 27 mm. It is slender. The second to the sixth segments have truncated and indistinctly spinous prominences on the aboral side. The distal segments are one quarter again as long as wide and are toothed.

P_2 has about 55 segments and measures 21 mm. P_4 has 46 segments and is about 20 mm. long. P_5 is without a comb. P_7 has 19 segments and measures 12 mm. The distal pinnules have 22 segments and measure 12 mm. Their third and following segments are very slender and twice as long as wide.

The disk measures 8 mm. It has no granules. The anal cone measures 6 mm.

Specimen 2. The cirri have 26 to 40 segments and measure 14 to 40 mm. There is a median carination and indistinct dorsal spines. The longest segments are half again as long as wide. An opposing spine is present. The arms are 85 mm. long. The third syzygy is between brachials 14+15, 15+16, or 16+17. P_1 has 50 segments and measures about 20 mm. P_2 has about 45 segments and is 17 mm. long. P_3 has 37 segments and measures 15 mm. P_4 has about 20 segments and measures 8 mm.; it lacks a comb. The distal pinnules have 22 segments and are 11 mm. long.

Gislén comments that these specimens are adolescents of *Florometra mariae*, differing only from the adults in the smoother arm bases and smaller size. They approach *Heliometra* in having the smoother arm bases but are sharply distinguished from it by, among other things, the lack of a synarthrial backward projection on the axillaries and by the very slender pinnules of which the proximal bear distinct teeth on the distal pinnulars.

He says also that they bear some resemblance to *Cyclometra* (now *Boleometra*) *clio*, which is here considered as belonging to the subfamily Bathymetrinae. Specimen two apparently differs mainly from the smaller type specimen of *B. clio* in having longer cirri composed of more segments and longer proximal pinnules also composed of more segments. However, *B. clio* has the axillaries rhombic rather than triangular.

Localities.—*Albatross* station 5047; off Kinka San, eastern coast of Japan; Kinka San Light bearing N. 69.5° W., 11.6 miles distant (lat. 38°12′50″ N., long. 141°49′15″ E.); 195 meters; temperature 9.78° C.; dark gray sand, broken shells and pebbles; October 10, 1906 [A. H. Clark, 1907, 1915] (2, U.S.N.M., 22651, 35750).

Albatross station 5048; off Kinka San; Kinka San Light bearing N. 61° W., 15.4 miles distant (lat. 38°09′24″ N., long. 141°52′30″ E.); 236 meters; temperature 4.83° C.; dark gray sand and broken shells; October 10, 1906 [A. H. Clark, 1907, 1915] (8, U.S.N.M., 35715).

Albatross station 5092; Uraga Strait, entrance to Tokyo Gulf; Joga Shima Light bearing N. 19° W., 3.5 miles distant (lat. 35°04′50″ N., long. 139°38′18″ E.); 128

meters; temperature 13.50° C.; coarse black sand; October 26, 1906 [A. H. Clark, 1907, 1915] (1, U.S.N.M., 22608). Type locality.

Entrance to Tokyo Gulf; 600 meters; Prof. Franz Doflein [A. H. Clark, 1915] (1, Munich M.).

Albatross station 3706; southern Japan; entrance to Port Heda bearing N. 86° E., 2 miles distant; 616 meters; green volcanic mud; May 8, 1900 [A. H. Clark, 1915] (1, U.S.N.M., 35716).

Albatross station 4969; southern Japan; Shio Misaki Light bearing N. 77° E., 9.8 miles distant (lat. 33°23′40″ N., long. 135°33′00″ E.); 1073 meters; temperature 3.83° C.; brown mud, sand and stones; August 29, 1906 [A. H. Clark, 1907, 1915] (1, U.S.N.M., 22609).

Dr. Th. Mortensen's station 15, Sagami Sea, Japan; 720 meters [Gislén, 1927].

Geographical range.—Southeastern and southern Japan, from off Kinka San (lat. 38°12′50″ N.) southward and westward to the Kii Channel (Linschoten Strait).

Bathymetrical range.—From 128 to 1073 meters; the average of 6 records is 475 meters.

Thermal range.—From 3.83° C. to 13.50° C.; the average of 4 records is 7.98° C.

History.—The first specimen of this species to come to light was dredged by the *Albatross* off southern Japan on May 8, 1900, at sta. 3706. This was sent, together with the other crinoids collected in that year, to Dr. Hubert Lyman Clark, then at Olivet College, who later most generously turned it over to me. The next specimen, a remarkably perfect one, was collected by Prof. Franz Doflein in 1904 at the entrance to Tokyo Gulf.

From the dredgings of the *Albatross* in 1906 off the eastern and southern Japanese coasts I described in 1907 *Antedon mariae, A. laodice* and *A. hondoensis*, the two first based upon single mutilated individuals from each of two stations, the third based upon a series of 10 from two stations.

Considering the enormous abundance of the other species of *Florometra* in favorable localities, it is rather curious that at 4 out of the 7 localities at which this species has been dredged only one individual should have been obtained, while at the other 3 the numbers were only 2, 2 and 8.

In 1918 I decided that *hondoensis* was the same as *mariae; laodice* I maintained as a distinct species uniting with it, erroneously as I am now convinced, *rathbuni*. I further remarked that *laodice* may prove to be the same as *asperrima*, and mentioned some specimens from the Gulf of Alaska (herein included under *serratissima*), which seemed to be referable to *mariae*, stating also the possibility that *serratissima*, which is probably only a spinous form of *perplexa* (here so considered), will eventually prove to be a synonym of *mariae*.

FLOROMETRA TANNERI (Hartlaub)

[See vol. 1, pt. 2, pl. 5, fig. 1008, pl. 13, fig. 1054, pl. 15, fig. 1070]

Comatula A. Agassiz, Bull. Mus. Comp. Zool., vol. 21, No. 4, 1891, p. 197 (off the Tres Marias Is.); vol. 23, No. 1, 1892, p. 80 (same), p. 82 (color).

Antedon tanneri Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 141 (description; *Albatross* sta. 3385; discussion), pl. 1, fig. 9, pl. 2, fig. 13, pl. 3, figs. 20, 22.—A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 69 (overlapping of brachials; compared with allied north Pacific forms).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pp. 1579, 1580 (listed).

Antedon rhomboidea (not of P. H. Carpenter, 1888) HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 137 (range), p. 138 (detailed description of a specimen from *Albatross* sta. 3357, except of the cirri and pinnules which are from a specimen from sta. 3424; discussion [example from Smyth's Channel=*magellanica*]), pl. 1, figs. 1–3, 6, 10, 11, pl. 2, figs. 12, 14, 15, 17, pl. 3, fig. 24.

Heliometra tanneri A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliametra rhomboidea A. H. CLARK, Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 238 (*Albatross*, stas. 4621, 4622, 4630), p. 239 (tactile cirri).

Florometra tanneri A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 138 (*Albatross* sta. 3385); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 241 (in key; range), p. 243 (references), p. 244 (discussion).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 18 (abnormal arm structure).

Florometra magellanica (not of Bell, 1882) A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 138 (*Albatross* stas. 3357, 3424, 4621, 4622, 4630).

Promachocrinus (Florometra) magellanica A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 142 (in part; Panama records).

Diagnostic features.—A species of *Florometra* in which there are no carinate processes on the basal segments of the proximal pinnules which therefore appear very slender. The middle and distal pinnules are also more slender with more elongate segments than those of any of the other species in the genus. The third syzygy is usually between brachials 16+17.

With this species there occurs *Fariometra parvula*, which is very easily mistaken for its young. In *F. parvula*, however, the centrodorsal is sharply conical, and the distal intersyzygial interval is only 2 muscular articulations, while the third syzygy is between brachials 14+15.

Description.—The centrodorsal is flattened hemispherical with a more or less deep depression at the dorsal pole; the cirrus sockets, which completely cover the sides, are arranged in 4 or 5 alternating rows.

The cirri are about LX, 40–54, 60 mm. long; the fourth-tenth segments are elongated, and the following to the twentieth are longer than broad. Beyond the eighth segment the cirri are strongly compressed laterally. In the distal half the dorsal ends of the segments are produced into a small spine.

The radials are even with the rim of the centrodorsal, or extend for a very slight distance beyond it. The IBr_1 are very short, not in lateral contact with each other, with converging sides; there is a strong rounded synarthrial tubercle on the line of union with the axillaries which is scarcely marked in the younger individuals. The IBr_2 (axillaries) are moderately large and triangular; the proximal border is markedly broader than the distal edge of the IBr_1.

The 10 arms are from 150 to 155+ mm. in length (in the specimens from stas. 4630 and 3357). The first brachials are short, not in contact with each other interiorly; there is a strong synarthrial tubercle on the line of union with the second brachials, which are approximately triangular. The first syzygial pair (composed of brachials 3+4) is roughly oblong. The following brachials to the second syzygial pair are of almost the same length, but more wedge-shaped. After the second syzygial pair there are two or three shorter discoidal brachials after which they become markedly triangular. In the distal half of the arms where the brachials have the distal ends thickened, finely spinous and overlapping, their form becomes again more wedge-shaped. Articular tubercles, less strongly developed than the synarthrial tubercles between the first two brachials, occur as far as the tenth or eleventh brachials.

Syzygies occur between brachials 3+4, 9+10 (exceptionally 10+11), usually 16+17 (sometimes 15+16, more rarely 14+15 or 17+18), and distally at intervals of usually 4, sometimes 3, more rarely 5, muscular articulations.

The disk is about 12 mm. in diameter.

P_1 is 18 mm. long, slender and flagellate, with 50 to 55 short segments. P_2 is somewhat longer and slightly stouter, 22 mm. long with 53 segments, almost of the same form but with slightly longer and somewhat thicker segments. P_3 is shorter, 17 mm. long, with 31 segments which are proportionately much longer. P_4 and P_5 are about the length of P_3 or slightly shorter, with 25 to 30 segments of which the proximal 5 or 6 are short and the remainder elongated. The remaining pinnules are slender and their segments, with the exception of the two first, are much elongated. The length of a pinnule on about the fifty-ninth brachial is 25 mm.

Description of the type specimen.—The centrodorsal is flattened hemispherical, with a depression at the dorsal pole.

The cirri are about LX, 33 mm. long, uniformly slender and laterally compressed; the cirrus segments are for the most part elongated, but the distal are shorter and sometimes bear a small terminal spine on the dorsal side.

The radials are visible, but short. The IBr_1 are short, narrowing distally, not in lateral contact. The IBr_2 (axillaries) are rhombic and broad.

The 10 arms are about 100 mm. long, very slender, with a very uneven profile from the base. The first brachials are short and not in contact. The second are irregular in shape and about twice as long. The first two brachials each carry a small lateral spine, that of the second lying closely beneath the base of the pinnule. The first syzygial pair (composed of the third and fourth brachials) is longer than the second brachial. The brachials following to the seventh are about as long as broad with strongly excavated surfaces. The second syzygial pair (composed of the ninth and tenth brachials) is of the same length as the first. The three following brachials are oblong, the form then becoming more trapezoidal, but never triangular. The brachials broaden somewhat distally and their distal edges, which in the distal half of the arms are somewhat spinous, strongly overlap the bases of those succeeding. At their bases the arms are dorsally rounded, becoming more flattened distally. They taper rapidly to about the fifteenth or twentieth brachial, more gradually from that point onward.

Syzygies occur between brachials 3+4, 9+10, 16+17, and distally at intervals of 3 or 4 muscular articulations.

The disk is about 7 mm. in diameter and bears scattered calcareous nodules.

P_1 is from 14 to 16 mm. long, flagellate and running out to a fine point, composed of 35 to 44 short segments of which the distal bear a sort of terminal comb. P_2 is similar, somewhat longer or of about the same length. P_3 is markedly shorter than P_2, composed of much fewer elongated segments and without a terminal comb. P_4 is about as long as P_3. The following pinnules very slowly decrease in length. The fourteenth pinnule is about 10 mm. long, and those in the distal half of the arms are a few millimeters longer.

Notes.—In the detached arms from *Albatross* sta. 4621 the brachials are wedge-shaped, all longer than broad, becoming elongate distally, with a finely serrate overlapping distal border which is more developed than in the specimens described. The distal intersyzygial interval is in four instances of 3, in eight of 4, in thirteen of 5, in seven of 6, in six of 7, in four of 8, in one of 9, and in one of 10 muscular articulations. The two proximal pinnule segments are relatively somewhat larger than in the other specimens and more expanded laterally; the first are shorter and more oblong, and the second are more distinctly trapezoidal.

A small specimen from sta. 4621 has an arm length of 75 mm. The cirri have 36 segments. The third syzygy is usually between brachials 16+17, but once between brachials 17+18, and the distal intersyzygial interval is 4 to 6 (usually 4) muscular articulations.

Localities.—*Albatross* station 3385; north of the Pearl Islands, Bay of Panama (lat. 7°32′36″ N., long. 79°16′00″ W.); 523 meters; temperature 7.72° C.; green mud; March 8, 1891 [Hartlaub, 1895; A. H. Clark, 1915]. Type locality.

Albatross station 4630; off Mariato Point, Panama; Mariato Point bearing N. 70° E., 51 miles distant (lat. 6°55′00″ N., long. 81°42′30″ W.); 1016 meters; temperature 4.72° C.; green sand; November 3, 1904 [A. H. Clark, 1908, 1915] (1, U.S.N.M., 36201).

Albatross station 4622; off Mariato Point; Mariato Point bearing N. 52° E., 66 miles distant (lat. 6°31′00″ N., long. 81°44′00″ W.); 1062 meters; green sand and rocks; October 21, 1904 [A. H. Clark, 1908, 1915].

Albatross station 3357; southwest of Mariato Point (lat. 6°35′00″ N., 81°44′00″ W.); 1429 meters; temperature 3.61° C.; green sand; February 24, 1891 [Hartlaub, 1895; A. H. Clark, 1915].

Albatross station 4621; off Mariato Point; Mariato Point bearing N. 55° E., 63 miles distant (lat. 6°36′00″ N., long. 81°45′00″ W.); 1062 meters; temperature 4.72° C.; green sand, mud and rocks; October 21, 1904 [A. H. Clark, 1908, 1915].

Albatross station 3424; off the Tres Marías Islands, Tepic Territory, Mexico (lat. 21°15′00″ N., long. 106°23′00″ W.); 1236 meters; temperature 3.33° C.; gray sand and black specks; April 18, 1891 [Hartlaub, 1895; A. H. Clark, 1915].

Geographical range.—From the Bay of Panama northward to the Tres Marías Islands, Tepic Territory, Mexico.

Bathymetrical range.—From 523 to 1429 meters; the average depth of habitat is 1032 meters.

Thermal range.—From 3.33° C. to 7.72° C.; the average temperature of the habitat is 4.8° C.

History.—This species was first mentioned by Mr. Alexander Agassiz (1891) in a letter written to the U.S. Commissioner of Fisheries, Col. Marshall McDonald, during the cruise of the *Albatross* off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California. In this letter he merely noted that comatulids had been secured off the Tres Marías Islands. In a subsequent letter (1892) he remarked that among the comatulids dredged between Central America and the Galapagos Islands yellow prevails, passing to a reddish tinge, or even to brilliant red, as the principal color. It is probable that the reddish and brilliant red individuals to which he referred were specimens of *Psathyrometra bigradata*, which was taken at two localities, and that the yellow ones were *F. tanneri* and *Fariometra parvula*.

In his account of the unstalked crinoids taken on this expedition Dr. Clemens Hartlaub (1895) included two species referable to the genus *Florometra, rhomboidea* P. H. Carpenter(now considered to be a synonym of *F. magellanica*), and *tanneri*, sp. nov.

The specimens included under the name *rhomboidea*, from *Albatross* stas. 3357 and 3424, he had at first considered as representing a new species. He gave a detailed description of them, based upon the single individual from sta. 3357, except for the cirri and pinnules which were described from the specimen from sta. 3424. This new species seemed to him to differ from P. H. Carpenter's description and figure of *rhomboidea* in several particulars. In Carpenter's figure the centrodorsal is bounded ventrally by a sharp and straight line; only the interradial angles of the radials are visible; and the IBr_1 seem to be in lateral contact and are, like the first brachials, "deeply incised." In all these details *rhomboidea* as described by Carpenter differed from his specimens, and therefore the latter seemed to him to deserve specific separation.

Later, however, he was able to study a specimen of *rhomboidea* in the Hamburg museum which had been collected by Dr. Rehberg in Smyth's Channel, and he then came to the conclusion that the apparent differences were due merely to the insufficiencies of Carpenter's figure. The Hamburg specimen agreed in every respect with those collected by the *Albatross;* he decided, therefore, that this species, *rhomboidea*, occurs on the Pacific coast of Central America as well as in the Magellanic region.

The individuals from the Tres Marías Islands differed more or less from that from sta. 3357, possibly, he remarked, because of the very different depth of the habitat. The former have a much more slender habitus, the synarthrial tubercles are only feebly developed while the articular tubercles are entirely lacking, and the brachials, especially the syzygial pairs, are more elongate.

Antedon tanneri from sta. 3385, which he described in detail, he said possesses an entirely different habitus from the form he called *rhomboidea*, and especially the strong serration of the profile of the arms is noteworthy. He described minutely the differences in the radial articular faces which he considered as especially significant. But none of the differences between the description of the specimens referred to *rhomboidea* and that of *tanneri* in the light of our present knowledge of the variability of the species of *Florometra* seem sufficient to warrant specific separation.

In 1908 I recorded as *rhomboidea* specimens from three additional *Albatross* stations 4621, 4622 and 4630, off the western coast of Central America obtained by the *Albatross* expedition to the eastern tropical Pacific from October 1904, to March 1905, under the direction of Mr. Agassiz. The specimens appeared to be practically identical with those described as *rhomboidea* by Hartlaub, but I had no representatives of true *rhomboidea* for comparison, nor any of those described by him under that name.

In a discussion of the species of this genus published in 1915, the specimens recorded by Hartlaub and by myself as *rhomboidea* were mentioned under the name of *Promachocrinus* (*Florometra*) *magellanica*, it having been found that *rhomboidea* is a synonym of *magellanica; tanneri* was maintained as a distinct species.

In a revision of the genus *Florometra* incorporated in the *Siboga* report in 1918, written after the examination of all the available material, including numerous examples of the Magellanic species in the museums of London, Paris and Hamburg, I considered *magellanica* (including *rhomboidea*) as a distinct species confined to southern South America; *tanneri* I admitted as a good species giving its range from southern California to Panama Bay in 102 to 711 meters, the extension resulting from the identification with it of some small specimens from southern California in the U.S. National Museum collection; and the individuals recorded as *rhomboidea* by Hartlaub and by myself I placed in the synonymy of *perplexa*. But I remarked that while *tanneri* appears to be distinct it may prove to "be the young of *perplexa* or of *serratissima*, or of both forms." These two last I now find to be synonymous.

FLOROMETRA ASPERRIMA (A. H. Clark)*

[See vol. 1, pt. 1, figs. 66 (not 67 as given in the legend), (p. 93), 225–226 (p. 243), 297 (p. 263), 391 (p. 307), 508 (p. 371); pt. 2, figs. 87, 98 (p. 62), 294 (p. 221), 333 (p. 227), 576–577 (p. 298), 769, 771 (p. 362)]

Antedon asperrima A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 73 (description; *Albatross* Sta. 3332); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (in Russian), p. 223 (English translation) (referred to *Florometra*).

Antedon rathbuni A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 76 (description; *Albatross* Sta. 5033); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 243 (=*Florometra laodice*).—Sowerby, The naturalist in Manchuria, Tientsin, vol. 5, 1930, p. 79.—A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (in Russian), p. 223 (English translation) (synonym or perhaps distinct variety of *Florometra asperrima*).

Antedon inexpectata A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 75 (description; *Albatross* Sta. 2853); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (in Russian), p. 223 (English translation) (synonym of *Florometra asperrima*).

Heliometra asperrima A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliometra inexpectata A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliometra rathbuni A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliometra glacialis biarticulata A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 231 (description; Tsugaru Strait?); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (in Russian), p. 223 (English translation) (synonym of *Florometra asperrima*).

Heliometra glacialis var. *biarticulata* A. H. Clark, Vid. Medd. Nat. Foren. København, 1909, p. 189 (?Shanghai; ?Tsugaru Strait; description); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 213 (very closely related to *H. glacialis*), p. 215 (Japanese arctic fauna; range and its significance).

Heliometra biarticulata A. H. Clark, Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range in eastern Asia); Die Crinoïden der Antarktis, 1915, p. 125 (comparison with related species), p. 127 (?Tsugaru Strait; ?Shanghai).

Florometra asperrima A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 141 (*Albatross* Sta. 3332).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 102, 1917, p. 20 (*Albatross* Sta. 3070; inorganic constituents of the skeleton).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 241 (in key; range), p. 243 (references), p. 244 (discussion).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 124, 1922, p. 17 (*Albatross* Sta. 3070; inorganic constituents of the skeleton).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 250 (with *Retiometra*); Explorations des mers de l'U.R.S.S., vol. 23, 1937, pp. 220, 221 (localities new and old; range), pp. 221, 222, pp. 223, 227, 228 (references), pp. 229, 230 (English translation) — Vinogradov, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (skeletal composition).—Baranova, Invest. Far East Seas U.S.S.R., No. 4, 1957, p. 152 (occurrence in Bering Sea; distribution), p. 248.

Florometra inexpectata A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 141 (*Albatross* Sta. 2853).

Florometra rathbuni A. H. Clark, Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (antarctic type; range and its significance); Die Crinoïden der Antarktis, 1915, p. 141 (*Albatross* Sta. 5032).

Heliometra eschrichtii var. *biarticulata* von Hofsten, Kungl. Svenska Vet.-Akad. Handl., vol. 54, No. 2, 1915, p. 12, footnote 2.

Florometra asperrima var. *rathbuni* A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (in Russian), p. 223 (English translation).

Diagnostic features.—So far as I can see the only character that separates this species from *F. serratissima* is the position of the third syzygy, which occurs between brachials 14+15.

* See also Addenda (p. 836) under 1962.

This character is by no means invariable, for the third syzygy on individual arms may fall anywhere from between brachials 12+13 to between brachials 16+17; but it is found to hold true in the great majority of cases.

Commonly associated with this species is the much smaller *Retiometra alascana* which bears a superficial resemblance to its young. *R. alascana* may be distinguished at once, however, by the very slender and greatly elongated P_1 which is twice as long as P_2 and is composed of greatly elongated segments with spinous distal ends, by the occurrence of a large gonad on P_2, which is of the same length as and similar to the succeeding pinnules, and by the distal intersyzygial interval of only 2 muscular articulations.

Description.—The centrodorsal is flattened hemispherical, 8 mm. in diameter at the base, with a deep pit at the dorsal pole 2 mm. in diameter. The sides of the centrodorsal, up to the borders of this pit, are entirely covered with cirrus sockets which decrease slowly in size distally.

The cirri are L–LXXX, 42–53, from 45 to 70 mm. in length, moderately stout. The first segment is about two and a half times as broad as long, the second is from half again to twice as broad as long, the third is slightly broader than long, and the fourth is as long as broad or somewhat longer than broad, while the fifth is slightly longer; the sixth and following are about twice as long as broad or slightly longer, the segments in the distal fourth of the cirri slowly decreasing in length so that the last two are about as long as broad. The opposing spine is represented by a small terminal tubercle. The terminal claw is longer than the penultimate segment, moderately stout and only moderately curved; it decreases rapidly in diameter in the proximal half, but much less rapidly in the distal so that the profile of the ventral surface is regularly convex, while that of the dorsal is a rounded angle. In the proximal half the cirrus segments have rather prominent ends and the ventral profile is slightly concave. In the distal half these features disappear, the segments acquire a polished surface, become gradually more compressed laterally, and the middle of the dorsal portion of the distal edge becomes prominent. On the last twelve segments the dorsal midline is roundedly carinate, ending distally in a prominent tubercle. The last three segments decrease slightly in size.

The distal edges of the radials are even with the border of the centrodorsal.

The IBr_1 are very short, not quite in contact laterally, five or six times as broad as the median length, the sides strongly converging distally and making an angle of about 90° with each other. The IBr_2 (axillaries) are about as broad as long, as wide as the base of the IBr_1 so that the lateral angles extend far beyond the anterolateral angles of the IBr_1, with a produced but truncated distal angle and a rounded posterior process which rises to a fairly prominent synarthrial tubercle on the border line between the IBr_1 and the IBr_2. The distal edge of the IBr_1 and the proximal and distal edges of the axillaries are rarely smooth; they are usually finely spinous, sometimes coarsely denticulate or spinous.

The 10 arms reach a length of 235 mm., and are composed of up to 330 brachials. The first brachials are almost triangular in shape, their short inner sides, which just meet over the anterior angle of the axillary, lying in the same straight line. The second brachials are triangular, with the distal border slightly longer than the other two, the interior angles almost meeting and forming a conspicuous opening bounded by the inner edges of the first brachials, lying in a straight line, and the inner edges of the second extending inward and upward from them at an acute angle. The first syzygial pairs (composed of brachials 3+4) are about twice as long inwardly as outwardly, and nearly twice as broad as long. The following five or six brachials are obliquely wedge-shaped, about twice as broad as long, with strong articular tubercles, giving the arm bases a very rugged appearance. Beyond the second syzygy the articular tubercles disappear, and beyond the third the brachials are triangular, about twice as broad as the median length, with prominent and finely serrate distal edges which become more and more marked distally.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 31 mm. long, composed of 63 segments, slender, and tapering gradually to a delicate and flagellate tip. The first segment is almost oblong, nearly twice as broad as long, with a slight angle in the middle of the distal border. The second is shorter, with the anterolateral angles broadly cut away so that the proximal edges make nearly a right angle with each other, with the ventral border rounded and the distal short and straight; the dorsal portions of the proximal and distal borders are armed with fine spines. The following segments decrease gradually in width and in the amount of the truncation of the anterolateral angles so that after about the eighth the segments in lateral view are almost square. The terminal twenty-five segments have the dorsal side produced into a rounded angle crowned with fine spines which on superficial examination to a certain extent simulate the teeth of the combs of the Comasteridae.

P_2 is 32 or 33 mm. long with 65 segments, resembling P_1 but not tapering quite so rapidly and hence less flagellate distally.

P_3 is 33 mm. long with 55 segments, resembling P_2 but with the segments beyond the proximal eight half again as long as broad instead of as long as broad.

P_4 is 34 mm. long with 44 segments, resembling P_3 but with the segments more elongated and the distal without the production of the dorsal border.

P_5 is 30 mm. long with 35 segments most of which are twice as long as broad.

P_6 is 28 mm. long with 32 segments which become three times as long as broad in the distal third and have the distal edge armed with very fine spines.

P_7 is 25 mm. long with 28 segments which have the distal ends slightly more prominent.

The following pinnules are similar, slowly decreasing in length so that the twenty-fifth is 23 mm. long with 32 segments which have the distal edges slightly everted and finely spinous.

The distal pinnules are 24 mm. long with 30 segments most of which are about twice as long as broad, becoming more elongate distally, with finely spinous distal ends.

Notes.—The preceding description is based upon an unusually fine specimen from *Albatross* station 3330, north of Unalaska in 642 meters.

In the type specimen of *asperrima,* which is from *Albatross* station 3332, north of Unalaska in 742 meters, the centrodorsal is hemispherical, 9 mm. in diameter, and the cirri are LXX, 50–60, from 50 to 53 mm. in length; the apical cirri are only half as large as the peripheral with half the number of segments, 25 mm. long with 25 to 30 segments, but in most specimens this dimorphism is not so well marked, the apical cirri being usually not very conspicuously smaller than the peripheral.

The arms are about 230 mm. in length and are composed of 250 to 300 brachials.

P_1 is 20 mm. long with nearly 100 very short segments. P_2 is 24 mm. long. P_3 is 25 mm. long with its component segments much longer than those in the two preceding pinnules. P_4 is 24 mm. long, P_5 is 23 mm. long, and P_6 is 20 mm. long, or the same length as P_1. The following pinnules decrease gradually in length to about the twelfth, then increase again. P_4 and the following pinnules bear gonads.

In the type specimen of *inexpectata*, from *Albatross* station 2853, in the Gulf of Alaska in 291 meters, the cirri reach 70 mm. and the arms 230 mm. in length. The proportions of the lower pinnules are very different from those of the proximal pinnules of the type specimen of *asperrima*. P_1 and P_2 are about equal in length, proportions, and number of component segments, but P_3 is shorter, frequently very much so, and P_4 is shorter still. The minimum is reached on the seventh or eighth pinnule beyond which the length gradually increases.

In the type specimen of *rathbuni*, from *Albatross* station 5033, in Yezo strait in 974 meters, which is considerably more robust than that of *asperrima* though only slightly more robust than the specimen described from *Albatross* station 3330, P_1, P_2 and P_3 are of equal length and P_4 is somewhat and P_5 much shorter.

In the abundant material at hand all possible intermediates between these types of pinnulation are found, while among very small specimens P_1 may be longer than those following.

The ossicles of the division series and arm bases never show the extreme development of spines frequent in *F. serratissima*, but the least spinous individuals of that species are less spiny than the extreme specimens of *asperrima*.

From Monterey, California, northward to the Gulf of Alaska *asperrima* is more variable than farther northward and westward, and apparently intergrades with *F. serratissima*.

Localities.—*Albatross* station 4538; Monterey Bay, California; Point Pinos Light House bearing S. 85° E., 6.5 miles distant; 1453–1592 meters; hard gray sand; May 31, 1904 (3, U.S.N.M., 35822).

Albatross station 4530; Monterey Bay; Point Pinos Light House bearing S. 78° E., 6.8 miles distant; 1380–1751 meters; soft gray mud; May 27, 1904 (23, U.S.N.M., 35847).

Albatross station 4537; Monterey Bay; Point Pinos Light House bearing S. 74° E., 7.4 miles distant; 1574–1941 meters; temperature 3.61° C.; hard sand and mud; May 31, 1904 (129, U.S.N.M., 35853).

Albatross station 4546; Monterey Bay; Point Pinos Light House bearing S. 46° E., 8.4 miles distant; 1552 meters; fine black sand and rock; June 3, 1904 (10, U.S.N.M., 35825).

Skidegate Channel, between Graham and Moresby Islands, Queen Charlotte group; 73 meters; 1895 (1, Victoria Memorial Museum).

Albatross station 4302; off Shakan, Sumner Strait, southeastern Alaska; Point Amelius bearing S. 80° W., 5.8 miles distant; 309–387 meters; temperature 6.78° C.; blue mud; August 24, 1903 (1, U.S.N.M., 35821).

Albatross station 2858; southwest of the Kenai peninsula, Alaska (lat. 58°17′00″ N., long. 148°36′00″ W.); 420 meters; temperature 4.33° C.; blue mud and gravel; August 24, 1888 (94, U.S.N.M., 35736, 35820, 35903, 35904).

Albatross station 2853; south of the Trinity Islands, Alaska (lat. 56°00′00″ N., long. 154°20′00″ W.); 291 meters; temperature 5.00° C.; gray sand; August 9, 1888 [A. H. Clark, 1907, 1915] (225, U.S.N.M., 21703, 35729, 35738, 35906, 35947, 36183, 36252, E. 1094).

Albatross station 3339; east of the Shumagin Islands (lat. 54°46′00″ N., long. 157°43′30″ W.); 252 meters; temperature 3.00° C.; mud and gravel; August 28, 1890 (76, U.S.N.M., 35732, 35824).

Albatross station 3340; east of the Shumagin Islands (lat. 55°26′00″ N., long. 155°26′00″ W.); 1270 meters; temperature 2.67° C.; mud; August 29, 1890 (1, U.S.N.M., 35980).

Albatross station 3255; north of Unimak Island, Aleutians (lat. 56°33′30″ N., long. 164°31′40″ W.); 79 meters; temperature 2.78° C.; green mud and sand; June 14, 1890 (1, U.S.N.M., 35798).

Albatross station 3332; north of Unalaska (lat. 54°02′50″ N., long. 166°45′00″ W.); 742 meters; sand and rocks; August 21, 1890 [A. H. Clark, 1907, 1915] (12, U.S.N.M., 22650, 35713, 35986). Type locality.

Albatross station 3316; north of Unalaska (lat. 54°01′00″ N., long. 166°48′45″ W.); 565 meters; temperature 3.44° C.; black sand and gravel; August 16, 1890 (10, U.S.N.M., 35781).

Albatross station 3331; north of Unalaska (lat. 54°01′40″ N., long. 166°48′50″ W.); 640 meters; mud; August 21, 1890 (33, U.S.N.M., 21702, 35782).

Albatross station 3330; north of Unalaska (lat. 54°00′45″ N., long. 166°53′50″ W.); 642 meters; temperature 3.22° C.; black sand and mud; August 21, 1890 (40, U.S.N.M., 35714, 35740).

Albatross station 3324; Umnak Pass, between Unalaska and Umnak Islands, Aleutians (lat. 53°33′50″ N., long. 167°46′50″ W.); 199 meters; coarse black sand, gravel and rock; August 20, 1890 (1, U.S.N.M., 35783).

Albatross station 4784; near Attu Island, Aleutians; East Cape, Attu Island, bearing S. 18° W., 4 miles distant (lat. 52°55′40″ N., long. 173°26′00″ E.); 247 meters; coarse pebbles; June 11, 1906 (14, U.S.N.M., 35799, 35981).

Gagara station 215; Okhotsk Sea (lat. 49°29′ N., long. 152°00′ E.); 1366 meters; bottom temperature 2.26° C.; Ushakov, 1932 [A. H. Clark, 1937].

Gagara station 216; Okhotsk Sea (lat. 51°10′ N., long. 154°17′ E.); 591 meters; bottom temperature 1.97° C.; Ushakov, 1932 [A. H. Clark, 1937].

Gagara station 250; Okhotsk Sea (lat. 54°53′ N., long. 144°00′ E.); 515 meters; bottom temperature 1.44° C.; Ushakov, 1932 [A. H. Clark, 1937].

Albatross station 5033; Yezo Strait, between Yezo (Hokkaido), the northernmost island of Japan, and Kunashir, Kuriles (lat. 44°04′20″ N., long. 145°28′00″ E.); 974 meters; temperature 2.17° C.; green mud and fine black sand; September 20, 1906 [A. H. Clark, 1907] (12, U.S.N.M., 22648, 35712).

Albatross station 5032; Yezo Strait (lat. 44°05′00″ N., long. 145°30′00″ E.); 548–974 meters; temperature 1.61°–2.17° C.; brown mud, fine black sand and gravel; September 30, 1906 [A. H. Clark, 1915] (2, U.S.N.M., 35786).

?Tsugaru Strait, between Yezo and Hondo (Honshu), Japan [A. H. Clark, 1908, 1909, 1913, 1915] (1, C.M.).

?Shanghai [A. H. Clark, 1909, 1913, 1915] (1, U.S.N.M., 36049).

Geographical range.—From Monterey Bay, California, in deep water, northward to the Aleutian Islands, southern Bering Sea, the Okhotsk Sea, and southward to Tsugaru Strait, Japan.

Bathymetrical range.—From 79 to 1574 (?1941) meters; the average of 22 records is 854 meters.

Thermal range.—From 1.44° C. to 6.78° C.; the average of 14 records is 3.18° C.

History.—During the *Albatross* cruise of 1906 I collected 28 specimens of this species, 14 off Attu Island in the Aleutians (sta. 4784) and 14 in Yezo Strait (stas. 5032 and 5033). Their brilliant yellow color and large size made them very conspicuous objects in the net, especially those taken in Yezo Strait which were considerably larger than those from Attu.

On commencing the intensive study of the crinoids after my return, I found in the U.S. National Museum no less than 659 specimens belonging to this species which had been accumulating as a result of the investigations of the *Albatross* in Alaskan waters. The species had first been discovered on August 9, 1888 (sta. 2853); most of the specimens had been collected during the summer of 1890.

In a preliminary paper published on September 17, 1907, I described as new *Antedon asperrima*, based upon some remarkably fine individuals from sta. 3332; *A. inexpectata*, based on specimens from sta. 2853; and *A. rathbuni*, based upon specimens which I had collected at sta. 5033 in Yezo Strait the preceding year and which still retained their bright yellow color. Marked differences in the proportions of the lower pinnules were supposed to separate *asperrima* from the other two forms, which were separated from each other on the basis of the number of cirrus segments, the shape of the brachials, and the greater or lesser development of articular tubercles.

These three nominal species were removed to the new genus *Heliometra* on its establishment later in 1907.

Among the collections of the Copenhagen Museum sent me for study I found a curious individual labeled as doubtfully from Tsugaru Strait which I took to be a specimen of a varietal form of *Heliometra glacialis* with the distal intersyzygial interval of 3 instead of the usual 4 muscular articulations; this I described in 1908 under the name of *Heliometra glacialis biarticulata*. In 1909 I again mentioned it, together with another similar one in the collection of the U.S. National Museum which had been purchased at Shanghai. On reexamination I find that the latter is identical with *rathbuni* from Yezo Strait, which is the same as *asperrima*. The former was returned to Copenhagen, but I have no doubt that it, too, is a specimen of *asperrima* which may well occur in the Tsugaru Strait.

In 1915 *asperrima, inexpectata* and *rathbuni* were removed to the new genus *Florometra*.

During the preparation of the *Siboga* report (1918) I again went over all the available specimens of the species of *Florometra* in the light of about ten years' additional experience with other forms, especially with *Heliometra glacialis*. It was now evident that *inexpectata*, in spite of the very different pinnulation, is a synonym of *asperrima*, and also that the specimens called *rathbuni* from Yezo Strait are very closely related to it, if not identical with it. These last, however, I united with the more southern *laodice* which I am now convinced is a synonym of *mariae*, while *rathbuni* is a synonym of *asperrima*.

In a memoir on the crinoids of the Okhotsk and Japanese seas published in 1937, this species was revised, and *Antedon rathbuni*, *A. inexpectata* and *Heliometra glacialis biarticulata* were included under *asperrima* as synonyms. Several new localities were given, with notes on the specimens from each. A complete list of previous localities was included, and the geographical, bathymetrical and thermal ranges were given, together with a general account of its associations.

FLOROMETRA AUSTINI sp. nov., A. M. C.*

Figure 16

Diagnostic features.—A species of *Florometra* with the basal segments of the oral pinnules markedly broadened but not carinate; P_1 usually has about 60 segments but the number varies from 45 to 78; it consists of segments which are not longer than broad, the distal ones being shorter and modified with dorsal processes into a distinct comb; the cirri are L–XCV with up to 59 segments and may be as much as 54 mm. in length, the longest segments about two and a half times as long as their proximal widths; the axillary has a very acute distal angle; the third syzygy is usually at brachials 14+15; the size is not known to exceed about 130 mm. arm length.

Description.—Holotype B.M. reg. no. 1958.5.2.1.

The centrodorsal is rounded conical with a very small dent in the center of the flattened apex. It measures 5.2 mm. in basal diameter by a vertical height (measured radially) of 4.0 mm. The cirrus sockets extend up the sides for more than half the height of the centrodorsal; they are arranged irregularly, sometimes in distinct vertical columns, or in diagonal columns or in alternating rows.

Most of the cirri are lost. Their number is estimated from the sockets as about LXXX. The longest peripheral ones have up to 53 segments and measure 45 mm. in length. Those towards the apex of the centrodorsal are progressively shorter, the apical ones having about 36 segments and measuring about 25 mm. In the large cirri the first two segments are broader than long. The third segment is as long as broad and the length increases to a maximum of two and a half times the proximal width (in side view) at about the twelfth segment. From here the length decreases until it is equal to the width at about the thirty-seventh segment (the sixteenth from the tip). The apical segments are very little shorter than broad. In shape the segments are at first slightly waisted but after about the tenth from the base the proximal enlargement of each is reduced so that the dorsal and ventral sides become parallel except for a distal eversion only a little marked on the ventral side but distinctly flared dorsally to become a small dorsal spine. On about the last 10 segments this spine disappears. The opposing spine and the terminal claw are both well-developed, sharp and hyaline.

The segments of the apical cirri are similar but proportionally shorter, the longest being about twice as long as broad.

The longest remaining arm is of 159 brachials and measures 120 mm. in length probably not more than 10 mm. has been lost. The arms taper more abruptly in the first third of their length than in the outer two thirds. The breadth at the first syzygy (3+4) is 1.9 mm., at the tenth syzygy (42+43) 35 mm. from the base it is 1.2 mm., and at the twenty-fifth syzygy (105+106) 75 mm. from the base it is 0.9 mm.

The length from the proximal edge of the IBr_1 to the second syzygy (9+10) is 10.5 mm. and to the third syzygy (14+15) 15.0 mm. The distal intersyzygial interval is usually three muscular articulations.

The position of the third syzygy is somewhat irregular; on 6 arms it is between

*This species has since been collected by the New Zealand Oceanographic Institute at station A.378 near the Antipodes Islands at 58 meters and by the Victoria University of Wellington at station 116 in Cook Strait, between the North and South Islands of New Zealand, at a depth of ca. 550 meters. These records are included in a paper on crinoids from New Zealand waters by A. M. Clark, now (April 1966) going to press; it also contains descriptions of two new species of the subfamily Perometrinae, one representing a new genus.

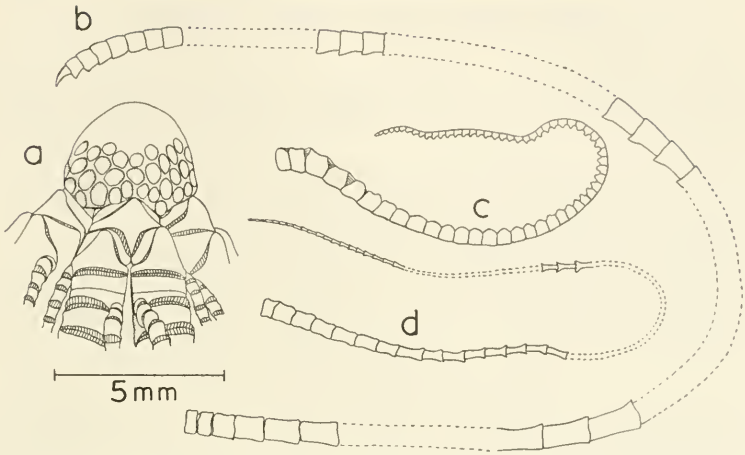

FIGURE 16.—*Florometra austini* sp. nov., holotype: *a*, Lateral view, division series foreshortened; *b*, peripheral cirrus of 54 segments; *c*, P_1; *d*, P_2 of paratype.

brachials 14+15, on two between 13+14, on another between 12+13 while on the last where the second syzygy is irregular at 7+8 the third is at 11+12.

The IBr_1 are very short. In direct dorsal view they are completely concealed by the expanded base of the centrodorsal and the well developed proximal angle of the axillary which forms a notable synarthrial tubercle. Even in dorsolateral view only a narrow strip of the IBr_1 is visible. The axillaries are rhombic and considerably wider than the IBr_1; their very short sides diverge distally. The distal angle is even more produced and acute than the proximal one and the two distal sides are also very concave. The length is 2.5 mm. and the maximum width 2.8 mm. The first brachials are very short and almost completely overlaid dorsally by the large proximal angle of the second brachials each of which forms a synarthrial tubercle even more prominent than that of the division series. The second brachials of each pair of arms are distinctly separated from each other although the first brachials are closely united. The first syzygial pair is much wider than long.

The edges of the brachials are everted and finely spinous but not markedly so.

P_1 has 68 segments and is 20 mm. in length. Most of them are tightly curled up towards the tip where the segments are very short. The basal 6 or 7 segments are notably stouter than the rest and taper more abruptly than the remaining three quarters of the pinnule. They are not noticeably carinate. None of the segments are longer than broad. From about the ninth segment onwards a knob appears on the distal end of the dorsal side which increases markedly in size in the outer half of the pinnule producing a comb very comparable to that of the Comasterids.

P_a is the longest pinnule with about 77 segments and measures 30 mm. in length. Its segments are relatively longer than those of P_1, all but the first few being longer

TABLE 7.—*Type material of* Florometra austini, *sp. nov., in the British Museum; the last three lines give the range and the average (in parentheses) of each column*

Centrodorsal		Breadth at first syzygy (mm.)	I Br_1 to second syzygy (mm.)	Cirri			P_1		P_2		P_a	
Diameter (mm.)	Height (mm.)			Number	Segs.	Length (mm.)	Segs.	Length (mm.)	Segs.	Length (mm.)	Segs.	Length (mm)
5. 2	4. 0	1. 9	10. 5	LXXX	54	45+	68	20	45+	22+	77	30
4. 7	4. 5	2. 0	11. 0	LXXX	43	35	60	19	49	22	65	26
4. 5	2. 7	1. 9	10. 0	–	50	40	53	20	28	14	68	27
5. 0	3. 5	2. 0	10. 5	XC	50	40	–	–	–	–	–	–
5. 0	3. 0	1. 9	10. 5	LXXV	42	38	52	18	–	–	–	–
4. 8	3. 0	1. 8	10. 5	LXXX	52	40	60	19	38	18	–	–
4. 0	2. 6	1. 8	10. 0	LXXV	94	36	60	17	47	20	–	–
4. 5	2. 7	1. 8	8. 0	LV	–	–	58	16	40	17	62	21
4. 5	2. 6	1. 8	10. 0	LV	54	52	65	18	23	13	68	26
4. 0	2. 2	1. 6	8. 5	–	42	36	45	14	43	18	–	–
5. 1	3. 0	1. 8	9. 5	LXII	48	35	58	17	46+	23+	60	22
5. 2	2. 4	1. 9	11. 0	LX	52	43	56	17	51	22	–	–
4. 2	2. 0	1. 7	8. 5	L	49	35	–	–	28	12	58	22
4. 0	1. 8	1. 6	9. 5	LII	45	30	55	15	42	15	64	23
5. 0	2. 7	1. 8	9. 0	LXV	45	35	66	16	38	16	60	22
4. 3	3. 3	2. 0	10. 5	LXXXV	54	42	58	20	52	23	65	25
5. 5	3. 0	2. 1	10. 0	L	–	–	50	15	42	18	–	–
4. 8	3. 0	1. 8	10. 5	–	50	45+	60	20	49	20	60	24
5. 0	3. 5	2. 2	11. 0	LXXV	–	–	48	23	45	18	70	28
4. 5	2. 7	1. 8	8. 0	–	55	47	65	19	33	14	64	32
4. 8	3. 4	2. 2	10. 0	LXX	54	40	60	17	–	–	76	35
5. 0	3. 5	2. 2	10. 5	XCV	–	–	60	18	21	16	70	27
5. 0	3. 2	2. 0	10. 0	LV	–	–	–	–	30	15	–	–
4. 2	2. 0	1. 7	10. 0	–	50	39	–	–	46	19	83	33
4. 0	2. 6	1. 8	10. 0	–	48	40	60	18	58	24	75	33
5. 0	3. 5	2. 1	9. 5	LXV	50	35	–	–	–	–	41	19
5. 0	3. 0	2. 2	10. 5	LXXIII	56	54	78	27	55	28	–	–
5. 2	3. 0	2. 0	10. 0	LXV	59	45	–	–	–	–	–	–
4. 6	3. 4	1. 9	9. 5	–	44	33	–	–	20	12	–	–
4. 5	3. 0	2. 0	9. 5	L	51	35	60	19	35	14	–	–
4. 0–	1. 8–	1. 6–	8. 0–	L–XCV	42–	30–	45–	14–	20–	12–	41–	19–
5. 5	4. 5	2. 2	11. 0	(LXV)	59	54	78	27	58	28	83	35
					(50)	(39)	(59)	(18)	(40)	(18)	(66)	(26)

than broad. The comb is much less marked, the distal edges of the outer segments being flared ventrally as well as dorsally. The basal segments are broadened as in P_1.

No P_2 is complete but the longest remaining one has 45 segments, probably less than 10 having been lost. It measures 22 mm. The segments are relatively longer than in P_1 or P_a. The basal segments are again enlarged.

P_3 is the first genital pinnule. It has 35 segments and measures 19 mm. P_{11} has 29 segments and measures 14 mm. P_{26} has over 35 segments and measures 15 mm. Most of the segments of the distal pinnules are about three times as long as broad with only a slight flaring at the distal end.

The disk is naked.

The color in life is given as "aboral side chrome yellow, arms dark orange."

Notes on the paratypes.—Some of the characters which can be enumerated are shown in the table. The blanks are due to loss, regeneration, concealment or irregularity (such as in the position of the third syzygy).

The proportions of the centrodorsal vary considerably. About 5 of the specimens have a distinct pit at the apex with consequent reduction in the height, but it is usually rounded conical or hemispherical.

The number of cirri does not appear to increase with size, several of the specimens with more massive arms having only the minimum number of cirri.

The synarthrial tubercles vary in development and may be even more exaggerated than in the holotype, completely occluding the IBr_1 and first brachial in the midline.

The greatest variation in the pinnules is in P_2. This may bear a small gonad but even so it may be comparable in length to P_1. However, there is obviously a tendency towards abbreviation when it is a genital pinnule since one specimen has at least one P_2 with no gonad, which has 38 segments and is 18 mm. long, while another P_2 bearing a small gonad has only 33 segments and is 14 mm. long.

P_3 is usually the first genital pinnule but it may be P_2 or P_4.

The ratio of basal diameter to vertical height of the centrodorsal in 15 of the specimens ranges from 1.0 to 2.2:1, averaging 1.7. The ratio of the length of the division series and first nine brachials to the width at the first syzygy in 20 specimens averages 5.3:1. This compares with an average of 7.0:1 in *F. mawsoni* where the arms are relatively narrower.

Since completing this monograph, I received two other specimens identifiable as *Florometra austini* from Prof. H. B. Fell at that time of Victoria University of Wellington. These were collected in Cook Strait at about 300 fathoms. Unfortunately both of them have every P_1 either broken or regenerating, but the original segments appear to have the same proportions as in the type specimens. The details corresponding to those given in the table for the better preserved specimen are as follows: Centrodorsal 4.5 mm. in basal diameter and 2.5 mm. in radial height (the shape rounded conical); arm breadth at the first syzygy 2.1 mm. and the length to the second syzygy 10.5 mm.; LXXII cirri, the only peripheral one seen having 40 segments and measuring 35 mm. in length; P_1 with up to 52 segments, with which number it is 16 mm. long, P_2 with over 36 segments and P_a with over 50 segments and measuring at least 21 mm. in length. There were probably some longer peripheral cirri present when the specimen was intact, which would bring the total within the range of 42–59 segments found in the type series of *F. austini*. An interesting abnormality is the bifurcation of a P_1 at the fifteenth segment, the two branches being aligned in the dorsoventral plane, each of them having an additional 22 segments, or thereabouts.

Localities.—*Discovery* Investigations station 2211; off Campbell Island, south of New Zealand (lat. 52°29.3′ S., long. 169°18.2′ E.); 159–157 meters; January 28, 1938 (2, B.M.).

Discovery Investigations station 2215; off the Antipodes Islands (lat. 49°45.6′ S., long. 178°48′ E.); 163–210 meters; February 19, 1938 (the holotype and 46 paratypes, B.M.). Type locality.

Victoria University of Wellington station 116; eastern end of Cook Strait, New Zealand; about 550 meters (2, B.M.; Victoria Univ.).*

* See footnote on p. 324 for extra record.

FLOROMETRA GOUGHI John*

FIGURE 17

Florometra goughi JOHN, *in* Vaney and John, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, pp. 665–667 (station, description), p. 667 (first crinoid from Gough Island); fig. 1, p. 666.

Diagnostic features.—Centrodorsal conical, with the bare dorsal pole very small; cirri very numerous, about a hundred and with up to 38 segments; no dorsal spines on the distal segments; longest proximal segments about two and a half times as long as broad; division series and brachials quite smooth; third syzygy at brachials 14+15; grows to a size of probably over 150 mm. arm length, with the width at the first syzygy over 3 mm.; P_1 with up to 52 segments, the distal ones modified into a distinct comb.

Description of the holotype (from John, 1939).—The centrodorsal is conical, rather swollen in the ventral two-thirds. The ventral diameter is nearly one and a third times the length. The ventral edge is produced into low wide corners interradially. The surface of the centrodorsal is thickly covered with cirrus sockets, arranged in alternating rows. The dorsal pole is very small.

The cirri are very numerous, well over C; 16–27. They decrease in number of segments and in length from the periphery to the apex. The peripheral cirri are 16–17 mm., the apical only 6 mm. long. The following is a description of a peripheral cirrus of 27 segments and 17 mm. long.

The first two segments are irregular, the first very short, the second only slightly broader than long. The third is slightly longer than broad, the fourth twice as long as broad. The fifth and sixth, the longest in the cirrus, are more than twice as long as broad. The third to sixth segments are slightly waisted. Beyond the sixth the segments slowly decrease in length, but all except for the last three or four are longer than broad. The tenth is about one and a half times as long as broad; the fifteenth is only slightly longer than broad; the twenty-fourth is as broad as long. The ventral edges of these segments are straight. The dorsal edges of the sixth to fourteenth are slightly concave; those of the more distal segments are at first straight and then convex, but no dorsal spine is developed. The distal end of each segment is wider than the proximal. The opposing spine is strong and bladelike, the terminal claw curved.

The small apical cirri are generally similar, but their segments are slightly more elongated. The longest, the fourth, is three times as long as broad.

The radials are entirely concealed in the midline by the centrodorsal; their lateral corners are visible. The IBr_1 are widely separated. Their breadth is equal to eight times their length in the midline. They are wider proximally than distally and are fairly deeply incised by the axillaries. The axillaries are as long as broad. The distal angle is considerably more acute than the proximal. The edges of these ossicles are quite smooth.

The following are the syzygial pairs on one of the more complete arms: 3+4, 9+10, 14+15, 19+20, 22+23, 27+28.

The first brachials are large and irregular and are in contact beyond the axillary. The interior edge is short, the exterior long; the anterior edge is incised by the backward projection of the second brachial. The second brachial is of an irregular shape with a strong backward projection incising the first. The first syzygial pair is wider

* See also Addenda (p. 837) under 1963.

than long; its interior edge is longer than the exterior. The brachials between the first and third syzygy are slightly wider than long; in each, one side, alternately the exterior and interior in successive brachials, is longer than the other. Immediately beyond the third syzygy the brachials are triangular and more elongate. The distal edges of all but the most proximal brachials are everted and finely spinous.

P_1 is of about 30 to 33 segments and 7 mm. long. None of the segments except for three or four in the region of the fifth is longer than broad. The dorsal edges of the proximal segments are raised into roughened protuberances, those of the middle segments into short spiny crests, while those of the distal segments are still more strongly produced so as to give the appearance of a rudimentary terminal comb. When examined under the microscope the comblike structure is seen to be of less dense stereom than the core of the segments. No other pinnule has this structure.

P_2 is a genital pinnule of 21 to 23 regular, cylindrical segments; it is about 8 mm. long, that is longer, although of fewer segments, than P_1. It bears a small gonad on the fourth to sixth segments. The first two segments are short, the third about as long as broad. The fourth is longer than broad. The remaining segments are about three times as long as broad with swollen and spinous distal ends. P_2 lacks an ambulacral furrow—it first appears on P_5.

There is no complete P_3. P_c is of more than 16 segments, all but the first three of which are elongated; it is about 9 mm. long. A long gonad lies on the fourth to seventh segments. P_f is of 16 segments, 9 mm. long, with a gonad along the third to eighth segments.

Sacculi of a bright yellow color and somewhat irregularly arranged are abundant along the pinnule ambulacra; they occur too on the lower genital pinnules which lack

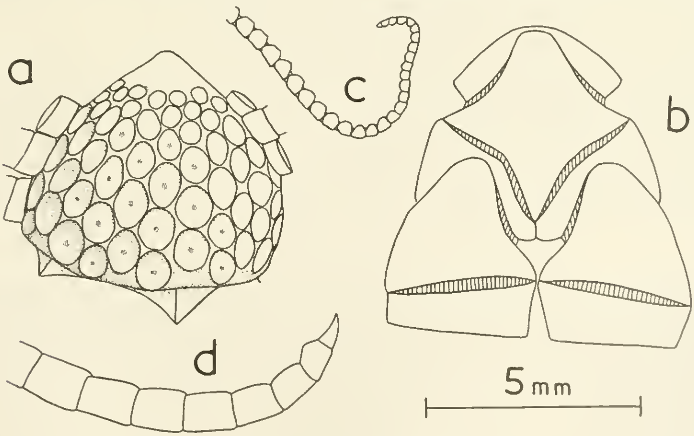

FIGURE 17.—*Florometra goughi* John, B.M., 1958.5.2.26–28, *Discovery* Investigations station 2493: *a*, Centrodorsal; *b*, division series and first two brachials; *c*, tip of P_1; *d*, tip of cirrus.

ambulacra and are particularly numerous on the oral pinnules (P_1 and P_a). They are far less abundant on the arms.

This specimen has all the arms broken. It is of medium size (presumably less than 100 mm. arm length, A. M. C.); the distance from the proximal edge of the IBr_1 to the second syzygy (brachials 9+10), is about 9 mm. The paratype has a broken centrodorsal and lacks any complete cirri, but its arms are more complete than in the type. It is a slighter, presumably a younger, specimen. The longest arm, which is not quite complete, is of 79 brachials and 45 mm. long. The syzygial pairs beyond the third, 14+15, are separated by two brachials.

The brachials beyond the third syzygy are triangular and as long as broad. Farther out on the arm they become at first wedge-shaped and then rectangular and longer than broad. The distal edges of the brachials, particularly of the outer, are everted and finely spinous.

P_2 exceeds the length of P_1 even more than in the type; P_1 is of 30 segments, 6 mm. long; P_2 is of 25 segments and 9 mm. long. P_2 carries a very small gonad along the fourth to sixth segments. The genital pinnules extend to P_{15} or P_{16}. P_7 is of 17 segments and 8 mm. long. The distal pinnules are about 9 mm. long and of about 20 segments, of which all but the first and second are more than twice as long as broad and have swollen distal ends. The sacculi are regularly arranged.

The ambulacral skeleton of the pinnules is very reduced. There are side plates in the form of smooth slender rods, straight or curved, two to three to each segment, along the outer segments of the distal pinnules. There are no spicules in the tentacles.

Notes [BY A.M.C.].—There are in the British Museum four large but broken specimens of *Florometra* from *Discovery* station 2493 on the Discovery Bank to the east of Gough Island, collected in 1938 and so not included in the *Discovery* report. Some details of these are given in table 8 (all dimensions in mm.):

TABLE 8.—*Details of four specimens of* Florometra goughi

Centrodorsal		Width at 1st syzygy	IBr_1 to 2nd syzygy	Cirri			P_1		P_2	
Diam.	Ht.			No.	Segs.	Length	Segs.	Length	Segs.	Length
5. 6	5. 0	2. 9	16. 5	c. XCV	—	—	—	—	—	—
6. 0	5. 5	3. 0	16. 5	XC	33	48	45	18	—	—
6. 7	6. 0	3. 4	18. 0	—	37	55	49	23	53	24
—	—	3. 2	17. 5	XC	38	60	52	23	39	18

The size is very much larger than that of the type specimens but the large number of cirri, the complete absence of dorsal spines on their distal segments, the relatively small number of these segments, the very small bare dorsal pole of the centrodorsal, the comblike distal segments of the P_1 and the smooth brachials coupled with the proximity of the two localities leave little doubt that these specimens should be included in *Florometra goughi*. The larger number of pinnule segments and size of the pinnules and the fact that P_4 is usually the first genital pinnule rather than P_2 are attributable to the much greater size. P_2 has very short segments like P_1 and the distal segments are similarly modified into a distinct comb. The longest cirrus segments are two and a half times as long as broad. The size of the proximal angle of the axillaries is variable.

It may be short and obtuse as in the type or considerably more acute and prolonged. The second brachials tend to be triangular in dorsal view, those of each pair approximating distally and forming a triangular space midradially with the tangential free border of the joined first brachials.

Localities.—*Scotia*, April 24, 1904; off Gough Island, South Atlantic; 183 meters [Vaney and John, 1939] (holotype, Royal Scottish M.; paratype, B. M.). Type locality.

Discovery station 2493; Discovery Bank (lat. 42°03.9′ S., long. 00°03.5′ E.); 472 meters; November 29, 1938 (4, B. M.).

FLOROMETRA MAWSONI A. H. Clark*

FIGURES 18,*c*,*d*,*g*,*h*,*j*; 40,*e*

Antedon antarctica (part) BELL, National Antarctic Exped., Nat. Hist., vol. 4, Echinod., 1908, p. 4 (*Discovery;* Winter Quarters).

Solanometra antarctica (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 61, No. 3 (*Discovery;* Winter Quarters).

Promachocrinus (*Promachocrinus*) *kerguelensis* (part) A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 130, bottom of page, pl. 4, figs. 1*a*, 1*b* (vicinity of Gaussberg, 222 fathoms).

Florometra mawsoni A. H. CLARK, Sci. Rep. Australasian Antarctic Exped., 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 5 (listed), p. 8 (in key), pp. 10–14 (description; localities; range; notes).—JOHN, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), pp. 125, 129, p. 132 (in key), pp. 144–148 (references; *Discovery* stations; description; distribution), fig. 3, p. 147, pl. 3, fig. 2; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 191 (listed), p. 192 (abnormality of one specimen with two arms fused at the first syzygy), pp. 198, 199 (references; *F. antarctica* a synonym; descriptive remarks).—VANEY and JOHN, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, p. 667 (comparison with *F. goughi*).—A. H. CLARK, Journ. Washington Acad. Sci., vol. 40, No. 10, 1950, p. 335 (references; locality).

Florometra antarctica JOHN, *Discovery* Reports, vol. 18, 1938, pp. 148–151 (localities; description; comparison with *F. mawsoni*); fig. 4, p. 149, pl. 3, fig. 3; Rep. B.A.N.Z. Antarctic Res. Exped., ser. B, vol. 4, pt. 6, 1939, p. 198 (synonym of *mawsoni*).

Diagnostic features.—A species of *Florometra* with XL–LXXVII cirri, having up to 34 segments of which the longest may be three times as long as broad and the distal ones usually have a very well-marked dorsal spine; the opposing spine is conical and the terminal claw slender and curved; the proximal brachials are more or less strongly spinous and everted towards their distal edges but in some specimens, particularly larger ones, this may be reduced and inconspicuous; the third syzygy is usually at brachials 14+15; P_1 has up to 50 segments of which the distal ones are slightly modified to form a rudimentary comb, giving the profile a scalloped appearance; the segments of the middle and distal pinnules are mostly hardly longer than wide.

[NOTE BY A.M.C.] Of the other southern hemisphere species of *Florometra*, *magellanica* differs from *mawsoni* in the position of the third syzygy and the larger size, *goughi* has very reduced dorsal spines on the cirri, which are also more numerous and *austini* has a better developed comb and more numerous segments in P_1 as well as more cirri also with more numerous segments, the dorsal spines again being less prominent than in *mawsoni*. All these three species are from subantarctic localities. I believe that *mawsoni* is more closely related to *Solanometra antarctica*, from Heard Island—an antarctic locality—as discussed further on pp. 339–340; the short segments of the distal

*See also Addenda (p. 837) under 1963, 1964.

pinnules and the prominent dorsal processes on the cirri are very similar (see fig. 18, p. 422). Most of the differences between them can be attributed to size.

Description.—The centrodorsal is moderate in size, flattened hemispherical, with numerous (from 60 to 80) cirrus sockets which are closely crowded and irregularly arranged, though on the apical half showing a tendency to become aligned in columns. Beneath each radial there are between 4 and 5 sockets, irregularly alternating higher and lower, one or more being smaller than the others.

The cirri are XL–L, 27–29, the longest 20–25 mm. in length. The first segment is very short, the second is from half again to twice as broad as long, the third is half again as long as its median width, and the fifth to seventh are about three times as long as their median width; those following very slowly decrease in length so that the outermost 14 or 15 are about as long as the distal width, except that the penultimate, which is narrower than those preceding, is from half again to twice as long as broad and the antepenultimate may be somewhat elongated. The third and following segments are constricted centrally with the dorsal and ventral (and also lateral) profiles markedly and evenly concave and the flaring distal ends overlapping the bases of the succeeding segments all around, though somewhat more strongly dorsally than elsewhere. As the segments decrease in length distally, the dorsal and dorsolateral portions of their distal borders become more strongly produced and at the same time finely spinous, with a prominent tooth in the middorsal line. On the short outermost segments the dorsal surface becomes sharply carinate. As a result of the production of the dorsal surface of the segments the dorsal profile of the outer half of the cirri is very strongly and conspicuously serrate (see fig. 18*c*, p. 422). The opposing spine is very small, low, conical, and subterminal in position, rarely somewhat elongated. The terminal claw is as long as, or longer than, the penultimate segment, and is very slender and only moderately curved.

The distal edges of the radials are even with the rim of the centrodorsal in the midradial line but curve strongly upward in the interradial angles where they are considerably produced outwardly, the general surface of the interradial triangle formed by the anterolateral portions of two adjacent radials being deeply sunken. The edges of the radials are very finely spinous.

The IBr_1 are exceedingly short and bandlike, between 6 and 8 times as broad as the median length, broadly chevron-shaped, with the lateral borders convergent distally. The lateral portions of the distal edge are more or less strongly armed with fine spines. The IBr_2 (axillaries) are rhombic, somewhat broader than long, with all the sides rather strongly and almost equally concave. Their lateral angles project for some distance beyond the obtuse anterolateral angles of the IBr_1. The anterior (distal) edges are finely spinous.

The 10 arms are about 85 mm. long. The first brachials are 5 or 6 times as long exteriorly as interiorly. From the inner side their distal border runs parallel to the proximal border to beneath the posterior projection of the second brachial, then turns distally and runs at an angle of about 45° with the proximal border to the outer distal angle. The distal edge is roughened with numerous very small spines, the roughening being broadest in the middle. The second brachials are very much larger than the first and are irregularly quadrate. Their outer border is about as long as the outer border of the first. A small area, roughly a right angled triangle with the hypotenuse coinciding with the distal border and the opposite angle proximal and median, is roughened with fine short spines. The first syzygial pair (composed of brachials 3+4) is almost oblong, but slightly longer interiorly than exteriorly, with the proximal and distal borders slightly concave. The central half of the distal border is somewhat produced and is armed with short spines, this production being broadest in the median line. The next 4 brachials are wedge-shaped with strongly concave ends, twice as broad as the median length, with the longer side about half again as long as the shorter. The distal border is abruptly everted, and the central half is strongly produced at right angles to the axis of the arm, forming (as viewed along the arm) a high rounded-triangular coarsely spinous process. Shortly after the second syzygy the brachials become very obliquely wedge-shaped with strongly concave ends, not quite so long as broad, with the distal border rather strongly but evenly produced and coarsely spinous. Distally the brachials become gradually less and less obliquely wedge-shaped, and toward the end of the arms somewhat longer than broad and slightly constricted basally. The coarsely spinous production of the distal edge is conspicuous to the arm tips.

Syzygies occur between brachials 3+4, 9+10 and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 10 mm. long, very slender, flexible and flagellate, and is composed of 36 segments of which the first is between 2 and 3 times as broad as long, those succeeding gradually increasing in length and becoming about as long as broad on the eighth and very slightly longer than broad on the thirteenth to fifteenth, the remainder being about as long as broad. The third to fifth segments have the outer edge (the edge toward the arm tip) somewhat swollen and produced into a roundedly angular blunt-edged process which on the next two segments is truncated and lower. The last 18 segments have the side toward the arm tip with a prominent rounded process which is minutely spinous on the crest, the distal profile of this portion of the pinnule being prominently scalloped as in *Anthometra adriani*. On the 6 or 8 segments preceding these, going toward the base of the pinnule, the swelling of the edge of the segments becomes more and more restricted to the distal end, and also progressively lower, finally disappearing altogether.

P_2 is of about the same length as P_1, but it is considerably stouter basally, somewhat less flexible, and is composed of only 30 segments. The first segment is twice as broad as long, trapezoidal, the second is longer with the proximal angles broadly truncated, the third is about as long as broad, and the ninth and following are about twice as long as the width of their proximal ends. Distally the segments become shorter again, the last 4 or 5 being about as long as their greatest width. On the tenth segment the median portion of the distal border of the side toward the arm tip becomes swollen and minutely spinous. On the succeeding segments this swelling rises in height and extends basally so that the end of each segment on the side toward the arm tip projects some distance beyond the base of the following segment, the dorsal profile running in a straight line from the apex of this production to the base of the segment. Gradually the maximum height of this projection moves basally, and on the last 4 or 5 segments it is about in the middle, so that the segments are seen to be provided, on the side toward the arm tip, with a conspicuous, evenly rounded, finely spinous, blunt-edged crest.

P_3 is 8 mm. long with 16 segments, somewhat stouter basally than P_2, less flexible, and tapering evenly from the base to the tip. The first segment is about 3 times as broad as long, the second is broader than long with the proximal angles broadly truncated, the third is nearly or quite half again as long as broad, the fifth is twice as long as broad, and those following slowly increase in length, becoming about 3 times as long as broad distally. The side of the segments toward the arm tip bears a rather broad roughened line of fine spines and a slight and inconspicuous tuft of longer spines at the distal end, while the distal ends of the outer segments are slightly produced and finely spinous.

P_4 is 7 mm. long with 16 segments, and resembles P_3.

The distal pinnules are about 15 mm. long with 25 segments which have a broad roughened or minutely spinular line along the side toward the arm tip.

Notes [BY A.M.C.].—The foregoing description is of one of the type specimens from *Aurora* station 2. In 1938 Dr. Dilwyn John gave some supplementary descriptive remarks based on the *Discovery* material. The arms of the eight specimens are from 50 to 110 mm. long. The cirri are XL–LXV, 16–31, but mostly 24–26. The fourth to seventh segments, which are the longest, are not so elongated as in the type specimen, but the distal segments are longer than described, that is they are longer than their distal widths.

The distal edges of the radials are produced into a thin liplike frill which may stand out at right angles or be curved farther backwards. It has the appearance of being formed of a row of spines, all but the points of which are connected by a web, and it is stronger on the sides than in the midline. The distal edge of the IBr_1 is produced into a similar thorny frill. The spinous processes may be small on, or absent from, the first and second brachials. They are strongest between the first and second syzygial pairs, where they stand out at right angles to the arm. On the brachials beyond the third syzygy they are forwardly directed but still coarse and strong. They persist to the end of the arm.

In the smallest adult specimen P_1 is of 25 segments, in the others of 28 to 39 segments and up to 12 mm. long. P_2 has from 24 to 38 segments. P_3 may be a whiplike oral pinnule, with heavier basal segments than the others, but in most of the specimens it is a genital pinnule. The earlier genital pinnules may be considerably shorter than the orals. The number of segments in the genital pinnules varies from 14 to 23, the proximal usually having a smaller number than the distal. All but the first two segments are longer than broad. The distal edge of each is produced into a row of spines. The distal pinnules are like the genitals but slightly longer, of 20 to 30 segments.

The disk is naked. Sacculi are abundant. In some of the specimens there is a single row of small fenestrated plates along each side of the ambulacral furrow in a few segments near the tip of the pinnules. They vary in number from about two to ten and when the bigger number is present, the more proximal are very small, the distal larger. In some specimens there are spicules in the tentacles. Both plates and spicules may be absent or one or both may be present.

One of the smaller specimens from the *Discovery* collections named *mawsoni* by Dr. John lacked the spiny processes on the proximal ossicles, as also did the three specimens which he described as a separate species—*Florometra antarctica*. In the following year the more abundant material of the B.A.N.Z.A.R.E. collection convinced him that these also come within the range of variation of *F. mawsoni*.

One of the three type specimens of *F. antarctica* has the arms about 95 mm. long. The centrodorsal is a large rounded cone closely covered with cirrus sockets arranged in regular or fairly regular columns. The dorsal pole is rounded and rough in two of the specimens, sunken in the third.

The cirri are LXIX–LXXVII, 23–32, usually 27–32. The cirri are long and strong, much longer in proportion to the length of the animal than in the types of *F. mawsoni*, particularly so in the largest specimen. The first two segments are short, the third is about as long as broad. The fourth is twice as long as broad and distinctly waisted. The fifth to about the ninth are about two and a half times as long as broad and faintly waisted. Beyond the ninth the segments gradually decrease in length though all are longer than broad. The distal segments possess a strong dorsal spine, the apex of which is subterminal. The opposing spine and the terminal claw are strong.

In the specimen with arms 95 mm. long, the basal rays are visible externally as small triangular plates. In the other two specimens, the largest and the smallest, only four basal rays are visible.

The radials are short, especially in the midline, because their distal edges are strongly concave. They are in apposition for the greater part of their length but the distal corners are free. The distal edge may be smooth or raised into a low, finely thorny ridge. The IBr_1 are longer than the radials, not in apposition laterally. The distal edge of each is raised on either side of the incision by the axillary into a thorny lip at right angles to the surface of the ossicle. The axillary is rhombic, wider than the IBr_1 with which it forms a prominent synarthrial tubercle; its distal egde is smooth but there are small spines on the free outer portions of its proximal edges. The inner edges of the first brachials are much shorter than the outer; they do not meet, or at most their corners meet, above the axillary; the distal edges are smooth or finely thorny. The second brachial forms a slight tubercle where it incises the first; there may be fine spines along part of its proximal edge but its distal edge is smooth.

The first syzygy normally occurs between brachials 3+4 but in one specimen it is between brachials 4+5 on one arm and 10+11 on another. The second syzygy is usually between brachials 9+10 but it also occurs between 8+9 and 10+11. Syzygies are numerous beyond the second with one to four brachials between the pairs.

The brachials between the first and third syzygial pairs are nearly rectangular, wider than long; those beyond are at first wedge-shaped and then triangular, a little broader than long; farther out on the arm they become rectangular, at first broader than long, then as long as broad.

In the two large specimens the distal edges of the brachials between the first and second syzygies are smooth. The first one to three of these brachials are smooth in the small specimen but the others are raised distally, in the midline only, into a group of spines much smaller and lower than those of the types of *F. mawsoni* but, like them, standing out at right angles to the arm. The distal edges of the brachials beyond the third syzygy are the same in all three specimens: they are produced into a row of strong forwardly directed spines.

The oral pinnules are longer and composed of a greater number of segments than in the types of *F. mawsoni* and the first genital pinnule is farther out on the arm. P_1 is of 44 to 50 segments and 16 mm. long; P_2 of 38 to 45 segments, 15 to 16 mm. long; P_3 of 35 to 43 segments, about 13 mm. None of the segments of the oral pinnules is much longer than broad; the proximal have spiny dorsal carinations which become reduced to low rounded protuberances on the segments at the tip of the pinnule. The first genital pinnule is P_4 or more often P_5. P_5 is of about 23 segments and 11 mm. long;

the gonad lies along the fourth to the tenth or eleventh segments. The other genital pinnules are of between 23 and 30 segments and up to 16 mm. long; the gonads usually lie along the third to eighth segments. All but the first two segments of the genital pinnules are considerably longer than broad. Their distal edges are beset with fine spines.

The disk is naked. Sacculi are abundant. None of the specimens shows any trace of an ambulacral skeleton. In the largest specimen there are many spicules, some smooth and rodlike and others branched, in the tentacles of the distal segments of the outer pinnules.

Dr. John thought *F. antarctica* was distinguished from *mawsoni* by having considerably longer oral and genital pinnules composed of a greater number of segments and by the absence of strong spiny ridges on the distal edges of the lower brachials. Also the cirri of the type specimens of *antarctica* are much heavier and longer than in *mawsoni*. However in 1939 he decided that these were all characters of older specimens of *mawsoni* and that the two could not be specifically distinguished. He found that, in general, the younger specimens have the lower brachials more spiny but there is great individual variation and an old specimen may be very spiny while a young one is nearly smooth.

Some very young specimens from B.A.N.Z.A.R.E. stations 40, 42 and 107 have very strong, deeply-serrate, finlike processes standing out at right angles from the distal edges of the IBr_1 and sometimes of the radials, strong groups of spines near the lateral corners of the axillaries and enormous spinous processes arising from the distal halves of the brachials. The various specimens have cirri composed of from 12 to 26 segments and P_1 of 11 to 19 segments.

An atypical specimen from B.A.N.Z.A.R.E. station 107 differs considerably from the rest, particularly in its cirri. These are of 26 to 33 segments and up to 36 mm. long. The third segment is half again as long as broad; the fourth to tenth are three to four times as long as broad. Thereafter the segments slowly decrease in length, but the most distal are twice as long as broad. The fourth to the tenth or twelfth are slightly constricted in the midline, and the distal ends are wider than the proximal. Beyond the twelfth or so the distal end increases in width so that it is considerably wider than the proximal, but there is no dorsal spine. The cirrus tapers at the extremity; the opposing spine is rudimentary, the terminal claw very short and but little curved.

Another specimen from station 107 shows a curious abnormality. On one ray the arms start normally but beyond the second brachials, each of which carries the usual pinnule, they are fused together by a large syzygial pair, common to both arms. Beyond it the ray splits again into two arms, each commencing with a syzygial pair, the two pairs being closely apposed. The epizygal of each pair carries a pinnule on the outer side.

The characters of the species can be summed up as follows.

The centrodorsal varies from low flattened hemispherical or broadly truncated conical in the larger examples, to conical with slightly swollen sides, usually about two thirds to three quarters as high as wide. The cirri are XL–LXXX, with up to 33 segments. The arms in fully grown specimens vary from about 70 to 110 mm. in length. P_1 has up to 50, but usually about 30, segments. P_2 is similar to P_1. P_3 may be the first genital pinnule but in larger specimens that is P_4 or even P_5.

Except in some of the larger specimens of arm length about 100 mm. and rarely in smaller ones, the proximal brachials either have the middle portion of the distal edge greatly produced into a thin rounded triangular deeply serrate finlike process at right angles to the axis of the arm, or there may be on the dorsal surface an abruptly elevated triangular area thickly studded with minute spines with the base occupying about the middle half of the distal edge and the more or less rounded apex on, or very near, the proximal edge. In a lateral view of the arms these elevated spinous areas appear as high rounded processes which are about their own width apart; but they may become much narrowed and restricted to the distal half or less of the brachials, in which case they appear as short and broadly rounded carinate processes.

TABLE 9.—*Details of some specimens of* Florometra mawsoni *in the British Museum (all measurements in mm.)*

Centrodorsal		Breadth at 1st syzygy	IBr_1 to 2nd syzygy	Cirri			P_1		P_2		Arm length
Diam.	Ht.			No.	Segs.	Length	Segs.	Length	Segs.	Length	
4.5	3.6	2.0	15.0	LXX	31	36	48	16	42	16	c. 100
4.5	3.5	2.3	16.5	LXV	32	48	49	16	43	15	c. 110
3.0	2.0	1.7	11.5	L	26	22	35	12	35	11	55++
3.6	3.0	2.0	12.5	LX	28	25	38	14	35	13	105
3.0	2.0	1.5	11.0	XL	23	20	–	–	25+	10	c. 80
4.5	3.5	2.5	15.5	LX	28	30	43	17	39	15	–
–	–	1.4	10.0	–	25	15	30	10	29	11	c. 70
4.0	2.0	2.0	12.5	–	30	28	–	–	–	–	–
4.2	3.5	2.5	16.0	LX	–	–	30	15	30	15	–
4.0	3.2	2.0	13.0	LVII	32	29	35	12	35	13	–
4.0	3.8	1.5	14.0	LX	32	26	–	–	–	–	–

Localities.—*Aurora* (Australasian Antarctic Expedition) station 2; Adelie Land (lat. 66°55′ S., long. 145°21′ E.); 581 meters; bottom temperature −1.8° C.; bottom, ooze; December 28, 1913 [A. H. Clark, 1937] (1, Australian M.; 1, U.S.N.M., E. 3052). Type locality.

Aurora station 12; Queen Mary Land (lat. 64°32′ S., long. 97°20′ E.); 201 meters; bottom, rock; January 31, 1914 [A. H. Clark, 1937; John, 1939] (11, U.S.N.M., E. 3054, E. 3056; 2, Australian M.)

Aurora station 10; Queen Mary Land (lat. 65°06′ S., long. 96°13′ E.); 594 meters; bottom temperature −1.65° C.; bottom, ooze; January 29, 1914 [A. H. Clark, 1937] (4, Australian M.).

Aurora station 9; Queen Mary Land (lat. 65°20′ S., long. 95°27′ E.); 439 meters; bottom temperature +1.38° C.; bottom, granitic pebbles, with a small amount of ooze; January 28, 1914 [A. H. Clark, 1937] (2, U.S.N.M., E. 3053).

Aurora station 8; Queen Mary Land (lat. 66°08′ S., long. 94°17′ E.); 219 meters; bottom, small granitic rocks, no ooze; January 27, 1914 [A. H. Clark, 1937] (6, U.S.N.M., E. 3055).

Aurora; no data [A. H. Clark, 1937] (2, U.S.N.M.).

Gauss (German Southpolar Expedition); vicinity of Gaussberg; 400 meters; bottom temperature −1.85° C.; February 15, 1903 [A. H. Clark, 1915] (1, Berl. Mus.).

Discovery Winter Quarters; Ross Sea; 326 meters [John, 1938] (1, B.M.).

Discovery, Mounts Erebus and Terror [John, 1938] (2, B.M.).

Terra Nova station 314; 5 miles N. of Inaccessible Island, McMurdo Sound, Ross Sea; 406–441 meters; mud [John, 1938] (4, B.M.).

Terra Nova station 316; off Glacier Tongue, about 8 miles N. of Hut Point, McMurdo Sound, Ross Sea; 348–457 meters; February 9, 1911 [John, 1938] (1, B.M.).

Discovery Investigations station 180; Schollaert Channel, Palmer Archipelago; 160–330 meters; mud and stones; March 11, 1927 [John, 1938] (3, B.M., including 2 syntypes of *F. antarctica*).

Discovery Investigations station 181; Schollaert Channel, Palmer Archipelago (lat. 64°20′ S., long. 63°01′ W.); 160–335 meters; mud; March 12, 1927 [John, 1938] (2, B.M.).

Discovery Investigations station 190; Bismarck Strait, Palmer Archipelago (lat. 64°56′ S., long. 65°35′ W.); 100–130 meters; mud, stones and rock; March 24, 1927 [John, 1938] (1, B.M.).

Discovery Investigations station 599; Adelaide Island (lat. 67°08′ S., long. 69°06′ W.); 203 meters; January 17, 1931 [John, 1938] (5, B.M., including one syntype of *F. antarctica*).

Discovery Investigations station 1652; Ross Sea (lat. 75°56′ S., long. 178°35′30″ W.); 567 meters; January 23, 1936 [John, 1938] (1, B.M.).

Discovery Investigations station 1660; Ross Sea (lat. 74°46′ S., long 178°23′ E.); 351 meters; mud; January 27, 1936 [John, 1938] (1, B.M.).

B.A.N.Z.A.R.E. station 40; off Enderby Land (lat. 66°12′ S., long. 49°37′ E.); 300 meters; January 17, 1930 [John, 1939] (3, B.M.).

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 180–209 meters; January 24, 1930 [John, 1939] (1, B.M., 2, Australian M.).

B.A.N.Z.A.R.E. station 42; off Enderby Land (lat. 65°50′ S., long. 54°23′ E.); 220 meters; January 26, 1930 [John, 1939] (11, Australian M.).

B.A.N.Z.A.R.E. station 97; off Knox Land (lat. 65°10′ S., long. 108°12′ E.); 474 meters; January 26, 1931 [John, 1939] (1, B.M.).

B.A.N.Z.A.R.E. station 98; off Knox Land (lat. 65°07′ S., long. 107°29′ E.); 502 meters; January 27, 1931 [John, 1939] (1, Australian M.).

B.A.N.Z.A.R.E. station 105; off MacRobertson Land (lat. 67°46′ S., long. 67°03′ E.); 163 meters; February 13, 1931 [John, 1939] (5, B.M., 2, Australian M.).

B.A.N.Z.A.R.E. station 107; off MacRobertson Land (lat. 66°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (10, B.M., 13, Australian M.).

U.S. Navy Antarctic Expedition, 1947–48; off Queen Mary Land (lat. 65°25′ S., long. 101°13′ E.); 183 meters; temperature −1.1° C.; January 14, 1948 [A. H. Clark, 1950] (1, U.S.N.M., E. 7973).

Geographical range.—Known from the shores of the Antarctic continent from Enderby Land (49° E.) eastwards to Adelie Land, the Ross Sea and the Graham Land area.

Bathymetrical range.—From 130 (? 100) to 594 meters.

Thermal range.—From −1.85° to +1.36° C.

Remarks.—In the British Museum there are several small comatulids collected by the *Discovery* at Winter Quarters of which I wrote in 1913 that they "are probably [*Solanometra*] *antarctica*, but their small size renders accurate determination difficult" and in 1937 that "it is quite likely that these will prove to represent the present species [*F. mawsoni*]." [Note by A.M.C.] The second suggestion was confirmed by Dr. Dilwyn John in 1938.

In 1915 I recorded and figured what I considered at the time to be a half-grown individual of *Promachocrinus kerguelensis*, with 5 rays and 10 arms which had been dredged by the *Gauss* in 222 fathoms (400 meters) in the vicinity of Gaussberg. In this specimen the cirri were said to be 52 mm. long with 33 to 37 segments. The centrodorsal is conical, 4 mm. broad at the base and 4 mm. high, and shows no resorption at the dorsal pole. The dorsal surface of the earlier brachials is thickly beset with fine spines.

This specimen was figured natural size (fig. 1*a*) and also twice natural size (fig. 1*b*). The original photographs were not very clear, and the background was blocked out by myself. While the larger figure does not show the scalloped profile so characteristic of the arm bases of this species, this is indicated in the smaller figure on the left side, so that it may have been inadvertently obliterated in the larger figure in the blocking-out process.

I am now inclined to believe that this so-called 5-rayed individual of *Promachocrinus kerguelensis* is in reality a specimen of *Florometra mawsoni*, and that the cirri described (52 mm. in length with 33 to 37 segments) may have come from a different individual.

[Notes by A.M.C.] Mr. Clark also left a comment concerning the resemblance of this species to the smaller *Challenger* specimens of *Solanometra antarctica* from station 150 off Heard Island which were named *Antedon australis* by Carpenter. Mr. Clark remarked that *mawsoni* is distinguished by the prominent eversion of the lower brachials and by the relatively longer brachials and axillaries.

The abundant collections of the *Discovery* Investigations and B.A.N.Z.A.R.E. led Dr. Dilwyn John to the conclusion that specimens which have the proximal brachials almost smooth (called *Florometra antarctica* by him at first) are not specifically distinct from those with strong ornamentation of the brachials, intermediate forms having been found. As for the relative width of the brachials, this depends to some extent on the size of the specimen, the width tending to increase with absolute size. In the largest type specimen of *australis*, with arms about 90 mm. long, the length from the IBr_1 to the second syzygy is 12.5 mm. and the width at the first syzygy is 2.0 mm., just as in the fourth specimen of *mawsoni* in table 9 above. However, in larger specimens there is some divergence since none of the four specimens of *mawsoni* in the table which have the length to the second syzygy 15 mm. or more have the width over 2.5 mm., whereas in the types of *Solanometra antarctica* where the length is 15 or 16 mm. the width is 3.2 to 3.3 mm. Two large specimens from off Adelie Land named *S. antarctica* by Mr. Clark have the length 17.5 to 19 mm. when the width is 3.0 to 3.2 mm. (see table 12, p. 426), but I am inclined to think that these should have been referred rather to *F. mawsoni*.

There are other points of resemblance between the types of *australis* and specimens of *mawsoni* of comparable size. In the former the cirri have up to 30 segments according to Carpenter (though all the cirri are now lost from the largest of the three). The longest segments are about two and a half times their proximal widths, as in *mawsoni* and there are well developed dorsal spines on the distal segments in both (see fig. 18, p. 422). P_1 in the largest *australis* has about 38 segments and measures 14 mm.

in length (compare with the fourth specimen in table 9 above). Finally the shape of the segments of the middle and distal pinnules is very similar in both, these being mostly almost as broad as long and expanded towards their distal ends (fig. 18*i,j*).

As for possible differences between *Solanometra antarctica* and *Florometra mawsoni*, following this comparison there appear to be only two. Firstly the centrodorsal is relatively higher in most specimens of *mawsoni*, the height being normally from two-thirds to three-quarters of the basal width, as opposed to just under two-thirds in the largest type of *australis* as well as in the types of *S. antarctica*. Secondly there are LXXV cirri in the largest *australis* (Carpenter's figure of L applying only to the smaller specimens) as opposed to rarely more than LX in *mawsoni* of similar size. Neither of these differences are of great significance and I am inclined to think that *mawsoni* is congeneric with *Solanometra antarctica*. The two specimens which I have seen collected by the Australasian Antarctic Expedition off Adelie Land and named *S. antarctica* by Mr. Clark seem to approach more closely to *mawsoni* considering their size, with relatively narrower arms, longer but fewer cirri and relatively higher centrodorsals than in the types of *S. antarctica*. A better range of specimens from the vicinity of Heard Island, the type locality of *antarctica*, is needed to clarify this issue.

Genus HELIOMETRA A. H. Clark.

Asterias (part) Phipps, A voyage toward the North Pole, 1774, p. 284.

Alecto (part) [Leach], Catalogue of the contents of the museum of the Royal College of Surgeons of London, pt. 4, fasc. 1, 1830, p. 14, and following authors.

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Comatula (*Alecto*) J. Müller, Abh. Preuss. Akad. Wiss. for 1847, 1849, p. 254.

Antedon (part) Loven, Ofvers. K. Vetensk Akad. Förhandl., 1866, No. 9, p. 224, and following authors.

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Helometra A. H. CLARK, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 229.

Diagnosis.—A genus of Heliometrinae in which the brachials are about as long as broad or longer and, like the elements of the division series, are without carinate processes or spinous borders; P_1 is composed of 50 to 100 segments of which only the terminal, if any, are longer than broad; P_2 is similar in size to P_1 (except in some very small specimens); the middle and distal pinnule segments are not much longer than broad; and there are five radials and ten arms.

Type species.—*Alecto eschrichtii* J. Müller, 1841 (a synonym of *A. glacialis* Owen, 1833). [NOTE BY A.M.C.] In checking on the proper nomenclature of the type species of this genus, I found that Mr. Clark was mistaken in thinking that Leach's catalogue of the museum of the Royal College of Surgeons, published in 1830, included a description of the digestive system on page 14 with the localities of the *Dorothea* and *Trent* specimens. It was Owen in the catalogue of the physiological series in the same museum, published in 1833, who included such a description under the heading of *Alecto glacialis.* Although this description was said to be of the digestive system of "the genus *Alecto*" it was clearly derived from Leach's specimens which were those in the museum of the Royal College of Surgeons. Strictly speaking, the anatomical description would fit most comatulids, but under the rules of nomenclature similar imprecise indications have been accepted as sufficient foundations for maintaining other specific names. *Alecto glacialis* can therefore be said to be valid, but with Owen as author, not Leach, who simply noted that one "was a very fine and perfect specimen" (a statement that cannot be construed in any way as a description) and gave two localities for his material. Since 1908, when Mr. Clark unfortunately revived the name *glacialis* Leach in place of the well-founded *eschrichtii* Müller, 1841, the majority of people, headed by Mortensen and Grieg, have adopted the name *Heliometra glacialis,* although in 1915 von Hofsten declared that *glacialis* is a *nomen nudum* and reverted to *eschrichtii* Müller, followed by Gislén (1923 and 1924) and Koehler (1924 and 1927). Accordingly in this monograph I am leaving Mr. Clark's terminology but am changing the name of the author of *glacialis* from Leach to Owen. Two specimens from the

Dorothea which could be designated as syntypes (since they were probably received from the Royal College of Surgeons) are in the British Museum collections.

Geographical range.—Arctic Seas and southward to the eastern shore of Hudson Bay, Georges Bank off Cape Cod, Iceland, the Faroe Islands, northern Norway and eastward along the coast of the USSR to Wrangel Island near the Bering Strait; also from the Okhotsk Sea south of 55° N. southward to the Korean Straits.

Bathymetrical range.—From 14 (?6)—1358 meters.

Thermal range.—From −1.90° C. to +5.80° C.

KEY TO THE SUBSPECIES OF HELIOMETRA GLACIALIS

a^1. Size up to 265 mm. arm length (Arctic Seas and south to Georges Bank off Cape Cod, the Faroe Islands, northern Norway and northern Siberia; 14–1358 meters)----**glacialis glacialis** (p. 342)

a^2. Size up to 350 mm. arm length (Okhotsk Sea south of 55° N. to the Korean Straits; 117–783 meters). **glacialis maxima** (p. 414)

HELIOMETRA GLACIALIS GLACIALIS (Owen)*

[See vol. 1, pt. 1, figs. 292–293 (p. 263), 393 (p. 307), 507 (p. 371), 511 (p. 373), pl. 1, fig. 526, pl. 4, fig. 545, pl. 5, fig. 557; pt. 2, figs. 233 (p. 193), 234, 239 (p. 197), 307 (p. 223), 345 (p. 229), 543–548 (p. 289), pl. 4, figs. 999–1000, pl. 34, fig. 1215, pl. 37, figs. 1226, 1231, pl. 45, fig. 1354]

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*See also Addenda (p. 836) under 1962.

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* Translated by Prof. R. B. Anderson of the University of Wisconsin from a series of letters to the "Dagbladet."

** Translated from Professor Sars' report on the North Atlantic Expedition of 1876.

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Heliometra glacialis f. *quadrata* GORBUNOW, Trans. Arctic Inst., Leningrad (in Russian), vol. 7, 1933, p. 42 (station), p. 50; vol. 8, 1933, pp. 10, 11, 36 (*Jermak* stations), p. 55.

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Diagnostic features.—The range of *H. glacialis* does not, so far as we know, overlap the range of any other species of this subfamily. In the northwest Pacific region, however, it may possibly be found to approach, or even to overlap, the range of some species of *Florometra*, from which it may be at once distinguished by the absence of spines on the distal edges of the brachials and on the borders of the ossicles of the division series and arm bases, by the absence of a rudimentary terminal comb on the outer portion of the proximal pinnules, and by the position of the syzygies of which the third is between the fourteenth and fifteenth brachials and the distal occur at intervals of typically 4 muscular articulations.

This species has frequently been confused with *Poliometra prolixa*, which has a similar geographical range, and with the species of *Hathrometra*, which in the Atlantic overlap the southern border of its habitat.

Heliometra glacialis is bright yellow in color, sometimes tinged with purple, while the species of *Poliometra* and of *Hathrometra* are grayish green to dull grayish white.

The centrodorsal in *Poliometra* and in *Hathrometra* is conical, about as high as broad, while in *Heliometra* it is flattened hemispherical and always broader than high; and in both these genera P_1 is greatly elongated, from 2 to 3 times as long as P_2, and composed of segments, all of which except the basal are greatly elongated with spinous distal ends.

Description.—The centrodorsal is large, up to 9.25 mm. broad at the base and about 7 mm. high, hemispherical with the dorsal pole flattened and sometimes more or less excavated and the surface elsewhere covered with closely crowded cirrus sockets which show no regular arrangement.

The cirri are LXXX–C, 40–60 (usually 45–55), the longest marginal from 55 mm. to 91 mm. long (usually between 60 and 70 mm.) and rather stout. The first four segments are very short, the following increasing in length to about the ninth or even to the thirteenth, which are from one third to one half again as long as broad, and then gradually decreasing so that those in the distal third of the cirri are somewhat broader than long. The short distal segments are slightly compressed laterally with a more or less sharpened median dorsal edge and their dorsal profile distally diverges slightly from the ventral, which is parallel with the longitudinal axis, so that the median portion of the dorsal end of each is higher than the base of the next succeeding, causing the dorsal profile of the distal portion of the cirrus as a whole to appear more or less distinctly serrate.

In any one specimen only relatively few of the cirri are of this type, the majority being shorter with fewer segments, regularly decreasing in length and in the number of the component segments from the margin of the centrodorsal to the region immediately about the dorsal pole.

The distal dorsal border of the radials is even with the edge of the centrodorsal throughout most of their width, but the distal corners are visible in the interradial angles. The IBr_1 are very short, the median portion in lateral view being concealed by the rounded posterior projection of the axillary, and their sides are almost or quite in contact with those of their neighbors basally, diverging distally. The IBr_2 (axillaries) are typically rhombic with the proximal angle more or less rounded and the distal angle acute and about as long as broad. However, they vary considerably in shape from rhombic to triangular, according to the extent of their posterior projection into the IBr_1; they may be somewhat longer than broad, but in most cases their width is equal to or slightly greater than the length, more than half of which is on the distal side of the line joining the lateral angles.

The 10 arms reach a length of from 240 to 265 mm. and are composed of more than 300 brachials. The first brachial is very short, twice as long outwardly as inwardly, deeply incised in the median line by a rounded posterior projection from the second, which is much larger and irregularly quadrate. The third and fourth brachials form together the first syzygial pair which is from half again to almost twice as broad as long. The following brachials are wedge-shaped, about twice as broad as the median length, after the second syzygial pair quickly becoming triangular, usually broader than long, sometimes about as long as broad, and distally wedge-shaped again and gradually elongate.

On the articulations between the earlier wedge-shaped brachials at the base of the arms, the region immediately adjacent to the ends of the apposed fulcral ridges is produced into a series of more or less prominent pointed tubercles, which alternate in position, giving the arm bases a singularly rugged appearance.

Syzygies occur between brachials 3+4, 9+10, 14+15 and distally at intervals of 3 or 4 (most commonly 4) muscular articulations. When the first syzygy is about 4 mm. wide the length from the proximal edge of the IBr_1 to the second syzygy is 18 to 20 mm. This corresponds to an arm length of 150 to 200 mm. When the length to the second syzygy is about 15 mm., the width at the first syzygy is 2.8 to 3.0 mm.

In young individuals the borders of the elements of the IIBr series and of the first two brachials are conspicuously spinous, and these ossicles also bear a low rounded spinous median carination. But after an arm length of usually from 80 to 100 mm. has been reached, these characters disappear and the borders and the dorsal surface of these segments, like those of all the succeeding brachials, become quite smooth.

P_1 is from 30 to 34 mm. long, and is composed of 75 to 82 short segments, of which the proximal eight to ten are much broader than long and more or less carinate on the distal side, and the remainder are usually about as long as broad. In the short proximal segments the distal and proximal borders of adjacent segments diverge from the median point of contact at an acute angle on either side so that the corners of the segments appear to be cut away, this feature becoming less conspicuous on the shorter distal segments. In the small terminal segments of the outer third of the pinnule the distal border of the segments is more or less produced into a rounded or blunted point so that the distal dorsal profile is more or less sharply serrate. The pinnule as a whole tapers rather rapidly, though evenly, in the proximal half, and becomes very delicate and flexible in the terminal third. P_2 closely resembles P_1. It is from 30 to 40 mm. in length, usually slightly longer than P_1, though commonly of the same length, and is composed of a slightly lesser number of segments. The carination of the proximal segments, the cutting away of their angles, and the serrate distal profile in the outer portion of the pinnule are usually very slightly less marked than in P_1; but examples of either of these are not definitely recognizable. P_3 is from 28 to 40 mm. long, but usually shorter than P_1 and P_2, composed of about 50 segments which are relatively longer than those of the preceding pinnules with their characteristic features much less marked. P_4 and P_5 are about as long as P_3, or very slightly shorter, reaching as a maximum from 30 to 35 mm. in length, composed of the same number of segments which are, however, of a more generalized type. P_6 is much shorter, about 16 mm. in length, composed of much fewer, about 28, segments, and P_7 is 12 mm. long with the same number of segments. From this point onward the pinnules slowly increase in length so that the distal pinnules are 30 mm. long and composed of about 40 segments of which the first is short and more or less crescentic, the second much longer and trapezoidal, diminishing in width distally, and the following are slender, mostly about twice as long as broad, becoming somewhat longer in the terminal third, but shorter again at the tip. The last six or seven segments bear on their dorsal side numerous spines, sometimes more or less hooklike, and the terminal has two or three groups of large hooks.

The very considerable variation in the development of the perisomic plating along the sides of the ambulacral grooves has already been described (Part 2, p. 268).

In some specimens the first two segments of the middle and distal pinnules bear carinate processes, causing them to appear abruptly larger than those succeeding.

In young individuals, with an arm length up to about 80 mm. or even 100 mm., the lower segments of the proximal pinnules are very finely, but conspicuously, spinous.

It is seldom that examples of this species are found so large and so well-developed as those just described, which are typical of the species in its most perfected form.

Color (in alcohol).—Dark brown, brick red, or light reddish or yellowish brown to gray or white, sometimes washed with violet in examples from Labrador. Small specimens from the Kola Fjord have the arms narrowly and regularly banded with more or less deep brown.

Characters of individual specimens.—Challenger station 48: According to P. H. Carpenter the numerous examples from this station are by no means so large and well developed as individuals which he has examined from higher latitudes, and notably those obtained in the Barents Sea by the Dutch Arctic expeditions. The arm length of these specimens does not exceed about 200 mm. and there are not more than 200 brachials. The cirri and the lower pinnules are also fewer jointed and shorter in proportion, while the arm bases are much less tubercular than in the more northern forms. Beyond the third syzygy the brachials are very distinctly triangular, but they are considerably wider than long, and this disproportion increases in the middle and outer parts of the arms so that the successive pinnules are very closely set, and it is only quite at the extremities of the arms that the brachials become at all quadrate.

Jones and Smith Sounds: The cirri in the larger specimens are up to 65 mm. in length and are composed of 51 segments. The diameter of the calyx reaches 32 mm. The relative length of the lower pinnules is very variable. In one individual the proportion between the P_2 and P_3 on three of the arms varies between 1:0.78 and 1:1.19; in another it varies between 1:0.66 and 1:0.85; and in a third between 1:0.72 and 1:0.92 on four of the arms. The calcareous plates in the perisome of the genital pinnules are relatively more feebly developed than in specimens from the North Atlantic, and are much more perforated and looser in structure. They also vary very considerably in form and in relative development. In young individuals they are less developed than in older ones, and whereas in the latter they form a continuous series in the former they are separated.

Willem Barents station 17, 1881: The cirri are 60 mm. long, composed of 50 segments, of which the 20 following the few short basal ones are longer than wide, though in gradually diminishing proportion. The radials are invisible, and but little can be seen of the IBr_1. The axillaries are diamond-shaped, about as long as broad, more than half of the length being on the distal side of the line joining the lateral angles. The tubercular ornamentation of the arm bases is strongly developed. The arms are 250 mm. long, composed of more than 300 brachials which are distinctly broader than long and triangular throughout until quite near the ends of the arms when they become quadrate, but never longer than broad. P_1 is about 30 mm. long; P_2 and P_3 are from 35 to 40 mm. long, P_2 being rather the longer, while P_4 falls to from 30 to 35 mm. The pinnules of the first four pairs have broad lower segments which are somewhat longer along the ventral than along the dorsal edge which is slightly sharpened and not in contact with those of adjacent segments. For the first 15 or 20 segments these pinnules taper rather rapidly, afterwards remaining tolerably slender and uniform until near their ends, and the segments retain indications of the sharpened dorsal edge which is produced in the later ones into a bluntly angular process giving the end of the pinnule a somewhat serrate appearance. After P_3 the length diminishes considerably, P_6 barely reaching 20 mm. The basal segments of the pinnules then become longer as well as broad, so as to support the large gonads, and the later ones are markedly longer than broad. The pinnules also taper more slowly and again increase in length, those in the middle of the arm reaching 30 mm., after which they diminish again. The dorsal surface of these middle and outer pinnules is nearly smooth.

Willem Barents station 18, 1881: A specimen nearly as large as that from sta. 17 was obtained here. The disk is 25 mm. across. The axillaries are not so much diamond-shaped as triangular with a posterior projection in the middle of the base forming the proximal angle, which is a good deal blunter than in that from sta. 17, its limbs being more horizontal so that a still larger proportion of the plate lies in front of the

TABLE 10.—*Details of some specimens of* Heliometra glacialis glacialis

Locality (or station nos.)	Arm length (mm.)	Cirri		P_1		P_2		P_3	
		Segs.	Length (mm.)	Segs.	Length (mm.)	Segs.	Length (mm.)	Segs.	Length (mm.)
Spitzbergen	235	63	102	48	23	51	24	–	–
Vøringen 223	–	56	91	58	27	54	25	55	29
M. Sars. 25	–	56	84	45	21	48	22	26	15
Tasiusak Fj.	c.240	–	–	75–82	30–34	74	30–33	51	28
do	237	45–48	62	50	20–22	48–9	23–25	29	16
Ingolf 116	c.200	53–54	65	42–43	19–20	50	23	20	11
do do	–	51–56	80	53	29	44–54	26–31	46	26
Vøringen 336	–	44	47	56	24	53	24	44	23
Upernivik	–	–	–	50–55	21–23	46–52	21–23	27–33	15–16
do	–	42–52	55–78	51	23	47–50	23	38–42	20–21
Disco Bay	175	–	–	53	22	54	25	32	19
do	–	–	–	42–44	21	50	22	39	17–18
do	170	45–50	55	45	18	43	21	34	17
Zarya 50	–	–	–	–	–	53	27	51	28
do do	–	–	–	–	–	–	20.5	–	15.5
do 48	–	–	–	–	–	50	25	47	23.5
do 53	–	–	–	–	–	51	25	47	22.5
do do	–	–	–	–	–	41	20	36	18
Helgoland 10	170	30–42	50	–	18–20	–	20–21	–	13–15
do do	165	37–44	55	–	22–26	–	23–27	–	15–20
do 6	170	30–44	50	–	21–23	–	22–23	–	18–21
M. Sars 87	–	38	39	–	–	37–54	16–23	40–41	16–19
do do	–	46	55	–	–	44	19	33	16
do do	–	48	56	–	–	37–47	16–20	23–37	11–16
do do	–	42	52	–	–	29–41	13–18	27–34	13–16
Ingolf 15	–	26	–	50	18	41	16	32	13
Vøringen 374	–	48	54	36–41	17–19	42	20–21	30–36	17–18
Helgoland 3	110	24–38	45	–	16–17	–	15–19	–	11–15
do 36	110	26–42	50	–	17	–	15	–	10
Kara Sea	110	42	50	42	17	42	17.5	18	8
do	100	–	–	33	14	36	15	21	9
do	80	35	26	31	11	31	11	21	8
Helgoland 34	90	20–32	30	–	11	–	10	–	6
E. Iceland	55	24–26	–	38	9.5	29	8	14	5
Zarya 46	–	31	23	–	–	20	7.3	15	5.5
do 53	–	31	23	–	–	28	10.5	12	5
Helgoland 25	40+	16–23	18	–	8	–	5	–	5
do 49	35	14–22	10	–	5	–	3	–	3
do 36	24+	14–21	10	–	5	–	3	–	2
Ranges	→240	21–63	10–102	31–82	5–34	20–74	3–33	12–55	2–29

line joining its lateral angles, and more of the IBr_1 is visible. Similarly the second brachial projects backward less strongly into the first, and the arm bases as a whole are less tubercular.

Willem Barents station 21, 1881: In the 10 specimens obtained here some of the axillaries are distinctly triangular, while others are as distinctly diamond-shaped, and there is more or less variation in form between the five axillaries of each individual. A similar indefiniteness prevails in the relative proportions of the lower pinnules, for both P_3 and P_4 may be much smaller than P_2, and more nearly equal than they are in the two large specimens from Stas. 17 and 18, while the basal segments of these lower pinnules have their distal ends considerably raised above the proximal ends of the following segments.

Willem Barents station 21, 1880: The 9 specimens obtained here are somewhat less mature than those dredged in 1881, and the arm bases are less tubercular, with relatively longer segments. Portions of the radials are visible in the angles of the calyx, as well as the whole of the trapezoidal IBr_1, which are much raised in the center and deeply incised to receive the strong posterior process from the middle of the base of the axillary.

Jan Mayen, 140–300 meters: In small specimens with arms from 40 to 60 mm. long the cirri have 20 to 28 segments. At the ends of the arms the two basal pinnule, segments which, in the fully grown are flattened and larger than those following, in the young appear rounded.

Jan Mayen, 150 meters, *Pourquoi Pas*? station 2041: Remy (1928) comments that Mortensen's figure (Medd. Grønl., 1900) of the tip of an ovigerous pinnule is inexact, showing the terminal segment as too long, the division between the last two segments probably having been omitted. Remy found that both specimens from Jan Mayen and the *Challenger* specimens examined by him have the last segment of the ovigerous pinnules almost twice as short as the preceding segment and with the form of a hook terminated by a few strong spines.

A number of specimens of arm length less than 100 mm. have been recorded with some development of ornamentation on the proximal ossicles. Eight specimens from Seydisfjord, Iceland, have the arms between 45 and 70 mm. in length; the smaller have the elements of the division series and the first two brachials spinous but the larger ones are almost entirely smooth. In one from *Ingolf* station 15, with arms only 26 mm. long, these same ossicles bear long spines on their borders. Other such specimens include one from Camp Clay, Cape Sabine, with cirri 13 mm. long, another from Tasiusak Fjord with arms 65 mm. long and others from the Kara Sea with arms 30 to 50 mm. long. Some specimens show a trace of median carination, at least on the division series, notably from *Alexander Kovalevsky* station 70, with arms 80 mm. long, station 58 with arms 40 mm. long, and station 56 with arms 30 mm. long.

Differences in the proportions of the proximal pinnules of different arms of the same individual have been observed. One from *Yermak* station 28, with arms 60 mm. long has on four different arms P_2 14.5 mm., 14 mm., 13 mm., and 14 mm. long with 37, 32, 28 and 34 segments respectively and P_3 8 or 9 mm., with 17 or 20 segments.

In general, larger specimens tend to have more of the proximal pinnules elongated and similar to P_1 than do small specimens. At an arm length of 50 to 100 mm., only P_1 and P_2 are much elongated, P_3 being abruptly smaller, but when the arms are over 200 mm. long the pinnules as far as P_5 or P_6 may be very long.

In some specimens, notably from Fylla, Disco Bay, Greenland, the basal segments of the proximal pinnules are strongly carinate.

The status of quadrata, barentsi *and* juvenalis.—In 1884 Dr. P. H. Carpenter diagnosed a new species which he called *Antedon quadrata*, giving as distinctive characters the shape of the lower brachials (after the fourteenth) which are as long as, or slightly longer than, wide and slightly quadrate in outline, while those in the middle of the arm are distinctly quadrate, the length bearing a large proportion to the breadth, and the later ones are somewhat elongated; the fact that none are shaped like an isosceles triangle and much shorter than broad; and the length of the pinnules of the third pair (on the sixth and seventh brachials) which are little more than half as long as those of the second pair, while the basal segments of all the proximal pinnules have their dorsal edges more or less produced into sharp flattened processes.

His specimens came from *Triton* stations 4 and 6, and he identified with these the *Tegetthof* specimen, also one which he himself collected off Disco during the cruise of the *Valorous*, two from Discovery Bay, and one from Franklin Pierce Bay dredged by Fielden in the *Alert*, some from *Challenger* station 48 off Halifax, and some from the *Willem Barents* collection dredged near the locality where the one taken by the *Tegetthof* was found.

He says that the three *Triton* specimens are all of them small, like those from the *Tegetthof* and *Valorous* collections, while they have a stiffer and less feathery appearance than the larger ones obtained farther north by the *Alert* and the *Willem Barents*. The dorsal processes on the lower segments of the basal pinnules are less prominent than usual, while the peculiar characters of the first two pinnule segments in the outer parts of the arms are by no means so marked as in larger individuals.

In 1886 Levinsen, basing his deductions on material secured in the Kara Sea by the *Dijmphna*, concluded that *quadrata* was merely the young of *glacialis*.

In the same year Carpenter discussed this form at considerable length on the basis of two specimens from *Willem Barents* station 21, 1880, and in the following year he again discussed it, describing some specimens which had been dredged by the *Varna*.

In the *Challenger* report Carpenter described *quadrata* in great detail. In his key to the species of the "*Eschrichti* group" he placed it, together with *barentsi*, in a special division, contrasted with all the other species through having P_3 composed of a few elongated segments and much shorter than P_2 instead of equal to, or not much shorter than, P_2. In this key *quadrata* is thus separated from *glacialis* ("*eschrichti*") by the species *antarctica* (=*Solanometra*), *australis* (=*Solanometra antarctica*), *rhomboidea* (=*Florometra magellanica*) *and magellanica* (=*Florometra*); and in the descriptive text *antarctica, australis* and *rhomboidea* are placed between *glacialis* and *quadrata*.

The characters of *quadrata* as given by Carpenter are: Centrodorsal hemispherical; cirri L–LXX, 30–35; several of the segments longer than wide, the later sharpened, but not distinctly carinate; radials very short; IBr_1 longer and trapezoidal, somewhat incised by the rhombic axillary which is as wide as, or wider than, long, with a fairly open distal angle, and forming with it a slight prominence. The 10 arms consist of about 200 smooth brachials, of which the first is rather deeply incised with a short inner and much longer outer edge, the second is irregularly quadrate, and the six following are more oblong or obliquely quadrate with the pinnule on the shorter side. The first three brachials above the third syzygy are sometimes nearly triangular and as wide as long, but those following are distinctly quadrate and gradually become longer than broad. The terminal brachials are somewhat elongated. P_1 and P_2 are long and flagellate, composed of numerous short segments, the basal wide and slightly carinate, sometimes with dorsal processes, the later serrate; P_3 little more than half as long as P_2, with much fewer segments, of which the basal are stouter and the remainder mostly much longer than wide. The following pinnules are more massive, with square segments which gradually become elongated. The two basal segments of the distal pinnules are flattened and trapezoidal in some forms, but only slightly modified in others. The ambulacra are not plated, but the disk sometimes bears a number of small calcareous granules.

Carpenter here repeats the discussion of this form given in 1884, adding that the radials are not entirely concealed by the centrodorsal but appear above it as short bandlike plates, and the IBr_1 have more sloping sides than in the smaller forms of *glacialis* so as to be trapezoidal in general outline, while the axillaries have a blunter distal angle and the articular tubercles are much less developed.

He writes that the relatively long quadrate shape of the brachials immediately after the third syzygy is less marked in the *Challenger* specimens of *quadrata* (from station 48), the southernmost ones known, than it is in the two obtained farther north by the *Triton* and in those from the Arctic Ocean; but the middle and outer brachials of the two species are always distinguishable, those of *glacialis* being short, generally triangular, and much wider than long till quite near the end of the arm, while those of *quadrata* are obliquely quadrate and the length is more nearly equal to the width.

Regarding the other special mark of *quadrata*, he notes that in large examples of *glacialis* from the Arctic Ocean P_3 is of almost exactly the same length as P_2, but in the western Atlantic representatives of *quadrata* (from *Challenger* station 48) it is distinctly shorter, and the southern forms of the two therefore approach one another in the characters of the pinnules just as in those of the brachials although the more northern varieties are entirely distinct in both respects.

He remarks that not only is P_3 in *quadrata* altogether smaller than P_2, but its component segments, while fewer in number, are also different in their relative proportions; the basal segments are stouter, as in the following genital pinnules, and their successors are distinctly longer than wide, indications of which appear in P_2. But there is no sign of this in *glacialis*, the segments of P_3 being as wide as or wider than long; furthermore there is generally less trace in *quadrata* of the modification of the two lowest segments in the distal pinnules which is usually so marked in *glacialis*, though it is extremely well-developed in a specimen taken by the *Varna* in the Kara Sea.

He gives measurements of P_2 and P_3 in a specimen of *quadrata* and in another of *glacialis* of equal size, P_2 in *quadrata* being 14 mm. long with 31 segments and P_3 8 mm. long with 17 segments (four-sevenths as long as P_2), while P_2 in *glacialis* is 15 mm. long with 39 segments, and P_3 12 mm. long with 28 segments (four-fifths as long as P_2).

He points out that *quadrata* has been dredged at 11 stations altogether, but at only 5 of these was it found in association with *glacialis;* the *Triton*, *Alert*, *Valorous*, *Tegetthof* and *Varna* obtained examples of *quadrata* at localities where *glacialis* did not occur, and in the last four cases there were only single individuals. He says that these facts would seem somewhat improbable if *quadrata* were merely an immature stage of *glacialis*, as supposed by Levinsen; and further that it is a common experience of Arctic dredging to find individuals of *glacialis* associated together in considerable abundance, and at various stages of development, and one would therefore not expect to find isolated examples of young individuals unaccompanied by older ones as is mentioned above.

It is evident throughout his discussion that Carpenter is not entirely satisfied with the status of *quadrata*. In his account of *glacialis* he pointed out that a small specimen of this species dredged by the *Triton* differed from the adults in the same way that *quadrata* does, and stated that therefore *quadrata* was to be regarded as a permanently immature form of *glacialis*. On the next page he uses the expression "if, indeed, the two species are not identical."

But he closes with the statement that his present impression is that we have to deal with two distinct species, the smaller of which represents a permanently immature form of the larger.

Answering Levinsen at considerable length again in 1891, he maintained the distinctness of *quadrata* and *glacialis*.

Rankin (1901) admitted *quadrata* as a species distinct from *glacialis*, but was doubtful regarding its validity. He says that he finds the differences between the two in the material examined by him to be very slight; but there are 5 specimens from Granville Bay which seem to belong to *quadrata*. Dr. Arnold E. Ortmann, who collected them, told him that in life there is a distinct difference in their appearance, but that this is less evident in the alcoholic material. The color of *quadrata* is lighter, and the arms have a less feathery appearance, due to the slightly greater length of the brachials and the consequently greater distance between the pinnules. The character of *quadrata* to which Carpenter gives specific weight, that is the shorter P_3 as compared with P_2, he could not find at all well marked, though its segments seemed, as Carpenter says, to be slightly longer than those of the same pinnule in *glacialis*.

Michailovskij in 1903 recognized *quadrata* as distinct from *glacialis*.

In 1904 Grieg discussed the status of *quadrata*, his studies being based upon a very large number of specimens collected by the *Vøringen* and by the *Michael Sars*.

He found that apparently in the young individuals the quadrate brachials are the most usual, while in the older and larger they are triangular; but between these two forms the intergradation is complete, while both may be present in the same individual. In specimens with triangular brachials their length is often as great as their width, even in old well-developed individuals in which the brachials are pronouncedly triangular in shape.

Regarding the relationships of the earlier pinnules, on which much stress was laid by Carpenter, Grieg found that the relative length of P_2 and P_3 in a number of specimens which he measured from *Michael Sars* station 10, 1900 (see table 11), which are all young, is as 1 : 0.50–0.81, the majority showing the very proportion which Carpenter considered typical for *quadrata*, that is, 1 : about 0.57; but there is a regular transition to the condition Carpenter considers characteristic for *glacialis*, 1 : about 0.80.

In the specimens from *Michael Sars* station 87, 1901, of which all but one are old individuals, the relation varies between 1:0.58 and 1:1.19. In most of them P_3 is four-fifths of the length of P_2, while in some it is even longer than that pinnule; but again there are others in all ways typical *glacialis* in which P_3 is no longer than it is in *quadrata*.

Confirming Michailovskij's observation regarding the great variability in the relative length and in the number of the component segments in the corresponding pinnules on different arms of the same individual, Grieg finds that the relation between P_2 and P_3 on the five arms of a single specimen varied from 1:0.58 to 1:1.00; in another

TABLE 11.—*Relation between P_2 and P_3 in 16 specimens of* Heliometra, *several arms of the last three having been examined*

[From Grieg, 1904, p. 16.]

	Michael Sars, *1900, Sta. 10*												
Largest cirrus:													
Segments	27	31	30	34	37	32	38	39	40	36	41	44	45
Length (mm.)	17	23	23	34	41	24	--	40	51	41	50	37	50
P_2 Segments	27	32	28	22	33	41	37	37	40	44	46	53	42
Length (mm.)	9	10	11	11	13	14	14	15	16	17	18	21	22
P_3 Segments	13	12	19	16	16	20	21	19	30	21	25	38	26
Length (mm.)	5	5	7	8	8	8	9	8	13	10	11	15	12
Length ratio, P_3/P_2	0.6	0.5	0.6	0.7	0.6	0.6	0.6	0.6	0.8	0.6	0.6	0.7	0.5

	Michael Sars, *1901, Sta. 87*												
Largest cirrus:													
Segments			48					42				38	
Length (mm.)			56					52				39	
P_2 Segments	37	39	43	40	47	29	31	36	36	41	37	51	54
Length (mm.)	16	16	18	19	20	13	15	17	17	18	16	22	23
P_3 Segments	32	33	31	23	37	29	27	30	34	31	40	40	41
Length (mm.)	16	14	15	11	16	14	13	14	16	15	19	19	16
Length ratio, P_3/P_2	1.0	0.8	0.8	0.6	0.8	1.1	0.9	0.9	0.9	0.8	1.2	0.9	0.7

from 1:0.83 to 1:1.08; and in a third, of which three arms were measured, from 1:0.69 to 1:1.19. On two arms of one of the specimens from *Vøringen* station 374 the relationship was 1:0.95 and 1:1.16.

Grieg finds that the IBr series of *quadrata* also differ somewhat from those of *glacialis*, though here again intergrades occur.

The genital pinnules in typical *glacialis* are relatively shorter and more robust than in *quadrata*, though not more so than can be accounted for through difference in age in the individuals concerned.

Grieg came to the final conclusion that Levinsen (1886) was correct in considering *quadrata* as a synonym of *glacialis*.

Döderlein says that *quadrata* can scarcely be maintained even as a variety of *glacialis*, with which it agrees in its geographical distribution. The *Helgoland* collection which he studied contained a large number of specimens from eastern Spitzbergen with an arm length of from 30 to 170 mm. The largest showed indubitably the characters of typical *glacialis;* the characters of the smallest are rather indefinite; those of medium size, with an arm length of about 100 mm. show in part more or less clearly the characters of *quadrata*, while others may be clearly recognized as *glacialis*. The strangest thing is that a close study of the specimens shows in some cases that individual arms of a single example belong to the *quadrata* type while other arms of the same one must without any question be determined as *glacialis*! He is firmly convinced that, as Levinsen said, no sharp line of demarcation can be drawn between them.

Michailovskij in 1905 still recognized *quadrata* as a distinct species. He said that although the most characteristic features, the relative length of P_2 and P_3 and the shape of the brachials, are sometimes very pronounced in the young of *glacialis*, some of the *Yermak* specimens are in this respect so very typical of *quadrata* that he prefers to assign them to this species until he is able to study more extensive material.

Kalischewskij in 1907 admitted *quadrata* as a variety of *glacialis*, and in my earlier work I recognized the form as valid, as stated by Mortensen (1910, p. 250).

Both Derjugin (1915) and Djakonov (1926) maintained *quadrata* as a separate species but in 1933 the latter followed Gorbunow (1932 and 1933) in reducing *quadrata* to a form or variety of *glacialis*. Gorbunow commented that the status of *quadrata* was doubtful and it might prove to be only a growth stage of *glacialis*.

In 1886, P. H. Carpenter described a new species, *Antedon barentsi*, of which the characters were given by him as follows: Centrodorsal hemispherical and thickly covered with cirri except at the dorsal pole; these do not reach 20 mm. in length, and consist of from 20 to 25 or 30 segments of which the fourth and the eight or ten following are longer than broad and overlap slightly on the dorsal side; the later ones are somewhat sharpened and carinate, but there is very little trace of an opposing spine on the penultimate. The radials are concealed. The IBr_1 are short, even at the sides, and only just visible in the middle line of the ray, as they are deeply incised to receive the strong posterior projections of the rhombic axillaries which are about as long as broad. The first brachials have long outer sides and short inner ones which are well separated above the axillaries. The second brachials are irregularly quadrate, projecting backwards into the first, but not so much so as to conceal them in the median line of the arm. The first syzygial pair is roughly oblong, and the next 6 brachials are quadrate with pinnules on the shorter sides, the longer sides being marked by posterior projections. The lower and middle brachials are triangular and about as wide as long, but farther out the length exceeds the width and the quadrate form is gradually assumed. The distal edges of the brachials are somewhat raised so that the dorsal surface of the arm is rather uneven. P_1 consists of some 30 segments and reaches nearly 15 mm. in length; the dorsal edges of the wide lower segments are cut away at the ends so as to be somewhat pointed while those of the following segments are sharpened, and traces of this sharpening appear on the more elongated later segments so that the end of the pinnule has a slightly serrate appearance. P_2 is much shorter than P_1, only reaching 8 mm. in length, and consists of about 20 segments of which the basal ones are larger than those of the preceding pinnules, while P_3 is still shorter, though with larger basal segments. The next following pinnules consist of longish segments, the lowest of which are very stout and the later slender. In the outer parts of the arms the pinnules are very slender and delicate with 15 segments. of which the 2 lowest are flattened and expanded and the remainder elongated. The gonads are fusiform, but not very long, only occupying about half the length of the pinnules which bear them. The 6 or 8 segments which support them have their outer sides produced upwards, and the perisome enclosing the gonads is thickly covered with very irregularly arranged calcareous plates. The plates are not very well defined, and are usually disposed quite irregularly. The calcareous network extends up into the edges of the food groove, but it does not form regular side- or covering-plates. There are gaps in it for the reception of the sacculi. Where these plates are absent, as at the ends of the ovarian pinnules and in the later pinnules of the arm, the calcareous network is still largely developed at the sides of the ambulacra, though without any regular arrangement into plates.

In 1903 Mortensen described and figured well-developed covering plates in *glacialis* from eastern Greenland, and showed that *barentsi* is merely a variety of *glacialis* with these plates more developed than is commonly the case.

In 1904 Grieg confirmed Mortensen's disposition of *barentsi.*

In 1905 Döderlein also confirmed the identity of *barentsi* with *glacialis,* and remarked that covering plates, more or less developed, are always found in *glacialis* except in the youngest specimens.

Michailovskij in the same year also assented to this interpretation of *barentsi;* he says further that *glacialis* is subject to great variation which apparently to a large degree is correlated with local ecological conditions.

In 1908 I described under the name of *Heliometra juvenalis* some very curious specimens from off Cape Raper, Davis Strait, in 109 meters (*Esquimaux* collection). The arms are 75 mm. long with the middle and outer brachials wedge-shaped and longer than broad. The cirri are XX–XXX, 15–20, from 10 to 12 mm. long. P_1 is 2 mm. long, with 4 or 5 squarish segments. P_2 is similar, but slightly longer. P_3 is still longer, with 8 segments. P_4 is 4 mm. long, with about 12 segments. P_5 is 6 mm. long, with 15 segments, mostly rather longer than broad, of which the third to fifth bear a large rounded gonad which is repeated on the following 14.

Mr. Rodger, in his account of the collection which he made while on the *Esquimaux,* says that at this locality he obtained crinoids in great numbers, including a species which he was assured by Canon A. M. Norman was new. Undoubtedly this was the form referred to.

These specimens scarcely resemble *Heliometra glacialis* in any detail of their structure, yet I am convinced that they are nothing but aberrant examples of this species. In *H. glacialis* of this size the ossicles of the IBr series and the lower brachials are spiny, whereas in these they are smooth. But they are also smooth in the variety *quadrata.* The lower pinnules are obviously stunted and functionless; the outer segments of these pinnules in *glacialis* being exceedingly small and delicate, it is possible that in these they have been destroyed by some acidity in the preserving fluid. The cirri, however, agree with the cirri of small *glacialis,* and this feature is sufficiently diagnostic to indicate their true identity.

Abnormal specimen.—Levinsen (1886) described a 9-armed specimen from the Kara Sea. In this (Part 2, pl. 37, fig. 1231) the first to fourth brachials on each of the two derivatives from one of the axillaries are approximately normal, though only one of the fourth brachials bears a pinnule, which is rudimentary. Beyond the two apposed fourth brachials is a single ossicle which covers the entire distal surface of both; following this is a series of five similar ossicles of dimishing size beyond which is a series of normal brachials.

Localities.—Northeastern part of Georges Bank; schr. *Martha and Susan;* Gloucester Donation 931 (3, U.S.N.M., 4912).

Western Bank; schr. *Mystic;* Gloucester Donation 806 (1, U.S.N.M., 35882).

Western Bank; schr. *Mystic;* Gloucester Donation 832 (3, U.S.N.M., 4849, 4850, 36027).

Western Bank; schr. *Mystic;* Gloucester Donation 867 (1, U.S.N.M., 4852).

Western Bank; schr. *Paul Revere*, August 1880; Gloucester Donation 800 (2, U.S.N.M., 35753; Y.M.).

Jeffries Bank; schr. *Paul Revere;* Gloucester Donation 926 (3, U.S.N.M., 4847, 4848).

Fishing Banks; schr. *Marion;* Gloucester Donation (1, U.S.N.M., 35894).

Fifty miles east of East Light, Sable Island; 512 meters [Verrill, 1882].

Albatross station 2518; off Nova Scotia (lat. 43°05′00″ N., long. 64°40′30″ W.); 110 meters; temperature 3.72° C.; July 12, 1885 (1, U.S.N.M., 35899).

Challenger station 48; Le Have Bank, southeast of Cape Sable, Nova Scotia, about 90 miles south of Halifax (43°04′ N. lat., long. 64°05′ W.); 93 meters; rock; May 8, 1873 [von Graff, 1884, 1887; P. H. Carpenter, 1888; Ganong, 1888; A. H. Clark, 1913] (9, M.C.Z., 56, 285; B.M.).

Eastern part of Le Have Bank; 91 meters; schr. *Rebecca Bartlett;* Gloucester Donation 461 [Verrill, 1882] (1, U.S.N.M., 35965).

Banquereau; 457 meters [Verrill, 1882].

Speedwell station 44; about 30 miles SE. ½ E. of Cape Sable, Nova Scotia (lat. 43°06′ N., long. 65°04.5′ W.); 165 meters; August 21, 1877 (5, U.S.N.M., 35766).

Speedwell station 47; about 22 miles SE. ½ S. of Cape Sable, Nova Scotia (lat. 43°10′ N., long. 65°12.5′ W.); 108 meters; August 21, 1877 (1, U.S.N.M., 9953).

Speedwell station 48; about 20 miles SE. ½ E. of Cape Sable, Nova Scotia (lat. 43°11′ N., long. 65°14.5′ W.); 108 meters; August 21, 1877 (1, U.S.N.M., 9954).

Speedwell station 49; about 18 miles SE. ½ S. of Cape Sable, Nova Scotia (lat. 43°13′ N., long. 65°17′ W.); 102 meters; August 21, 1877 (4, U.S.N.M., 9955, 35751, 35767).

Speedwell station 50; off Cape Negro, Nova Scotia (lat. 43°14′ N., long. 65°17.5′ W.); 82–91 meters; August 21, 1877 (2, U.S.N.M., 9956).

A little to the south of Halifax, Nova Scotia; 93 meters [P. H. Carpenter, 1881, 1884].

On the Anglo-American (Brest) cable [Honeyman, 1889].

Albatross station 2471; off Nova Scotia (lat. 44°34′00″ N., long. 56°41′45″ W.); 399 meters; temperature 4.67° C.; July 4, 1885 (1, U.S.N.M., 36205).

Seven to ten miles SE. of Little Hope Light, Nova Scotia; schr. *Proctor Brothers;* Gloucester Donation 257 (1, U.S.N.M., 5104).

Ten miles SE. by S. from Little Hope Light, Nova Scotia; 91–110 meters; schr. *Proctor Brothers;* Gloucester Donation 257 [Verrill, 1882] (3, U.S.N.M., 35963; Y.M.).

Speedwell station 118; about 9 miles SE. by E. from Chebucto Head Light (Halifax harbor), Nova Scotia; 97 meters; September 24, 1877 (1, U.S.N.M., 4958).

Speedwell stations 112–118; 8½ to 9 miles SE. by E. of Chebucto Head, Nova Scotia; 95–97 meters; September 24, 1877 (1, U.S.N.M., 9959).

Speedwell station 81; Chebucto Light, Nova Scotia, bearing N. ½ E., 9 miles distant; 104 meters; September 5, 1877 (1, U.S.N.M., 9957).

Albatross station 2429; off Newfoundland (lat. 42°55′30″ N., long. 50°51′00″ W.); 861 meters; temperature 3.72° C.; June 23, 1885 (5, U.S.N.M., 36208).

Albatross station 2697; off Newfoundland (lat. 47° 40′ 00″ N., long. 47° 35′ 30″ W.); 377 meters; August 12, 1886 (1, U.S.N.M., 14999).

Labrador [Wyville Thomson, 1873].

Outside Hebron, Labrador (about lat. 58°10′30″ N.); 110 meters; Owen Bryant, August 25, 1908 (13, U.S.N.M., 35755, 35966).

Outside Hebron, Labrador; 146 meters; Owen Bryant, August 26, 1908 (4, U.S.N.M., 35752).

Off Fish Island, outside Hebron, Labrador; 137 meters; Owen Bryant, August 25, 1908 (Fragments, U.S.N.M., 35754).

Half way between Cape Mugford and Hebron, Labrador; 110 meters; Owen Bryant, August 23, 1908 (1, U.S.N.M., 35964).

Godthaab station 14; off Labrador (lat. 55°00′ N., long. 56°34′ W.); 314 meters; bottom temperature 2.8° C. [Mortensen, 1932].

Calanus station 102; Forbes Sound, Hudson Strait (lat. 60°23.5′ N., long. 64°52′ W.); 90–130 meters [Grainger, 1955].

Calanus station 103; two miles west of Jackson Island, west of Port Burwell, Hudson Strait (lat. 60°24′N., long. 64°58′ W.); 145–275 meters [Grainger, 1955].

Calanus station 106; three miles west of Cape William Smith (lat. 60°21′ N., long. 64°58′ W.); 100–110 meters [Grainger, 1955].

Calanus station 222; south of Lake Habor (lat. 62°45′ N., long. 69°41′ W.); 80–90 meters [Grainger, 1955].

Calanus station 319; mouth of Frobisher Bay (lat. 62°21′ N., long. 65°16′ W.); 68–118 meters [Grainger, 1955].

Calanus station 322; 10 miles west of Countess of Warwick Sound (lat. 62°46′ N., long. 65°55′ W.); 119 meters [Grainger, 1955].

Calanus station 331; SW. of Countess of Warwick Sound (lat. 62°42′ N., long. 65°31′ W.); 77 meters [Grainger, 1955].

Calanus station 333; SW. of Countess of Warwick Sound (lat. 62°39′ N., long. 65°47.5′ W.); 104–137 meters [Grainger, 1955].

Calanus station 334; SW. of Countess of Warwick Sound (lat. 62°38′ N., long. 65°52′ W.); 183–192 meters [Grainger, 1955].

Hudson Bay; Richmond Gulf; about 28 meters; August 24, 1920 [A. H. Clark, 1922] (2, Victoria Mem. M.).

Loubyrne station 12; northwest side of Hudson Bay (lat. 61°53′ N., long. 91°37′ W.); 115 meters; mud; August 13, 1930 [A. H. Clark, 1937] (3).*

Loubyrne station 14; northwest side of Hudson Bay (lat. 62° 44′ N., long. 88°27′ W.); 111 meters; mud and stones; August 14, 1930 [A. H. Clark, 1937] (2).

Loubyrne station 22; west side of Hudson Bay (lat. 60°07′ to 59° 20′ N., long. 91°40′ to 93°04′ W.); 111–66 meters; mud; August 16, 1930 [A. H. Clark, 1937] (1+).

Loubyrne station 23; west side of Hudson Bay (lat. 59°13′ N., long. 91°00′ W.); 100 meters; mud and stones; August 20, 1930 [A. H. Clark, 1937] (1).

?*Loubyrne* station 53; northeast side of Hudson Bay (lat. 61° 19′ N., long. 80° 32′ W.); 161 meters; mud and stones; September 5, 1930 [A. H. Clark, 1937] (1).

Fram; Jones Sound; 14–64 meters [Grieg, 1907].

* The data for the *Loubyrne* stations are given in "Contributions to Canadian Biology and Fisheries," vol. 6, p. 470, 471, 1931.

Fram; Gaase Fjord, western end of Jones Sound (long. 89° W., between North Devon and Ellesmere Land) [Grieg, 1904].

Fram; bay to the south of Sjøpølse Ness; 30–40 meters; small stones with Laminaria March 7, 1900 [Grieg, 1907].

Fram; Winter harbor, Havne Fjord; about 60 meters; small stones and clay; July 8, 1900 [Grieg, 1907].

Fram; Winter harbor, Havne Fjord; about 60 meters; small stones with calcareous algae; July 21, 1900 [Grieg, 1907].

Fram; Winter harbor, Havne Fjord; about 60 meters; small stones and clay; July 22, 1900 [Grieg, 1907].

Fram; Winter harbor, Havne Fjord; about 40 meters; July 23, 1900 [Grieg, 1907].

Fram; mouth of Stor valley; July 30, 1900 [Grieg, 1907].

Fram; mouth of Stor valley; 60–64 meters; small stones and sand; August 1, 1900 [Grieg, 1907].

Fram; off Forvisnings valley; 40–44 meters; small stones and clay; September 19, 1900 [Grieg, 1907].

Fram; head of Gaase Fjord; 40–6 meters; small stones and clay; September 20, 1900 [Grieg, 1907].

Fram; head of Gaase Fjord; about 40 meters; small stones; August 2, 1901 [Grieg, 1907].

Fram; head of Gaase Fjord; about 14 meters; August 16, 1901 [Grieg, 1907].

Camp Clay, Cape Sabine, Ellesmere Land (on Smith Sound); Lieut. Greely, U.S. Army [A. H. Clark, 1907] (1, U.S.N.M., 22610).

Grinnell Land [Duncan and Sladen, 1877].

Morrissey station 4; 3 miles south of Salisbury Island, Hudson Strait [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 10; center of Fox Basin [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 16; off the eastern end of Cobourg Island (lat. 75°10′ N., long. 78°50′ W.) [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 17; off the eastern end of Cobourg Island (lat. 75°40′ N., long. 78°53′ W.) [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 32; Northumberland Island, Murchison Sound [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 33; Murchison Sound [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 43; Clavering Island [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station III; western Greenland, between Cape Alexander and Cape Chalon; 46–73 meters; rocky bottom; August 2, 1938 [A. H. Clark, 1940] (4, E.5758, E.5815, E.5825, U.S.N.M.).

Morrissey station VII; western Greenland, off Northumberland and Hakluyt Islands (approximately lat. 77°28′ N.); August 8, 1937 [A. H. Clark, 1940] (3, E.5843, U.S.N.M.).

Morrissey station VIII; western Greenland, Whale Sound; rocky bottom; July 28, 1937 [A. H. Clark, 1940] (4, E.5814, U.S.N.M.).

Morrissey station IX; western Greenland, Walrus grounds, Murchison Sound (approximately lat. 77°45′ N.); August 7, 1937 [A. H. Clark, 1940] (8, E.5844, U.S.N.M.).

Morrissey station XI; western Greenland, Walrus grounds, Murchison Sound (approximately lat. 77° 42′ N.); August 7, 1938 [A. H. Clark, 1940] (3, E.5845, U.S.N.M.).

Morrissey station XII; western Greenland, Walrus grounds, Murchison Sound (approximately 77°38′ N.); August 8, 1938 [A. H. Clark, 1940] (8, E.5841, E.5842, U.S.N.M.).

Morrissey station XIX; southeastern Greenland, off Cape Farewell; 110–128 meters; August 25, 1939 [A. H. Clark, 1940] (1, E.5729, U.S.N.M.).

Morrissey station XXI; off southeastern Greenland (lat. 61° N., long. 42°30′ W.); 146 meters; mud and pebbles; August 24, 1939 [A. H. Clark, 1940] (9, E.5735, U.S.N.M.).

Morrissey station XXV; northwestern Greenland; between the north shore of Parker Snow Bay and Conical Rock; 46–82 meters; mostly pebbles and shells; July 22, 1940 [A. H. Clark and Lockley, 1942] (fragments, U.S.N.M.).

Morrissey station XXVI; same locality and date [A. H. Clark and Lockley, 1942] (1, U.S.N.M.).

Morrissey station XL; northwestern Greenland; west side of Wolstenholme Island; about 23 meters; July 23, 1940 [A. H. Clark and Lockley, 1942] (1, U.S.N.M.).

Morrissey station LIII; northwestern Greenland; off the north shore of Wolstenholme Island; 24–46 meters; July 23, 1940 [A. H. Clark and Lockley, 1942] (5, U.S.N.M.).

Morrissey station LIV; same locality and date [A. H. Clark and Lockley, 1942] (5, U.S.N.M.).

Alert; Discovery Bay, Robeson Channel, Grinnell Land (lat. 81°41′ N.); 46 meters; hard bottom; 1875 [Duncan and Sladen, 1877, 1881; Nares, 1878; P. H. Carpenter, 1884, 1888; Mortensen, 1913, 1914; A. H. Clark, 1913] (3, B.M.).

Cape Louis Napoleon, just north of Franklin Pierce Bay [A. H. Clark, 1913] (3, B.M.).

Alert; Franklin Pierce Bay, western side of Smith Sound (lat. 79°25′ N.); 24 meters; 1875 [Nares, 1878; Duncan and Sladen, 1881; P. H. Carpenter, 1884, 1888; A. H. Clark, 1913; Mortensen, 1914] (5, B.M.).

Arctic Expedition, 1875–1876 (2, B.M.).

Arctic Expedition; coll. Hart (2, B.M.).

No locality (*Discovery* collection) (8, B.M.).

Greenland [J. Müller, 1841, and many succeeding authors] (20, U.S.N.M., 35749; M.C.Z., 54, 281, 282; B.M.; C.M.; Berl.M., 1046; Berg.M.; H.M.; Y.M.; L.M.; P.M.). Greenland, 110 meters (1, B.M.). Greenland, about 274 meters [E. C. and A. Agassiz, 1865, 1871]. (A specimen in the British Museum from "Greenland" was purchased in 1866 from Wright, and the catalogue records the fact that it formed part of a collection named by Lütken.)

Etah, Foulke Fjord, just north of Cape Alexander on the eastern side of the entrance to Smith Sound, Greenland; 73 meters; Crocker Land Expedition, August 21, 1914 (2, Amer. M.). Etah, with *Loxosomella antedonis*; Crocker Land Expedition [Osburn, 1919] (1, Amer. M.). Etah; dredged; Crocker Land Expedition, August 7, 1914 (8, Amer. M.). Probably Etah; Crocker Land Expedition (4, Amer. M.).

Greenland; Robert E. Peary collection (4, Amer. M.).

Princeton Arctic Expedition, 1899, station 26; south of Cape Alexander; 49 meters [Rankin, 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899, station 27; off Cape Chalon; 64 meters [Rankin 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899, station 29; Olriks Bay, Inglefield Gulf, lower narrows; 12–46 meters [Rankin, 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899, station 49; Olriks Bay, upper narrows; 27–36 meters [Rankin, 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899; Granville Bay, just south of Inglefield Gulf; 36–55 and 36–73 meters [Rankin, 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899, station 39; Granville Bay; 55–73 meters [Rankin, 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899, station 40; Granville Bay; 36–55 meters [Rankin, 1901; Mortensen, 1913, 1914].

Princeton Arctic Expedition, 1899, station 51; Robertson Bay, just north of Murchison Sound; 64–73 meters [Rankin, 1901; Mortensen, 1913, 1914].

Falcon; Murchison Sound, between Robertson Bay and Inglefield Gulf; 46 meters; mud, and rocky bottom with mud and sand [Ohlin, 1895].

Falcon; Inglefield Gulf and Murchison Sound; down to 109 meters [Ohlin, 1895].

Melville Bay (lat. 75°23′ N., long. 64°31′ W.); Olrik, 1858 [Mortensen, 1913, 1914].

Fox; Melville Bay; 146–174 and 256 meters [Walker, 1860, 1875].

Baffin's Bay; 37 meters (1, K.M.).

Upernivik District; Lieut. C. Ryder, October 2, 1887 [Mortensen, 1913, 1914] (3, U.S.N.M., 36150; C.M.).

Prøven, Upernivik District, just south of Upernivik; 91 meters; Olrik 1866 [von Graff, 1884; Mortensen, 1913, 1914].

Tjalfe; Umanak Fjord (lat. 70°45′ N., long. 52°21′ W.); 568 meters; 1909 [Mortensen, 1913, 1914].

Esquimaux; off Cape Raper, western side of Davis Strait (about lat. 70° N.); 110 meters; September 13, 1892; sand and small stones [Rodger, 1893; A. H. Clark, 1908, 1913] (2, M.C.Z., 283, 284; 3, and 2 pentacrinoids, B.M.).

Esquimaux; 10 miles southwest of Cape Wild, western side of Davis Strait; 365 meters; June 29, 1892 [Rodger, 1893].

Esquimaux; 3 miles off Coutt's Inlet, Davis Strait; 237 meters; muddy bottom; July 30, 1892 [Rodger, 1893].

Valorous station 1; Vaigat Strait, off Hare Island, just north of Disco Island (lat. 70°30′ N., long. 54°41′ W.); 320 meters; sand and mud; July 22, 1875 [Norman, 1877; P. H. Carpenter, 1884, 1888].

Fylla; Davis Strait, south of Holsteinsborg (lat. 66°32′ N., long. 55°34′ W.); 183 meters; 1884 [Holm, 1889; Mortensen, 1913, 1914].

Northern Strøm Fjord (about lat. 67°30′ N.); 35–46 meters; Dr. V. Nordmann, 1911 [Mortensen, 1913, 1914].

Tjalfe; south of Holsteinsborg (lat. 66°22′ N., long. 57°16′ W.); 686 meters; 1909 [Mortensen, 1913, 1914].

Fylla; south of Holsteinsborg (lat. 65°40′ N., long. 55°14′ W.); 468 meters; 1884 [Holm, 1889; Mortensen, 1913, 1914].

Fylla; Disco Bay; 256 meters; July 29, 1886 [Mortensen, 1913, 1914] (6, U.S.N.M., 36149; C.M.).

Kaksimiut; 36 meters; mud; Pastor Jørgensen [Lütken, 1857; Mortensen, 1913, 1914].

Davis Strait [A. H. Clark, 1911] (1, P.M.).

Ingolf station 35; Davis Strait (lat. 65°16′ N., long. 55°05′ W.); 662 meters; temperature 3.6° C.; July 18, 1895 (fragments, C.M.).

Tjalfe; Davis Strait, off Godhaab (lat. 64°40′ N., long. 56°37′ W.); 720–775 meters; 1909 [Mortensen, 1913, 1914].

Tjalfe; off Godhaab (lat. 64°22′ N., long. 56°06′ W.); 740 meters; 1909 [Mortensen. 1913, 1914].

Godthaab station 65; Baffin Bay (lat. 73°31′ N., long. 59°36′ W.); 225 meters; bottom temperature ±1.3° C. [Mortensen, 1932].

Godthaab station 86; Baffin Bay (lat. 76°36′ N., long. 68°54′ W.); 80–180 meters; bottom temperature ±0.1° C. [Mortensen, 1932].

Godthaab station 87 (lat. 77°05′ N., long. 71°13′ W.); 790 meters; bottom temperature ±0.4° C. [Mortensen, 1932].

Godthaab station 90 (lat. 77°17′ N., long. 69°59′ W.); 930 meters; bottom temperature ±0.4° C. [Mortensen, 1932].

Godthaab station 97 (lat. 78°15′ N., long. 73°29′ W.); 290 meters; bottom temperature ±1.05° C. [Mortensen, 1932].

Godthaab station 99 (lat. 78°14′ N., long. 74°10′ W.); 672 meters; bottom temperature ±0.5° C. [Mortensen, 1932].

Godthaab station 107 (lat. 76°25′ N., long. 69°38′ W.); 165 meters; bottom temperature ±1.2° C. [Mortensen, 1932].

Godthaab station 112 (lat. 76°37′ N., long. 74°18′ W.); 580 meters; bottom temperature ±0.5° C. [Mortensen, 1932].

Godthaab station 114 (lat. 76°40′ N., long 76°20′ W.); 85 meters; bottom temperature ±1.1° C. [Mortensen, 1932].

Godthaab station 116 (lat. 76°08′ N., long. 80°53′ W.); 80 meters; bottom temperature ±1.05° C. [Mortensen, 1932].

Godthaab station 166c; Totness Road, Exeter Sound; 100 meters [Mortensen, 1932].

Godthaab station 188; off the southern tip of Greenland (lat. 60°22′ N., long. 47°27′ W.); 120 meters; bottom temperature 5.8° C. [Mortensen, 1932].

Kangerdlugsuak, southeast Greenland; stations 1 and 12, August 1932; 80–100 meters [Heding, 1935].

Thule Expedition 1931–33; Lindenow Fjord, southeast Greenland; 300 meters; August 28, 1932 [Heding, 1936].

Thule Expedition 1931–33; off Narssak, Lindenow Fjord; 200–500 meters [Heding, 1936].

Thule Expedition 1931–33; Uttenthal Sound, southeast Greenland; 25–40 meters; clay bottom; August 22–28, 1933 [Heding, 1936].

Hedegaard, 1931–32; Angmagsalik, southeast Greenland [Heding, 1936].

Franz Joseph Fjord, East Greenland [Sparck, 1933].

Valorous station 6; Davis Strait (lat. 64°05′ N., long. 56°47′ W.); 750 meters; temperature +1.44° C.; sand and mud; August 10, 1875 [P. H. Carpenter, 1881, 1884, 1887, 1888; A. H. Clark, 1913] (1, B.M.). Same station, 852 meters (1, B.M.).

Brede Fjord; 250–450 meters; Stephensen, 1912 [Mortensen, 1913, 1914].

Rink station 45; Brede Fjord (lat. 60°36′ N., long. 46°47′ W.); 430–450 meters; temperature 4.0° to 3.4° C.; clay; salinity 34.7 per m.; July 18, 1912 [Stephensen, 1917].

Rink station 55; Brede Fjord (lat. 60°34′ N., long. 46°45′ W.); 310–330 meters; temperature 3.5° to 2.0° C.; clay with a few small stones; salinity 34.7–34.4 per m.; July 20, 1912 [Stephensen, 1917].

Rink station 69; Brede Fjord (lat. 60° 37′ N., long. 46°45′ W.); 290–355(?) meters; temperature 3.7° C.; clay; salinity 34.3–34.8 per m.; July 24, 1912 [Stephensen, 1917].

Rink station 97; Brede Fjord (lat. 60°49′ N., long. 46°18′ W.); 250–180 meters; temperature 3.0° C. to 3.2° C. stony clay; August 4, 1912 [Stephensen, 1917].

Rink station 121; Brede Fjord (lat. 69°32′ N., long. 46°51′ W.); 700 meters; clay; August 25, 1912 [Stephensen, 1917].

Belgica station 38; near Ile de France, off Germania Land, northeastern Greenland (lat. 77°35′ N., long. 18°15′ W.); 53 meters; temperature (at 50 meters) −1.79° C.; salinity 32.825 per m.; stones; July 29, 1905 [Grieg, 1907, 1909; Mortensen, 1913, 1914].

Belgica station 45; off Ile de France (lat. 77°31′ N., long. 18°34′ W.); 200–275 meters; temperature (at 210 meters) −0.29° C.; salinity 34.93 per m.; gray mud; August 3, 1905 [Grieg, 1907, 1909; Mortensen, 1913, 1914].

Danmark station 99; off Germania Land (lat. 77° N., long. 18°30′ W.); 304 meters [Mortensen, 1910, 1913, 1914] (1, C.M.).

Danmark station 63; Storm Bay, northeastern Greenland (lat. 76°45′ N.); 18–37 meters [Mortensen, 1910, 1913, 1914] (1, C.M.).

Belgica station 32; off King William Land, northeastern Greenland (lat. 75° 58′05″ N., long. 14°08′ W.); 300 meters; temperature +0.40° C.; salinity 34.82 per m.; brown and gray mud; July 24, 1905 [Grieg, 1907, 1909; Mortensen, 1913, 1914].

Frithiof station 18, 1900; off Shannon Island, northeastern Greenland (lat. 74° 30′ N., long. 18°40′ W.); 80–100 meters [von Hofsten, 1915].

Frithiof station 21; off northeastern Greenland [Gislén, 1923].

Frithiof station 25; off northeastern Greenland [Gislén, 1923].

Hekla; off Traill Island, northeastern Greenland (lat. 72°40′ N., long. 20°10′ W.); 183 meters; E. Bay; July 27, 1891 [Mortensen, 1913, 1914] (3, C.M.).

Frithiof station 16, 1900; east of Davy Sound, northeastern Greenland (lat. 72°25′ N., long. 17°56′ W.); 300 meters; stones and sand [von Hofsten, 1915].

Forsblad Fjord, northeastern Greenland (lat. 72° N.); 91–164 meters [Mortensen, 1913, 1914].

Antarctic; Cape Tobin on the northern side of the entrance to Scoresby Sound, eastern Greenland (lat. 70°30′ N.); 104 meters; 1900 [Mortensen, 1903, 1913, 1914].

Antarctic; off Henry Land, eastern Greenland (about lat. 69°30′ N.); about 36 meters; 1900 [Mortensen, 1903, 1913, 1914].

Antarctic; Turner Sound, Henry Land (lat. 69°30′ N.); 219 meters; 1900 [Mortensen, 1903, 1913, 1914].

Tasiusak Fjord, near Angmagsalik, eastern Greenland (lat. 65°39′ N.); 46–55 meters; June 1, 1889 (1, C.M.).

Tasiusak Fjord; about 91 meters; Chr. Kruuse, November 27, 1902 [Mortensen, 1913, 1914] (4, C.M.).

Jan Mayen [von Graff, 1884] (2+, W.M.; G.M.). Same. 128–165 meters (4, Berg. M.). Same, 137 meters (4, Berg. M.). Same, 140–300 meters and 180–400 meters [Fischer, 1886].

Michael Sars station 25, 1900; Jan Mayen; 100 meters; temperature −0.40° C.; August 8, 1900 [Grieg, 1904].

Michael Sars station 26, 1900; Jan Mayen; 100–150 meters; bottom, numerous alariae, laminariae and red algae; August 8–9, 1900 [Grieg, 1904].

Michael Sars station 29, 1900; Jan Mayen; 526 meters; temperature −0.1° C. to −0.2° C.; August 9, 1900 [Grieg, 1904] (2, Berg. M.).

Pourquoi Pas? station 20; south of Jan Mayen (lat. 70°52′ N., long. 10°33′ W.); 180 meters [Vaney, 1913].

Pourquoi Pas? station 72; near Jan Mayen (lat. 70°47′ N., long. 8°22′ W.); 140 meters [Vaney, 1914].

Pourquoi Pas? station 79; near Jan Mayen (lat. 70°58′30″ N., long. 8°07′ W.); 160 meters.

Pourquoi Pas? station 80; near Jan Mayen (lat. 70°58′30″ N., long. 8°42′ W.); 40 meters.

Pourquoi Pas? station 2041; northwest of Jan Mayen, one mile north of the Tour de Brielle; 150 meters; bottom, pebbles and volcanic sand mixed with mud; August 3, 1926 [Remy, 1928].

Ingolf station 116; south of Jan Mayen (lat. 70°05′ N., long. 8°26′ W.); 679 meters; temperature −0.4° C.; July 23, 1896 (9, C.M.).

Vøringen station 223; south of Jan Mayen (lat. 70°54′ N., long. 8°24′ W.); 128 meters; temperature −0.6° C.; dark gray sandy clay [Danielssen, 1892] (1, Berg. M.).

Iceland [Mortensen, 1913].

Ingolf station 15; off northwestern Iceland (lat. 66°18′ N., long. 25°59′ W.); 603 meters; temperature −0.75° C. (5, U.S.N.M., 36076; C.M.).

Off Iceland (lat. 66°16′ N., long. 25°20′ W.); 525 meters; Wandel, September 19, 1891 (2, C.M.).

Ingolf station 73; southwest of Iceland (lat. 62°58′N., long. 23°28′ W.); 889 meters; temperature 5.5° C. (fragments, C.M.).

North of Iceland (lat. 66°27′ N., long. 18°47′ W.); 420 meters [Einarsson, 1948] (Reykjavik M.).

East of Iceland (lat. 66°00′ N., long. 11°41′ W.); 280 meters [Einarsson, 1948] (Reykjavik M.).

Off Gerpir, eastern Iceland; 125–185 meters [Einarsson, 1948] (Reykjavik M.).

Southeast of Seydis Fjord, eastern Iceland, 247 meters [Einarsson, 1948].

Hvalsbaks Bank, eastern Iceland [Einarsson, 1948] (Reykjavik M.).

Litladjup, eastern Iceland; *c.* 210 meters [Einarsson, 1948] (Reykjavik M.).

Ingolf station 5; off southeastern Iceland (lat. 64°40′N., long. 12°09′ W.); 283 meters (8, U.S.N.M., 36077; C.M.).

Eastern coast of Iceland (4, C.M.). Same, 109 meters; Steincke, 1871 (1, C.M.).

Five miles southeast of Seydis Fjord, eastern Iceland; 247 meters; Wandel, September 29, 1890 (8, C.M.).

Thor station 52; east of Iceland (lat. 66° N., long. 11°41′ W.); 280 meters; clay, with stones and sponges; May 25, 1903 [Schmidt, 1904] (3, C.M.).

Ingolf station 4; east of Iceland (lat. 64°07′ N., long. 11°12′ W.); 433 meters; temperature 2.5° C. (5, U.S.N.M., 36147; C.M.).

Vøringen station 48; east of Iceland (lat. 64°36′ N., long. 10°22′ W.); 547 meters; temperature −0.3° C.; dark gray clay; August 6, 1876 [Danielssen, 1892] (8, and 2 pentacrinoids, Berg. M.).

Michael Sars station 10, 1900; east of Iceland (lat. 64°53′N., long. 10°00′ W.); 630 meters; temperature −0.69° C.; July 28, 1900 [Grieg, 1904] (about 30, Berg. M.).

Between Iceland and the Faroe Islands (lat. 62°43′ N., long. 10°26′ W.); 731 meters; Michael Sars (1, Berg. M.).

Ingolf station 3; between Iceland and the Faroe Islands (lat. 63° 35′ N., long. 10°24′ W.); 497 meters; temperature +0.5° C. (9, C.M.).

Michael Sars station 99, 1902; between Iceland and the Faroe Islands (lat. 63°14′ N., long. 9°46′ W.); 480 meters; temperature 3.12° C.; mud with sand; August 27, 28, 1902 [Grieg, 1904] (1, Berg. M.).

Triton station 4; southwest of the Faroe Islands (lat. 60°22′40″ N., and 60°31′15″ N., long. 8°21′00″ W. and 8°14′00″ W.); 598–786 meters; temperature −1.11 to −0.28° C. [P. H. Carpenter, 1884, 1888; Bell, 1892; A. H. Clark, 1913] (2, B.M.)

Michael Sars station 75, 1902; southeast of the Faroe Islands (lat. 60°10′ N., long. 6°35′ W.); 1220 meters; temperature −0.41° C.; fine brownish black sand; August 11, 1902 [Grieg, 1904] (8, C.M.; Berg.M.).

Faroe Islands, June 12, 1902 [Mortensen, 1913] (1, C.M.).

Porcupine, 1869–1870; in several hauls in the cold area of the channel between Scotland and the Faroe Islands [Wyville Thomson, 1872]. Cold area, Faroe Channel; *Porcupine* [W. B. Carpenter, 1870; Wyville Thomson, 1873].

Faroe Bank (lat. 60°58′ N., long. 8°37′ W.); 160 meters [Lieberkind, 1929].

Porcupine station 57, 1869; southeast of the Faroe Islands (lat. 60°14′ N., long. 6°17′ W.); 1156 meters; temperature −0.86° C.; August 1869 [P.H. Carpenter, 1884, 1888; von Graff, 1884; Bell, 1892; A. H. Clark, 1913] (3, B.M.).

Michael Sars station 74, 1902; southeast of the Faroe Islands (lat. 60°19′ N., long. 5°22′ W.); 1130 meters; temperature −0.03° C.; brown sand and small stones; August 10, 1902 [Grieg, 1904] (2, and a pentacrinoid, Berg. M.).

Southeast of the Faroe Islands (lat. 60°32′ N., long. 4°20′ W.); 960 meters; Wandel, June 1879 (1, C.M.).

Porcupine station 65, 1869; north of the Shetland Islands (lat. 61°10′ N., long. 2°21′ W.); 631 meters; temperature −1.1° C.; August 26, 1869 (1, C.M.).

Triton station 6; north of the Faroe Islands (lat. 69°08′00″ N., long. 7°26′30″ W.); 852 meters; temperature −1.39° C.; 1882 [P. H. Carpenter, 1884, 1888].

Michael Sars station 37, 1902; between the Faroe Islands and Aalesund, Norway (lat. 62°43′ N., long. 1°26′ E.); 775 meters; mud; June 29, 1902 [Grieg, 1904].

Slope of the deep basin off the Norwegian coast; cold area, where the temperature falls below 0° C. [Appelløf, 1912].

Michael Sars station 34, 1902; off Aalesund, Norway (lat. 62°53′ N., long. 4°14′ E.); 820 meters; mud; June 26–27, 1902 [Grieg, 1904] (1, Berg. M.).

Michael Sars; 22 miles southeast of Bjørnøen; 238 meters (6, Berg. M.).

Bergs Fjord (long. 21°20′ E.), west Finmark [Grieg, 1904].

Øx Fjord, west Finmark [Grieg, 1904].

Alten Fjord (long. 23°20′ E.), west Finmark (1, K.M.).

Komag Fjord (long. 23°30′ E.); west Finmark; Fandreim, 1875 [Grieg, 1904] (5, Berg. M.).

Willem Barents station 6, 1881; near Vardø (lat. 70°40′ N., long. 31°10′ E.); 241 meters; hard ground, covered with a thin layer of mud; June 24, 1881 [P. H. Carpenter, 1886].

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Michael Sars station 7, 1914; off the mouth of Varanger Fjord (lat. 70°18′ N., long. 32°23′ E.); 179–207 meters; temperature 2.2° C.; sand, shells and stones; June 5, 1914 [Grieg, 1916].

Varanger Fjord, east Finmark (long. 30°-32° E.) [Grieg, 1904].

Murman coast [Knipovich, 1900].

Litsa, Ara and Ura Fjords (opening into Motowski Bay between the Rybatschi peninsula and the mainland) [Jarzynsky, 1870; Wagner, 1885].

Kola Fjord [Jarzynsky, 1870; Wagner, 1885; Derjugin, 1911]. Kola Fjord, 20–80+ meters, stony-sandy bottom [Awerinzew, 1909]. Kola Fjord, 212 meters [Derjugin, 1906].

Orca station 2; Kola Fjord, entrance to Olenii Bay; mud mixed with shells and sand; June 19, 1904 [Derjugin, 1906; Michailovskij, 1906].

Orca station 38; Kola Fjord, western side, just north of the entrance to Great Volokovi Inlet; 200 meters; June 1, 1905 [Michailovskij, 1906].

Kola Fjord, opposite the entrance to Volokovi Inlet; 80 meters; mud and fine sand [Derjugin, 1906].

Orca station 42; Kola Fjord, trawling ground between 1 and 2 miles off the Biological Station; about 160 meters; mud; June 13, 1905 [Derjugin, 1906; Michailovskij, 1906].

Orca station 44; Kola Fjord, east of Syedlovati Island; 124 meters; coarse sand; June 16, 1905 [Derjugin, 1906; Michailovskij, 1906].

Orca station 52; Kola Fjord, west bank, opposite Great Olenii Island; coarse sand; July 4, 1905 [Derjugin, 1906; Michailovskij, 1906].

Alexander Kovalevski station 56; Kola Fjord, off Syedlovati Island; 146–238 meters; rocky; September 8, new style (August 26, old style), 1908 [Derjugin, 1915] (1, U.S.N.M., 35746 [part]).

Alexander Kovalevski station 58; Kola Fjord, off Syedlovati Island; 64–82 meters; September 8 (August 26, 1908 [Derjugin, 1915] (1, U.S.N.M., 35746 [part]).

Alexander Kovalevski station 105; Kola Fjord, east side of the entrance, off Lyetinski; 91–110 meters; July 3 (June 20), 1909 [Derjugin, 1915] (5, Murman Biol. Stat.).

Alexander Kovalevski station 228; Kola Fjord, off Tolstika; 64–73 meters; August 21 (August 8), 1909 [Derjugin, 1915] (1, Murman Biol. Stat.).

Alexander Kovalevski station 70; Kola Fjord, near Syedlovati Island; 91–128 meters; bottom covered with a growth of *Polysiphonia*, *Plocamium* and *Desmarestia*, in part with *Onuphis;* June 16 (June 3), 1909 [Derjugin, 1911, 1915] (1, U.S.N.M., 35745).

Alexander Kovalevski station 124; Kola Fjord, between Salni Island and Pitkoff Bay; 91–142 meters; mud with *Onuphis* and *Maldania*, and small stones; July 13 (June 30), 1909 [Derjugin, 1911, 1915].

Alexander Kovalevski stations 144–150; southern part of Kola Fjord, the stations being in a line across the fjord just east of Griazni inlet; 55–137 meters; July 20 (July 7), 1909 [Derjugin, 1911, 1915].

Alexander Kovalevski station 7; Kola Fjord; 128–139 meters; algae; August 26 (August 13), 1908 [Derjugin, 1915].

Alexander Kovalevski station 9; Kola Fjord; 80 meters; mud with sandy patches and with *Hyperammina* and Ascidians; August 26 (August 13), 1908 [Derjugin, 1915].

Alexander Kovalevski station 10; Kola Fjord; 58–117 meters; near coast rocky with lithothamnion and shells, deeper with sponges; August 27 (August 14), 1908 [Derjugin, 1915].

Alexander Kovalevski station 112; Kola Fjord, west side, not far from the entrance, between Toross Island and Voronugh Islet; 96–117 meters; stones, in part sand; June 23 (July 6), 1909 [Derjugin, 1915] (1, Murman Biol. Stat.).

Alexander Kovalevski station 13; Kola Fjord; 256 meters; mud with *Onuphis*, Maldanids and *Hyperammina;* August 27 (August 14), 1908 [Derjugin, 1915].

Alexander Kovalevski station 14; Kola Fjord; 110–183 meters; partly mud with *Onuphis*, partly rocky with lithothamnion; August 27 (August 14), 1908 [Derjugin, 1915].

Alexander Kovalevski station 50; Kola Fjord; 159–220 meters; partly mud with *Onuphis*, partly large rocks; September 7 (August 25), 1908 [Derjugin, 1915].

Alexander Kovalevski station 103; Kola Fjord; 49–62 meters; shells and lithothamnion; July 2 (June 19), 1909 [Derjugin, 1915].

Alexander Kovalevski station 106; Kola Fjord; 82–100 meters; shells and sand; July 3 (June 20), 1909 [Derjugin, 1915].

Alexander Kovalevski station 121; Kola Fjord; 128–146 meters; rocky; July 7 (June 24), 1909 [Derjugin, 1915].

Alexander Kovalevski station 126; Kola Fjord; 91–128 meters; small rocks and sand with Ascidians; July 14 (July 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 127; Kola Fjord; 46–73 meters; thin mud with some lithothamnion; July 14 (July 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 130; Kola Fjord; 73–91 meters; July 14 (July 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 133; Kola Fjord; 64 meters; rocks and mud; July 14 (July 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 163; Kola Fjord; 146 meters; rocks and a little mud with sand; July 24, (July 11), 1909 [Derjugin, 1915].

Alexander Kovalevski station 164; Kola Fjord; 36–73 meters; rocky with lithothamnion and shells; July 24 (July 11), 1909 [Derjugin, 1915].

Alexander Kovalevski station 170; Kola Fjord; 73 meters; small rocks, lithothamnion, sponges, polyzoa, hydroids etc.; July 27 (July 14), 1909 [Derjugin, 1915].

Alexander Kovalevski station 173; Kola Fjord; 146 meters; small shells, a little mud and sand; July 27 (July 14), 1909 [Derjugin, 1915].

Alexander Kovalevski station 177; Kola Fjord; 183–201 meters; *Onuphis* with a little mud and *Hyperammina;* July 27 (July 14), 1909 [Derjugin, 1915].

Alexander Kovalevski station 184; Kola Fjord; 143–160 meters; *Onuphis* and algae; July 31 (July 18), 1909 [Derjugin, 1915].

Alexander Kovalevski station 187; Kola Fjord; *c.* 183 meters; *Onuphis* with algae and a little *Hyperammina;* August 7 (July 25), 1909 [Derjugin, 1915.]

Alexander Kovalevski station 193; Kola Fjord; 73–88 meters; small rocks and mud; August 10 (July 28), 1909 [Derjugin, 1915].

Alexander Kovalevski station 198; Kola Fjord; 73–91 meters; large and small rocks, a little mud; August 13 (July 31), 1909 [Derjugin, 1915].

Alexander Kovalevski station 201; Kola Fjord; 36–91 meters; rock; August 14 (August 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 203; Kola Fjord; 55–73 meters; rock; August 14 (August 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 207; Kola Fjord; 91–137 meters; mud with *Onuphis*, Maldanids and rocks; August 14 (August 1), 1909 [Derjugin, 1915].

Alexander Kovalevski station 211; Kola Fjord; 146 meters; mud with Maldanids, *Onuphis* and *Hyperammina*, large rocks; August 17 (August 4), 1909 [Derjugin, 1915].

Alexander Kovalevski station 213; Kola Fjord; 109–128 meters; mud with *Onuphis*, *Hyperammina*, Maldanids and large rocks; August 17 (August 4), 1909 [Derjugin, 1915].

Alexander Kovalevski station 215; Kola Fjord; 55–64 meters; rock; August 18 (August 5), 1909 [Derjugin, 1915].

Alexander Kovalevski station 224; Kola Fjord; 164–183 meters; *Filograna*, *Onuphis*, middle sized rocks and sponges; August 20 (August 7), 1909 [Derjugin, 1915].

Alexander Kovalevski station 244; Kola Fjord; 137 meters; mud with *Onuphis*, *Hyperammina* and Maldanids; August 24 (August 11), 1909 [Derjugin, 1915].

Alexander Kovalevski station 247; Kola Fjord; 109 meters; rock, shells and algae; August 24 (August 11), 1909 [Derjugin, 1915].

Alexander Kovalevski station 191; Kola Fjord, off the entrance to Sredni inlet; 137 meters; stony; August 10 (July 28), 1909 [Derjugin, 1911, 1915].

Alexander Kovalevski station 205; Kola Fjord, near Shurinoff Island; 16–27 meters; bottom lithothamnion (partly dead) and large stones with incrustations of lithothamnion; August 14 (August 1), 1909 [Derjugin, 1911].

Alexander Kovalevski station 206; Kola Fjord, between Shurinoff Island and Sredni inlet; 101 meters; stony; August 14 (August 1), 1909 [Derjugin, 1909].

Alexander Kovalevski station 217; Kola Fjord, between Veliki and Griazni inlets; 101–121 meters; mud with *Onuphis* and Maldanids and a few small stones; August 18 (August 5), 1909 [Derjugin, 1911, 1915].

Alexander Kovalevski station 235; Kola Fjord, Olenii inlet; 64–73 meters; August 23 (August 10), 1909 [Derjugin, 1911, 1915] (1, U.S.N.M., 35747).

Alexander Kovalevski station 243; Kola Fjord, between Syedlovati Island and the Olenii shore; 73 meters; rocks, mud and broken shells; August 24 (August 11), 1909 [Derjugin, 1911, 1915].

Persey station 70; White Sea (lat. 66°30′ N., long. 40°50′ E.); July 3, 1923 [Messjatzew, 1925].

Barents Sea, north of the Kola peninsula (lat. 72°58′ N., long. 39°12′ E.); 270–294 meters; July 21, 1899 (1, M.C.Z.).

Poseidon station 3; off the Kola peninsula (lat. 68°58′ N., long. 37°28′ E.); 175–184 meters; temperature 1.23° C.; salinity 34.63 per m.; fine gray sand with clay [Scheuring, 1922].

Poseidon station 61; off the Kola peninsula (lat. 69°02′ N., long. 37°30′ E.); 178–188 meters; temperature 1.35° C.; salinity 34.67 per m.; fine gray sand [Scheuring, 1922].

Poseidon station 24; north of the Kola peninsula (lat. 71°59′ N., long. 38°00′ E.); 274 meters; temperature −1.4° C.; salinity 34.29 per m.; clay with fine sand [Scheuring, 1922].

Poseidon station 25; north of the Kola peninsula (lat. 72° 55′N., long. 39°19′ E.); 317–320 meters; temperature −1.74° C.; salinity 34.88 per m.; soft clay [Scheuring, 1922].

Poseidon station 31; off Cape Gorodezh (lat. 67°41′ N., long. 41°05′ E.); 55 meters; temperature 2.47° C.; salinity 33.33 per m.; fine and coarse sand with gravel [Scheuring, 1922; Schorygin, 1926].

Andrey Pervozvanny station 847 (199); north of the Kola peninsula (lat. 71°30′ N., long. 38° 00′ E.); May 5 (April 22), 1903 [Breitfuss, 1906].

Yermak (*Jermak*) station 41; Barents Sea, north of the Kola peninsula (lat. 72°51′ N., long. 37°52′ E.); 240 meters; temperature −0.9° C.; mud with stones; July 6 (June 23), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905].

Motka Fjord [Jarzynsky, 1870; Wagner, 1885].

Willem Barents station 5; close to Vardø, East Finmark (lat. 70°40′ N., long. 31°10′ E.); 241 meters; hard ground, covered with a thin layer of mud; June 24, 1881.

Poseidon station 2; off Vardø (lat. 70° 35′ N., long. 31° 44′ E.); 90–138 meters; temperature 2.78° C.; salinity 34.60 per m.; clay with sand [Scheuring, 1922].

Olga station 44; south of Bear Island (lat. 73° 52′N., long. 19°55′ E.); 130–200 meters; fine sand; August 4, 1898 [Hartlaub, 1898].

Michael Sars station 62, 1900; southwest of Bear Island (lat. 74°15′ N., long. 16° 50′ E.); 280 meters; temperature +2.10° C.; rocky; September 5, 1900 [Grieg, 1904].

Michael Sars station 84, 1901; southwest of Bear Island (lat. 74°43′ N., long. 17°10′ E.); 200 meters; temperature +2.30° C.; July 24, 1901 [Grieg, 1904] (1, Berg. M.)

Michael Sars station 62, 1914; near Bear Island (lat. 74°15′ N., long. 20°36′ E.); 159 meters; temperature +0.62° C.; mud and shell; July 16, 1914 [Grieg, 1916].

Michael Sars station 63, 1914; near Bear Island (lat. 74°09′ N., long. 19°18′ E.); 106 meters; sand and shell; July 16, 1914 [Grieg, 1916].

St. Rose station 33; W.N.W. of Bear Island (about 4 miles N.N.W. of sta. 32, which was 25 miles N.W. by W. ½W. of Bear Island); 150 meters [Robertson, 1932].

Kirkholmen station 34; off Bear Island (lat. 74°15′ N., long. 20°37′ E.); 125–220 meters; August 20, 1928 [Grieg, 1932].

Ernest Holt; 1949, cruise 6, station 66; NE. of Bear Island (lat. 75°05′ N., long. 23°45′ E.); 131 meters; temperature −0.65° C. [Blacker, 1957].

Ernest Holt; 1949, cruise 7, station 17 (lat. 76°48′ N., long. 33°22′ E.); 140 meters; temperature −0.64° C. [Blacker, 1957].

Ernest Holt; 1949, cruise 7, station 18 (lat. 76°51′ N., long. 33°14′ E.); 183 meters; temperature 0.02° C. [Blacker, 1957].

Ernest Holt; 1949, cruise 7, station 23 (lat. 76°15′ N., long. 26°04′ E.); 105 meters; temperature 0.78° C. [Blacker, 1957].

Ernest Holt; 1951, cruise 4, station 36 (details of this and the following stations not available); 165 meters; temperature −0.46° C. Station 41; 194 meters; −0.26° C. Cruise 5, station 20; 146 meters. Station 65; 131 meters; 4.52° C. Station 66; 95 meters; 3.28° C. 1953, cruise 3, station 33; 128 meters. Cruise 4, station 10; 165 meters; −1.58° C. Cruise 5, station 47; 234 meters; −0.24° C. Cruise 6, station 13; 142 meters. Station 28; 146 meters. Station 42; 211 meters; −0.11° C. Station 45; 243 meters; −0.38° C. Station 52; 208 meters; 0.33° C. Station 53; 210 meters; 0.46° C. Station 75; 142 meters; −1.27° C. Cruise 7, station 13;

248 meters; 0.40° C. Station 30; 165 meters. Station 50; 205 meters; −0.28° C. Station 53; 210 meters; 0.93° C. Station 54; 215 meters; 1.02° C. Station 55; 228 meters. Cruise 8, station 75; 238 meters; −1.57° C. 1954, cruise 5, station 108; 146 meters; 3.38° C. Station 132; 256 meters; 1.82° C. Station 134; 183 meters; 3.54° C. [Blacker, 1957].

Vøringen station 312; west of Bear Island (lat. 74°54′ N., long. 14°53′ E.); 1203 meters; temperature −1.2° C.; July 22, 1877 (2 pentacrinoids, Berg.M.).

Michael Sars station 83, 1901; five and a half miles southeast of Bear Island; 130 meters; temperature +0.50° C.; July 23, 1901 [Grieg, 1904].

North Atlantic Ocean (1, D.M.).

Spitzbergen [Lütken, 1871, and subsequent authors] (5, B.M.; Berg.M.).

No locality (Spitzbergen) (1, M.O.M.).

Helgoland station 13; Ross Island about 1 sea mile northwest (lat. 80°48′ N., long. 20°23′ E.); 85 meters; blue mud and red clay with many small and large stones; July 2, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Yermak station 28 (56); northwest of the Seven Islands (lat. 81°01′ N., long. 19°28′ E.); 180 meters; temperature +0.3° C.; mud; August 18 (6), 1899; A. Tschernyschew [Michailovskij, 1902, 1903; Grieg, 1904].

Near the Seven Islands; 40–70 meters; *Princesse-Alice* [Koehler, 1901].

Princesse-Alice station 1012; near the pack ice north of Spitzbergen (lat. 80°01′ N., long. 10°51′15″ E.); 430 meters; August 18, 1898 [Prince of Monaco, 1899; Koehler, 1901] (about 10, M.O.).

North of Spitzbergen (lat. 80°11′ N., long. 16°18′ E.); [Gislén, 1923].

Lofoten station 10; open sea north of Spitzbergen; 164–183 meters; stony bottom with mud; August 20, 1890 [Klinckowström, 1892].

Samson; northern coast of Spitzbergen; 1872 (1,B.M.).

Yermak station 29 (57); off the northwestern coast of Spitzbergen (lat. 80°19′ N., long. 14°18′ E.); 65 meters; temperature +2.0° C.; mud; A. Tschernyschew, August 19 (7), 1899 [Michailovskij, 1902, 1903; Grieg, 1904].

Dorothea; off the northwestern coast of Spitzbergen (lat. 80°26′ N., long. 12°30′ E.); 413 meters; 1818 [Leach, 1830; Owen, 1833] (2, B.M.). Type locality.

Trent; off the northwestern coast of Spitzbergen (lat. 80°26′ N., long. 11°32′ E.); 457 meters; 1818 [Leach, 1830; Owen, 1833].

Vøringen station 363; off the northwestern coast of Spitzbergen (lat. 80°03′ N., long. 8°28′ E.); 475 meters; temperature +1.1° C.; clay [Danielssen, 1892] (several, U.S.N.M., 8576; Berg.M.).

Willem Barents station 1, 1878; off Smeerenberg Island, northwestern Spitzbergen (lat. 79°50′ N., long. 11°40′ E.); 18 meters; temperature 1° C. [Hoffman, 1882; Michailovskij, 1903].

Willem Barents station 2, 1878; northeast of Smeerenberg Island, northwestern Spitzbergen (lat. 79°40′ N., long. 12°10′ E.); 37 meters; temperature 1.2° C. [Hoffmann, 1882; Michailovskij, 1903].

Frithiof station 10, 1900; north of Prince Charles Foreland (lat. 79°30′ N., long. 10°30′ E.); 100 meters; stones [von Hofsten, 1915; Gislén, 1924].

Princesse-Alice station 1070; north of Prince Charles Foreland (lat. 79°18′30″ N., long. 10°31′15″ E.); 175 meters; mud, sand and gravel; August 4, 1899 [Koehler, 1901, 1909].

Frithiof station 9, 1900; north of Prince Charles Foreland (lat. 79°10′ N., long. 11°00′ E.); 100 meters; ooze [von Hofsten, 1915].

Olga station 28; off the northern entrance to Foreland Sound (lat. 79°00′ N., long. 11°00′ E.); 36–140 meters; mud and small stones; July 19, 1898 [Döderlein, 1900].

Vøringen station 370; west of Ice Fjord, Spitzbergen (lat. 78°48′ N., long. 8°37′ E.); 199 meters; temperature +1.1° C.; clay [Danielssen, 1892].

Vøringen station 359; west of Ice Fjord, Spitzbergen (lat. 78°02′ N., long. 9°25′ E.); 761 meters; temperature +0.8° C.; brown and gray clay [Danielssen, 1892] (1, Berg. M.).

?Spitzbergen; voyage of H.S.H. the Prince Napoleon, 1856 [A. H. Clark, 1911] (1, P.M.).

Sofia; Spitzbergen; 16–20 miles west of the entrance to Ice Fjord; 215–250 meters; 1868 [von Hofsten, 1915].

Lofoten station 5; entrance to Ice Fjord; 183 meters; stones; July 14 and August 13, 1890 [Klinckowström, 1892].

Svenksund station 43; Svenksund Deep, at the entrance to Ice Fjord, south side; 228–257 meters; temperature +2.74° C.; loose mud; July 25, 1908 [von Hofsten, 1915].

Svenksund station 13; Ice Fjord, entrance to Safe Bay; 125–150 meters; temperature +0.87° to +1.23° C.; mud with shells; *Balanus porcatus* association; July 16, 1908 [von Hofsten, 1915].

Axel Thordsen; Safe Bay, Ice Fjord; 54–90 meters; mud; 1864 [von Hofsten, 1915].

Svenksund station 94; Ice Fjord, main fjord to the east of Tundra Bay; 141–147 meters; temperature −0.62° C.; loose mud with small stones; August 21, 1908 [von Hofsten, 1915].

Svenksund station 21; Ice Fjord, at the entrance to Tundra Bay; 71–68 meters; temperature −0.93° C.; very loose mud with scattered stones; July 20, 1908 [von Hofsten, 1915].

Antarctic; Ice Fjord, main fjord off Cape Boheman, between Tundra and Yoldia Bays; 40–50 meters; 1898 [von Hofsten, 1915].

Svenksund station 102; Ice Fjord, north arm, at the entrance to Yoldia Bay; 70–93 meters; temperature +0.68° C.; firm tenacious mud with many stones; August 14, 1908 [von Hofsten, 1915].

Svenksund station 106; Yoldia Bay, Ice Fjord, 2000 meters from the edge of the Svea glacier; 28 meters; temperature +2.87° C.; tenacious mud with gravel; August 19, 1908 [von Hofsten, 1915].

Svenksund station 116; Ice Fjord, north arm, off the entrance to Dickson Bay; 57–60 meters; temperature +1.2° C.; gravel and stones; August 25, 1908 [von Hofsten, 1915].

Svenksund station 122; Ice Fjord, Dickson Bay; 44–40 meters; temperature −0.2° to −0.7° C.; mud; August 28, 1908 [von Hofsten, 1915].

Svenksund station 125; Ice Fjord, Dickson Bay; 62–70 meters; temperature −1.32° C.; loose red mud; August 28, 1908 [von Hofsten, 1915].

Svenksund station 120; Ice Fjord, Dickson Bay; 98 meters; temperature −1.63° C.; loose mud; August 27, 1908 [von Hofsten, 1915].

Svenksund station 82; Ice Fjord, Billen Bay; 65 meters; temperature −0.7° C.; loose mud with gravel; August 15, 1908 [von Hofsten, 1915].

Svenksund station 87; Ice Fjord, Billen Bay; 35–37 meters; temperature +1.5° C.; very loose mud with a little gravel; August 17, 1908 [von Hofsten, 1915].

Svenksund station 47; Ice Fjord, at the entrance to Sassen Bay; 97–120 meters; temperature apparently about 0° C.; loose mud; July 29, 1908 [von Hofsten, 1915].

Svenksund station 46; Ice Fjord, Sassen Bay; 94–80 meters; loose mud; July 29, 1908 [von Hofsten, 1915].

Princesse-Alice station 997; Ice Fjord, Temple Bay (the eastward continuation of Sassen Bay) (lat. 78°22′ N., long. 17°10′15″ E.); 102 meters; black mud; August 11, 1898 [Prince of Monaco, 1899; Richard, 1900; Koehler, 1901] (1+, M.O.).

Vøringen station 374; Advent Bay, Ice Fjord (lat. 78°16′ N., long. 15°33′ E.); 110 meters; temperature +0.7° C.; clay [Danielssen, 1892] (2, Berg.M.).

Svenksund station 96; Ice Fjord, main fjord north of Green Bay; 200–230 meters; temperature +2.56° C.; mud with a few stones and gravel; August 22, 1908 [von Hofsten, 1915].

Bakan station 3 (63); Ice Fjord, opposite Green Bay (lat. 77°28′ N., long. 18°40′ E.); 205 meters; temperature −0.8° C.; ?mud; June 27 (14), 1900; A. Wolkowitsch [Michailovskij, 1902, 1903].

Princesse-Alice station 2632; entrance to Green Bay; 150 meters; August 5–9, 1907 [Koehler, 1909].

Olga station 26; Ice Fjord, entrance to Green Bay (lat. 78°05′ N., long. 14°13′ E.); 145–180 meters; muddy; July 17, 1898 [Hartlaub, 1900; Döderlein, 1900].

Michael Sars station 87, 1901, Ice Fjord, Green Bay; 140 meters; temperature +1.10° C.; July 26, 1901 [Grieg, 1904] (about 12, Berg. M.).

Polhem and *Gladan;* Ice Fjord, Green Bay; 180 meters; stones and mud; 1872–1873 [von Hofsten, 1915].

Bell Sound, Spitzbergen; Leche (1, Berl.M., 3855).

Lofoten station 3; entrance to Bell Sound; 110–128 meters; stones; July 3, 1890 [Klinckowström, 1892].

Helgoland station 10; in the middle of the entrance to Bell Sound (lat. 77°37′ N., long. 14°05′ E.); 150 meters; tenacious blue mud with many larger and smaller rounded stones; June 27, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Olga station 39; west of Horn Sound (lat. 76° 58′N., long. 13°20′ E.); 115 meters; mud; July 27, 1898 [Hartlaub, 1900].

Olga station 40; west of Horn Sound (lat. 76°43′ N., long. 13°40′ E.); 160 meters; mud; July 27, 1898 [Hartlaub, 1900].

Blaafjeld station 3; western coast of Spitzbergen (lat. 77°43′ N., long. 10°51′ E.); 203–215 meters; bottom temperature (at 185 meters) 2.30° C.; stones and mud; July 5–6, 1923 [Grieg, 1925].

Blaafjeld station 43; western coast of Spitzbergen (lat. 76°58′ 05″ N., long. 12°45′ E.); 220–253 meters; stones, bryozoans and shells; August 4–5, 1923 [Grieg, 1925].

Blaafjeld station 51; western coast of Spitzbergen (lat. 76°58′ N., long. 12°35′ E.); 210–256 meters; bottom temperature (at 230 meters) 2.57° C.; stones and mud; August 7–8, 1923 [Grieg, 1925].

Blaafjeld station 52; western coast of Spitzbergen (lat. 77°41′ N., long. 11°20′ E.); 233–264 meters; bottom temperature (at 220 meters) 2.58° C.; stones and mud; August 8, 1923 [Grieg, 1925].

Tovik station 88; western coast of Spitzbergen (lat. 77°48′ N., long. 10°55′ E.); 192–207 meters; stones; August 16–17, 1924 [Grieg, 1925].

Tovik station 91; western coast of Spitzbergen (lat. 78°02′05″ N., long. 14°12′ E.); 152 meters; bottom temperature (at 145 meters) 1.5° C.; August 22, 1924 [Grieg, 1925].

Tovik station 10; Spitzbergen Bank (lat. 77°44′ N., long. 11°45′ E.); 185–228 meters; June 30, 1925 [Greig, 1927].

Tovik station 14; Spitzbergen Bank (lat. 78°5′ N., long. 14°11′ E.); 150 meters; July 8, 1925 [Greig, 1927].

Tovik station 20; Spitzbergen Bank (lat. 77°45′ N., long. 10°44′ E.); 223–251 meters; July 9, 1925 [Greig, 1927].

Tovik station 23; Spitzbergen Bank (lat. 77°45′ N., long. 11°56′ E.); 117–160 meters; July 10–11, 1925 [Greig, 1927].

Tovik station 24; Spitzbergen Bank (lat. 77°43′ N., long. 12°7′ E.); 130 meters; July 11, 1925 [Greig, 1927].

Tovik station 26; Spitzbergen Bank (lat. 76°50′ N., long. 13°22′ E.); 115–230 meters; July 13, 1925 [Greig, 1927].

Tovik station 28; Spitzbergen Bank (lat. 78°7′ N., long. 14°8′ E.); 150–240 meters; July 14–15, 1925 [Greig, 1927].

Tovik station 31; Spitzbergen Bank (lat. 78°5′ N., long. 14°11′ E.); 150 meters; July 16, 1925 [Greig, 1927].

Armauer Hansen station 187; Bell Sound; 120–190 meters; August 27, 1926 [Greig, 1927].

Kirkholmen station 49; Green Harbor, Spitzbergen (lat. 78°2′5″ N., long. 14°12′ E.); 153 meters; September 2, 1928 [Greig, 1932].

Vøringen station 343; west of South Cape, Spitzbergen (lat. 76°34′ N., long. 12°51′ E.); 1358 meters; temperature −1.2° C.; clay [Danielssen, 1892].

Helgoland station 24; South Cape about 12 sea miles west (lat. 76°23′ N., long. 15°04′ E.); 135 meters; fine blue mud mixed with sand, and many large stones, smooth and sharp angled; July 21, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Olga station 57; South Cape bearing NNE. 14 miles distant; 179 meters; coarse stones with mud; August 10, 1898 [Hartlaub, 1900].

Olga station 41; southwest of South Cape (lat. 76°23′ N., long. 15°07′ E.); 145 meters; mud with sand; July 27, 1898 [Hartlaub, 1900].

Vøringen station 336; off South Cape (lat. 76°19′ N., long. 15°42′ E.); 128 meters; temperature +0.4° C.; clay; hard bottom [Danielssen, 1892] (1, Berg. M.).

Olga station 56; off South Cape (lat. 76°17′ N., long. 15°27′ E.); 114–146 meters; mud, followed by mud with stones; August 10, 1898 [Hartlaub, 1900].

Eastern Spitzbergen [Schaudinn, 1899].

Willem Barents station 4, 1884; mouth of Stor Fjord (lat. 76°59′ N., long. 18°21′ E.); 128 meters; temperature −0.3° C.; clay; July 6, 1884 [P.H. Carpenter, 1886].

Bakan station 23 (23); western side of the entrance to Stor Fjord (lat. 76°42′ N., long. 17°28′ E.); 131.5–139 meters; temperature −0.7° C.; coarse gravel; A. Birula, August 3 (July 22), 1899 [Michailovskij, 1902, 1903].

Bakan station 14 (84); north central Stor Fjord (lat. 78°03′ N., long. 20°05′ E.); 75.5 meters; thin sandy mud with gravel; temperature +2.5° C.; August 20 (7), 1901 [Michailovskij, 1902].

Bakan station 16 (86); Stor Fjord, Ginevra Bay, between Hellvaldsberg and Forväxlingsudden (lat. 78°34′ N., long. 20°25′ E.); 41.5 meters; temperature +2.3° C.; thin gray mud and stones, with red algae; July 24 (11), 1901; A. Wolkowitsch [Michailovskij, 1902, 1903].

Bakan station 3 (73); Stor Fjord, Ginevra Bay, near Forväxlingsudden (lat. 78°32′ N., long. 20°20′ E.); 36 meters; temperature +1.0° C.; mud with stones and Laminaria; A. Wolkowitsch, July 6 (June 23), 1901 [Michailovskij, 1902, 1903].

Helgoland station 6; Stor Fjord, near Changing Point at the entrance to Ginevra Bay (lat. 78°15′ N., long. 20°00′ E.); 105–110 meters; tenacious blue mud with small scattered rounded stones; June 20, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several Berl. M.).

Bakan station 18 (88); Stor Fjord, south of the entrance to Ginevra Bay, in the latitude of Anderson's Bay (lat. 78°24′ N., long. 19°52′ E.); 47 meters; temperature +1.4° C.; coarse gravel; A. Wolkowitsch, September 4 (August 22), 1901 [Michailovskij, 1902, 1903].

Bakan station 14 (84); north central Stor Fjord (lat. 78°03′ N., long. 20°05′ E.); 75.5 meters; temperature +2.5° C.; thin sandy mud with gravel; A. Wolkowitsch, August 20 (7), 1901 [Michailovskij, 1902, 1903; Greig, 1904].

Bakan station 6 (76); center of Stor Fjord, between Whales Head and Cape Agardh (lat. 77°47′ N., long. 19°07′ E.); 101 meters; temperature −1.8° C.; soft mud with fragments of annelid tubes; A. Wolkowitsch, July 16 (3), 1901 [Michailovskij, 1902, 1903].

Bakan station 2 (72); Stor Fjord, 5 miles west of Whales Point Bay (lat. 77°28′ N., long. 20°31′ E.); 93.5 meters; temperature −1.7° C.; fine mud with red algae and Laminaria; A. Wolkowitesh, June 25 (12), 1901 [Michailovskij, 1902, 1903].

Helgoland station 3; Stor Fjord, 13 sea miles WSW. of Whales Point (lat. 77°19′ N., 20°03′ E.); 52 meters; yellow mud with rounded stones; June 17, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Kükenthal's stations 8–11; off Deevie Bay, Edge Land, near Whales Point; about 27 meters; small stones and sand, and a little mud; June 10, 1886 [Pfeffer, 1894] (13, H. M.; Berl M., 3683).

Princesse-Alice station 976; between Hope (also known as Sea Horse or Walrus) Island and Edge Land (lat. 76°45′ N., long. 23°20′15″ E.); 186 meters; mud; August 2, 1898 [Koehler, 1898, 1901, 1909] (1, M.O.).

Helgoland station 9; 3 sea miles SE. of Half Moon Island (west of Cape Negro, Edge Land), in the vicinity of Menke Island (lat. 77°12′ N., long. 23°23′ E.); 90 meters; blue tenacious mud with scattered large and numerous small rounded stones; June 25, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 25; Half Moon Island about 20 sea miles NE. (lat. 77°23.5′ N., long. 24°07′ E.); 75 meters; gray-blue mud with many stones up to the size of one's head, partly rounded, partly sharp angled; July 22, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 49; Ryk-Ys Islands, among the islands (lat. 77°49′ N., long. 25°12′ E.); 60–80 meters; a few small stones, many pelecypod shells, and the remains of polyzoans; August 19, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 34; King Charles Land, Swedish Foreland, about 2 sea miles west of Cape Arnesen; 85 meters; yellow mud, without stones, numerous worm tubes; August 4, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 33; King Charles Land, Bremer Sound, about 3½ sea miles SSW. ¼W. of Cape Weissenfels; 105 meters; blue mud with a few small rounded stones, many mussel shells; August 4, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 32; King Charles Land, midway between Jena and Abel Islands; 40 meters; small and large stones, up to the size of one's head, encrusted with red calcareous algae, many red algae; August 2, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 36; North East Land, eastern side, about 4 sea miles from the glacier (lat. 79°35′ N., long. 28°00′ E.); 66 meters; a little blue mud and small and large stones up to the size of one's head, rounded and sharply angled; August 6, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 37; Great Island (off northeastern Spitzbergen) about 6 sea miles northeast (lat. 80°15′ N., long. 30°00′ E.) 95 meters; a little yellow mud, many stones up to the size of one's fist; August 8, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Helgoland station 38; Charles XII Island, about 12 sea miles north (lat. 81° 00′ N., long. 25°10′ E.); 195 meters; heavy stones, larger than a man's head, no mud; August 8, 1898 [Döderlein, 1905; A. H. Clark, 1912] (several, Berl. M.).

Willem Barents station 10, 1884; Barents Sea (lat. 75°30′ N., long. 33°40′07″E.); 164 meters; temperature −0.6° C.; clay and stones; September 17, 1884 [P. H. Carpenter, 1886].

Willem Barents station 6, 1879; central Barents Sea (lat. 74°00′30″ N., long. 37°31′30″ E.); 227 meters; temperature +0.2° C. [Hoffmann, 1882].

Michael Sars station 55, 1914; central Barents Sea (lat. 75°05′ N., long. 35°54′ E.); 167–170 meters; temperature +0.23° C.; mud; July 12, 1914 [Grieg, 1916].

Willem Barents station 2, 1879; central Barents Sea (lat. 75°13′30″ N., long. 25°51′30″ E.); 183 meters; temperature +1.0° C.; July 5, 1879 [van Lidth de Jeude, 1879].

Station 10; Barents Sea (lat. 74°10′ N., long. 54°20′ E.); 156 meters; dark green mud with rounded stones; August 17, 1921 [Schorygin, 1925].

Station 12; Barents Sea (lat. 75°00′ N., long. 54°00′ E.); 245 meters; mud with small stones; August 19, 20, 1921 [Schorygin, 1925].

Station 15; Barents Sea (lat. 77°00′ N., long. 62°00′ E.); 134 meters; stony bottom; August 21, 1921 [Schorygin, 1925].

Station 16b; Barents Sea (lat. 77°36′ N., long. 63°18′ E.); about 300 meters; mud with stones and concretions; August 21, 1921 [Schorygin, 1925; Gorbunow, 1933].

Station 17b; Barents Sea (lat. 76°59′ N., long. 62°52′ E.); 150 meters; mud with small and large stones; August 22, 1921 [Schorygin, 1925].

Station 20; Barents Sea (lat. 75°40′ N., long. 55°28′ E.); 100 meters; mud and stones, August 23, 1921 [Schorygin, 1925].

Station 88; Barents Sea (lat. 74°22′ N., long. 41°00′ E.); 260 meters; greenish gray mud with stones and concretions; August 26, 1923 [Schorygin, 1925].

Station 91; Barents Sea (lat. 76°07′ N., long. 40°50′ E.); 270 meters; greenish gray mud with stones and concretions; August 27, 1923 [Schorygin, 1925].

Station 92; Barents Sea (lat. 76°40′ N., long. 40°46′ E.); 214 meters; greenish gray mud with stones and concretions; August 28, 1923 [Schorygin, 1925].

Station 94; Barents Sea (lat. 77°51′ N., long. 40°38′ E.)· 237 meters; cinnamon colored mud with stones and concretions; August 28, 29, 1923 [Schorygin, 1925].

Station 95; Barents Sea (lat. 78°26′ N., long. 40°34′ E.); 268 meters; greenish gray mud with stones and concretions; August 29, 1923 [Schorygin, 1925].

Station 97; Barents Sea (lat. 79°50′ N., long. 43° 30′ E.); 334 meters; cinnamon colored and gray mud with stones and concretions; August 30, 1923 [Schorygin, 1925].

Station 98; Barents Sea (lat. 70°47′ N., long. 48°35′ E.); 325 meters; cinnamon colored and gray mud with stones and concretions; August 31, 1923 [Schorygin, 1925].

Station 99; Barents Sea (lat. 79°09′ N., long. 46°50′ E.); 75 meters; greenish sandy mud with stones; August 31, 1923 [Schorygin, 1925].

Station 100; Barents Sea (lat. 78°38′ N., long. 50°42′ E.); 290 meters; gray mud with stones; September 1, 1923 [Schorygin, 1925].

Station 103; Barents Sea (lat. 76°57′ N., long. 62°08′ E.); 170 meters; greenish gray mud with stones, September 2, 1923 [Schorygin, 1925].

Sokolitsa station 10; Barents Sea (lat. 74° N., long. 33°30′ E.); 274 meters; August 14, 1921 [Derjugin, 1924].

No. 1339; Barents Sea (lat. 75° N., long. 33°46′ E.); 186 meters; July 31, 1906 [Derjugin, 1924].

Biological Station of the Murman coast, Kola meridian Expedition, August 17–21, 1925; station 11, Barents Sea (lat. 74°30′ N., long. of the Kola meridian); 270 meters; mud with polychaete tubes; temperature −0.75° C. [Tanasijcuk, 1927].

Yermak station 65; Off Cape Flora, Franz Josef Land (lat. 79°38′ N., long. 50°38′00″ E.); 110 meters; temperature −1.7° C.; shells; August 10 (July 28), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905] (2, M.C.Z., 399).

Yermak station 80; south of Wilczek Land, Franz Josef archipelago (lat. 79°51′18″ N., long. 60°44′ E.); 323 meters; temperature −1.1° C.; mud [Knipovitsch, 1901; Michailovskij, 1904, 1905; Gorbunow, 1933].

Yermak station 82; east of Franz Josef Land (lat. 80°26′ N., long. 64°14′ E.); 204 meters; mud; August 3, 1901 [Knipovitsch, 1901].

Yermak station 77; between Franz Josef Land and northwestern Nova Zembla (lat. 78°21′ N., long. 61°15′ E.); 311 meters; temperature −0.1° C.; mud; August 1, 1901 [Knipovitsch, 1901].

Yermak station 85; between Franz Josef Land and Nova Zembla (lat. 78°07′ N. long. 63°33′ E.); 362 meters; temperature −1.2° C.; mud; August 17 (4), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905; Gorbunow, 1933].

Yermak station 76; between Franz Josef Land and Nova Zembla (lat. 77°53′ N., long. 61°29′ E.); 356 meters; temperature −1.2° C.; mud; August 1, 1901 [Knipovitsch, 1901].

Yermak station 86; NW. of northern Nova Zembla (lat. 77°31′ N., long. 64°34′ E.); 280 meters; temperature −1.1° C.; mud; August 4, 1901 [Knipovitsch, 1901].

Willem Barents station 18; between Franz Josef Land and Nova Zembla (lat. 77°05′ N., long. 63°53′ E.); 119 meters; temperature −1.0° C.; fine mud with many stones; August 25, 1881 [P. H. Carpenter, 1886].

Willem Barents station 21, 1881; west of northern Nova Zembla (lat. 76°51′ N., long. 44°20′ E.); 265 meters; temperature −1.1° C.; mud; September 7, 1881 [von Graff, 1884; P. H. Carpenter, 1886].

Willem Barents station 10, 1878; west of northern Nova Zembla (lat. 76°31′ N., long. 45°36′ E.); 237 meters; temperature +1.0° C. [Hoffmann, 1882].

Willem Barents station 17, 1881; western coast of Nova Zembla (lat. 75°49′ N., long. 58°41′ E.); 124 meters; temperature −1.8° C.; fine gray mud with stones; August 18, 1881 [P. H. Carpenter, 1886].

Willem Barents station 10, 1879; west of the southern part of Nova Zembla (lat. 72°38′ N., long. 44°30′24″ E.); 68 meters; temperature 4.2° C. [Hoffmann, 1882].

Zarnitza station 14; northern Nova Zembla; Neupokojew Bay (lat. 74°42′30″ N., long. 59°32′ E.); 52–75 meters; bottom temperature −1.40° C.; clay with stony flakes; September 4, 1925 [Gorbunow, 1933].

Zarnitza station 28; northern Nova Zembla; between Mack Harbor and Inostrantzew Bay; 120 meters; September 8, 1928 [Gorbunow, 1933].

Zarnitza station 30; northern Nova Zembla; 13 miles from Suchoi Noss; 145 meters; small and large stones and gray mud; September 9, 1925 [Gorbunow, 1933].

Lomonossow station V; northern Nova Zembla; off the entrance to Krestowaja Bay; 105 meters; mussels; September 22, 1931 [Gorbunow, 1933].

Lomonossow station I; northern Nova Zembla; at the entrance to Russian Harbor; 200 meters; gray mud and small stones; September 12, 1931 [Gorbunow, 1933].

Matotchkin Char (Scharr), Nova Zembla; 8–15 meters; clay and stone; July 15, 1921 [Grieg, 1928].

Tegetthof; west of central Nova Zembla (lat. 74°45.8′ N., long. 51°42′ E.); 236 meters; mud; July 28, 1872 [von Marenzeller, 1878].

Andrey Pervozvanny station 890 (240); west of southern Nova Zembla (lat. 72°19′ N., long. 47°45′ E.); 220 meters; mud; August 7 (July 25), 1903 [Breitfuss, 1906].

Willem Barents station 21, 1880; west of central Nova Zembla (lat. 74°41′04″ N., long. 50°23′ E.); 153 meters; temperature +0.6° C.; July 30, 1880 [von Graff, 1884; P. H. Carpenter, 1886, 1887].

Yermak station 88; off north central Nova Zembla (lat. 75°59′ N., long. 55°24′ E.); 95 meters; temperature −1.9° C.; mud; August 21 (8), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905].

Yermak station 71; off the northwestern coast of Nova Zembla (lat. 76°30′ N., long. 59°24′ E.); 194 meters; temperature −1.3° C.; mud; August 13 (July 31), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905].

Yermak station 58; west of north central Nova Zembla (lat. 75°13′ N., long. 53°23′ E.); 179 meters; temperature −1.9° C.; mud; August 6 (July 24), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905].

Yermak station 48*b*; west of central Nova Zembla (lat. 74°28′ N., long. 54°18′ E.); 160 meters; mud; July 15 (2), 1901 [Knipovitsch, 1901; Michailovskij, 1904, 1905].

Kosten Scharr, southwestern Nova Zembla; 46 meters; mud [Stuxberg, 1878, 1886].

Off the southwestern coast of Nova Zembla (lat. 72°07′ N., long. 50°58′ E.); 110 meters; sand and mud [Stuxberg, 1878, 1886].

Willem Barents station 13, 1879; off the southwestern coast of Nova Zembla (lat. 71°23′00″ N., long. 49°38′00″ E.); 122 meters; temperature −0.1° C.; August 1, 1879 [d'Urban, 1880].

Kara Sea [Nordenskiöld, 1876] (16, M.C.Z. [F. Müller], 286; C.M.).

Dijmphna: Kara Sea; 80–183 meters [Levinsen, 1886; A. H. Clark, 1913] (10, U.S.N.M., 17826; B.M.; C.M..; Berl. M., 3193).

Station 27; Kara Sea (lat. 70°42′ N., long. 58°33′ E.); 145 meters; sandy mud with small stones; August 26, 1921 [Schorygin, 1925].

Station 29; Kara Sea (lat. 72°14′30″ N., long. 62°04′ E.); 121 meters; yellow mud; August 27, 1921 [Schorygin, 1925].

Station 30; Kara Sea (lat. 73°07′ N., long. 60°04′ E.); 59 meters; mud with concretions and stones; August 27, 1921 [Schorygin, 1925].

Sedow station 25; northern Kara Sea (lat. 78°33′ N., long. 63°10′ E.); 300 meters; bottom temperature +1.14° C; small stones; September 5, 1929 [Gorbunow, 1933].

Sedow station 44; northern Kara Sea (lat. 78°58′ N., long. 68°25′ E.); 350 meters; bottom temperature −1.60° C.; loose brown mud; August 12, 1930 [Gorbunow, 1933].

Sedow station 46; northern Kara Sea (lat. 79°26′ N., long. 78°03′ E.); 40 meters; bottom temperature −1.60° C.; probably stones; August 16, 1930 [Gorbunow, 1933].

Sedow station 48; northern Kara Sea (lat. 79°?′ N., long. 78°30′ E.); 95 meters; loose brown mud; August 18, 1930 [Gorbunow, 1933].

Sedow station 50; northern Kara Sea (lat. 78° 20′ N., long. 79°10′ E.); 175 meters; bottom temperature −1.54° C.; loose brown mud and concretions; August 19, 1930 [Gorbunow, 1933].

Sedow station 58; northern Kara Sea (lat. 80°26′ N., long. 85°57′ E.); 170 meters; bottom temperature −1.36° C.; loose brown mud, gray clay, and stones; August 31, 1930 [Gorbunow, 1933].

Sedow station 59; northern Kara Sea (lat. 80°47′ N., long. 89°50′ E.); 52 meters; bottom temperature −1.48° C.; presumably stones and lithothamnion; August 31, 1930 [Gorbunow, 1933].

Sedow station 60; northern Kara Sea (lat. 79°00′ N., long. 87°04′ E.); 180 meters; bottom temperature −1.53° C.; loose brown mud; September 1, 1930 [Gorbunow, 1933].

Sedow station 61; northern Kara Sea (lat. 78°31′ N., long. 86°20′ E.); 119 meters; bottom temperature −1.82° C.; very sandy brown mud and stones; September 2, 1930 [Gorbunow, 1933].

Sedow station 62; northern Kara Sea (lat. 78°02′ N., long. 86°30′ E.); 108 meters; bottom temperature −1.63° C.; very sandy brown mud and stones; September 2, 1930 [Gorbunow, 1933].

Sedow station 64; northern Kara Sea (lat. 77°13′ N., long. 85°38′ E.); 53 meters; bottom temperature −1.64° C.; loose brown mud and gray clay; September 3, 1930 [Gorbunow, 1933].

Sedow station 65; northern Kara Sea (lat. 76°38′ N., long. 81°48 E.); 57 meters; bottom temperature −1.61° C.; loose brown mud, gray clay, and concretions on stones, mussels, and polychaete tubes; September 3, 1930 [Gorbunow, 1933].

Sedow station 67; northern Kara Sea (lat. 76°30′ N., long. 76°53′ E.); 104 meters; bottom temperature −1.60° C.; loose brown mud; September 4, 1930 [Gorbunow, 1933].

Lomonossow station 69; northern Kara Sea (lat. 79°57′ N., long. 70°03′ E.);

512 meters; bottom temperature −0.79° C.; stones and fine rubble; September 2, 1931 [Gorbunow, 1933].

Lomonossow station 71; northern Kara Sea (lat. 77°32′ N., long. 70°05′ E.); 320 meters; bottom temperature −0.97° C.; stones; September 2, 1931 [Gorbunow, 1933].

Lomonossow station 77; northern Kara Sea (lat. 78°08′ N., long. 73°47′ E.); 446 meters; bottom temperature −0.98° C.; brown mud; September 6, 1931 [Gorbunow, 1933].

Lomonossow station 79; northern Kara Sea (lat. 77°39′ N., long. 74°00′ E.); 300 meters; bottom temperature −0.97° C.; brown mud; September 7, 1931 [Gorbunow, 1933].

Lomonossow station 81; northern Kara Sea (lat. 77°10′ N., long. 74°10′ E.); 224 meters; bottom temperature −0.97° C.; brown mud and gray clay; September 7, 1931 [Gorbunow, 1933].

Lomonossow station 82; northern Kara Sea (lat. 77°25′ N., long. 76°00′ E.); 203 meters; bottom temperature −1.04° C.; September 8, 1931 [Gorbunow, 1933].

Lomonossow station 83; northern Kara Sea (lat. 77°42′ N., long. 76°00′ E.); 275 meters; brown mud and gray clay; September 8, 1931 [Gorbunow, 1933].

Belgica station 37, 1907; Kara Sea, off southern Nova Zembla (lat. 72°33′ N., long. 56°06′ E.); 105 meters [Grieg, 1910].

Belgica station 110, 1907; Kara Sea, off southern Nova Zembla (lat. 71°31′ N., long. 57°09′E.); 220 meters [Grieg, 1910].

Belgica station 147, 1907; Kara Strait, between Nova Zembla and Waigatsch Island (lat. 70°39′ N., long. 58°33′ E.); 127 meters [Grieg, 1910].

Belgica station 153, 1907; Kara Strait (lat. 70°25′ N., long. 57°56′ E.); 66 meters [Grieg, 1910].

Belgica station 146, 1907; Kara Strait (lat. 70°40′ N., long. 58°33′ E.); 135 meters [Grieg, 1910].

Varna station 82; off the mouth of Kara Bay (lat. 71°05′ N., long. 62°45′ E.); 134 meters; temperature −0.7° C.; density 1.024; brown mud; July 26, 1883 [Ruijs, 1887].

Varna station 74; off the mouth of Kara Bay (lat. 71°06′ N., long. 63°16′ E.); 128 meters; temperature −1.2° C.; density 1.025; brown mud; July 3, 1883 [Ruijs, 1887].

Varna station 18; off the mouth of Kara Bay (lat. 71°04′ N., long. 64°05′ E.); 101 meters; temperature −1.2° C.; density 1.024; February 14, 1883 [Ruijs, 1887].

Varna station 51; off the mouth of Kara Bay (lat. 71°31′ N., long. 64°13′ E.); 86 meters; temperature −1.4° C.; density 1.025; brown mud; May 4, 1883 [Ruijs, 1887; P. H. Carpenter, 1887].

Varna station 56; off the mouth of Kara Bay (lat. 71°25′ N., long. 64°16′ E.); 93 meters; gray mud with a thin brown upper layer; May 15, 1883 [Ruijs, 1887; P. H. Carpenter, 1887].

Varna station 35; off the mouth of Kara Bay (lat. 71°35′ N., long. 64°36′ E.); 110 meters; temperature -1.8° C.; density 1.026; gray mud with a brown upper layer; March 22, 1883 [Ruijs, 1887; P. H. Carpenter, 1887].

Varna station 41; off the mouth of Kara Bay (lat. 71°30′ N., long. 64°38′ E.); 101 meters; temperature −0.8° C.; density 1.025; thin brown mud [Ruijs, 1887].

Varna station 37, off the mouth of Kara Bay (lat. 71°33′ N., long. 64°43′ E.); 99 meters; thick masses of mud with a brown upper layer; March 27, 1883 [Ruijs, 1887].

Varna station 38; off the mouth of Kara Bay (lat. 71°33′ N., long. 64°45′ E.); 107 meters; temperature 0° C.; density 1.025; thin brown mud; March 26, 1883 [Ruijs, 1887; P. H. Carpenter, 1887].

Varna station 50; off the mouth of Kara Bay (lat. 71°38′ N., long. 64°52′ E.); 91 meters; temperature −1.5° C.; density 1.026; gray mud mixed with brown; April 29, 1883 [Ruijs, 1887].

Varna station 25; off the mouth of Kara Bay (lat. 71°20′ N., long. 64°53′ E.); 124 meters; temperature −0.8° C.; density 1.024; viscous gray mud with a brown upper layer; March 1, 1883 [Ruijs, 1887].

Varna station 48; off the mouth of Kara Bay (lat. 71°39′ N., long. 64°58′ E.); 142 meters; temperature −0.1° C.; density 1.025; thin brown mud; April 23, 1883 [Ruijs, 1887].

Varna station 26; eastern side of the mouth of Kara Bay (lat. 71°30′ N., long. 65°04′ E.); 152 meters; temperature −0.2° C.; viscous gray mud with a brown upper layer; March 3, 1883 [Ruijs, 1887].

Varna station 45; western coast of the Yalmal peninsula (lat. 71°43′ N., long. 65°13′ E.); 150 meters; temperature −0.3° C.; density 1.025; thin brown mud; April 14, 1883 [Ruijs, 1887].

Vega station 46; east of Beluga Bay, Nova Zembla (lat. 73°28′ N., long. 58°00′ E.); 91–228 meters; stony; September 7, 1876 [Stuxberg, 1882, 1886].

Vega station 47; off Matthew Strait, Nova Zembla (lat. 73°30′ N., long. 58°20′ E.); 146 meters; ?stony; September 7, 1876 [Stuxberg, 1878, 1882].

Vega station 49; central Kara Sea (lat. 73°38′ N., long. 63°45′ E.); 146 meters; sand and broken shells; September 5–6, 1876 [Stuxberg, 1878, 1882, 1886].

Vega station 51; southeast of Cape Edward, Nova Zembla (lat. 74°43′ N., long. 65°35′ E.); 146 meters; ?mud; September 4, 1876 [Stuxberg, 1878, 1882].

West of central Nova Zembla (lat. 74°45′ N., long. 51°42′ E.); 236 meters [Stuxberg, 1886].

Ymer station 53; south of northern Nova Zembla (lat. 75°43′ N., long. 65°20′ E.); 73–91 meters; mud; August 24, 1875 [Stuxberg, 1878, 1886].

Ymer station 32; northwest of Cape Ragosin, the northwestern point of Beli Island, off the Samoyed peninsula (lat. 73°45′ N., long. 69°10′ E.); 18 meters; temperature −1.0° C.; sand; August 10, 1875 [Stuxberg, 1886].

Ymer station 38; north of the Gulf of Obi (lat. 75°00′ N., long. 75°20′ E.); 40 meters; temperature −1.7° C.; salinity 32.2 per m.; mud and sand; August 11, 1875 [Stuxberg, 1882].

Ymer station 41; north of Dickson's Island, at the mouth of the Yenesei river (lat. 74°30′ N., long. 80°30′ E.); 36 meters; mud; August 14, 1875 [Stuxberg, 1878, 1882, 1886].

Vega station 62; near Cape Palander (lat. 76°18′ N., long. 92°20′ E.); 73 meters; temperature −1.4° C.; brown mud; August 13, 1878; density 1.0266 [Stuxberg, 1882, 1886].

Vega; near Taimur (Taimyr) Island (long. 97° E.) [Nordenskiöld, 1881].

Vega; west of Taimur; 1878 (*Antedon dentata*, P. H. Carpenter, MS.) [Gislén, 1923].

Zarya station 44; Gulf of Taimur, north of the mouth of the Taimur river (lat. 76°59′30″ N., long. 100°19′30″ E.); 28 meters; mud with stones; August 31 (18), 1901 [Kalischewskij, 1907].

Vega station 67; east of Cape Cheliuskin, Taimur peninsula (lat. 77°28′ N., long. 108°28′ E.); 91 meters; temperature −1.4° C.; mud; August 21, 1878; density 1.0270 [Stuxberg, 1882].

Vega station 72; off the mouth of Chatanga Gulf (lat. 75°00′ N., long. 113°30′ E.); 27 meters; density 1.0238; mud with stones; August 24, 1878 [Stuxberg, 1882].

Zarya station 46; northeast of the Taimur peninsula (lat. 77°01′ N., long. 114°35′ E.); 60 meters; mud with stones; September 3 (August 21), 1901 [Kalischewskij, 1907].

Vega station 69; off Cape Stuxberg, on the eastern side of the Taimur peninsula (lat. 76°55′ N., long. 115°18′ E.); 58 meters; mud; August 22, 1878 [Stuxberg, 1882].

Vega station 71; off Cape Stuxberg (lat. 76°40′ N., long. 115°30′ E.); 66 meters; temperature −1.6° C.; density 1.0275; August 23, 1878 [Stuxberg, 1882].

Vega station 70; off Cape Stuxberg (lat. 76°52′ N., long. 116°00′ E.); 66 meters; fine gray mud; density 1.0273; August 22, 1878 [Stuxberg, 1882; Grieg, 1928].

Zarya station 48; off the Gulf of Chatanga (Khatanga) (lat. 75°32′30″ N., long. 118°32′ E.); 30 meters; mud and sand with stones; September 5 (August 23), 1901 [Kalischewskij, 1907].

Zarya station 49; off the Lena delta (lat. 75°42′ N., long. 124°41′ E.); 51 meters; mud; September 6 (August 24), 1901 [Kalischewskij, 1907].

Zarya station 50; north of the New Siberian (Liakhof) Islands (lat. 77°20′30″ N., long. 138°47′ E.); 38 meters; mud; September 10 (August 28), 1901 [Kalischewskij, 1907].

Zarya station 53; north of the New Siberian Islands (lat. 77°10′ N., long. 142° 48′00″ E.); 35 meters; stones; September 14 (1), 1901 [Kalischewskij, 1907; Grieg, 1928] (1, M.C.Z., 401).

Maud station 1013; north of Wrangel Island (lat. 72°44′ N., long. 179°47′ W.); 58 meters; October 9, 1922 [Grieg, 1928].

Maud station 1031; east of New Siberian Islands (lat. 75°30′ N., long. 164°28′ E.); 50 meters; July 9, 1923 [Grieg, 1928].

Maud station 1041; east of New Siberian Islands (lat. 75°56′ N., long. 162°57′ E.); 53 meters; September 17, 1923 [Grieg, 1928].

Vaigatsch station 33; Chukotsk Sea [Djakonov, 1952] (fragments).

No locality (30, P.A.; Essex Institute; B.M.; C.M.; P.M.; Berl. M., 5344).

Geographical range.—*Heliometra glacialis* has been recorded from Arctic seas and southward to Georges Bank, off Cape Cod, Massachusetts, Iceland, the cold part of the Faroe channel, northern Norway (west and east Finmark) and along the Siberian coast and off-lying land masses to Wrangel Island, not far from the Bering Strait; it has not yet been recorded from north of Alaska and the Canadian arctic east of Hudson Bay and Jones Sound (long. 89° W.), though probably occurring in favorable situations.

Bathymetrical range.—In the following tabulation are given the entire bathymetrical range and the ascertained ranges in several different areas. These latter ranges are, of course, dependent upon local conditions and limited by the amount of work done in the various regions. They are interesting in showing the present state of our knowledge rather than as definite statements of actual biological facts.

Area	Number of Records	Total range (meters)	Average (meters)
Cape Cod to Newfoundland	18	91 (?82)-861	220
Labrador and SE. Hudson Strait	14	68–275	137
Hudson Bay	6	28–166	109
Canadian Arctic and Greenland north of 68° N.	57	14(?6)–930	157
Southern Greenland	23	40 (?25)–750(?775)	344
Jan Mayen area	14	40–679	215
Iceland	18	109–889	432
Faroe Islands area	9	631(?598)–1220	842
Western Norway	2	238–820	529
East Finmark and the Murman coast	62	27 (?16)–317 (?320)	132
Bear Island area	10	130–1203	270
Spitzbergen, Franz Josef Land and the Barents Sea north of 78° N.	96	18–1358	163
Remaining Barents Sea, Kara Sea and off northern Siberia	111	15 (?8)–512	148
Entire range	447	14(?6)–1358	285

[Note by A.M.C.] The 25 depth records of the *Ernest Holt* for which the exact positions have not yet been published have been omitted from these calculations as some of them are from off Spitzbergen and the central Barents Sea as well as from the Bear Island area. They range from 95 to 256 meters, averaging 186 meters.

Thermal range.—The following tabulation shows the entire thermal range and that for such of the preceding geographical divisions as there exist records:

Area	Number of Records	Total range (° C.)	Average (° C.)
Cape Cod to Newfoundland	3	+3.72 to +4.67	+4.04
Labrador	1	+2.80	+2.80
North Greenland and Canadian Arctic	13	−1.79 to +1.30	+0.46
South Greenland	7	+1.44 to +5.80	+3.43
Jan Mayen area	4	−0.60 to −0.10	−0.39
Iceland	7	−0.75 to +5.50	+1.41
Faroe Islands area	6	−1.39 to −0.03	−0.75
Murman coast	8	−1.74 to +2.78	+0.75
Bear Island area	6	−1.20 to +2.30	+0.61
Spitzbergen and Franz Josef Land	43	−1.80 to +2.87	+0.54
Barents Sea and eastward	55	−1.90 to +1.14	−0.91
Entire range	153	−1.90 to +5.80	+0.20

[Note by A.M.C.] The temperature recorded at *Willem Barents* station 10 (+4.20° C.) is not included, being suspiciously high for the locality. (Though the *Ernest Holt* has recorded +4.52° C. at one station apparently off northern Spitzbergen, the exact position not having yet been published. Only the four *Ernest Holt* stations for which details have been published are included here, since the others are from Spitzbergen and the central Barents Sea as well as from the Bear Island area. The 19 other bottom temperatures range from −1.58° C. to +4.52° C., averaging +0.71° C.).

Salinity range.—On the coasts of eastern Greenland there are six records of salinity ranging from 32.825 to 34.93 parts per thousand. On the Murman coast and Barents Sea area, Scheuring gives six records varying from 33.33 to 34.88 parts per thousand and Stuxberg has one from the Gulf of Obi of 32.2 parts per thousand.

There are 16 density records from the north of Russia, ranging from 1.0238 to 1.0275, the average being 1.0252.

Bottom.—This species occurs almost exclusively on soft or loose bottom, mud, sand, gravel, or loose stones, sometimes upon any one of these alone, but usually on two or more mixed in varying proportions. Perhaps the most typical bottom is gravel with sand and mud.

Occurrence.—*Heliometra glacialis* is apparently more generally distributed and more abundant about Spitzbergen and eastward than it is in the Greenland area and westward, probably owing to the existence there of much wider areas of sea bottom of the character especially suited to it found within the optimum ecological limits.

It grows to a large size only in the colder portions of its range, especially on the coasts of Greenland and in the open sea about Spitzbergen, and in the northern part of the Barents Sea and eastward. From Labrador to Massachusetts the size is always rather small, as in the region of the Faroes; about Iceland the size is even less, while on the Murman coast and in the southern Barents Sea it is represented only by what appears to be a curious dwarf variety.

Throughout its range it is, for a crinoid, most exceptional in the relative evenness with which it is distributed over the sea floor, resulting probably from its peculiar adaptation to life on the very extensive and characteristic arctic bottoms of hard mud, gravel and stones of various sizes in its very numerous cirri, which prevent it from sinking into mud, and in the great size of these organs, which enables it to cling securely to a very rough bottom.

The difference in frequency of occurrence between this species and the second characteristic Arctic comatulid, *Poliometra prolixa* (see p. 588) is most striking, and is probably due to the inability of the latter to exist on stones or rough ground because of the delicacy and fragility of its cirri.

While occasionally mixed lots of this species are brought up by the dredge including large adults, young, and even pentacrinoids, as a general rule there is a marked tendency for the animals to be associated in definite age groups so that at any one station only individuals of approximately the same size are obtained.

As under different conditions, particularly of food and temperature, these, like most animals, to a greater or lesser extent show in the young a different correlation in the relative development of the different organs and structures though in the fully grown essentially the same condition of stability appears everywhere to be attained, there is commonly an appreciable difference between specimens of the same size from different localities.

For instance in two lots of similar half-grown specimens those in one lot may show already developed the form of the brachials, the interrelationships of the lower pinnules and the shape and proportions of their segments characteristic of much larger individuals, while those in the other lot may present these features in a form characteristic of the ordinarily much smaller young. Or these features may be combined in various ways, the brachials being of the kind found in the fully grown but associated with lower pinnules of the kind characteristic of the young, etc., and they may be thus mixed not only in the individuals from any given station, but even on the different rays of single specimens.

Each feature of the fully grown has its own developmental curve, but the correlation between these different curves varies widely in different localities. Thus in the smaller individuals, with an arm length of below 200 mm., this species occurs in a wide variety of more or less marked and intergrading forms, many of which are found with developed sexual products. But as the larger individuals are all quite uniform, it is admissible to assume that, no matter how extreme the differences in the correlation of the developmental curves may be in specimens from different localities, these everywhere ultimately reach the same, or approximately the same, correlation in the fully grown. In some places, however, as on the coast of New England and Nova Scotia, it appears that a large size is never attained and the individuals never progress beyond an early sexually mature stage which retains in varying degrees juvenile characters. Such a condition also occurs in individuals found among masses of large and fully formed adults, these being, possibly, the stunted victims of too crowded conditions.

At the majority of the stations at which this species has been dredged, a few specimens have been brought up together with various representatives of the other animal groups; but in certain restricted localities it has been found to be extraordinarily abundant, often occurring in enormous numbers almost to the complete exclusion of any of the other marine animals. Thus Edward Forbes (in Forbes and Godwin-Austen, 1859) wrote that, as he was informed by Prof. Goodsir, on the authority of a collector employed by him to dredge at Spitzbergen, this species is so abundant in water of moderate depth that the bodies of the individuals frequently filled the dredge to the exclusion of all other creatures. It has since been found to occur in similar abundance in isolated and restricted localities throughout its range, excepting only within the region between Cape Cod and Labrador.

The localities at which it has been reported to occur in great numbers are the following:

Franklin Pierce Bay, Smith Sound; Murchison Sound, 46 meters; three miles off Coutt's Inlet, Davis Strait, 237 meters; near Jan Mayen, 140–526 meters; east of Iceland, 630 meters; southeast of the Faroe Islands, 631–1156 meters; off Aalesund, Norway, 820 meters; southwest and southeast of Bear Island, 130–200 meters, southwest of South Cape, Spitzbergen, 145 meters; off South Cape, Spitzbergen, 114–146 meters; west of Horn Sound, 115–160 meters; at Green Harbor, 140 meters; Spitzbergen (?Advent Bay); at the entrance to Stor Fjord, 131.5–139 meters; near Cape Palander, 73 meters; and off Taimyr Land, 66 meters.

The depth at these localities ranges from 46 to 1156 meters (234 meters less than the range for all the localities from which the species is known), the average depth being 288 meters, which is very close to the average for all localities.

The temperature varies between $-1.60°$ C. and $+2.30°$ C. (a range of 3.80° less than that for all localities), the average being $-0.25°$ C., 0.46° less than the average for all stations.

At all of these localities the bottom was mud, or mud and stones, or gravel or of a closely similar nature, which indicates that this animal thrives best on bottoms of such a character and that the growth upon them of the large fixed and arborescent plankton-feeding animals (*Primnoa*, etc.), which would compete with them for food, is not possible.

Prof. Nils von Hofsten has worked out in great detail the local distribution of this species in the Ice Fjord, Spitzbergen. He writes that it is common there, although according to his information it never occurs there in such great masses as it sometimes does elsewhere. It lives there, as usual, on a bottom of rather diverse character; apparently it is more common on mud than on stony ground, but on the other hand perhaps it is less common on unmixed mud than on different sorts of mixed bottom.

According to his observations the bathymetrical range in the Ice Fjord is from 28 to about 250 meters, but it is not impossible that it may go deeper. In the entire outer half of the fjord it was not found in a lesser depth than 70 meters, and it is absent from all the bays opening off the main fjord. Prof. von Hofsten says that the reason for this restricted distribution is not clear; either the species is everywhere commonest at these depths, or the character of the bottom (partially very loose mud) is unfavorable in the regions mentioned.

That it may occur, at least casually, in the inner portions of the bays tributary to the Ice Fjord is shown by the Prince of Monaco's record in Temple Bay, the eastward continuation of Sassen Bay, while I believe that Prof. Goodsir's collector, who reported it in such enormous numbers, worked in Advent Bay.

The Stor Fjord (Wijde Jans Water) is a much larger body of water than the Ice Fjord, with a much less incised coast line. Here this species occurs locally throughout, in from 27 to 139 meters, sometimes on fine or soft mud or clay, but usually on mud and pebbles or mud and gravel, sometimes on gravel alone. On the western side of the entrance it has been dredged on coarse gravel in enormous numbers, but though very generally distributed it has elsewhere, as in the Ice Fjord, been found somewhat sparingly.

Scheuring (1922) remarked that the *Poseidon* found very large individuals only at station 24 on a cold bottom in the central Barents Sea. The specimens from the Murman coast were all small. But wherever this species was found the individuals were numerous.

Hartlaub wrote (1900) that on the *Olga* expedition the richest catches of this species were brought up on the return journey from Spitzbergen to Hammerfest at some distance from the coast of the former, and that at many stations this form was found in quantities comparable to the masses of *Gorgonocephalus eucnemis* and *Strongylocentrotus droebachiensis*. As he is well acquainted with the comatulids, but does not mention *Poliometra prolixa* it is probable that the *Olga* did not find that species, and that all the records given by Hartlaub under *Antedon* refer to *Heliometra glacialis*.

In his account of the invertebrates collected by the *Vega*, Dr. Anton Stuxberg described what he called an *Antedon-Astrophyton* association, of which the two chief elements are this species and *Gorgonocephalus eucnemis*. He says that this is one of the few associations that are rarely investigated, and at least shows some peculiar animal forms. In a few places on the Taimyr Land coast (*Vega* stations 62, 70, 71) it is found typical and unmixed in 64 to 73 meters on a bottom of fine clay, or clay with large stones.

The community is characterized by many handsome individuals of *Heliometra glacialis* and of *Gorgonocephalus eucnemis*, which are the predominant forms. Besides these Stuxberg found at sta. 62 *Cleippides quadricuspis*, *Acgina echinata*, *Anonyx*, sp. (?*pumilus*), *Scalpellum stroemi*, *Solaster* [*Poraniomorpha*] *tumidus*, and a new pennatulid. At stas. 70 and 71 there were found in large numbers several species of polyzoans, hydroids, the smaller pycnogonids, *Chiridota laevis*, *Molpadia borealis* and *Diastylis goodsiri*, and in lesser numbers *Pteraster militaris*, *Sabinea septemcarinata*, *Idothea sabinei*, *Munnopsis typica*, *Anonyx lagena*, *Acanthozone cuspidata*, *Podocerus anguipes*, *Aegina echinata*, *Alcyonidium*, sp., *Lucernaria*, sp., and several species of mollusks and starfishes, together with the immense pycnogonid *Collosendeis gigantea*. He writes that such characteristic animal species as *Collosendeis gigantea*, the pennatulid mentioned, *Cleippides quadricuspis* and *Solaster tumidus* give a remarkable interest to this association.

This *Antedon-Astrophyton*, or more properly *Heliometra-Gorgonocephalus*, association has been subsequently noted, more or less developed, in various other places, mostly in the vicinity of Spitzbergen. It seems to mark the areas where abundant plankton is continually delivered over a bottom not firm enough for development of the large arborescent coelenterates, such as *Primnoa*, and to be composed of plankton-feeding types together with animals which abstract the food collected by them or feed directly upon them, and others which consume the organic detritus lying on or mixed with the cold surface mud.

While in the Arctic and north Atlantic oceans the ranges of *Heliometra glacialis* and of *Gorgonocephalus eucnemis* are practically the same and the latter lives between 38 and 1187 meters, in the Pacific the conditions are quite different. Here *Heliometra* is confined to the Sea of Okhotsk and to the western side of the Sea of Japan, where it lives under strictly arctic surroundings, but *Gorgonocephalus eucnemis* is very widely distributed, occurring both further southward in the Eastern Sea and much further northward to and throughout the Bering Sea, where it is especially abundant, and thence southward along the American coast to California, here and in the Bering Sea being associated with the species of *Florometra*. Furthermore *Gorgonocephalus eucnemis* is found in temperatures as high as 15.89° C.

In the Okhotsk and Japan Seas *Gorgonocephalus eucnemis* was found by the *Albatross* associated with *Heliometra* only at stations 4983, 4986 and 5021.

Occurrence of the pentacrinoids.—The pentacrinoid young of this species have been taken at the following localities:

Davis Strait, 3 miles off Coutt's Inlet, 237 meters, and off Cape Raper, 110 meters; *Vøringen* station 48, east of Iceland, 547 meters, −0.3° C.; *Michael Sars* station 74, 1902, southeast of the Faroes, 1130 meters, +0.03° C.; *Alexander Kovalevski* station 70, Kola Fjord, 91–128 meters; *Vøringen* station 312, west of Bear Island, 1203 meters, −1.2° C.; *Vøringen* station 363, off the northwestern coast of Spitzbergen, 475 meters, +1.1° C.; *Frithiof*, western Spitzbergen, 80–300 meters; *Varna* station 18, off the mouth of Kara Bay, 101 meters, −1.2° C.; *Dijmphna*, Kara Sea.

All of the pentacrinoids dredged by the *Porcupine* in the "cold area" of the Faroe Channel belong to *Poliometra prolixa*, none to this species.

The pentacrinoids have been found from June 16 to September 13, which dates, however, represent nothing more than the limits of the practicable working season in the regions in which they occur. As they probably take nearly or quite, possibly over, two years in attaining their full growth and as the breeding season in most of the deeper localities in which they occur is probably continuous throughout the year because of the unvarying conditions, intensive work in any rich region away from the shore line should yield at any one time a good series of pentacrinoids in all stages.

The depths at which they have been found vary between 80 and 1203 meters, the average being 440 meters; but this probably has little significance, as they are so easily overlooked among the fragments of the adults.

The temperatures range between −1.20° C. and +1.10° C., the average being −0.31° C. Though possibly without significance, this may indicate that these animals breed more freely in the colder portions of their range and, where there is a seasonal difference, in the colder season.

The pentacrinoid from the *Dijmphna* expedition and the two collected by the *Frithiof* in Spitzbergen have already been described (Part 2, p. 528).

The two dredged by the *Varna* were described by P. H. Carpenter (1887). Though no adults accompanied them there can be no doubt that they represent this species.

The length of the larger is 35 mm., which is about equally divided between the crown and the column. The latter consists of 29 segments, the last of which is somewhat irregular in shape and has rather the appearance of being a root-joint like that at the bottom of the stem in *Rhizocrinus* and *Bathycrinus*. The stem as a whole is singularly like that of the young *Rhizocrinus*.

Beneath the centrodorsal come three discoidal segments, gradually increasing in thickness. The next is about as high as wide, and those just below gradually increase in height while diminishing slightly in width until they become cylindrical and elongated. In the lower part of the stem the width increases again, especially towards the ends of the segments, which assume the characteristic dice-box shape, while the segments immediately above the root-joint, though the stoutest on the whole stem, are distinctly shorter than those above, just as in *Rhizocrinus* and *Bathycrinus*.

The centrodorsal bears 15 cirri, the longest of which reaches 5 mm. in length and consists of about 18 segments with a terminal claw, but no opposing spine, slight indications of which appear on some of the other cirri.

The radials are partly overgrown by the centrodorsal so that but little of their dorsal surface is visible, though they extend upwards in the interradial angles of the calyx at the sides of the IBr_1; these are relatively long, transversely oblong, and considerably incised to receive the posterior process from the rhombic axillaries.

There are over 30 elongated brachials, the second with a slender pinnule 3 mm. long and consisting of about 15 segments; the P_a are mere stumps of less than half a dozen segments, but the next four pinnules gradually increase in size. Beyond this point the arms present a certain amount of variation. Two or three brachials are altogether devoid of pinnules on some arms, and the first long pinnule, consisting of 12 slightly elongated segments, appears on the tenth or eleventh brachial; while on other arms these brachials bear pinnule stumps but smaller ones than those on the brachials nearer the axillaries.

The two basal segments of the outer and longer pinnules are shorter than their successors, trapezoidal in shape, and in contact by their longer ends, thus showing traces of the peculiarity which is so especially marked in *Heliometra glacialis*.

In the smaller pentacrinoid the column measures 18 mm. and the crown 14 mm. The column consists of 18 segments, most of which are cylindrical; but instead of three discoidal segments immediately beneath the centrodorsal there is only one. This is somewhat hexagonal in outline, being wider a little above its equator than at either end, while the segment below it, although longer than wide, exhibits a similar expansion for some little way down from its upper end.

The cirri are almost the same in number, size, and number of segments as in the larger pentacrinoid. But the radials are much less concealed and form a well-defined cup. The articular facets do not occupy their whole sides, but a portion of the dorsal surface remains on either side of each facet so that the width of the IBr_1 is less than that of the radials.

Neither the axillaries nor the second brachials have such strong posterior processes as they do in the larger pentacrinoid, and the pinnules borne by the latter are quite small with only 6 or 8 short segments. The pinnule on the fourth brachial is a mere stump, and traces of still smaller stumps appear on some of the fifth brachials. The following segments, up to the thirteenth, bear no pinnules, beyond this point there are 6 or 8 pinnules on either side.

Grieg (1904) has described in detail the pentacrinoid from *Michael Sars* station 74, 1902. This pentacrinoid, which is attached to a sprig of *Bicellaria alderi*, is 24 mm. in total length, the crown being 7.5 mm. long. The uppermost columnals, just under the centrodorsal, are short and discoidal, those in the middle of the stem are cylindrical, and the distal are hour-glass shaped, being somewhat constricted centrally. The topmost columnal is 0.18 mm. long, the second 0.14 mm., the third 0.23 mm., the fourth 0.37 mm., and the fifth 0.46 mm. The largest columnal is 0.64 mm. long, 0.28 mm. broad at the ends, and 0.18 mm. broad in the middle. The centrodorsal bears a circlet of 10 cirri which are 3 mm. long, composed of 9 to 10 segments and a terminal claw. On the distalmost segment there is a feebly developed opposing spine, and on the distal ends of the other segments there are small dorsal spines. The radials and brachials recall most nearly those of the smaller *Varna* specimen, especially the axillaries. But in the *Varna* specimen there are no pinnules on the 11 lowest brachials, while in this there are pinnules on the second brachials. P_1 and P_2 are of equal size and have about 15 segments, their form recalling that of the same pinnules in the adults. The arms consist of 26 to 28 brachials.

Grieg (1904) suggests that one of the pentacrinoids described by M. Sars (1868, p. 50, pl. 6, fig. 20) which was dredged at Brettesnaes, Lofoten Islands, in 183 to 366 meters, belongs in reality to this species and not to *Hathrometra sarsi* as supposed by Sars. He bases his conclusions on the shape of the ambulacral deposits. But until these are much better understood than they are now, and in view of the fact that *Heliometra glacialis* is not known from the vicinity of the Lofoten Islands, it seems safe to assume that Sars' determination was correct.

History.—The history of this species falls naturally into two divisions, which are rather sharply separated. The first division includes the accumulation of information regarding its range and habitat and the physical conditions under which it lives, and is inextricably intertwined with the history of Arctic exploration, while the second includes the development of our knowledge concerning its anatomy and the finer details of its structure and its development, and is quite inseparable from the history of the same features in *Antedon*. The only one who has contributed to both lines of investigation has been P. H. Carpenter.

It is most practicable, however, to divide the history into a section outlining the various expeditions by which this species has been obtained, which will serve equally for all the other arctic crinoids, and a second section dealing with the records by individuals personally interested in this animal and including the anatomical, morphological and nomenclatorial history.

So far as I have been able to ascertain, this species was first found by Capt. John Phipps in 1773 in the course of his work in mapping the northern coast of Spitzbergen. This expedition, which consisted of the two small war vessels of the type known in those days as "bombs," the *Racehorse* and the *Carcass*, resulted from the efforts of the Hon. Daines Barrington and of the Royal Society who prevailed upon the British Government to undertake anew the work of Arctic exploration with the general object of acquiring additional knowledge in all branches of science. Capt. Phipps' record under the name of *Asterias pectinata* (1774, 1775) was repeated by Scoresby (1820) and by Dewhurst (1834).

In the British Museum there is a large specimen without indication of locality which was presented by the Admiralty. It might possibly have come from this expedition. Two other fine specimens, both of them bleached white, are simply labeled *Dorothea*. Since the zoological collection of the Royal College of Surgeons was passed on to the British Museum it is almost certain that these are two of Leach's original specimens. The *Dorothea* and *Trent* were two whalers, commanded by Capt. David Buchan and Lieut. John Franklin, which sailed in April 1818, to try to force a passage north of Spitzbergen, since Scoresby had reported the icy seas to be remarkably open the preceding year. In the same month two other whalers, the *Isabella* and the *Alexander*, commanded by Capt. James Ross and Lieut. Edward Parry, left England to attempt the northwest passage. These expeditions were largely due to the efforts of Sir John Barrow and also to the passage by Parliament in 1818, largely thanks to Barrow, of a measure through the operation of which very substantial rewards would accrue to successful Polar expeditions.

Both the *Dorothea* and the *Trent* secured this species, in deep water off the northwest coast of Spitzbergen, not long before they were severely nipped in the ice and forced to return to England.

In 1837 Prof. Sven Lovèn undertook a voyage of two months to the western coast of Spitzbergen, which was indirectly the stimulus for the later Swedish polar expeditions. The cost of the voyage, which was begun at Hammerfest in the schooner *Enigheten*, was entirely defrayed by Lovèn himself.

In the year 1856 Prince Napoleon made a journey to Norway and Iceland, stopping on the way at Bergen. Here he was received with great pomp and formality, and among other gifts which he received were several specimens of this species which probably had come from Spitzbergen, whence "curios" of all sorts were being constantly brought back by whalers and others. One of these specimens is now in the Paris Museum.

The loss some time subsequent to 1845 of Sir John Franklin's expedition in the *Erebus* and *Terror*, with 134 officers and men, served to focus public attention on the Arctic, and the discovery among the Eskimo of a number of objects undeniably belonging to the expedition by Dr. Rae, who in 1854 conducted a party in the interests of the Hudson Bay Company, and brought back these items with him to England, still further stimulated general interest. Between 1854 and 1858 about 15 expeditions were sent out from England and the United States in search of some trace of the missing men; but they were uniformly unsuccessful. Undeterred by previous failures, Lady Franklin purchased and equipped the small yacht *Fox*, which sailed from Aberdeen in July 1857 under the command of Mr. Leopold McClintock. Though unsuccessful in the main object for which she was sent out, the *Fox* brought back important zoological collections, including specimens of this species from Melville Bay.

In 1864 A. E. Nordenskiöld and N. Duner, accompanied by A. J. Malmgren, sailed for Spitzbergen, also visiting Bear Island, in the schooner *Axel Thorssen*. Their purpose was to conclude the reconnoitering of the southern part of the chain of triangles for measuring an arc of meridian, the northern part of which had been staked out in 1861.

In 1868 a Swedish expedition, which was equipped and manned through the mediation of the Minister of Marine, Count von Platen, out of the grant for naval maneuvers, started for Spitzbergen under the leadership of A. E. Nordenskiöld. The vessel used was the iron steamer *Sofia*, belonging to the Post Office Department. The following naturalists took part in this expedition: S. Berggren, Th. Fries, A. E. Holmgren, G. Nauckhoff and F. A. Smitt. The commander of the *Sofia* was F. W. von Otter, the second-in-command L. Palander, and the surgeon C. Nyström. Bear Island was visited and at Spitzbergen the fjords on the west and north coasts were studied.

With the three cruises of the *Porcupine* in 1869, the intensive study of the broader aspects of oceanography may be said to have been begun. The first of these cruises was off western Ireland and northwestward to Rockall, the scientific work directed by Mr. J. Gwyn Jeffreys, assisted by Mr. William Lant Carpenter; the second, off southwestern Ireland, was under the supervision of Prof. C. Wyville Thomson, assisted by Mr. Hunter; and the third, northward from Scotland to the Shetlands and the Faroes, was under the leadership of Dr. William Benjamin Carpenter, accompanied by Prof. Wyville Thomson and assisted by his son Mr. Philip Herbert Carpenter, all three of whom had served in the same capacities on the *Lightning* in August and September of the previous year. On this third cruise the *Porcupine* discovered this species in the Faroe Channel, a region far removed from any previously known habitat.

In the summer of 1872 Mr. Benjamin Leigh Smith made a voyage on his schooner-yacht *Samson* to the north of Spitzbergen, and in the following year he visited Spitzbergen again in the *Diana*.

An Austro-Hungarian expedition in the steamer *Tegetthof*, commanded by Captain Weyprecht, left Tromsø on July 14, 1872. Franz Josef Land was discovered, other important geographical observations were made, and large zoological collections were brought together. But the *Tegetthof* encountered particularly unfavorable conditions, and it was finally found necessary to abandon her. The party from the *Tegetthof* was picked up by a Russian schooner and reached Vardø on September 3, 1874, bringing with them a considerable amount of their zoological material.

The *Challenger* in 1873 dredged this species off Halifax, Nova Scotia, and specimens from this locality were presented by Sir Wyville Thomson to the local museum.

In 1872–73, under A. E. Nordenskiöld, the first wintering of the Swedes in Spitzbergen was undertaken. The State placed at the disposal of the expedition the steamer *Polhem*, built as a winter mail steamer for the Baltic, and the brig *Gladan*, both equipped and manned. A special transport vessel, the *Onkel Adam*, was chartered in addition. The naturalists of the expedition were F. R. Kjellman and Aug. Wijkander; the commander of the *Polhem* was L. Palander, and the surgeon was A. Envall; Lieut. E. Parent of the Royal Italian Navy also accompanied the expedition.

In 1875 the two steamers *Alert* and *Discovery*, under the command of Capt. (later Adm., Sir) George Nares, detached from the *Challenger* to lead this expedition, with

Comdr. (later Adm., Sir) Albert H. Markham, Lieut. (later Adm.) Pelham Aldrich, also detached from the *Challenger*, and Capt. (later Col., Sir) Henry W. Feilden as naturalist, on the *Alert*. This expedition found this species in Franklin Pierce and in Discovery Bays.

With the *Alert* and *Discovery* there was sent out a third ship, the *Valorous*, as a store ship to accompany them as far as Disco in Davis Strait. It was arranged that she should undertake dredging and sounding work on her return journey. The *Valorous* was commanded by Capt. Loftus F. Jones, and carried as naturalist Prof. J. Gwyn Jeffreys, who had as his assistant Mr. P. Herbert Carpenter.

Dr. P. Herbert Carpenter thus laid the foundation for his life's work on recent crinoids by service with three marine surveying expeditions, that of the *Lightning* in 1868, the third cruise of the *Porcupine* in 1869, and the cruise of the *Valorous*.

In 1876 Prof. Nordenskiöld, who had previously participated in no less than seven arctic expeditions, undertook another voyage to Spitzbergen in the *Ymer*, on which he gathered additional information concerning the present species.

On July 4, 1878, he commenced on the *Vega* that extraordinarily successful expedition in the course of which Asia and Europe were completely circumnavigated. With him on this expedition were Lieut. Palander as commander of the ship, Lieut. (later Adm.) Hovgaard of the Danish and Lieut. Bove of the Italian navies, and Dr. Anton Stuxberg as naturalist. An enormous extent of unknown territory to the east of Nova Zembla was explored and this species was found, often in great abundance, in many new localities.

The Norwegian North Atlantic Expedition of 1876–78 was the first expedition dispatched for the purpose of making a detailed survey within a relatively restricted oceanic area. In this case the region included the area between Vardø, western Spitzbergen, Iceland, the Faroe Islands, and Stavanger. The steamer *Vøringen*, chartered by the Norwegian government for this work, sailed from Bergen on June 1, 1876, under the command of Capt. C. Wille of the Norwegian navy, with Profs. George Ossian Sars and D. C. Danielssen as naturalists.

In 1877 the United States Fish Commission (subsequently the Bureau of Fisheries, Department of Commerce and Labor, later Department of Commerce) carried out extensive dredging operations, using the steamer *Speedwell*, her headquarters being first at Salem, Massachusetts, but later, during the session of the commission of arbitration on the fisheries claims, at Halifax, Nova Scotia. The work off the coast of Nova Scotia yielded many specimens of this species.

In 1878 the Dutch schooner *Willem Barents* began a series of annual polar voyages with the objects of examining the ice and of making natural history collections around Spitzbergen and in the Barents Sea. She was at first commanded by Lieut. A. de Bruijne, with Lieut. Koolemans Beijnen as second-in-command, succeeding Lieut. de Bruijne on his death after the first cruise. Lieut. Koolemans Beijnen had previously accompanied Sir Allen Young on two polar voyages in his steam yacht *Pandora*, which was later purchased from him by Mr. Gordon Bennet, rechristened the *Jeanette*, and finally lost somewhere in the vicinity of Wrangel Island.

In 1882 Lieut. Hovgaard, who had accompanied Baron Nordenskiöld on the *Vega*, fitted out a small steamer, the *Dijmphna*, with which he reached the Kara Sea, where, however, he was beset with ice.

In 1875 Lieut. Weyprecht had urged the establishment of a number of stations within or near the Arctic circle for the purpose of recording complete series of synchronous meteorological and magnetic observations, a plan which was successfully carried into effect after his death. In the present connection the work of two of the stations founded in accordance with this plan is of interest.

The Dutch were to establish a station at Dickson Harbor. For this work the *Varna* was equipped and sent out; but in the winter of 1882–83 she was caught in the ice in the Kara Sea and lost, her crew taking refuge on Lieut. Hovgaard's ship the *Dijmphna*.

One of the American parties, under Lieut. (later Maj. Gen.) Adolphus W. Greely, sailing on the *Proteus* August 11, 1881, carried out its portion of the work successfully, though disaster overtook it, and of the original party of 24 only seven were found alive in 1884 by the rescuing steamers *Thetis* and *Bear*. It was this expedition that brought back the small specimen later (1907) described as *Antedon arctica*.

The Danish man-of-war *Fylla* visited west Greenland in 1884, carrying Dr. Th. Holm, who had previously accompanied Lieut. Hovgaard on the *Dijmphna* as naturalist.

At this time the collections of the U.S. National Museum were being materially enriched through the cooperation of the Gloucester fishing fleet. Strange and curious animals brought up on the fishing lines were carefully preserved and turned over to a representative of the U.S. Fish Commission for shipment to Washington. It was through this cooperation that all the known specimens of the extraordinary *Tremaster mirabilis* were obtained, as well as a very considerable number of examples of the present species from regions where previously it had not been known to occur and from bottoms on which dredging is impracticable. The Gloucester fishing schooners which secured this form on the fishing banks were the *Martha and Susan*, the *Mystic*, the *Paul Revere*, the *Marion*, the *Rebecca Bartlett*, and the *Proctor Brothers*.

In the summer of 1885 the U.S. Fish Commission steamer *Albatross* made a large number of dredge hauls off Newfoundland and Nova Scotia, and in the following summer again worked off Newfoundland, meeting with this species on both cruises.

Prof. Willy Kükenthal visited Spitzbergen in 1886 and again, with Prof. Alfr. Walter, in 1889, finding this species in the Stor Fjord on the second trip.

A Swedish expedition to Spitzbergen in 1890, sailing in the *Lofoten*, under the command of Capt. Marcus Johnsen, and including G. Nordenskiöld as geologist, Baron A. Klinkowström as zoologist, and J. A. Björling as botanist, secured additional information regarding the occurrence of this form in north and west Spitzbergen.

In 1892, through the courtesy of Messrs. David Bruce & Co. of Dundee, Mr. Alexander Rodger, an assistant to Prof. D'Arcy W. Thompson, obtained a berth on the whaler *Esquimaux* and proceeded with her on her usual sealing and whaling voyage. Thanks to Mr. Rodger's energy and industry, and to the sympathy for his work shown by the commander, Capt. Jeffery Phillips, very considerable collections were brought back. *Heliometra juvenalis* was described (1908) from specimens in this collection.

An expedition to East Greenland under the command of Lieut. C. Ryder left Copenhagen on the *Hekla* on June 7, 1891, returning on October 12, 1892.

The Russian expedition to Nova Zembla in the *Nayezdnik* in 1893 had as naturalist Mr. N. M. Knipovich.

The Peary Relief Expedition of 1894 on the steamer *Falcon*, under the command of Captain Bartlett and the leadership of Mr. Henry G. Bryant of Philadelphia, sailed for the West Greenland seas on July 7 to bring back Lieut. Robert E. Peary and his party. The naturalist of this expedition was Dr. A. Ohlin, a Swede. Doctor Ohlin left the expedition on its return to Godhavn, Disco, proceeding thence to Copenhagen and taking with him the relics of the ill-fated Björling expedition on the *Ripple*, which had been found on the Cary Islands.

The Jackson-Harmsworth Expedition, outfitted and dispatched by Mr. Alfred C. W. Harmsworth (later Lord Northcliffe) and commanded by Mr. Frederick G. Jackson, left England in 1894 on the *Windward* and explored Franz Josef Land and the adjacent regions. On his return, Mr. Jackson brought back with him Dr. Fridtjof Nansen. The *Windward* was later given by Mr. Harmsworth to Commander Peary.

For four months in 1895 and again for the same length of time in 1896 the Danish cruiser *Ingolf* explored the arctic seas around Iceland, Jan Mayen and Greenland, the assembling of zoological collections being the principal object of these expeditions. The ship was commanded by Capt. (later Adm.) C. F. Wandel, and carried as zoologists Drs. H. J. Hansen, Hector F. C. Jungersen, and W. Lundbeck, Mr. Wesenberg-Lund taking the place of Dr. Hansen in 1896.

In 1897 the Norwegian fisheries steamer *Michael Sars* was built, and at once, under the direction of Prof. Johan Hjort, commenced a series of most important and unusually productive marine investigations. On her cruises of 1900, 1901, and 1902, under the command of Professor Hjort, she added materially to the knowledge of the distribution of this species.

In 1898 Dr. A. G. Nathorst carried out his first expedition in the ship *Antarctic*, during which Bear Island, Bell Sound, and King Charles Land were explored and mapped, Spitzbergen was circumnavigated, and Giles Land was visited. The scientific members of the expedition were G. and J. G. Andersson, A. Hamberg, H. Hesselman, O. Kjellström, G. Kolthoff, E. Levin and A. Ohlin.

The second Norwegian expedition in the *Fram*, under the leadership of Capt. Otto Sverdrup, left Christiania (Oslo) on June 24, 1898, with the object of ascertaining the extension of Greenland toward the north and determining the exact configuration of the mainland. The zoologist was Mr. Bay, who had previously served on the *Hekla* with Lieut. Ryder. They obtained *Heliometra* in the area of Ellesmere Island.

The German expedition in the *Helgoland*, Captain Rüdiger, under the leadership of Mr. Theodor Lerner, returned to Hammerfest in August 1898, without having found a trace of Andree's expedition, one of the purposes for which it had been sent out. But it brought back unusually extensive zoological collections from the east Spitzbergen region together with a mass of accurate data on the occurrence of marine life there which served as the basis for an elaborate series of monographs published under the title of the "Fauna Arctica" by Römer and Schaudinn.

Extending to the northward the scope of his oceanographic work, the Prince of Monaco visited Spitzbergen in the *Princesse Alice* in 1898, and again in 1899, securing this species in both years.

The Princeton Expedition to North Greenland, or the Peary Auxiliary Expedition of 1899, with Professor William Libbey and Dr. Arnold E. Ortmann, made important collections in new territory.

The Carlsberg Fund, or Amdrup Expedition to East Greenland was sent out for the purpose of surveying the northeastern coast from lat. 66° N. to Scoresby Sound. The ship employed was the *Antarctic*, with 1st. Lieut. G. Amdrup in command. The work of this expedition falls naturally into two sections, that carried out in 1898–99, and that done in 1900.

On May 20, 1899, the Swedish Professor A. G. Nathorst sailed from Stockholm on the *Antarctic* for the northern part of the eastern coast of Greenland to find if possible some trace of Andree who had ascended in a balloon from Danish Island, Spitzbergen, on July 11, 1897, and who had been last heard from two days later when a message arrived by carrier pigeon.

In 1900 a Swedish expedition under the direction of Gustave Kolthoff visited northeastern Greenland on the whaler *Frithiof* between July 31 and August 25, going as far north as lat. 74°58′ N.

During the seasons of 1899 to 1901 the Russians sent to Spitzbergen several ships which made important zoological collections, although their chief purpose was the determination of an arc of meridian, in cooperation with Swedish expeditions, and the taking of gravity observations. These ships were, in 1899, the *Bakan*, with Dr. A. A. Birula as naturalist, and the famous ice-breaker *Yermak*, with Dr. A. A. Tschernyschew as naturalist; in 1900 the *Bakan* again, with Dr. A. N. Wolkowitsch as naturalist; and in 1901 the *Bakan* and the *Ljedokol II*. Most of the collections were made in the southern part of western Spitzbergen and in the Stor Fjord.

During the summer of 1901 the *Yermak* dredged to west central and northwestern Nova Zembla, and thence northward to Franz Josef Land.

In 1901–02 Dr. Chr. Kruuse undertook explorations in eastern Greenland, the objects of which were partly botanical, partly ecological; but his instructions enjoined him in addition to investigate meteorological, biological and geological phenomena insofar as his principal duties permitted. The region in which he worked was that about the Tasiusak Fjord, near Angmagsalik (lat. 65°37′ N.).

The Russian Arctic Expedition of 1900–03 worked along the Siberian coast, gathering the first information regarding the distribution of this species in the region from Taimyr Land eastward to the New Siberian Islands. This expedition sailed in the *Zarya* (formerly the Norwegian whaler *Harald Hårfager*) and was under the leadership of Baron E. W. von Toll, well known for his previous work in the New Siberian Islands, who had with him as oceanographer Lieut. (later Adm.) Alexander V. Koltschak and as zoologist Dr. A. A. Birula.

The only biological station within the range of this species is that at Alexandrovsk on the Kola Fjord, established in 1899 as the continuation of the older station which was founded in 1881 by Prof. N. P. Wagner on the island of Solovetski near Archangel and from 1904 onwards maintained throughout the year. Dr. S. Averinzew was the first resident director. This species is common and very generally distributed here, and there are many records resulting from the work of the *Orea* in 1904–05 and of the *Alexander Kovalevsky* in 1908–09; but so far only its local distribution has been studied.

In 1905 the Duke of Orleans chartered the *Belgica* and, with Capt. A. de Gerlache in command, visited Spitzbergen, sailing thence across to Greenland, which he first sighted at Cape Bismark.

On July 8, 1907, the Duke of Orleans again sailed on the *Belgiea*, this time for Nova Zembla. Passing through the Matyushin Shar, the *Belgica* was caught in the ice, with which she drifted southward, finally reaching the Kara Strait on August 16. Sailing northward to the Matyushin Shar, she completed the circumnavigation of the southern island of Nova Zembla, and after cruising along the western coast of the northern island as far as lat. 78° N. she returned to Norway, arriving on September 11.

The *Danmark* Expedition to East Greenland in 1906–08 or, as it is commonly called, the Mylius-Erichsen Expedition, was sent out primarily to chart the quite unknown stretch of coast from the northernmost point reached by Koldewey, in the vicinity of Cape Bismark, to the limit of Peary's discoveries, Navy Cliff, and the eastern coast of Peary Land. The *Danmark*, previously the Norwegian polar ship *Magdalene*, had been especially built for polar work at Peterhead, Scotland, in 1855. The leader of the expedition, most unfortunately lost, was Ludvig Mylius-Erichsen. First Lieut. A. E. M. J. C. Trolle, second-in-command, took command of the ship. The naturalist for the lower invertebrates was Mr. Frits Johansen (later connected with the Victoria Memorial Museum at Ottawa); but a very considerable part of the collection was made by the surgeon, Dr. Jens P. J. Lendhard. The *Danmark* left on June 24, 1906, reaching Greenland by way of the Faroes and Iceland, and returned in 1908.

The Swedish Expedition to Spitzbergen in 1908 was sent out especially for the purpose of studying intensively, from all points of view, an arctic fjord. The greatest emphasis was placed on the investigation of the bottom fauna. The object was not to amass material for the study of systematic zoology but to investigate ecological zoogeography in the broadest sense.

The expedition sailed on the *Svensksund*, commanded by Capt. C. G. Norselius, and the zoologists were Prof. Nils von Hofsten and Mr. S. Bock. The work was confined to the Ice Fjord.

This expedition deserves especial notice, for it marks the inception of a new line of Arctic investigation, the well-planned and intensive study of a typical and restricted region.

In the summer of 1908 Mr. Owen Bryant dredged along the Labrador coast, obtaining definite records for this species from a region where its occurrence had previously been known only through a casual reference by Sir Wyville Thomson in 1873.

The *Tjalfe* under the direction of Dr. Adolph Jensen made two trips to Greenland, one in 1908 and the other in 1909, for the purpose of studying hydrographical conditions and the distribution of the larger species of fish.

In 1911 Dr. V. Nordmann was sent out by the Committee for Geological and Geographical Investigations in Greenland to study the fauna of the northern Strøm Fjord in western Greenland (about lat. 67°30′ N.). This location is typical of those Greenland fjords in which the bottom temperature is below 0° C., and as a consequence all animal life is of arctic, or at least of boreo-arctic, character without any true Atlantic (boreal) deep sea forms.

The work of the *Tjalfe* in 1908 and 1909 had shown that in some of the fjords of southern Greenland, south of the ridge running across Davis Strait in about lat. 66° N., there was free access to the bottom water of the Atlantic except in cases where the mouth of the fjord itself was blocked by a submarine ridge. In these fjords, while the higher levels were found to contain the usual arctic or boreo-arctic littoral fauna, the deeper portions showed the presence of Atlantic (boreal) deep sea forms. The Committee chose as typical of such fjords the Kvane Fjord, near Frederikshaab (about lat. 62° N.) and the Brede Fjord, between Julianehaab and Ivigtut (about lat. 61° N.), and Dr. K. Stephensen, accompanied by Messrs. K. Birket-Smith and N. Petersen, was sent out in 1912 to make an intensive study of them. The dredging operations were carried out in the motor boat *Rink*.

About 1912, Dr. Jean Charcot, on his Arctic expeditions in the *Pourquoi Pas?* dredged this species around Jan Mayen.

In 1913 the German research vessel *Poseidon* dredged widely in the Barents Sea, obtaining salinity and temperature records at each station.

The Norwegian North Polar Expedition of 1918–1925 in the *Maud*, went much farther to the east and collected this species at the New Siberian Islands as well as near Wrangel Island, not far from the Bering Strait and close to longitude 180°. This was a considerable extension of the known range.

On a trip to the eastern side of Hudson Bay in the summer of 1920 Mr. Frits Johansen, formerly the naturalist of the *Danmark* expedition and later one of the naturalists of the Canadian Arctic Expedition of 1913–18, discovered this species in a region far removed from any previously known locality.

The Norwegian Fishery Investigations carried out an extensive survey of the fauna of the Spitzbergen Bank area from 1923 to 1926, using the ships *Blaafjeld*, *Tovik* and *Armauer Hansen*, under the leadership of Thor Iversen and Einer Koefoed.

From 1927 to 1931 in the *Zarnitza*, *Sedow* and *Lomonossow*, the Arctic Institute of the U.S.S.R. sponsored a series of expeditions to the northern Kara Sea and Franz Josef Land, led by L. O. Retowsky and W. L. Wagin. *Heliometra* was taken at a number of stations by all these ships.

The deep basin of Baffin Bay was investigated in 1928 by the Danish Godthaab Expedition and from 1931 to 1933 the seventh Thule and second Scoresby Sound Committee's expeditions obtained some further material from the east coast of Greenland.

The Canadian Arctic, as well as Greenland, has also been the site of investigations in recent years. The Hudson Bay fisheries expedition in the *Loubyrne* in 1930 was followed by the collections of Captain Robert A. Bartlett in the *Morrissey* around Baffin Land and Greenland and since the war in the Hudson Strait area by the *Calanus*, sponsored by the Eastern Arctic Investigations of the Fishery Research Board of Canada.

The specimens collected by Captain Phipps in 1773 and recorded by him in 1774 and 1775 seem to have disappeared; but those brought home by the *Dorothea* and the *Trent* in 1818 found their way into the Museum of the Royal College of Surgeons and there formed part of an exhibit illustrating the comparative anatomy of animals. Two from the *Dorothea* are now in the British Museum.

In the catalogue of the contents of the College of Surgeons Museum published in 1830 these specimens are listed under the name of *Alecto glacialis*, which is ascribed to Dr. William Elford Leach, and a short description of their digestive system is given.* In spite of a most diligent search I have been unable to find that Doctor Leach ever formally diagnosed *Alecto glacialis*, and yet I feel that he must have placed a short description of it somewhere. Though for all practical purposes utterly inadequate, technically the notice of the digestive system published in 1830 is, under the rules of the International Code of Nomenclature, sufficient to establish the name which therefore can not be considered a *nomen nudum*. This name *glacialis* was used by Sir Richard Owen in 1833, in the "Penny Encyclopedia" in 1837, by Walker in 1860 and 1875,

* This statement is incorrect; it is further discussed on p. 341.

and by Knight in 1867, while a specimen in the Paris Museum mentioned by Dujardin and Hupé in 1862 and examined by myself in 1910 also bears it.

For some years I have used this name in preference to *eschrichtii* which first appeared 10 years later and was not formally established until 1841, both because it is permissible, if not obligatory, under the accepted code to do so and in order to call attention to the zoological work of those early explorers, Buchan and Franklin, with whose material the name is found associated.

In 1841 Prof. Johannes Müller, unaware of the previously published references to this species, described in detail a specimen which he found in the Anatomical and Zoological Museum, Berlin, and which had been collected in Greenland by Prof. D. F. Eschricht, calling the species *Alecto eschrichtii.* He had in the previous year mentioned it under the name of *Comatula eschrichtii*, giving merely the distal intersyzygial interval. In 1849 he published a revised description, calling it *Comatula* (*Alecto*) *eschrichtii.*

In 1853 Mr. William Stimpson recorded this species from the island of Grand Manan in the Bay of Fundy, in 45 meters. This record has been very widely noticed, but his specimen was in reality an example of *Hathrometra tenella* as is shown by its size and color. He mentions, however, an individual of this species from Greenland in the collection of Prof. Louis Agassiz which is probably the one referred to by Mrs. E. C. and Mr. Alexander Agassiz in 1865 and 1871.

In 1857 Prof. Christian Lütken recorded it, under the name of *Alecto eschrichtii* from Prøven, Greenland, where it had been found by Pastor Jørgensen in 36 meters. To him belongs the credit of identifying with Müller's *Alecto eschrichtii* the *Asterias pectinata* of Phipps, Scoresby and Dewhurst; but he seems never to have come across the references to the name *glacialis.*

In 1860 Walker recorded this species as *Alecto glacialis* from the collections made by the *Fox* in 1857, his final memoir appearing in 1875.

In 1865 Mrs. E. C. and Mr. Alexander Agassiz mentioned the occurrence of this species in Greenland in 274 meters, a new depth record and therefore a record based upon previously unnoticed material. The specimens to which reference is made are undoubtedly those numbered 282 in the collection of the Museum of Comparative Zoology, and apparently also those numbered 54. These were given to the Museum by Prof. Louis Agassiz in 1863, but there is no evidence as to how he obtained them. Some others in the collection (281) were purchased from Salmin of Hamburg in 1859. There is a possibility that the lot numbered 54 was collected by Dr. Hayes on the schooner *United States*, which left Boston on July 10, 1860, and returned on October 23, 1861. Dr. Hayes was already familiar with work in the Arctic, for he had previously served with Dr. Kane in the *Advance*, which, together with the *Rescue*, was sent out by Mr. Grinnel in search of Franklin.

Some of the specimens from "Greenland" in the British Museum may have been collected by Dr. Robert Brown and Mr. Edward Whymper near Disco in 1867.

In 1870 Th. Jarzynsky published a preliminary catalogue of the animal life on the Murman coast in which he included "Alecto sarsii" and "Alecto, sp.," both of which he gave from the Arctic seas and the western region of the Murman littoral, the Motka, Kola, Ura, Ara and Litza fjords. I have no doubt whatever that both of these names refer to this species. In the Kola Fjord very small specimens with about 20 cirrus segments are common, and these are unquestionably Jarzynsky's *sarsii;* the unnamed form was probably based on larger individuals, which in general appearance are more or less different, especially through lacking the spines on the division series and arm bases. The only other littoral or sublittoral crinoid in the Arctic is *Poliometra prolixa* which, so far as known, never occurs under the conditions found in these fjords. If it did exist in this region, it would surely have been brought to light by the extensive dredging operations which have been carried on in connection with the work of the Murman station.

In the northern part of western Greenland, as I am informed by Dr. Morten P. Porsild, this species is occasionally taken by the Greenlanders and by them traded to Europeans. This was the origin of the specimen of which Professor Lütken describes a color sketch by Mr. H. P. J. Møller, who was Inspector for North Greenland under the Godhavn (Disco) District government from 1843 to 1845; of those recorded from Melville Bay, 1858, and Prøven, 1866, which were brought back by Mr. C. M. S. Olrik, the Inspector for North Greenland from 1846 to 1866, succeeding Mr. Møller; and of that from the Upérnivik District obtained by Lieut. C. Ryder on October 2, 1887. The example from Kagssimiut (Kaksimiut) in the Julianehaab District, taken on mud in 36 meters and recorded by Professor Lütken, was secured by the Rev. J. F. Jørgensen, the Pastor for this district from 1835 to 1841.

In the early days the trade between Greenland and Europe was almost entirely in the hands of the inhabitants of the town of Wyck on the island of Før, one of the North Friesland islands off the coast of Schleswig. In those times all ships trading with distant lands brought back, in addition to the usual articles of commerce, all sorts of curios, the sale of which helped to increase the meager stipends of the crew. From Greenland came such things as Eskimo implements, narwhal tusks, the skins of great auks and other birds, and many strange forms of marine life taken by the sailors themselves or bartered from the natives.

The Moravian missionaries in Greenland were all Germans, and they too were in the habit of increasing their income by sending home to Germany, especially to Leipsig where their headquarters were, all sorts of ethnological and natural history specimens.

At first the trade between Greenland and Før was Danish, but after the annexation of Schleswig by Germany in 1864 it became German. The exportation from Greenland of skins and of the more valuable commodities generally was forbidden except to Denmark, but curios could be freely taken out, and thus the German museums were gradually enriched by large collections from Greenland, even some of the smallest and most obscure becoming possessors of most interesting ethnological material and of the stuffed skins of great auks.

From these sources came the supply of this species from Greenland in the German museums and in the hands of the German dealers in curios, especially in Hamburg.

In England, where *Antedon bifida* is locally abundant, it was quite natural that all of the early anatomical work on the comatulids should have been done on that form. But in Scandinavia and in Germany, as specimens of *H. glacialis* were being intermittently, but more or less constantly, received from Greenland and from Spitzbergen, in these countries such work was to a large extent carried out on this species.

In 1866 Prof. Sven Lovèn described the skeletal structure of this species in considerable detail, figuring the articular face of the radials, the dorsal surface of the radial pentagon with the rosette, and the articulating surfaces of syzygies and synarthries.

The simultaneous publication of this paper by Lovèn and of W. B. Carpenter's memoir on *Antedon bifida* was unfortunate as neither had an opportunity to compare his results with those of the other. Had either commented on the differences in the articular faces of the radials between *Antedon bifida* and *Heliometra glacialis*, attention would at once have been directed toward this line of investigation, so important in connection with fossil species, which was entirely neglected until P. H. Carpenter took it up in connection with his work on the *Challenger* collections many years later.

Though this species had been first found as early as 1773, first recorded in 1774, and described in detail in 1841, the first figure of it was published by Quenstedt in 1876 in connection with his monograph on the fossils of Germany.

Following the publication of the memoirs of Sir Wyville Thomson (1865) and Dr. W. B. Carpenter (1866), very considerable interest had been aroused in the structure and anatomy of these curious animals. This led to the publication by Greeff, Lange, and Ludwig in 1876 of the results of independent investigations based chiefly upon *Antedon mediterranea*, but in all three cases, with additional information derived from the study of *H. glacialis*, an especially attractive species with which to work on account of its large size. In the same year both W. B. and P. H. Carpenter discussed certain of the points brought out in these papers.

In 1877 Ludwig published additional anatomical notes on the species, and P. H. Carpenter presented a further discussion of certain anatomical features and described the centrodorsal, following this in 1878 with a description of the basal rays and the rosette. In this year Dr. Anton Stuxberg gave a preliminary account of the material in the collections made by the *Vega*, and Sir George Nares published a short popular notice of their occurrence in Franklin Pierce Bay as he met with them while on the *Discovery*; he remarks that these beautiful crinoids, closing and opening their pinnules when exposed to the atmosphere, reminded him of sensitive plants.

In 1879 P. H. Carpenter noted the occurrence of this species in the *Challenger* collections, and in another paper discussed its structure and anatomy at considerable length. In the same year Ludwig republished in collected form all his observations regarding it, van Lidth de Jeude noted its occurrence in the *Willem Barents* collection of 1879, and Prof. Addison E. Verrill listed it (with the varietal name *acadiae*) among the invertebrates of New England.

In 1880 Stuxberg described what he called the *Antedon-Astrophyton* association (see pp. 391–392), which he had studied in the Siberian Polar sea off Taimyr Land, d'Urban recorded this species from one of the *Willem Barents* stations of 1879, and P. H. Carpenter published further notes on its structure and anatomy, studying especially the radial articular faces of the radials in connection with fossil forms.

The best popular account of this species which has yet appeared, accompanied by an excellent and characteristic figure, was published by Nordenskiöld in his narrative (in English) of the voyage of the *Vega* in 1881. In the same year Duncan and Sladen described its occurrence in the northwest Greenland area as it was found by the *Alert* and *Discovery*. Additional notes on the nomenclature, structure, and anatomy were published by P. H. Carpenter, who also recorded it from Davis Strait in 410 fathoms (749 meters) and from *Challenger* Station 48, south of Halifax, in 51 fathoms (93 meters).

Prof. Verrill in 1882 in two papers recorded this species from a number of localities on the fishing banks off Nova Scotia, remarking that it is especially common off Cape Sable. At the same time Hoffmann listed it from several of the *Willem Barents* stations occupied in 1878 and 1879, and Stuxberg gave a detailed account of the *Vega* material, redescribing the *Antedon-Astrophyton* association. Prof. F. Jeffrey Bell included this species in the list of comatulids to which he applied his so-called specific formulae, and P. H. Carpenter in three papers took up certain points in the nomenclature, structure, and anatomy. Toward the end of the year Prof. Bell described as a variety of this species material which had been dredged by the *Alert* in the Straits of Magellan (*Florometra magellanica*).

In 1883 P. H. Carpenter emended the specific formula which had been applied by Bell to this species and published some anatomical notes. The *Vega* material was again discussed by Stuxberg in a German translation of his previous work.

In 1884 P. H. Carpenter gave a detailed account of this species, recording specimens from the *Porcupine*, *Triton*, *Valorous*, *Alert*, *Challenger*, and *Willem Barents* collections, discussing its characters and nomenclature, and describing two pentacrinoids. At the same time under the name of *Antedon quadrata* he described what he considered a new species but which has since turned out to be a depauperate form of this. In a second paper dealing primarily with *Thaumatocrinus* he again discussed the nomenclature and described a pentacrinoid obtained by the *Porcupine*. In two contributions in this year Prof. Ludwig von Graff discussed the myzostome parasites associated with this species. W. B. Carpenter also mentioned certain features connected with the structure of the oral pinnules.

In 1886 Prof. G. M. R. Levinsen described the *Dijmphna* collection, which included pentacrinoids and a 9-armed individual for both of which he gave figures; Fischer described the occurrence of the species at Jan Mayen; and Stuxberg discussed the *Vega* material.

P. H. Carpenter in the same year described in detail the material brought back by the *Willem Barents*, under the names *Antedon eschrichti*, *A. quadrata*, *A. dentata* and *A. barentsi*. *Antedon barentsi*, according to Carpenter, differed strikingly from all the other comatulids of the arctic and temperate regions, and resembled those of the Caribbean Sea and Oceania, in the extreme development of "ambulacral" plates in the perisome of the genital pinnules. It has since been found, however, to be merely a variety of *H. glacialis*. His record of *A. dentata* was based upon two calices with portions of the arms attached, one small and the other "fairly mature," from station 6, 1881. He says that these have rather over 20 cirrus segments with forward projecting spines which are much more marked than in individuals from southern Norway. This identifies them at once as specimens of *glacialis*, similar to those recorded as *sarsii* by Jarzynsky in 1870 from various fjords on the Murman coast. I have examined a number of these from the Kola Fjord sent by Prof. Derjugin. Gislén records (1923) that there are in the Stockholm Museum other small specimens taken by the *Vega* west of Taimyr identified by Carpenter as *dentata*.

In 1886 also the dimorphism of the cirri was noted by P.H. Carpenter in connection with his studies of the same feature in *Leptometra phalangium* and in *L. celtica*; the nerves were described by Prof. A. Milnes Marshall, and various anatomical points were treated by Prof. [J. O.] Edmond Perrier.

In 1887 Dr. J. M. Ruijs recorded this species from a number of *Varna* stations, and some of the *Varna* specimens, including two pentacrinoids, were described in detail by P. H. Carpenter, who in two additional papers discussed the sacculi and certain points in the morphology. Prof. von Graff contributed further information regarding the myzostome parasites.

P. H. Carpenter's *Challenger* report, published in 1888, included a monographic account of this species in which all existing information was summarized and much new information brought out. In the same year Dr. Th. Holm recorded it from the *Fylla* dredgings in Davis Strait, and Ganong noted its occurrence along the shores of eastern Canada.

In 1889 Dr. Otto Hamann and Prof. Perrier compared the anatomy of *glacialis* with that of the species of *Antedon*, Prof. Percival de Loriol [-Fort] compared it with fossil species, and the Rev. D. Honeyman cited its occurrence off Halifax.

In 1891 P. H. Carpenter published an extended account of this species and of the other Arctic comatulid, *Hathrometra* (i.e. *Poliometra*) *prolixa*. He devoted himself especially to the defense of his *quadrata*, in answer to Levinsen, who in 1886 had stated that it is merely the young of *glacialis*. In the same year Cuénot considered certain points in the morphology.

The report on the crinoids of the *Vøringen* (Norwegian North Atlantic) expedition was published by Prof. D. C. Danielssen in 1892. This report is chiefly devoted to a detailed discussion of *Ilycrinus carpenteri*, and this species is merely listed from a number of stations. In the same year Prof. Bell gave a summary of the records from the British Seas and Seeliger compared its anatomy with that of *Antedon adriatica*.

In 1893 Mr. Alexander Rodger published an account of the material he had secured in Davis Strait while on the whaler *Esquimaux*, and in the following year Prof. Georg Pfeffer recorded the specimens secured by Kükenthal in Spitzbergen in 1889.

Dr. A. Ohlin in two contributions, published in 1895, recorded the specimens which had been collected in the previous year by the *Falcon*, on which ship he had been the naturalist, and Hartlaub discussed the geographical and bathymetrical distribution of this species and compared it with some specimens from Panama which he identified as [*Florometra*] *rhomboidea* [since referred to *F. tanneri*].

The Prince of Monaco in 1899 mentioned localities at which this species had been taken by the *Princesse Alice* at Spitzbergen, and in the same year Dr. Fritz Schaudinn cited it from eastern Spitzbergen, and both Prof. Hubert Ludwig and Dr. Arnold E. Ortmann discussed its bearing, in connection with the related Antarctic species, or the question of bipolarity.

In 1900 Dr. Clemens Hartlaub and Prof. Ludwig Döderlein gave this species from a number of *Olga* stations about Spitzbergen, and Prof. Jules Richard recorded it from Sassen [Temple] Bay, Spitzbergen, in 102 meters, where it had been dredged by the *Princesse Alice*. Prof. N. M. Knipovich again recorded it from the Murman coast.

In the following year Prof. Knipovich listed it from a number of *Yermak* stations, Prof. Rene Koehler gave a detailed account of the material collected about Spitzbergen by the *Princesse Alice*, Prof. W. M. Rankin described the specimens collected in northern Greenland by the Princeton Expedition of 1899, Dr. G. Kolthoff recorded those brought back by the *Frithiof* from northeastern Greenland, Dr. J. F. Whiteaves listed the records for eastern Canada, and Mr. Frank Springer compared the wide distribution of the species with that of *Uintacrinus*.

In 1903 Dr. Theodor Mortensen recorded this species from a number of localities in eastern Greenland, and described and figured the side- and covering-plates, showing *barentsi* to be merely a variety of *H. glacialis*, and Dr. M. Michailovskij described the material accumulated by the *Yermak*, *Bakan*, and *Ljedekol II* during the expeditions to Spitzbergen for the purpose of measuring an arc of the meridian.

Dr. James A. Grieg in 1904 discussed this species in great detail, paying particular attention to the status of *quadrata*, and recorded it from a number of stations on the *Michael Sars* cruises of 1900, 1901, and 1902, and from several new localities in West Finmark.

Prof. Ludwig Döderlein in 1905 published a monographic account of this species based upon the *Helgoland* collections, Dr. Michailovskij listed it from some additional *Yermak* stations, Mr. J. Schmidt recorded it from east of Iceland from specimens taken in 1903, Dr. K. A. Andersson mentioned a pentacrinoid from the cirrus of an adult taken off Spitzbergen by the *Frithiof* expedition of 1900, Dr. August Reichensperger discussed various points in its anatomy, and Dr. Wilhelm Minckert took up various features connected with its structure, with special reference to regeneration.

In 1906 Prof. K. Derjugin recorded it again from the Kola Fjord, where it had been found by Jarzynsky in 1869 and 1870, and gave a list of the localities in the fjord at which it had been dredged by the station ship *Orca*.

Dr. M. Kalischewskij's important memoir on the echinoderms of the *Zarya* expedition to the New Siberian Islands, in which the known range of this species was extended far to the eastward, appeared shortly after his death in 1907. In the same year Prof. Grieg recorded the material in the *Belgica* collections of 1905 and I described under the name of *Antedon arctica* a curious little specimen, since found to be quite typical of the normal young, from Cape Sabine which, through some mischance, I located in Alaska.

In the following year Andersson again mentioned the pentacrinoid found on a cirrus of a specimen from the *Frithiof* expedition, and says that he examined all the specimens in the Stockholm Museum without finding another; and under the name of *Heliometra juvenalis* I described a very curious variety from the *Esquimaux* collection.

In 1909 Prof. Rene Koehler gave a complete account of all the collections resulting from the various cruises of the Prince of Monaco's yacht *Princesse Alice*, Prof. Grieg described at greater length the specimens from the *Belgica* cruise of 1905, and Dr. S. V. Averincev (Awerinzew) described the occurrence of this animal as determined by the surveys carried out from the biological station at Alexandrovsk in the Kola Fjord.

Professor Grieg in 1910 gave the details of the occurrence of this species as found during the *Belgica* cruise of 1907 about southern Nova Zembla, and Dr. Th. Mortensen recorded the specimens collected by the *Danmark* in 1906–08, at the same time describing two pentacrinoids collected by the *Frithiof* in 1900.

In 1911 Professor Derjugin listed a number of localities in the Kola Fjord where this species had been found by the *Alexander Kovalevsky*, the ship operated from the station at Alexandrovsk, and Dr. Edwin Kirk compared the centrodorsal and arm bases with the corresponding structures in fossil types.

In 1912 Prof. Clement Vaney recorded the material from the dredgings of the *Pourquoi Pas?* about Jan Mayen, and Prof. A. Appelløf summarized the distribution of *glacialis* in the Norwegian Sea.

In 1913 Dr. Th. Mortensen published a summary of all the localities from which this species is known in Greenland, which was repeated in the following year, and in 1915 Prof. Nils von Hofsten described in great detail its distribution and especially its occurrence in the Ice Fjord, Spitzbergen.

In 1914 Professor Vaney published additional records from the dredgings of the *Pourquoi Pas?*.

In 1917 Dr. Knud Stephensen brought out the detailed account of the results of his survey of the Brede fjord in southwestern Greenland in 1912, recording this species from several stations, and in 1919 Dr. Raymond F. Osburn found it to be the host of Mortensen's *Loxosomella antedonis*, his material having been collected by the Crocker Land expedition at Etah, Greenland.

In 1922 the author recorded this species for the first time from Hudson Bay, where it had been found by Mr. Frits Johansen, and in 1923 he recorded it from a number of new localities at which it had been obtained by various Danish steamers, especially the *Ingolf*. In 1923 also Dr. Torsten Gislén mentioned it from several additional localities and discussed the characters of the young in comparison with those of the species of *Hathrometra* and *Poliometra*.

In his Echinoderm Studies of 1924, Dr. Gislén covered a number of facets of the biology, particularly, of crinoids. Among the anomalies found, he recorded and figured a specimen of *H. glacialis* with a forked pinnule. The shape of the brachials and their articulations as well as those of the pinnules were also dealt with. Measurements of the gonads gave an estimated total weight of 7.43 grams and a volume of 6.76 cubic centimeters. The length of the ambulacral groove of a specimen with arm length 200 mm. was estimated at 54.5 meters. This was related to the volume of the specimen. The intestinal contents of a specimen from west of Spitzbergen in 100 meters were found to consist of numerous copepods, solitary ostracods, polynoid bristles and a ciliate.

A. A. Schorygin wrote in 1925 that in 1921 and 1923 this species was found north of lat. 74° N. by the expeditions of the Institute of Marine Science. The length of the pinnules of different specimens, and also on the various arms of a single specimen, is very variable. At the northern stations specimens were found with extraordinarily short proximal pinnules, approaching in length the proximal pinnules of *Poliometra prolixa*.

Both Koehler and Mortensen, in their comprehensive works on the echinoderms of Europe and of the British Isles in 1927, gave brief descriptions and figures of this species as well as surveys of its distribution. Mortensen also mentions that it is liable to parasitization by *Myzostoma gigas* Lütken and *M. fimbriatum* von Graff, also the endoproct Bryozoan *Loxosomella antedonis* Mortensen.

Grieg in 1927 records one instance from *Tovik* station 26 of a specimen found in the stomach contents of a cod and two instances, from stations 23 and 28, of its occurrence in a haddock. The *Tovik* also obtained the species free at several other stations on the Spitzbergen Bank.

In 1928 Prof. K. M. Derjugin listed *Heliometra glacialis* among the species which are absent from the White Sea basin, though common in the neighboring area of the White Sea.

In his monographic account of the echinoderms of the Barents Sea published in 1928 (pp. 1–107 in Russian, with a summary, pp. 109–128, in German), Schorygin decribed at length the distribution of *Heliometra glacialis*. He said that it is absent from the southeastern and southwestern parts of the Barents Sea. In the Barents Sea it ranges in depth from 50 to 2,000 meters, being most frequent between 150 and 250 meters. In temperature it ranges from −2.0° to +5.0° C, being most frequent at the lower temperatures with a maximum frequency at −0.5° C. The range in salinity is from 33.00 to 35.25 per thousand, the greatest frequency being at 34.75 per thousand.

It lives on bottoms of sand, sand and mud, mud and stones, stones, and stones and sand, most commonly on mud and stones.

Grieg in 1928, reporting on the collections of the *Maud* in the waters north of Siberia, remarked on the extension of range provided by that collection as far east as Wrangel Island (179° *West*), there being no earlier record between the New Siberian Islands and Jones Sound, far to the north of Hudson Bay in Canada, except of course for the variety *maxima* in the North Pacific.

Mortensen, 1932, recorded the species at many of the Godthaab stations, mainly in northern Baffin Bay, where, he said, the specimens were particularly well-developed in contrast to the material collected at two stations off the southern tip of Greenland, at one of which the bottom temperature of +5.8° C. was the highest known for this species.

In his paper on the echinoderm fauna of the Franz Josef archipelago and the Queen Victoria Sea published in 1932, G. P. Gorbunow recorded *Heliometra glacialis* f. *quadrata* from three stations in the Barents Sea, one in Mellenus Strait, one in Allen Young Strait, and one in the British Channel, all in the Franz Josef archipelago, giving the location, depth, and character of the bottom. He said that although he doubted the specific distinctness of *quadrata* and *glacialis*, yet at the time he studied the material collected in 1927, 1928, and 1930, he recognized two varieties. In the region of Franz Josef Land and in the northeastern Barents Sea not a single typical *H. glacialis* was found. He said that the form *quadrata* is apparently circumpolar, panarctic, weakly eurythermal, in a lesser degree euryhaline, but strongly eurybathic (from 14 to 1,359 meters), and apparently prefers muddy ground with stones. He noted that this was the first time the interior of the Franz Josef archipelago had been explored.

In 1933 Gorbunow published a paper on the echinoderm fauna of the inshore waters of the North Island of Nova Zembla, based upon collections made by himself together with P. Uschakov in 1925 and 1927, by himself alone in 1929 and 1930, and by L. Retowski and W. Wagin in 1931. The material collected in 1925 and 1927 was studied by E. Gurjanova and revised by him. He recorded from station V one adult *H. glacialis;* from station 1 one adult *H. g. typica* and three adult *H. quadrata;* from station 30 one young *H. quadrata;* from station 28 one young *H. glacialis;* and from station 14 one *H. g. typica*. This species was found at depths of from 52 to 200 meters on muddy and stony bottoms, and on shells. Nothing new was discovered in regard to the ecology or geographical distribution.

Later in 1933 Gorbunow published a paper on the echinoderms of the northern half of the Kara Sea, in which *Heliometra glacialis* and *H. g.* forma *quadrata* were recorded from 19 stations, and all the earlier records for the region were given. He again discussed the forms *typica* and *quadrata* of *H. glacialis*. He said that *H. glacialis* is very widely distributed in this region, though never found in great numbers. Both *H. glacialis* and "*Poliometra*" *prolixa*, he said, were found at from 30 to 20 percent of the stations, whereas in the Barents Sea *H. glacialis* was found at only 20 to 10 percent of the stations.

Also in 1933 Djakonov published an account of the echinoderm fauna of the northern seas with keys for differentiating the species. He included the variety *quadrata* as separate from *H. glacialis*, distinguishing it by the fact that P_3 was shorter than P_2 rather than almost equal and by the shape of the proximal brachials and the segments of P_3 as well as the visibility of the radial plates. As for the distribution, he found *quadrata* together with *glacialis* in the more northern parts of its range; in the vicinity of Franz Josef Land it occurs alone.

In 1935 and 1936, Heding recorded the species from localities on the east coast of Greenland, where it was taken by the seventh Thule and Scoresby Sound Committee's expeditions.

In 1936 I published a paper on a large collection of echinoderms from the seas about Baffin Land and Greenland that had been brought together and sent to the National Museum by Capt. Robert A. Bartlett as a result of Arctic investigations in his schooner the *Effie J. Morrissey.*

In a memoir on the crinoids of the Okhotsk and Japanese Seas, published (in Russian and English) in 1937, I gave the geographical range of *Heliometra glacialis* and noted that it has not been reported from between the New Siberian Islands (long. 142°48′ E.) on the west and Hudson Bay and Jones Sound (long. 89° W.) on the east, though probably occurring in favorable situations at least throughout the Canadian Arctic Archipelago. I gave the bathymetric range as from 18 (?16) to 1358 meters, the average of 278 records being 203 meters; the thermal range was given as from −1.90° to +5.50° C., with the average of 96 records +0.48° C. This information was included for comparison with *Heliometra glacialis* var. *maxima* of the Okhotsk and Japan Seas, of which the known bathymetric range is from 117 to 783 meters, with an average of 322 meters, and the known temperature range is from −1.75° to +1.72° C., with the average +0.46° C.

In a paper on the echinoderms of Hudson Bay published in 1937 I recorded *Heliometra glacialis* from five stations in the northern half of the bay, where it had been dredged by the Canadian steamer *Loubyrne* in 1930.

In 1940 I recorded this species from eight localities off western and southern Greenland, where it had been collected by the *Morrissey.*

In coauthorship with Gordon J. Lockley, formerly of the British Museum (Natural History) but at the time visiting Washington on duty in the Royal Navy, I recorded *Heliometra glacialis* from four more localities off northwestern Greenland, where it had been dredged by Captain Bartlett in the *Morrissey.*

In a study of the relationship between the Arctic and North Pacific echinoderm faunas published in 1945, Djakonov commented on the larger size of the North Pacific specimens of *H. glacialis* in comparison with Atlantic ones. He listed typical *glacialis* among the endemic, low-Arctic species.

In 1948, Einarsson included it in the Arctic littoral—sublittoral fauna and gave a map of its distribution around Iceland.

Tortonese in 1949 reiterated its known bathymetrical range.

In 1952 Djakonov recorded some fragments from the Chukotsk Sea.

In 1953 an English version of Vinogradov's account of the chemical composition of some marine invertebrates was published, in which the bromine content of the skeleton of *Heliometra glacialis* was given.

Some further localities in the region northeast of Canada were provided in 1955 by Grainger, while Hyman, in the same year, outlined the northern distribution of the species and commented on the geographical size variation. She attributes the size differences to temperature rather than food supply.

Finally, in 1957 R. W. Blacker published a study on the distributions of benthic animals in the waters south and southeast of Spitzbergen and around Bear Island, based on collections by the Fisheries vessel *Ernest Holt* and earlier records. He con-

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cluded that the increased temperature in recent years has resulted in the disappearance of *Heliometra* in the southern part of the area.

Nomenclature.—Because of the absence in the Arctic and in the North Atlantic of closely related species with which this might be confused, the nomenclatorial history of this species is relatively simple.

As it is very similar in general aspect, though vastly superior in size, to *Antedon bifida*, it was quite natural that Phipps (1774, 1775) should refer it to the Linnean *Asterias pectinata*.

The name *Alecto glacialis* used by Leach (1830) and Owen (1833) has already been discussed on p. 341.

Referred to by J. Müller in 1840 as *Comatula eschrichtii*, the species was in the succeeding year formally described by him under the name of *Alecto eschrichtii*, which he modified in 1849 to *Comatula* (*Alecto*) *eschrichtii*.

In 1857 Prof. C. F. Lütken identified as *Alecto eschrichtii* the *Asterias pectinata* of Phipps (1774, 1775), Scoresby (1820) and Dewhurst (1834).

In 1860 Walker reverted to the name *Alecto glacialis*, while in 1862 Dujardin and Hupé used *Comatula eschrichtii*, identifying with it a specimen labeled *Comatula glacialis* from the Polar seas which they found in the Paris Museum. Mrs. E. C. and Mr. Alexander Agassiz in 1865 followed Prof. Lütken and M. Sars in the use of *Alecto eschrichtii*.

Prof. Sven Lovén in 1866, following the lead of Lütken and Norman, reinstated the generic name *Antedon* for all the endocyclic comatulids, at the same time emending the specific name to *eschrichti*. In this emendation of the specific name he has been followed by most subsequent workers, mainly because of its adoption by Prof. F. Jeffrey Bell and, following him, by Dr. P. H. Carpenter in 1882.

In 1875 Lütken disregarded Lovén's alteration of the specific name, calling the species *Antedon eschrichtii*, in which he was followed by W. B. and P. H. Carpenter prior to 1882, and subsequent to that date by such of the continental authors as were more or less independent of the work of the latter. But after the publication of his memoir on the exocyclic comatulids (1879) and especially after the publication of the *Challenger* reports (1884, 1888), P. H. Carpenter's prestige was deservedly so great, while at the same time he was always so ready to aid everyone who applied to him for information or for assistance, that his lead was unquestioningly followed in everything concerning the recent crinoids.

Hesitating between the use of the commonly accepted name *Comatula*, used shortly before in Dujardin and Hupé's monograph and the newly reinstated name *Antedon*, rescued from oblivion by Lütken and Norman only a year or two before, and as yet unfamiliar, W. B. Carpenter had in 1865 and 1866 called the common English comatulid *Antedon* (*Comatula*) *rosaceus;* and in 1870 he similarly referred to this species as *Antedon* (*Comatula*) *eschrichti*.

Sir Wyville Thomson identified some small specimens from the Faroe Channel with the *Comatula woodwardii*, described by Barrett in 1857, which, on account of the preoccupation of this name by Forbes for a fossil in 1852, had been renamed *celtica* by Barrett and McAndrew in 1858. Sir Wyville therefore called these *Antedon celticus* in 1873, and von Marenzeller applied the same name to some other similarly small ones in 1878. The feminine form *celtica* (following the discovery of the origin of the name *Antedon* by Mr. T. R. Stebbing in 1877) was used for this species by Sladen (on the authority of P. H. Carpenter in 1877 and 1881, the misapplication of the name being pointed out by Carpenter in the latter year.

In his work upon the marine invertebrates of New England, the Maritime Provinces of Canada, and Newfoundland, Prof. Addison E. Verrill was struck by the small size and generally undeveloped aspect of the individuals of this species from this region as compared with the magnificent large and robust specimens from Greenland, with which he was familiar in the Peabody Museum at Yale University and in the Museum of Comparative Zoology at Harvard. He designated this depauperate form as *Antedon eschrichtii* var. *acadiae*, which name appears as a *nomen nudum* in a checklist of the marine invertebrates of this coast published in 1879, but there is no further reference to it.

Prof. F. Jeffrey Bell in 1882 described under the name of *Antedon eschrichti* var. *magellanica* [=*Florometra magellanica*] what he considered to be a variety of this species from the *Alert* collections.

In 1884 P. H. Carpenter described as *Antedon quadrata* some small specimens which had been dredged by the *Porcupine* in the Faroe Channel—those which had been mentioned by Wyville Thomson under the name *celticus*. This name *quadrata* has been widely used for a number of undersized and undeveloped varieties of this species, including the one covered by Verrill's name *acadiae*, published five years previously but never diagnosed, as well as for young individuals in various stages.

Through the study of the material in the *Challenger* and *Blake* collections P. H. Carpenter had learned the great importance from the systematic standpoint of the development of side and covering plates along the ambulacra as seen in the Calometridae, Thalassometridae and Charitometridae. Finding comparable plates well-developed in certain specimens from near Vardø, he described them in 1886 as a remarkable new species, which he called *Antedon barentsi*. That this in reality is only a minor variety of *H. glacialis* was later shown by Mortensen (1903), Grieg (1904) and Döderlein (1905).

In 1907 the present author described under the name *Antedon arctica* a small discolored specimen from Cape Sabine, and a few months later proposed the genus *Heliometra* with *Alecto eschrichtii* J. Müller, 1841, as the type. In the following year he described *Heliometra juvenalis* from off Cape Raper, Baffin Land (from the *Esquimaux* collection), and in the same year adopted the specific name *glacialis* in place of *eschrichtii*, a change to which exception was taken by Prof. von Hofsten and by Dr. H. L. Clark. However, following issue with Mortensen and Koehler, the name *glacialis* has now been generally adopted.

Remarks.—Thanks to its very general occurrence within its range, its great size, conspicuous color and beautiful form, and to the remoteness of its habitat, interest in it not being inhibited by familiarity, this is in many respects the best known of all the crinoids. The major features of its geographical, bathymetrical, and thermal distribution are known in greater detail and with greater exactness than those of any other species.

But its embryology and early stages still remain to be studied, and its pentacrinoid stage has only been described from a few specimens, all in the later phases of development.

Its occurrence, like many echinoderms and other fixed or sedentary marine animals, in aggregations of which all the individuals are of a similar size and sometimes show definite structural similarities, such as a pronounced spinosity in the case of the young, and the occurrence among masses of large individuals of much smaller examples lighter in color with persistent juvenile features, are especially worthy of investigation.

Two myzostomes (see part 2, p. 685) have been described from it, *Loxosomella* and *Truncatulina* have been found attached to it, and fragments of an encysted crustacean have been found on sections through the disk. What this last is has never been determined, and we know nothing of any other parasites.

HELIOMETRA GLACIALIS MAXIMA (A. H. CLARK)*

[See vol. 1, pt. 1, fig. 392 (p. 307); pt. 2, fig 164 (p. 86), pl. 54, fig. 1348]

Antedon eschrichtii (not of Müller, 1841) VON MARENZELLER, Denkschr. Akad. Wiss. Wien, math.-nat., vol. 72 for 1902, 1903, p. 564 (lat. 42°08′ N., long. 130°39′ E.; 300 meters; with *Myzostoma gigas*).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 75 (Okhotsk Sea; La Perouse Strait; southern Sakhalin; parts of the Gulf of Tartary; northern part of the Sea of Japan).—SOWERBY, The Naturalist in Manchuria, Tientsin, 1930, vol. 5, p. 79 (repeats distribution from A.H.C.).—PYCRAFT, The Illustrated London News, vol. 196, No. 5263, March 2, 1940, p. 266 (abundance in North Pacific; from A.H.C.).

Antedon sp., SCHMIDT, Pisces marium orientalium imperii rossici, 1904, pp. 42, 43, 44, 46 (various localities in Peter the Great Bay; 75–125 sagens).

Antedon eschrichtii var. *maxima* A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 69 (about 3 feet in diameter; obtained in enormous numbers), p. 75 (locality).

Antedon brachymera A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 76 (*Albatross* station 4986).—SOWERBY, The Naturalist in Manchuria, Tientsin, 1930, vol. 5, p. 79.

Heliometra maxima A. H CLARK, Smithsonian Misc. Coll., vol. 50, 1907, pt. 3, p. 351 (listed); Amer. Nat., vol. 42, 1908, No. 500, p. 542 (corresponds to the Atlantic *H. glacialis;* with the latter and *H. brachymera* and *H. quadrata* forms a definite subdivision of the Polar Pacific fauna); No. 503, p. 719 (range; variation in size); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 267, fig. 5 (off southern Sakhalin; 12-armed specimen); vol. 35, 1908, p. 126 (12-armed specimen illustrates the origin of *Promachocrinus*); vol. 39, 1911, p. 487 (chemical composition of the skeleton); Mem. Australian Mus., vol. 4, 1911, p. 709 (chemical composition of the skeleton); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range in eastern Asia); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 80 (Arctic fauna in the western part of the Okhotsk and Japan seas; derived from the fauna of the Bay of Bengal); Die Crinoïden der Antarktis, 1915, p. 125 (analogy with *Anthometra adriani*), p. 126 (specimen with a doubled radial, representing a 6-rayed *Promachocrinus kerguelensis;* list of localities; geographical, bathymetrical and thermal ranges); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 21 (in reduction to mere essentials, and in size, resembles *Rafflesia arnoldi*).

Heliometra brachymera A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, pt. 3, p. 351 (listed); Amer. Nat., vol. 42, No. 500, 1908, p. 542 (represents in the Okhotsk and Japan Seas *H. quadrata;* these, with *H. maxima* and *H. glacialis*, form a distinct arctic section of the Polar-Pacific fauna).—H. L. CLARK, Mem. Australian Mus., vol. 4, 1909, p. 525 (association with *H. eschrichtii maxima* in the Japan Sea).—A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 125 (exhibits the characteristic features of *Solanometra antarctica*), p. 127 (*Albatross* Sta. 4986).

Heliometra glacialis var. *maxima* A. H. CLARK, Geogr. Journ., vol. 32, No. 6, 1908, pp. 604, 605 (distribution; variation in size; ecology); Vid. Medd. Nat. Foren. København, 1909, p. 188 (localities); Proc. U.S. Nat. Mus., vol. 39, 1911, p. 488 (*Albatross* station 4986; chemical composition of the skeleton).—F. W. CLARKE and WHEELER, U.S. Geol. Surv. Prof. Paper 90–D, 1914, p. 35 (inorganic constituents of the skeleton).—A. H. CLARK, Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 213 (very closely related to *H. glacialis*), p. 215 (Japanese Arctic species; bathymetrical and thermal ranges and their significance).—F. W. CLARKE *in* A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 207 (relative proportion of magnesium and calcium carbonates in the skeleton).—F. W. CLARKE and WHEELER, U.S. Geol. Surv. Prof. Paper 102, 1917, p. 22 (inorganic con-

*See also Addenda (p. 836) under 1959, 1962.

stituents); Paper 124, 1922, p. 19 (inorganic constituents).—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42.—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 37 (North Pacific).—A. H. CLARK, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 219 (*Gagara* stations 204, 233, 246; *Rossinante* station 74; *Albatross* stations 5021, 4997, 5017, 4992, 4991, 4993, 4986, 4983, 4982, 4861, 4860; *Nadejnyi* stations 48, 49, 57, 58, 64; off Gashkevich Bay; coast of Korea; off Pusan, Korea; eastern Asia; ?Hirado Strait; geographical, bathymetrical and thermal ranges; in Russian), p. 225 (same, in English).—VINOGRADOV, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (skeletal composition).

Heliometra H. L. CLARK, Mem. Australian Mus., vol. 4, 1909, p. 525 (association of two species in the Japan Sea).

Heliometra eschrichtii maxima H. L. CLARK, Mem. Australian Mus., vol. 4, 1909, p. 525 (association with *H. brachymera* in the Japan Sea).

Heliometra glacialis brachymera A. H. CLARK, Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 213 (very closely related to *H. glacialis*), p. 215 (Japanese Arctic fauna; bathymetrical and thermal ranges and their significance).

Heliometra eschrichtii var. *maxima* VON HOFSTEN, Kungl. Svenska Vet.-Akad. Handl., vol. 54, 1915, p. 12 (range), p. 235 (size).

Helometra glacialis var. *maxima* A. H. CLARK, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 229.

Heliometra glacialis maxima DJAKONOV, Reports of the Japan Sea Hydrobiological Expedition of the Zool. Inst. Acad. Sci. U.S.S.R. in 1934, pt. 1, 1938, p. 426 (listed; one of the two Arctic species found), p. 429 (on muddy-sandy bottoms), p. 430 (depth; associated with *Ophiura sarsi typica*), pp. 453, 454 (biocenosis with *O. sarsi*), p. 457, pp. 467, 471 (associations), p. 482 (references; distribution; distinction from typical form); also pp. 488–490 and 498 in English summary.—DERJUGIN and SOMOVA, Invest. Far East Seas U.S.S.R., vol. 1, 1941, pp. 26, 28 (communities in Peter the Great Bay), p. 35 (English summary).—DJAKONOV, Bull. Pacific Inst. Fish. Oceanogr., Vladivostok, vol. 30, 1949, p. 13 (in key).—USCHAKOV ET AL., Atlas of the invertebrates of the far eastern seas of the U.S.S.R., 1955, p. 203 (distribution), pl. 63, fig. 1.—BARANOVA, Invest. Far East Seas U.S.S.R., vol. 4, 1957, p. 246 (absent from the Bering Sea).—DJAKONOV, BARANOVA, and SAVELJEVA, Invest. Far East Seas U.S.S.R., vol. 6, 1959, p. 238 (listed). [NOTE BY A.M.C.] I agree with these Russian authors in considering *maxima* as a geographic subspecies of *glacialis* and have accordingly omitted the term "variety" from the heading above.

Subspecific characters.—There appear to be no tangible differences between this and the typical form except in size, which averages much larger. The arms reach a length of 350 mm. and the cirri a length of 115 mm. as contrasted with a maximum, rarely attained, of 265 mm. and 91 mm. in arctic specimens of *glacialis glacialis.*

Abnormal specimen.—An example from *Albatross* station 5017 has 12 arms, due to the existence of two IBr series in one radial area (see vol. 1, part 2, fig. 164, p. 86 and fig. 1348, pl. 54). These two IBr series are closely crowded with their longitudinal axes approximately at right angles, the adjacent sides of the IBr_1 projecting considerably from the centrodorsal, the opposite sides mainly concealed beneath it. The arms borne by these two IBr series and the arms on the other four IBr series are normal in structure; but the outer arm from the left-hand one of the paired IBr series has the first brachial fused with the axillary of the adjacent IBr series, the second brachial fused with the dorsal surface of the first and lower part of the second brachial of the same series, with its pinnule arising from a point over the second brachial of the normal arm, and its first syzygial pair (brachials 3+4) fused with the lateral border of the second brachial of the normal arm; the remaining brachials of the two arms are free.

Localities.—Sea of Okhotsk [A. H. Clark, 1907, 1937].

Gagara station 246; Okhotsk Sea (lat. 55°04′ N., long. 142°56′ E.); 128 meters; bottom temperature −1.75° C.; Uschakov 1932 [A. H. Clark, 1937] (1, Leningrad).

[NOTE BY A.M.C.] In the English version of A.H.C. (1937) this temperature appears to be positive, the true value is shown by the thermal range given.

Gagara station 233; Okhotsk Sea (lat. 53°05′ N., long. 148°07′ E.); 180 meters; bottom temperature −0.49° C.; Uschakov 1933 [A. H. Clark, 1937] (1, Leningrad).

Albatross station 5021; near Cape Patience, Sakhalin Island (lat. 48°32′30″ N., long. 145°08′45″ E.); 134 meters; temperature −0.61° C.; September 27, 1906 [A. H. Clark, 1915, 1937] (2, U.S.N.M., 35951).

Rossinante station 74; Sea of Japan (lat. 48°14′ N., long. 140°52′ E.); 576–592 meters; Ivanov, August 6, 1931 [A. H. Clark, 1937] (1 small specimen, Leningrad).

Parts of the Gulf of Tartary [A. H. Clark, 1907, 1937].

Albatross station 4997; Gulf of Tartary, off southwestern Sakhalin (lat. 47°38′40″ N., long. 141°24′30″ E.); 581 meters; bottom temperature +0.44° C.; September 23, 1906 [A. H. Clark, 1915, 1937] (6, U.S.N.M., 35728).

Off southern Sakhalin [A. H. Clark, 1908, 1937]. About southern Sakhalin [A. H. Clark, 1907, 1937]. La Perouse Strait [A. H. Clark, 1907, 1937].

Albatross station 5017; off the eastern coast of the southern end of Sakhalin Island; Cape Tonin bearing N. 59° W., 12.5 miles distant (lat. 46°43′30″ N., long. 143°45′00″ E.); 117 meters; bottom temperature −1.22° C.; September 26, 1906 [A. H. Clark, 1915, 1937] (1, U.S.N.M., 35952).

Northern part of the Sea of Japan [A. H. Clark, 1907, 1937].

Gagara station 204; Okhotsk Sea (lat. 46°02′ N., long. 143°36′ E.); 135 meters; bottom temperature +0.38° C.; Uschakov [A. H. Clark, 1937] (1+, Leningrad).

Albatross station 4992; Sea of Japan; Bomasiri Shima (off the northern end of Rebun To) bearing N. 52° E., 8 miles distant (lat. 45°24′00″ N., long. 140°49′10″ E.); 594 meters; bottom temperature +0.56° C.; September 22, 1906 [A. H. Clark, 1915, 1937] (6, U.S.N.M., 35726).

Albatross station 4991; Sea of Japan; Bomasiri Shima (off the northern end of Rebun To) bearing N. 50° E., 9.2 miles distant (lat. 45°23′20″ N., long. 140°48′00″ E.); 594 meters; bottom temperature +0.56° C.; September 22, 1906 [A. H. Clark, 1915, 1937] (10, U.S.N.M., 35723).

Albatross station 4993; Sea of Japan; Bomasiri Shima (off the northern end of Rebun To) bearing N. 47° E., 5 miles distant (lat. 45°25′30″ N., long. 140°53′00″ E.); 260 meters; bottom temperature +1.72° C.; September 22, 1906 [A. H. Clark, 1915, 1937] (4, U.S.N.M., 35724).

Albatross station 4986; Sea of Japan; Benkei Misaki Light bearing N. 35° E., 15 miles distant (lat. 43°01′00″ N., long. 140°22′40″ E.); 314 meters; bottom temperature +1.05° C.; September 19, 1906 [A. H. Clark, 1907, 1911, 1915, 1937] (4, U.S.N.M., 22649, 35722).

Albatross station 4983; Sea of Japan; Benkei Misaki Light bearing S. 2° E., 12 miles distant (lat. 43°01′35″ N., long. 140°10′40″ E.); 783 meters; bottom temperature +0.39° C.; September 19, 1906 [A. H. Clark, 1907, 1915, 1937] (1, U.S.N.M., 35725). Type locality.

Albatross station 4982; Sea of Japan; Benkei Misaki Light bearing S. 3° E., 10.5 miles distant (lat. 43°00′00″ N., long. 140°10′30″ E.); 713–783 meters; bottom temperature +0.39° C.; September 19, 1906 [A. H. Ctark, 1915, 1937] (3, U.S.N.M., 35748; M.C.Z., 354, 357).

Peter the Great Bay (on the western coast of the Sea of Japan, lat. 42°30′ N.); 160–267 meters [Schmidt, 1904; A. H. Clark, 1937].

Nadejnii station 48; off Cape Povorotnyi, the northern boundary of Peter the Great Bay (lat. 42°30′ N.); 228–267 meters; mud; May 10 (old style), 1900 [Schmidt, 1904; A. H. Clark, 1937].

Nadejnii station 49; off Cape Povorotnyi, 6–7 miles from shore; 153–166 meters; mud; May 10 (old style), 1900 [Schmidt, 1904; A. H. Clark, 1937].

Nadejnii station 57; off Cape Povorotnyi, approximately 10 miles from shore; 232 meters; gravel; May 14 (old style), 1900 [Schmidt, 1904; A. H. Clark, 1937].

Nadejnii station 58; a little nearer the shore than the preceding station; 153–232 meters; slimy yellow mud; May 14 (old style), 1900 [Schmidt, 1904; A. H. Clark, 1937].

Nadejnii station 64; off Cape Povorotnyi; 175–189 meters; May 19 (old style), 1900 [Schmidt, 1904; A. H. Clark, 1937].

Off Gashkevicha Bay (lat. 42°08′ N., long. 130°39′ E.); 300 meters [von Marenzeller, 1903; A. H. Clark, 1915, 1937].

Japan Sea Hydrobiological Expedition, 1934; station 51; Siaukhu Bay, Japan Sea (lat. 42°48′ N., long. 133°45′ E.); 175 (or 173) meters [Djakonov, 1938] (many specimens, probably in the Zool. Inst., Leningrad).

Japan Sea Hydrobiological Expedition, 1934; station 62; Siaukhu Bay, Japan Sea (lat. 42°48′ N., long. 133°45′ E.); 150 meters [Djakonov, 1938] (many specimens, probably in Leningrad).

Coast of Korea (lat. 38°15′ N., long. 128°45′ E.); 183 meters; Schønau, April 29, 1896 [A. H. Clark, 1909, 1915, 1937] (1, C.M.).

Coast of Korea; 183 meters; Suensson, 1882 [A. H. Clark, 1909] (1, C.M.).

East Asia; Suensson, 1882 [A. H. Clark, 1909, 1937] (1, C.M.).

Albatross station 4861; Sea of Japan; Cape Clonard, southeastern Korea, bearing S. 27° W., 16.5 miles distant (lat. 36°19′00″ N., long. 129°47′00″ E.); 298 meters; bottom temperature +0.78° C.; July 31, 1906 [A. H. Clark, 1915, 1937] (3, U.S.N.M., 35727).

Albatross station 4860; Sea of Japan; Cape Clonard bearing S. 23° W., 13 miles distant (lat. 36°18′00″ N., long. 129°44′00″ E.); 223 meters; bottom temperature 1.17° C.; July 31, 1906 [A. H. Clark, 1915, 1937] (21, U.S.N.M., 35734, 35953).

?Off Fusan, Korea (lat. "45°" [probably 35°] 15′ N., long. 130°43′ E.); 549 meters; Schønau, March 9, 1895 [A. H. Clark, 1909, 1915, 1937] (1, C.M.).

[Hirado Strait, 59 meters. The correctness of this locality is open to question.] [A. H. Clark, 1909, 1915, 1937] (1, C.M.).

Geographical range.—From 55° N. in the Okhotsk Sea, Cape Patience, Sakhalin Island and the southern part of the Gulf of Tartary southward in the cold water area along the western shore of the Sea of Japan to the Korean Straits.

Bathymetrical range.—From 117 to 783 meters; the average depth from 27 records is 313 meters.

Thermal range.—From −1.75° C. to +1.72° C., the average of 14 records is +0.17° C.

Occurrence.—One of the most vivid recollections which I still retain from the *Albatross* cruise of 1906 is the sight of the forward deck of the steamer literally buried under several tons of mutilated individuals of *maxima*, of which tens of thousands passed through my hands in the search for some sufficiently intact for preservation.

On one or two occasions there was practically nothing else in the dredge, and at one station (4860) a 12-foot Tanner net 23 feet in length was completely filled so that we had great difficulty in getting it aboard.

In its great abundance in certain circumscribed localities this subspecies recalls the arctic form, and like the latter it is associated with *Gorgonocephalus eucnemis*, though apparently not so constantly.

With the masses of large brilliant lemon yellow specimens there were sometimes found others smaller and of a yellowish white (*brachymera*), which looked very different on the steamer's deck but which I am now convinced represent nothing but stunted individuals which for some reason or other fell behind in the struggle for existence among the great crowds of their more fortunate companions.

In Peter the Great Bay, Schmidt says that this species is very characteristic of the fauna of the deeper levels. It was found by him at depths of from 160 to 228 meters (75 to 125 sagens).

In Siaukhu Bay, to the east, Djakonov (1938) found *maxima* in great numbers at depths of 150 to 175 meters on muddy-sandy bottoms. It was associated particularly with *Ophiura sarsi* but also with *O. quadrispina*, *Ophiopholis aculeata japonica* and *Ophiacantha bidentata* as well as the sea urchin *Strongylocentrotus droebachiensis sachalinica*. Djakonov concluded that there is a characteristic biocenosis of *maxima* and *Ophiura sarsi* in this area forming a wide belt along the slope of the continental shelf, of which the upper limit in Peter the Great Bay is deeper than it is in Siaukhu Bay.

History.—This Pacific form of the common Arctic *Heliometra glacialis* was first mentioned in 1903 by Prof. Emil von Marenzeller, who recorded a specimen from off Gashkevicha Bay in 300 meters. In the following year a species of "*Antedon*" which can not be any other form than this was recorded by Dr. Peter Schmidt from various localities in and near Peter the Great Bay, where it had been dredged in 1900 by the *Nadejnii*.

In her work along the Siberian and Korean coasts in 1906 the *Albatross* found it abundantly, and in 1907 I suggested the recognition of the Pacific form as var. *maxima* on account of the large size. At the same time I proposed the name *brachymera* for some interesting specimens which bear about the same relation to the fully developed *maxima* that *quadrata* does to typical *glacialis*.

In 1908 I described a curious 12-armed specimen which had been collected by the *Albatross*, and in 1911 I published an analysis of the inorganic constituents of the skeleton which had been made for me by Prof. Frank W. Clarke and Dr. William C. Wheeler.

In 1909 I recorded some specimens in the collection of the Copenhagen Museum, and in 1915 I listed the localities at which it had been secured by the *Albatross* in 1906. Prof. Nils von Hofsten in the latter year discussed its distribution in comparison with that of *H. glacialis glacialis*.

Prof. K. M. Derjugin of the Academy of Sciences, Leningrad, sent me for study a small collection of crinoids dredged by the steamers *Gagara* and *Rossinante* in the Okhotsk Sea and the Sea of Japan. On the basis of this collection I prepared a detailed account of the crinoids of the region, including the complete synonymy and all the records of the known species, which was published, in Russian and English, in 1937. In this I said that *Heliometra glacialis* var. *maxima* differs from specimens of Arctic and North Atlantic *Heliometra* only in being generally larger and more robust.

In the following year, 1938, Professor A. M. Djakonov published a report on the echinoderms of Siaukhu Bay on the Sea of Japan. He recorded *maxima* from two stations, at both of which it occurred in large quantities in association with *Ophiura sarsi.*

In 1955 the distribution of *maxima* was outlined by Uschakov in a comprehensive work on the marine fauna of the far eastern seas of the U.S.S.R. Finally in 1957 Baranova commented on the absence of *maxima* from the Bering Sea.

Genus SOLANOMETRA A. H. Clark

Antedon (part) P. H. CARPENTER, Quart. Journ. Geol. Soc., vol. 36, 1880, p. 47, and following authors.
Heliometra (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351.
Solanometra A. H. CLARK, Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 128 (*nomen nudum;* the remarks refer to *Florometra*), p. 129 (characteristic antarctic genus; significance); Mem. Australian Mus., vol. 4, 1911, p. 727 (type species *Antedon antarctica* P. H. Carpenter, 1880; directly derived from *Cyclometra; Promachocrinus* a meristic variation of this genus; route followed by this genus to the antarctic and thence [*Florometra*] to the Bering Sea, etc.); Crinoids of the Indian Ocean, 1912, p. 5 (derived from the East Indian *Cyclometra;* an antarctic genus), p. 6 (large number of species in the genus [including *Florometra*]), p. 26 (closely allied to *Cyclometra*).—VANEY, Bull. Mus. Hist. Nat., Paris, No. 2, 1912, p. 33 (resemblance of the young of *Heliometra glacialis* to the species of this genus [including *Florometra*]); *in* Koehler, Bull. Mus. Hist. Nat., Paris, vol. 19, 1913, p. 34.—A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 61 (subgenus of *Promachocrinus;* restricted by the separation of *Florometra* from it); Bull. Inst. Océanogr., Monaco, No. 285, 1914, p. 3 (type *Antedon antarctica*); No. 294, 1914, p. 6 (shortness of the brachials due to the coldness of the habitat); Die Crinoïden der Antarktis, 1915, pp. 122–126 (structural and systematic relationships; characters; origin), p. 132 (covering plates), p. 134 (synonymy; diagnosis; range), p. 190 (further discussion); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Heliometrinae); No. 16, p. 508 (in key; range; best considered as a subgenus of *Promachocrinus*); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 52 (in key).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 11.—TORTONESE, Natura, Milano, vol. 24, 1933, p. 165.—A. H. CLARK, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 222 (in Russian), p. 230; Sci. Rep. Australasian Antarctic Exped., 1911–1914, ser. C, vol. 8, pt. 4, 1937, p. 6 (limited to Antarctic), p. 9.—JOHN, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86; *Discovery* Reports, vol. 18, 1938, p. 130 (monotypic and confined to the Antarctic), p. 152.—GISLÉN, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 21.
Promachocrinus (*Solanometra*) A. H. CLARK, Die Crinoïden der Antarktis, 1915, pp. 105, 106, 135.

Diagnosis.—A genus of Heliometrinae in which the arms are never carinate; the brachials are very short, the longest twice as broad as long, with finely serrate distal ends; the segments of the middle and distal pinnules, except the terminal, are about as long as broad; the longest segments of the longest cirri are never more than twice as long as broad and in most of the cirri the segments are about as long as broad; and there are 5 radials and 10 arms.

Type species.—*Antedon antarctica* P. H. Carpenter, 1880.

Geographical range.—Only known from the vicinity of Heard Island, and (?) from off Adelie Land in the Antarctic Continent.

Bathymetrical range.—From 137 to 645 meters.

Thermal range.—From $-1.84°$ to $+1.78°$ C.

Remarks [by A.M.C.].—As noted on p. 340 I think that *Florometra mawsoni* may prove to be congeneric with *Solanometra antarctica.* It appears to be intermediate in many characters between the type species of the two genera.

History.—The single species of this genus was described by Carpenter under the generic name *Antedon*. In 1907, upon the creation of that genus, it was removed to *Heliometra*.

In 1911 the name *Solanometra* first appeared, with no indication of its intent, but covering, by inference, the species both of *Solanometra* and of *Florometra* as now understood. It was used in this sense in 1913, when it appeared as a subgenus of *Promachocrinus*, including the single species *antarctica*, *Florometra* being also used to include *magellanica* and by inference the species associated with it.

In 1914 the type species of *Solanometra* was given as *Antedon antarctica*, and in 1915 a diagnosis was published; it was still, as in 1913 and in 1914, regarded as a subgenus of *Promachocrinus*, but in my *Ingolf* report of 1923, I used *Solanometra* as a generic name in a key to the genera of Heliometrinae. Since then other authors have also treated it as a full genus.

SOLANOMETRA ANTARCTICA (P. H. Carpenter)*

FIGURE 18,*a*,*b*,*e*,*f*,*i*

[See also vol. 1, pt. 1, figs. 295 (p. 263), 418 (p. 321), 506 (p. 371); pt. 2, pl. 4, figs. 997, 998]

Antedon, sp. P. H. CARPENTER, Quart. Journ. Geol. Soc., vol. 36, 1880, p. 47 (Heard I.; closely allied to [*Heliometra*] *eschrichtii* [*glacialis*]; possesses certain characters in common with *Antedon paradoxa*), pl. 5, fig. 3 (ventral surface of the centrodorsal).

Antedon antarctica P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 15, 1880, p. 198 (centrodorsal and radial articular faces), pl. 12, fig. 29 *a*, *b* (same); Proc. Zool. Soc. London for 1882, 1883, p. 746 (specific formula); Quart. Journ. Micr. Sci., new ser., vol. 23, 1883, pp. 615, and following (relations of the vascular system).—PERRIER, Nouv. Arch. Mus. Hist. Nat., Paris, ser. 2, vol. 9, 1886, p. 150 (anatomy); Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 102 (anatomy).—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 144 (description; *Challenger* Sta. 151), pl. 1, figs. 6, *a–d*, 7, *a*, *b*, pl. 25.—HAMANN, Jenaische Zeitschr., vol. 23, (neue Folge 16), 1889, p. 234 (anatomy).—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 137 (range), p. 141 (comparison with *Antedon rhomboidea* [*Florometra magellanica*]), p. 143 (comparison with *Antedon* [*Florometra*] *tanneri*).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief 2, 1905, p. 404 (antarctic representative of the *Eschrichti* group).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 120 (systematic and structural relationships). (Not *A. antarctica* BELL, National Antarctic Exped., Nat. Hist., vol. 4, Echinod., 1908, p. 4 (Winter Quarters); British Antarctic (*Terra Nova*) Exped., 1910, Nat. Hist. Rep., Zool. vol. 4, No. 1, Echinoderms, 1917, p. 2 (Stations 194, 295) [=*Florometra mawsoni*, *Promachocrinus kerguelensis* and *Notocrinus virilis*]).

Antedon australis P. H. CARPENTER, *Challenger* Reports, Zool., vol. 26, pt. 60, 1888, p. 146 (description; *Challenger* Sta. 150), pl. 26, figs. 4, 5, pl. 27, figs. 14–20.—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 137 (geographical and bathymetrical distribution).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 404 (antarctic representative of the *Eschrichti* group).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Bull. Mus. Hist. Nat. Paris, No. 4, 1911, p. 258 (synonym of *Heliometra magellanica* [error]; Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 80 (synonym of *Solanometra antarctica*).

Heliometra antarctica A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed).

Heliometra glabra A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (new name for *Antedon australis* P. H. C., 1888, not *Antedon australis* P. H. C. [Lütken, MS], 1882).

Solanometra antarctica A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 61 (published references to specimens in the British Museum; *Challenger* stations 150, 151; *Discovery*, Winter Quarters and Mts. Erebus and Terror [*F. mawsoni*]; characters of the specimens; *australis* P. H.

* See also Addenda (p. 837) under 1963.

Carpenter a synonym of this species; *rhomboidea* P. H. Carpenter a synonym of *magellanica* and not of this species as inadvertently stated in the Bull. Mus. Hist. Nat. Paris, 1911, No. 4, p. 258); Journ. Washington Acad. Sci., vol. 5, No. 3, 1915, p. 81 (antarctic; range); Die Crinoïden der Antarktis, 1915, p. 107 (in key to the antarctic crinoids), p. 122 (characters), p. 168 (a shallow water antarctic form; a species of the Gauss and Victoria quadrants lacking in the Weddell and Ross quadrants), pp. 190-192 (further discussion).—Gislén, Ark. Zool., vol. 19, 1928, p. 11 (notes; a specimen so labeled in the British Museum is of *Florometra magellanica*).—A. H. Clark, Sci. Rep. Australasian Antarctic Exped., 1911–1914, ser. C, vol. 8, pt. 4, 1937, p. 7 (in key), p. 9 (stations 1 and 3), p. 10 (distribution; color; diagnostic characters).—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 85 (Antarctic), p. 86 (not taken by *Discovery* Investigations); *Discovery* Reports, vol. 18, 1938, p. 124 (not taken by *Discovery* Investigations), p. 129 (table of distribution), p. 132 (in key to Antarctic comatulids), p. 152 (Bell's Ross Sea specimens not this species; known distribution only Heard Island and Adelie Land); Rep. B.A. N.Z. Antarctic Res. Exped. 1929–1931, ser. B, vol. 4, pt. 6, 1939, p. 191 (not taken by B.A.N.Z. A.R.E. though collecting in the sector where it has been reported).

Promachocrinus (*Solanometra*) *antarctica*, A. H. Clark, Die Crinöiden der Antarktis, 1915, p. 105 (collected by the *Challenger;* history), p. 106 (collected by the *Discovery*), p. 135 (synonymy; range; résumé of previous records).

Antedon (*Solanometra*) *antarctica* Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 287.

Promachocrinus antarctica Ekman, Tiergeographie des Meeres, 1935, p. 319.

Diagnostic features.—This species is most easily distinguished from its relatives by the short cirri composed of rarely more than 40, and usually not more than 30 segments of which the longest are rarely, even in immature specimens, more than twice as long as broad, most of them, in large cirri, being as broad as long. The cirrus segments have rather flaring ends particularly dorsally, which give the cirri a characteristic knobby appearance. The axillaries are very broad, broader than long. The brachials beyond the oblong proximal ones are short, twice as broad as the greater length. P_3 is more like P_4 than it is like P_2, and the segments of the outer pinnules are strikingly short.

Description.—The centrodorsal is hemispherical or low rounded conical, thickly covered with cirrus sockets which are arranged in more or less regular closely crowded alternating rows.

The cirri are LXXX or more, 25–35 (usually 25–30), the longest reaching 35 mm. in length, but the majority being between 25 and 30 mm. long; the apical cirri measure about 11 mm. and consist of about 17 segments. In the longest cirri the first two segments are about twice as broad as long, the third is somewhat longer, the fourth is longer than broad, and the fifth to ninth are nearly twice as long as broad; from this point the length of the segments gradually decreases so that the outermost are only about a third again as long as broad. On the thirteenth the median portion of the dorsal edge begins to project somewhat, two or three segments beyond forming a moderately developed dorsal spine; this decreases in size on the terminal three or four segments. The opposing spine is very small. The terminal claw is about as long as the penultimate segment, moderately stout and moderately curved. The majority of the cirri are somewhat shorter with somewhat fewer segments, all, or nearly all, of which are about as long as broad, and the dorsal spines are comparatively small. In the very short apical cirri the first two segments are short, and the remainder are about as long as broad; dorsal spines are developed from the third or fourth onward.

The ends of the basal rays are sometimes visible in the angles of the calyx.

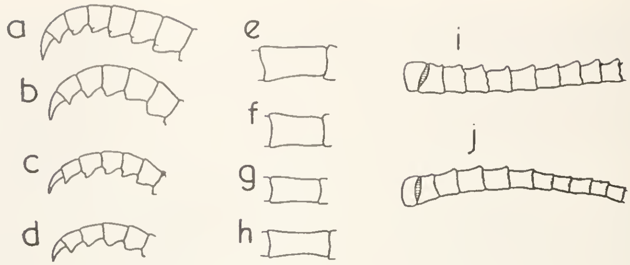

FIGURE 18.—*a*, ?*Solanometra antarctica* (P. H. Carpenter), U.S.N.M., E. 3073, Adelie Land, width at first syzygy 3.2 mm., tip of cirrus with 41 segments; *e*, same, longest cirrus segment. *b*, *S. antarctica*, syntype, B.M., 88.11.9.34, width at first syzygy 3.2 mm., tip of cirrus with 31 segments; *f*, same, longest segment; *i*, same, proximal part of P_{19}. *c*, *Florometra mawsoni* A. H. Clark, B.A.N.Z.A.R.E. station 105, width at first syzygy 2.6 mm., tip of cirrus with 30 segments; *g*, same, longest segment. *d*, *F. mawsoni*, syntype of *F. antarctica* John, *Discovery* Investigations station 599, width at first syzygy 2.1 mm., tip of cirrus with 30 segments; *h*, same, longest segment; *j*, same, proximal part of P_{19}.

The distal edges of the radials in the median line reach the rim of the centrodorsal, the radials being usually visible only in the interradial angles. The IBr_1 are short and bandlike, four or five times as broad as long, entirely free laterally, more or less incised by a posterior projection from the axillaries, with which they form on the articulation a moderately developed synarthrial tubercle. The IBr_2 are triangular and nearly as long as broad; the anterior angle is rather strongly produced, and truncated, and there is a rounded posterior projection of variable size, but never very large, in the median portion of the proximal border incising the IBr_1.

The 10 arms are about 125 mm. long. The first brachial is wedge-shaped, much longer exteriorly than interiorly, more or less deeply incised by a posterior projection from the larger and irregularly quadrate second brachial. The first syzygial pair (composed of brachials 3+4) is longer inwardly than outwardly, and somewhat broader than the greater length. The following brachials are wedge-shaped, about twice as broad as the greater length, becoming more obliquely wedge-shaped and after the fifteenth short-triangular and twice as broad as long, shortening to about two and a half times as broad as long after the thirtieth or at about the middle of the arm; distally the length increases slightly. From the second syzygy onward the brachials develop overlapping and finely serrate distal edges which become prominent after the third syzygy.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 4 muscular articulations.

P_1 and P_2 are about 22 mm. long, slender and flagellate, composed of about 60 short segments, which in the basal portion are about twice as broad as long, in the central portion are somewhat broader than long, and in the terminal portion are about as long as broad; these pinnules are strongly compressed, and the dorsal edges of the segments are produced into a rounded keel giving the distal profile a scalloped appearance. P_3 is about 25 mm. long with about 50 segments, much stouter than P_1 and P_2; the first two segments are rather broader than long, the remainder about as long as broad; a long gonad lies on the eighth to eighteenth segments, beyond which the pinnule tapers gradually to a very slender and delicate tip. The dorsal border of the segments of this pinnule is sharply carinate, but the carination rises progressively from the proximal to the distal end so that the dorsal profile presents a serrate appearance quite different from the rounded scallops on the distal profile of P_1 and P_2. P_4 is 21 mm. long resembling P_3, but the segments have finely dentate projecting distal edges, which are especially noticeable dorsally, and the gonad is longer. The following pinnules are similar, gradually decreasing in length and gradually losing the flagellate tip, the segments at the same time becoming more elongated. P_6 is 17 mm. long, with 33 segments, of which the first two are not so long as broad, the third is about as long as broad, and the following are very slightly longer than broad distally, gradually becoming elongated and reaching a length of nearly twice the width terminally. With the gradual disappearance of the gonads, which persist to about the twenty-fifth, the pinnules become gradually longer, but remain of the same proportions, the component segments being about as long as broad except in the terminal portion. All the segments of the pinnules have overlapping and finely dentate distal ends, this feature being most marked on the dorsal side. The tenth pinnule is 20 mm. long. The distal pinnules are more slender, about 20 mm. long, with the first segment about twice as broad as long, trapezoidal or almost crescentic, the second slightly larger and wedge-shaped, broader than long, the remainder about as long as broad becoming longer than broad terminally. All the segments except the first two have strongly overlapping distal ends.

The color in alcohol is light brown; in life it is yellow.

The preceding description was drawn up from the very fine specimen from *Challenger* station 151 in the Museum of Comparative Zoology at Cambridge.

Notes.—This species was described by P. H. Carpenter, on the basis of several specimens from *Challenger* station 151, in the following terms.

The centrodorsal is hemispherical, thickly covered with cirrus sockets.

The cirri are LXXX+, 25–35, reaching 35 mm. in length. Several of the segments are longer than broad, and the later ones project slightly beyond the base of their successors. The terminal claw is well developed.

The radials are concealed except in the angles of the calyx, where they are sometimes separated by the ends of the basal rays. The IBr_1 are quite short and bandlike, very convex in the center and deeply incised. The IBr_2 (axillaries) are usually rather broader than long, subtriangular, with a backward process of variable size in the middle of the base which is sometimes so large as to give the plate an unequally rhombic appearance.

The 10 arms are about 125 mm. long. They are but slightly tubercular at the base. The first brachial is much incised with a short inner and long outer edge. The brachials after the third syzygy are quite short, triangular, and slightly overlapping. They become slowly quadrate toward the ends of the arms, but always remain broader than long.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and then usually at intervals of 4 muscular articulations.

The lower pinnules are long and flagellate with a serrate dorsal edge, reaching 25 mm. in length. They are composed of about 60 short segments, of which the basal are rather broad. P_1 and P_2 are nearly equal, but P_3, though of about the same length, consists of fewer and larger segments, some of the lower ones being as long as or longer than broad. The pinnules following are shorter and more massive with larger lower segments which are nearly square in outline and overlap considerably. The middle and outer pinnules are composed of more elongated, but still overlapping, segments, the two lowest broader and more flattened with their apposed edges incurved.

The disk, which is 17 mm. in diameter, and the ambulacra are naked. Sacculi are abundant.

Carpenter noted that the centrodorsal of *Solanometra antarctica* is somewhat more conical than that of *Heliometra glacialis*.

He also said that the cirri of *Solanometra antarctica* are much smaller than those of *Heliometra glacialis*, even in individuals of equivalent size, not having more than 35 segments, a considerable proportion of which are longer than broad, while the later segments project considerably more on the dorsal side than is the case in *Heliometra glacialis*. This is especially marked in the younger cirri which are of the "small mature" type, while in *Heliometra glacialis* those which develop in the usual way, though both relatively and absolutely larger, are much more smooth-jointed.

Rather more of the radials is visible on the exterior of the calyx in *Solanometra antarctica* than in *Heliometra glacialis*, and in some instances the ends of the basal rays appear between their lower angles.

As in *Heliometra glacialis* the shape of the IBr_1 depends considerably upon that of the IBr_2. The latter are always broader than long, but vary considerably in shape even in the same individual. They are almost triangular in some cases and widely rhombic in others, owing to the strong backward projection which forms a sort of tubercle (synarthrial tubercle) together with the very convex center of the IBr_1. Carpenter said that a detailed comparison of the elements of the IBr series and lower brachials of *Solanometra antarctica* and *Heliometra glacialis* reveals a number of points of difference between them.

Carpenter found a variation comparable to that in the elements of the IBr series in the shape of the first two brachials. The junctions of the following brachials are by no means so tubercular as in the largest (Arctic) variety of *Heliometra glacialis*, though more so than in the smaller and smoother Atlantic specimens, which are of about the same size as the largest individuals of *Solanometra antarctica* that were obtained by the *Challenger*. Beyond the third syzygy the brachials of *Solanometra antarctica* are even shorter relative to the width than they are in *Heliometra glacialis*, and they have a very decided tendency to overlap, which is absent in that species, the arms of which are unusually smooth.

Carpenter remarked that the same may be said of the pinnule segments, especially the segments of the genital pinnules nearest the calyx. In *Solanometra antarctica* the long flagellate pinnules on the arm bases are serrate from end to end, whereas in *Heliometra glacialis* the middle segments are smooth with sharp edges, but nothing more. In *Solanometra antarctica* P_3 is much more like its successor than is the case in *Heliometra glacialis*. Its lower segments are considerably stouter than those of P_2, some of them being as long as or longer than broad whereas in *Heliometra glacialis* they are distinctly broader than long. In fact P_3 in *Solanometra antarctica* resembles P_4 in

Heliometra glacialis rather than its fellow, P_3. In the middle and outer pinnules there is a good deal of variation in the extent of modification in the two basal segments, but they are never so much flattened and so nearly trapezoidal in form as they are in the larger *Heliometra glacialis*.

The axial opening on the ventral surface of the centrodorsal is relatively much larger in *Solanometra antarctica* than in *Heliometra glacialis* so that it reveals a large number of the internal ridges which separate the inner openings of the cirrus canals. Five of these, interradial in position, are much more prominent than the rest. The basal grooves on the ventral surface of the centrodorsal are scarcely more distinct than they are in *Heliometra glacialis*, but on the other hand the dorsal surface of the radial pentagon bears a very well-defined basal star, of which there is rarely any trace in that species.

The rosette lies deeper in *Solanometra antarctica* than it does in *Heliometra glacialis*, and the basal rays connected with it are unusually stout. This is most noticeable when they are isolated. In some cases their distal ends appear on the exterior of the calyx.

In *Solanometra antarctica* the slope of the articular faces of the radials (see Part 2, plate 4, figures 997, 998) is more uniform than it is in *Heliometra glacialis*, and there is much less of an angle between the upper and lower parts of each face. As a consequence of this, more of the large muscular fossae is visible when the calyx is viewed ventrally. The ridges which separate the muscular fossae from the interarticular ligament fossae are much more nearly horizontal than is the case in *Heliometra glacialis*, so that the two pairs of fossae are of very unequal size.

Carpenter described *Antedon australis* as follows.

The centrodorsal is hemispherical, thickly covered with about L cirri. The cirri have 25–30 segments, nearly all of which are longer than broad. The later segments are laterally compressed, and their dorsal edges project considerably beyond the bases of their successors, thus giving rise to a strong spine on the last few segments. The young cirri around the dorsal pole resemble the mature form, but have fewer segments. The marginal cirri may have 30 smooth and elongated segments which only develop spines quite late.

The radials are just visible. The IBr_1 are short and nearly oblong, but little incised for the axillaries, which are broadly pentagonal or triangular, with a slight backward projection in the middle of the base.

The 10 arms are about 60 mm. long. The brachials are somewhat overlapping, but the proximal brachials are not tubercular. After the second syzygy the brachials are shortly triangular, gradually becoming quadrate, but always much broader than long.

Syzygies occur between brachials 3+4, 9+10 and 14+15, and distally at intervals of 3 or 4 muscular articulations.

P_1 is flagellate, about 12 mm. long, and is composed of 45 short segments, of which the basal are broad, flattened, and somewhat carinate. P_2 is sometimes nearly equal to, and sometimes shorter than, P_1. P_3 is also shorter, with stouter segments, most of which are distinctly longer than broad, and generally bears a fusiform genital gland. The following pinnules are more massive with squarer segments, which become elongated further out, while the two basal ones are flattened and trapezoidal with their apposed edges incurved.

The disk (which is 10 mm. in diameter) and the ambulacra are naked. Sacculi are abundant in some places, but less so in others.

The color in alcohol is white, with purplish or brownish patches.

Carpenter said that this is a smaller and more delicate species than *Antedon antarctica,* which it resembles in the shortness of its brachials; but the arms generally are much smoother, and there are fewer cirrus segments, while P_3 is much less like P_2 than is the case in that species. The 3 lowest segments of P_3 are by no means so broad as in *A. antarctica,* but more nearly square, while the following segments until quite near the end are very distinctly longer than broad, which is not the case in *A. antarctica.* Even the first 2 pinnules of *A. australis* have a tendency in this direction, as compared with the much longer ones of *Heliometra glacialis* and *Solanometra antarctica.*

It can scarcely be doubted that *Antedon australis* was based upon structurally immature individuals of *Solanometra antarctica.*

The types of *australis* were 7 specimens from *Challenger* station 150 off Heard Island and a mutilated specimen of much smaller size from which all the arms had been broken away at the syzygy between brachials 3+4.

[NOTES BY A.M.C.] A comparison of the figures given in the table shows some differences between the specimens from Heard Island and those from Adelie Land. The latter appear to have relatively higher centrodorsals, slightly narrower arms, longer cirri with more and longer segments (fig. 18*a,e*) and proximal pinnules with fewer segments, taking the size into consideration, although at least one of the types of *antarctica* (that in the M.C.Z.) has cirri with up to 35 segments.

I suspect that these larger specimens from the Australasian Antarctic Expedition (*Aurora*) collections are conspecific with the smaller ones from Adelie as well as Queen Mary Lands, which Mr. Clark described as a new species, *Florometra mawsoni.* In his key to the comatulids of the Southern Ocean given in the report of that expedition (1937), Mr. Clark distinguished *S. antarctica* from *F. mawsoni* by the larger size, more numerous (60:36) segments of P_1, more numerous (c.40:30) cirrus segments, "most of which are not longer than broad," (they may be so in the types of *antarctica* from Heard Island but at least one Adelie Land specimen has 20 out of the 41 segments of a peripheral cirrus distinctly longer than broad and the longest just over twice as long as broad) and by the broader brachials of which the proximal ones are smooth. All these char-

TABLE 12.—*Details of six specimens of* S. antarctica *from two* Challenger *stations off Heard Island, and of two specimens also recorded under this name from Adelie Land*

Specimens	Arm length (mm.)	Centrodorsal		Width at 1st syzygy (mm.)	IBr_1 to 2nd syzygy (mm.)	Cirri			P_1		P_2	
		Diam. (mm.)	Height (mm.)			No.	Segs.	Length (mm.)	Segs.	Length (mm.)	Segs.	Length (mm.)
Station 151	100+	7.0	4.5	3.2	16.0	C	28	30	55+	18	–	–
	100+	7.0	4.0	3.3	15.0	CXX	–	–	57	21	45	19
	100+	7.1	4.5	3.4	16.5	CXX	–	–	62	24	–	–
Station 150	c.90	4.3	2.5	2.0	12.5	LXXV	–	–	38	14	–	–
	c.60	–	–	1.8	11.5	c.L	24	15	–	–	40	12
	c.50	–	–	1.4	9.5	XLV	21	12	32	10	–	–
Adelie Land	100+	6.0	4.5	3.2	19.0	LXXX	41	50	35+	–	31+	–
	–	5.5	4.0	3.0	17.5	LXXX	–	–	–	–	–	–

acters appear to me to be concomitant with size, as has already been shown to some extent by the larger specimens of *mawsoni* taken by the *Discovery* Investigations and B.A.N.Z.A.R.E. around the Antarctic continent.

A comparison of table 12 with table 9 on page 337 for *Florometra mawsoni,* shows many similarities between the smaller specimens of *S. antarctica* from Heard Island (the types of *australis*) and specimens of *mawsoni* of comparable size. Nevertheless I think the two species are quite distinct, larger specimens exhibiting greater divergence of characters, such as the relative arm width. This is discussed further under the heading of *F. mawsoni.*

Localities.—Challenger station 150; near Heard Island (lat. 52°04′ S., long. 71°22′ E.); 274 meters; temperature 1.78° C.; coarse gravel; February 2, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1913] (4, B.M.).

Challenger station 151; near Heard Island (lat. 52°59′30″ S. long. 73°33′30″ E.); 137 meters; volcanic mud; February 7, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1913] (4, M.C.Z., 3, B.M.). Type locality.

Doubtful localities [A.M.C.].—*Aurora* (Australasian Antarctic Expedition) station 3; Adelie Land (lat. 66°32′ S., long. 141°39′ E.); 287 meters; temperature −1.62° C.; ooze; December 31, 1913 [A. H. Clark, 1937] (5, U.S.N.M., E. 3072).

Aurora station 1; Adelie Land (lat. 66°50′ S., long. 142°06′ E.); 640–731 meters; temperature −1.84° C.; thick ooze; December 22, 1913 [A. H. Clark, 1937] (2, U.S.N.M., E. 3073).

Aurora; no definite locality [A. H. Clark, 1937] (3, Austr. M.).

These three *Aurora* records should probably be referred to *Florometra mawsoni.*

Geographical range.—Heard Island, to the south of Kerguelen and (?) from Adelie Land.

Bathymetrical range.—From 137 to 274 (?731) meters.

History.—This species was first mentioned by Dr. P. H. Carpenter in two papers published in 1880, in which he described and figured the centrodorsal and radials. In one of these papers he referred to it simply as *Antedon,* sp., while in the other he called it *Antedon antarctica.* In 1883 Carpenter published a specific formula for *Antedon antarctica,* and in another paper published in the same year he discussed the relations of the vascular system.

In the report on the *Challenger* comatulids Carpenter described and figured *Antedon antarctica* comparing it in great detail with *Heliometra glacialis.* He said that this is no doubt the species to which Sir Wyville Thomson referred when he stated that *Antedon eschrichti* [=*Heliometra glacialis*] had been obtained in the Southern Ocean. He gave no reference to Sir Wyville's statement and I cannot find that such a statement by him ever appeared in print. He did not mention any crinoid from Heard Island in any of his letters written from on board the *Challenger,* or in his book on the Atlantic. The statement must therefore have been made in an unpublished letter to Dr. W. B. Carpenter, or in notes taken on the cruise which subsequently came into P. H. Carpenter's hands.

Following the description of *Antedon antarctica* in the *Challenger* report, there is described *Antedon australis,* the latter being based upon 7 mutilated specimens and one very young that were dredged not far from the locality off Heard Island which yielded the specimens of *Antedon antarctica. Antedon australis* is simply the young of *A. antarctica.*

In 1907, before I had discovered that *Antedon australis* is simply the young of *A. antarctica*, I suggested the name *glabra* to replace *australis*, as Carpenter had mentioned quite a different species (*Craspedometra acuticirra*) under the name *Antedon australis* in 1882.

In 1908 Prof. F. J. Bell mistakenly recorded this species from the *Discovery* Winter Quarters in the Ross Sea. These specimens are of *Florometra mawsoni.*

In my paper on the crinoids of the Paris Museum published in 1911 I wrote, under the heading *Heliometra magellanica*, "Cette espèce est la même que l' *Antedon australis* et aussi que l' *Antedon rhomboidea* décrite par Carpenter dans le rapport sur les échantillons recueillis par le *Challenger*." This is, of course, an error. *Antedon australis* is the same as *A. antarctica*, and *A. rhomboidea* is the same as *A. magellanica.*

In 1913 I published notes upon the crinoids which I had studied in the British Museum in 1910. *Antedon australis* was placed definitely in the synonymy of *A. antarctica.* Two specimens dredged at "Mts. Erebus and Terror" by the *Discovery*, which had been identified as *Anthometra adriani* by Bell, were redetermined as this species. [Note by A.M.C.] However, following the establishment of *Florometra mawsoni* in 1937, these specimens were recognized as belonging rather to that species by John, 1938.

In 1915 I published a complete synonymy of this species and a list of all the known records.

Prof. Bell in 1917 mistakenly recorded it from *Terra Nova* stations 194 and 295, mentioning a 6-rayed individual which is in reality *Promachocrinus kerguelensis.* His other specimens were *Notocrinus virilis.*

[Note by A.M.C.] In 1937 Mr. Clark recorded under this name specimens from two stations of the Australasian Antarctic Expedition off Adelie Land. The color in life was given as yellow. I believe that these specimens should have been referred to *Florometra mawsoni.*

Genus PROMACHOCRINUS P. H. Carpenter*

Comatula (not of Lamarck, 1816) von Willemöes-Suhm, Zeitschr. wiss. Zool., vol. 24, Heft 3, Sept. 16, 1874, p. xvi; Proc. Roy. Soc., vol. 24, 1876, p. 589 (characteristic of the second faunal zone at Kerguelen, in 40–120 fms.).

Promachocrinus P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 385; Nature, vol. 19, 1879, p. 450.—Zittel, Handbuch der Palaeontologie, vol. 1, 1876, pp. 346, 397.—P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 15, 1880, p. 214; Quart. Journ. Geol. Soc., vol. 36, 1880, p. 40; Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 161 (11 of separate) (sacculi present); Proc. Zool. Soc. London for 1882, 1883, p. 732, footnote; Quart. Journ. Micr. Sci., new ser., vol. 23, 1883, pp. 611 and following (relations of the vascular system).—Perrier, Compt. Rend. Acad. Sci., vol. 96, No. 11, 1883, p. 725.—Hoernes, Elemente der Palaeontologie (Palaeozoologie), 1884, p. 131.—P. H. Carpenter, Phil. Trans. Roy. Soc., vol. 174, pt. 3, 1883, 1884, p. 922 (rosette and basal star pentamerous, the rays of the latter lying under the "interradial radials" which, however, are in no way different from the true ["radial"] radials), p. 926; *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 36–38, 68, 90, 92, 97, 137, 138, 140, 144, 216, 403; *Challenger* Reports, Narrative, vol. 1, pt. 1, 1885, p. 311; Ann. Mag. Nat. Hist., ser. 5, vol. 15, 1885, p. 112.—Perrier, Nouv. Arch. Mus. Hist. Nat., Paris, ser. 2, vol. 9, 1886, p. 149; Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 101.—P. H. Carpenter, Ann. Mag. Nat. Hist., ser. 5, vol. 19, 1887, p. 40; Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 385 (sacculi present); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 348.—W. Marshall,

* See also Addenda (pp. 836, 837) under 1962, 1963.

Die Tiefsee und ihr Leben, 1888, p. 239.—de Loriol, Paléontologie française, ser. 1, Animaux invertébrés, Terrain jurassique, vol. 11, pt. 2, 1889, p. 435.—Pfeffer, Ergebn. Deutsch. Polar-Exped., Allgem. Theil., vol. 2, 1890, p. 485 (30 of separate).—Bather, Ann. Mag. Nat. Hist., ser. 6, vol. 7, 1891, p. 464.— P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 21.—Norman, Ann. Mag. Nat. Hist., ser. 6, vol. 8, No. 44, August 1891, p. 181.—Perrier, Traité de zoologie, 1893, p. 858.—Walther, Einleitung in die Geologie als historische Wiss., 1894, pp. 297, 300.—Lang, A text book of comparative anatomy, vol. 2, 1896, p. 313.—Bather, Royal natural history, vol. 6, 1896, p. 300; Geol. Mag., new ser., Dec. 4, vol. 5, 1898, p. 523; Rep. British Assoc. for 1898, 1899, p. 923; *in* Wachsmuth and Springer's Monograph on crinoids, 1899, p. 523; *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, pp. 124, 137, 150, 195.—Delage and Herouard, Traité de zoologie concrète, vol. 3, 1903, p. 394.—Minckert, Arch. Naturg., Jahrg. 71, vol. 1, Heft 1, 1905, p. 166 (syzygies; regeneration); Zool. Anz., vol. 28, 1905, p. 490.—Reichensperger, Zeitschr. wiss. Zool., vol. 80, 1905, p. 24; Bull. Mus. Comp. Zool., vol. 46, No. 10, 1905, p. 171.—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 343 (included by Carpenter in the Comatulidae), p. 344 (subsequently included with *Decametrocrinus* in the family Decametrocrinidae; later found not closely related to *Decametrocrinus*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (closely related to *Heliometra* and very different from *Decametrocrinus*), p. 136 (referred to the Antedonidae, restricted); Amer. Nat., vol. 42, No. 503, 1908, p. 725; Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 267 (relation to *Heliometra*), p. 269; vol. 35, 1908, p. 126 (probable origin); vol. 36, 1909, p. 363 (origin); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Heliometrinae).—Vaney, Bull. Mus. Hist. Nat., Paris, No. 3, 1910, pp. 158–161 (discussion; history and position of *Decametrocrinus*).—A. H. Clark, Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (differs from *Solanometra* only in the doubling of the rays; characteristic of the antarctic fauna; significance); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 460 (normally 10-rayed); Mem. Australian Mus., vol. 4, 1911, p. 727 (meristic variation from *Solanometra*, which is derived from *Cyclometra*); Crinoids of the Indian Ocean, 1912, p. 5 (an antarctic genus derived from the East Indian *Cyclometra*), p. 17 (merely differs from *Solanometra* in the doubling of the radials), p. 26 (closely allied to *Cyclometra*).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 485.—Reichensperger, Zeitschr. wiss. Zool., vol. 101, Heft 1–2, 1912, p. 32 (sacculi).—A. H. Clark, Bull. Inst. Océanogr. Monaco, No. 285, 1914, p. 3, footnote (type species *P. kerguelensis;* includes as subgenera *Promachocrinus, Solanometra, Anthometra* and *Florometra*); No. 294, 1914, p. 6 (10 rays the result of the coldness of the habitat); Die Crinoïden der Antarktis, 1915, p. 120 (diagnosis; range; origin; history; phylogenetic position and interrelationships), p. 127 (synonymy; diagnosis; range), p. 132 (covering plates), p. 190 (further discussion); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 13 and following (phylogenetic study); Amer. Nat., vol. 49, 1915, p. 525 (range), p. 526 (asymmetrical character; probably the most specialized of the Heliometrinae), p. 527 (types of asymmetry), p. 539 (asymmetrical disk), p. 542 (more than five rays), p. 546 (asymmetrical through phylogenetically excessive cold).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 90–L, 1915, p. 195 (inorganic constituents of the skeleton); Prof. Paper 102, 1917, pp. 23 and following (same).—A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Heliometrinae); No. 16, p. 507 (in key; range); Unstalked crinoids of the *Siboga*-Exped. 1918, p. 239 (in key; range).—Bather, Ann. Mag. Nat. Hist., ser. 9, vol. 1, No. 4, 1918, pp. 294, 297, 298, 299, 300.—Mortensen, Vid. Medd. Nat. Foren. København, vol. 72, 1920, p. 78 (discussion of elongate marginal cirri).—Springer, Crinoidea Flexibilia, 1920, pp. 30, 39, 48, 52, 53, 54, 63, 64, 71 (structure, larval stages, etc.).—A. H. Clark, Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 13 (asymmetry).—F. W. Clarke and Wheeler, U.S. Geol. Survey Prof. Paper 124, 1922, p. 20 (inorganic constituents of the skeleton).—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 52 (in key).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 39.—Bernasconi, An. Mus. Argent. Cienc. Nat., Buenos Aires, vol. 37, 1932, p. 30 (brief diagnosis).—Tortonese, Natura, Milano, vol. 24, 1933, p. 165.—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.—Ekman, Tiergeographie des Meeres, 1935, p. 319.—A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 222 (in Russian), p. 230; Sci. Rep. Australasian Antarctic Exped., 1911–1914, ser. C, vol. 8, pt. 4, 1937, p. 6 (limited to Antarctic).—John, Proc. Linn. Soc. London, sess.

149, pt. 2, 1937, p. 86; Res. Voy. *Belgica*, 1897–1899, Zoology, Crinoidea, 1937, p. 9; *Discovery* Reports, vol. 18, 1938, p. 130 (monotypic; limited to Antarctic), p. 133; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–1931, ser. B, vol. 4, pt. 6, 1939, p. 196.—Cuénot *in* Grassé, Traité de zoologie, vol. 11, 1948, pp. 39, 52, 71.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (depth range).

Promachorinus (part) de Loriol, Paleontologie française, ser. 1, Animaux invertébrés, Terrain jurassique, vol. 11, pt. 2, 1889, p. 434.

Antedon (part) Vanhöffen, Zeitschr. Ges. Erdkunde, 1904, p. 369.

Promacochrinus Bell, National Antarctic Exped., Nat. Hist., vol. 4, Echinod. 1908, p. 16.

Promachocrinus (*Promachocrinus*) A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 60; Die Crinoïden der Antarktis, 1915, pp. 105, 106, 128.

Promachoerinus Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 53.

Diagnosis.—A genus of Heliometrinae in which there are 10 radials and 20 arms; the centrodorsal is conical; the arms are rounded dorsally; the brachials, of which the longest are slightly broader than long, have spinous distal ends with often a greater or lesser development of spines on the dorsal surface; and P_1, which is similar to P_2, has 40 to 50 segments.

Geographical range.—Shores of the Antarctic continent, the Graham Land peninsula, South Shetland and South Sandwich Islands, South Georgia, Bouvet, Kerguelen and Heard Islands.

Bathymetrical range.—From 20 to 1080 meters.

Thermal range.—From $-1.90°$ to $+2.75°$ C.

History.—Mentioned under the broad and comprehenisve name *Comatula* by von Willemoes-Suhm in 1874, this genus was first diagnosed by P. H. Carpenter in 1879. *Promachocrinus* as understood by Carpenter was characterized by the occurrence of 10 radials superimposed upon 5 basals, and he included in this new genus not only *P. kerguelensis* but also *P. abyssorum* and *P. naresi* which also have 10 radials, but undivided arms.

Carpenter wrote that there is a most remarkable general resemblance between *Promachocrinus kerguelensis* and *Heliometra glacialis* and *Solanometra antarctica*, the characters of the cirri, brachials, pinnules, and even of the gonads being very closely similar in the 3 types, so that if nothing were known of *Promachocrinus kerguelensis* but some fragments of its arms, one would unhesitatingly refer them to a species of the "*Eschrichti* group," that is, of Heliometrinae. He also noted that in the other 2 species which he assigned to *Promachocrinus* the arms remain undivided just as in *Eudiocrinus* (including *Pentametrocrinus*). But the presence of 10 radials seemed to him to set *Promachocrinus*, as he understood it, so entirely apart from all other comatulids as to preclude the necessity of any close comparison between the component species and other genera.

In 1905 Dr. Wilhelm Minckert created the genus *Decametrocrinus* for the inclusion of those species of Carpenter's *Promachocrinus* in which the arms are undivided, that is, *P. abyssorum* and *P. naresi*, leaving *kerguelensis* the only species in the original genus. He also created a new family, the Decametrocrinidae, for the reception of *Promachocrinus* and *Decametrocrinus*.

In 1908 I placed *Promachocrinus*, as understood by Minckert, in the family Antedonidae, and associated *Decametrocrinus* with *Eudiocrinus* in the family Eudiocrinidae. On the discovery later in the same year that the 5-armed comatulids placed by Carpenter in the genus *Eudiocrinus* belong in reality to two entirely different genera, *Eudio-*

crinus, ss., and another which I called *Pentametrocrinus*, I introduced a new family, the Pentametrocrinidae for the latter.

PROMACHOCRINUS KERGUELENSIS P. H. Carpenter*

[See vol. 1, pt. 1, figs. 294 (p. 263), 505 (p. 371), pl. 5, figs. 549–551; pt. 2, figs. 807 (p. 378), 881–894 (p. 533), 895–909 (p. 538), 910–919 (p. 541), 920–928 (p. 545), 929–937 (p. 549), pl. 4, figs. 1001, 1002, pl. 42, fig. 1276]

Comatula VON WILLEMOËS-SUHM, Zeitschr. wiss. Zool., vol. 24, 1874, p. xvi (Kerguelen; characteristic of the second littoral zone, 40–120 fms.); Proc. Roy. Soc., vol. 24, 1876, p. 589 (same).

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* See also Addenda (pp. 836, 837) under 1962, 1963, 1964.

collections), p. 87 (Kerguelen and Heard Islands); Res. Voy. *Belgica*, 1897–1899, Crinoidea, 1937, p. 9 (synonymy; descriptive remarks); *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 124 (nearly two-thirds of Antarctic specimens are of this species), p. 129 (in distribution table), p. 131 (known from Kerguelen and Heard Islands as well as the Antarctic; in key) p. 133 (synonymy; station list), pp. 134–144 (history; synonyms; full description with variations), pp. 200–202 (pentacrinoid larvae); fig. 1, p. 136 (cirri); fig. 2, p. 138 (brachials), pl. 3, fig. 1; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–1931, ser. B, vol. 4, pt. 6, 1939, p. 191 (Kerguelen is type locality), pp. 196, 197 (stations; synonyms; variations in number of arms).—Jägersten, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 11, No. 8, 1940, p. 6 (myzostome parasite).—A. H. Clark, Journ. Washington Acad. Sci., vol. 40, No. 10, 1950, p. 335 (references; localities; notes).—Vinogradov, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (composition of skeleton).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 113 (most common Antarctic species).—Madsen, Sci. Res. Norwegian Antarctic Exped., No. 37, 1955, p. 3 (localities).—Tortonese, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182 (in Tortonese collection from Banzare station 107).

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Promachocrinus kerguelenensis Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 53.

Description.—The centrodorsal is conical with the tip pointed or somewhat blunted in the most highly developed individuals, reaching 7 mm. in diameter at the base and

8 mm. in interradial length. Except for a small area about the apex it is completely covered with cirrus sockets, which are arranged in closely crowded alternating rows, those of the succeeding rows becoming gradually smaller distally.

The cirri are L–CC, 30–65, from 40 to 130 mm. in length. In some specimens the longer cirri have the first three segments broader than long, the fourth about as long as broad, and those following up to twice as long as broad, the length slowly decreasing towards the tip. In others the segments are relatively longer, the first segment very short, the second about as long as broad, the third longer than broad, and the following ones increasing in length to a maximum of four times as long as broad; the outermost segments are shorter again, becoming terminally about as long as broad, with slightly prominent ends. The opposing spine may be either absent, small, or well-developed, and the terminal claw is slender, sharp, and moderately curved. The apical cirri have 25 to 30 segments and are from 15 to 30 mm. long.

The ends of the basal rays are just visible as small transversely elongate tubercles under the interradial radials.

The radials in the most fully developed specimens are just visible beyond the rim of the centrodorsal; they are more extensively visible in the immature, in which the interradial radials are slightly longer than the radial radials. The distal edge of the radials is slightly concave, and their lateral edges are wholly in contact with those of their neighbors. The IBr_1 are twice as broad as long, not quite, or just, in contact with each other at the proximal angles, with the lateral edges almost straight or more or less convergent, in the best developed specimens with the distal border almost straight, in the less developed with it deeply incised by a posterior projection from the axillary. The IBr_2 in the most mature specimens are large and widely rhombic, broader than long, about 5 mm. in width and 3.2 mm. in length; in smaller individuals they are relatively much longer and shield-shaped, in the specimens from the *Gauss* collection being 2.5 mm. wide and 3.0 mm. long. The median portion proximal to a line between the lateral angles is more or less swollen. In immature specimens the axillaries borne on the radial radials are relatively slightly longer than those on the interradial radials. The variation in form of the radials and division series has been illustrated by Dr. John in his *Discovery* Report, (1938).

The 20 arms are up to 250 mm. in length. In the larger specimens the first brachials are twice as broad as long, about twice as long exteriorly as interiorly, just in contact by the inner proximal angles, with the distal border almost straight or slightly concave; in less mature specimens they are deeply incised by the posterior process of the second brachials. The second brachials are as long as broad, or in the less developed specimens longer than broad and shield-shaped with a long posterior process. The first syzygial pair (composed of brachials 3+4) is about as long as broad, slightly constricted centrally in the larger, more strongly constricted centrally in the smaller individuals. The following brachials to the thirteenth or sixteenth have approximately parallel ends, and their length in fully mature specimens is about three-fourths of their width. The following brachials become triangular, distally gradually becoming wedge-shaped and longer.

In the smaller specimens the dorsal surface of the radials, ossicles of the IBr series and lower brachials is often thickly covered with short spines; after the fifth brachial these spines become longer and more prominent, and become restricted within a triangular area, of which the distal edge, now somewhat produced, forms one side and the median point on the proximal edge is the opposite apex. On the succeeding brachials the spines become more and more prominent, the spinous area at the same time becoming restricted by the moving distally of the proximal apex of the triangle to a point about midway between the proximal and distal borders, and the eversion of the distal edge, now very spinous, becomes more marked. After the proximal third of the arm the spinosity of the dorsal surface of the brachials gradually disappears, leaving the dorsal surface smooth and the brachials with produced and very finely spinous distal edges.

On the largest specimens there are few or no spines on the dorsal surface of the division series and proximal brachials.

Syzygies occur between brachials 3+4, 9+10 (from 8+9 to 10+11), 14+15 (or 15+16), and distally at intervals of from 3 to 11, usually 4 or 5, muscular articulations. The arm width at the first syzygy is respectively 1.3, 1.7, and 2.5 mm. in three specimens with arm length about 100, 150, and 200 mm., while the lengths from the proximal edge of the IBr_1 to the second syzygy are 13.0, 16.5, and 19.5 mm.

The disk is 15 or 16 mm. in diameter. Ordinarily each groove trunk on leaving the mouth soon divides, and each of these derivatives divides again near the base of the arms so that each of the 5 main grooves about the mouth carries the material from 4 arms; but there is great variation; the groove formed by the union of the two grooves of an arm pair may run direct to the mouth, or it may join with the grooves from the arm pairs on either side.

P_1 is slender and flagellate, from 17 to 26 mm. in length, composed of 40 to 75 segments, of which the basal are broader than long, the middle segments are up to twice as long as broad and the distal ones are again shorter. The 6 proximal segments have their corners cut away and the first 15 or so bear numerous ventrolateral spines, which, at least in the smaller specimens, are continued to the tip of the pinnule so that the distal segments appear relatively short.

P_2 may resemble P_1 and be of the same length or slightly longer and a little stouter basally, with the same number or rather fewer but slightly longer segments; usually there are 26 to 46, rarely up to 62 segments. P_a resembles P_2, varying with it.

P_3 is slightly stouter basally than P_2, with 16 to 40 segments which are proportionally much longer than those of P_2 where the latter resembles P_1. P_3 may be the first genital pinnule, in which case it is usually much shorter and more tapering than P_2 with all but the basal segments elongated.

The middle and distal pinnules are 10 to 20 mm. long, not especially slender, with 20 to 26 elongated segments the distal ends of which are sometimes armed with a few spines.

The gonads are long and slender.

The ambulacral grooves of the pinnules and arms may be bordered with prominent plates or they may be entirely without calcareous deposits. When the plates are well-developed, there are three or four to each pinnule in a single continuous series, the distal edge of one overlapping the proximal edge of the next. Each is curved in the axis of the pinnule and has its outer part curved over the ambulacral furrow (see part 2, p. 268, fig. 378). When they are present, the tentacles usually contain numerous knobbed spicules. The plates may be smaller and not in contact. Their occurrence is discussed more fully below.

The color in life is very variable. The entire specimen may be straw-colored, very light grey, flesh-colored, pale or brilliant yellow, orange brown or purple; the greater part of it may lack stronger colors except for bands of dark brown or purple on the cirri or the arms, where the bands often coincide with the syzygial pairs, or the pinnules, or all three; alternatively, portions of a specimen, such as the pinnules or the distal parts of the arms, may be brown or purple or yellow. Different specimens from one station may range in color from cream to dark brown or purple.

Notes.—*Gauss* (German South Polar Expedition), May 6, 1902, 172 meters; a specimen with 12 arms borne on 6 radials; the arms are 80 mm. long; the longest cirri are 28 mm. long with 28 segments; the dorsal surface of the ossicles of the IBr series and lower brachials is rather prominently spinous; the covering plates are highly developed but lack the narrow produced distal portion. The left posterior ambulacrum on the disk supplies 4 arms.

Gauss, June 20, 1902; 385 meters; the arms are 50 mm. long; the longest cirri are 18 mm. long with 22 segments.

Gauss, January 28, 1903, 380 meters; the arms are about 40 mm. long; the ossicles of the IBr series and the lower brachials are very spinous.

Gauss, January 3, 1903, 380 meters; the arms are 30 mm. long; the longest cirri are 9 mm. long and are composed of 17 segments. This specimen in all ways resembles the preceding one.

Gauss, June 20, 1902, 385 meters; the longest cirri are 17 mm. in length and are composed of from 23 to 25 segments. The ossicles of the IBr series and the lower brachials have the dorsal surface thickly covered with fine spines, and possess everted and very spinous edges, as in the young of *Heliometra glacialis*. On the disk the left posterior ambulacrum divides half way between the mouth and the edge of the disk, each of these two derivatives supplying two arms; the other ambulacra are as in ordinary 10-armed endocyclic species.

Of the 2 specimens from *Aurora* (Australasian Antarctic Expedition) station 8, one is about two-thirds full size, with 8 rays and 16 arms, and the other is about half-grown with 6 rays and 12 arms.

The 5 specimens from *Aurora* station 9 all have 10 rays and 20 arms, which in the largest are about 150 mm. long. In the smallest the middle two-thirds of the outer half of the fourth and following brachials is abruptly elevated and densely covered with very small erect spines. In lateral view the dorsal profile of the arms shows an abrupt and rather high rounded elevation occupying slightly less than the distal half of each brachial.

Two small specimens from *Aurora* station 10 have 10 rays and 20 arms. The third specimen is fairly large with 8 rays and 16 arms. A single complete cirrus 80 mm. long, with 40 segments remains. On the sixth and following brachials a triangular portion with the base occupying the entire dorsal portion of the distal edge and the apex about in the middle of the brachial is abruptly elevated and studded with fine spines, the dorsal profile of the lower portion of the arms being very conspicuously scalloped. This disappears at about the thirtieth brachial, after which the brachials have a slightly produced and strongly serrate distal edge.

Of the 8 specimens from *Aurora* station 12, one is large with 22 arms, one of the IBr axillaries bearing 2 IIBr series, which exactly resemble the IBr series. Three of the others are fully grown, with 10 rays and 20 arms. One, also with 10 rays and 20 arms, is small, with the arms 60 mm. long, and the longest cirri 27 mm. long, with 24 segments. Another, still with 10 rays and 20 arms, is smaller, with the arms 45 mm. long, and the cirri 25 mm. long, with 24 segments. There is another small specimen, with 10 rays and 20 arms. The last specimen is very small, with 8 rays and 16 arms.

Of the 3 specimens from *Aurora* station 3, two have 10 rays and 20 arms and one has 9 rays and 18 arms.

Among the specimens from *Aurora* station 1 there are 32 with 10 rays and 20 arms. One has 10 rays and 22 arms (as has also a specimen from station 12), two IIBr series being present, abnormally developed (see p. 439), on the same IBr series. One specimen has 9 rays and 18 arms, and 2 small specimens have 6 rays and 12 arms. In a specimen not quite full size the longest cirri are 70 mm. long, with 26 to 38 segments. The terminal claw is sharp and very slender, gently curved in the proximal third but becoming straight in the distal two-thirds. In some of these specimens there is no elevation at the synarthrial lines, while in others there are rather prominent small conical synarthrial tubercles.

Among the 7 specimens from *Aurora* station 2, there are 4 with 10 rays and 20 arms, 2 with 9 rays and 18 arms, and 1 with 8 rays and 16 arms. A rather small specimen with 10 rays and 20 arms has the distal edge of the brachials everted and the dorsal surface finely spinous. A specimen with 9 rays and 18 arms has the brachials with the dorsal surface moderately roughened. A rather small and slender specimen with 10 rays and 20 arms about 140 mm. long is moderately rough. One of the specimens with 10 rays and 20 arms is very small.

From the *Aurora* collection without data there are 2 specimens with 10 rays and 20 arms.

[NOTES BY A.M.C.] The *Discovery* Investigations collection shows that the number of cirri may exceed CC. Dr. Dilwyn John (1938) says that there is always a sharp contrast between the apical cirri and those of the more ventral part of the centrodorsal: the latter are long, of up to 47 or, exceptionally, 65 segments; the former very much shorter and of fewer segments. The contrast is greatest in large specimens; the longest peripheral cirri may be three or more times as long as the shortest apical cirri. They may be up to 130 mm. long.

P_1 may have as many as 75 segments and be up to 26 mm. long. The dorsal surfaces of the first 6 to 12 segments may be raised into thorny crests. P_2 is usually of fewer segments, five to ten less than in P_1, but in one *Discovery* specimen it has 62 segments. It is usually the same length as P_1. The first genital pinnule is normally P_3 or P_4. P_3 is commonly of 16 to 40, sometimes up to 60 segments. Whether it is an oral or a genital pinnule it may be of roughly the same length as P_2, but sometimes, when it is a genital, it is very much shorter and of segments which decrease rapidly in stoutness from the base to the end. P_3 is usually of anything from 5 to 20 segments fewer than P_2 of the same specimen; all but its basal segments are more elongated, being as much as, or more than, twice as long as broad. The middle genital pinnules are of about 20 to 26, exceptionally more, segments; they are 10 to 20 mm. long, sometimes longer.

Number of arms.—Large specimens of this species almost invariably possess 10 rays and 20 arms, but rarely IIBr series resembling the IBr series are present and the number of arms is increased to 22 or even 23. In small individuals the number of the rays and arms is frequently reduced.

Of the 66 specimens in the collection of the Australasian Antarctic Expedition (*Aurora*), 53 have 10 rays and 20 arms; 2 have 10 rays and 22 arms, IIBr series being present; 4 have 9 rays and 18 arms; 4 have 8 rays and 16 arms; and 3 have 6 rays and 12 arms.

Of the 20 specimens from the Swedish South Polar Expedition (*Antarctic*), 17 have 10 rays and 20 arms; one has 10 rays and 23 arms; one has 10 rays and 19 arms; and one has 9 rays and 18 arms.

Of the 15 specimens from the collection of the German South Polar Expedition (*Gauss*), 7 have 10 rays and 20 arms, and 8 have 6 rays and 12 arms. The specimen with 10 arms proved to be *Florometra mawsoni.*

The *Terra Nova* Expedition also yielded a 12-armed specimen.

The *Discovery* Investigations obtained a total of 163 specimens, of which 28 have less than 20 arms and one has more. This last has 11 radials and 22 arms. There were 16 specimens from the Bransfield Strait area with 18 arms and five others with from 16 to 19 arms. Twenty-two specimens with the normal 20 arms were taken with them in that area, which, Dr. John says, are much younger and smaller than those with abnormal numbers of arms; their longest cirri consist of 25 to 38, mostly 30, segments; those of most of the specimens with 16 to 19 arms are of 50 to 65 segments. Five of the six specimens with abnormal numbers of arms from the Graham Land region are of medium size, their longest cirri of 39 to 45 segments; one is small, its longest cirrus of 28 segments.

In the 19-armed *Discovery* Investigations specimen from the Graham Land region, the single arm arises from a normal radial which is followed by a regular ossicle slightly longer than the IBr_1 (costals) of the other rays. Next comes a still longer ossicle with a pinnule arising from either side of it. It is succeeded by a syzygial pair with a pinnule arising from the epizygal and beyond this the arm is normal. The single arms of the 19- and 17-armed specimens from the Bransfield Strait are different. The second ossicle beyond the radial is shaped like an irregular axillary, and a pinnule arises from one side of it. It is followed by a very short ossicle with no pinnules, which appears to correspond with the first brachial of normal arms; after it, comes a longer ossicle shaped like the second brachial of normal arms, with a pinnule on the opposite side to the first. A syzygial pair with the pinnule arising from the epizygal, on the same side of the arm as the first pinnule, comes next and thereafter the arm is normal.

The B.A.N.Z.A.R.E. collection included 43 out of a total of 183 Antarctic specimens, with other numbers of arms than 20. One specimen has 22 arms arising from 11 radials. Dr. John writes that the 11 specimens with 18 arms are all large. Twenty-seven specimens with only 12 arms are all of medium or small size; but they have the same arm length; the ossicles are heavier, the axillaries and second brachials are elongated, and there are strong synarthrial tubercles. These are signs of age, and are to be seen in the larger of the normal 20-armed specimens from the Antarctic; the smaller have short, wide axillaries and first brachials, and no synarthrial tubercles. In the youngest specimens the interradial rays are smaller than the radial. The nineteen specimens from Kerguelen in this collection all have 20 arms.

The U.S. Navy Antarctic Expedition of 1947–48 collected one specimen from off the Knox Coast, 110° E. on the Antarctic continent, with 6 rays and 12 arms, 150 mm. long.

Side plates and spicules.—Dr. Dilwyn John made a particular study of the abundant material collected by the *Discovery* Investigations with regard to this character, from which he concluded that the occurrence of well-developed side plates is not a sign of immaturity but can be correlated with the locality. In 37 specimens from the Bransfield Strait area he found that 29 have both plates and spicules and two more have plates alone, whereas out of 34 from South Georgia only 5 have plates and none have both plates and spicules. He also writes that it is not only a question of numbers, the degree of plating varies as well. Of the 29 specimens from the Bransfield Strait area at least 13 are heavily plated, while the plates in the five from South Georgia are very small. It appears from this, that in this sector of the Antarctic, the specimens of *P. kerguelensis* living in lower latitudes are most often without plates and always devoid of spicules and that the majority of those living in high latitudes have big plates along the entire lengths of the pinnules and many spicules in the tentacles. Those living intermediately seem to be intermediate in character. In support of this, Grieg described the pinnules of seven specimens from the Bransfield Strait as having well-developed covering plates. However, Mortensen (1918) found no plates in 16 specimens from the east side of Graham Land as well as in four from South Georgia.

Dr. John also examined 38 specimens from the Ross Sea. Thirteen have plates along the ambulacra and spicules in the tentacles; in eight the plates are strongly developed, in five they are small and scattered. Another thirteen have small and scattered plates but no spicules. One specimen has spicules in the tentacles but no plates, and eleven have neither plates nor spicules. Two pinnules of a small *Challenger* specimen from Kerguelen were examined; one has a single diminutive plate near the tip, the other has none.

However, among the twenty B.A.N.Z.A.R.E. specimens from Kerguelen, Dr. John found that some of the larger ones have strong side plates along the distal halves of the distal pinnules. In other specimens they are lacking. None appeared to have spicules in the tentacles.

Variations in the cirri, division series and lower brachials.—In the *Discovery* Investigations material Dr. John found that the specimens from the South Sandwich Islands and South Georgia usually have cirri with relatively short segments, whereas specimens from Bransfield Strait and the west coast of Graham Land have cirri with longer segments. Also out of 23 specimens from the Ross Sea, 21 have cirri of the long type.

As for the arm ossicles, none of the bigger specimens from South Georgia have elongated axillaries and second brachials forming strong shoulders with the IBr_1 and first brachials; in the biggest the shoulders are but slight. On the other hand, most of the bigger specimens from the South Sandwich Islands and the Bransfield Strait and all those from the west coast of Graham Land have axillaries and second brachials which are elongated and form strong shoulders with the IBr_1 and first brachials respectively. Among the Ross Sea specimens there are none so large and old as in the collections from the Falkland sector; however, most of them have moderately long axillaries and second brachials but in only five do they form strong shoulders with the IBr_1 and first brachials.

Ambulacral furrows on the disk.—It is obvious from all accounts that these are extremely variable. Bernasconi (1932) figures the disks of five specimens, all more or less different. There has been no suggestion of a connection between this feature and the geographical location.

Regional variations.—Emerging from examination of the *Discovery* and other material, Dr. Dilwyn John found that specimens from high latitudes, such as the Ross Sea, the Graham Land peninsula and Bransfield Strait, tend to have cirri with elongate segments, the axillaries and second brachials also elongate and forming marked shoulders with the adjacent proximal ossicles, and usually well-developed side plates and spicules in the pinnules. On the other hand, specimens from farther north around South Georgia have cirri with relatively shorter segments, no shoulders on the proximal arm ossicles and very small, if any, side plates in the pinnules.

The B.A.N.Z.A.R.E. specimens from Kerguelen were also found by Dr. John to have cirrus segments on the short side, and the axillaries and second brachials not elongated and without synarthrial tubercles. However, some of the larger specimens do have strong side plates distally on the outer pinnules, though apparently lacking spicules.

Abnormal specimen.—In the specimen with 10 rays and 22 arms from *Aurora* station 1, one of the IBr_1 bears 2 axillaries, the usual one, which is normally developed, and a second situated on its left distal border. The arms from this last are given off in a plane at right angles to the plane of the other axillary—that is, one exteriorly, protruding between the left arm from the normal axillary and the right arm from the next axillary to the left, and the other interiorly and not visible in a lateral view.

Very young specimens.—Gauss, 400 meters, February 15, 1903: There are 10 rays and 20 arms about 60 mm. long; the right posterior ambulacrum of the disk supplies 6 arms, and the right anterior supplies 2 arms.

Gauss, 385 meters, December 13, 1902: There are 10 rays and 20 arms 35 mm. long.

Gauss, 400 meters, February 15, 1903: There are 10 rays and 20 arms 25 mm. long; on one side alternate radials are longer than those between which they are situated, and bear smaller and narrower post-radial series; the longest cirri have 15 segments.

Gauss, 385 meters, March 18, 1902: A specimen similar to the preceding with 10 rays and 20 arms.

Gauss, 385 meters, December 2, 1902: There are 5 full sized rays bearing 10 arms 20 mm. long and, alternating with these, 5 very small radials bearing very narrow division series, less than half the diameter of the other division series, followed by a few brachials.

Pentacrinoid young.—A number of these are described in part 2 of this work (pp. 530–557, figs. 881–937). Dr. Dilwyn John (1938) has described a pentacrinoid from South Georgia which is similar to my oldest specimen but has developed a fourth whorl of cirri.

Localities.—Challenger; off Kerguelen Island; 18–183 meters [P. H. Carpenter, 1888; A. H. Clark, 1913] (1, B.M.). Type locality.

Challenger station 149H; off Cumberland Bay, northwestern Kerguelen; 232 meters; volcanic mud; January 29, 1874 [P. H. Carpenter, 1888].

Challenger station 149D; Royal Sound, eastern side of Kerguelen (lat. 49°28′ S., long. 70°13′ E.); 51 meters; volcanic mud; January 20, 1874 [P. H. Carpenter, 1879, 1888].

Challenger station 149C; Balfour Bay, Kerguelen; 36–110 meters; volcanic mud; January 19, 1874 [P. H. Carpenter, 1879, 1888; Hartlaub, 1912].

Challenger station 149E; off Cape Maclear, northern side of the entrance to Greenland Harbor, southwestern Kerguelen; 55 meters; volcanic mud; January 21, 1874 [P. H. Carpenter, 1879, 1888; A. H. Clark, 1913] (2, B.M.).

Kerguelen; Ring; December 1910 [Madsen, 1955] (Oslo M.).

B.A.N.Z.A.R.E. station 47; off Kerguelen (lat. 50°01′ S., long. 69°20′ E.); 150 meters; February 7, 1930 [John, 1939] (3, B.M.).

B.A.N.Z.A.R.E. station 58; off Kerguelen (lat. 49°30′ S., long. 70°04′ E.); 50 meters; February 22, 1930 [John, 1939] (1, B.M.).

B.A.N.Z.A.R.E. station 64; Kerguelen (lat. 49°28′ S., long. 70°33′ E.); 91 meters; March 2, 1930 [John, 1939] (2, B.M.; 8, Austr. M.).

B.A.N.Z.A.R.E. station 5; Royal Sound, Kerguelen (lat. 49°33′ S., long. 69° 49′45″ E.); 20 meters; November 16, 1929 [John, 1939] (1, B.M.).

B.A N.Z.A.R.E. station 15; between Hog Island and Blakeney Island, Kerguelen; 55 meters; November 23, 1929 [John, 1939] (1, B.M.; 3, Austr. M.).

Challenger station 151; off Heard Island (lat. 52°59′30″ S., long. 73°33′30″ E.); 137 meters; volcanic mud; February 7, 1874 [P. H. Carpenter, 1879, 1888] (1, B.M.).

Norwegia Expedition; station 42; east of Cape Lolo, Bouvet Island; 200 meters; December 20, 1928 [Madsen, 1955] (Oslo M.).

Discovery Investigations station MS 14; East Cumberland Bay, South Georgia; 190–110 meters; February 17, 1925 [John, 1938] (2, B.M.).

Discovery Investigations station MS 71; East Cumberland Bay; 110–60 meters; March 9, 1926 [John, 1938] (28, B.M.).

Discovery Investigations station MS 74; East Cumberland Bay; 22–40 meters; at 35 meters depth, temperature 2.75° C., salinity 33.82‰; March 17, 1926 [John, 1938].

Discovery Investigations station 27; West Cumberland Bay, South Georgia; 110 meters; mud and rock; March 15, 1926 [John, 1938] (1 adult and 1 pentacrinoid, B.M.).

Discovery Investigations station 39; East Cumberland Bay; 179–235 meters; gray mud; at 175 meters, temperature 1.02° C., salinity 34.02‰ [John, 1938] (1, B.M.).

Discovery Investigations station 42; off mouth of Cumberland Bay; 120–204 meters; mud; at 100 meters, temperature 2.08° C., salinity 33.86‰ [John, 1938] (8, B.M.).

Discovery Investigations station 123; off mouth of Cumberland Bay; 230–250 meters; gray mud; at 240 meters, temperature −0.2° C., salinity 34.04‰ [John, 1938] (1, B.M.).

Discovery Investigations station 144; off mouth of Stromness Harbor, South Georgia; 155–178 meters; green mud and sand; at 145 meters, temperature −0.15° C , salinity 33.98‰; January 5, 1927 [John, 1938] (6, B.M.).

Antarctic (Swedish South Polar Expedition) station 20; near South Georgia (lat. 54°12′ S., long. 36°50′ W.); 250 meters [Mortensen, 1918] (Stockholm M.).

Antarctic station 22; near South Georgia (lat. 54°17′ S., long. 36°28′ W.); 75 meters [Mortensen, 1918] (Stockholm M.).

Antarctic station 34; near South Georgia (lat. 54°11′ S., long. 36°18′ W.); 252–310 meters [Mortensen, 1918] (Stockholm M.).

Diaz; Bay of Islands, South Georgia; 24 meters; November 22, 1929 [Bernasconi, 1932].

Diaz; Larsen Harbor, South Georgia; 27 meters [Bernasconi, 1932].

Discovery Investigations station 148; off Cape Saunders, South Georgia; 132–148 meters; at 142 meters, temperature 0.22° C., salinity 33.92‰; gray mud and stones; January 9, 1927 [John, 1938] (4, B.M.).

Discovery Investigations station 149; mouth of East Cumberland Bay, South Georgia; 200–234 meters; at 190 meters, temperature 0.25° C., salinity 34.13‰; mud; January 10, 1927 [John, 1938] (5, B.M.).

Discovery Investigations station 152; off South Georgia (lat. 53°51′ S., long. 36°18′ W.); 245 meters; at 235 meters, temperature 0.68° C., salinity 34.20‰; rock; January 17, 1927 [John, 1938] (2, B.M.).

Discovery Investigations station 156; off South Georgia (lat. 53°51′ S., long. 36°21′ W.); 200–236 meters; January 20, 1927 [John, 1938] (8, B.M.).

Discovery Investigations station 345; off South Georgia (lat. 55°20′ S., long. 34°47′ W.); 180 meters; temperature 1.11° C., salinity 34.31‰; small stones and shells; February 8, 1930 [John, 1938] (1, B.M.).

Discovery Investigations station 363; 2½ miles S., 80° E. of the SE. point of Zavodovski Island, South Sandwich Islands; 329–278 meters; at 300 meters, temperature 0.43° C., salinity 34.62‰; scoria; February 26, 1930 [John, 1938] (3, B.M.).

Discovery Investigations station 366; 4 cables south of Cook Island, South Sandwich Islands; 77–152 meters; black sand; March 6, 1930 [John, 1938] (6 adults and 1 pentacrinoid, B.M.).

Discovery Investigations station 371; 1 mile E. of Montagu Island, South Sandwich Islands; 99–161 meters; at 150 meters, temperature −0.49° C., salinity 34.45‰; March 14, 1930 [John, 1938] (5, B.M.).

Visikoi, South Sandwich Islands; 55–90 meters; C. A. Larsen; November 11, 1908 [Madsen, 1955] (Oslo M.).

Bransfield; South Shetland area; from harpoon line; March 22, 1915 [Grieg, 1929] (7, Bergen M.).

Discovery Investigations station 170; off Cape Bowles, Clarence Island (lat. 61°25′ S., long. 53°46′ W.); 342 meters; rock; February 23, 1927 [John, 1938] (6, B.M.).

Discovery Investigations station 172; off Deception Island (lat. 62°59′ S., long. 60°28′ W.); 525 meters; rock; February 26, 1927 [John, 1938] (2, B.M.).

Discovery Investigations station 175; Bransfield Strait (lat. 63°17′ S., long. 59°48′ W.); 200 meters; mud, stones and gravel; March 2, 1927 [John, 1938] (3, B.M.).

Discovery Investigations station 177; 27 miles SW. of Deception Island (lat. 63°17′ S., long. 61°17′ W.); 1080 meters; mud, coarse sand and stones; March 5, 1927 [John, 1938] (8 adults and 1 pentacrinoid, B.M.).

Discovery Investigations station 1948; Bransfield Strait area (lat. 60°49′ S., long. 52°40′ W.); 490–610 meters; January 4, 1937 [John, 1938] (1, B.M.).

Discovery Investigations station 1952; between Penguin Island and Lion's Rump, South Shetland Islands; 367–383 meters; soft mud; January 11, 1937 [John, 1938] (43, B.M.).

Discovery Investigations station 1955; Bransfield Strait area (lat. 61°35′ S., long. 57°23′ W.); 440–410 meters; January 29, 1937 [John, 1938] (2, B.M.).

Discovery Investigations station 1957; 7 miles E. of Cape Bowles, Clarence Island; 830 meters; rough, stony; 785–767 meters; stones; February 3, 1937 [John, 1938] (2, B.M.).

Antarctic station 6; off Graham Land (lat. 64°36′ S., long. 57°42′ W.); 125 meters [Mortensen, 1918] (Stockholm M.).

Antarctic station 5; southeast of Seymour Island (lat. 64°20′ S., long. 56°38′ W.); 150 meters [Mortensen, 1918] (Stockholm M.).

Antarctic station 8; off Graham Land (lat. 64°03′ S., long. 56°37′ W.); ?360 meters [Mortensen, 1918] (Stockholm M.).

Français; Biscoe Bay, Graham Land (lat. 64° S.) [Vaney, 1910].

Discovery Investigations station 180; 1.7 miles W. of north point of Gand Island, Schollaert Channel, Palmer Archipelago; 160–330 meters; mud and stones; March 11, 1927 [John, 1938] (5, B.M.).

Discovery Investigations station 181; Schollaert Channel (lat. 64°20′ S., long. 63°01′ W.); 160–335 meters; mud; March 12, 1927 [John, 1938] (3, B.M.).

Discovery Investigations station 182; Schollaert Channel (lat. 64°21′ S., long. 62°58′ W.); 278–500 meters; mud; March 14, 1927 [John, 1938] (6, B.M.).

Schollaert Channel; 220 meters; O. Poulsen; February 1914 [Madsen, 1955] (Oslo M.).

Norwegian Antarctic Expedition; Port Lockroy, Palmer Archipelago; *c.* 90 meters; clay and a little brown algae; January 23, 1928 [Grieg, 1929*a*] (1, Oslo M.).

U.S. Navy Antarctic Expedition; Marguerite Bay, Graham Land; 64 meters; temperature −1.1° C.; February 20, 1948 [A. H. Clark, 1950] (11, U.S.N.M., E. 7975).

U.S. Navy Antarctic Expedition; Marguerite Bay; 73 meters; temperature −1.1° C.; February 22, 1948 [A. H. Clark, 1950] (7, U.S.N.M., E. 7976, 7978).

Discovery Investigations station 599; Adelaide Island, Graham Land (lat. 67°08′ S., long. 69°06′ W.); 203 meters; January 17, 1931 [John, 1938] (1, B.M.).

Belgica number 278; west of Graham Land (lat. 71°09′ S., long. 89°15′ W.); May 11, 1898 [John, 1937] (3, Brussels M.).

Belgica number 636; west of Graham Land (lat. 70°00′ S., long. 80°48′ W.); ?500 meters; October 18, 1898 [John, 1937] (2 fragments, Brussels M.).

Terra Nova station 194; off Oates Land (lat. 69°43′ S., long. 163°24′ E.); 329–365 meters [Bell, 1917].

Discovery; off Coulman Island (just south of Cape Adare, on the western side of the entrance to the Ross Sea); 183 meters [Bell, 1908; A. H. Clark, 1913] (4, B.M.).

Discovery; Winter Quarters, just west of Cape Armitage, west side of Ross Island (lat. 77°50′50″ S., long. 166°44′45″ E.) [Bell, 1908; A. H. Clark, 1913] (1, B.M.). Same, No. 10 Hole [A. H. Clark, 1913] (4, B.M.).

Discovery; off mounts Erebus and Terror (Ross Island); 915 meters [A. H. Clark, 1913] (1, B.M.).

Discovery; Ross Sea, at the eastern end of the ice barrier (lat. 78° S.); 183 meters [Bell, 1908; A. H. Clark, 1913] (1, B.M.).

Terra Nova station 294; Ross Sea (lat. 74°25′ S., long. 179°3′ E.); 289 meters; January 15, 1913 [John, 1938] (3, B.M.).

Terra Nova station 314; 5 miles N. of Inaccessible Island, McMurdo Sound, Ross Sea; 406–441 meters; January 23, 1911 [John, 1938] (1, B.M.).

Terra Nova station 316; off Glacier Tongue, about 8 miles N. of Hut Point, McMurdo Sound; 348–457 meters; February 9, 1911 [John, 1938] (1, B.M.).

Terra Nova station 317; between Cape Evans and Inaccessible Island; 175 meters [John, 1938] (2, B.M.).

Terra Nova station 339; Ross Sea (lat. 77°5′ S., long. 164°17′ E.); 256 meters; January 24, 1912 [John, 1938] (5, B.M.).

Terra Nova station 340; Ross Sea (lat. 76°56′ S., long. 164°12′ E.); 293 meters; January 25, 1912 [John, 1938] (4, B.M.).

Terra Nova station 341; off Cape Bird Peninsula; 80 meters; January 25, 1912 [John, 1938] (1, B.M.).

Terra Nova station 349; off Butter Point, west shore of McMurdo Sound; 146 meters; February 15, 1912 [John, 1938] (9, B.M.).

Terra Nova station 355; Ross Sea (lat. 77°46′ S., long. 166°8′ E.); 547 meters; January 20, 1913 [John, 1938] (6, B.M.).

Terra Nova station 356; off Granite Harbor, entrance to McMurdo Sound; 92 meters; January 22, 1913 [John, 1938] (1, B.M.).

Discovery Inlet, Ross Sea; 550 meters; S. Wallin; March 3–5, 1924 [Mortensen, 1925] (3, Lund M.).

Discovery Investigations station 1644; Bay of Whales, Ross Sea (lat. 78°24′ S., long. 164°10′ W.); 626 meters; at 590 meters, temperature −1.85° C., salinity 34.55‰; rocks and mud; January 16, 1936 [John, 1938] (1, B.M.).

Discovery Investigations station 1652; Ross Sea (lat. 75°56′ S., long. 178°35′ W.); 567 meters; at 540 meters, temperature −1.90° C., salinity 34.85‰; January 23, 1936 [John, 1938] (19, B.M.).

Discovery Investigations station 1658; off Franklin Island, Ross Sea (lat. 76°06′ S., long. 168°40′ E.); 520 meters; January 26, 1936 [John, 1938] (4, B.M.).

Aurora (Australasian Antarctic Expedition) station 3; Adelie Land (lat. 66°32′ S., long. 141°39′ E.); 287 meters; bottom temperature −1.62° C.; ooze; December 31, 1913 [A. H. Clark, 1937] (3, U.S.N.M.).

Aurora station 1; Adelie Land (lat. 66°50′ S., long. 142°06′ E.); 640–731 meters; temperature −1.84° C.; thick ooze; December 22, 1913 [A. H. Clark, 1937] (36, U.S.N.M.).

Aurora station 2; Adelie Land (lat. 66°55′ S., long. 145°21′ E.); 581 meters; temperature −1.8° C.; ooze; December 28, 1913 [A. H. Clark, 1937] (4, U.S.N.M.; 3, Austr. M.).

B.A.N.Z.A.R.E. station 90; off Adelie Land (lat. 66°21′ S., long. 138°28′ E.); 640 meters; January 7, 1931 [John, 1939] (2, B.M.; 3, Austr. M.).

U.S. Navy Antarctic Expedition; off Knox Coast (lat. 66°31′ S., long. 110°26′ E.); 183 meters; January 19, 1948 [A. H. Clark, 1950] (1, U.S.N.M., E. 7974).

Aurora station 8; Queen Mary Land (lat. 66°08′ S., long. 94°17′ E.); 219 meters; small granitic rocks; January 27, 1914 [A. H. Clark, 1937] (2, U.S.N.M.).

Aurora station 9; Queen Mary Land (lat. 65°20′ S., long. 95°27′ E.); 439 meters; temperature +1.38° C.; granitic pebbles with a small amount of ooze; January 28, 1914 [A. H. Clark, 1937] (2, Austr. M.; 3, U.S.N.M.).

Aurora station 10; Queen Mary Land (lat. 65°06′ S., long. 96°13′ E.); 594 meters; temperature −1.65° C.; ooze; January 29, 1914 [A. H. Clark, 1937] (3, U.S.N.M.).

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Aurora station 12; Queen Mary Land (lat. 64°32′ S., long. 97°20′ E.); 201 meters; rock; January 31, 1914 [A. H. Clark, 1937] (8, U.S.N.M.).

Gauss (German South Polar Expedition); near Gaussberg (lat. 66°02′09″ S., long. 89°38′ E.); 172–400 meters; temperature −1.85° C., salinity 33°/₀₀; March 18, 1902; 385 meters [A. H. Clark, 1915] (1, Berl. M.). April 4, 1902 (1, Berl. M.). May 1, 1902 (1, Berl. M.). May 6, 1902; 172 meters (1, Berl. M.). June 20, 1902; 385 meters (2, Berl. M.). December 2, 1902; 385 meters (1, Berl. M.). December 13, 1902; 385 meters (1, Berl. M.). January 3, 1903; 380 meters (1, Berl. M.). January 8, 26, 28, 1903; 380 meters (4, Berl. M.). February 8, 1903; 350 meters (fragments, Berl. M.). February 15, 1903; 400 meters (3, U.S.N.M., E. 379). 1902; 385 meters (5, U.S.N.M., E. 380). 1902 (1, U.S.N.M., E. 378). 1902–03 (7 pentacrinoids, U.S.N.M., E. 381).

B.A.N.Z.A.R.E. station 105; off MacRobertson Land (lat. 67°46′ S., long. 67°03′ E.); 163 meters; February 13, 1931 [John, 1939] (3, B.M.; 9, Austr. M.).

B.A.N.Z.A.R.E. station 107; off MacRobertson Land (lat. 66°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (54, B.M.; 101, Austr. M.).

B.A.N.Z.A.R.E. station 40; off Enderby Land (lat. 66°12′ S., long. 49°37′ E.); 300 meters; January 17, 1930 [John, 1939] (1, B.M.; 3, Austr. M.).

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 180–209 meters; at 200 meters, temperature −1.77° C., salinity 34.24°/₀₀; January 24, 1930 [John, 1939] (6, Austr. M.).

B.A.N.Z.A.R.E. station 42; off Enderby Land (lat. 65°50′ S., long. 54°23′ E.); 220 meters; January 26, 1930 [John, 1939] (1, Austr. M.).

Norwegia Expedition; off Crown Princess Martha Land (lat. 71°26′ S., long. 12° W.); 220 meters; February 17, 1930 [Madsen, 1955] (Oslo M.).

Geographical range.—Off the shores of the Antarctic continent, the Graham Land peninsula, the South Shetland and South Sandwich Islands, South Georgia, Bouvet and Heard Islands and Kerguelen, the type locality.

Bathymetrical range.—From 20 to 1080 meters.

Thermal range.—From −1.90 to +2.75° C.

Salinity range.—From 33.82 to 34.85 parts per thousand.

Remarks.—Minckert's *Promachocrinus vanhöffenianus* was based upon two specimens from the *Gauss* collection, both of which I have examined. It was said to differ from *P. kerguelensis* in having the cirrus segments from the fourth outward much longer; in having the axillaries and second brachials longer and more slender, long and shield-shaped instead of "widely rhombic" as described by Carpenter in *P. kerguelensis*, and the bases of the post-radial series also of a more slender build; in having no lateral excavation between the two elements of the IBr series; and, the most distinctive and significant feature, in possessing well-developed covering plates along the ambulacral grooves, excepting those of the disk and of the proximal pinnules.

The narrow and sharply conical centrodorsal of these specimens, the long and slender axillaries and second brachials, the slender build of the bases of the post-radial series, and the absence of excavation on the lateral margins of the IBr series are all correlated characters, all indicating the immaturity of the individuals, which is further attested by the comparatively long segments of the proximal pinnules. The specimens which have been collected at Kerguelen, some of which have been figured by Carpenter and by Hartlaub, are mostly robust and of larger size than those which were dredged by the *Gauss*; but similar, and even larger, specimens were taken by the *Discovery* at her winter quarters, which were east of the locality explored by the *Gauss*, and therefore further away from Kerguelen; this shows that this stoutness is in no way a character peculiar to Kerguelen specimens.

Hartlaub, describing a specimen from Balfour Bay, Kerguelen, presumably from the *Challenger* collection, notes the presence of covering plates. This specimen from the figure appears to be a very well-developed example; the arm pairs are all of the same size, and the axillaries are broad with no posterior processes; in fact it is better developed than either of the two figured by Carpenter, resembling more the one figured by Vaney. As Hartlaub's specimen possesses covering plates, yet in all other respects differs more widely from *P. vanhöffenianus* than do Carpenter's from Kerguelen, it is a safe conclusion that *P. vanhöffenianus* and *P. kerguelensis* are synonymous, and also that the presence or absence of covering plates in this species is without systematic significance.

The differentiation of *P. vanhöffenianus* from *P. kerguelensis* principally on the basis of the presence of covering plates in the former finds an almost exact parallel in the case of *Antedon barentsi*. *Antedon barentsi* was described by Carpenter in 1886 from specimens taken north of Norway, and was supposed to differ from *Heliometra glacialis* in possessing a strong and well-developed calcareous plating on the ventral surface of the genital pinnules. In 1903 Mortensen demonstrated the existence of these plates in undoubted specimens of *Heliometra glacialis* from eastern Greenland, and also showed the presence along the ambulacra of the distal pinnules of well-formed plates closely resembling those occurring in these specimens of *Promachocrinus* (vol. 1, part 2, fig. 807, p. 378) and, like some of them, not differentiated into side and covering plates.

Of the two figures given by Bell in his report upon the echinoderms collected by the *Discovery*, one (fig. 1) would represent very faithfully the specimens upon which *P. vanhöffenianus* was based, while the other (fig. 2) shows an exceptionally robust and well-developed example of typical *P. kerguelensis*.

The *Discovery* specimens, therefore, are quite parallel to those collected by the *Challenger* at Kerguelen; the larger present the characters of *P. kerguelensis* as understood by Minckert, while the smaller with equal faithfulness present the characters of *P. vanhöffenianus*.

In London I examined 13 specimens of this species taken by the *Challenger* and by the *Discovery*, and I have no hesitation in saying that all of them, large and small, represent the same species, as stated by Carpenter and by Bell, though the smaller ones present all the characters of *P. vanhöffenianus*.

M. C. Vaney has described a third supposed species of *Promachocrinus*, *P. joubini*, based upon a single specimen which was collected by Dr. Charcot at Biscoë Bay, in lat. 64° S. Comparing it with the other described species he says that *P. joubini* comes nearer *P. kerguelensis* than it does to *P. vanhöffenianus*. This latter possesses an ambulacral skeleton formed of plates which does not occur either in *P. kerguelensis* or in *P. joubini*. Moreover, in the two last the IBr axillaries are rhombic, while in *P. vanhöffenianus* these axillaries, like the second brachials, have a slender posterior process. Comparison of the figures of *P. kerguelensis* given by Carpenter and later by Bell show that the axillaries are more pronouncedly lozenge-shaped in *P. joubini* than in *P. kerguelensis*. The proximal brachials in *P. joubini* have a characteristic form, each with its tuft of dorsal spines. The arrangement of the syzygies and the structure of the proximal pinnules is not the same in these two species, which are sharply separated from each other by the fact that the apex of the centrodorsal is bare in *P. joubini*, while it bears cirri in *P. kerguelensis*.

He says further that the cirri of *P. joubini* are quite comparable to those of *P. vanhöffenianus;* in both species they show at the base three or four short segments while those following are elongated.

The value of the presence or absence of the ambulacral skeleton as a differential specific character has already been discussed. The axillaries of *P. joubini* are not in any way different from some of the axillaries in the more developed of the two *Discovery* specimens figured by Bell. The first brachials are also the same as in this specimen. The occurrence upon the brachials of a tuft of dorsal spines merely indicates that this characteristic feature of the young has not as yet been suppressed. The extent of the bare dorsal pole of the centrodorsal is a very variable feature and, so far as I have been able to determine, offers no grounds for systematic differentiation. The structure of the earlier pinnules as described by Vaney indicates merely the immaturity of the specimen; in all of the Heliometrinae the earlier pinnules in the relative proportions of their component segments as well as in their interrelationships vary greatly with age and relative maturity. The cirri of Vaney's specimen agree with those of *P. vanhöffenianus*, as opposed to *P. kerguelensis*, this again merely indicating immaturity; but like the lower pinnules the cirri of the Heliometrinae are of little systematic value.

I cannot see that *Promachocrinus joubini* differs in any essential particular from *P. kerguelensis*, of which species it appears to be a specimen which has not yet attained its full development. It can be matched in all its features by specimens taken by the *Challenger* at Kerguelen, as well as by others taken by the *Discovery* at her winter quarters.

These conclusions were fully borne out by the work of Dr. Dilwyn John on the crinoids of the *Discovery* Investigations (1938). As he remarked in his *Belgica* report (1937), the range of variation of *P. kerguelensis* is even greater than it need be to embrace *vanhöffenianus* and *joubini*. However, it appears from his investigations that certain characters, such as the proportions of the cirrus segments and brachials and the occurrence of side plates in the pinnules, are correlated not so much with age as with the locality, specimens from high and low latitudes having a distinct tendency for variation in one direction or another.

History.—Writing from on board the *Challenger*, Dr. R. von Willemoës-Suhm in a letter to Professor von Siebold published by the latter in 1874 said that at Kerguelen a *Comatula*, which he did not further particularize, was characteristic of the second littoral zone in from 73 to 219 meters.

Dr. P. H. Carpenter in 1879 mentioned this species under the name of *Promachocrinus kerguelensis*, in that year (twice), in 1880 (twice), in 1883 and in 1884 calling attention to various morphological features exhibited by it, finally describing it in detail and figuring it in 1888.

Perrier in 1886, quoting some of Carpenter's statements regarding the anatomy, emended the specific name to "*kerguelenensis*" and "*kerguellenensis*," the former being adopted by Bell in 1908.

The German South Polar Expedition with the *Gauss*, working between 1901 and 1903 in the vicinity of Gaussberg, found this species in abundance in all stages. In 1904 Professor Vanhöffen, referring to it as "*Antedon*," remarked that in life it is golden yellow or violet, and in 1905 Dr. Wilhelm Minckert, identifying Vanhöffen's *Antedon* as *Promachocrinus*, described a new species, *Promachocrinus vanhöffenianus*, based on specimens from the *Gauss* collection.

The *Discovery*, during Scott's first expedition, working in the Ross Sea, a district remote from any region where crinoids had previously been discovered, also secured this form. In April 1905, Hodgson wrote that on this expedition "a crinoid was found abundant everywhere just beyond the 100 fathom [183 meter] line"; this crinoid was undoubtedly the present species. The material from the *Discovery* expedition was recorded by Prof. F. J. Bell under the names *Promachocrinus kerguelenensis* and *Antedon antarctica* in 1908.

The expedition of the *Français* under Dr. Charcot in 1903–05 to the region south of Tierra del Fuego brought back a single specimen of a species of *Promachocrinus*, which was described as new by Prof. C. Vaney in 1910 under the name of *P. joubini*.

Dr. Clemens Hartlaub in 1912 described a specimen of *P. kerguelensis* from Balfour Bay, Kerguelen, which had been sent to him from the Museum of Comparative Zoology. Without doubt it had originally formed part of the *Challenger* collection.

A note on the homologies of the so-called anal plate in the pentacrinoids of the comatulids, which was shown to be in reality the radianal of fossil species, was published by the author in 1912. (Journ. Washington Acad. Sci., vol. 2, no. 13, July 19, 1912, pp. 309–314.) This paper was based mainly upon the pentacrinoids of this species secured by the *Gauss*, althought that fact was not stated. The *Gauss* collections were described in detail in 1915 excepting for the pentacrinoids, an account of which will be found in vol. 1, part 2, pp. 530–557 of this work.

The *Terra Nova* expedition in 1910 to the Ross Sea area discovered numerous examples of this species which were mentioned by Prof. Bell in 1917 as *Promachocrinus kerguelensis* and from station 194 as *Antedon antarctica*.

The Swedish South Polar Expedition of 1901–03 in the *Antarctic* under the leadership of Dr. Otto Nordenskjöld brought back a number of specimens of this species from the region south of South America, which were recorded in 1918 by Dr. Th. Mortensen.

Detailed analyses of the inorganic constituents of the skeleton of this species were published by Prof. Frank W. Clarke and Dr. William C. Wheeler in 1914, 1915, 1917, and 1922.

In 1916 the myzostomes found on the examples from the *Terra Nova* collection were described by Mr. Boulenger.

In 1925 Dr. Th. Mortensen recorded three specimens in a collection from the Ross Sea.

Grieg in 1929 noted that the whaler *Bransfield* took seven specimens of *kerguelensis* from the harpoon line when a whale was hauled in. That the species is an active swimmer is confirmed by Mr. J. W. S. Marr (in John, 1938, p. 141), who wrote that it "is very powerful and swims with a remarkable grace of movement."

The species was next recorded by Bernasconi from South Georgia, where it was collected by the *Diaz*.

In 1937 I gave notes on the sixty-four specimens collected by the Australasian Antarctic Expedition in the *Aurora* and Dr. Dilwyn John reported it from the *Belgica* collections. In the following year the same author published his report on the large amount of material taken by the *Discovery* Investigations, in which he confirmed that *vanhöffenianus* and *joubini* fall within the synonymy of *kerguelensis*.

In 1939 Dr. John added some remarks on specimens from the type locality, Kerguelen, where a number of specimens were taken by the B.A.N.Z.A.R.E. Oddly enough the species was not taken by the *Scotia*.

Since then it has been recorded by the author (1950) and by Madsen (1955), from the collections of the U.S. Navy and the Norwegian Antarctic Expeditions.

Genus ANTHOMETRA A. H. Clark

Antedon (part) Bell, National Antarctic Exped., Nat. Hist. Rep., vol. 4, Echinod., 1908, p. 4, and following authors.

Anthometra A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 60 (subgenus of *Promachocrinus;* no diagnosis; name used in combination with *adriani*); Bull. Inst. océanogr. Monaco, No. 285, 1914, p. 3, footnote (type species *Antedon adriani* Bell); No. 294, 1914, p. 6 (spiny carination the result of the coldness of the habitat); Die Crinoïden der Antarktis, 1915, pp. 122–126 (characters structural and systematic relationships; origin), p. 132 (covering plates), p. 135 (synonymy; diagnosis; type species *Antedon adriani* Bell, 1908; range), p. 190 (further discussion); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Heliometrinae); No. 16, p. 507 (in key; range), p. 508 (best considered as a subgenus of *Promachocrinus*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 239 (in key; range), p. 240 (best considered as a subgenus of *Promachocrinus*).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 124, 1922, p. 20 (inorganic constituents of the skeleton).—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 52 (in key).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 39, 288.—Ekman, Tiergeographie des Meeres, 1935, p. 307.—A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 222 (in Russian), p. 230; Sci. Rep. Australasian Antarctic Exped., 1911–1914, ser. C, vol. 8, pt. 4, 1937, p. 6 (confined to the Antarctic), p. 14.—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86; *Discovery* Reports, vol. 18, 1938, p. 130 (monotypic and confined to the Antarctic), p. 151; Rep. B.A.N.Z. Antarctic Res. Exped., ser. B, vol. 4, pt. 6, 1939, p. 197.

Promachocrinus (*Anthometra*) A. H. Clark, Die Crinoïden der Antarktis, 1915, pp. 104, 106, 135.

Diagnosis.—A genus of Heliometrinae in which the arms are narrow and strongly carinate, the ossicles of the division series and lower brachials bearing high carinate or spinelike processes; P_1 is twice as long as P_2; the cirri are few, long, delicate, and nearly straight; the centrodorsal is conical with a large bare polar area; and there are 5 radials and 10 arms.

Geographical range.—Shores of the Antarctic continent, the Graham Land peninsula, and the South Shetland Islands.

Bathymetrical range.—From 130(?100) to 914 meters.

Thermal range.—From $-1.85°$ to $+1.38°$ C.

History.—The single species in this genus was originally described as an *Antedon*. In 1913 the name *Anthometra*, treated as a subgenus of *Promachocrinus*, was used for it, without any diagnosis or explanation. In 1914 the type species of *Anthometra* was formally given as *Antedon adriani*. In 1915 a diagnosis was published. Since 1918 (Mortensen) *Anthometra* has been treated as a distinct genus.

ANTHOMETRA ADRIANI (Bell)*

[See vol. 1, pt. 2, fig. 938, p. 549]

Antedon adriani Bell, National Antarctic Exped., Nat. Hist., vol. 4, Echinod., 1908, p. 4 (description; *Discovery*, Winter Quarters, down to 130 fms., and off Mts. Erebus and Terror, 500 fms.), pl. 2.—von Stummer-Traunfels, National Antarctic Exped., Nat. Hist, vol. 4, Myzostomidae, 1908, pp. 2, 7 (myzostomes).—A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 17, footnote (not identifiable from the description; remarks); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 80 (of Bell, 1908=*Anthometra adriani*+*Solanometra antarctica* [*Promachocrinus kerguelensis*]).—Boulenger, British Antarctic (*Terra Nova*) Exped. 1910, Nat. Hist. Rep., Zool., vol. 2, No. 6, Jan. 22, 1916, pp. 135, 136 (myzostomes).—Bell, British Antarctic (*Terra Nova*) Exped. 1910, Nat. Hist. Rep., Zool., vol. 4, No. 1, 1917, p. 2 (*Terra Nova* stas. 194, 314, 348).

Anthometra adriani A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 60 (published reference to specimens in the B. M.; *Discovery*, Winter Quarters, 124 and 130 fms.; same, No. 10 Hole, and No. 10 Hole, 127 fms.; Mts. Erebus and Terror; characters).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 90–D, 1914, pp. 34 and following (inorganic constituents of the skeleton).—A. H. Clark, Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (Antarctic; range); Die Crinoïden der Antarktis, 1915, p. 107 (in key to Antarctic crinoids), p. 122 (characters), p. 168 (a shallow water antarctic species; circumpolar; range), p. 169 (relationships), p. 192 (further discussion), p. 207 (complete analysis of the skeleton by F. W. Clarke).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 102, 1917, pp. 21 and following (analysis of the skeleton).—Mortensen, Wiss. Ergeb. schwed. Südpolar-Exped., 1901–1903, vol. 4, Lief. 8, 1918, p. 18 (*Antarctic* sta. 8).—F. W. Clarke and Wheeler, U. S. Geol. Surv. Prof. Paper 124, 1922, p. 17 (inorganic constituents of the skeleton).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 194, 288; fig. 342, p. 281.—Mortensen, Ark. Zool., vol. 17, No. 31, 1925, p. 2 (Ross Sea; 550 meters).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 11 (proximal pinnules with some expanded segments so that the species is transitory to the Isometrinae).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 662 (*Terra Nova* station).—Grieg, Bergens Mus. Aarb., 1929, No. 3, p. 4 (specimens collected from harpoon line).—A. H. Clark, Sci. Rep. Australasian Antarctic Exped., 1911–1914, ser. C, vol. 8, pt. 4, 1937, pp. 14–16 (*Aurora* stations 1, 2, 3, 8, 9, 12; distribution; color in life; description).—John, Res. Voy. *Belgica*, 1897–1899, Crinoidea, 1937, p. 10 (processes on the lower brachials cleft); Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 85; *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 124 (taken with *Myzostomum*), p. 129 (in distribution table), p. 131 (in key), p. 151 (stations; notes), p. 152 (*Myzostomum* on disk); fig. 5, p. 151, pl. 3, fig. 4; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–1931, ser. B., vol. 4, pt. 6, 1939, p. 191 (listed), pp. 197–198 (stations; range of size).—Vaney and John, Sci. Res. Voy. *Scotia*, 1939, p. 668 (*Scotia* station).—Vinogradov, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (skeletal composition).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 113.—Tortonese, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182.

Promachocrinus (*Anthometra*) *adriani* A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 104 (in *Gauss* collection), p. 106 (recorded as *Antedon adriani* from the *Discovery* collection), p. 135 (synonymy; detailed description of *Gauss* specimens; *Gauss* station, 350–400 meters; résumé of previous records), pl. 6, figs 1–5, pl. 7, figs. 1–5.

Promachocrinus adriani Ekman, Tiergeographie des Meeres, 1935, p. 319.

Diagnostic features.—The cirri number up to XC with a maximum length of 100 mm. and at the most 93 segments; the arms are up to 250 mm. long but usually about 150 mm., with a prominent dorsal keel which may be serrated or notched or in the form of a series of tubercles; P_1 is also carinate; it is up to 22 mm. long, with 59 segments; P_2 is much shorter, about 12 mm. long, with only about 18 to 20 segments.

Description.—The centrodorsal is usually more or less sharply conical, more rarely almost hemispherical, with a relatively large bare polar area. The cirrus sockets, which

*See also Addenda (p. 837) under 1963.

are commonly variable in size, are arranged in from two to three irregular rows on the proximal two-thirds of the centrodorsal, beyond which is the bare conical tip, though this may be absent. The cirrus sockets may be closely crowded, or more or less isolated.

The cirri are XXX–XXXV, 50–71 (usually 60–65), from 65 to 75 mm. in length, very long, slender and delicate, and almost straight. The first three segments are more than twice as broad as long, the fourth is half again as broad as long to nearly as long as broad, and the sixth and following are about twice as long as broad, or slightly longer; in the outer half of the cirri the segments decrease very gradually in length so that the last half dozen are about as long as broad. After about the seventh or eighth the median portion of the distal dorsal edge slowly becomes prominent so that in the outer half of the cirri each segment bears a small but prominent blunt spine directed obliquely forward and very slightly overlapping the base of the succeeding segments. These spines are confined to the distal portion of the segments and are rounded dorsally until about the last six, when they come to arise gradually from the entire dorsal surface of the segments and become more or less sharply carinate, at least distally. In the terminal quarter the cirri taper very slightly. The penultimate segment is rather small, slightly longer than broad, and bears a blunt opposing spine directed obliquely forward. The terminal claw is somewhat longer than the penultimate segment, slender, and only very moderately curved.

There are no basal rays.

The distal portion of the radials projects as a narrow band of approximately uniform width beyond the rim of the centrodorsal. The IBr_1 are very short, from 4 to 6 times as broad as the lateral length, more or less incised in the middle by a rounded posterior projection from the axillaries; their sides are parallel, and parallel with those of their neighbors, from which they are separated by a very narrow interval. The IBr_2 (axillaries) are rhombic, broader than long, with a more or less, though never very strongly, developed rounded posterior process, a truncated and slightly notched distal angle, and, in the more mature individuals, strongly concave sides. In the proximal half or third the IBr_2 bear a more or less elevated, and often high, carination which may have a plain or serrate crest. Beneath the lateral angles there is a more or less developed rounded lateral extension covered with very fine spines.

The 10 arms are 115 to 165 mm. (commonly about 150 mm.) in length. The first brachial is about 3 times as long exteriorly as interiorly, with the proximal and distal edges parallel in the inner half and widely diverging in the outer; the inner edges of the 2 first brachials on each arm pair are not in contact basally, and are slightly divergent. The second brachials are much larger, irregularly quadrate, with a high keel or a series of laterally flattened tubercles in the proximal two-thirds to three-fourths. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, about as broad as the interior length; the epizygal bears in its proximal portion an abrupt and usually high median laterally flattened tubercle, or sometimes two arranged in tandem. The next 6 or 7 brachials are wedge-shaped, about twice as broad as the median length, each with a high median tubercle or longitudinal keel, the crest of which may be notched in the middle. The following brachials are much more obliquely wedge-shaped, about as long as broad, becoming longer than broad terminally; they are narrow and high, and strongly carinate in the median line, the narrowly rounded keel being high distally and rapidly falling away to the proximal border so that the profile of the arms is very strongly serrate. After the proximal third of the arm the distal height of the keel diminishes and after the middle of the arm the profile becomes practically smooth, though the keel, which always has a sharply rounded crest, persists to the arm tips. The brachials in the proximal third of the arm have a finely spinous distal overlap, the spines being longest and most prominent at the end of the carination; in the outer half of the arm the distal border of the brachials is smooth and without an overlap. There is considerable variation in the carination on the earlier brachials; it may be high, slender and spinelike, or with a long knifelike edge parallel to the longitudinal axis, sometimes having a central notch so that it is more or less divided into two.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations.

P_1 is from 18.5 to 19 mm. in length, flagellate and resembling P_1 in *Heliometra glacialis*, composed of 44 to 50 segments, all of which are broader than long; those in the outer two-thirds are provided with a strong rounded sharply carinate dorsal process; those in the proximal third are provided with a similar process which has a straight distal edge parallel to the longitudinal axis of the pinnule. P_2 is about half as long as P_1, from 8 to 9 mm. long, with 17 to 19 segments, which are at first much broader than long, becoming on the eleventh about twice as long as broad; the second to fourth bear a strong dorsal carination. P_3 is similar to P_2 but larger, 10 mm. long with 17 segments, of which the outer are slightly more elongated than the corresponding segments of P_2. P_4 is similar to P_3, 10 mm. long. The distal pinnules are 14 mm. long.

The ambulacral grooves of the genital and distal pinnules, but not those of the arms, are bordered with a row of large and heavily calcified covering plates; these have a broad subquadrangular proximal portion and a narrower rounded cuneiform distal portion which folds down over the ambulacral grooves. Though the plates are large and solid there is no indication of a division into side and covering plates.

Color in life.—Arms flesh color, the pinnules pink (note with specimens collected by the *Aurora*).

Notes.—In large specimens from *Aurora* station 12 the longest cirri are 90 mm. long with 81 segments. The first segment is about 4 times as broad as long, the next three are about 3 times as broad as long, the fifth is slightly over twice as broad as long, the sixth is nearly as long as broad, the seventh is one-third again as long as broad, and the ninth to twelfth are nearly twice as long as broad. The segments following very slowly decrease in length so that the last eight are scarcely longer than broad. After about the twelfth the median portion of the distal dorsal border becomes very slightly prominent. In dorsal view the middle third of the distal edge is seen to be slightly bowed outward and serrate. Later this becomes slightly elevated and more strongly serrate, appearing in lateral view as a slight terminal spine directed obliquely forward. Distally this projection slowly narrows, on about the tenth segment from the end the dorsal surface of the segments becoming broadly and roundedly subcarinate; the median elevation gradually becoming still narrower and more easily evident, the last two segments before the penultimate are distinctly carinate dorsally. The opposing spine is a longitudinally elongate tubercle occupying the distal half of the penultimate segment. The terminal claw is somewhat longer than the penultimate segment, and is moderately stout and evenly curved. In the outer half the cirri taper very slowly and gradually to a slender tip.

P_1 is 20 mm. long with 50 segments. The first 4 or 5 segments are about twice as broad as long, and the remainder are all broader than long. The third and following segments have a prominent carinate crest on the side toward the arm tips. On the third the crest is broad and gently convex, on the fourth and fifth the process is bluntly pointed, and on the segments following the crest is long and high, rising to a height of half the width of the segment or more, with the outer edge straight and parallel to the longitudinal axis of the segment. These prominent crests on the segments present in general the same effect as the combs on the proximal pinnules of the comasterids, but the outer edge is straight so that they are in shape oblong with the corners rounded, and they are situated on the side of the segments toward the arm tip instead of on the opposite edges. The pinnule is slender, evenly tapering, flagellate, and flexible.

P_2 is 12 mm. long with 18 segments, of which the first 3 are twice as broad as long, the seventh is about as long as broad, and those following gradually increase in length, the distal being twice as long as broad. The pinnule is slightly stouter basally than P_1, tapers more gradually, and is less flexible. It tapers gradually to a point, and there is no modification of the segments.

P_3 is 10 mm. long with 20 segments and resembles P_2.

P_4 is 12 mm. long with 19 segments.

P_5 is 12 mm. long with 18 segments, very slightly stouter basally than P_4. The pinnule increases slowly in width to the fifth and sixth segments, the seventh segment tapers strongly distally, and the remaining segments are slender. Viewed dorsally, the first 2 segments are very short, the fourth is about as long as broad, the seventh is about twice as long as the central width, and those following soon become about 4 times as long as broad. The fourth to seventh segments have their ventrolateral edges produced and broadly rounded, these flanges serving as a protection for the gonad. In lateral view the fourth to seventh segments are seen to be broadened, this broadening being greatest on the fifth. The seventh and eighth taper distally, and the ninth and following are slender.

P_6 is 22 mm. long with 36 segments. Viewed laterally, it increases in width to the fifth and sixth segments, tapers on the seventh to ninth, and is slender with increasingly elongate segments from that point onward. The fourth to sixth segments have a slight flangelike production of the ventral edges.

The following pinnules are similar, about 20 mm. long, with the third to seventh segments somewhat expanded and with their ventrolateral edges produced into a thin narrow flange. The genital pinnules have much the same appearance as those of the species of *Perissometra*. The ventral surface of the pinnules is completely enclosed by large covering plates imbricating distally, each of which bears a more or less elongate fingerlike process extending over the median line, the processes of the plates on the two sides of the median line exactly dovetailing over the median line.

In the largest specimens from *Aurora* station 12 the arms are about 160 mm. long, or somewhat less than twice as long as the longest cirri.

There is very considerable variation in the height of the middorsal carinate processes on the brachials, particularly on the more or less oblong brachials before the third syzygy. In occasional specimens (for instance from *Aurora* station 1) the processes on these proximal brachials are almost wholly obsolete, being represented only by low obscure and broadly rounded tubercles, while in others (also from *Aurora* station 1) they are very high with the crest forked.

[NOTES BY A.M.C.] I am selecting a lectotype from among Bell's *Discovery* specimens. It is from Winter Quarters (McMurdo Sound) No. 6 hole, 130 fathoms (238 meters), B.M. registered number 1905.3.9.81. All the arms are broken within 80 mm. of their length from the base, but the width at the first syzygy is 2.5 mm. and the length to the second syzygy is 15.0 mm. The centrodorsal is 5.0 mm. in basal diameter and 3.3 mm. high. There are about LV cirri, with up to 60 segments and up to 55 mm. in length. Only one coiled P_1 remains intact; it has 52 segments. P_2 with 21 segments is 12 mm. long. For numerical details on other specimens see table 13, page 454.

Grieg (1929) notes that the largest cirri in the specimens collected by the whaler *Bransfield* are about 50 mm. long and have up to 62 segments. At a length of 40 to 45 mm. the cirri have 52 to 54 segments. In one of the largest specimens the distance between the radial and the first syzygy is 5 mm. The first pinnule is 10 mm. long with 36 segments.

John (1938) gives the characters of the cirri of large specimens thus: L–LXX, 60–86, up to 90 mm. long. He also notes the expansion of some segments of the proximal pinnules first described by Gislén in 1928, which he points out is limited to the genital pinnules and is more marked in the female than the male. The figure which he gives to illustrate this character in the female is taken from a *Terra Nova* specimen of considerable size, the almost complete arms measuring 250 mm. in length.

Young specimens.—Gauss, 385 meters, March 20, 1902: The arms are 50 mm. long and the cirri are 17 mm. long with 28 to 31 segments; the apical cirri are 7 mm. long with 16 segments. The carination on the proximal brachials is very long with a very finely spinous crest. The dorsal surface of the proximal brachials is thickly covered with fine spines which increase in size toward the carinate processes.

Gauss, 400 meters, February 8, 1903: The arms are 50 mm. long and the cirri are 18 mm. long with 22 to 30 segments; the apical cirri are 4.5 mm. long with 13 segments. The carination on the proximal brachials is spinelike, and is proportionately as strong as in the fully grown specimens.

Gauss, 385 meters, December 3, 1902: The arms are 40 mm. and the cirri 13 mm. long. The carination on the proximal brachials is spinelike and very high.

Gauss, 350 meters, February 7, 1903: The arms are 25 mm. long and the cirri are 9 mm. long with 17 segments. The brachial carination is long and very high.

Gauss, November 29, 1902: The arms are 13 mm. long and the cirri are 4 mm. long with 16 segments. The orals are still of large size. The characteristic brachial carination is already developed in the form of high and coarsely spinous eversions of the median portion of the distal part of the proximal brachials.

Two pentacrinoids of this species have already been described (vol. 1, part 2, pp. 557–559).

Localities.—Discovery; Winter Quarters, 1901–04; McMurdo Sound; No. 6 hole; down to 130 fathoms (238 meters) [Bell, 1908; A. H. Clark, 1913; John, 1938] (2, B.M.). Same, 227 meters [A. H. Clark, 1913; John, 1938] (2, B.M.). Same, No. 10 hole [A. H. Clark, 1913; John, 1938] (5, B.M.). Same, No. 10 hole, 232 meters [A. H. Clark, 1913] (1, B.M.). Type locality.

Terra Nova station 314; off Cape Bird Peninsula, at the entrance to McMurdo Sound; 406–441 meters [Bell, 1917; A. H. Clark, 1929; John, 1938] (3, B.M.).

TABLE 13.—*Details of specimens of* Anthometra adriani *in the British Museum taken by Mr. M. J. Mann, now Acting Director, E. African Freshwater Fisheries Research Organisation. (When the width at the first syzygy is 2.5 mm., the arm length is 160–190 mm.)*

Width at first syzygy (mm.)	*Length to second syzygy (mm.)*	*Cirri*			P_1		P_2	
		No.	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*	*Segs.*	*Length (mm.)*
3. 0	17. 0	LXV	60	66	48	22. 5	20	12
2. 9	17. 5	LVIII	—	—	50	22	20	12
2. 8	17. 0	LIX	—	1—	54	21	23	12
2. 8	17. 0	LXVI	87	00	49	20	19	11
2. 8	16. 5	LIX	70	74	52	20	21	11
2. 7	16. 0	LIV	—	—	43	18	22	11
2. 7	16. 0	LXIX	—	—	29	16	18	10
2. 7	15. 0	LIII	66	76	38+	18+	18	10
2. 7	15. 5	c. XC	81	82	44	20	22	13
2. 6	16. 0	c. LIII	—	—	38	17	23	12
2. 6	15. 5	LXIII	87	90	48	17	19	10
2. 6	16. 5	LXXII	70	81+	49	20	20	12
2. 6	17. 0	LXV	93	79	43	18	19	11
2. 6	15. 5	LVIII	77	84	34	15	18	11
2. 5	15. 0	LIII	86	82	41	17	20	12
2. 5	16. 0	LVI	73	89	46	18	23	12
2. 5	15. 0	LXXII	—	—	59	21	18	10
2. 5	15. 0	LX	86	86	46	18	16	8
2. 5	15. 5	LIV	62	58	—	—	20	10
2. 4	15. 0	LXI	88	91	43	17	20	10
2. 4	16. 5	LXVII	75	81+	47	20	19	11
2. 4	14. 5	LVII	70	70	48	19	17	9
2. 3	15. 5	c. LIII	75	58	47	19	17	9
2. 3	15. 5	LVI	c. 57	60	—	—	17	10
2. 2	14. 0	LVIII	70	61	44	16	18	9
2. 1	13. 0	LXXIX	60	51	47	17	18	8
1. 9	12. 0	LIV	60	48	37	13	14	7
1. 8	11. 0	LII	60	55	39	13	14	7
1. 5	12. 0	XLII	43	28	28	9	12	5
1. 4	10. 0	XXXV	33	18	—	—	—	—
1. 3	9. 0	XLII	39	25	33	11	16	5

Terra Nova station 348; off Barne Glacier, McMurdo Sound; 365 meters [Bell, 1917; John, 1938] (1, B.M.).

Discovery, Mts. Erebus and Terror (Ross Island) [A. H. Clark, 1913; John, 1938] (7, B.M.). Same, 914 meters [Bell, 1908].

Terra Nova station 225?; Ross Sea (lat. 69°45′ S., long. 177°19′ E.); 20 meters? (this is a plankton station only and probably a mistake) [John, 1938].

Terra Nova station 316; off Glacier Tongue, about 8 miles N. of Hut Point, McMurdo Sound; 348–457 meters; February 9, 1911 [John, 1938] (5, B.M.).

Discovery Inlet, Ross Sea; 550 meters; S. Wallin [Mortensen, 1925] (1, Lund M.).

Discovery Investigations station 1660; Ross Sea (lat. 74°46′ S., long. 178° 23′ E.); 351 meters; at 345 meters, temperature −0.56° C., salinity 34.67‰; mud; January 27, 1936 [John, 1938] (1, B.M.).

Terra Nova station 194; off Oates Land (lat. 69°43′ S., long. 163°24′ E.); 329–365 meters [Bell, 1917; John, 1938] (1, B.M.).

B.A.N.Z.A.R.E. station 90; off Adelie Land (lat. 66°21′ S., long. 138°28′ E.); 640 meters; January 7, 1931 [John, 1939] (3, B.M.).

Aurora (Australasian Antarctic Expedition), station 3; Adelie Land (lat. 66°32′ S., long. 141°39′ E.); 287 meters; temperature −1.62° C.; ooze; December 31, 1913 [A. H. Clark, 1937] (3, U.S.N.M.).

Aurora station 1; Adelie Land (lat. 66°50′ S., long. 142°06′ E.); 640–731 meters; temperature −1.84° C.; thick ooze; December 22, 1913 [A. H. Clark, 1937] (10; 3, U.S.N.M.).

Aurora station 2; Adelie Land (lat. 66°55′ S., long. 145°21′ E.); 581 meters; temperature −1.8° C.; ooze; December 28, 1913 [A. H. Clark, 1937] (4, U.S.N.M.).

Aurora station 8; Queen Mary Land (lat. 66°08′ S., long. 94°17′ E.); 219 meters; small granitic rocks; January 27, 1914 [A. H. Clark, 1937] (1, U.S.N.M.).

Aurora station 9; Queen Mary Land (lat. 65°20′ S., long. 95°27′ E.); 439 meters; temperature +1.38° C.; granitic pebbles with a small amount of ooze; January 28, 1914 [A. H. Clark, 1937] (2, U.S.N.M.).

Aurora station 12; Queen Mary Land (lat. 64°32′ S., long. 97°20′ E.); 201 meters; rock; January 31, 1914 [A. H. Clark, 1937; John, 1939] (9, U.S.N.M.; 1, Austr. M.).

Gauss (German South Polar Expedition); in the vicinity of Gaussberg (lat. 66°02′09″ S., long. 89°38′ E.); 350–400 meters; temperature —1.85° C.; salinity 33‰. March 20, June 20, 1902; 385 meters [A. H. Clark, 1915] (1+ arms, Berl. M.). October 12, 1902; 385 meters (1, U.S.N.M., E. 377). November 29, December 3, 1902; 385 meters (2, Berl. M.). December 1902 (1, U.S.N.M., E. 383). 1902 (2, U.S.N.M., E. 376). February 7, 1903; 350 meters (1, Berl. M.). February 8, 1903; 400 meters (1, U.S.N.M., E. 382). February 15, 1903; 400 meters (8+, Berl. M.). (Two pentacrinoids from this locality were described in vol. 1, part 2, pp. 557, 558.)

B.A.N.Z.A.R.E. station 30; off Princess Elizabeth Land (lat. 66°48′ S., long. 71°24′ E.); 540 meters; December 27, 1929 [John, 1939] (2, B.M.; 9, Austr. M.).

B.A.N.Z.A.R.E. station 103; off Princess Elizabeth Land (lat. 67°03′ S., long. 74°29′ E.); 437 meters; February 10, 1931 [John, 1939] (1, B.M.).

B.A.N.Z.A.R.E. station 107; off MacRoberston Land (lat. 60°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (45, B.M.; 74, Austr. M.).

B.A.N.Z.A.R.E. station 34; off Kemp Land (lat. 66°21′ S., long. 58°50′ E.); 603 meters; January 6, 1930 [John, 1939] (1, Austr. M.).

B.A.N.Z.A.R.E. station 39; off Enderby Land (lat. 66°10′ S., long. 49°41′ E.); 300 meters; January 17, 1930 [John, 1939] (1, B.M.).

B.A.N.Z.A.R.E. station 40; off Enderby Land (lat. 66°12′ S., long. 49°37′ E.); 300 meters; January 17, 1930 [John, 1939] (11, B.M.; 23, Austr. M.).

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 180–209 meters; at 200 meters, temperature −1.77° C., salinity 34.24‰; January 24, 1930 [John,1939] (1, B.M.; 3, Austr. M.).

B.A.N.Z.A.R.E. station 42; off Enderby Land (lat. 65°50′ S., long. 54°23′ E.); 220 meters; January 26, 1930 [John, 1939] (1, B.M.; 1, Austr. M.).

Scotia; Weddell Sea (lat. 74°01′ S., long. 22°00′ W.); 295 meters; March 7, 1904 [Vaney and John, 1939] (1, Edinburgh M.).

Antarctic (Swedish South Polar Expedition) station 8; off Graham Land (lat. 64°03′ S., long. 56°37′ W.); ?360 meters [Mortensen, 1918] (Stockholm M.).

Discovery Investigations station 1952; between Penguin Island and Lion's Rump, South Shetlands; 367–383 meters; soft mud; January 11, 1937 [John, 1938] (9, B.M.).

Bransfield; South Shetland area; from harpoon line; March 22, 1915 [Grieg, 1929] (10, Bergen M.).

Belgica; No. 536; west of Graham Land (lat. 70°23′ S., long. 81°47′ W.); about 480 meters; October 8, 1898 [John, 1937] (1, Brussels M.).

Discovery Investigations station 190; Bismarck Strait, Palmer Archipelago (lat. 64°56′ S., long. 65°35′ W.); 100–130 meters; stones, mud and rock; at 100 meters, temperature −0.31° C., salinity 33.89°/₀₀; March 24, 1927 [John, 1938] (2, B.M.).

Geographical range.—Shores of the Antarctic continent, the Graham Land peninsula and the South Shetland Islands; circumpolar.

Bathymetrical range.—130 (?100) to 914 meters.

Thermal range.—From −1.85° to +1.38° C.

Salinity range.—From 33.89 to 34.67 parts per thousand.

History.—This species was first brought to light by the British Antarctic Expedition of 1901–04 in the *Discovery* under the leadership of Capt. Robert Falcon Scott, R.N. It was originally described and figured in the reports of this expedition by Prof. F. Jeffery Bell in 1908, who named it in honor of Dr. Edward Adrian Wilson, the surgeon and naturalist to the Expedition.

Additional information regarding the original specimens was published by myself in 1913, and in 1915 I described in detail and figured the examples taken by the German South Polar Expedition in the *Gauss* near Gaussberg in 1901–03, excepting for two pentacrinoids which are described in vol. 1, part 2, pp. 557–559 of the present work.

In 1917 Prof. Bell recorded it from three localities where it had been found by the British Antarctic Expedition of 1910 in the *Terra Nova*. It was on this expedition that Capt. Scott and Dr. Wilson lost their lives.

A single individual secured south of South America by the Swedish South Polar Expedition of 1901–03 in the *Antarctic* under the leadership of Dr. Otto Nordenskjöld was recorded by Dr. Th. Mortensen in 1918.

Analyses of the inorganic constituents of the skeleton, determined from material secured by the *Gauss*, were published by Prof. Frank W. Clarke and Dr. William C. Wheeler in 1914, 1915, 1917, and 1922.

The myzostomes found with the specimens collected by the *Discovery* were described by Dr. Rudolf Ritter von Stummer-Traunfels in 1908, and those found with the material from the *Terra Nova* Expedition were described by Mr. C. L. Boulenger in 1916.

In 1925 Dr. Mortensen recorded the species from the collections of Mr. Sten Wallin in the Discovery Inlet, Ross Sea, in 550 meters.

The whaler *Bransfield* took 10 specimens of *Anthometra* from a harpoon line when hauling in a whale in the South Shetland Islands area. Grieg in 1929 gave some notes on these.

In 1937 my report on the crinoids of the Australasian Antarctic Expedition in the *Aurora* was published, giving details of material from off Adelie Land and Queen Mary Land on the antarctic continent.

In the same year Dr. D. Dilwyn John recorded the species from the *Belgica* collections made in 1897–99. Only a single broken specimen was present.

In 1938, however, Dr. John listed a further 12 specimens from the collections of the *Discovery* Investigations and in 1939 reported on the 177 specimens (119 of them from a single station) collected by the B.A.N.Z.A.R. Expedition off the shores of Antarctica. The largest of these have arms up to 200 mm. long and cirri of up to 90 segments and 90 mm. long. By contrast, the *Scotia* in 1902–04, obtained only a single specimen of *Anthometra* in the Weddell Sea (Vaney and John, 1939).

Subfamily Perometrinae A. H. Clark

Perometrinae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Perometra, Erythrometra* and *Hypalometra*); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Crinoids of the Indian Ocean, 1912, p. 6 (number of East Indian genera also found in the Atlantic; genera represented in the Atlantic by closely allied genera; genera exclusively confined to the East Indies; number of East Indian species), p. 9 (absent from Australia), p. 25 (range; 51–140 fms.), p. 60 (in key); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (temperature relations); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., Leipzig, vol. 6, 1914, p. 5 and following (Atlantic and corresponding Indo-Pacific genera); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges); No. 20, p. 582 (relation of habitat to temperature); vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance); Amer. Journ. Sci., vol. 40, 1915, p. 68 (detailed philosophical discussion of bathymetrical range); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, p. 42 (phylogenetical study); Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (includes *Perometra, Erythrometra* and *Hypalometra*); No. 16, p. 505 (in key), p. 507 (key to the included genera); Unstalked crinoids of the *Siboga*-Exped., 1918, p. vii (not found by the *Albatross* in the East Indies), p. 196 (in key), p. 233 (key to the included genera; *Nanometra* added since 1917); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 2.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 7, 10, 80, 140, 142.—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 49 (in key).—Gislén, Zool. Bidrag. Uppsala, vol. 9, 1924, pp. 91, 212, 232, 241.—Ekman, Zoogeographica, vol. 2, No. 3, 1934, pp. 328, 343 (zoogeographic significance); Tiergeographie des Meeres, 1935, p. 66.—Gislén, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 15.—John, Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 193.—Gislén, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54, footnote 1; Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (absent below 1,000 meters).

Diagnosis.—A subfamily of Antedonidae in which the cirrus sockets are closely crowded and arranged irregularly or in several alternating transverse rows on a rounded conical, low to moderately high, centrodorsal; the cirri are rather long, with numerous (25 to 55, but rarely less than 30) segments of which the proximal are somewhat elongated and the short distal bear strong carinate dorsal processes or spines; the mid-dorsal line of the usually prominent radials makes a wide angle with the dorsoventral axis; P_1 is rather stout, composed of relatively few (usually 12, and never over 20) segments of which all but the basal are moderately elongated; P_2 resembles P_1, but is usually smaller; it always differs from the genital pinnules; P_a is frequently and P_1 sometimes absent. The segments of the genital pinnules are never expanded.

Geographical range.—From southern and southwestern Japan southward to the Moluccas, Celebes and the Kei Islands, westward to Madagascar and from southeast Australia; also in the West Indies off Havana, Cuba.

Bathymetrical range.—From 60 to 1040 meters.

Thermal range.—From 9.67° C. to 23.33° C.

Remarks.—The species of this subfamily are characteristic of water of from 100 to 300 meters in depth and with a rather high temperature, between 12° and 20° C. [Note by A.M.C.: *Nanometra johnstoni* from the Bass Strait, south of Australia, is probably an exception to this. Unfortunately no bottom temperatures were taken in this vicinity by the B.A.N.Z.A.R.E.] None of them are littoral, yet all of them occur in less than 255 meters, and only a single one extends downward beyond 400 meters.

Characters.—The centrodorsal in the Perometrinae shows relatively little variation. It is small, conical with the sides somewhat swollen, distinctly broader at the base than high, more rarely nearly as high as broad; in small specimens it may be almost low hemispherical. The bare dorsal pole is always small, roughened or papillose; it usually forms a rounded point, but may be concave. The sides of the centrodorsal are almost completely covered by several transverse alternating rows of closely crowded cirrus sockets which decrease in size from the periphery toward the apex; about the periphery there are approximately 15 sockets, or 3 beneath each radial.

Like the centrodorsal, the cirri show comparatively little variation. They are from 10 to 30 mm. in length, or from 25 to 55 percent of the length of the arms; in all but 2 species they are very nearly one third of the arm length.

The number of the cirri varies from XV to LXX, but is usually from XXV to XXXV; in only one species are there more than L.

The number of segments in the fully developed cirri is singularly restricted; it varies from 28 to 55, but is mostly between 30 and 40; it probably does not fall below 30 in any species, and appears always to exceed 40 in only one.*

The cirri always decrease in size from the periphery of the centrodorsal toward the dorsal pole, and in extreme cases the apical cirri may be exceedingly delicate, scarcely more than a tenth the length of the peripheral, and composed of about half as many segments, all of which are much elongated; but the difference is usually much less than this.

The cirri are practically uniform in shape. They are moderately stout, rather strongly attached to the centrodorsal, and are composed of a few short basal, several elongated proximal, and many short distal segments.

The distal ends of the cirrus segments are usually unmodified, or in the smallest species may be slightly produced. The longest proximal segments are twice as long as broad, longer in only a single small species, and more or less, but never strongly, constricted centrally; the segments in the outer half of the cirri are about as long as broad, becoming broader than long in the large species.

The dorsal surface of the short distal segments is always more or less sharply carinate in the median line and is usually elevated so that the dorsal profile of the outer part of the cirri is scalloped, or serrate with broad teeth; but in one case the elevation is so slight that there appears to be little more than small terminal dorsal spines.

Basal rays are not ordinarily developed; but in one species the ends of partially differentiated basal rays may be seen in the angles of the calyx.

The radials are usually rather prominent, extending some distance beyond the rim of the centrodorsal; but in the larger species they may be almost concealed in the

*But see note on page 464.

median line. The plane of their mid-dorsal line makes a broad angle, sometimes approaching 90°, with the dorsoventral axis, imparting a very characteristic appearance. The distal angles of the radials are separated by a slight notch, and their borders may be smooth, or more or less everted and tubercular.

The IBr_1 are from two and a half to four (usually three or four) times as broad as long, oblong, or with more or less converging sides, with the borders unmodified, or with the lateral edges coarsely spinous or tubercular, and the proximal and distal edges sometimes everted and spinous or tubercular. The distal border is usually more or less depressed in the middle by a rounded posterior process from the axillary.

The IBr_2 (axillaries) are always broad, from about as broad as long to nearly twice as broad as long. Their lateral angles usually extend somewhat beyond the anterolateral angles of the IBr_1. Their edges may be smooth, but there are commonly ventrolateral processes or tubercles beneath the lateral angles, and the proximal and distal borders may be everted and spinous or tubercular. The middle of the proximal border is always extended downward more or less in the form of a rounded process incising the distal border of the IBr_1, and this proximal process, with the adjacent portion of the IBr_1, commonly rises into a marked synarthrial tubercle, which may be (especially in *Perometra*) greatly exaggerated.

Two quite different kinds of IBr series occur in this subfamily In *Perometra* the elements of the IBr series are quite smooth all around the edges and are in close lateral apposition, with their sides sharply flattened against those of their neighbors in the manner characteristic of the species of Thalassometridae (see fig. 19, p. 463). In the other genera the IBr series are narrower, and the lateral angles of the axillaries extend more or less, though never very greatly, beyond the anterolateral angles of the IBr_1. In these genera the ventrolateral borders of the elements of the IBr series usually bear flangelike processes or tubercles which may meet those of their neighbors.

There is never any ornamentation on the dorsal surface of the IBr series.

When IIBr series are present (only in *Perometra afra*), they are always of 2 ossicles.

The first 2 brachials as usual reduplicate the essential features of the elements of the IBr series; the second brachial is always larger than the first and irregularly quadrate in form.

The division series and arm bases lie in planes making a relatively small angle with the dorsoventral axis, so that the proximal portion of the animals appears more or less compressed.

The arms vary in length in adult individuals from 25 to 120 mm., and are usually between 35 and 70 mm. The average length for all the species is 53 mm., and in only one do they exceed 90 mm.

The general structure of the arms varies rather more than in most of the subfamilies of Antedonidae. The first 2 brachials may be relatively large with the second of approximately the same shape as, and but little larger than, the first (*Perometra*), or the first may be small and the second larger, sometimes considerably larger, as is usual in the Antedonidae.

The first brachial is usually twice, rarely as much as 3 times, as long exteriorly as interiorly; it may be almost wedge-shaped, or the distal border may form an obtuse angle in such a way that the inner half is nearly or quite parallel with the proximal border while the outer forms an acute angle with that border.

The second brachial is larger, sometimes considerably larger, with the middle of the proximal border depressed into an obtuse angle entering the concavity on the distal border of the first, so that it is irregularly quadrate in dorsal view.

The first syzygial pair is usually longer interiorly than exteriorly; in extreme cases the hypozygal (third brachial) may be reduced to a low triangle with the apex just reaching the outer edge of the arm. In length it varies from as long as broad in the smaller species to twice as long as broad in the largest.

The next 2 brachials are oblong or slightly wedge-shaped, from about as broad as long to twice as broad as long, and those following rapidly become very obliquely wedge-shaped or triangular and as long as, or somewhat longer than, broad. Distally the ends of the brachials become gradually less and less oblique and the relative length increases so that in the terminal portion of the arms the brachials are elongate with almost or quite parallel ends and more or less strongly swollen articulations.

The distal ends of the brachials are sometimes, though rarely, smooth; usually they are more or less conspicuously bordered with fine spines, and the central and outer portion of the distal brachials may be covered with fine longitudinal striations.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 2 to 6 (usually 2 or 4) muscular articulations. The position of the second and third syzygies and the distal intersyzygial interval in the larger species is somewhat less definitely fixed than in the other subfamilies of Antedonidae.

One species (*Perometra afra*) has only been found with 13 or more arms, the IIBr series being 2; but all the other species in the subfamily are 10-armed.

The oral pinnules in this subfamily show very considerable uniformity. The most interesting feature is the uniform absence of P_a in one species of *Erythrometra* and in *Hypalometra*, and the usual absence of this pinnule in another species of *Erythrometra* and in one of the three species of *Perometra*. In *Hypalometra*, P_1, as well as P_a, is invariably absent. The absence of these pinnules is undoubtedly correlated with the unusually small angle between the planes of the division series and arm bases and the dorsoventral axis characteristic of this group.

P_1 is the longest and stoutest of the oral pinnules. In nearly all the species P_1 is considerably more robust than is usually the case in the Antedonidae, somewhat stiffened, and composed of 12 segments, all but the first of which are twice as long as broad and have more or less spinous distal ends. In one species of *Nanometra* P_1 has 15 to 20 segments which are mostly two and a half times as long as broad and is quite smooth, resembling P_1 in certain species of *Psathyrometra;* but in the other species of the same genus P_1 has only 8 to 12 segments and resembles the same pinnule in the other genera.

P_2 is usually shorter than P_1; it may be only slightly shorter, but sometimes is only half as long. At the same time it is proportionately less stout than P_1 with somewhat fewer segments, from nearly as many to about two-thirds as many, which have more spinous distal ends. In *Perometra afra* and *P. diomedeae* only is P_2 similar to P_1.

P_3 is similar to P_2 but more or less shorter; the component segments have more spinous distal ends.

The distal pinnules are from half again as long to only slightly longer than (rarely about as long as) P_1, and are commonly composed of twice as many segments, though sometimes the number is only slightly larger. Generally the distal pinnules are rather stouter than is usual in the Antedonidae, and are composed of less elongated segments.

Deposits along the sides of the ambulacral grooves of the pinnules are present in all the species; these consist of straight or slightly bent rods sometimes roughened at the ends, which are usually short, rarely long, and may be either stout or slender.

In *Hypalometra* the tentacles contain a thin line of spicules placed end to end which runs nearly to their tips. Similar spicules have also been observed in two species of *Perometra*.

Relationships.—The genera of Perometrinae seem to be all very closely related to each other. As a group the Perometrinae seem to represent an offshoot from the Bathymetrinae which has become adapted to a comparatively warm habitat and has acquired a considerable resemblance in certain features to the 10-armed genera of Colobometridae.

KEY TO THE GENERA OF PEROMETRINAE*

a^1. P_1 and P_a absent; size small, the 10 arms being from 25 mm. to 35 mm. (usually between 25 mm. and 30 mm.) in length; cirri XX–XXX, 22–25, 10 mm. long (Straits of Florida; 60–386 meters)........Hypalometra (p. 487)

a^2. P_1 always present, though P_a is sometimes absent.

b^1. Elements of the IBr series and first 2 brachials with smooth and straight borders, laterally in close apposition with their neighbors and sharply flattened against them; synarthrial tubercles very prominent, sometimes extravagantly developed (figs. 19 and 21, pp. 463, 471); 10–15+ (usually 10) arms (Madagascar to the Kei Islands and southern Japan; 71–256 [?278] meters)........Perometra (p. 461)

b^2. Elements of the IBr series and first 2 brachials never with sharply flattened sides, though they may be just in contact laterally; their lateral borders always bear tubercles, one or several to each ossicle, and their distal and proximal borders are usually prominently everted and tubercular.

c^1. Interradial and interbrachial portions of the perisome naked; P_a always present (Kei Islands and Celebes to southern Japan and north of Tasmania; 122–1040 meters).
Nanometra (p. 478)

c^2. Interradial and interbrachial portions of the perisome with numerous prominent rounded calcareous nodules which are not in lateral contact; P_a usually absent (Moluccas and Kei Islands to southern Japan; 100 [?95]–274 meters)........Erythrometra (p. 473)

Genus PEROMETRA A. H. Clark

Antedon (part) P. H. CARPENTER, Proc. Roy. Soc., vol. 28, 1879, p. 384, and following authors.

Nanometra (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 349.

Perometra A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 357 (diagnosis; type species *Antedon diomedeae* A. H. Clark, 1907); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 248 (same); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (pinnulation), p. 136 (referred to Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Antedonidae, restricted), p. 212 (occurs in Japan); Amer. Nat., vol. 42, No. 500, 1908, p. 541 (only known from Indo-Pacific-Japanese area); No. 503, p. 725 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 602 (characteristic of Indo-Pacific-Japanese region); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to Perometrinae); Amer. Nat., vol. 43, 1909, p. 580 (pinnulation); Proc. U.S. Nat. Mus., vol. 36, 1909, p. 362 (deficient pinnulation like that of *Comatilia*); vol. 40, 1911, p. 13 (common to southeastern Africa and the Bay of Bengal, but not occurring in the Arabian Sea); Crinoids of the Indian Ocean, 1912, p. 11 (occurs both east and west of Ceylon), p. 12 (represented in the southeastern African region), p. 14 (corresponds to the West Indian *Hypalometra*), p. 26 (range; covers the range of the subfamily in the East Indian region), pp. 61, 63 (in keys), p. 232 (original reference; type); Die Crinoïden der Antarktis, 1915, p. 181 (range; represented in the Atlantic by *Hypalometra*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to Perometrinae); No. 16, p. 507 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 234 (in key;

*See also Addenda (p. 839) for 1967.

range; key to the included species).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 12; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 18, 20.

Caryometra (not of A. H. Clark, 1936) A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, pp. 96, 103.

Diagnosis.—A genus of Perometrinae in which the elements of the IBr series and the first 2 brachials have smooth and straight borders and are laterally in close opposition with their neighbors and sharply flattened against them; the synarthrial tubercles are very prominent, sometimes extravagantly developed; and P_a may or may not be present. There are 10 to 15 or more arms up to 90 mm. in length. [Note by A.M.C.]. In the specimens belonging to this genus which I have examined, the cirrus sockets have the form of a boss sunken into a hollow in the centrodorsal (see figs. 19,*a* and 21,*a* pp. 463 and 471).

Type species.—*Antedon diomedeae* A. H. Clark, 1907.

Geographical range.—From Madagascar to the Maldive and Kei Islands and southern Japan.

Bathymetrical range.—From 71 to 256 (?278) meters.

Thermal range.—From 11.61° C. to 20.39° C.

[Note by A.M.C.] I have added *Caryometra robusta* A. H. Clark, from off the Maldive Islands, to this genus. Apart from having only 10 arms it has great similarity to *P. afra*. This is discussed further on page 470.

KEY TO THE SPECIES OF PEROMETRA

[by A.M.C.]

a^1. More than 10 arms (northeast of Madagascar; 228 meters) .... **afra** (p. 462).

a^2. 10 arms.

- b^1. The outer segments of P_1 not expanded and spinous at their distal ends (fig. 20,a, p. 465).
  - c^1. P_a usually absent; the longest cirri about equal to one third of the arm length (Southern Japan; 71–254 [?278] meters) .... **diomedeae** (p. 464)
  - c^2. P_a present; the longest cirri about one fifth of the arm length (Kei Islands; 256 meters). **pusilla** (p. 469)
- b^2. The outer segments of P_1 conspicuously flared and spinous (fig. 21,c, p. 471) (off the Maldive Islands; 229 meters) .... **robusta** (p. 470)

PEROMETRA AFRA A. H. Clark

Figure 19

Perometra afra A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 8 (southeastern coast of Africa), p. 43 (description; Providence I., 125 fms.); Crinoids of the Indian Ocean, 1912, p. 233 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 57 (published reference to specimens in the B.M.; locality); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 234 (in key; range; references).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 18, 20.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 102 (range), p. 104 (listed).

Diagnostic features.—This species closely resembles *P. diomedeae* from which it differs in having all the pinnules present, 13 to 15+ arms, which are 50 to 60 mm. long, in the 4 syntypes and less strongly developed synarthrial tubercles; there are up to 55 cirrus segments.

Description [by A.M.C.].—The centrodorsal is rounded conical with the dorsal pole completely covered with rounded papillae, some of which approximate in diameter to the apical cirri though most are smaller. They rub off without leaving any distinct socket. The cirrus sockets are without any special arrangement on the centrodorsal; they are somewhat sunken. In three of the four specimens the cirrri number about XL and in the fourth XLV. The longest cirri in each have 55, 47, 43 and 48 segments, measuring 27, 23, 23 and 24 mm. in length. The longest cirrus segments are about twice as long as broad. The distal ones are much shorter with a dorsal carination of which the apex is towards the distal end.

The division series and first brachials have a markedly thickened lateral flange bringing the neighboring ones into contact and the first three brachials also have a flange on the inner side. The synarthrial tubercles on the division series and first pairs of brachials are prominent but not of exaggerated size.

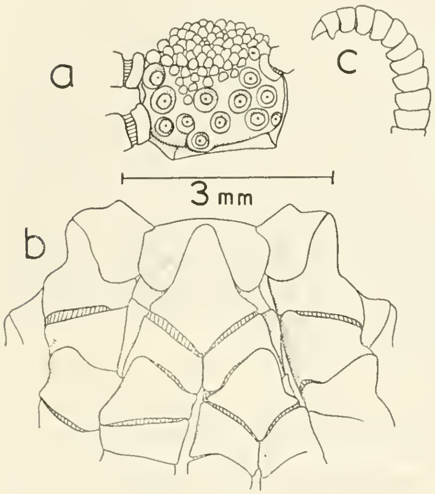

FIGURE 19.—*Perometra afra* A. H. Clark, syntypes, B.M., 1907.7.1.84–6: *a*, Laterodorsal view of centrodorsal; *b*, proximal part of postradial series of another syntype; *c*, cirrus tip.

The specimens are more or less incomplete and some of the division series are broken so that the exact number of arms cannot be ascertained. One specimen certainly has 15 arms and the others all have at least 13. One of the latter could have had 20 arms since all those remaining arise from IIBr series and the other IBr series are broken. All the IIBr series are of two ossicles. The arm length was probably between 50 and 65 mm. in all the four specimens. The width at the first syzygy is 1.0–1.1 mm. and the length from the proximal edge of the IBr_1 to the second syzygy at 9+10, where no IIBr series intervenes, is about 8.5 mm.

The proximal pinnules have very slender segments several times as long as wide with prominent hyaline spines at the distal ends of most of them, particularly on the ventral side. In two of the types P_1 and P_2 have 14 segments and measure 7.0 mm.

in length. In one of these P_3 also has 14 segments but is 6.5 mm. long and in the other it is 5.0 mm. long, with only 11 segments. A third specimen has no P_1 complete but P_2 and P_3 have 20 and 18 segments and measure 9 and 8 mm. respectively. I do not agree with the original description which states that P_3 is the longest proximal pinnule. The distal pinnules have slender, simple, often somewhat bent spicules in the tentacles.

The color in alcohol is purplish, the ventral side dark.

Locality.—Sea Lark; off Providence Island, northeast of Madagascar; 228 meters; J. Stanley Gardiner [A. H. Clark, 1911, 1913, 1918] (4, B.M.).

PEROMETRA DIOMEDEAE (A. H. Clark)

FIGURE 20

[See also vol. 1, pt. 1, figs. 13 (p. 65) 112, (p. 179), 289 (p. 262), 387 (p. 307), 431 (p. 349), 503 (p. 371); pt. 2, figs. 82–84 (p. 53), 119 (p. 79), 319 (p. 227), 772 (p. 362)]

Antedon diomedeae A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 132 (color), p. 146 (description; *Albatross* Sta. 4947); vol. 39, 1911, p. 562 (related to *Antedon pusilla* P. H. Carpenter).

Perometra diomedeae A. H. CLARK, Smithsonian Misc. Coll., vol. 50, part 3, 1907, p. 358 (listed); vol. 52, pt. 2, 1908, p. 230 (compared with *P. elongata* [*Balanometra balanoides*]); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 225 (compared with *Himerometra* [*Amphimetra*] *ensifer*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 275 (synarthrial tubercles), p. 316 (localities in Sagami Bay); vol. 35, 1908, p. 119 (arm structure; synarthrial tubercles); vol. 39, 1911, p. 562 (closely related to *Antedon pusilla* P. H. Carpenter); vol. 40, 1911, p. 43 (compared with *P. afra*); Zool. Anz., vol. 39, Nos. 11, 12, 1912, p. 423 (synarthrial tubercles compared with those of *Calometra diana*); Crinoids of the Indian Ocean, 1912, p. 233 (synonymy; range); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 58 (comparison with *P. pusilla*); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 234 (in key; range; references).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 88; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (Sta. 9); footnote 1 (includes *Erythrometra rubra* part of Gislén, 1922), p. 48 (notes), p. 68 (listed).

Erythrometra rubra (part) GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 140 (Sp. 1, 3; Bock Sta. 11; characters).

Diagnostic features.—There are 10 arms only, which are up to 90 mm. long; P_a is usually absent; the synarthrial tubercles are extravagantly developed; there are 35 to 55 (usually about 40) cirrus segments.*

Description.—The centrodorsal is small, usually rounded conical, but varying from almost hemispherical (in small specimens) to long conical. The cirrus sockets are closely crowded and more or less regularly arranged in 4 or 5 rows. The apex is papillose.

The cirri are XXX–XL, 35–55 (usually about 40), slender, 30 mm. long. The first segment is short, the second is nearly as long as broad, the third is about as long as broad, the fifth to eleventh are about twice as long as broad, and those following become gradually shorter so that from about the eighteenth onward they are about as long as broad. On about the eighteenth segment the distal dorsal edge begins to project, this condition passing gradually into low spines. In a lateral view the dorsal

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*Utinomi and Kogo (see Addenda for 1965) identified as *P. diomedeae* a specimen of which they figured a cirrus ca. 30 mm. long with as many as 84 segments, all relatively shorter than those illustrated in figure 20. Since their specimen also appears to lack P_1 as well as P_a on the arm bases drawn, it is possible that another species is involved.

profile of the cirri is smooth in the basal half, and serrate with more or less broad teeth in the distal half.

The radials are oblong, about twice as broad as long, rather longer in young and shorter in very large individuals. The IBr_1 are oblong, longer than the radials, with the distal border rather deeply incised and the lateral borders straight and sharply flattened against those of their neighbors on either side. The IBr_2 (axillaries) are about as long as broad with a sharp distal angle. On the articulation between these two ossicles there rises an extravagantly elongated synarthrial tubercle.

The 10 arms are from 65 to 90 mm. in length. The first two brachials are relatively very large, irregularly quadrate with the shorter side in, the articulation between them rising into an enormously elongated synarthrial tubercle similar to that between the elements of the IBr series. The third brachial (the hypozygal of the first syzygial pair) is low triangular with the apex of the triangle on the outer side. The fourth brachial (epizygal) is short and oblong, almost discoidal. The fifth and sixth brachials are oblong, longer than the fourth. The following 4 or 5 brachials are slightly wedge-shaped, those following becoming triangular, about as long as broad, and distally wedge-shaped again and elongate. The earlier brachials, to about the eighth, are in close apposition to those on the adjacent arms against which they are sharply flattened. There is often, in large specimens, a considerable development of articular tubercles.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 4 muscular articulations. The width at the first syzygy in the type is 1.5 mm. and the length from the IBr_1 to the second syzygy is 11.5 mm.

P_1 is 7 to 8 mm. long, moderately slender and evenly tapering, composed of 14 to 15 segments [A.M.C.], of which the first is short and the remainder are about twice as long as broad. P_a is absent. P_2 is similar to P_1 and of about the same length. P_3 is similar, but slightly shorter, about 7 mm. long. P_4 and P_5 are shorter still, 4 mm. long and composed of about 10 segments, but resemble the preceding in character.

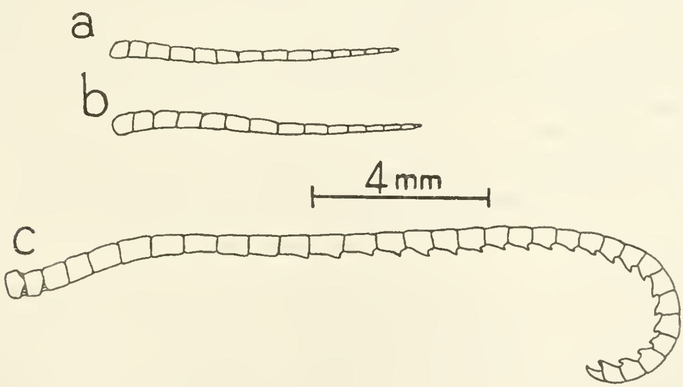

FIGURE 20.—*Perometra diomedeae* (A. H. Clark), holotype: *a*, P_1; *b*, P_2; *c*, nonperipheral cirrus.

The following pinnules gradually become longer, the distal being 12 mm. long with about 24 segments, of which the first is short and trapezoidal, the second short, about as long as broad, and those succeeding become progressively elongated. The lower pinnules are somewhat stiffened, and the distal, while long, are not especially slender.

Notes.—Dr. Torsten Gislén (1922) described two small specimens of this species.

In one the cirri are XX, the peripheral with 34–36, the apical with 24–25 segments, from 7 to 11 mm. in length. The first and second segments are short, the third is about as long as broad, the fifth is the longest, from a half to two-thirds again as long as broad, and the following slowly decrease in length so that the tenth is about as long as broad. From the tenth segment onward a dorsal swelling appears on each cirral distally which gradually develops into a blunt longitudinal crest, most prominent on the ninth or tenth segments from the end of the cirri. The antepenultimate segment is almost smooth. The opposing spine is stout, reaching two-thirds of the width of the penultimate segment in height. The terminal claw is about as long as the penultimate segment, and curved.

The radials are 6 times as broad as long. The IBr_1 are twice as broad as long, almost free laterally, distally somewhat incised in the middle by the posterior extension of the axillary. The synarthrial elevation is inconspicuous. The axillaries are rhombic, one quarter again as broad as long; the lateral angles are provided with very slight small spines.

The 10 arms are 25+ mm. long. The first brachials are half again as long exteriorly as interiorly, and are interiorly united. The proximal border of the second brachials is similar to that of the axillaries. The brachials after the tenth are triangular and smooth.

Syzygies occur between brachials 3+4, (9+10), 15+16, and 21+22, and distally at intervals of usually 3 or 4 muscular articulations.

P_1 is 4.2 mm. long, composed of 11 to 12 segments, of which the first and last are short and the others are from two to two and a half times as long as broad. P_a is usually absent. P_2 is 4 mm. long with 11 segments, of which the distal are slightly swollen and spiny. P_3 is 2.2 mm. long with 8 to 9 segments. P_4 is a little shorter, and the following pinnules become longer again. The distal pinnules are 3 mm. long with about 13 segments, of which the first and second are somewhat stouter than those following.

In the second specimen the bare dorsal pole of the centrodorsal is finely granular, 0.8 mm. in diameter.

The cirri are XIV, 17–19, arranged in a single row. The fourth segment is the longest and bears a dorsal tubercle which on the seventh passes over into a stout dorsal spine which becomes less developed on the antepenultimate.

The 10 arms are all broken. The distal intersyzygial interval is 3 to 4 muscular articulations.

P_1 is 3 mm. long with 11 segments. P_a is absent. P_2 is 4.2 mm. long with 11 segments which have small spines on their distal borders. P_3 is 3 mm. long with 9 segments. P_4 is 2 mm. long with 10 segments.

The 2 specimens dredged in Sagami Bay by Dr. Haberer were both small, with the synarthrial tubercles just beginning to develop. P_a is present on all the arms.

In 1927 Gislén gave notes on two specimens collected by Dr. Th. Mortensen off Kiu-Shiu. One has the centrodorsal 1.3 mm. high; cirri XXIV, with 27–34 segments and measuring 8–9 mm. in length. The arms are all broken. The IBr_1 is one third as long as wide and the axillary four fifths as long as wide. Syzygies occur at brachials 3+4, 11+12, and 18+19, distally at intervals of from 5 to 17 muscular articulations. P_1 has 11 segments and measures 6.5 mm. P_2 has 10 segments and measures 6 mm. P_3 with 10 segments measures 5.2 mm. All the pinnulars are smooth. P_a is present.

The second specimen has XXIII cirri with 27–36 segments and measuring 8–11 mm. in length. The arms are about 35 mm. long, but broken. The syzygial interval is 4 to 5 muscular articulations. P_1 with 9 segments is 4.3 mm. long. P_2 with 10 is 3.2 mm. long. P_3 has 9 segments and measures 3.5 mm. P_a is present.

One of these has a rather stout synarthrial tubercle on the IBr series but in the other it is much less developed.

Gislén also comments that the young of this species can be distinguished from those of *Erythrometra rubra* (with which it occurs) by the more distinct dorsal spines of the cirrus segments, the closer arm bases, the absence of granules in the skin of the disk and the smooth proximal pinnules.

Young individuals of this species are very different in appearance from the fully grown. They have fewer cirri with somewhat fewer segments, the brachials are all more or less elongated, and there are no traces of the characteristic exaggerated synarthrial tubercles, though their future location is indicated by purple spots. On the basal portion of the arms there is a light purple median line fading into white distally.

When an arm length of about 30 mm. is reached, the synarthrial tubercles begin to appear, rapidly increasing in size and becoming quite evident at an arm length of about 40 mm., and reaching the full size at the latest when the arm length has reached 45 mm. With the development of the synarthrial tubercles, the median purple lines on the arms gradually disappear, giving place to bands of greater or lesser width, or sometimes large blotches. These are at first light in color and do not become dark until nearly the full size has been attained, when purple bands also appear upon the cirri.

Most of the specimens of this interesting species so far secured are young, only a very few being sexually mature. The most richly colored individuals are from the least depth, though some others very similar were found at 188 meters. The largest specimens were brought up from 128 to 164 meters.

Color in life.—In the most richly colored individuals the arms, pinnules and cirri are a rich reddish purple blotched and streaked with white, the arm bases and calyx being white with the synarthrial tubercles and a broad band on each of the lower brachials reddish purple.

More commonly the color is white, with the synarthrial tubercles, narrow bands on the arms and cirri, and blotches on the pinnules purple.

Abnormal specimens.—In a large and pale individual dredged by Mr. Alan Owston's yacht *Golden Hind* in Sagami Bay in 155 meters one post-radial series is dwarfed, being about half the size of the others. On this post-radial series the IBr_1 is lacking, the axillary springing directly from the radial without any tubercular elevation of its proximal border. On the left arm there is a partial additional second brachial which is dorsally visible externally from the outer side of the arm to the median line, its length in the direction of the long axis of the arm being about half as great as its width. This

556–622—67——31

partial brachial rises to a strong tubercle proximally, and to a less strong tubercle distally. It does not bear a pinnule.

One of the specimens dredged by Dr. Haberer had an arm on which the first and second brachials were missing. The first brachial present was the third, which was not united to the fourth by the usual syzygy. It bore a pinnule on its inner side, the following (fourth) brachial bore a pinnule on the outer side, and the succeeding pinnules alternated regularly.

Localities.—*Albatross* station 4894; southwest of the Goto Islands; Ose Saki Light bearing N. 41° E., 5 miles distant (lat. 32°33′00″ N., long. 128°32′10″ E.); 174 meters; green sand, broken shells and pebbles; August 9, 1906 (1, U.S.N.M., 36207).

Albatross station 4904; southwest of the Goto Islands; Ose Saki Light bearing N. 27° E., 6 miles distant (lat. 32°31′20″ N., long. 128° 32′40″E.); 195 meters; fine gray sand and broken shells; August 10, 1906 (10, U.S.N.M., 35649).

Albatross station 4893; southwest of the Goto Islands; Ose Saki Light bearing N. 29° E., 5.5 miles distant (lat. 32°32′00″ N., long. 128°32′50″ E.); 174–194 meters; temperature 13.28° C.; gray sand, broken shells and pebbles; August 9, 1906 (5, U.S.N.M., 36121).

Albatross station 4903; southwest of the Goto Islands; Ose Saki Light bearing N. 22° E., 6 miles distant (lat. 32°31′10″ N., long. 128° 33′20″ E.); 195–254 meters; gray sand and broken shells; August 10, 1906 (17, U.S.N.M., 35650).

Albatross station 4901; southwest of the Goto Islands; Ose Saki Light bearing N. 9° E., 6.5 miles distant (lat. 32°30′10″ N., long. 128°34′40″ E.); 254 meters; temperature 11.61° C.; gray sand and broken shells; August 10, 1906 (1, U.S.N.M., 35652).

Albatross station 4902; southwest of the Goto Islands; Ose Saki Light bearing N. 10° E., 6 miles distant (lat. 32°30′50″ N., long. 128°34′40″ E.); 254 meters; temperature 11.61° C.; gray sand and broken shells; August 10, 1906 (7, U.S.N.M., 35653).

Dr. Sixten Bock's Expedition to Japan, 1914, station 11; Goto Islands, Kiu Shiu; Pallas rock 5 miles S. by E.; 164 meters [Gislén, 1922].

Albatross station 4934; off Kagoshima Gulf; Sata Misaki Light bearing N. 77½° E., 7 miles distant (lat. 30°58′30″ N., long. 130°32′00″ E.); 188–278 meters; temperature 13.33° C.; rocky; August 16, 1906 (2, U.S.N.M., 35651).

Albatross station 4946; off Kagoshima Gulf; Okiko Jima bearing N. 31° E., 4 miles distant (lat. 31°29′10″ N., long. 130°34′30″ E.); 71 meters; temperature 20.39° C.; brown sand, broken shells and pebbles; August 20, 1906 (10, U.S.N.M., 35648, 35928).

Albatross station 4947; off Kagoshima Gulf; Okiko Jima bearing N. 17° E., 4.4 miles distant (lat. 31°28′20″ N., long. 130°35′30″ E.); 93 meters; brown sand, broken shells and pebbles; August 20, 1906 [A. H. Clark, 1907] (3, U.S.N.M., 22640, 35654). Type locality.

Albatross station 4936; off Kagoshima Gulf; Sata Misaki Light bearing N. 21° E., 5.7 miles distant (lat. 30°54′40″ N., long. 130° 37′30″ E.); 188 meters; bottom temperature 15.89° C.; stones; August 16, 1906.

Albatross station 3719; Sagami Bay; Ose Saki bearing S. 13° W., 1.5 miles distant; 128–164 meters; volcanic sand, shell and rock; May 11, 1900 (1, U.S.N.M., 35646).

Albatross station 3704; Sagami Bay; Seno Umi bearing S. 30° E., 1.1 miles distant; 172–274 meters; fine volcanic sand; May 7, 1900 (1, U.S.N.M., 35644).

Sagami Bay, between Ito and Hatsushima; about 150 meters; Doctor Haberer.

Golden Hind; Sagami Bay (lat. 35°04′ N., long. 138°41′ E.); 201 meters; Alan Owston, August 6, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 35645).

Golden Hind; Sagami Bay (lat. 35°03′ N., long. 138°47′ E.); 155 meters; Alan Owston, August 14, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 35647).

Dr. Th. Mortensen's station 9; off Kiu-Shiu, Japan; 162 meters [Gislén, 1927] (2, C.M.).

Geographical range.—Southern Japan, from Kiu-Shiu eastward to Sagami Bay.

Bathymetrical range.—From 71 to 254 (?278) meters; the average of 15 records is 186 meters.

Thermal range.—The 4 records show a range of from 11.61° C. to 20.39° C., with an average of 14.65° C.

Remarks.—This species was originally described in 1907 from a specimen dredged by the *Albatross* at station 4947 in the preceding year.

In 1908 additional specimens were recorded from Sagami Bay where they had been dredged by Mr. Alan Owston in his yacht *Golden Hind* in 1902, and an abnormal one was described.

In 1922 Dr. Torsten Gislén recorded two specimens of this species from Dr. Sixten Bock's station 11 under the name of *Erythrometra rubra* as he acknowledged in his later work of 1927, when two further specimens were recorded from Dr. Mortensen's station 9 off Kiu-Shiu.

PEROMETRA PUSILLA (P. H. Carpenter)

Antedon, sp. P. H. CARPENTER, Proc. Roy. Soc., vol. 28, 1879, p. 384.

Antedon pusilla P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 103, 131 (description; *Challenger* sta. 192), pl. 23, fig. 1.—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1578 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 144 (comparison with *Antedon minor*); vol. 39, 1911, pp. 561, 562 (systematic position; referable to *Perometra* and related to *P. diomedeae*); Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888=*Perometra pusilla*).

Nanometra pusilla A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 349 (listed).

Perometra pusilla A. H. CLARK, Proc. U.S. Nat. Mus., vol. 39, 1911, p. 561 (does not possess P_a according to Bell; referable to *Perometra*), p. 562, footnote (personal examination shows that it does possess P_a); vol. 40, 1911, p. 43 (synarthrial tubercles compared with those of *P. afra*); Crinoids of the Indian Ocean, 1912, p. 33 (=*Antedon pusilla* P. H. Carpenter, 1888), p. 233 (synonymy; locality; comparison with *P. diomedeae*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 58 (published reference to specimen in B. M.; *Challenger* sta. 192; comparison with *P. diomedeae*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 234 (references).

Diagnostic features.—There are 10 arms in the unique holotype, which are only about 30 mm. long; the cirri are few in number (XVII in the type) and relatively short, up to 6 mm. long with 28 segments, that is about a fifth as long as the arms; P_1 has cylindrical segments though the following pinnules have their outer segments expanded and slightly spinous at the distal ends; P_a is present.

Description [modified by A.M.C.].—The centrodorsal is low hemispherical.

The cirri are XVII, the longest with about 28 segments and measuring about 6 mm. in length; few of the segments are longer than broad and the distal have a slight dorsal keel, rounded in lateral view.

The IBr_1 are short and oblong, with the center of the distal edge raised to meet the proximal edge of the axillary and form a quite prominent tubercle. A similar, but smaller, tubercle occurs at the junction of the first two brachials. The elements of the IBr series and the first two brachials are straight-edged and sharply flattened laterally, with the margins of the dorsal surface flattened.

The 10 arms were probably about 30 mm. long and are composed of smooth and elongate obliquely quadrate segments. The length from the proximal edge of the IBr_1 to the second syzygy is 5.5 mm. and the width of the first syzygy is 0.8 mm. The distal intersyzygial interval is two to six, usually four, muscular articulations. The arms taper more abruptly for the first 6 mm. of their length than they do distally. The width at brachials 9+10 is already reduced to 0.6 mm.

P_1 consists of about 11 much elongated, cylindrical, segments and is considerably longer and stouter than the following pinnules, which decrease in length to about P_4 and then gradually increase. P_a is present on all the arms. P_2 has 9 segments, of which the outer ones are slightly expanded and spinous at their distal ends; it is 2.4 mm. long. P_3 with 8 segments is only 1.8 mm. long; its segments are more conspicuously flared and spinous distally. The two basal segments of the later pinnules are expanded and trapezoidal, but the following segments are slender.

Locality.—*Challenger* station 192; near the Kei Islands (lat. 5°49′15″ S., long. 132°14′15″ E.); 256 meters; blue mud; September 26, 1874 [P. H. Carpenter, 1879, 1888; A. H. Clark, 1911, 1913] (1, B.M.).

Remarks.—The only known specimen of this species, which served as the basis of Carpenter's description in 1888, is evidently young with the mature characters not yet fully developed.

In revising the species of Antedonidae in 1907 I was unable to place this form with any degree of certainty, and tentatively assigned it to the genus *Nanometra.*

Later, however, I became impressed with its similarity to the young of *Perometra diomedeae* and, suspecting that Carpenter might have overlooked the absence of P_a, I wrote to Prof. Bell, asking him to investigate the point for me. He replied: "I have, as you requested, made an examination of the type of Carpenter's *Antedon pusilla*, and so far as I can see, there is no pinnule on the third brachial." In 1911 I published a note on this species, definitely assigning it to the genus *Perometra.* After this note was written, but before it was published, I visited the British Museum and examined the type specimen when I found, much to my surprise, that P_a was present on all the arms. This information I inserted in a footnote.

A study of the original specimen shows that this is a species of the genus *Perometra,* but it differs from *P. diomedeae* in possessing P_a. [Note by A.M.C.: However, several specimens of *diomedeae* from off Kiu-Shiu and from Sagami Bay, Japan, have now been taken (see pp. 466–467) in which P_a is present.] The synarthrial tubercles are also much more strongly developed than in *P. diomedeae* of equal size. The radials have the characteristic features of the radials of *P. diomedeae.*

PEROMETRA ROBUSTA (A. H. Clark)

Figure 21

Caryometra robusta A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 95 (description; *Mabahiss* station 157), pl. 1, fig. 4.

Diagnostic features.—The cirri are up to 20 mm. long when the arm length is 60 mm.; they are rather stout basally, with 39–47 segments, the longer proximal twice as long as broad, the distal about twice as broad as long with a rounded dorsal spine;

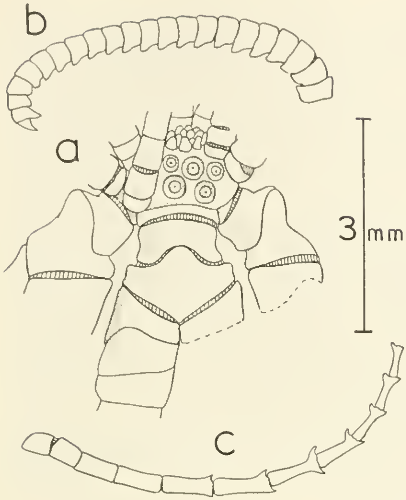

FIGURE 21.—*Perometra robusta* (A. H. Clark), holotype: *a*, Laterodorsal view of calyx; *b*, distal half of cirrus; *c*, P_1, broken but probably of about 13 segments.

there is a transition segment about the ninth; the division series and first two brachials have well developed synarthrial tubercles and marked lateral flanges; P_1 is 6 mm. long with about 12 elongate, distally flared and spinous, segments; P_2 and P_3 are progressively shorter; P_a is present.

Description.—The centrodorsal is conical with swollen sides and a flattened and coarsely papillose dorsal pole, 2 mm. broad at the base and 1.5 mm. high. The cirrus sockets are arranged in 15 crowded and somewhat indistinct columns of usually two each, the sockets of one column alternating with those in the adjacent ones.

The cirri are about XXX, 39–47, up to 20 mm. long, rather stout and with the distal portion capable of being tightly coiled. The first segments are broader than long, the length increasing to the eighth to tenth (usually the ninth), which is a transition segment twice as long as broad. The segments following slowly decrease in length so that the outermost are twice as broad as long, or nearly so. The distal dorsal edge of the transition segment is slightly prominent. This feature gradually increases in extent distally, on the last eighteen segments developing into a high thin median dorsal process with a broadly rounded crest arising from nearly or quite the entire dorsal surface of the segments. The opposing spine is long conical, arising from most or all of the dorsal surface of the penultimate segment, its length equal to about half the width of that segment; it is directed slightly distally. The terminal claw is about as long as the penultimate segment and is slender and moderately curved. The cirri are dark in color with a dull surface as far as the middle or outer third of the transition segment, beyond that point white with a highly polished surface.

The radials are short, between eight and ten times as broad as long, with a slightly concave distal edge, and are closely united laterally. In dorsal view at right angles to the arm the IBr_1 are somewhat over twice as broad as their lateral length. They are very deeply incised by a proximal process from the axillaries so that in the median line they are about as long as the radials. In profile the dorsal surface is seen to extend directly outward at right angles to the axis of the arm. The IBr_2 (axillaries) are shield-shaped, about as long as broad, with an obtuse distal angle and proximally a long rounded swollen process deeply incising the IBr_1. Strongly developed synarthrial tubercles are present, and there are pronounced lateral flanges on the ossicles of the division series which are continued as far as the third brachials so that the neighboring arm bases are almost in contact.

The 10 arms are 60 mm. long. The first brachials are twice as long exteriorly as interiorly, about twice as broad as the exterior length, and form a large synarthrial tubercle with the proximal process from the second brachials, which are roughly shield-shaped, not greatly broader than long. The first syzygial pair (composed of brachials 3+4) is about half again as broad as long, and is slightly longer interiorly than exteriorly. The next four brachials are approximately oblong, nearly three times as broad as long, after which the brachials become triangular, about as long as broad, and soon very obliquely wedge-shaped until distally they become about twice as long as broad, and terminally still longer. Beyond the third syzygy the brachials are constricted centrally and have very finely serrate, though not produced, distal ends.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

The length from the proximal edge of the IBr_1 to the second syzygy is 7.0 mm.; the width of the first syzygy is about 1.2 mm.

P_1 is 6 mm. long with about 12 segments, of which the first is about as long as broad and is slightly trapezoidal, the second is about half again as long as broad, and those following are much elongated, becoming five or six times as long as broad distally; the third and following segments have moderately flaring and coarsely spinous distal ends. P_a is also 6 mm. long with 11 or 12 segments. P_2 is 5.7 mm. long with 11 segments and resembles P_1. P_3 is 5 mm. long with 11 segments and resembles the preceding pinnules. P_4 is 3.2 mm. long with 8 segments and resembles the earlier pinnules.

The color in alcohol is bright yellow with the cirri beyond the transition segment white.

Notes [BY A.M.C.].—Another specimen from the same station is similar in size to the holotype. It has lost all the cirri except for one peripheral one, which has 39 segments and measures 16 mm. in length. The dorsal spines have the same crestlike form as in the type. The centrodorsal is revealed as flattened hemispherical, which is also how I would describe that of the holotype. The cirrus sockets are crowded and though some appear to be placed in columns, just as many seem to alternate. This specimen also has large synarthrial tubercles on the division series and first two brachials as well as the lateral flanges extending to the third brachials.

Locality.—*Mabahiss* station 157; John Murray Expedition; Maldive Islands (lat. 4°43′48″ N., long. 72°55′24″ E. to lat. 4°44′ N., long. 72°54′18″ E.); 229 meters; coral rock; April 6, 1934 [A. H. Clark, 1937] (2, B.M.).

Remarks [by A.M.C.].—Since the type and only specimens of both *Adelometra angustiradia* and *Caryometra robusta* are in the British Museum, I was able to compare them. Mr. Clark had decided (MS.) that they are both congeneric with the West Indian species of *Caryometra*. I presume this decision was made since his 1940 paper on comatulids from off Cuba, when he described several new species of *Caryometra*, and was therefore reached, as far as the Indo-Pacific species were concerned, by comparison of the published descriptions. These are somewhat misleading, particularly Carpenter's description of *angustiradia*, in which the very distinct columnar arrangement of the cirrus sockets with interradial spaces was not made clear. The crowded and rather irregular arrangement of the sockets in *robusta* is so much at variance with this, as well as the laterally expanded division series and lower brachials, that I think it outweighs the similarity in the cirri themselves. On the other hand, the genus *Perometra* and particularly *P. afra* (oddly enough another of the very few Macrophreates with more than 10 arms like *angustiradia*) has many similarities to *robusta*, particularly the possession of papillae on the apex of the centrodorsal, pinnules of very similar type, cirri of comparable length, proportions, number and arrangement as well as laterally flanged proximal ossicles with large synarthrial tubercles. Of the other two species of *Perometra*, both of which do have only 10 arms, *diomedeae* usually lacks P_a and the single known specimen of *pusilla* has only XV cirri. Both these species have the outer segments of P_1 lacking the spinous flared distal ends developed conspicuously by *robusta*.

Genus ERYTHROMETRA A. H. Clark*

Antedon (part) A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 146.

Cyllometra (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, part 3, 1907, p. 357.

Erythrometra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 126 (diagnosis; type species *Antedon ruber* A. H. Clark, 1907), p. 134 (pinnulation), p. 136 (referred to Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Antedonidae, restricted), p. 212 (occurs in Japan), p. 316; Amer. Nat., vol. 42, No. 503, 1908, p. 725 (color); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to Perometrinae); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 10 (represented in West Indies by *Hypalometra*); Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (characteristic of Japanese fauna; significance); Crinoids of the Indian Ocean, 1912, p. 9 (does not occur in area of maximum intensity of the East Indian fauna), p. 10 (confined to Japan), p. 17 (only known from Japan), p. 26 (confined to southern Japan; 55–105 fms.), p. 61 (in key), p. 233 (original reference; type); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 16 and following (phylogenetical study); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to Perometrinae); No. 16, p. 507 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 234 (in key; range), p. 235 (key to the included species).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 140; Ark. Zool., vol. 19, No. 32, 1928, p. 12; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.

Diagnosis.—The elements of the IBr series and lower brachials are never in close lateral contact with and flattened against their neighbors; the borders of these ossicles are always more or less tubercular; the interradial and interbrachial portions of the perisome bear numerous prominent rounded calcareous nodules, which are not in lateral contact; and P_a is usually absent. The 10 arms are up to 60 mm. long.

The most characteristic feature of the species of this genus is the occurrence of numerous conspicuous interradial and interbrachial plates. The color in life seems to be always red or orange.

Type species.—*Antedon ruber* A. H. Clark, 1907.

Geographical range.—From the Moluccas and Kei Islands north to southern Japan.

Bathymetrical range.—From 100 (?95) to 274 meters.

Thermal range.—From 11.11° C. to 15.89° C.

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* See footnote on p. 457.

KEY TO THE SPECIES OF ERYTHROMETRA

[See note by A.M.C., p. 475]

a^1. Cirri with 36–39 segments, 18 mm. long; arms 60 mm. long (Moluccas and Kei Is.; 239–245 meters). **australis** (p. 474)

a^2. Cirri with 30 segments, 10–11 mm. long; arms 25–35 mm. long (southern Japan; 100 [?95]–274 meters) ---------- **rubra** (p. 475)

ERYTHROMETRA AUSTRALIS A. H. Clark

[See vol. 1, pt. 2, fig. 773, p. 362]

Erythrometra australis A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 235 (in key; range; detailed description; *Albatross* sta. 5617).

Diagnostic features.—When the arms are 60 mm. long, the cirri have 36–39 segments.

Description.—The centrodorsal is hemispherical, the small bare dorsal pole covered with closely set rounded tubercles.

The cirri are about XXX, 36–39, 18 mm. long, decreasing to 4 mm. long, with about 15 segments near the dorsal pole of the centrodorsal. In the long peripheral cirri the first two segments are more than twice as broad as long, the third is slightly broader than long, the fourth is from a third to a half again as long as broad, the fifth and sixth are about twice as long as broad, and the following gradually decrease in length to the fourteenth, which is about as long as broad, and still further to the last dozen or so, which are about twice as broad as long. The longer earlier segments are rather strongly constricted centrally, with prominent ends. The distal dorsal border of the proximal segments is prominent, and as the segments become shorter they gradually develop a prominent median carination, the crest of which is convex in profile.

The radials extend slightly beyond the rim of the centrodorsal; their distal border is abruptly everted, smooth or more or less tubercular. The IBr_1 are approximately oblong, between 3 and 4 times as broad as long, with the proximal and distal edges prominently everted and the lateral edges bearing from 4 to 6 long blunt tubercles. The IBr_2 (axillaries) are rhombic, not quite twice as broad as long, with the proximal and distal edges everted and the lateral angles produced into a ventrolateral process, or bearing 2 long blunt tubercles resembling those on the lateral borders of the IBr_1. Usually the sides of adjacent IBr_1 diverge at an angle of about 60°, and the lateral angles of the axillaries nearly meet above the gap thus formed.

The 10 arms are about 60 mm. long. The first brachials are short, twice as long exteriorly as interiorly, the median length approximately the same as the inner; the inner edges are in apposition, and the outer bear a rather broad thin ventrolateral process, and at the distal angle a tubercle. The proximal and the outer half of the distal edges are thickened and everted. The second brachials are irregularly quadrate, twice as broad as long, with the proximal border slightly everted; the proximal inner and outer angles usually bear a tubercle. The first syzygial pair (composed of the third and fourth brachials) is slightly longer interiorly than exteriorly, and half again as broad as the median length. The next two brachials are roughly oblong, and those following become triangular, about as long as broad, and after the basal third of the arm wedge-shaped and elongate distally. The distal edges of the brachials are rather prominent and finely spinous; their dorsal surface is longitudinally striate.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

The interradial portions of the perisome of the disk bear numerous calcareous concretions subequal in size which are entirely and rather widely separated from each other, and are elevated above the general surface in the shape of thick papillae.

P_1 is relatively large and stout and recalls P_2 in certain varieties of *Oligometra serripinna;* it is 6 mm. long and is composed of 12 segments, of which the first is about as long as broad and the remainder are about half again as long as broad; the outer distal borders of the segments are everted and finely spinous. P_2 is 3 mm. long with 10 segments; it resembles P_1 but is proportionately smaller and the outer segments have a greater development of spines. P_3 is 3 mm. long with 10 segments, more slender than P_2, the component segments more elongate with more strongly everted and more spinous distal ends. The following pinnules resemble P_3, but slowly increase in length. The distal pinnules are 7 mm. long, very slender, with 19 segments, of which all but the first two are greatly elongated with swollen articulations and overlapping and spinous distal ends.

P_a is absent from 7 arms, and present on 3.

Color in life.—According to a note by Mr. F. M. Chamberlain, the color in life is pale orange and yellow.

[NOTE BY A.M.C.] A manuscript record written by Mr. Clark is of a small specimen taken by the Danish Expedition to the Kei Islands, with arms 25 mm. long and with the longest cirri measuring 10 mm. in length with 28 segments. Since the known specimens of *E. rubra* have the arms 25 to 35 mm. long and the cirri 10 mm. with up to 30 segments, the characters used in the key for distinguishing *australis* and *rubra* are obviously of little use in dealing with specimens of comparable size. The differences in proportions of the various ossicles are probably explicable by the different sizes of the type specimens and it seems to me most likely that the Japanese and East Indian specimens will prove to be conspecific when more material has been taken.

Locality.—*Albatross* station 5617; Moluccas; Dodinga Bay, Gilolo Island; Ternate Island (S.E.) bearing S. 45° W., 7 miles distant (lat. 0°49′30″ N., long. 127°25′30″ E.); 239 meters; November 27, 1909 [A. H. Clark, 1918] (1, U.S.N.M., 36050).

Danish Expedition to the Kei Islands, sta 41; 245 meters; April 25, 1922 (1, C.M.).

Geographical distribution.—Recorded only from the Moluccas and Kei Islands.

Bathymetrical range.—Recorded from 239 and 245 meters.

ERYTHROMETRA RUBRA (A. H. Clark)*

FIGURE 22

[See also vol. 1, pt. 1, figs. 288 (p. 262), 504 (p. 371); pt. 2, figs. 87, 88 (p. 53), 666, 667 (p. 329), 753 (p. 349)]

Antedon ruber A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 146 (description; *Albatross* sta. 4894).

Cyllometra ruber A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 357 (listed).

Erythrometra ruber A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 127 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 316 (Sagami Bay); Vid. Medd. Nat. Foren. København, 1909, p. 190 (south of the Goto Is., 105 fms.; description of a specimen); Crinoids of the Indian Ocean, 1912, p. 233 (synonymy; southern Japan, 55–105 fms.); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 179 (range in eastern Asia); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918,

*Utinomi and Kogo (see Addenda for 1965) have good figures of a japanese specimen, including a cirrus with 29 segments.

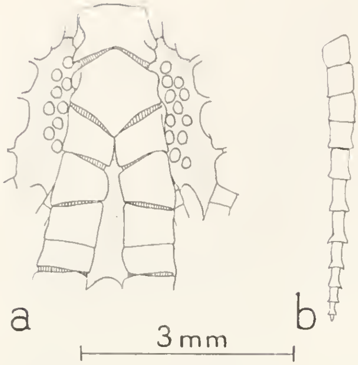

FIGURE 22.—*Erythrometra rubra* (A. H. Clark), U.S.N.M., 35642, *Albatross* station 3755: *a*, Postradial series; *b*, P_1.

p. 235 (in key; range), p. 236 (references).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 141, 142; figs. 150–152, p. 146.

Erythrometra rubra GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 140 (Bock sta. 11; Sp. 2, but not Sp. 1 and 3, which are young *Perometra diomedeae);* Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (sta. 9; 162 meters), footnote 1 (of Gislén, 1922, in part=*Perometra diomedeae*), p. 48 (sta. 9; notes), p. 68 (listed); fig. 60, p. 44.

Diagnostic features.—The arms are not known to exceed 35 mm. in length, and the cirri have up to 30 segments.

Description.—The centrodorsal is small, sub-conical to almost hemispherical, almost entirely covered with well-defined cirrus sockets, of which about the periphery there are 3 beneath each radial. The apex bears some low papillae.

The cirri are XX–XXXII, 28–30, 10 mm. long, the apical cirri being much shorter with about half the number of segments. In the peripheral cirri the first segment is short, the second is about as long as broad, the third and fourth, which are the longest, are about twice as long as broad, and the following slowly diminish in length, becoming about as long as broad after the eleventh or twelfth. After the fourth or fifth the distal border on the dorsal side begins to rise somewhat, this elevation progressively occupying more and more of the dorsal surface of the segment, and after the fifteenth or sixteenth, occupying the entire dorsal surface and appearing regularly convex in profile so that the dorsal profile of the distal half of the cirri appears to be deeply lobed. These elevations are broad transversely, occupying the entire dorsal surface of the segments. The opposing spine is prominent, terminally situated, in length about equal to the width of the penultimate segment. The terminal claw is rather longer than the penultimate segment, and it is rather strongly curved.

The interradial perisomic areas carry several columns of rather small rounded plates, and there is a single column of 4 or 5 similar plates between the 2 arms of each pair.

The radials are prominent, projecting almost horizontally beyond the rim of the centrodorsal. The IBr_1 are short, about two and a half times as broad as long, with the distal border moderately concave, and the lateral borders straight with a much broadened single tubercle, or sometimes 2 or 3 tubercles, at the anterolateral angles. The IBr_2 (axillaries) are rhombic, broader than long, with a rounded posterior process incising the IBr_1; the lateral edges are somewhat produced into a rounded flange-like process, these processes on adjacent IBr_2 being almost or quite in apposition.

The 10 arms are from 25 to 35 mm. long. The first brachials are wedge-shaped, nearly twice as long outwardly as inwardly, interiorly united for most of their length. The second brachials are larger and irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is about as long as broad, with the sides somewhat concave. The fifth and sixth brachials are oblong, not quite twice as broad as long, and those following are wedge-shaped, about as long as broad, gradually becoming more elongate distally, the terminal brachials being twice as long as broad or even longer with almost parallel ends and swollen articulations.

Syzygies occur between brachials 3+4, 9+10, and 14+15 (the last 2 somewhat irregular) and distally at intervals of 2 muscular articulations. The arm width at the first syzygy is 0.8 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 6.5 mm. in the specimen from *Albatross* station 3755, Sagami Bay.

P_1 is 4 mm. long, moderately stout and evenly tapering, composed of 12 segments, of which the first is about as long as broad and the remainder about twice as long as broad, the terminal rather longer; from the third onward the segments have the distal ends everted, somewhat overlapping, and armed with small spines, this feature becoming progressively more pronounced distally. P_a is absent. P_2 is similar to P_1 but shorter and rather less stout, with the component segments proportionately slightly less elongate. P_3 to P_{10} are similar, but the first two segments are about as long as broad and there is a long gonad on the third to sixth segments. The following pinnules gradually increase to 6 mm. in length with about 12 segments, of which the first is short, the second is trapezoidal and about as long as its basal width, and the remainder are much elongated with swollen articulations.

Notes.—The specimen secured by Captain Suensson had the arms 25 mm. and the cirri 5 mm. in length.

In the specimen recorded by Dr. Torsten Gislén in 1922 the cirri were XXXII, the peripheral 7 mm. long with 25–28 segments, and the apical 2.5 mm. long with 15–16 segments. The IBr_1 had 3 small tubercles on either side. P_1 was 3.5 mm. long with 9 segments of which the distal had slightly produced and slightly spinous distal ends. P_2 was 2.5 mm. long with 8 segments, similar to P_1. P_3 was about as long as P_2, and was composed of 9 segments. P_a was absent. The disk bore large calcareous granules, and there were also interbrachial granules. The color was salmon red, the cirri white.

In 1927 Dr. Gislén described another specimen which had about XXV cirri with 20–27 segments and measuring 6–8 mm. in length. The IBr_1 was half as long as wide, the IBr_2 (axillary) two thirds as long as wide. There was hardly any synarthrial thickening. The syzygial interval was 3 muscular articulations. P_1 with 8 segments was 2.5 mm. long; P_2 with 8 segments was 2.2 mm. long; P_3 also with 8 segments was 2.3 mm. long and bore a gonad. P_b with 7 segments was 1.5 mm. long. The distal segments had spiny crowns distally. The disk diameter was 2.5 mm. and there were coarse interradial calcareous granules. The arm bases were well separated laterally.

Localities.—*Albatross* station 4894; southwest of the Goto Islands; Ose Saki Light bearing N. 41° E., 5 miles distant (lat. 32°33′00″ N., long. 128°32′10″ E.); 173 meters;

green sand, broken shells and pebbles; August 9, 1906 [A. H. Clark, 1907] (4, U.S.N.M., 22643, 36143, 36288). Type locality.

Albatross station 4895; southwest of the Goto Islands; Ose Saki Light bearing N. 42° E., 4.7 miles distant (lat. 32°33′00″ N., long. 128°32′10″ E.); 173 meters; green sand, broken shells and pebbles; August 9, 1906 (2, U.S.N.M., 35641).

South of the Goto Islands (lat 32°02′ N., long. 128°45′ E.); 192 meters; Captain Suensson, May 12, 1898 [A. H. Clark, 1909] (1, C.M.).

Near the Goto Islands (lat. 32°20′ N., long. 128°15′ E.); 201 meters; temperature 11.11° C. (1, C.M.).

Eighty miles west of Nagasaki (lat. 32°15′ N., long. 128°20′ E.); 274 meters; temperature 12.78° C. (1, C.M.).

Dr. Sixten Bock's Expedition to Japan, 1914, station 11; Goto Islands, Kiu Shiu; Pallas Rock 5 miles S. by E.; 164 meters [Gislén, 1922].

Albatross station 4935; Eastern Sea, off Kagoshima Gulf; Sata Misaki Light bearing N. 58° E., 4.5 miles distant (lat. 30°57′20″ N., long. 130°35′10″ E.); 188 meters; temperature 15.89° C.; stones; August 16, 1906 (1, U.S.N.M., 35643).

Albatross station 3755; Sagami Bay, Japan; Suno Saki bearing S. 63° E., 3.6 miles distant; 95–141 meters; gray sand and coral; May 19, 1900 (1, U.S.N.M., 35642).

Golden Hind; Sagami Bay (lat. 34°59′ N., long. 139°34′ E.); 100 meters; Alan Owston, April 23, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 35640).

Dr. Th. Mortensen's station 9; off Kiu-Shiu, Japan; 162 meters [Gislén, 1927] (1, C.M.).

Geographical range.—Southern Japan, from Kiu-Shiu to Sagami Bay.

Bathymetrical range.—From 100 (?95) to 274 meters; the average of 10 records is 169 meters.

Thermal range.—From 11.11° C. to 15.89° C.; the average of 3 records is 13.26° C.

Remarks.—This species was originally described in 1907 from specimens taken by the *Albatross* in the vicinity of the Goto Islands in the preceding year. In 1908 it was recorded from the dredgings of Mr. Alan Owston's yacht, the *Golden Hind*, in Sagami Bay. In 1909 it was again recorded, this time from the investigations of Captain Suensson in the vicinity of the Goto Islands.

In 1922 Dr. Torsten Gislén recorded 3 specimens from near the Goto Islands where they had been dredged by Dr. Sixten Bock in 1914. Of these 3 specimens, as he was so good as to write me, only the second really belongs to this species, the other 2 being young examples of *Perometra diomedeae.*

In 1927 Dr. Gislén recorded a further specimen from Dr. Th. Mortensen's collections off Kiu-Shiu in 162 meters.

Genus NANOMETRA A. H. Clark

Antedon (part) A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 148.

Nanometra A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 348 (diagnosis; type species *Antedon minor* A. H. Clark, 1907); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 246 (same); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 136 (referred to Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Antedonidae, restricted), pp. 212, 318 (occurs in Japan); Amer. Nat., vol. 42, No. 500, 1908, p. 541 (only known from the Indo-Pacific region), No. 503, p. 724 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 602 (characteristic of Indo-Pacific region); Vid. Medd. Nat. Foren. København, 1909, p. 193 (probably occurs at Singapore, though not yet discovered there); Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (characteristic of the Japanese fauna; significance); Crinoids of the Indian Ocean, 1912, p. 17 (only known from southern Japan), p. 62 (in key), p. 241 (original reference; type); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to Perometrinae); No. 16, p. 507 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 234 (in key; range), p. 236 (key to the included species).—H. L. Clark, Echinoderm fauna of Australia, 1946, p. 60 (in key), p. 61 (type species; mainly East Indian genus).

Diagnosis.—A genus of Perometrinae in which P_1 and P_2 are always present; the elements of the IBr series and the first 2 brachials may be laterally just in contact with their neighbors, but their sides are never sharply flattened; their lateral borders always bear tubercles, one or many to each ossicle, and their distal and proximal borders are usually prominently everted and tubercular; prominent synarthrial tubercles are not developed; and the interradial and interbrachial portions of the perisome are without calcareous nodules.

Type species.—*Antedon minor* A. H. Clark, 1907, preoccupied; a synonym of *A. bowersi* A. H. Clark, 1907.

Geographical range.—From southern Japan, the East Indies, and southeast Australia.

Bathymetrical range.—From 122 to 1040 meters.

Thermal range.—From 9.67° C. to 13.33° C.

KEY TO THE SPECIES OF NANOMETRA

a^1. Segments of the proximal pinnules smooth, slightly tapering.
- b^1. Centrodorsal broadly truncated with a wide, nearly flat dorsal pole; cirri about LXX; P_1 with 14–20 segments (Kei Islands, northern Celebes and the Moluccas; 204–1040 meters). **clymene** (p. 479)
- b^2. Centrodorsal conical, the dorsal pole small; cirri up to L; P_1 with about 10 segments (southern Japan; 254–349 meters) **bowersi** (p. 483)

a^2. Segments of the proximal pinnules with conspicuously spinous distal ends (Tasmania and Bass Strait; 122–174 meters) **johnstoni** (p. 485)

NANOMETRA CLYMENE A. H. Clark

FIGURE 23

Nanometra clymene A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 143 (description; *Siboga* sta. 253); Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationship with *N. bowersi*), p. 237 (in key; range; detailed description; stas. 173, 251, 253, 254), p. 274 (listed), pl. 26, fig. 84.

Diagnostic features.—The centrodorsal is broadly truncated with a wide, more or less flat, dorsal pole; the cirri are about LXX when the arms are 70–120 mm. long; P_1 has 14 to 20 segments which are smooth and slightly tapering.

Description.—The centrodorsal is truncated conical, 3.3 mm. in diameter at the base and 2.6 mm. in vertical height; the bare almost flat dorsal pole is 2.0 mm. in diameter. The cirrus sockets are arranged in 4 or 5 closely crowded regularly alternating rows, or 4 closely crowded alternating columns in each radial area.

The cirri are about LXX, 43–47, from 25 to 30 mm. long, moderately slender. The first segment is very short, the second is about twice as broad as long or even somewhat broader, the third is nearly as long as broad, the fourth is about a third again as long as broad, the sixth to eleventh or twelfth are about twice as long as broad; the following segments gradually decrease in length so that the last 10 or 11 before the

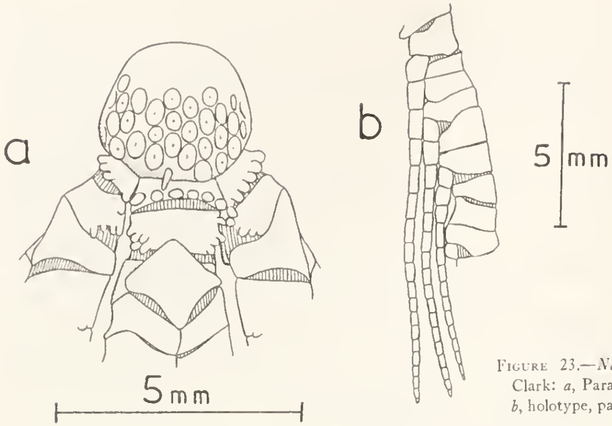

FIGURE 23.—*Nanometra clymene* A. H. Clark: *a*, Paratype, *Siboga* station 251; *b*, holotype, part of arm with P_1 to P_3.

penultimate are twice as broad as long. On the fourth and following segments the distal dorsal edge projects slightly, this on the short outer segments becoming a prominent median carination with a convex profile occupying the entire dorsal surface of the segments.

The ends of the basal rays are visible as rather prominent rounded triangular areas in the angles of the calyx.

The radials are rather prominent, and are nearly as long in the median line as laterally. The plane of their middorsal line makes an angle of almost 90° with the dorsoventral axis. The IBr_1 are 4 times as broad as long in the median line; the lateral edges are from a third to a half again as long as the median length, strongly convergent, continuing in the same direction as the lateral portion of the distal border of the radials on either side; the median third of the proximal border is slightly convex; the distal border is deeply incised by a posterior rounded projection from the axillary; the distal half of the lateral borders is produced in the form of a prominent tubercular process. The IBr_2 (axillaries) are about as broad as long, with the anterior angle slightly produced and the anterior sides making approximately a right angle with each other; a strong rounded posterior process extends to about the same distance below the line passing through the two lateral angles that the anterior angle reaches above it; just below the lateral angles there is a prominent tubercular process; the distal edges, like the lateral portions of the distal edge of the IBr_1, are bordered with exceedingly fine spines. The synarthrial tubercles, though broadly rounded, are rather prominent.

The 10 arms are 120 mm. long. The first brachials are short, three times as long exteriorly as interiorly, slightly longer in the median line than interiorly; the interior borders are in apposition; the outer borders are slightly concave; the distal inner corners bear a rudimentary tubercle similar to that on the outer part of the lateral borders of the IBr_1. These tubercles on the IBr_1, with the adjacent tubercles under the lateral angles of the axillaries, almost close what otherwise would be a large rhombic water pore. The second brachials are much larger than the first, in direct dorsal view almost equilateral triangles; the outer border is slightly concave, and the distal edge is slightly spinous. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, about twice as broad as long in the median line, the sides slightly concave, the distal edge very finely spinous. The following brachials rapidly become obliquely wedge-shaped, after the second syzygy triangular and as long as broad with very finely spinous edges, and later obliquely wedge-shaped again. The brachials have projecting and overlapping finely spinous distal edges, and their dorsal surface is marked with fine parallel longitudinal ridges.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 4 (more rarely 3) muscular articulations. The width at the first syzygy is 1.9 mm. and the length from the IBr_1 to the second syzygy is 11.5 mm.

P_1 is from 12 to 13 mm. long and is composed of 19 or 20 segments, of which the first is slightly longer than broad, the second is about half again as long as broad, the third is about twice as long as the proximal breadth, and the fourth and following are about two and a half times as long as broad. P_1 is the longest pinnule on the arm, though it is only slightly longer than the distal pinnules; it is smooth with long segments, rather stiff and moderately stout, tapering moderately in the proximal third, more gradually from that point onward. In its general appearance, especially in the very close union of its component segments, it recalls P_1 in the larger species of *Psathyrometra.* P_2 is from 10.0 to 10.5 mm. in length with 17 segments, similar to P_1 but tapering rather more evenly. P_3 is 8 mm. long with 13 or 14 segments, similar to P_1 and P_2, but with the segments more enlarged distally, and proportionately smaller. P_4 is 5.5 mm. long with 12 or 13 segments, similar to P_3 but with the distal segments slightly more elongated. P_5 is 5.5 mm. long, resembling the preceding pinnule but more slender, with 12 or 13 segments, of which the distal are more elongated. P_6 is 7 mm. long with 15 segments, longer, less slender, and less stiff than those preceding. The distal pinnules are exceedingly slender, from 11 to 12 mm. long, with 23 segments, of which the first two are usually enlarged and the following are moderately elongate with swollen articulations and finely spinous ends.

Notes.—In a specimen from station 59 of the Danish Expedition to the Kei Islands, the centrodorsal is large, a rather broadly truncated cone with swollen sides 4.5 mm. in basal diameter and 3.5 mm. high, viewed radially. The dorsal pole, which is about 2 mm. in diameter, is rather deeply concave. The sides are completely covered with closely set cirrus sockets.

The cirri are LXX, 39–47.

The radials are visible as a narrow band beyond the rim of the centrodorsal. Their distal border forms a very broadly obtuse angle with a round apex in the median line, and is somewhat produced.

The IBr_1 have strongly convergent sides and are deeply incised in the median line. The lateral portions bear a small group of short, blunt, stumplike spines, and the median line is rather strongly elevated and broadly rounded.

The IBr_2 (axillaries) are rhombic, about as long as broad, with a strong rounded posterior process deeply incising the IBr_1, and a sharp and acute distal angle. The outer portion of the proximal border, within the sharp lateral angle, bears an abrupt flangelike extension or a row of tubercles.

The arms are about 70 mm. long.

P_1 is 10 mm. long with 14 to 15 segments. The first segment is slightly longer than broad at the base with very slightly divergent sides; the second segment is half again as long as broad at the base and more than twice as long as broad at the distal end; the sides are rather strongly convergent in the proximal half, becoming parallel in the distal half. From the distal end of the second segment the pinnule tapers slowly and gradually to the tip, which is moderately slender, but not flagellate. The third segment is twice as long as broad and the sixth and following are from two and a half to three times as long as broad.

P_2 is 8 mm. long with 12 segments, resembling P_1 but slightly less stout basally.

P_3 is 6.5 mm. long with 12 segments, resembling P_2 and scarcely or not at all less stout basally than P_2 but becoming more slender in the distal portion.

P_4 is 5 mm. long with 11 to 12 segments, less stout basally than P_3 and becoming very slender in the distal half. The distal ends of the segments are slightly produced and finely spinous, this feature becoming conspicuous in the outer half.

[Note by A.M.C.] The paratype from *Siboga* station 251 also has a development of stumplike spines on the proximal ossicles but, besides those on the lateral parts of the IBr_1, there is a row of about six along the edge of each radial (see fig. 23,*a*). The centrodorsal is 3.0 mm. in diameter and 2.6 mm. high in this specimen and the arm width at the first syzygy is 1.3 mm.

Localities.—*Albatross* station 5629; west of Halmahera (Gilolo), Moluccas; south of Patiente Strait, Doworra Island (S.) bearing S. 62° W., 6 miles distant (lat. 0°50′00″ S., long. 128°12′00″ E.); 375 meters; coral sand; December 2, 1909 (1, U.S.N.M., 36020).

Albatross station 5630; west of Halmahera; Doworra Island (N.) bearing N. 3° W., 4.5 miles distant (lat. 0°56′30″ S., long. 128°05′00″ E.); 1040 meters; coral sand and mud; December 2, 1909 (1, U.S.N.M., 36021).

Siboga station 173; between Ceram and northwestern New Guinea (lat. 3°27′00″ S., long. 131°00′30″ E.); 567 meters; fine yellow gray mud; August 28, 1899 (1, Amsterdam Mus.).

Siboga station 251; west of the Kei Islands (lat. 5°28′24″ S., long. 132°00′12″ E.); 204 meters; hard coral sand; December 8, 1899 (4, U.S.N.M., E.394; Amsterdam Mus.).

Siboga station 254; southwest of the Kei Islands (lat. 5°40′00″ S., long. 132°26′00″ E.); 310 meters; fine gray mud; December 10, 1899 (1, Amsterdam Mus.).

Siboga station 253; southwest of the Kei Islands (lat. 5°48′12″ S., long. 132°13′00″ E.); 304 meters; gray clay, hard and crumbly; December 10, 1899 (1, Amsterdam Mus.). Type locality.

Menado Bay, northern tip of Celebes (lat. 1°31′ N., long. 124°47′ E.); 457 meters; Captain Christiansen, Great Northern Telegraph Co.; March 12, 1913 (2, C.M.)

Danish Expedition to the Kei Islands, station 58; 290 meters; May 12. 1922 (1, C.M.)

Danish Expedition to the Kei Islands, station 59; 385 meters; May 12, 1922 (1, C.M.)

Geographical range.—From the Kei Islands to Halmahera (Gilolo) and the northern part of Celebes.

Bathymetrical range.—From 204 to 1040 meters.

Remarks.—This species is known from the seven specimens dredged by the *Siboga* in 1899 and described in 1912 and 1918, besides unpublished records of two others taken in the same region by the *Albatross* in 1909, two in the Copenhagen Museum from the northern end of Celebes and two more from the Kei Islands expedition.

NANOMETRA BOWERSI (A. H. Clark)

[See vol. 1, pt. 1, figs. 310 (p. 269), 390 (p. 307); pt. 2, figs. 106–107 (p. 67)]

Antedon minor A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 144 (description; *Albatross* sta. 4965) [preoccupied by a fossil species].

Antedon bowersi A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 148 (description; *Albatross* sta. 4934).

Antedon orientalis A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 341 (description; *Albatross* sta. 4933), p. 353 (listed).

Nanometra minckerti A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 349 (new name for *Antedon minor* A. H. Clark, 1907, preoccupied).

Nanometra bowersi A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (Japan; considered as including *minor* [*minckerti*] and *orientalis*); Crinoids of the Indian Ocean, 1912, p. 241 (synonymy; includes *minor, bowersi, orientalis* and *minckerti;* southern Japan, 103–191 fms.); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. ix (relationship with *N. clymene*), p. 237 (in key; range), p. 239 (synonymy); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 1, fig. 10 (proximal portion).

Diagnostic features.—The centrodorsal is conical with a small dorsal pole; the cirri are not very numerous, XXX–L, with 30–45 (usually 35–40) segments, when the arms are from 40 to 50 mm. long; P_1 has 8 to 10 smooth, cylindrical segments; the distal borders of the radials and the borders of the elements of the division series are prominently everted and finely tubercular or spinous.

Description.—The centrodorsal is conical, low to (usually) more or less elongated, and is almost completely covered with cirrus sockets of which about the periphery there are 3 beneath each radial.

The cirri are XXX–L, 30–45, from 13 to 15 mm. long; the cirri immediately about the very small dorsal pole are from 3 to 4 mm. long with 12 to 15 segments. In the long peripheral cirri the first segment is short, the second is about as long as broad, the third is about half again as long as broad, and the fourth to ninth or tenth are about twice as long as the greatest (terminal) width; after the tenth the segments gradually decrease in length, the twenty-first being about as long as broad and the last 10 to 16 broader than long. The elongated proximal and middle segments have expanded articulations, this gradually giving way to a somewhat trapezoidal shape, the segments increasing in width from the proximal to the distal end and bearing a slight projection dorsally on the distal end which soon develops into a low spine arising from the entire dorsal surface of the segment. The opposing spine is terminal in position, arising from the entire dorsal surface of the penultimate segment, stout, and not quite so long as the width of the segment. The terminal claw is stout, strongly curved, and about as long as the penultimate segment. The apical cirri are very slender and almost filiform with elongated segments and much swollen articulations; there are no dorsal spines, but the opposing spine is well developed.

The radials are rather prominent and rather strongly concave distally, smooth, or furnished with two, three or four large blunt teeth along their distal borders. The IBr_1 are about three times as broad as long, rising in the middle of the distal border to form a rounded tubercle with the IBr_2; their edges are more or less fringed with coarse, short, blunt spines which are, however, sometimes almost entirely lacking; these are usually most prominent in the interradial angles. The IBr_2 (axillaries) are triangular, about half again as broad as long, with the median part of the posterior border rising into a low rounded tubercle with the IBr_1; the borders all around are everted and somewhat prominent. Typically the elements of the IBr series are in close apposition and more or less flattened against each other laterally, but this feature is not very evident in young individuals.

The 10 arms are from 45 to 50 mm. long. The first brachials are wedge-shaped, about twice as long exteriorly as interiorly, concave distally where they are incised by a posterior projection from the second brachials, which are irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is rather broader than long. The fifth brachial is very slightly wedge-shaped, those following rapidly becoming more so, and after the eleventh being very obliquely quadrate, almost triangular, rather longer than wide. Distally the length of the brachials increases, the terminal being almost oblong and much elongated.

Syzygies occur between brachials 3+4, 9+10 to 14+15 (usually nearer the former) and distally at intervals of from 4 to 6 (usually 5) muscular articulations.

P_1 is the longest pinnule, and is somewhat stouter than those following. It is about 4 mm. long and is composed of 8 to 10 segments of which the first is about as long as broad, the second is about half again as long as broad, and those following become progressively elongated. The pinnule tapers evenly from the base to the tip. P_2 is about 2 mm. long, with 6 or 7 segments, of which the first is about as long as broad, the second is rather longer than broad, and the remainder are elongated. The first two segments are slightly broader than the others. P_3 is similar, but slightly shorter. The following pinnules increase in length, and the articulations become rather prominent. The distal pinnules are about 5 mm. long, with about 12 segments, of which the first is not so long as broad, the second is rather longer than broad and somewhat trapezoidal, the third is between two and three times as long as broad, and the remainder gradually become more elongated; the first two segments are slightly broadened, and the articulations between those from the third onward are somewhat swollen.

Localities.—Albatross station 4900; southwest of the Goto Islands; Ose Saki Light bearing N. 10° E., 8 miles distant (lat. 32°28′50″ N., long. 128°34′40″ E.); 254 meters; temperature 11.61° C.; gray sand and broken shells; August 10, 1906 (1, U.S.N.M., 35880).

Albatross station 4933; Eastern Sea, off Kagoshima Gulf; Sata Misaki Light bearing N. 84° E., 8.5 miles distant (lat. 30°59′00″ N., long. 130°29′50″ E.); 278 meters; temperature 13.33° C.; rocky bottom; August 16, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 22663).

Albatross station 4934; Eastern Sea, off Kagoshima Gulf; Sata Misaki Light bearing N. 77½° E., 7 miles distant (lat. 30°58′30″ N., long. 130°32′00″ E.); 188–278 meters; rocky bottom; August 16, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 22641). Type locality.

Albatross station 4965; near Kobe, Japan; Hiro Misaki Light bearing N. 20° W., 18.5 miles distant (lat. 33°35′20″ N., long. 135°10′50″ E.); 349 meters; temperature 9.67° C.; dark green-gray sand and shells; August 28, 1906 [A. H. Clark, 1907] (3+, U.S.N.M., 22638, 36034, 36191).

Geographical range.—Southwestern Japan, from the Goto Islands to the vicinity of Kobe.

Bathymetrical range.—From 254 (?188) to 349 meters; the average of 4 records is 269 meters.

Thermal range.—From 9.67° C. to 13.33° C.; the average of 3 records is 11.53° C.

Remarks.—This species was described under no less than 3 different names in 1907, and in addition had a fourth bestowed upon it to replace the first, which was found to be preoccupied. In 1908 the identity of all these supposed species was discovered, and in a list of the crinoids of Japan the name *bowersi* was used as including *minor, orientalis* and *minckerti,* although that fact was not specifically stated.

NANOMETRA JOHNSTONI John

Nanometra johnstoni John, Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, pp. 193–196 (stas. 113 and 115; description; range of the genus); fig. 1, p. 193.—H. L. Clark, Echinoderm fauna of Australia, 1946, p. 61 (notes).

Diagnostic features.—The centrodorsal is rounded conical with a domed dorsal pole; the cirri are XX–XL, with up to 35 segments; P_1 has 10 to 12 segments, which are markedly spinous at their distal ends; the distal borders of the radials and of the IBr series are everted and more or less tubercular or spinous.

Description.—The centrodorsal is large. Its length is nearly equal to its basal diameter. The sides of the proximal two-thirds, which bear the cirrus sockets, are rounded; the distal third, formed of the dorsal pole, is like a separate smaller dome superimposed on the truncated apex of the centrodorsal itself; it is closely beset with tubercles and very rough. The ventral edge of the centrodorsal is produced into low interradial corners. The cirrus sockets are arranged in closely placed, slightly irregular columns, three columns to each radius; two, or more usually, three sockets to each column; the sockets of adjacent columns alternate with one another.

The cirri are about XL, 24–35, up to 10 mm. long. The apical are much shorter and slighter than the peripheral. The longer cirri have the first two segments shorter than broad, the second longer than the first. The third to about the fourteenth are longer than broad. The third is one and a half times as long as broad; the fourth and fifth are twice, the sixth and seventh nearly twice, as long as broad and the following ones are progressively shorter. From about the fifteenth, the segments are broader than long. The dorsal and ventral edges of the third segment are moderately concave; those of the fourth are slightly so. The distal ends of the fifth to twelfth segments are a little wider than the proximal. Beyond the twelfth segment a strong dorsal keel, occupying almost the whole dorsal edge and having a rounded outline, is developed, so that the distal end of these segments is considerably wider than the proximal. The keel is lower on the three to four segments before the penultimate. The opposing spine is hyaline, triangular and very strong and stands out at right angles from the penultimate segment. The terminal claw is short and curved.

The radial is short, about seven times as broad as long, with a concave distal edge. The middle point of the distal edge of some radials, but not of all, is raised into a strong high tubercle.

The IBr_1 is two-fifths as long as broad. The proximal edge is straight and slightly wider than the distal, which is also nearly straight, since it is not deeply incised by the axillary. Strong tubercles arise from the surface, of which there are two on each side of the distal edge, one where the dorsal surface meets the lateral, the other on the lateral corner. In most cases there is a third pair of tubercles proximal to, but slightly outside the dorsolateral ones. The IBr_1 are not in apposition.

The IBr_2 (axillary) is slightly wider than long. Its posterior angle is very obtuse, its anterior acute. The anterolateral borders are nearly straight. They are strongly everted into a frilled spinous edge. The whole dorsal surface of the ossicle is hollowed. There are two or three tubercles on each side near the lateral corners.

There is a single IIBr series which is composed of two ossicles, which bear no tubercles. The first is shaped like the first brachial of an undivided arm, the second (the axillary), like an axillary of the first division series, except that its proximal edge is nearly straight.

The first brachial is unusual and irregular in shape. The interior edge is much shorter than the exterior. It is not straight, its proximal half being in contact with that of its neighbor while the distal half diverges strongly. The distal edge is nearly straight, not incised by the second brachial, but it lies obliquely across the arm. The lateral edge is irregular; its proximal part is produced laterally and posteriorly into a flange. There may be a strong tubercle on the proximal lateral corner and another on the distal lateral corner.

The second brachial is as long as broad and slightly wider distally than proximally. Its distal edge lies straight across the axis of the arm. The first syzygial pair is as long as its greatest proximal width. The interior edge is slightly longer than the exterior. The hypozygal is considerably wider and longer than the epizygal.

All but one of the 11 arms are broken off at the first syzygy, which is 1.4 mm. wide. The remaining arm is of 11 brachials. The fifth and sixth brachials are roughly oblong, a little longer than broad and constricted in the middle. The second syzygial pair, 7+8, is considerably longer than broad. The epizygal is longer than the hypozygal; its distal border runs obliquely across the arm. The ninth and tenth brachials are triangular and considerably longer than broad. The last remaining brachial is a hypozygal. The distal edges of the brachials are everted but not spinous.

P_1 is stout and stiff, of 12 segments and 4 mm. long. The first segment is of an irregular shape and about as long as broad. The following segments are regular, half again to twice as long as broad, with slightly swollen and strongly spinous distal edges. The last three or four taper rapidly to a point.

P_a is shorter, slighter and more evenly tapered than, but otherwise similar to, P_1. It is of 10 segments and 3 mm. in length.

Notes.—Of the four paratypes, the largest is like the type. There are from 15 to 25 cirrus segments. The tubercles on the division series and first brachials are not so well-developed, but their distal edges are strongly spinous. All the arms are broken at the first syzygy. A row of purplish spots, usually two to each ossicle, runs down the side of each arm. There are similar spots on the first pinnules and some of the proximal cirrus segments.

Another specimen has the centrodorsal much more rounded and shorter than in the holotype, with the dorsal pole flattened. It also has purplish spots on the sides of the arms and division series.

A third but younger paratype has the cirri XX, 19–28, arranged in two alternating rows so that there are four in each radius. The dorsal pole of the centrodorsal is beset with high tubercles. The radials and IBr series are relatively longer than in the holotype. They do not have so many tubercles. Six arms are complete to or beyond the second syzygy, which is 9+10; some are broken at the third syzygy, which is 12+13 and one at the fourth, which is 15+16. P_1 is of 10 segments, 3 mm. long. It tapers more rapidly than in the holotype. The distal edges of the outer segments are produced into very strong spines. P_2 is similar but smaller, with 8 segments and less than 2 mm. long. P_3 is a genital pinnule longer than P_2, with 9 or 10 segments and over 2 mm. long.

The remaining specimen is similar in size to the last. The XIX cirri also are arranged in two alternating rows. One arm is complete to the twenty-fourth brachial and shows that the syzygial pairs beyond the third are separated by one brachial. The only two genital pinnules which remain in good condition have their third and fourth segments expanded from side to side and raised into a keel in the midline. The sex of these last two specimens was not determined.

Localities.—B.A.N.Z.A.R.E. station 113; off Tasmania (lat. 42°40′ S., long. 148° 27′30″ E.); dredge, 174–155 meters; otter trawl, 122 meters; March 23, 1931 [John, 1939] (2 including holotype, B.M.; 2, Austral. M.). Type locality.

B.A.N.Z.A.R.E. station 115; Bass Strait (lat. 41° 03′ S., long. 148°42′ E.); 128 meters; March 24, 1931 [John, 1939] (1, B.M.)

Geographical range.—Known only from the Bass Strait between Australia and Tasmania.

Bathymetrical range.—From 122 to 174 meters.

Genus HYPALOMETRA A. H. Clark

Antedon (part) P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, pp. 155, 164, and following authors.

Hypalometra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 133 (diagnosis; type species *Antedon defecta* P. H. Carpenter, 1888), p. 136 (referred to Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to Antedonidae, restricted), p. 212 (occurs in the West Indies); Amer. Nat., vol. 42, No. 503, 1908, p. 725 (color); vol. 43, 1909, p. 580 (pinnulation); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to Perometrinae); Proc. U.S. Nat. Mus., vol. 36, 1909, p. 362 (deficient pinnulation, like *Comatilia*); vol. 40, 1911, p. 10 (represented in East Indies by *Erythrometra*); Amer. Journ. Sci., ser. 4, vol. 32 (whole number 182), 1911, p. 129 (characteristic of West Indian fauna; significance); Crinoids of the Indian Ocean, 1912, p. 14 (corresponds to the East Indian *Perometra*); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (represents *Perometra* in the Atlantic; range); Die Crinoïden der Antarktis, 1915, p. 181 (range; represented in the Indo-Pacific by *Perometra*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to Perometrinae); No. 16, p. 507 (in key; range); Unstalked crinoids, of the *Siboga*-Exped., 1918, p. 233 (in key; range), p. 236; Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (confined to West Indies), p. 16 (in key).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 7, 142 (compared with *Hypalometra*).—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 54, 212; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139.

Diagnosis.—A genus of Perometrinae in which P_1 and P_a are absent. The size is small, the arms not exceeding 35 mm. in length. The cirri have 22–25 segments.

Geographical range.—Straits of Florida.

Bathymetrical range.—From 60 to 386 meters.

Thermal range.—From 16.67° C. to 23.33° C.

HYPALOMETRA DEFECTA (P. H. Carpenter)

FIGURE 24

[See also vol. 1, pt. 1, fig. 388 (p. 307); pt. 2, figs. 85–86 (p. 53), 297 (p. 53), 297 (p. 221), 768 (p. 362)]

Antedon, sp. P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No 4, 1881, p. 155 (found with *Antedon* [*Coccometra*] *hagenii*; deficient pinnulation).

Antedon defecta P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 206 (in key), p. 207 (taken by *Blake*), pp. 367, 368 (depths), p. 378 (Caribbean Islands; 77–242 fms.).—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, 1905, Heft 1, p. 171 (syzygies; pinnulation; regeneration).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1580 (listed).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (in *Blake* collection), pp. 381–384 (?loc.; detailed description of two of Carpenter's specimens; discussion), p. 391 (identified with species with deficient pinnulation mentioned in Carpenter, 1881), pl. 6, figs. 1-4, pl. 14, fig. 11.

Hypalometra defecta A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 133 (listed); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 236 (references); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 42, 44, 53.—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 141 (in key), p. 159 (references); Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Description.—The centrodorsal is small, subconical to hemispherical. The cirrus sockets are numerous, usually almost completely covering the centrodorsal though there may be a more or less extensive bare polar area; they are arranged in closely crowded rows which are more or less irregular, and about the rim of the centrodorsal there are approximately 3 sockets beneath each radial.

The cirri are XX–XXX, 22–25 (Hartlaub gives as a maximum about 30), 10 mm. long. The first segment is short, the second is about as long as broad, the third and fourth are the longest, about 3 times as long as broad, and those following gradually decrease in length, the segments in the distal half of the cirri being about as long as broad. The second to fifth segments are constricted centrally with swollen ends; those succeeding broaden gradually from their proximal to their distal ends, the latter overlapping the bases of the following segments. The short segments in the distal third of the cirri sometimes bear more or less well-developed dorsal spines, and sometimes show but slight traces of them. The opposing spine is very prominent, about equal in height to the width of the penultimate segment, of which its base occupies the distal half of the dorsal side; it is rather narrow and very sharp. The terminal claw is rather longer than the penultimate segment, and is rather strongly curved.

The radials are short in the middorsal line but extend well up into the interradial angles where their anterolateral corners are separated by a narrow cleft. The IBr_1 are very short in the median line, but laterally almost as long as broad. The IBr_2 (axillaries) are almost square with the sides somewhat concave, and their proximal projection deeply incises the IBr_1; their lateral angles extend beyond the anterolateral corners of the IBr_1. The IBr series are narrow and laterally well-separated.

The 10 arms are from 25 to 35 mm. (most commonly between 25 and 30 mm.) in length. The first brachials are short, about twice as long on the outer as on the inner side, incised by the second brachials, which are considerably larger and irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is about as long as broad with the ends concave. The fifth to eighth brachials are very slightly wedge-shaped, almost square, those following becoming very obliquely wedge-shaped, longer than broad, and elongate and centrally constricted in the outer two-thirds of

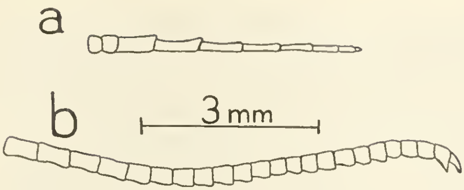

FIGURE 24.—*Hypalometra defecta* (P. H. Carpenter), U.S.N.M., 35658, *Albatross* station 2326: *a*, P_2; *b*, detached cirrus.

the arms. Owing to the relatively great length of the brachials the pinnules are rather widely separated, giving the arms a very characteristic appearance quite different from that of any other of the small comatulids.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 2 muscular articulations.

P_1 and P_a are absent. P_2 (the lowest pinnule) is from 5 to 7 mm. long, slender and evenly tapering, but moderately stiff; it is composed of 10 segments, of which the first two are about as long as broad and the remainder greatly elongated with prominent and somewhat overlapping ends, becoming slightly shorter again distally; the third to fifth segments may bear a more or less elongated gonad. P_3 to P_6 are similar but shorter. The following pinnules become longer again and more slender; they have the first segment short, the second about as long as broad, the third between 2 and 3 times as long as broad, and the following similar, but becoming progressively elongated and very long and slender distally.

Color.—The color in alcohol is white, with usually narrow well-spaced transverse bands of brown on the arms.

Localities.—*Albatross* station 2166; off Havana, Cuba (lat. 23°10′36″ N., long. 82°20′30″ W.); 358 meters; temperature 22.17° C.; coral; May 1, 1884 (2, U.S.N.M., 14286, 34834).

Albatross station 2161; off Havana (lat. 23°10′36″ N., long. 82°20′28″ W.); 267 meters; coral; April 30, 1884 (1, U.S.N.M., 34831).

Albatross station 2324; off Havana (lat. 23°10′25″ N., long. 82°20′24″ W.); 60 meters; temperature 26.17° C.; coral; January 17, 1885 (2, U.S.N.M., 34575).

Albatross station 2335; off Havana (lat. 23°10′39″ N., long. 82°20′21″ W.); 373 meters; January 19, 1885 (7, U.S.N.M., 34577; M.C.Z., 352).

Albatross station 2342; off Havana (lat. 23°10′39″ N., long. 82°20′21″ W.); 367 meters; coral; January 19, 1885 (1, U.S.N.M., 34597).

Albatross station 2346; off Havana (lat. 23°10′39″ N., long. 82°20′21″ W.); 366 meters; coral; January 20, 1885 (1, U.S.N.M., 34582).

Albatross station 2348; off Havana (lat. 23°10′39″ N., long. 82°20′21″ W.); 386 meters; coral; January 20, 1885 (4, U.S.N.M., 34583, 34584).

Albatross station 2349; off Havana (lat. 23°10′40″ N., long. 82°20′15″ W.); 333 meters; coral; January 20, 1885 (3, U.S.N.M., 34585).

Albatross station 2338; off Havana (lat. 23°10′40″ N., long. 82°20′15″ W.); 345 meters; coral; January 19, 1885 (2, U.S.N.M., 34579).

Albatross station 2345; off Havana (lat. 23°10′40″ N., long. 82°20′15″ W.); 336 meters; fine gray and white coral; January 20, 1885 (13+, U.S.N.M., 34580, 34581, 34586).

Albatross station 2159; off Havana (lat. 23°10′39″ N., long. 82°20′08″ W.); 179 meters; coral; April 30, 1884 (1, U.S.N.M., 34829).

Albatross station 2319; off Havana (lat. 23°10′37″ N., long. 82°20′06″ W.); 261 meters; gray coral; January 17, 1885 (1, U.S.N.M., 16907).

Albatross station 2323; off Havana (lat. 23°10′51″ N., long. 82°19′03″ W.); 298 meters; white and brown coral; January 17, 1885 (2, U.S.N.M., 34574).

Albatross station 2326; off Havana (lat. 23°11′45″ N., long. 82°18′54″ W.); 355 meters; brown coral; temperature 16.67° C.; January 17, 1885 (1, U.S.N.M., 35658).

Albatross station 2336; off Havana (lat. 23°10′48″ N., long. 82°18′52″ W.); 287 meters; coral; January 19, 1885 (1, U.S.N.M., 34598).

Albatross station 2320; off Havana (lat. 23°10′39″ N., long. 82°18′48″ W.); 238 meters; fine coral; January 17, 1885 (2, U.S.N.M., 34573, 34596).

Albatross station 2327; off Havana (lat. 23°11′45″ N., long. 82°17′54″ W.); 333 meters; fine brown sand; January 17, 1885 (2, U.S.N.M., 34578).

Albatross station 2316; off Havana (lat. 24°25′30″ N., long. 81°47′45″ W.); 91 meters; temperature 23.33° C.; January 15, 1885 (1, U.S.N.M., 16906).

Albatross stations 2319–2350; off Havana; 60–510 meters; January 17–20, 1885 (10+, U.S.N.M., 34572, 34886).

Albatross stations 2156–2157; off Havana; 53–508 meters; coral; April 30, 1884 (1, U.S.N.M., 34833).

Albatross stations 2156–2163; off Havana; 53–508 meters; coral; April 30, 1884 (1, U.S.N.M., 34830).

Albatross; off Havana; 1885 (1, U.S.N.M., 36011).

Florida Straits [P.H. Carpenter, 1881].

"Caribbean Islands"; 141–442 meters [P. H. Carpenter, 1888]. Type locality.

Probable type localities.—*Blake* station 58Ag.; off Havana (lat. 23°09′30″ N., long. 82°11′30″ W.); 442 meters; 1878.

Bibb station 202P (on charts and in record books, 5Z; in bulletin, 5); Florida Keys, off Conch reef (lat. 24°52′20″ N., long. 80°22′20″ W.); 141 meters; sand and shells; May 11, 1869.

[Note by A.M.C.] Mr. Clark does not state whether these stations were only traced by himself as fitting with the depth limits given by Carpenter (77 and 242 fathoms) or whether he had some other justification for them. I would point out that *Blake* stations 53 and 55 in the same vicinity were also in 242 fathoms, and at station 53 *Coccometra hageni* was also taken. Carpenter commented in 1881 that this species was found with *hageni*, which would suggest that both were taken at one station, though with all the stations so close together this is by no means certain.

Geographical range.—Known only from off Havana, on the north side of Cuba.

Bathymetrical range.—The 18 definite records range from 60 to 386 meters, the average being 291 meters.

Thermal range.—The three records range from 16.67 to 23.33° C.

Remarks [by A.M.C.].—Mr. Clark has attributed this species to P.H. Carpenter, though Carpenter himself and Hartlaub both referred to it as 'Carpenter MS' and the latter designated it 'sp. nov.' in 1912. However, the very unusual character of the absence of both P_1 and P_a, together with the number of cirri and segments, given by Carpenter in a key (1888, p. 206) are, in fact, sufficient to identify the species, which can therefore properly be attributed to Carpenter.

History.—In his preliminary account of the comatulids obtained by the *Blake*, published in 1881, Carpenter said that among the large number of individuals of *Antedon* [i.e., *Coccometra*] *hagenii* from the Florida Straits he found a few examples of a species with no pinnules at all on the second and fourth brachials, though the other pinnules were developed as usual.

In the *Challenger* report (1888) he inserted the name "*defecta*, Carpenter, MS" in a key to the species of "Antedon" which he was unable to place in any of the "groups" into which he divided the 10-armed species. In his list of the known species of "Antedon" he inserted "*defecta*, Carp., MS., Caribbean Islands, 77–242 fathoms".

After Carpenter's death the *Blake* material was turned over to Dr. Clemens Hartlaub, and by him was assigned for preliminary study to Dr. Wilhelm Minckert. In 1905 Minckert published some notes on the distribution of the syzygies and the pinnulation, as well as on regeneration in this species.

In the *Blake* material Hartlaub found only two specimens of *H. defecta*, a larger and a smaller, with no locality label. Both of these appeared on a plate which had already been prepared by Carpenter, and there is no evidence that the latter had had any others. Hartlaub described these in detail, accompanied by figures of each, prepared by Carpenter, and also original photographs of both.

[Note by A.M.C.] Neither of these specimens appear to have been preserved, presuming the above locality list includes the specimens in the M.C.Z. (where the *Blake* specimens belong) as well as those in the U.S.N.M. The basis for the species must therefore be the description and figures given by Hartlaub.

In the report upon the *Ingolf* crinoids (1923) the range of this species was given, based upon unpublished as well as published data.

Subfamily Zenometrinae A. H. Clark

Zenometrinae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (includes *Zenometra, Psathyrometra, Leptometra, Adelometra,* and *Balanometra*); Mem. Australian Mus., vol. 4, 1911, p. 725 (absent from Australia); Notes Leyden Mus., vol. 34, 1912, p. 142 (probably arose from *Trichometra*-like forms); Crinoids of the Indian Ocean, 1912, p. 6 (number of East Indian genera; number of genera also occurring in the West Indies; number represented by closely allied genera in the Atlantic; number confined exclusively to the East Indies; number of East Indian species), p. 9 (absent from Australia), p. 11 (occurs west to the west coast of the Malay peninsula), p. 14 (certain genera are characteristic of the Intermediate faunas), p. 26 (range, 78–1,588 fathoms), p. 60 (in key); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (temperature relations); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges); No. 20, 1914, p. 582 (relation to temperature of habitat); Internat. Rev. gesamt. Hydrobiol., und Hydrogr., vol. 6, 1914, pp. 5 and following (Atlantic and corresponding Indo-Pacific genera); Die Crinoïden der Antarktis, 1915, p. 113 (synonymy; geological, geographical, and bathymetrical range), p. 114 (key to the included genera), p. 117 (*Eumorphometra*, new genus), p. 168 (shallow water Antarctic species); Amer. Journ. Sci., vol. 40, 1915, p. 68 (detailed philosophical discussion of the bathymetrical range); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 42 and following (phylogenetic study); Journ. Washington Acad. Sci., vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance); vol. 7, No. 5, 1917, p. 127 (includes *Balanometra, Psathyrometra, Leptometra, Adelometra, Zenometra, Sarametra*, new genus and *Eumorphometra*); No. 16, 1917, p. 504 (in key), p. 509 (key to the included genera); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (gap between this subfamily and the Bathymetrinae almost bridged by three small species of *Psathyrometra* discovered by the *Siboga*), p. 196 (in key), p. 222 (key to the included genera); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921,

p. 2.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 10, 138, 139, 140.—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 7 (*Poliometra*, new genus).—GISLÉN, Ark. Zool., vol. 15, No. 23, 1923, p. 15; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 88, 91, 232, 239.—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key), p. 32.—A. H. CLARK, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 661.—GISLÉN, Kungl. Fysiograf. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 53.—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (*Eometra*, new genus); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 222 (in Russian), p. 229.—JOHN, *Discovery* Reports, vol. 18, 1938, pp. 123, 124, 152 (*Kempometra*, new genus); Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B., vol. 4, pt. 6, 1939, pp. 202–205 (*Anisometra*, new genus).—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139, p. 142 (in key), p. 144.—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.—A. H. CLARK, Trans. Roy. Soc. South Africa, vol. 33, pt. 2, 1952, p. 189 (*Cyclometra* referred to this subfamily).—TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182.

Zénomètres A. H. CLARK, Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 257.

Zenometriden A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 192 (certain genera of this subfamily are characteristic of the Intermediate fauna).

Diagnosis.—A subfamily of Antedonidae in which the cirri, which are long with numerous, rarely less than 20, segments, are arranged in definite columns, rarely obscured, which are sometimes separated into radial groups by interradial spaces; the centrodorsal is conical, sometimes columnar and may be higher than wide, rarely it is low rounded conical; the cirri are usually weakly attached to the centrodorsal; P_1 usually resembles P_2 and has mostly elongated segments; rarely some of the lower pinnules may be absent.

Geographical range.—Known from the Antarctic, Southern Ocean, Galapagos Islands, to the Queen Charlotte Islands, the Aleutians, the Okhotsk and Japan Seas, southern Japan, the Hawaiian Islands, the East Indies and Philippines, the Indian Ocean and east Africa, southwest Africa, northwest Africa, Madeira, the Mediterranean and Sea of Marmara, Brazil, the West Indies and southeastern United States and from Spain to the Faroe Islands, the southern part of the Barents Sea, the Kara Sea and east and west Greenland.

Bathymetrical range.—Known from 20 to 3426 meters.

Thermal range.—From $-1.97°$ [$?-2.10°$] to $+18.2°$ C.

Remarks [by A.M.C.].—Of the fourteen genera now included in this subfamily, six are monotypic; namely *Zenometra*, *Balanometra*, *Anisometra*, *Adelometra*, *Kempometra* and *Poliometra*. The genus with most species is *Psathyrometra* with eight, ranging from the Indian Ocean, East Indies and North Pacific. Four genera are limited in their distribution to the Antarctic and Southern Oceans; these are *Anisometra*, *Eumorphometra*, *Kempometra* and *Eometra; Poliometra* comes from the cold northern seas. On the other hand *Zenometra*, *Balanometra*, *Sarametra*, *Caryometra*, *Adelometra* and *Hybometra* are limited to tropical areas with temperatures of not less than 5° C. *Psathyrometra* seems to occupy the greatest range of temperature, from 0.39° C. to 13.3° C.

Most of the species live at depths of well over 200 meters, in fact only four, *Hybometra senta*, *Poliometra prolixa*, *Leptometra phalangium* and *L. celtica* have been taken at depths of less than 100 meters.

Characters [by A.M.C.].—The centrodorsal in this subfamily varies in shape from the extraordinary high columnar form with the apex truncated, found in some specimens of the type species of *Zenometra*, *Balanometra*, and *Sarametra*, through high conical in other specimens of the same species (formerly described under separate names but now acknowledged by Mr. Clark to be synonyms), to lower conical, about as high as wide at the base in the majority of species, for example *Poliometra prolixa,* reaching an extreme of low rounded conical in a few species such as *Cyclometra flavescens.*

At the same time the degree of interradial ornamentation of the centrodorsal is decreased. In *Zenometra* there is a conspicuous vertical ridge in each interradius. In *Balanometra* and *Adelometra* this is replaced by a groove. The various species included in *Psathyrometra* exhibit grooved, raised or plane interradial areas. In *Sarametra* and *Anisometra* the interradial spaces are plane. In the eight other genera there are no distinct interradial spaces between the cirrus sockets.

The number of columns of sockets may be 10, 15 or 20. In *Zenometra, Balanometra, Adelometra* and *Anisometra* there are only two columns in each radius; in *Sarametra* there are three or four columns, the unique type specimen of *S. nicobarica* having four columns basally, giving way to three towards the apex as the centrodorsal narrows. The same thing happens in some of the other genera where the centrodorsal tapers towards the apex. There may also be variation in the number of columns of sockets in specimens of different sizes of the same species. The two columns of small specimens may gradually separate and one or more sockets of a third or third and fourth columns be introduced between them. The additional midradial column or columns tends to be more irregular than those on each side as well as being more incomplete, so that although in interradial view the columns may appear regular, when seen radially this is not so obvious (see fig. 31, p. 551). On this account it is difficult to decide whether such species as *Hybometra senta* or *Cyclometra flavescens* should be referred to the Zenometrinae or to the Bathymetrinae.

As in some other comatulids a number of the sockets towards the apex of the centrodorsal may be obsolete with the central canal closed. In the type specimen of *Sarametra nicobarica,* for instance, there are about 140 sockets altogether but probably less than 100 of them actually bore cirri at the time of capture. In *Zenometra columnaris,* where the sockets are much fewer as well as being more widely spaced, nearly half the total number may be obsolete.

The cirri average about L in number, ranging from XX to about XCV. They are often damaged or lost before specimens reach the museum.

The number of segments in the peripheral cirri ranges from 20 to 70 in all but two of the known species, the maximum being found in *Adelometra angustiradia,* while *Sarametra triserialis* has up to 60 and *Poliometra, Zenometra* and *Leptometra* have up to 50 segments. It seems to be in the antarctic species that the lowest numbers are found. Only one of the five species of *Eumorphometra—E. fraseri*—has over 30 segments. The cirri of both *Anisometra frigida* and *Eometra weddelli* are only known from single detached ones which were probably not peripheral, these being more likely to be lost; they have 21 and 18 segments respectively. However, in *Kempometra grisea* the attached cirri have up to only 16 segments, but neither of the type specimens have the arms as much as 40 mm. long.

In length the peripheral cirri vary from 23 to about 60 percent of the arm length, averaging 40 percent. The proportions of the segments themselves are very variable but usually the longest ones are three to four times their median widths though in some genera such as *Caryometra* they may be up to six times as long as wide. Conversely in *Eumorphometra* they are little longer than wide. The distal segments are usually somewhat shorter. In most of the species there is a tendency for distal enlargement of the dorsal sides of the segments, sometimes resulting in a keel as in *Sarametra triserialis*, rarely in a high crest as in *Adelometra* or in distinct dorsal spines as in *Eumorphometra fraseri*. Correspondingly, the opposing spine is usually fairly well developed. However, in a few cases, as in some species of *Psathyrometra* and *Caryometra*, the cirri taper to a point, the outer segments remaining very elongated and without distal enlargements or even an opposing spine. *Leptometra phalangium* approaches this extreme form, with no opposing spine but the terminal segment still claw-like and slightly curved. In *L. celtica* the distal segments are relatively shorter with a small development of dorsal processes.

The proximal pinnules are usually slender and delicate with more or less elongated segments after the basal two or three (rarely up to five). The only exception to this is *Cyclometra*, in which the pinnules have more numerous and shorter segments, up to 45 with a length of 19 mm. in P_1 of *C. flavescens*, where the same pinnule of the other species averages just under 20 segments and about 9 mm. length. However, *Poliometra prolixa* also has P_1 with up to 45 segments, but whereas in *Cyclometra* most of the segments are barely longer than wide, in *Poliometra*, after the first five to seven, the segments "rapidly become elongated and excessively long and slender distally." *Leptometra phalangium* has up to 35 segments in P_1 but few of the other species have over 25.

P_1 is completely absent in *Balanometra* and *Kempometra*.

P_2 is shorter than P_1 in *Psathyrometra*, *Eumorphometra* and *Poliometra*, similar in *Anisometra* and *Leptometra* and longer in *Zenometra*, *Sarametra*, and *Eometra*. Of the two species of *Cyclometra*, *flavescens* has P_2 shorter and *multicirra* longer, while in *Caryometra* it is usually shorter but may be similar or longer.

KEY TO THE GENERA OF ZENOMETRINAE

[modified by A.M.C.]

(Three genera have had to be included twice in this key, *Poliometra* because of the discovery of an aberrant specimen with bare interradial spaces on the centrodorsal, *Psathyrometra* because of the considerable range its species show in the positioning of the cirrus sockets, and *Hybometra* because of our ignorance of its cirri.—A.M.C.)

a^1. Centrodorsal with the radial areas delimited by distinct ridges, grooves or flat spaces which separate the proximal parts at least of the lateral columns in adjacent radial areas.

- b^1. Cirrus sockets in two parallel and usually contiguous columns in each radial area.
  - c^1. Division series and proximal brachials with conspicuous spinous borders.
    - d^1. The paired columns of cirrus sockets separated by broad high ridges; adjacent division series and lower brachials in close lateral contact (from St. Lucia to the Gulf of Mexico and the coast of Georgia; 308–804 meters) **Zenometra** (p. 495)
    - d^2. The paired columns of cirrus sockets separated by narrow interradial spaces which are plane; division series not in lateral contact (Antarctica; 219 meters). **Anisometra** (p. 499)
  - c^2. Division series and proximal brachials smooth.
    - d^1. Centrodorsal long conical, its height much greater than its basal diameter; P_1 absent (Philippine Islands; 142–150 meters) **Balanometra** (p. 500)
    - d^2. Centrodorsal conical but not higher than wide; P_1 present.
      - e^1. More than 10 arms; distal cirrus segments shorter than broad, with prominent dorsal keels (Kei Islands; 256 meters) **Adelometra** (p. 503)
      - e^2. 10 arms; distal cirrus segments very long and quite without dorsal processes (Indian Ocean to the East Indies, Sea of Japan, Alaska, west central America, the Galapagos and Hawaiian Islands; 366–2903 meters) **Psathyrometra** (p. 510)

b^2. Cirrus sockets in three or more columns, or if in two then the columns are separated and lie at the borders of the radial areas converging towards the apex.

c^1. Outer cirrus segments broader than long, with dorsal spines; borders of the elements of the IBr series and lower brachials conspicuously spinous (Hawaiian and Nicobar Islands; 351–643 meters) ---- **Sarametra** (p. 506)

c^2. Outer cirrus segments much longer than broad; edges of the elements of the IBr series and lower brachials smooth.

d^1. Cirri with up to 40 segments; P_2 not much shorter than P_1 (Indian Ocean to the East Indies, Sea of Japan, Alaska, west central America, the Galapagos and Hawaiian Islands; 366–2903 meters) ---- **Psathyrometra** (p. 510)

d^2. Cirri with up to 50 segments; P_2 only about a third as long as P_1 (Arctic; 20–1960 meters). **Poliometra** (p. 572)

a^2. Centrodorsal without interradial ridges, grooves or spaces separating the sockets.

b^1. P_1 and P_a absent; peripheral cirri with not more than 16 segments of which all but the two basal and the penultimate are longer than broad (South Shetland Islands; 830 meters). **Kempometra** (p. 530)

b^2. P_1 and P_a present; peripheral cirri with at least 20 segments.

c^1. P_1 and P_2 long and slender, flexible distally, with 24–45 segments of which the longest distal are only slightly longer than broad, recalling the oral pinnules of the Heliometrinae (Arabian Sea and southwest Africa; 461–2194 meters) ---- **Cyclometra** (p. 532)

c^2. P_1 and P_2 with elongated distal segments.

d^1. Longest cirrus segments less than twice as long as wide.

e^1. P_2 with less than 15 segments; centrodorsal with 15 (rarely 20) cirrus sockets around the periphery; probably all viviparous (Antarctic; 177–490 [?610] meters). **Eumorphometra** (p. 536)

e^2. P_2 very attenuate with over 25 segments; centrodorsal with 20 peripheral cirrus sockets (arm length about 100 mm.) (off Brazil; 42 meters) ---- **Hybometra** (p. 550)

d^2. Longest cirrus segments over twice as long as wide, often much longer.

e^1. P_2 with over 20, usually 25–35, segments.

f^1. P_2 tapering abruptly near the base, then very attenuate, all the segments but the first one being longer than broad and the outer ones flared distally (Brazil; 42 meters). **Hybometra** (p. 550)

f^2. P_2 not markedly tapering basally, the first 3 to 6 segments not longer than broad, outer segments not markedly flared (north of Scotland to Sierra Leone and the Mediterranean; 46–1292 meters) ---- **Leptometra** (p. 552)

e^2. P_2 with up to 17 segments.

f^1. Peripheral cirri with up to 50 segments; P_1 with 25–45 segments (Arctic; 20–1960 meters) ---- **Poliometra** (p. 572)

f^2. Peripheral cirri with up to 35 segments; P_1 with 10–24 segments.

g^1. P_1 shorter than P_2, both of them much shorter than P_3; cirrus sockets in 10 closely crowded columns (Antarctic; 2725–3426 meters) ---- **Eometra** (p. 592)

g^2. P_1 shorter or longer than P_2 but neither shorter than P_3; cirrus sockets in 10 or 15 columns (West Indies; 338–777 meters) ---- **Caryometra** (p. 595)

Genus ZENOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 152, and following authors.

Zenometra A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 354 (diagnosis; type species *Antedon columnaris* P. H. Carpenter, 1881); vol. 52, pt. 2, 1908, p. 233 (undoubtedly occurs in the East Indian region); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 247 (same); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 212 (occurs in the West Indies and the Hawaiian Is.), p. 221 (relation to *Psathyrometra*); Amer. Nat., vol. 42, No. 503, 1908, p. 725 (color); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 136 (referred to the Antedonidae); vol. 22, 1909, p. 176 (referred to the Zenometrinae); Vid. Medd. Nat. Foren. København, 1909, p. 128 (closely related to *Leptometra*); Proc. U.S. Nat. Mus., vol. 40, 1911,

p. 10 (represents in the West Indies the East Indian *Psathyrometra*); Notes Leyden Mus., vol. 34, 1912, p. 151 (centrodorsal and pinnules compared with those of *Atopocrinus sibogae*); Crinoids of the Indian Ocean, 1912, p. 9 (does not occur in the area of maximum intensity of the East Indian fauna), p. 10 (occurs in the Hawaiian Is.; absent from Japan), p. 14 (corresponds to the East Indian *Psathyrometra*), p. 62 (in key), p. 234 (original reference; type species); Internat. Rev. gesamt. Hydrobiol., und Hydrogr., vol. 16, 1914, pp. 5 and following (occurs in both Atlantic and Indo-Pacific; in the Pacific represented by *Zenometra* and *Eumorphometra*; range); Die Crinoïden der Antarktis, 1915, p. 114 (in key to the genera of Zenometrinae), p. 182 (range; represented in the Indo-Pacific by *Zenometra* and *Eumorphometra*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 16, p. 510 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 222 (in key; range), p. 231; Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (confined to the West Indies), p. 16 (in key); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range), p. 52 (in key).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 117.—Ekman, Zoogeographica, vol. 2, No. 3, 1934, pp. 328, 343 (zoogeographic significance); Tiergeographie des Meeres, 1935, p. 67.—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139.—Gislén, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54, footnote 1.—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 37, fig. 14E.

Diagnosis.—A genus of Zenometrinae in which the large centrodorsal is columnar, broadly truncated conical, or conical with the radial areas delimited by prominent rounded ridges; the cirrus sockets are arranged in contiguous pairs of columns in each radial area; the cirri are long and stout with numerous (about 50) segments, of which the longest proximal are about 4 times as long as broad and the last 20 are broader than long; the elements of the IBr series and the lower brachials are in close lateral contact and laterally flattened, and have conspicuously spiny borders; and all of the pinnules are present.

Type species.—*Antedon columnaris* P. H. Carpenter, 1881.

Geographical range.—From St. Lucia, Lesser Antilles, northward to the coast of Georgia and the eastern portion of the Gulf of Mexico.

Bathymetrical range.—From 308 to 804 meters.

Thermal range.—From 5.83° C. to 12.11° C.

ZENOMETRA COLUMNARIS (P. H. Carpenter)

[See vol. 1, pt. 1, figs. 215–216 (p. 241), 217 (p. 243), 378 (p. 301), pl. 5, fig. 558; pt. 2, figs. 93–94 (p. 62), 754 (p. 349), 800 (p. 378)]

Antedon columnaris P. H. Carpenter, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 152 (*Blake* sta. 222), p. 169 (centrodorsal; basals); pl. 1, fig. 8; *Challenger* Reports, Zool., vol. 26, pt. 60, 1888, pp. 207, 377.—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907 p. 1579 (listed).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (in *Blake* collection), pp. 406–409 (synonymy; history; *Blake* sta. 222 [specimen lost]; *Albatross* sta. 2663; detailed description of the latter; discussion), pl. 8, fig. 13, pl. 10, figs. 6–14, pl. 15, figs. 8, 9.

Zenometra columnaris A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 354 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 221 (compared with *Z.* [*Sarametra*] *triserialis*), p. 237 (with *Z. pyramidalis*); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 233 (West Indian species) Unstalked crinoids of the *Siboga*-Exped., 1918, p. 231 (references); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, pp. 139, 140, p. 142 (in key), p. 144 (references); Bull. U.S. Fish Comm., vol. 55, 1954, p. 374 (listed).

Zenometra pyramidalis A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 221 (compared with *Z. triserialis*), p. 237 (description; *Albatross* sta. 2415); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 233 (West Indian species).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 409.—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 231 (=*Z. columnaris*).

Description.—The centrodorsal is long columnar, about 5 mm. in diameter throughout and about 8 mm. long, to long truncated conical, about twice as long as broad at the base, with 5 high and sharply rounded interradial ridges, which decrease slightly to considerably in height distally; in each radial area there are 2 regular columns of cirrus sockets, usually 6 in each, which are separated in the median line by a more or less developed low ridge. Only about half the cirrus sockets in each column appear to be functional, the 2 or 3 apical-most in each column having the central canal closed, though being otherwise perfectly formed. The dorsal pole of the centrodorsal is irregular, plane, or slightly concave.

The cirri are XX–XL, 50, from 55 to 60 mm. in length, strongly compressed laterally. The first segment is short, the second is about half as long as broad, the third is about as long as broad, the fourth is about half again as long as broad, and the following increase in length, the tenth being about 4 times as long as broad. After the fourteenth the length gradually decreases so that the twenty-first is only about twice as long as broad, the twenty-seventh is about as long as broad, and those following become very short. Half of the entire length of the cirri is included within the first 16 segments. The earlier segments as far as the fourteenth have expanded and produced distal ends which overlap the proximal ends of the segments succeeding. From about the fifteenth segment onward this overlapping gradually dies away ventrally, but dorsally becomes more pronounced and transforms into a forward projecting spine which occupies progressively more and more of the dorsal surface of each segment, on the short terminal segments becoming a high curved carinate process. The opposing spine is triangular, its base occupying the entire dorsal surface of the small penultimate segment. The terminal claw is conical, not longer than the penultimate segment.

The ends of the basal rays are visible as a continuation of the high interradial ridges of the centrodorsal to the angles of the calyx, forming high bridges between the deep subradial clefts.

The radials are very short, U-shaped, with a median and 2 lateral tufts of fine spines or a broad fringe of long glassy spines. The IBr_1 are very short and band-like, broadly V-shaped, deeply incised by a posterior process from the axillaries, with a broad fringe of fine spines along the proximal border. The IBr_2 (axillaries) are large, rhombic, with all the sides concave, broader than long; the borders all around are fringed with spines, which are much longer on the proximal than on the distal sides, and there is usually also a small tuft of spines in the distal angle.

The elements of the IBr series and the first 4 or 5 brachials are in close apposition with their neighbors and sharply and broadly flattened against them.

The 10 arms are about 130 mm. long. The first brachials are very short with the outer side somewhat longer than the inner and the latter in contact above the anterior angle of the axillary. The second brachials are large and irregular in shape. The first syzygial pair (composed of brachials 3+4) is oblong, not quite so long as broad. The following brachials to the tenth are wedge-shaped with more or less developed articular tubercles, and those succeeding are triangular and about as long as broad. After about the thirtieth the brachials become laterally compressed and develop prominently overlapping distal edges which bear dorsally a fringe of small spines. The distal brachials gradually become more wedge-shaped and finally elongate. The first 6 brachials may have a fringe of small spines on either side.

Syzygies occur between brachials 3+4, again about 9+10 (from 6+7 to 13+14), and distally at intervals of 3 or 4 muscular articulations.

P_1 is 7 mm. long, very much compressed, composed of about 12 segments all of which are much longer than broad, especially the distal which are excessively elongated. P_2 is 12 mm. long, much stouter than P_1, with 16 segments, of which the first is about half again as long as broad and the following become progressively elongated; the first 4 segments are comparatively broad and much flattened, those following being more slender and more nearly cylindrical. P_4 is 7 mm. long with 12 segments, stout at the base like P_2 but rapidly tapering; the first segment is not quite so long as broad, the second is about as long as broad, and the following rapidly become elongated. The distal pinnules are 16 or 17 mm. in length; the first segment is about 3 times as broad as long, trapezoidal, the second is nearly as long as broad, also trapezoidal, and the third and following are slender and cylindrical, greatly elongated, with the distal edges armed with a few slender spines. There are 18 to 20 segments in the distal pinnules.

Localities.—*Blake* station 222; off St. Lucia, British West Indies (lat. 13°58′37″ N., long. 61°04′45″ W.); 771 meters; temperature 5.83° C.; sand and ooze; February 16, 1879 [P. H. Carpenter, 1881; Hartlaub, 1912] (specimen lost). Locality of original type.

Albatross station 2400; Gulf of Mexico, southeast of Pensacola, Florida (lat. 28°41′00″ N., long. 86°07′00″ W.); 308 meters; gray mud; March 14, 1885 (arm fragment, U.S.N.M., 34570).

Albatross station 2663; off northern Florida (lat. 29°39′00″ N., long. 79°49′00″ W.); 769 meters; temperature 5.95° C.; brown sand; May 4, 1886 [Hartlaub, 1912] (3, U.S.N.M., 34630, 34633). Locality of neotype.

Albatross station 2415; off Savannah, Georgia (lat. 30°44′00″ N., long. 79°26′00″ W.); 804 meters; temperature 7.56° C.; coral, coarse sand, shells and foraminifera; April 1, 1885 (7, U.S.N.M., 22668, 34569, 34571, 36141, 36249).

Albatross station 2416; off Georgia (lat. 31°26′00″ N., long. 79°07′00″ W.); 504 meters; temperature 12.11° C.; coarse broken shells; April 1, 1885 (1, U.S.N.M., 36214).

Geographical range.—From St. Lucia to Pensacola, Florida, and the coast of Georgia.

Bathymetrical range.—From 308 to 804 meters; the average of 5 records is 631 meters.

Thermal range.—From 5.83° C. to 12.11° C.; the average of 4 records is 7.86° C.

History.—In his preliminary report (1881) on the comatulids collected by the *Blake*, Dr. P. H. Carpenter mentioned as a new species *Antedon columnaris*. Later in the same paper he said:

> The peculiarities of *Antedon columnaris* are almost sufficiently obvious in Fig. 8. I can find no traces on its columnar centrodorsal of any sutures which would indicate its composition out of two or more anchylosed joints. In fact the alternating arrangement of its cirrhus sockets indicates the improbability of such an anchylosis. They are disposed in five double rows separated by interradial ridges, at the tops of which minute basals [the ends of the basal rays] are visible, just as in *Pentacrinus* [*Cenocrinus*] *asteria*. The lower end of the column is somewhat concave, but appears to be completely closed and devoid of any central perforation. The loose arms obtained with the calyx are rather large and massive, and resemble those of *Atelecrinus* in having the ambulacrum close down upon the top of the large muscular bundles.

In the *Challenger* report in 1888 Carpenter gives this species from off St. Lucia in

422 fathoms, so that the single individual from *Blake* station 222 mentioned and figured in 1881 is evidently the only one he ever saw.

In 1908 I described a supposedly new species which I called *Zenometra pyramidalis;* but this is obviously nothing more than a case of individual variation.

Hartlaub did not find Carpenter's specimen in the *Blake* collection, which was turned over to him after Carpenter's death. He wrote me to see if he could have another for study, and I sent him one from *Albatross* station 2663, which is the one described and figured by him in 1912 as a supplement to the description published and the figures left by Carpenter.

Genus ANISOMETRA John

Anisometra John, Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 204 (diagnosis; type species *Anisometra frigida* sp. nov.).

Diagnosis.—A genus of Zenometrinae in which the cirrus sockets are arranged in ten columns, two in each radius, the radial pairs being separated from one another on the peripheral part of the centrodorsal by a narrow naked space, which is not ridged or grooved; cirri not fully known; P_1 present; oral pinnules short, of few and unequal segments; genital pinnules twice as long and of elongated segments.

Type species.—*Anisometra frigida* John, 1939.

Geographical range.—Known only from off MacRobertson Land, Antarctica (lat. 66° S., long. 62° E.).

Bathymetrical range.—219 meters.

ANISOMETRA FRIGIDA John*

Anisometra frigida John, Rep B.A.N.Z. Antarctic Res. Exped., 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 192 (listed), pp. 204, 205, fig. 4.

Description.—The type and only known specimen is small, the distance from the proximal edge of the IBr_1 to the second syzygy (9+10) is 6.0 mm.

The centrodorsal is high and conical, slightly higher than wide, the basal width being 1.2 mm. and the height 1.3 mm. The dorsal pole is rounded, the ventral edge straight. The cirrus sockets are arranged in ten regular columns, the pair of columns in each radius being separated on the proximal part of the centrodorsal by a narrow naked area which is quite flat. There are three to five sockets in each column.

No cirri remain attached to the centrodorsal, but a small one, about 6 mm. long, was found wedged between a pair of arms and presumably belongs to this species. It is probably immature. There are 21 segments. The first two are short. The third is slightly longer than broad. The fourth and fifth are twice as long as broad and slightly waisted. The remaining segments decrease gradually in length, the distal ones are broader than long. Each is wider distally than proximally, the greater width being on the dorsal side, but there are no dorsal spines. The opposing spine is weak, the terminal claw strong.

The radials are long and considerably wider distally than proximally. The distal half of the dorsal surface is bent outwards at a marked angle to the proximal

*See also Addenda (p. 837) under 1963.

half. The distal edge is very concave, and is everted and coarsely spiny. The IBr_1 are shorter than the radials, being about three times as broad as their length in the midline. The proximal edge is concave, the distal fairly deeply incised by the axillary. The IBr_1 are not in apposition. The axillaries are slightly broader than long; all the edges are concave, the distal more so than the proximal.

The first three syzygies are at brachials 3+4, 9+10, and 14+15. The fragments which remain of the more distal parts of the arms show syzygial pairs separated by one brachial. The width at the first syzygy is 0.7 mm.

The middle part of the dorsal surfaces of the division series and the proximal brachials as far as the second syzygy is beset with low and irregular spines; in addition the distal edges of the brachials between the first and second syzygies are everted and produced into spines. Beyond the second syzygy the brachials have smooth and somewhat hollow dorsal surfaces, but their distal edges are more everted and produced into stronger spines than those of the lower brachials.

P_1 is of 4 to 6 unequal segments, and very short, but of different lengths on different arms; on some arms it is much less, on others more, than 1 mm. long. On one arm the first segment is short, the second longer and much wider than any of the remainder, but twice as long as broad; the third and fourth are slightly longer than broad; the fifth short and small. The P_1 of another arm is of equal length, and the proportions of the segments are the same except that the second segment is not conspicuously wider than the others. In a very short P_1 of four segments, each segment is only slightly longer than broad.

P_2 is generally similar to P_1. It is of five or six segments, of which all but the first and last may be considerably longer than broad; the second may be more massive than the others. P_2 may be of the same length as, or longer or shorter than, the P_1 of the same arm. P_a is similar.

The genital pinnules, of which P_3 is the first, are more than twice as long as the oral pinnules. P_3 is 2.5 mm. long and of nine segments, of which all but the first two are elongated, being up to five times as long as broad. The distal ends of the segments are everted and spiny. An enormous gonad lies along the third to sixth segments of one, a still larger one along the third to seventh segments of another. They are testes. P_4, P_c and P_d are similar to P_3. They lack ambulacral grooves. It cannot be stated whether the genitals extend beyond P_4, for none is complete beyond.

The disk is naked.

Locality.—B.A.N.Z.A.R.E. station 107; off MacRobertson Land, Antarctica (lat. 66°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (1, B.M.).

Genus BALANOMETRA A. H. Clark

Antedon (part) P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 155, and following authors.

Perometra (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 258.

Balanometra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 177 (diagnosis; type species *Antedon balanoides* P. H. Carpenter, 1888; referred to the Zenometrinae); Crinoids of the Indian Ocean, 1912, p. 10 (absent from Japan), p. 11 (absent from the west coast of the Malay peninsula, the Andamans, and further westward), p. 26 (confined to the Philippine Islands), p. 61 (in key) p. 238 (original reference; type); Die Crinoïden der Antarktis, 1915, p. 114 (in key to the genera of Zenometrinae); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the

Zenometrinae); No. 16, p. 509 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 222 (in key; range), p. 232 (key to the included species).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 212; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.

Diagnosis.—A genus of Zenometrinae in which the centrodorsal is elongate conical with its surface divided into 5 radial areas by prominent interradial furrows; the cirrus sockets are arranged in 2 columns in each radial area, the 2 columns being separated by a midradial line or shallow groove; the cirri have rather numerous (27 to 40) segments, of which the longest are about 4 times as long as broad or even longer, and the last 10 are little if any longer than broad with the distal edge projecting dorsally; the elements of the IBr series and the lower brachials are not in lateral contact, and their edges are smooth; P_1 and P_a are absent.

Type species.—*Antedon balanoides* P. H. Carpenter, 1888.

Geographical range.—Only known from the Philippine Islands.

Bathymetrical range.—From 142 to 150 meters.

BALANOMETRA BALANOIDES (P. H. Carpenter)

Antedon, sp. P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 155 (specimen from near the Philippines lacking the lower pinnules).

Antedon balanoides P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 207 (description; sta. 201), pl. 33, figs. 6, 7.—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (related species exhibiting characters of the *Basicurva* group).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1580.—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 34 (of P. H. Carpenter, 1888=*Balanometra balanoides*).

Perometra balanoides A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 358 (listed); vol. 52, pt. 2, 1908, p. 229 (compared with *P. elongata*).

Perometra elongata A. H. CLARK, Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 229 (description; *Albatross* sta. 5178).

Balanometra balanoides A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 34 (=*Antedon balanoides* P. H. Carpenter, 1888), p. 238 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 57 (published references to specimen in the B.M.; *Challenger* sta. 201); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 232 (in key; range), p. 233 (references).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 10, no. 49 (notes).

Balanometra elongata A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 238 (synonymy; locality); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 232 (in key; range; references).

Description of the type specimen.—The centrodorsal is a much elongated cone 5.5 mm. high, its sides divided into 5 radial areas by deep interradial furrows, which are broader than the cirrus sockets. In each radial area there is a shallower median furrow not so broad as the cirrus sockets. The cirrus sockets in each radial area are arranged in 2 columns of 6 or 7 each, beyond which more or less faint scars continue the columns toward the dorsal pole.

The cirri number about LX and have 35 to 40 segments of which the basal are short and the following to the tenth or twelfth are much longer than broad and develop a faint dorsal keel which projects beyond the base of the succeeding segments and decreases in height proximally. The succeeding segments are shorter, though always longer than broad, and become laterally compressed.

The radials are concealed by the centrodorsal. The IBr_1 are oblong with a deeply incised distal border, and are just in contact at their proximal angles. The IBr_2 (axillaries) are rhombic, their obtuse proximal angle rising to a synarthrial tubercle with the median portion of the distal border of the IBr_1.

The 10 arms are probably about 60 mm. long. The first brachials have long exterior borders. The second brachials are irregularly quadrate and rise posteriorly to a synarthrial tubercle with the first. The following brachials are triangular, broader than long. The width at the first syzygy is 1.5 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 7.0 mm.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 3 to 7 (usually 4) muscular articulations.

P_1 and P_a are absent.

P_2 is 7 mm. long with 15 segments. P_3 and P_c are generally stouter, and those following less so, but of increasing length.

The disk is naked, about 6 mm. in diameter.

The color in alcohol is a deep rose red with the cirri and the ends of the arms white.

Description of the type of B. elongata.—The centrodorsal is sharply conical, greatly elongated, 1.5 mm. broad at the base and 4 mm. high, with the sides divided into 5 radial areas by shallow U-shaped furrows averaging about half as broad as the adjacent cirrus sockets. In each radial area there is a median line rather less than half as broad as the interradial furrows. Each radial area carries 2 columns of cirrus sockets, one on either side of the median line, of 4 or 5 each, beyond which, in the apical third of the centrodorsal, are several partially obliterated sockets continuing the columns.

The cirri are XLV, 27–35 (usually nearer the latter), from 20 to 26 mm. long. The first segment is about twice as broad as long, the second is slightly longer than broad, the third is about two and a half times as long as broad, the fourth is rather over three times as long as broad, and the fifth and following are about four times as long as broad, or rather longer; after the tenth or twelfth the segments gradually decrease in length so that the last ten are about as long as broad or only slightly longer than broad. After the first ten the distal dorsal edge of the segments begins to be somewhat prominent, this feature very gradually increasing distally. The opposing spine rises from almost the entire dorsal surface of the penultimate segment; it is rather stout, with the apex terminal in position, and its height is somewhat less than the width of the segment which bears it. The terminal claw is moderately stout and moderately curved, and about as long as the penultimate segment.

The radials are rather long, about twice as broad as long in the median line. The IBr_1 are over twice as broad as their lateral length with slightly converging sides, which are not in contact basally, and with the distal border concave. The IBr_2 (axillaries) are rhombic, about as long as broad.

The 10 arms are all broken off near the base. The first brachials are small, about 3 times as long exteriorly as interiorly, not in contact interiorly, with the distal border concave. The second brachials are much larger, irregularly quadrate. The first syzygial pair (composed of the third and fourth brachials) is half again as long interiorly as exteriorly, and about twice as broad as the exterior length. The following brachials as far as the second syzygy are slightly wedge-shaped, about twice as broad as long.

P_1 and P_a are absent.

The color in alcohol is purple, the pinnules and cirri and a broad median band on the arms white.

Notes.—The differences between the type of *balanoides* and the type of *elongata* may be summarized as follows:

balanoides	*elongata*
Centrodorsal half again as high as broad at the base.	Centrodorsal nearly 3 times as high as broad at the base.
Interradial furrows on the centrodorsal deep, broader than the cirrus sockets.	Interradial furrows on the centrodorsal shallow, only about half as broad as the cirrus sockets.
Columns of cirrus sockets in each radial area separated by a median furrow not so broad as the cirrus sockets.	Columns of cirrus sockets in each radial area separated by a narrow median line, not a furrow.
Cirrus segments 35–40, the longest not over 3 times as long as broad, and the distal all markedly longer than broad.	Cirrus segments 27–35, the longest about 4 times as long as broad or even longer, and the terminal 10 as long as, or only slightly longer than, broad.
Synarthrial tubercles developed.	Synarthrial tubercles absent.

From this comparison it would seem that the only differences of importance between *balanoides* and *elongata* lie in the longer centrodorsal and the longer earlier cirrus segments of the latter. Considering the fact that both specimens came from the same region and were taken at practically the same depth, it seems safe to consider the former to be the result of individual variation, and the latter as indicating immaturity, and thus correlated with the slightly lesser number of cirrus segments and the absence of synarthrial tubercles.

Localities.—*Challenger* station 201; off Mindanao, Philippine Islands (lat. 7°03′ N., long. 121°48′ E.); 150 meters; stones and gravel; October 26, 1874 [P. H. Carpenter, 1881, 1888; A. H. Clark, 1913] (1, B.M.). Type locality.

Albatross station 5178; near Romblon, Philippine Islands; Point Origon (N.) bearing S. 5° E., 2.3 miles distant (lat. 12°43′00″ N., long. 122° 06′15″ E.); 142 meters; fine sand; March 25, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 25449).

History.—It was the type specimen of this species to which Carpenter referred in 1881 when, in remarking upon a peculiar species dredged by the *Blake* in which P_1 and P_a are absent (subsequently called by him *Antedon* [now *Hypalometra*] *defecta*), he mentioned that the *Challenger* had dredged a specimen near the Philippine Islands which presented the same peculiarity.

Carpenter described and figured this species in 1888 from a single mutilated example, and in 1908 I described as *elongata* another mutilated specimen which I now feel sure is conspecific with it.

Genus ADELOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 384, and following authors.

Adelometra A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 363 (diagnosis; type species *Antedon angustiradia* P. H. Carpenter, 1888); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 248 (same); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted); Amer. Nat., vol. 42, No. 503, 1908, p. 724 (color); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Zenometrinae); Crinoids of the Indian Ocean, 1912, p. 10 (absent from Japan), p. 26

(habitat), p. 62 (in key), p. 238 (original reference; type); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (both Atlantic and Indo-Pacific; range and its significance); Die Crinoïden der Antarktis, 1915, p. 114 (in key), p. 182 (occurs in Atlantic and Indo-Pacific; range); Journ. Washington Acad. Sci., vol. 7, No. 16, 1917, p. 509 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 222 (in key; range), p. 233 (key to the included species); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 13 (West Indies and Indo-Pacific), p. 16 (in key); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range), p. 53 (in key).—EKMAN, Zoogeographica, vol. 2, No. 3, 1934, pp. 328, 343 (zoogeographical significance); Tiergeographie des Meeres, 1935, p. 67.—GISLÉN, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54, footnote.

Diagnosis [by A.M.C.].—A genus of Zenometrinae in which the centrodorsal is conical, almost equal in height to the basal diameter, with two regular columns of cirrus sockets in each radial area separated by naked, shallow interradial grooves; the longest cirri have over 50 segments, of which less than half are longer than broad and the distal ones are very short, each with a prominent dorsal crest; the division series and lower brachials are smooth and cylindrical, those of neighboring series not in lateral contact; the single specimen known is multibrachiate with 14 arms and hence four IIBr series, of which three are of 4 ossicles and the other of 2; P_D where present is long with the outer half very attenuated; the following three pinnules, P_1, P_2 and P_3, are progressively shorter.

Type species.—*Antedon angustiradia* P. H. Carpenter, 1888.

Geographical distribution.—Known only from off the Kei Islands.

Bathymetrical distribution.—Known only from 256 meters.

Remarks.—The genus *Adelometra* was established in 1907 for *Antedon angustiradia*, which had been described and figured by Dr. P. H. Carpenter in 1888 and referred by him to his "*Savignyii* Group" (now the family Himerometridae) because of the presence of 14 arms in the unique type, three of the extra division series being 4(3+4) and one 2. This specimen with its conical centrodorsal and cirrus sockets in vertical columns clearly belongs rather to the subfamily Zenometrinae of the family Antedonidae.

[NOTE BY A.M.C.] In 1908 Mr. Clark described a new species from off Havana, Cuba, which he called *Adelometra tenuipes*, but in 1936 he established a new genus, *Caryometra*, to accommodate this species.

ADELOMETRA ANGUSTIRADIA (P. H. Carpenter)

FIGURE 25

[See also vol. 1, pt. 2, pl. 44, fig. 1300]

Antedon, sp. (part) P. H. CARPENTER, Proc. Roy. Soc., vol. 28, 1879, p. 384 (*Challenger* sta. 192).

Antedon angustiradia P. H. CARPENTER, *in* von Graff, *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, p. 74 (sta. 192; myzostomes; *nomen nudum*); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 253 (description; sta. 192), pl. 45, fig. 4.—BRAUN, Centralbl. Bakteriol. und Parasitenk., vol. 3, 1888, p. 210 (myzostomes).—HARTLAUB, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 16.—MINCKERT, Arch. Naturg., 1905, vol. 1, p. 224.—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1582 (listed).

Antedon angustiradiata MINCKERT, Arch. Naturg., 1905, vol. 1, p. 224.

Adelometra angustiradia A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 364 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 236 (compared with *A. tenuipes*); vol. 35, 1908, p. 119, footnote (arm structure); Crinoids of the Indian Ocean, 1912, p. 35 (=*Antedon angustiradia* P. H. Carpenter, 1888), p. 238 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 57 (published references to the specimen in the British Museum; *Challenger* sta. 192); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 233 (in key; range; references).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 10 (notes).

Adelometra angustiradiata Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, pp. 18, 22.

Description [modified by A.M.C.].—The centrodorsal is conical, 2.8 mm. in diameter and 2.5 mm. in vertical height. The cirrus sockets are arranged in 10 regular vertical columns with usually four to a column; the sockets of adjacent columns tend to alternate in level. The interradial spaces between the columns are wider than the radial ones and are slightly hollowed.

The cirri are XLII in number with up to 70 segments and may be 25 mm. in length. They are almost straight for the first three-quarters of their length but are tightly coiled towards the tip. The first three segments are short; the fourth to about the fourteenth are longer than broad, but not more than a third again as long as broad; the following segments become progressively shorter and each develops a forward projecting dorsal spine which becomes very prominent on the short terminal segments, changing from a high crest, rounded in profile, to a more acute projection. The opposing spine is prominent and the terminal claw short and curved.

The radials are short and are depressed at their lateral edges. The IBr_1 are longer, tapering distally and widely separated laterally. The IBr_2 (axillaries) are pentagonal with the proximal side only slightly convex. They are broader than long.

The arms are 14 in number, about 45 mm. long. The IIBr series are 4 in three cases and 2 in the other. [Note by A.M.C.] Gislén (1928) writes that where there are 4 ossicles in the IIBr series the third and fourth are not united by syzygy. Carpenter himself took these articulations for syzygies but commented that one of them at least does not have the appearance of a syzygy. From an external examination I am inclined to agree with Gislén; certainly the joint is much more constricted than are the syzygies in comparable positions in Oligophreate species.

From the proximal edge of the IBr_1 to the second syzygy (where no IIBr series intervenes) measures 8.5 mm. and the width at the first syzygy is 1.15 mm.

The free undivided arms consist of about 100 brachials which are at first triangular, then wedge-shaped, later becoming narrow and elongated. On brachials arising from IIBr series the second syzygy appears to be delayed until the thirteenth and fourteenth brachials, or even further distally. The distal intersyzygial interval varies between two and seven (usually five or six) muscular articulations.

One (almost?) complete P_D remains (1957); it is about 10 mm. long and has about 30 elongated segments, of which the basal are rather stout but those of the outer half are very attenuate. P_1 probably had about 20 segments measuring 8 mm.; all are broken. P_2 has 11 segments, 5 mm. long and P_3 with 8 segments is 4 mm. long. All these pinnules are similar in shape but are progressively shorter. The following ones tend to increase in length and the distal pinnules are long and filiform with 16 to 18 segments measuring 8 to 9 mm. in length. They have no trace of spicules in the ambulacra.

The disk is naked and much incised, 9 mm. in diameter. The division series and the lowest pinnules are somewhat webbed by perisome.

Sacculi are abundant on the disk, arms and pinnules.

Remarks.—This species presents a number of anomalies. The arms suggest that it might possibly be the young of some species of *Himerometra* or a related genus but the arrangement of the cirrus sockets in definite columns, the large number of

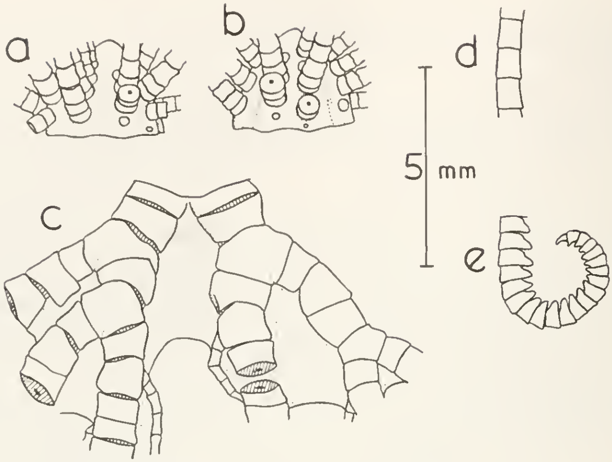

FIGURE 25.—*Adelometra angustiradia* (P. H. Carpenter), holotype: *a*, Centrodorsal in interradial view; *b*, in radial view; *c*, two radials and proximal parts of the postradial series; *d*, longest cirrus segments; *e*, distal part of cirrus.

cirrus segments of which the outer are short with dorsal spines, and the long segmented pinnules which become very slender and filiform distally, are features duplicated elsewhere only in such genera as *Zenometra*, *Sarametra* and *Poliometra*, and it is near these that this species undoubtedly belongs.

Although no other species in the Zenometrinae has ever been found with more than 10 arms, in the Perometrinae all the four known examples of *Perometra afra* have 11 or more arms.

Locality.—*Challenger* station 192; near the Kei Islands (lat. 5°49′15″ S., long. 132°14′15″ E.); 256 meters; blue mud; September 26, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1913; Gislén, 1928] (1, B.M.).

Genus SARAMETRA A. H. Clark

Zenometra (part) A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 213.

Sarametra A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Zenometrinae), p. 129 (diagnosis; type species *Zenometra triserialis* A. H. Clark, 1908; range); No. 16, p. 510 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 223 (in key; range), p. 231; Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 661.—GISLÉN, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54.

Diagnosis.—A genus of Zenometrinae in which the centrodorsal is elongate conical with the surface divided into 5 radial areas by 5 bare interradial lines not raised above the general surface which are equal in width to about half the transverse diameter of the cirrus sockets; the cirrus sockets are arranged in 3 closely crowded columns in each radial area; the cirri are long with numerous (about 60) segments, of which the longest proximal are from two and a half to three times as long as broad and the last 20 or more are broader than long with prominent dorsal spines; the elements of the IBr series are not in lateral contact; these ossicles and the earlier brachials have conspicuously spiny borders; and all the pinnules are present.

Type species.—*Zenometra triserialis* A. H. Clark, 1908.

Geographical range.—The Hawaiian and Nicobar Islands.

Bathymetrical range.—One record, 351–643 meters.

Thermal range.—Between 18.11° C. (at 351 meters) and 5.72° C. (at 643 meters).

KEY TO THE SPECIES OF SARAMETRA

a^1. Cirri about LXXV, arranged in three columns in each radial area; P_1 and P_2 both with 22 segments (Hawaiian Islands; 351–643 meters)............................**triserialis** (p. 507)

a^2. Cirri about CXL, arranged in three or four columns in each radial area; P_1 with 17 segments, P_2 with only 15 segments (off the Nicobar Islands)......................**nicobarica** (p. 508)

SARAMETRA TRISERIALIS (A. H. Clark)

[See vol. 1, pt. 1, figs. 109 (p. 175), 214 (p. 241), 377 (p. 301); pt. 2, figs. 300 (p. 221), 801(p. 378)]

Zenometra triserialis A.H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 213 (in key), p. 219 (description; *Albatross* sta. 4122); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 233 (Hawaiian species); Crinoids of the Indian Ocean, 1912, p. 234 (synonymy; locality).

Sarametra triserialis A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 129 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 231 (references); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 26 (ambulacral deposits); Journ. Linn. Soc. (Zool.), vol. 36, No. 249, 1929, p. 661 (compared with *S. nicobarica*); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140.

Diagnostic features.—The cirri are about LXXV, arranged in three columns in each radial area; P_1 is 8 mm. long with 22 segments; P_2 also has 22 segments but is stouter and 10 mm. long.

Description.—The centrodorsal is elongate conical, 3.5 mm. broad at the base and 6 mm. high, with its sides divided into 5 radial areas by 5 interradial lines equal in width to about half the diameter of the adjacent cirrus sockets which are not raised above the general surface. The cirrus sockets are arranged in 3 closely crowded columns of 5 each in each radial area. The apical third of the centrodorsal is thickly covered with short more or less branched spines and bears more or less obliterated cirrus sockets.

The cirri are about LXXV, 60, rather slender, from 40 to 45 mm. long. The first segment is short, the second is rather longer, the third is about as long as broad, and the following gradually increase in length to the seventh to eighteenth or twentieth which are between two and a half and three times as long as broad; those succeeding gradually decrease in length becoming about as long as broad on or near the thirty-third, and distally broader than long. From the fourth or fifth to the eighth or ninth the segments have their ends somewhat expanded, and the following have the distal dorsal edge rather prominent so that the cirri have a serrate dorsal and smooth ventral profile; in the terminal portion the cirri become moderately compressed, and the dorsal surface of the segments becomes carinate and forms low spines. The opposing spine is terminally situated, triangular, about equal in height to the diameter of the penultimate segment, arising from the entire dorsal surface of that segment. The terminal claw is stout basally, slender distally, strongly curved, and longer than the penultimate segment. Both the opposing spine and the terminal claw are rather disproportionately large.

The ends of the basal rays are visible, delimiting the deep subradial clefts.

The radials are short, with the distal edge fringed with spines. The IBr_1 are short, about 4 times as broad as long, with the posterior border strongly everted and very spinous and the anterior edge incised by a posterior projection from the axillary. The IBr_2 (axillaries) are rhombic, about twice as broad as long, with all the sides everted and very spinous.

The 10 deep laterally compressed arms are apparently about 150 mm. long. The first brachials are short, rather longer exteriorly than interiorly where they are united in their proximal half above the anterior angle of the axillary, with the anterior border incised, and with the posterior border everted and spinous. The second brachials are larger, irregularly quadrate, with the anterior and posterior borders everted and spinous. The first syzygial pair (composed of the third and fourth brachials) is about as long as broad, slightly longer interiorly than exteriorly, with the anterior and posterior borders and the syzygial line spinous. The following 5 segments are oblong, about half again as broad as long, with both edges everted and standing up vertically as a row of fine thickly set spines. The following brachials are obliquely wedge-shaped, about as long as broad, gradually becoming more elongate distally, at the extreme tip of the arm being oblong and twice as long as broad. All of the brachials have overlapping spinous ends.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 2 to 5 (usually 3 or 4) muscular articulations.

All the pinnules, especially the lower, are very slender. P_1 is 8 mm. long with 22 segments, of which the first 3 are about as long as broad with the corners cut away, the next 2 are progressively longer and more slender, and the remainder are greatly elongated and very slender. P_2 is 10 mm. long, slightly stouter than P_1 but with the same number of segments which are similarly proportioned. The following pinnules become progressively stouter and shorter, with shorter segments, P_6 being 7 mm. long with 17 segments, of which the first is short, the second is about as long as broad, the third and following are about twice as long as broad, and the few last become more elongate and very slender. The distal pinnules are 15 mm. long with the first 2 segments rather markedly expanded, the first short, wedge-shaped, the second strongly trapezoidal, about as long as its basal width, and the remainder becoming progressively elongated with somewhat swollen articulations and with one or two long forward projecting spines on the distal end.

Locality.—Albatross station 4122; near Honolulu, Hawaiian Islands; Barber's Point Light bearing N. 82° E., 2.2 miles distant; 351–643 meters; temperature between 5.72 (at 643 meters) and 18.11° C. (at 351 meters); coarse coral sand and shells; July 26, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 22682).

SARAMETRA NICOBARICA (A. H. Clark)

Sarametra nicobarica A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 635 (listed), pp. 661, 662 (off the Nicobar Is.; description), pl. 43, fig. 11.

Diagnostic features.—The centrodorsal, which is wholly without spines, is more than half again as high as broad at the base, and its radial areas carry from three to four columns of cirrus sockets of which about a hundred probably bore cirri; the spines on the ossicles of the division series and on the brachials are short, and are confined to the borders of the ossicles, and there is a slight development of synarthrial and articular tubercles; P_1 and P_2 have 17 and 15 segments respectively.

Description.—The centrodorsal is elongate-conical, 8.5 mm. high by 5 mm. broad at the base. For about the basal third the sides converge somewhat less rapidly than from that point onwards. The tip is unusually acute. The sides are divided into five radial areas by bare interradial lines, which are not raised above the general surface of the centrodorsal except in one interradial area, where the median portion of the bare lines forms a low and inconspicuous ridge. These lines are at first from half as wide to quite as wide as the adjacent cirrus sockets, but gradually narrow and become obsolete somewhere between the basal half and terminal third of the centrodorsal. Two of the radial areas contain basally four closely crowded columns of cirrus sockets, the sockets of one column alternating with those of the columns on either side; between a third and half way up the centrodorsal these four columns of cirrus sockets pass over into three. Another radial area has basally three columns, and along the right hand border a few sockets representing a fourth column, and the two remaining radial areas have three columns of sockets from base to apex. There are 13 or 14 sockets to a column, of which the basal four to six, which are larger and better formed than the others, alone appear to have been functional. But well-formed sockets continue to the apex of the centrodorsal, which is wholly without spines. [NOTE BY A.M.C.] The total number of cirri is estimated at about XCV, though the sockets altogether number about 140.

None of the cirri are preserved beyond the base. The longest stump remaining consists of three segments which do not differ from those in the largest cirri of *S. triserialis.*

The ends of the basal rays are prominent as tubercles in the interradial angles bridging over the regions between the shallow subradial clefts.

The surface and distal border of the radials are wholly without spines. The division series and arms resemble those of *S. triserialis*, but are proportionally stouter and also more rugged, with a slight development of synarthrial and articular tubercles. The general effect is much less spinous than *S. triserialis.* The spines on the proximal and distal edges of the elements of the division series and lower oblong brachials, though very numerous, are short. The lateral borders of the axillaries and of the second brachials bear a series of webbed spines which are much longer than those found elsewhere. The outer brachials have a group of long and very closely set spines in the middle of the distal border, but much shorter spines elsewhere.

The width at the first syzygy is 1.8 mm. and the length to the second syzygy 14 mm.

P_1 is 8 mm. long with about 17 segments, of which the first is nearly half again as long as the maximum width, the second and third are somewhat shorter, the fourth is half again as long as broad and the remainder are greatly elongated. The pinnule is slender, gradually tapering, and becomes filiform in the outer portion. The first three segments have the corners on the side turned toward the arm very broadly rounded.

P_2 is about 10 mm. long with about 15 segments, resembling P_1, but slightly less slender. P_3 is slightly longer than P_2, stouter and less flexible, and tapering more gradually.

Locality.—Off the Nicobar Islands, on the Madras-Penang cable; C.S. *Patrol* [A. H. Clark, 1929] (1, B.M.).

Genus PSATHYROMETRA A. H. Clark

Antedon (part) Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 145, and following authors.

Psathyrometra A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (diagnosis; type species *Antedon fragilis* A. H. Clark, 1907); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 247 (same); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 212 (range; Japan, and the Aleutian, Galapagos and Hawaiian Is.), p. 221 (relation to *Zenometra*), p. 274 (comparison with *Pentametrocrinus* and *Decametrocrinus* [*Thaumatocrinus*]); Amer. Nat., vol. 42, No. 503, 1908, p. 721 (large size in the Japan Sea), p. 725 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 605 (ecology); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (reaches maximum size, in common with *Thaumatometra* and *Heliometra*, in the northern part of the Japan Sea), p. 136 (referred to the Antedonidae); vol. 22, 1909, p. 176 (referred to the Zenometrinae); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 10 (closely related to the Atlantic *Leptometra;* represented by *Zenometra* in the West Indies), p. 14 (not known from the Arabian Sea, though possibly existing there); Mem. Australian Mus., vol. 4, 1911, p. 726 (closely related to *Leptometra*); Notes Leyden Mus., vol. 34, 1912, p. 145 (P_1 compared with P_1 in *Nanometra clymene;* pinnules compared with those of *Atopocrinus sibogae;* centrodorsal compared with that of *Atopocrinus sibogae*); Crinoids of the Indian Ocean, 1912, p. 10 (occurs in the Hawaiian Is.), p. 11 (occurs in the Andamans), p. 12 (closely related to, and parent of, *Leptometra*), p. 14 (corresponds to the West Indian *Zenometra*), p. 26 (range, in detail), p. 62 (in key), p. 234 (original reference; type species); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (represents *Leptometra* in the Indo-Pacific; range); *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, vol. 1, pt. 2, Echinoderma II, Crinoidea, 1914, p. 311 (Indo-Pacific representative of *Leptometra*); Die Crinoïden der Antarktis, 1915, p. 114 (in key to genera of Zenometrinae), p. 115 (synonymy; diagnosis; range; complete list of species and of localities), p. 182 (range; represents *Leptometra* in the Indo-Pacific); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Zenometrinae); No. 16, p. 509 (in key; range).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 102, 1917, p. 23 (percentage of magnesium carbonate in skeleton).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery of three small species almost bridging the gap between the Zenometrinae and Bathymetrinae), p. 222 (in key; range).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 124, 1922, p. 20 (skeletal composition).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 138.—A. H. Clark, The Danish *Ingolf*-Exped., Crinoidea, vol. 5, No. 5, 1923, p. 53 (in key).—Gislén, Ark. Zool., vol. 15, No. 23, 1923, p. 15; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 53.—A. H. Clark, Exploration des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (species local in distribution), p. 218 (in key), p. 222 (in Russian), pp. 223, 224, 229, 230 (in English version).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56 (range of depth).

Diagnosis.—The centrodorsal is conical, ranging from higher than broad at the base to very low, with its sides not divided into radial areas; beneath each radial the cirrus sockets are arranged in two to four columns, sometimes in two apically converging columns with a broad gap between their peripheral ends, however the interradial spaces between the columns tend to be wider than any radial spaces (exceptionally in *P. congesta* all the sockets are closely crowded); the cirri are long and slender, slightly curved, in the distal half gradually tapering to a sharp point, composed of 25 to 40 segments, all of which except the basal are much longer than broad and none of which have dorsal processes except for a minute opposing spine which may be absent (in four of the eight species the cirri are unknown); the elements of the IBr series and the lower brachials are high and narrowly rounded dorsally, not in lateral contact; their borders are smooth; all the pinnules are present.

Type species.—*Antedon fragilis* A. H. Clark, 1907.

Geographical range.—From Zanzibar to the East Indies, thence northward to Japan and the Aleutian Islands, eastward to the Gulf of Alaska and southward to the coast of Central America and the Galapagos Islands and from the Hawaiian Islands.

Bathymetrical range.—From 366 to 2903 meters.

Thermal range.—From 0.39° to 13.3° C.

Remarks [by A.M.C.].—The type species, *Psathyrometra fragilis*, has flat bare areas on the centrodorsal interradially between the columns of cirrus sockets. Most of the other species in the genus are similar in this respect but Mr. Clark has also included *P. congesta* (which I have not seen), which has the cirrus sockets crowded all over the centrodorsal and not forming radial groups. In two species—*mira* and *gracillima*—the interradial areas may be grooved, at least in larger specimens. Following examination of some specimens of *mira, minima, gracillima* and *anomala* I have made some alterations to the key to try to make allowance for differences of size. With so few specimens known of the three last-named species the extent of their variation cannot be appreciated.

KEY TO THE SPECIES OF PSATHYROMETRA

[modified by A.M.C.]

a^1. Centrodorsal higher than broad, often markedly so (Monterey Bay, California, to Alaska, thence westward to the western Aleutian Islands and southward to southern Japan; 439–2903 meters). **fragilis** (p. 512)

b^1. Centrodorsal with four columns of cirrus sockets in each radial area (from northern Japan northward and eastward to southeastern Alaska; 439–974 meters)----------forma **fragilis**

b^2. Centrodorsal with three columns of cirrus sockets in each radial area (geographical range of the species, but in deep water; 1210–2903 meters)----------forma **borealis**

a^2. Centrodorsal not higher than broad.

b^1. Centrodorsal with four columns of cirrus sockets in each radial area.

c^1. Centrodorsal with the radial areas separated by narrow interradial lines; cirrus sockets not in contact with each other (Galapagos Islands and the western coast of Central America; 704–1014 meters)----------**bigradata** (p. 515)

c^2. Centrodorsal with no indication of division into radial areas, and all the cirrus sockets closely crowded (Hawaiian Islands; 965 meters)----------**congesta** (p. 517)

b^2. Centrodorsal with not more than three columns of cirrus sockets in each radial area.

c^1. Centrodorsal a broadly truncated cone with three complete and equal very closely placed columns of 4 or 5 (usually 4) cirrus sockets in each radial area, the radial areas being separated by interradial flat spaces; size usually large, the arms up to 150 mm. in length; cirri with 35–40 segments (north-eastern part of the Sea of Japan; 713–742 meters). **erythrizon** (p. 518)

c^2. Centrodorsal conical, sometimes slightly rounded off at the tip, with 2, or 2 lateral and a partial median, columns of cirrus sockets in each radial area, the radial areas being separated by interradial spaces which may be slightly convex, flat or grooved; arms not known to exceed 100 mm. in length; cirri probably with not more than 30 segments.

d^1. Interradial bare areas of the centrodorsal narrow, hardly, if at all, wider than the individual peripheral sockets.

e^1. Interradial areas often grooved; centrodorsal fairly high conical, the ratio of basal diameter to vertical height rarely more than 1.5:1; cirrus sockets fairly close together in each radial area (from off Zanzibar to the East Indies and southern Japan; 366–924 meters). **mira** (p. 519)

e^2. Interradial areas plane or slightly raised; cirrus sockets spaced radially, or if close together then the centrodorsal is low with the ratio of diameter to vertical height about 1.7:1.

f^1. Centrodorsal fairly high, the ratio of diameter to vertical height being about 1.2:1; the surface between the cirrus sockets is flat (north of Sumbawa, East Indies; 2060 meters)--**minima** (p. 526)

f^2. Centrodorsal low, the surface between the cirrus sockets convex (south of Celebes; 1158 meters)--**anomala** (p. 526)

d^2. Interradial areas much wider than the individual peripheral sockets (southwest of Akyab, Burma; 497 meters)--**gracillima** (p. 528)

PSATHYROMETRA FRAGILIS (A. H. Clark)*

[See vol. 1, pt. 1, figs. 110 (p. 176), 209–211 (p. 241), 286 (p. 262), 379 (p. 301), 502 (p. 369); pt. 2, figs. 91, 92 (p. 62)]

Antedon fragilis A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 80 (description; *Albatross* sta. 5032).—Sowerby, The naturalist in Manchuria, Tientsin, vol. 5, 1930, p. 79.

Psathyrometra fragilis A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 274, fig. 3 (centrodorsal and radial articular faces); Crinoids of the Indian Ocean, 1912, p. 234 (synonymy; locality); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 213 (originally antarctic; entered the Sea of Japan from the northeast), p. 215 (antarctic; range and its significance); Die Crinoïden der Antarktis, 1915, p. 115 (range).—F. W. Clark and Wheeler, U.S. Geol. Surv. Prof. Paper 102, 1917, p. 20 (*Albatross* sta. 5032; inorganic constituents of skeleton).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 223 (in key; range), p. 226 (references).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 124, 1922, p. 17 (inorganic constituents of skeleton).—A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (widely distributed in N. Pacific), p. 218 (in key), p. 219 (localities; range), pp. 221, 222 (in Russian); pp. 223, 224, 225, 229, 230.—Vinogradov, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (skeletal composition).—Baranova, Invest. Far East Seas U.S.S.R., No. 4, 1957, p. 152 (occurrence in Bering Sea; distribution), p. 248.

Psathyrometra borealis A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 236 (description; *Albatross* sta. 4780); Crinoids of the Indian Ocean, 1912, p. 234 (synonymy; locality); Die Crinoiden der Antarktis, 1915, p. 115 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 223 (in key; range), p. 226 (references); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (synonym of *P. fragilis*), p. 223.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56 (depth range).

Psathyrometra profundorum A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 237 (description; *Albatross* sta. 3342); Crinoids of the Indian Ocean, 1912, p. 235 (locality); Die Crinoïden der Antarktis, 1915, p. 115 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 226 (synonym of *P. borealis*); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (synonym of *P. fragilis*), p. 223.

Psathyrometra, sp. A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 115 (*Albatross* sta. 4537); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (=*P. fragilis*) (in Russian), p. 223.

Psathyrometra alaseana A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 223 (in key; range), p. 226 ("description in press"; *nomen nudum*); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (synonym of *P. fragilis*), p. 223.

Psathyrometra borealis Tortonese, Natura, Milano, vol. 24, 1933, p. 164.

Antedon (*Psathyrometra*) *fragilis* A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 217 (in Russian), p. 223.

Diagnostic features.—The centrodorsal is nearly always markedly higher than broad at the base, conical with the apex more or less broadly rounded; rarely it is only a little higher than wide; there are three or four crowded, or more or less separated, columns of cirrus sockets in each radial area with narrow bare interradial areas between; the arms are up to 130 mm. in length, and the cirri are 45 to 60 mm. in length with 25 to 35 segments; P_2 is shorter than P_1.

*See also Addenda (p. 836) under 1962.

Description of the type material.—The centrodorsal is conical with the tip rounded, longer than broad at the base, with the sides divided into 5 radial areas by bare interradial lines which basally are almost as broad as the adjacent cirrus sockets, becoming obsolete in the apical half. Each radial area contains four very crowded columns of oval cirrus sockets, 6, 7 or 8 in a column, which are more or less raised above the general surface.

The cirri are XL–LXX, 30–35, up to 60 mm. long and strongly compressed laterally throughout. The first two segments are about as long as broad, the third is twice as long as broad, the following to the fourteenth are nearly four times as long as broad, and the succeeding very gradually decrease in length to the antepenultimate which is about twice as long as broad. The penultimate segment is very small, about as long as broad. The opposing spine is represented by a small conical tubercle, terminally situated. The terminal claw is short, conical, about as long as the penultimate segment, very slightly curved. All of the cirrus segments increase slowly in width to the distal end, which is slightly produced.

The ends of the basal rays are very prominent, continuing anteriorly the bare interradial lines of the centrodorsal in the form of conspicuous bridges between the deep but narrow subradial clefts.

The radials are short, 5 or 6 times as broad as long in the median line, and their interradial angles are strongly produced anteriorly, entirely separating the bases of the IBr_1. The tip of the interradial processes of the radials shows a deep U- or V-shaped notch. The proximal borders of the radials are straight and are separated from the centrodorsal by a deep but very narrow cleft.

The IBr_1 are short, from 3 to 4 times as broad as the median length, with their bases widely separated by the interradial processes of the radials, their lateral edges converging, and the distal border broadly V-shaped. The IBr_2 (axillaries) are nearly square, with the anterior sides slightly concave and the distal angle truncated; their proximal border is in the form of a right angle incising the anterior border of the IBr_1; their lateral angles extend for some distance beyond the anterolateral angles of the IBr_1. The dorsal surface of the IBr_1 and IBr_2 is very high and strongly arched, and the midline of both rises to the point of union between them, making, in profile, an angle of about 120°.

The 10 arms are apparently somewhat more than 120 mm. in length. The first brachials are short, with a longer outer than inner edge, deeply concave anteriorly, and with the bases just in contact interiorly. The second brachials are triangular, slightly longer than broad. The first syzygial pair (composed of the third and fourth brachials) is nearly as long as broad, very slightly longer inwardly than outwardly. The next 4 brachials are very slightly wedge-shaped, almost oblong, somewhat more than twice as broad as long, and the following are triangular, about as long as broad, distally becoming wedge-shaped again and finally elongate.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 or 4 muscular articulations.

P_1 is 14 mm. long, slender and evenly tapering, with 20 segments, of which the first is nearly 3 times as long as broad and the remainder are much elongated, the outer with slightly expanded distal ends. P_2 is similar, but about 1 mm. shorter. P_3 is slightly longer again and somewhat stouter with the first segment about as long as broad, the second nearly or quite twice as long as broad, and the following becoming progressively elongated. The fifth to ninth segments bear a long fusiform gonad. The following pinnules resemble P_3, becoming gradually shorter and then longer again distally. The distal pinnules are about 15 mm. long with the first segment very short, the second trapezoidal about as long as the greater (basal) width, and the third and following about twice as long as broad, becoming rather more elongate distally. These pinnules are slender, in this respect resembling P_1 and P_2.

Notes.—In 1908 I described 2 additional species of *Psathyrometra*, both of which I now believe to be identical with *Ps. fragilis*, as indicated in my memoir of 1937 on the crinoids of the Okhotsk and Japan seas. These were described wholly in terms of the centrodorsal.

In *Psathyrometra borealis* the centrodorsal was given as long conical, 6 mm. long and 5 mm. broad at the base, with the bare interradial lines as wide as, or slightly wider than, the columns of cirrus sockets and continued to the dorsal pole. The cirrus sockets are in 3 columns in each radial area, from 7 to 9 to a column, the columns within each radial area being separated from each other by narrow lines.

In the type of *Ps. borealis* the cirri, none of which are preserved for more than two-thirds of their length, seem to be identical with those of *Ps. fragilis.*

The posterior projection of the axillaries is rather stronger than in the type of *fragilis*, and the earlier brachials have traces of articular tubercles.

P_1 is 16 mm. long. P_2 is 14 mm. long. P_3 is 17 mm. long. P_4 is 16 mm. long. P_5 is 17 mm. long. P_6 is 18 mm. long. These pinnules resemble the corresponding pinnules in the type of *fragilis*, and as in that specimen P_1 and P_2 are rather more slender than P_3.

The distal portion of the arms is lacking.

In *Psathyrometra profundorum* the centrodorsal was described as long conical, 7 mm. long by 4.5 mm. broad at the base, the interradial lines being basally about half as broad as the cirrus sockets and apically become obsolete. There are 3 closely crowded columns of cirrus sockets in each radial area, 6 sockets to a column, the edges of the sockets being very prominent, especially the proximal edges.

On the arms the synarthrial and articular tubercles are especially well developed.

The radials, division series, and arm bases resemble those of the type of *Ps. fragilis*, but are rather more slender and delicate, though with the posterior projection of the axillaries and second brachials more developed.

P_1 is 16 mm. long with about 18 segments, of which the first is about twice as long as broad and the following become progressively elongated and exceedingly long and slender distally. P_2 is similar, 14 mm. long. P_3 is 13 mm. long and slightly stouter than the two preceding pinnules.

In a series of 11 specimens from *Albatross* station 4230, which at first I considered as representing a new species (*alascana*), the centrodorsal varies from a broadly truncated cone not much higher than wide at the base to very elongate, half again or more as high as broad. The cirrus sockets may be arranged in 3 regular and well-spaced columns as in the type of *borealis*, in 3 closely crowded columns as in the type of *profundorum*, or in 4 closely crowded columns as in the type of *fragilis.* There are frequently 3 regular columns with a greater or lesser number of additional cirrus sockets between them.

In a series of 57 specimens from *Albatross* station 4537 the centrodorsal shows much variation in length. The number of columns of cirrus sockets in each radial area is invariably 3, though they may be closely crowded or more or less widely separated.

It is almost certain that all the specimens mentioned above represent a single species, though it might be possible to consider those from *Albatross* stations 4230 and 5032 (southeastern Alaska and Yezo Strait, in 197 to 974 meters) as representing typical *fragilis*, and the remainder, all of which are from depths of more than 1200 meters, as representing a forma *borealis*.

Localities.—*Albatross* station 4537; Monterey Bay, California; Point Pinos Light House bearing S. 74° E., 7.4 miles distant; 1574–1941 meters; temperature 3.61° C.; hard sand and mud; May 31, 1904 [A. H. Clark, 1915] (57, U.S.N.M., 35784).

Albatross station 3342; off the Queen Charlotte Islands, British Columbia (lat. 52°39′30″ N., long. 132°38′00″ W.); 2903 meters; temperature 1.83° C.; gray ooze and coarse sand; September 3, 1890 [A. H. Clark, 1908] (2, U.S.N.M., 22669, 35742).

Albatross station 4230; Behm Canal, southeastern Alaska, in the vicinity of Naha Bay; Indian Point bearing N. 70° E., 5 miles distant; 197–439 meters; temperature 5.78° C.; rocky bottom; July 7, 1903 [A. H. Clark, 1918, as *alascana*] (11, U.S.N.M., 35787).

Albatross station 4780; east of Agattu Island, Aleutians (lat. 52°01′00″ N., long. 174°39′00″ E.); 1912 meters; temperature 2.17° C.; gray mud, sand and pebbles; June 7, 1906 [A. H. Clark, 1908] (1, U.S.N.M., 22670).

Albatross station 5032; Yezo Strait, between Yezo and Kunashir, Kuriles (lat. 44°05′00″ N., long. 145°30′00″ E.); 548–974 meters; temperature 1.61°–2.17° C.; brown or green mud, fine black sand and gravel; September 30, 1906 [A. H. Clark, 1907] (4, U.S.N.M., 22614, 35739, 36199). Type locality.

Albatross station 5082; Suruga Gulf, Japan; Omai Saki Light bearing N. 22° E., 33 miles distant (lat. 34°05′00″ N., long. 137°59′00″ E.); 1210 meters; temperature 3.17° C.; green mud, fine sand and globigerinae; October 20, 1906 (part of an arm and most of a cirrus, U.S.N.M., 35925).

Geographical range.—From Monterey Bay, California, northward to Alaska, thence westward to the western Aleutian Islands and southward to southern Japan.

Bathymetrical range.—From 439 (?197) to 2903 meters; the average of 6 records is 1299 meters.

Thermal range.—From 1.61° to 5.78° C.; the average of 6 records is 2.91° C.

Remarks.—As at present understood *Psathyrometra fragilis*, described in 1907, includes as synonyms *Ps. borealis* and *Ps. profundorum* described in 1908, and *Ps. alascana* inserted in the key to the species of *Psathyrometra* given in the *Siboga* report in 1918.

All of the known specimens have been dredged by the *Albatross*.

PSATHYROMETRA BIGRADATA (Hartlaub)

[See vol. 1, pt. 2, pl. 11, fig. 1028]

Antedon bigradata Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 145 (description; *Albatross* stas. 3358, 3404), pl. 1, fig. 5.—H. L. Clark, Proc. Washington Acad. Sci., vol. 4, 1902, p. 522 (from Hartlaub).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pp. 1578, 1580 (listed).

Psathyrometra bigradata, A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 240 (arm fragments from *Albatross* sta. 2818 possibly belong to this species); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 222 (compared with

Ps. congesta); Crinoids of the Indian Ocean, 1912, p. 234 (synonymy; locality); Die Crinoïden der Antarktis, 1915, p. 115 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 224 (in key; range), p. 226 (synonymy).

Psathyrometra, sp. A. H. Clark, Bull. Mus. Comp. Zool., vol. 51, No. 8, 1908, p. 240 (*Albatross* sta. 2818).

Diagnostic features.—The centrodorsal is a little shorter than its basal diameter; the cirrus sockets are not in contact with each other and are arranged in 4 columns in each radial area separated by narrow interradial lines; P_1 has about 13 segments; P_2 is shorter with about 9 segments.

Description.—The centrodorsal is truncated conical with somewhat swollen sides, according to the figure measuring 6 mm. across the base and 5 mm. high. The cirrus sockets are deep, about 80 in number, arranged in 4 columns of 4 each. The individual sockets are not in contact. Narrow interradial lines separate the radial areas.

The cirri are not known.

Narrow subradial clefts are present, bounded by high interradial bridges.

The radials are short. The IBr_1 are short; their dorsal profile stands out at right angles to the dorsoventral axis and forms a right angle with the dorsal profile of the axillary, which is parallel to this axis. The IBr_2 (axillaries) are longer than broad with the proximal angle sharp and much produced and the lateral angles turned distally.

There are 10 arms. The first brachials are short, and shorter dorsally than ventrally. The second brachials are triangular, bearing the same relation to the first brachials that the axillaries do to the IBr_1. The first syzygial pairs (composed of the third and fourth brachials) are moderately short. The next 4 brachials are fairly short and trapezoidal, about half as long on the pinnule-bearing side as on the other.

P_1 has about 13 segments of which the first is markedly longer than broad and the second is at least 2 mm. long. P_a is small and also has elongated basal segments. P_2 is shorter than P_1 with 9 segments of which the basal are likewise all elongate. In P_3, which is also composed of 9 segments, the 2 basal segments are scarcely longer than broad and those following are also proportionately shorter.

The disk in the specimen from *Albatross* station 3404 is 12 mm. in diameter.

Localities.—*Albatross* station 3404; between Chatham and Hood Islands, Galapagos (lat. 1°03′00″ S., long. 89°28′00″ W.); 704 meters; temperature 6.22° C.; rocky bottom; March 28, 1891 [Hartlaub, 1895]. Type locality.

Albatross station 2818; east of Santa Cruz Island, Galapagos (lat. 0°29′00″ S., long. 89°54′30″ W.); 716 meters; temperature 6.61° C.; white and black sand; April 15, 1888 [A. H. Clark, 1908] (arm fragments, U.S.N.M., 36209).

Albatross station 3358; in the vicinity of Mariato Point, Panama (lat. 6°30′00″ N., long. 81°44′00″ W.; 1014 meters; temperature 4.56° C.; green sand; February 24, 1891 [Hartlaub, 1895].

The type is not in the M.C.Z., according to Dr. E. Deichmann, to whom thanks are due.

Geographical range.—Galapagos Islands and the coast of Panama.

Bathymetrical range.—From 704 to 1014 meters; the average of three records is 811 meters.

Thermal range.—From 4.56° C. to 6.61° C.; the average of three records is 5.80° C.

Remarks.—In his original account (1895) Hartlaub did not say at which of the two localities he gave the specimen described and figured by him was obtained. The only dimension he gives, the diameter of the disk, was taken from the specimen from station 3404. There seems to be no reason why this should not be considered as the type locality.

In 1908 I recorded under the heading *Psathyrometra*, sp., some arm fragments from *Albatross* station 2818, near station 3404 and at almost the same depth and temperature. There can be no doubt that these came from a specimen of Hartlaub's species.

PSATHYROMETRA CONGESTA (A. H. Clark)

[See vol. 1, pt. 1, fig. 208, p. 241]

Psathyrometra congesta A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 213 (in key), p. 221 (description; *Albatross* sta. 3992); Notes Leyden Mus., vol. 34, 1912, pp. 141, 142 (compared with *Ps. inusitata*); Crinoids of the Indian Ocean, 1912, p. 235 (synonymy; locality); Die Crinoïden der Antarktis, 1915, p. 116 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 224 (in key; range), p. 228 (references).

Diagnostic features.—The centrodorsal is about as high as it is broad at the base, with the 20 columns of cirrus sockets closely crowded and not divided into radial groups by naked areas. The cirri and pinnules are unknown.

Description.—The centrodorsal is conical with the tip rather sharply rounded, 5 mm. broad at the base and 5 mm. high; about its sides it bears 20 crowded columns of cirrus sockets, 4 columns of 5 sockets each in every radial area. There is no division of the sides of the centrodorsal into radial areas, though the downward extension of the ends of the basal rays may separate slightly the adjacent sockets.

The cirri are lacking.

The ends of the basal rays are prominent, forming a dorsoventrally elongate tubercle which at its lower end separates the two topmost cirrus sockets of adjacent radial areas. A deep narrow subradial cleft is present, bridged over interradially by the ends of the basal rays.

The radials are visible only as small triangles over the upper end of the tubercles representing the ends of the basal rays. The IBr_1 are short with converging lateral borders and with the anterior edge deeply incised by a strong posterior process from the axillary. The IBr_2 (axillaries) are rhombic, longer than broad, with the distal angle approximately a right angle, the proximal angle acute, and the two proximal sides rather strongly concave. A fairly sharp high median keel occupies the proximal two-thirds of the ossicle.

There are 10 arms, all of which are broken. The first brachials are short, longer exteriorly than interiorly, very sharply incised by an angular proximal prolongation from the second brachials, and interiorly united for their proximal half, their inner sides from the point of union diverging in a straight line which is at right angles to their apposed edges. The second brachials are triangular, somewhat longer than broad. The following brachials are at first slightly wedge-shaped, almost oblong, broader than long, soon becoming triangular and as long as broad, and wedge-shaped and finally elongate distally. The distal edges of the brachials have a slight spinous projection.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

Locality.—*Albatross* station 3992; off Kauai, Hawaiian Islands; Mokuaeae Islet bearing S. 54° E., 3.5 miles distant; 965 meters; temperature 4.22° C.; fine gray sand and mud; June 12, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 22684).

PSATHYROMETRA ERYTHRIZON (A. H. Clark)

[See vol. 1, pt. 1, figs. 212–213 (p. 241); pt. 2, figs. 117 (p. 79), 295 (p. 221)]

Antedon erythrizon A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 79 (description; *Albatross* sta. 4981).—Sowerby, The naturalist in Manchuria, Tientsin, vol. 5, 1930, p. 79.

Psathyrometra erythrizon A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Crinoids of the Indian Ocean, 1912, p. 234 (synonymy; locality); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (in the arctic fauna of the Okhotsk and Japan Seas; probably an intrusion here under present conditions); No. 6, p. 213 (antarctic; entry into Okhotsk and Japan Seas), p. 215 (member of the Japanese arctic fauna; range and its significance); Die Crinoïden der Antarktis, 1915, p. 115 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 224 (in key; range), p. 226 (references).—Gislén, Ark. Zool., vol. 15, No. 23, 1923, p. 15.—A. H. Clark, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 218 (in key; locality and range), pp. 221, 222 (in Russian), p. 224 (in key; synonymy; range), pp. 229, 230.

Diagnostic features.—The centrodorsal is broadly truncated, about as high as it is broad at the base; the cirrus sockets are arranged in 3 columns in each radial area, which are separated by bare interradial bands; the cirri are about LXV, 35–40 and about 50 mm. long when the arm length is 140 mm.; P_1 with 16 segments is about 20 mm. long; P_2 is shorter, 15 mm., with 12 segments, and the following pinnules become at first still shorter and then more elongate.

Description.—The centrodorsal is truncated conical, 6 mm. broad at the base and 6 mm. high, with nearly straight sides and a concave dorsal pole 2 mm. in diameter. The cirrus sockets, which are oblong with broadly rounded corners, longer dorsoventrally than transversely, are arranged in 3 regular columns in each radial area, there being 4 or 5 sockets in each column which decrease gradually in size from the periphery to the dorsal pole. The sockets in each column are usually in touch with those above and below. The columns may be in contact or separated by very narrow lines. The radial areas are delimited by bare interradial bands that run from the periphery to the dorsal pole and gradually decrease in width and which are nearly or quite as broad as the sockets of the adjacent columns.

The cirri are about LXV, 35–40, about 50 mm. long, strongly compressed laterally. The first segment is short, the second and third are about as long as broad, the fourth is half again as long as broad, the fifth is twice as long as broad, and the following are about 3 times as long as broad, after the twenty-second slowly decreasing in length to the antepenultimate, which is twice as long as broad, and the penultimate, which is about as long as broad. The terminal claw is very small.

The ends of the basal rays are visible as small tubercles continuing the interradial lines of the centrodorsal to the interradial angles of the calyx and bridging over the narrow subradial clefts.

The radials are very short in the median line, but extend well upward in the angles of the calyx where the truncate tip of the triangle formed by two adjacent radials separates the bases of the IBr_1. The IBr_1 are short and very deeply incised by the proximal projection from the axillary. The IBr_2 (axillaries) are as long as broad, 4 mm. long by 4 mm. broad, with all the sides, especially the two distal, concave and the proximal angle as well as the distal sharp; the lateral angles do not touch those of their neighbors. The dorsal surface of the IBr series is high and well-rounded. On the line of union between the IBr_1 and IBr_2 there is a strong articular tubercle which in profile makes an angle of about 120° and shows a slightly blunted apex.

The 10 arms are probably at least 130 mm. long. The first brachials are short, twice as long exteriorly as interiorly, and very deeply incised by the second brachials; interiorly they are just in contact basally, their inner borders diverging at an angle of about 45° to 60°. The first syzygial pair (composed of the third and fourth brachials) is oblong, and almost twice as broad as long. The next 5 brachials have slightly oblique ends and are more than twice as broad as long in the median line; those after the third syzygy become almost triangular, about as long as broad, and the distal become wedge-shaped and finally elongate.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 to 11 (usually 4) muscular articulations.

P_1 is about 20 mm. long, tapering gradually from the base to the tip, composed of 16 segments, of which the first is about twice as long as broad and the following gradually become more elongate; the 5 basal segments are strongly flattened, the remainder more cylindrical. P_2 is 15 mm. long with about 12 segments, of which the first is somewhat less than half again as long as broad, the second is twice as long as broad, and the following become progressively elongated. P_3 is similar, but shorter, with the first segment as broad as long and the remainder proportionately shorter than the corresponding segments in P_2. P_4 and P_5 are shorter still with shorter segments. The following pinnules become more slender and less flattened basally with relatively shorter and more slender segments. The distal pinnules have the first segment oblong, about half as long as broad, the second trapezoidal, about as long as broad, and the following increasingly elongate.

Notes.—In a smaller specimen taken with that just described, the centrodorsal is 4 mm. broad at the base and 4 mm. high, there are only 2 or 3 cirrus sockets in each column, and the brachials are relatively longer.

Locality.—*Albatross* station 4981; northeastern part of the Sea of Japan, off Iwanai; Benkei Mizaki Light bearing S. 9° E., 8.8 miles distant (lat. 42°58′15″ N., long. 140°09′10″ E.); 713–742 meters; temperature 0.39° C.; green mud; September 19, 1906 [A. H. Clark, 1907] (2, U.S.N.M., 22613, 35657).

PSATHYROMETRA MIRA A. H. Clark

[See vol. 1, pt. 1, figs. 98, p. 159, 228, p. 245]

Psathyrometra mira A. H. Clark, Proc. U.S. Nat. Mus., vol. 36, 1909, p. 648 (description; 11°31′40″ N., 92°46′40″ E.; 188–220 fms.); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 149 (compared with *Ps. gracillima*); Proc. U.S. Nat. Mus., vol. 39, 1911, p. 562 (compared with *Ps. parva*); Rec. Indian Mus., vol. 7, pt. 3, No. 26, 1912, p. 270 (west of Alleppey, 406 fms.; 13 miles S. by W. from North Sentinel I., Andamans, 130–250 fms.; 7 miles SE. by S. from Ross I., 265 fms.); Notes Leyden Mus., vol. 34, 1912, p. 140 (compared with *Ps. major*); Crinoids of the Indian Ocean, 1912, p. 21 (intermediate between *Psathyrometra* and *Leptometra*), p. 235 (synonymy; detailed description; localities), fig. 43, p. 235; Die Crinoïden der Antarktis, 1915, p. 116 (range), p. 117 (characters of the centrodorsal); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 225 (in key; range), p. 227 (references; notes; stas. 45, 170), pp. 271, 273 (listed); Smithsonian Misc. Coll., vol. 91, No. 4, 1934, p. 4 (compared with *P. acuta*); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 87 (listed), p. 94 (*Mabahiss* sta. 109; notes; range), pp. 102, 104 (listed).

Psathyrometra parva A. H. Clark, Proc. U.S. Nat. Mus., vol. 39, 1911, p. 562 (description; *Albatross* sta. 5284; compared with *Ps. mira*); Crinoids of the Indian Ocean, 1912, p. 236 (synonymy; locality); Die Crinoïden der Antarktis, 1915, p. 116 (range), p. 117 (characters of centrodorsal; comparison with *Ps. antarctica*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 225 (in key; range), p. 228 (references).

Psathyrometra major A. H. Clark, Rec. Indian Mus., vol. 7, pt. 3, No. 26, 1912, p. 270 (*Investigator* sta. 115; *nomen nudum*); Notes Leyden Mus., vol. 34, 1912, p. 140 (description; *Siboga* sta. 45); Die Crinoïden der Antarktis, 1915, p. 116 (range), p. 117 (characters of the centrodorsal; comparison with *Ps. antarctica*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 224 (in key; range), p. 226 (references; notes; sta. 45; *Investigator* sta. 115), fig. 12, p. 227, p. 271 (listed), pl. 26, fig. 87.

Psathyrometra inusitata A. H. Clark, Rec. Indian Mus., vol. 7, pt. 3, No. 26, 1912, p. 270 (*nomen nudum;* 7 miles SE. by S. from Ross I., 265 fms.); Notes Leyden Mus., vol. 34, 1912, p. 141 (description; *Siboga* sta. 45); Die Crinoïden der Antarktis, 1915, p. 116 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga* and its significance), p. 225 (in key; range), p. 229 (detailed description; stas. 38, 45, 178, 314, 316; 7 miles SE. from Ross I., 265 fms.), fig. 13, p. 229, pp. 271, 274, 276 (listed), pl. 26, figs. 88, 89.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 140.

Psathyrometra, sp. A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 231 (sta. 38), p. 271 (listed).

Psathyrometra wireni Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 138, figs. 128–132, p. 134, pl. 2, fig. 12 (description; Sixten Bock's sta. 6); Ark. Zool., vol. 15, No. 23, 1923, p. 15; Zool. Bidrag Uppsala, vol. 9, 1924, p. 82; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (stas. 6, 18; 360–450 meters), p. 47 (stations; notes), pp. 68, 69 (listed).

Diagnostic features.—The centrodorsal is almost as high as it is wide at the base in large specimens but relatively lower in small ones; five interradial furrows separate the crowded cirrus sockets into radial groups of usually 2 converging lateral columns and a shorter median one (the latter absent in small specimens); the cirri are about XLV, with up to 29 segments and 55 mm. long; P_1 has 20 to 30 segments and is very slender; P_2 may be similar or stouter and shorter with fewer segments.

Description.—The centrodorsal is nearly conical with straight sides and the tip slightly blunted, usually nearly as high as broad at the base, in large individuals such as the type specimen of *Ps. major* about 5.5 mm. in basal diameter and 5.0 mm. high. [Note by A.M.C.: This is the length from the apex to the interradial border; the vertical height would probably be a little less, about 4.2 mm.] The sides are divided into five radial areas by five interradial furrows, from shallow and U-shaped to deep and V-shaped, which are nearly or quite as broad as the adjacent cirrus sockets. The sockets in each radial area are closely crowded and are arranged in two marginal converging columns of three or four each with a short median column of from one to three (usually two) sockets between the proximal ends of the converging lateral columns which meet beyond it.

Very few fully developed cirri have been observed; the type of *Ps. major* has one entire cirrus and another with a broken tip. These are 55 mm. long and consist of 29 segments, of which the first is very short, the second is about twice as broad as long, the third is slightly longer than broad, the fourth is about twice as long as the diameter of the expanded distal end, the fifth is nearly or quite three times as long as the distal width, the sixth to ninth or tenth are slightly longer than the fifth, and the following ones decrease almost imperceptibly in length so that the nineteenth and following are about twice as long as broad. From the twenty-third segment onward the cirri taper to a very slender tip, and the segments increase in relative length so that the distalmost are five or six times as long as broad. From the third onwards in lateral view the segments are gently concave both dorsally and ventrally so that the articulations are prominent; but this feature decreases and disappears in the relatively short distal segments. The cirri are moderately compressed laterally throughout their entire length.

In large specimens the ends of the basal rays are visible in the angles of the calyx as small tubercles which only with difficulty are distinguishable from the general surface of the centrodorsal and radials. They are not discernible in small individuals.

There are no subradial clefts.

The distal edge of the radials is even with the rim of the centrodorsal in the median line (projecting for a slight distance beyond it in young individuals), but the radials are produced upward in the angles of the calyx, where the truncated tip of the process formed by two adjacent radials entirely separates the bases of the IBr_1. The IBr_1 are relatively large, about two and a half times as broad as long, with the lateral borders almost or quite straight and slightly convergent and the distal border straight or slightly depressed in the center. The IBr_2 (axillaries) are broadly pentagonal, from about as long as broad to nearly half again as broad as long, with the lateral borders not quite so long as those of the IBr_1 with which they form a broadly obtuse angle, and the lateral angles produced. The distal sides, which are only slightly concave, form approximately a right angle with each other.

The 10 arms are broken in all the known specimens, and usually lost at the first syzygy. In the largest individuals the distance from the distal edge of the radials to the first syzygy is 8.0 mm. The first brachials are slightly wedge-shaped, about twice as broad as the exterior (greater) length and entirely free interiorly, their inner edges making with each other an angle of about 90°. The second brachials are considerably larger, not quite so long as broad. There is little or no trace of synarthrial tubercles.

In a specimen from *Siboga* station 45 with the centrodorsal 4.0 to 4.5 mm. in diameter, P_1 is 10 mm. long with 22 segments, of which the first is short and the following gradually increase in length, becoming about as long as broad on the eighth and two or three times as long as broad terminally. The short earlier segments have their corners cut away as in *Heliometra*. The pinnule is slender and becomes flagellate distally. P_2 is 10 mm. long with 23 segments, resembling P_1. P_3 is 9 mm. long with 21 segments, similar to but slightly more slender than the first two pinnules, very slightly less stout basally, but tapering less rapidly and without the flagellate tip. P_4 is 8 mm. long with 18 segments, and resembles P_3. P_1 has the corners of the basal segments cut away more than does P_2, which itself has this feature more marked than does P_3. P_1 has a longer flagellate tip than P_2 and is in general more flexible, and P_2 differs from P_3 in the same way.

Notes.—In the type specimen of *Ps. mira* the sharply conical centrodorsal is 4 mm. broad at the base and 4 mm. high. The interradial furrows are shallow with a rounded bottom, and the median column of cirrus sockets is represented by only a single socket situated between the distal ends of the peripheral sockets in the two outer columns, which columns come into contact just beyond it.

In another specimen recorded in 1918 as *Ps. mira* the centrodorsal is relatively longer, 4.0 mm. in diameter at the base and 4.25 mm. from the apex to the interradial border. [Note by A.M.C.: I have also measured this specimen and estimate the basal diameter to be 4.5 mm. and the vertical height 3.9 mm.]

In the type specimen of *Ps. parva* the centrodorsal is 3.2 mm. broad at the base and 4.0 mm. high. [Note by A.M.C.: The vertical height is probably about 3.7 mm.] There are no sockets between the lateral converging columns, but sometimes one of the proximal sockets in these columns may be displaced more or less inwardly. The interradial furrows are very shallow. An example from *Investigator* station 116 is similar.

In the type of *Ps. inusitata* the centrodorsal is small and conical, the sides hardly, if at all, convex, 3.2 mm. broad at the base and 2.4 mm. high. [NOTE BY A.M.C.: If the figure given in the *Siboga* report is correct in the proportions of the centrodorsal, the vertical height is also about 2.4 mm., so in this case, at least, Mr. Clark appears to have made his assessment of height in lateral view rather than along the surface of the centrodorsal from apex to interradial edge.] The radial areas are delimited by very narrow irregular bare spaces which at the periphery of the centrodorsal are rarely as much as half as broad as the adjacent cirrus sockets, and are more or less encroached upon by the sockets on either side so that their course is usually more or less zigzag or irregular. They are scarcely to be recognized otherwise than that the outer columns in each radial area are slightly separated from the outer columns in the adjacent areas whereas within each radial area all the sockets are closely crowded together. Each radial area contains 3 columns of cirrus sockets, the 2 outer of 4 each, the median of 2 only, being occluded apically by the outer columns coming together. At the dorsal pole there are more or less numerous pits representing obsolete cirrus sockets. Some of these are situated in the interradial lines, and their arrangement appears to be in alternating rows instead of in columns.

In the description of *Ps. wireni* Gislén gives the details of a young detached but complete cirrus. This was 10 mm. long with 18 segments, of which the first is short, the second is about as long as broad, the third is three quarters again as long as broad, the fourth is two and a half times as long as broad, and the fifth to seventh are from three to three and a half times as long as broad; the following segments slowly decrease in length so that the antepenultimate is two and a quarter times as long as broad and the penultimate is twice as long as broad. The terminal claw is almost straight, half as long as the penultimate segment. Gislén records also the occurrence of the first seven segments of a fully grown cirrus. These are larger and stouter than the corresponding segments in the young cirrus, but of about the same proportions except for the third, which is one third again as long as broad. This cirrus, according to Gislén, was probably about 15 mm. in total length.

In the type of *Ps. inusitata* no basal rays are visible. The radials are even with the rim of the centrodorsal in the median line, but extend distally in the interradial angles where their distal lateral angles are slightly separated. The IBr_1 are short, proximally nearly 4 times as broad as long in the median line but with the sides converging so that the distal border is only about 3 times the median length. They are widely separated from their neighbors. The IBr_2 (axillaries) are rhombic, half again as broad as long, with the distal angle produced and the lateral angles extending far beyond the distal lateral angles of the IBr_1. The synarthrial tubercle is only slightly indicated.

In *Ps. wireni* the radials are only visible in the interradial angles, and Gislén does not mention the basal rays. The IBr_1 are free laterally, 4 times as broad as long in the median line, with converging sides. The IBr_2 are a third again as broad as long, rhombic, with the lateral angles extending beyond the laterodistal angles of the IBr_1, the distal angle narrow and very much produced, and the proximal angle rounded. There is a low synarthrial tubercle.

In the type of *Ps. inusitata* all the arms are broken. The first brachials are 3 times as long exteriorly as interiorly, and basally half again as broad as the exterior length. The inner sides are entirely free, and make approximately a right angle with each other. The outer sides just touch those of the first brachials on adjacent rays.

The second brachials are irregularly quadrate, the two on each post-radial series being in contact interiorly so that a prominent rhombic gap is left between the first brachials. The first syzygial pair (formed of the third and fourth brachials) is slightly longer interiorly than exteriorly, and about as broad as the interior length. The next four brachials are slightly wedge-shaped, twice as broad as the median length. The following brachials become more obliquely wedge-shaped. [Note by A.M.C.: The width at the first syzygy is 1.5 mm. and the length from IBr_1 to the second syzygy (9+10) is 10.0 mm.]

In *Ps. wireni* the 10 arms are probably about 60 mm. long. The first brachials are 2 or 3 times as long exteriorly as interiorly, basally in contact interiorly. The second brachials are very much shorter interiorly than exteriorly. There is a slight synarthrial tubercle on the line of union between the first and second brachials. After the twelfth the ends of the brachials become oblique. The first 10 brachials have their distal edges somewhat thickened and everted; distally the arms are smooth.

The distance from the radials to the first syzygy is 3.2 mm.

In *Ps. inusitata* syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of usually 4 muscular articulations; but the distal intersyzygial interval can only be estimated, as the outer part of the arms in all the specimens is lost. [Note by A.M.C.: In a specimen from *Siboga* station 45 the second syzygy is very irregular in position; on the six remaining arms it occurs twice each at brachials 11+12, 10+11, and 9+10. The length from the IBr_1 to the second syzygy at 9+10 is 13.5 mm. and the width at the first syzygy is 2.0 mm. The centrodorsal I estimate as 4.5 mm. in basal diameter.]

In *Ps. wireni*, according to Gislén, syzygies occur between brachials 3+4, 9+10, 14+15, and 21+22; or between brachials 3+4, 9+10, 16+17, 20+21, etc., with a distal intersyzygial interval of 3 muscular articulations.

In *Ps. wireni* P_1 is 6 mm. long, very slender and flagellate, composed of about 30 segments, of which the first 5 are broader than long to as long as broad with their angles cut away, and the following are slender, from half again to twice as long as broad, and more or less constricted centrally. P_a is similar, with about 25 segments. P_2 is stouter than P_1, from 3.5 to 4.0 mm. long, with 11 to 12 segments, of which the first 3 are broader than long and the remainder are from two to two and a half times as long as broad; the fifth to eighth segments bear a large gonad. P_b is similar, with 11 segments. The distal pinnules are 5.5 mm. long, with 16 segments, of which the first and second are short and the third and following are from two and a half to three times as long as broad, slender, with somewhat swollen articulations.

In *Ps. inusitata* P_1 is exceedingly slender and delicate with the first segment broader than long, the next 5 about as long as broad, the seventh slightly longer than broad, and the following becoming greatly elongated. P_2 is much stouter with the first 4 segments short but the following rapidly increasing in length and the outer exceedingly elongated.

In *Ps. wireni* the disk is slightly incised, without visible calcareous deposits, and measures 4.5 mm. in diameter.

Of the specimens taken by Dr. Th. Mortensen in Japan, one has the centrodorsal 1.6 mm. in diameter and 1.0 mm. in height. The cirri are in five groups separated by interradial cirrus-free areas, in each group two rows converging towards the tip of the centrodorsal. The cirri are in three to four whorls and there are six to seven in each group. One cirrus is preserved to the fifteenth segment. The sixth to eighth segments are the longest, with the length four times the breadth. There is no dorsal spine. The arms are broken. The length from the centrodorsal to the first syzygy is 2.2 mm. P_1 has about 22 segments and measures 4.5 mm. in length. P_2 has 10 segments and is 2.6 mm. long with a small gonad on the fifth to sixth segments. P_a is 4.6 mm. long and P_b 2.2 mm. long.

Another specimen with the centrodorsal 1.3 mm. high has the interradial cirrus-free area equal to the width of half a cirrus socket. The cirri are XXXIII, six or seven in each group, a third row in each radius comprising one socket only. The distance from the centrodorsal to the first syzygy is 2.7 mm. P_1 is about 4.5 mm. long. P_2 bears a gonad.

A third specimen with the centrodorsal 1.3 mm. high has about XXX cirri, with 20 to 22 segments, measuring 17 to 23 mm. in length. The longest segments are three to four times as long as broad. The arms are 60 mm. long. The syzygial interval is two to three muscular articulations. P_2 has about 14 segments, measures 4.8 mm. and has a stout gonad on the fourth to eighth segments.

Gislén (1927) comments that the smaller specimens lack the mid-radial cirrus row.

Localities.—*Investigator* station 197; west of Alleppey, Travancore, southwestern India (lat. 9°34′57″ N., long. 75°36′30″ E.); 742 meters; temperature 8.9° C.; green mud; January 20, 1895 [A. H. Clark, 1912] (2, I. M.).

Investigator station 116; Duncan Passage, Andaman Islands (lat. 11°25′05″ N., long. 92°47′06″ E.); 740 meters; temperature 8.3° C.; green mud; December 9, 1890 [A. H. Clark, 1912] (1, U.S.N.M., 35743).

Investigator station 115; Duncan Passage, Andaman Islands (lat. 11°31′40″ N., long. 92°46′06″ E.); 344–402 meters; temperature 13.3° C.; green mud; December 9, 1890 [A. H. Clark, 1909, 1912] (2, U.S.N.M., 35744; I.M.). Type locality.

Investigator station 9; 13 miles S. by W. from North Sentinel Island, Andamans; 238–457 meters; February 7, 1888 [A. H. Clark, 1912] (1, I. M.).

Investigator station 13; 7 miles SE. by S. from Ross Island, Andamans; 484 meters; April 25, 1888 [A. H. Clark, 1912] (2, I. M.).

Investigator station 223; northeast of the Andaman Islands, off the Gulf of Martaban (lat. 14°54′30″ N., long. 96°13′ E.); "11 meters"; soft mud; January 26, 1897 [A. H. Clark, 1912] (1, U.S.N.M., 35741).

Siboga station 178; Ceram Sea, north of Ceram (lat. 2°40′00″ S., long. 128°37′30″ E.); 835 meters; blue mud; September 2, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 170; Ceram Sea, between Ceram and New Guinea (lat. 3°37′42″ S., long. 131°26′24″ E.); 924 meters; fine gray mud; August 25, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 316; Flores Sea, north of Lombok (lat. 7°19′24″ S., long. 116°49′30″ E.); 538 meters; fine dark brown sandy mud; February 19, 1900 [A. H. Clark, 1918] (2, U.S.N.M., E. 446; Amsterdam M.).

Siboga station 38; Flores Sea, among the Paternoster Islands (lat. 7°35′24″ S., long. 117°28′36″ E.); 521 meters; coral; April 1, 1899 [A. H. Clark, 1918] (1, and fragments of another, Amsterdam M.).

Siboga station 314; Flores Sea, north of Sumbava (lat. 7°36′00″ S., long. 117°30′48″ E.); 694 meters; fine sandy mud; February 17, 1900 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 45; Flores Sea, north of Sumbava (lat. 7°24′ S., long. 118° 15′12″ E.); 794 meters; fine gray mud with some radiolarians; April 6, 1899 [A. H. Clark, 1912, 1918] (2, Amsterdam M.).

Albatross station 5284; Balayan Bay, between southern Luzon and Mindoro; Malavatuan Island (S.) bearing N. 46° W., 14.25 miles distant (lat. 13°42′05″ N., 120°30′45″ E.); 771 meters; temperature 5.72° C.; gray mud and globigerinae; July 20, 1908 [A. H. Clark, 1911] (2, U.S.N.M., 27508, 36276).

Dr. Sixten Bock's Expedition to Japan station 6; Kagoshima and Okinoshima, Kiu Shiu; 110 or 201–402 meters; May 13–14, or 18, 1914 [Gislén, 1922].

Dr. Th. Mortensen, May 13, 1914; station 6, 16 miles W. to S. from Bonomisaki, Kiu-Shiu, Japan; 366 meters [Gislén, 1927] (3, C.M.).

Dr. Th. Mortensen, June 10, 1914; station 18, off Misaki, Japan; 457 meters [Gislén, 1927] (1, C.M.).

Mabahiss station 109; Zanzibar area (lat. 5°10′36″ S., long. 39°33′48″ E.); 640 meters; temperature at 627 meters, 8.86° C., salinity 34.84°/₀₀; bottom light gray mud [A. H. Clark, 1937] (1, B.M.).

Geographical range.—From off Zanzibar to southwestern India, New Guinea, the Philippines and southwestern Japan.

Bathymetrical range.—From 366 (?201) to 924 meters; the average of 16 records is 595 meters.

Thermal range.—From 5.72° C. to 13.3° C.; the average of 5 records is 9.02° C.

Salinity range.—The single record is 34.84 parts per thousand.

Remarks.—With *Ps. mira*, described in 1909, I have united as synonyms *Ps. parva*, described in 1911, *Ps. major* and *Ps. inusitata* described in 1912, and *Ps. wireni* described by Dr. Torsten Gislén in 1922.

The types of *Psathyrometra mira*, *Ps. major*, and *Ps. parva* are all quite alike except for a difference in size and in the details of the arrangement of the cirrus sockets on the centrodorsal. In *Ps. major* the median column of cirrus sockets in each radial area consists of 2, or of 2 and a more or less developed third, sockets. In *Ps. mira* there is only a single median socket, and in *Ps. parva* there are only the 2 lateral columns. But in a specimen from *Investigator* station 116 there are only the 2 lateral columns in 2 radial areas while there is a single median socket in each of the other 3, disposing of the supposed difference between *Ps. parva* and *Ps. mira;* and *Ps. mira* intergrades with *Ps. major* in the same way.

The specimens which have been referred to *Ps. inusitata* are all small; but the centrodorsal is sharply conical as in the others. About the dorsal pole there are a number of obsolete cirrus sockets which appear to be arranged in alternate rows without any trace of a segregation into radial areas, as in the species of Bathymetrinae. But on the rest of the centrodorsal the cirrus sockets are assuming a columnar arrangement which is obviously the same as that characteristic of *Ps. mira*. The IBr series and lower brachials resemble those of some of the Bathymetrinae more than they do those of *Ps. mira*. But this form is common to most young comatulids and can, I think, be safely regarded as a condition correlated with the condition of the centrodorsal.

The pinnules of *Ps. inusitata* resemble those of *Ps. mira*, which are of a quite unusual kind, and this correspondence in the pinnulation seems to me more than to outweigh the differences in the basal arm structure.

The great variability among the specimens called *inusitata* which I have examined suggests that they are immature and do not represent a distinct species themselves.

At *Investigator* station 13 and at *Siboga* stations 38 and 45 *inusitata* was associated with *mira*. At *Siboga* stations 178, 314, and 316 *inusitata* was found alone. The occurrence with *mira* suggests a relationship between the two, since nowhere are two species of this, or of any of the related genera, ever found together. The occurrence alone at 3 stations very likely means that the larger individuals, which in most of the Antedonidae are much more brittle than the young, were so fragmented that they were not considered worth preserving.

I can find no tangible differences between Gislén's *Ps. wireni* and this species as represented by *inusitata*.

PSATHYROMETRA MINIMA (A. H. Clark)

Figure 26

Psathyrometra minima A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 141 (description; *Siboga* sta. 48); Die Crinoïden der Antarktis, 1915, p. 116 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga* and its significance), p. 226 (in key; range), p. 228 (description; sta. 48), p. 271 (listed), pl. 26, fig. 91.

Psathyrometra minimus A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 117 (comparison with *Ps. antarctica*).

Diagnostic features.—The single known specimen has the centrodorsal 1.9 mm. in basal diameter and 1.6 mm. in vertical height, with 4 or 5 cirrus sockets in each radial area in two irregular columns; interradially there is a flat or slightly grooved space between the columns; the arms, cirri and pinnules are unknown.

Description [by A.M.C.].—The centrodorsal is conical with the sides fairly straight

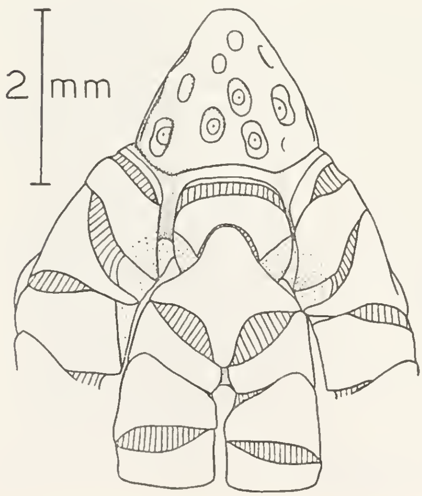

Figure 26.—*Psathyrometra minima* A. H. Clark, holotype.

and the apex slightly blunted; it is 1.9 mm. in basal diameter and 1.6 mm. in vertical height viewed radially; the cirrus sockets of adjacent radial areas are separated by flat or slightly grooved vertical bands about the width of a socket, whereas the sockets within each area are closer together. The arrangement of the sockets is irregular but there is a tendency towards apically converging columns with 1 to 3 sockets in each, but those on the apical third of the centrodorsal appear to be obsolete.

The cirri are unknown.

The radials are produced interradially so that the bases of the division series are separated from one another.

The axillaries are rhombic with a pronounced but rounded proximal angle, sharp lateral angles and a prolonged distal angle; all the sides are therefore markedly concave.

Only three smooth brachials of each arm have been preserved. The width at the first syzygy is 1.0 mm.

Locality.—*Siboga* station 48; Flores Sea (lat. 8°04′42″ S., long. 118°44′18″ E.); 2060 meters; fine gray mud, partially green; April 13, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.).

PSATHYROMETRA ANOMALA A. H. Clark

FIGURE 27

Psathyrometra anomala A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 143 (description; *Siboga* sta. 211); Die Crinoïden der Antarktis, 1915, p. 116 (range), p. 117 (characters of the centrodorsal; comparison with *Ps. antarctica*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga* and its significance), p. 225 (in key; range), p. 230 (description; sta. 211), p. 274 (listed), pl. 26, fig. 90.—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 139, 140 (comparison with *Ps. wireni*); Ark. Zool., vol. 15, No. 23, 1923, p. 15; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 48 (compared with *Ps. wireni*).

Diagnostic features.—The single specimen known has the low conical centrodorsal 1.7 mm. in basal diameter and 1.0 mm. in vertical height; the radial areas of the centrodorsal each have 2 columns of about 2 cirrus sockets and are separated by narrow, irregular, raised interradial areas; the cirri are unknown.

Description [by A.M.C.].—The centrodorsal is low rounded conical, 1.7 mm. in basal diameter and 1.0 mm. in vertical height. The surface is slightly raised around the cirrus sockets a little more prominently in the interradii. The sockets are arranged in nearly vertical columns, usually two sockets in each of the two columns in each radial area but the upper one may be obsolete. In one radial area there is a small peripheral midradial socket in addition.

The cirri are unknown.

The axillaries have a very obtuse proximal angle and a moderately produced distal one, so that only the distal sides are markedly concave.

The width of the arms at the first syzygy (3+4) is 0.8 mm. and the length from the proximal edge of the IBr_1 to the second syzygy (9+10) is 7.0 mm.

The pinnules have very elongated segments, some of which are expanded at the joints. P_1 has 10+ segments, possibly about 15; P_2 or P_3 may be the first genital pinnule. Beyond the gonad the segments are very attenuated but tapering.

Locality.—*Siboga* station 211; Banda Sea (lat. 5°40′42″ S., long. 120°45′30″ E.); 1158 meters; coarse gray mud, the superficial layer more fluid and brown; September 25, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.).

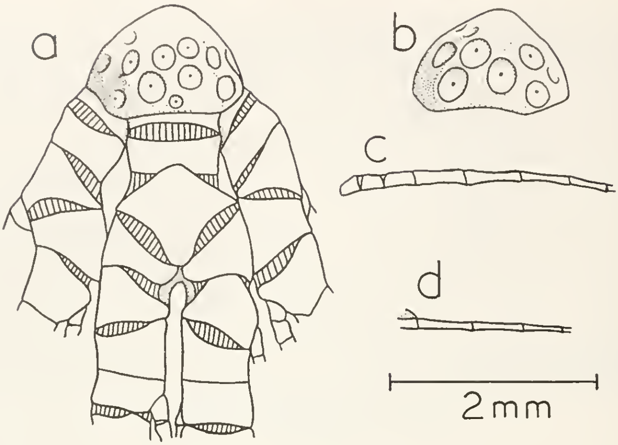

FIGURE 27.—*Psathyrometra anomala* A. H. Clark, holotype: *a*, Radial view; *b*, centrodorsal from the other side; *c*, proximal part of P_2; *d*, part of genital pinnule beyond gonad.

PSATHYROMETRA GRACILLIMA A. H. Clark

FIGURE 28

[See also vol. 1, pt. 2, figs. 578, 579, p. 298]

Psathyrometra gracillima A. H. CLARK, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 149 (description; 19°35′ N., 92°24′ E.; 272 fms.); Crinoids of the Indian Ocean, 1912, p. 21 (intermediate between *Psathyrometra* and *Leptometra*), p. 236 (synonymy; detailed description; locality), fig. 44, p. 237; Die Crinoiden der Antarktis, 1915, p. 116 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, pp. 225, 226 (in key; range), p. 228 (references).

Diagnostic features.—The centrodorsal is sharply conical but much wider at the base than it is high, the ratio being about 1.8:1; the bare interradial areas are usually much wider than the individual peripheral sockets and are grooved; the sockets lie fairly close together in each radial area and are arranged in two (apically) to four (peripherally) more or less regular columns; the arms are rather slender in the holotype, the ratio of the length of the division series plus the first nine brachials to the width of the first syzygy being 7.33:1 as opposed to about 6.7:1 in the two specimens of *Ps. mira* measured; the cirri probably taper evenly like those of *mira* with the terminal segments elongate.

Description.—The centrodorsal is sharply conical, 4 mm. broad at the base and 2.5 mm. high, its sides divided into 5 radial areas by 5 interradial furrows which are somewhat broader than the adjacent cirrus sockets. There are from 8 to 10 well-separated cirrus sockets in each radial area which are arranged approximately in 4 more or less irregular columns.

The cirri are XL–L, about 25, long, slender, smooth and delicate.

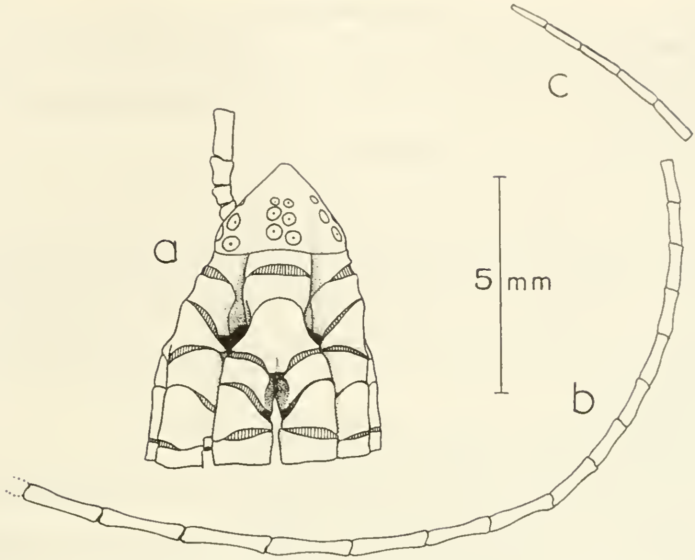

FIGURE 28.—*Psathyrometra gracillima* A. H. Clark, paratype, U.S.N.M., 35637: *a*, Lateral view; *b* and *c*, detached parts of cirri.

The 10 arms which, except for their greater slenderness, resemble those of the related species, are about 100 mm. long.

The color in life was a "pale earthy brown."

[NOTES BY A.M.C.] In a paratype in the U.S.N.M. the centrodorsal is 1.8 mm. in vertical height and 3.3 mm. in basal diameter, with two rows each of 3 or 4 cirrus sockets in each radius. All the cirri are broken by the eighth or ninth segment. Their largest segments are six times as long as wide. A detached piece of 15 segments lacking base and tip measures 21 mm. and a more terminal piece of 5 segments tapers evenly. The 8 proximal segments of a peripheral cirrus measure 11.0 mm.

The arms are all broken at the first syzygy but a piece of one to the second syzygy remains attached. The length from the proximal edge of the IBr_1 to the second syzygy is 11.0 mm. and the width of the first syzygy is 1.5 mm.

The proximal pinnules are all broken but appear to have been very long with elongated segments slightly swollen and inconspicuously spinous at the joints. Only the basal segment is not longer than wide.

Locality.—Investigator station 6; southwest of Akyab, Arrakan coast, Burma (lat. 19°35′ N., long. 92°24′ E.); 497 meters; temperature 10.0° C.; December 8, 1887 [A. H. Clark, 1909, 1912] (3, U.S.N.M., 35637; I.M.).

Genus KEMPOMETRA John

Kempometra John, *Discovery* Reports, vol. 18, 1938, p. 161 (diagnosis; only included species *K. grisea*, n. sp.).

The details of the genus are given below under the heading of *K. grisea*, the type and only species.

KEMPOMETRA GRISEA John*

Kempometra grisea John, *Discovery* Reports, vol. 18, 1938, p. 161, pl. 4, fig. 4; text fig. 9, a–e, p. 162 (description; South Shetland Islands; 830 meters).

Diagnosis.—A genus of Zenometrinae of which the two known specimens are of small size; P_1 and P_a are absent; the centrodorsal is rounded conical, not higher than broad at the base, its surface showing no differentiation into radial areas; the cirrus sockets are in 15 closely crowded columns; cirri with not more than 16 segments, all of which except the two basal and the penultimate are longer than broad; no dorsal spines; opposing spine absent or vestigial; brachials and pinnulars with everted and spinous distal ends; viviparous, the females with brood pouches distal to and somewhat to the side of the ovaries.

Geographical range.—Known only from the South Shetland Islands.

Bathymetrical range.—Known only from 830 meters.

History.—The genus *Kempometra* was established by Dr. D. Dilwyn John in 1938 for the reception of a new species, *Kempometra grisea*, that had been dredged by the *Discovery* Investigations in the South Shetland Islands.

Description.—The centrodorsal is conical, nearly as high as broad, with the ventral border produced interradially into low angles. The cirrus sockets, which are considerably longer than broad, are arranged in 15 closely crowded columns of 3 or 4 each, the sockets of one column alternating with those of the columns on either side.

The cirri are about L, 9–16 (usually 14), up to 9 mm. long. In the longer cirri the first two segments are broader than long, the second longer than the first; the third is about half again as long as broad, and the fourth to sixth are more than twice as long as broad. The segments following decrease gradually in length, though all but the penultimate, which is about as broad as long, are longer than broad. They are slightly broader than the first six segments, and each is broader distally than proximally, but there is no trace of a dorsal spine. The whole cirrus is laterally compressed, more strongly in the distal than in the proximal half. The opposing spine is usually absent, but may be represented by a minute terminal tubercle. The terminal claw is small and hyaline. The texture of the cirrus segments, like that of the brachials, is very finely thorny. The apical cirri are considerably smaller than the peripheral; they may be only half as long, with usually 9 to 12 segments.

The radials are fairly long, broader distally than proximally; their length is less than one-third the maximum width. The IBr_1 are widely separated from each other for their entire length. They are deeply incised in the median line by the posterior projection of the IBr_2 (axillaries). Whereas the lateral edges are more than half as long as the greatest width, the median length is only about one-tenth of the width. The IBr_2 are longer than broad and form shoulder-like projections with the IBr_1; the two proximal sides are slightly, and the two distal strongly, concave.

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* See also Addenda (p. 837) under 1963.

The 10 arms are nearly 40 mm. long. The first brachials are very short, deeply incised by the posterior projection of the second ones, which are about as long as the distal width. The first syzygial pair (composed of brachials 3+4) is slightly broader than long. The next two brachials are rectangular, about twice as broad as long. Those for some distance beyond are somewhat wedge-shaped and about as long as broad. The distal brachials are elongated and slender, rectangular, with the articulations, muscular and syzygial, slightly swollen. The distal edges of the brachials are everted and produced into frills of toothlike spines. Their entire surface, like that of the ossicles of the IBr series, is very finely thorny.

Syzygies occur between brachials 3+4, 9+10 (or exceptionally 8+9), 13+14 or 14+15, and distally at intervals of 2 to 4 (usually 3) muscular articulations. In the two syntypes the widths at the first syzygy are 1.0 and 1.1 mm., the lengths from the proximal edge of the IBr_1 to the first syzygy are 3.3 and 3.5 mm. and to the second syzygy, 6.8 and 7.2 mm.

P_1 and P_a are absent. P_2 is the first pinnule, and is a genital pinnule with a gonad. There are two, three, or more, usually four, genital pinnules on each side of the arm. The gonad on the outermost genital pinnule, more rarely that on P_2, may be small. None but the smaller outer genital pinnules have an ambulacral furrow. The course that the furrow would follow, if present, on the other genital pinnules is shown by a double line of pigment. P_2 is about 4 mm. long, with 8 segments. The first segment is slightly longer than broad, and the second is about half again as long as broad. The third and fourth are about four times as long as broad. The distal segments, except the terminal which is short and pointed, are as long, but more slender. The other genital pinnules are similar but slightly longer, with more segments. P_3 is more than 4 mm. long, with 9 segments. P_4 is 5 mm. long, with 9 segments. The distal pinnules are 7 mm. long, with about 15 segments, of which the first is broader than long, the second is about as long as broad, with the articulation between them greatly widened. The other segments are about four times as long as broad, becoming slightly longer and more slender distally. The articulations are swollen and the distal ends of the segments are everted and spinous.

On each genital pinnule there is a brood pouch that lies somewhat to the side of the ovary and distal to it. The ovary lies on the third and fourth segments of the genital pinnules and, in dorsal view, projects farther on the side away from the arm from which the pinnule springs than on the other. The brood pouch lies along part of the fourth, all of the fifth, and part of the sixth segments, and projects more on the side toward the arm from which the pinnule springs than on the other. On some pinnules the brood pouch is empty. Dr. John cleared and mounted two in which it was not. In each there were two or three small eggs 0.10 mm. in diameter in the proximal corner of the ovary. In one the remainder of the ovary appears to be occupied by one enormous egg. In the other there are five large eggs of an irregular oval shape, two about 0.25 mm. long, the other three much larger, the largest 0.62 mm. long by 0.36 mm. broad. The brood pouch of the first contains one large egg with no trace of skeletal plates to be seen within it; in the other there are two, the largest of which is 0.67 mm. long by 0.51 mm. broad.

On a P_3 that Dr. John examined the ovary contained a small number of large eggs like those described and perhaps some small eggs. In the brood pouch there was one young pentacrinoid about 1.3 mm. long, its crown consisting of two closed circles of plates, the basals and orals, its stalk of 10 or more stout columnals and a large terminal plate. Dr. John said that whether this stage represented the farthest to which the pentacrinoid larvae develop before being released from the brood pouch cannot be determined. No pentacrinoids are attached to any part of either of the two specimens.

So far as can be seen the disk is not plated. The anal cone is very high, higher than the level of the second syzygy.

The sacculi on the distal pinnules are regularly arranged.

In the perisome of the pinnules there are 3 or 4 side plates to a segment. Each is a long straight rod arising from a branching or reticulate base with the distal end thorny or slightly branched, or expanded into a small reticulate plate smaller than that at the base. The plates of the proximal segments are more simple, those of the distal more complex. Continuous with the end of each plate is a row of knobbed and curved rods, the end of one overlapping that of the next, arranged in an arc which travels backward (toward the base of the pinnule) and inwards; they appear to lie along the edges of the marginal lappets. Dr. John found no spicules in the tentacles.

The color in life was described as "Dark grey markings on a white ground. General effect grey." In alcohol the color is the same, even after 20 years. The dorsal surface of the elements of the IBr series, and of the brachials, is dusky gray, though the proximal edges of the brachials, like the muscular articulations, may be white. The pinnules, especially the lower segments of the distal pinnules, are of a darker color than the brachials; the slightly swollen articulations are white. The cirri appear white in comparison with the rest of the animal; a few of the basal segments, the penultimate and one or two of those preceding it, may be of a darker tinge. The terminal claw is hyaline. The disk is yellowish; the anal cone and the ambulacra of the disk, arms, and pinnules are darkly pigmented.

Locality.—Discovery Investigations station 1957; 7 miles east of Cape Bowles, Clarence Island, South Shetlands; 830 meters; bottom rough and stony; February 3, 1937 [John, 1938] (2, B.M.).

History.—Two females of this species were dredged by the *Discovery* in 1937 and were described by Dr. D. Dilwyn John in the following year. Dr. John was so kind as to send me one of the specimens for examination, but I have nothing to add to his excellent description.

Genus CYCLOMETRA A. H. Clark

Cyclometra A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 51 (in combination *Cyclometra flavescens, nomen nudum*); Proc. Biol. Soc. Washington, vol. 24, 1911, p. 87 (diagnosis; type species *Cyclometra flavescens* sp. nov.; referred to subfamily Heliometrinae); Mem. Australian Mus., vol. 4, 1911, p. 727 (Heliometrinae); Crinoids of the Indian Ocean, 1912, p. 11 (part), p. 12 (in Red Sea area), p. 26 (part) (range; relationships), p. 62 (in key), p. 238 (diagnosis; type species); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (range); Die Crinoïden der Antarktis, 1915, pp. 122–126 (characters; relationships; origin), p. 126 (part) (included species and ranges), p. 182 (discussion); Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (Heliometrinae); No. 16, p. 508 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 240 (in key; range), p. 244 (part) (key to the species); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 105 (single specimen known).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56 (bathymetrical range).—A. H. Clark, Trans. Roy. Soc. South Africa, vol. 33, pt. 2, 1952, p. 189 (*C. multicirra* sp. nov.), pp. 191, 192 (referred to Zenometrinae; notes on the type of *C. flavescens*).

Diagnosis.—A genus of Zenometrinae in which there are no bare interradial areas with ridges, grooves or lines on the centrodorsal; the division series and brachials are smooth or barely spinous at the edges; the oral pinnules have distal segments which are little longer than broad (as in the subfamily Heliometrinae) and there are no brood pouches.

Type species.—*Cyclometra flavescens* A. H. Clark, 1911.

Geographical range.—Known from the western part of the Arabian Sea and from off the west coast of South Africa.

Bathymetrical range.—From 461 and 2194 meters.

Remarks.—Since the discovery of the species *multicirra* in 1952 and the reexamination of the type specimen of *C. flavescens*, the genus *Cyclometra* has been regarded as best placed in the subfamily Zenometrinae. When first constituted it was placed in the Heliometrinae on account of the short and numerous segments of the oral pinnules.

KEY TO THE SPECIES OF CYCLOMETRA

a^1. Cirri XL, 41–43, 30 mm. long, the longest segments twice as long as broad; P_1 17–19 mm. long with 42–45 segments; P_2 shorter, 14 mm. long with 32 segments; P_3 12 mm. long with 25 segments; arms 130 mm. long in the unique holotype (northwest of Sokotra; 2,194 meters).
flavescens (p. 533)

a^2. Cirri LXXX, 31, 40 mm. long, the longest segments nearly or quite three times as long as broad; P_1 15 mm. long with 33–34 segments; P_2 stouter and slightly longer with 24–27 segments; P_3 10 mm. long with 17–19 segments; arms about 100 mm. long in the unique holotype (west coast of the Cape of Good Hope; 461 meters)............................**multicirra** (p. 534)

CYCLOMETRA FLAVESCENS A. H. Clark

Cyclometra flavescens A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 51 (*nomen nudum*; locality); Proc. Biol. Soc. Washington, vol. 24, 1911, p. 87 (description; locality); Crinoids of the Indian Ocean, 1912, p. 239 (description; locality); Smithsonian Misc. Coll., vol. 61, 1913, No. 15, p. 64 (references to the specimen in the B. M.; locality); Die Crinoïden der Antarktis, 1915, p. 126 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 244 (in key; references); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 102 (references; locality), p. 104 (listed), p. 105.—A. M. Clark, Trans. Roy. Soc. South Africa, vol. 33, pt. 2, 1952, pp. 191–192 (supplementary description); fig. 1, p. 192 (centrodorsal).

Diagnostic features.—The cirri are about XL when the arms are 130 mm. in length, arranged in three columns of two or three cirri in each radius; the longest cirrus segments are about twice as long as broad; P_1 is very long, with 42–45 segments and measures about 18 mm., the distal segments being little longer than broad; the following pinnules are shorter.

Description.—The centrodorsal is rounded conical, 4 mm. broad at the base and 2.7 mm. high. The cirrus sockets are arranged in 15 columns of 2 or 3 each.

The cirri are XL, 41–43, 30 mm. long. The first segment is short, the second is nearly as long as broad, and those following gradually increase in length, becoming twice as long as broad on the fourth. The next five are similar and those succeeding gradually decrease in length after about six more, becoming about as long as broad and maintaining a similar proportion until the end of the cirrus. The earlier segments are slightly constricted centrally with the ends all around finely spinous. The short outer segments are carinate, the carination appearing smoothly convex in lateral view. The opposing spine is quite conspicuous. The terminal claw is slightly curved and almost equals in length the penultimate segment.

The IBr series are essentially as in *Antedon bifida*. The IBr_1 are rectangular, about three times as broad as long, and form conspicuous rounded synarthrial tubercles with the IBr_2 (axillaries), which are not quite so long as broad, being 3 mm. broad and only 2.5 mm. long; the distal angle is approximately 90°.

The 10 arms are 130 mm. long. The first brachial is short and wedge-shaped, twice as long exteriorly as interiorly, and forms a synarthrial tubercle with the larger second brachial. The brachials following are more or less rectangular with only a slight tendency to be wedge-shaped until after the second syzygy when they assume a more triangular form. Distally the brachials become increasingly long, almost twice as long as broad. The distal ends of the brachials are rather prominent and finely spinous.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 or 4 muscular articulations.

P_1 is very long, measuring 17 to 19 mm., with 42 to 45 segments, of which the first seven are broader than long and the distal are slightly elongated, though not much longer than broad. P_2 is 14 mm. long, with about 32 segments, of which the distal are more than twice as long as broad. P_3 is 12 mm. long, with 25 segments, of which the distal are three times as long as broad; it bears a gonad. P_4 and P_5 are progressively shorter with more attenuated and longer distal segments. The distal pinnules are 17 mm. long, exceedingly slender, with about 20 segments which are 3 to 4 times as long as broad.

The color in alcohol is yellow.

The preceding description is based upon the original description supplemented by notes on the type specimen prepared by Ailsa M. Clark.

Locality.—South of Ras Sharwein, Arabia, or northwest of Sokotra (lat. 14°20′ N., long. 52°30′ E.); 2,194 meters; cable-repair ship *Electra*, Capt. V. F. Sparks, July 1909 [A. H. Clark, 1911, 1913, 1937; A. M. Clark, 1952] (1, B.M.).

CYCLOMETRA MULTICIRRA A. H. Clark

Cyclometra multicirra A. H. Clark, Trans. Roy. Soc. South Africa, vol. 33, pt. 2, 1952, pp. 189–191 (description; *Africana* station 759), pls. 15, 16.

Diagnostic features.—The cirri are about LXXX when the arms are just over 100 mm. in length, their longest segments up to three times as long as broad; they are arranged in three columns of 4 or 5 each corresponding to each radial; P_1 is about 15 mm. long, with about 33 segments; P_2 is similar but slightly longer.

Description.—The centrodorsal is conical with slightly convex sides, 3.3 mm. broad at the base and 4 mm. high, with the proximal border straight. The cirrus sockets are closely crowded all around the centrodorsal without division into radial groups, and are arranged in three columns of 4 or 5 under each radial; the two lateral columns under each radial are straight and regular, but the median column has at the proximal end one or two sockets between it and a lateral column.

The cirri are LXXX, the longest peripheral 40 mm. long, with 31 segments, of which the first three are broader than long, the fourth is half again as long as broad, and those following increase in length to the eighth or tenth, which is from two and a half to three times as long as broad, or even somewhat longer. The distal half of each cirrus tapers to a rather delicate tip. The length of the segments in the distal half slowly decreases so that the last five or six are only slightly, or not at all, longer than broad. The longer earlier segments have slightly flaring ends which overlap the bases of those succeeding. The distal segments increase slightly in width from the proximal to the distal end, the dorsal profile being almost straight and continuous with the profiles of the preceding and succeeding segments, the ventral profile forming an angle at the distal end, where it extends below the base of the following segment. The short distal segments are rather sharply carinate dorsally. The penultimate segment is slightly longer than broad; the opposing spine is represented by a broad blunt tubercle. The terminal claw is about as long as the penultimate segment, rather slender and slightly curved.

The cirri decrease in length from the peripheral to the apical, the latter (all broken) being apparently scarcely half the length of the former.

The ends of the basal rays are visible as very small rounded-triangular tubercles in the interradial angles.

The radials are very short with the distal border rather strongly concave so that the anterolateral angles extend well up into the interradial areas, where they separate entirely the bases of the IBr_1. The distal half is turned outward, especially in the lateral portions. The IBr_1 are short, about four times as broad as the median length, with the lateral edges slightly convergent and widely separated from those of their neighbors and the distal edge slightly concave, incised by the posterior projection of the axillary, with which it forms an apically well-rounded synarthrial tubercle, the sides of which in profile make an angle of about 120° with each other. The IBr_2 (axillaries) are about as long as broad, with the proximal sides nearly straight and making an angle of about 90° with each other, and the distal sides strongly concave so that the distal angle and the lateral angles, which extend well beyond the anterolateral angles of the IBr_1, are acute. The edges of the elements of the IBr series are smooth, the two distal edges of the axillaries slightly everted.

The 10 arms are probably a little more than 100 mm. long. The first brachials are short, about three times as long exteriorly as interiorly; the short interior sides of each pair make a straight line with each other. The second brachials are about half again as large as the first, approximately triangular, with the proximal angle incising the first and making with it a synarthrial tubercle which resembles that on the IBr series except that the apex is more sharply pointed. The first syzygial pair (composed of brachials 3+4) is about half again as broad as long with, like the first and second brachials, slightly everted and finely spinous ends. The next four brachials are wedge-shaped, about twice as broad as the median length, with the longer side about twice as long as the shorter. Following the second syzygy the brachials soon become more obliquely wedge-shaped, almost triangular, and nearly or quite as long as broad. The distal ends of the brachials are very finely spinous, but are not everted or produced. Distally the brachials become somewhat less obliquely wedge-shaped and longer.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of usually 3 muscular articulations.

P_1 is about 15 mm. long, slender, tapering rather more rapidly in the proximal than in the distal half and becoming very flexible in the distal third, with 33 to 34 short segments, of which the first five are broader than long and the remainder are slightly longer than broad. The first five or six have the dorsal side convex and finely spinous, and those following until near the tip are very slightly constricted centrally. P_2 is similar to P_1 but stouter and slightly longer with 24 to 27 segments, which distally are proportionately slightly longer than those of P_1. P_3 is 10 mm. long, with 17 to 19 segments, a little stouter than P_2 at the base but tapering more gradually and stiffened, and without the flagellate tip of the two preceding pinnules. The segments become about twice as long as broad on the fifth, and three times as long as broad distally. The sixth to tenth segments bear a slender and fusiform gonad. The following pinnules are similar to P_3. P_8 is 12 mm. long, with 22 segments, bearing a gonad on the fourth to ninth. The distal pinnules are about 18 mm. long, with about 27 segments, most of which are about twice as long as broad, the outermost about three times as long as broad. The segments of the middle and distal pinnules have finely spinous distal ends.

The disk is naked.

The color (in alcohol) is brownish white, the pinnules purplish, becoming distally purple with the articulations narrowly white.

Locality.—*Africana* station 759; off the west coast of Cape Province, South Africa (lat. 30°15′ S., long. 14°5′ E.); 461 meters [A. H. Clark, 1952] (1, Univ. Cape Town).

Genus EUMORPHOMETRA A. H. Clark*

Antedon (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 188, and following authors.

Thaumatometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21 1908, p. 128.

Eumorphometra A. H. Clark, Bull. Inst. Océanogr., Monaco, No. 294, 1914, p. 6 (spinosity the result of the coldness of the habitat; *nomen nudum*); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (represents, in part, *Zenometra* of the Atlantic; range); Die Crinoïden der Antarktis, 1915, p. 114 (in key to the genera of Zenometrinae), p. 117 (synonymy; diagnosis; type species *E. concinna;* range), p. 160 (relationships), p. 182 (represents, in part, *Zenometra* in the Indo-Pacific); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Zenometrinae); No. 16, p. 510 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 223 (in key; range), p. 232 (key to the included species); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 52 (in key).—Pelseneer, Bull. Soc. Zool. France, vol. 53, 1928, p. 172 (parasitized by *Eulima capensis* [error]).—Ekman, Tiergeographie des Meeres, 1935, p. 307.—A. H. Clark, Sci. Rep. Australasian Antarctic Exped. 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 6.—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 87 (discussion of species); *Discovery* Reports, vol. 18, 1938, pp. 130, 152; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. 3, vol. 4, pt. 6, 1939, p. 202.

Diagnosis.—A genus of the Zenometrinae in which the centrodorsal is conical with the cirrus sockets arranged in 10 or 15, rarely 20, irregular columns not separated into radial groups but all crowded; the peripheral cirri have 20 to 40 segments, of which the longest are from half again to almost twice as long as broad and the outer are broader than long with slight dorsal keels; the elements of the IBr series and the lower brachials are not in lateral contact and their dorsal surface is usually covered with fine spines; all the pinnules are present; P_1 and P_2 are usually similar, P_2 a little shorter, both with less than 15 segments, of which all but the basal are longer than wide; at least two of the species are viviparous, mature females of the others are unknown.

Type species.—*E. concinna* A. H. Clark, 1915.

Geographical range.—Shores of the Antarctic continent and the vicinities of Marion Island, the South Shetlands and Shag Rocks.

Bathymetrical range.—From 177 to 490 (?610) meters.

Remarks [by A.M.C.].—I have not seen an example of the type species—*E. con-*

* See also Addenda (p. 837) under 1963.

cinna—but have examined the holotypes of the other four species assigned to this genus. In two of these, *hirsuta* and *fraseri*, the interradial cirrus sockets are arranged in distinct columns but radially the sockets are quite irregular in position. In *E. aurora* and even more so in *E. marri* the arrangement is still more irregular, and certainly not indicative of the subfamily Zenometrinae. Mr. Clark had removed *marri* to the Isometrinae on account of the slightly expanded segments of the genital pinnules and the irregular arrangement of the cirrus sockets. However, a comparison of the holotype with specimens of *Isometra* showed that the expansion is relatively much less, even for a male, than that found in *Isometra* and is much more comparable with the slight expansion shown by *Anthometra adriani* of the subfamily Heliometrinae illustrated by Dr. Dilwyn John (1938, fig. 5, p. 151). Indeed I think *marri* with its short cirrus segments and short proximal segments of P_I cut away at the joints, would be very similar to a precocious, stunted Heliometrin. However, it appears to have more in common with *Eumorphometra aurora* than with any other antarctic comatulid, notably the proportions and numbers of the cirrus segments. With only one specimen known, it seems inadvisable to remove *marri* from the genus *Eumorphometra.* Possibly the whole genus might be better removed from the Zenometrinae. Only the shorter and more numerous cirrus segments and the higher and more conical centrodorsals seem to distinguish its species from those of the antarctic *Phrixometra* of the Bathymetrinae which also has viviparous species. Besides the more or less irregular arrangement of the cirri, these are fixed to the centrodorsal much more firmly than in most species of the Zenometrinae, as an attempt to detach some of the stumps in the types of *fraseri*, *marri*, and *aurora* has shown.

KEY TO THE SPECIES OF EUMORPHOMETRA

[by A.M.C.]

a^1. Peripheral cirri with 34–40 segments (South Shetland Islands; 410–440 meters)---**fraseri** (p. 537)
a^2. Peripheral cirri with not more than 30 segments.
- b^1. Axillary with very slight proximal angle, the distal edge of the IBr_1 almost straight; division series flared but not conspicuously spinous at their distal edges (near Marion Island; 256 meters)---**hirsuta** (p. 540)
- b^2. Axillary rhombic with a distinct proximal angle more or less incising the distal edge of the IBr_1; division series usually with spinous edges.
  - c^1. Only XXX cirri when the arm length is 30 mm.; P_1 only 2 mm. long with about 9 segments (shores of Antarctica near Gaussberg; 380–400 meters)---**concinna** (p. 542)
  - c^2. XL or more cirri when the arm length is 25–30 mm.; P_1 4–4.5 mm. long with 13–14 segments.
    - d^1. Three or four basal segments of P_1 not longer than broad, segments of the genital pinnules slightly expanded alongside the gonads (Clarence Island, South Shetlands; 490–610 meters)---**marri** (p. 544)
    - d^2. Second and following segments of P_1 more or less longer than broad, segments of genital pinnules not expanded (Shag Rocks near South Georgia and off Enderby Land, Antarctica; 177–220 meters)---**aurora** (p. 547)

EUMORPHOMETRA FRASERI John*

FIGURE 29,*a*,*b*

Eumorphometra fraseri JOHN, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 129 (range), p. 155 (description; *Discovery* Investigations sta. 1955), pl. 4, fig. 2, text-fig. 7, a–e, p. 155.

* See also Addenda (p. 837) under 1963.

Diagnostic features.—When the arms are 35–40 mm., the cirri are 34–40, about XLV, up to 12 mm. long and in 15 columns.

Description.—The centrodorsal is a high pointed cone with a sharp and rough dorsal pole; the basal diameter is 2.5 mm. and the vertical height also 2.5 mm.; the proximal border is produced interradially into low angles; it is thickly covered with cirrus sockets, interradially arranged in distinct columns but radially more irregular in position.

The cirri are XLV, 34–40, the peripheral about 12 mm. long, slightly longer than the apical. The first three segments are about twice as broad as long; the third segment is broader distally than proximally, the greater width being on the dorsal side, and is centrally constricted, more strongly on the dorsal than on the ventral side. The fourth and fifth segments are of similar shape but the fourth is more than half as long as broad and the fifth is nearly as long as broad. The sixth to tenth are slightly longer than broad, broader distally than proximally, but not to the same extent as the third to fifth; they are of a more regular shape, not constricted centrally. The eleventh and twelfth segments are as long as broad. The remaining segments are broader than long. Beyond about the fifteenth segment the dorsal edge becomes curved instead of straight, and on the distal segments it is produced into a strongly rounded dorsal spine. The opposing spine is strong and stands out at right angles. The terminal claw is strong.

The radials are short and bandlike with concave and everted distal edges. The IBr_1 are short, about six times as broad as long in the midline, and are in contact laterally; they are deeply incised by the posterior projection of the axillary, with which they rise into a synarthrial tubercle. The IBr_2 (axillaries) are rhombic, a little broader than long; their proximal edges are nearly straight, the distal strongly concave, so that the posterior projection is broadly rounded, the anterior angle sharper. The edges of the elements of the IBr series are everted and finely spinous.

[NOTE BY A.M.C.: The arms are all broken; their length is estimated at from 35 to 40 mm.]

The first brachial is short, slightly longer externally than internally; the distal edge is slightly incised by a posterior projection from the second brachial, which is approximately an equilateral triangle with the distal edge slightly concave. The inner border of the first syzygial pair (composed of brachials 3+4) is considerably longer than the outer. The fifth to eighth brachials, between the first and second syzygial pairs, are roughly rectangular, somewhat broader than long, alternately longer on one side than on the other. The brachials for some distance beyond the second syzygy are triangular and about as long as broad. Farther out on the arm they are wedge-shaped, slightly longer than broad, with one side, alternating on successive brachials, considerably longer than the other. The distal edges of the brachials between the first and third or fourth syzygial pairs are produced into single rows of strong toothlike spines; those of the more distal brachials are smooth.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 or 4, exceptionally 5, muscular articulations. The length from the proximal edge of the IBr_1 to the second syzygy is 8.0 mm. and the width at the first syzygy is 1.4 mm.

P_1 is incomplete or hidden. P_2 is slender, with 12 or 13 elongate segments; it is nearly 6 mm. long. P_a and P_b are each about 5 mm. long. P_a is composed of 11

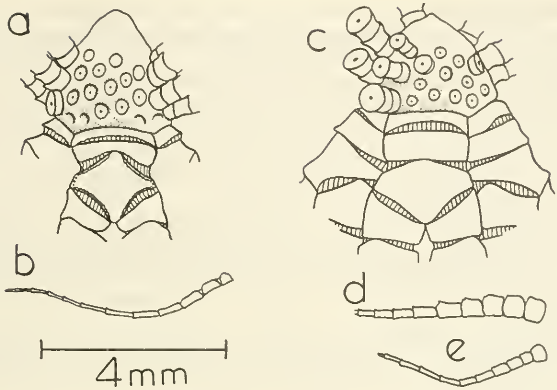

FIGURE 29.—*Eumorphometra fraseri* John, holotype: *a*, Lateral view of centrodorsal and division series; *b*, P_2. *E. hirsuta* (P. H. Carpenter), holotype: *c*, lateral view of calyx; *d*, proximal part of P_1; *e*, P_2 without gonad.

segments and tapers to the distal end. The first segment is as long as broad, the second and third are slightly longer than broad, and the fourth and fifth are about twice as long as broad; the slender distal segments are longer, three or more times as long as broad. The distal edges of the more distal segments are produced into strong spines. The ventral side of the pinnule is thickly covered with sacculi, although there is no ambulacral groove. P_b is usually an oral pinnule, with 9 slender and evenly tapering segments, of which the first is about as long as broad, the second is slightly longer, and the remainder are elongated. The third is twice, the fourth about three times, as long as broad; the fifth to ninth are about five times as long as broad. The distal edges of the segments are produced into a small number of spines; the entire dorsal surface of one or two of the lower segments may be rough with spines.

On some arms P_b is a genital pinnule, though P_3 is usually the first genital pinnule with a large fusiform testis (the single specimen is a male) along the third to seventh segments. One P_3 which is 5 mm. long with 9 segments appears to be nearly complete. The first two segments are short, the remainder elongated, the fourth and following being four or more times as long as broad. In the other genital pinnules the segments are not so elongated. The genital pinnules extend to P_{10} or P_{12}. In the middle genital pinnules the gonad lies along the third to eighth segments. As an example, P_7 is 6 mm. long, with 13 segments, of which the first two are short and the third to eighth increase from two to four times as long as broad. The distal end of each segment is flared out into a thorny cup around the base of the next, and the bases of each are swollen to a lesser extent. The distal segments are longer, more regular, and more slender.

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The distal pinnules are 8 mm. long, with about 18 segments, of which the first two are short, the third and fourth are longer than broad, and the remainder are about twice as long as broad, all with thorny distal ends.

The pinnule ambulacra are bordered with rodlike side plates, three to each segment. These are mostly simple smooth rods, but they may have forked or perforated ends; at the ends of some pinnules they are shorter and have a different and more platelike form. Strongly knobbed spicules occur in the tentacles.

Sacculi are numerous and conspicuous along the pinnule ambulacra.

The disk is concealed.

In life the proximal half of the animal, including the cirri, was orange yellow; distally the arms and pinnules were much banded with delicate gray, producing a dark effect. In the cirri the first four or six segments were lighter than the remainder, and on many cirri the eighth to tenth segments were much darker than the others, being rusty yellow.

Locality.—Discovery Investigations station 1955; north of the South Shetland Islands (lat. 61°35′06″ S., long. 57°23′18″ W.); 440–410 meters; January 29, 1937 [John, 1938] (1, B.M.).

[EUMORPHOMETRA HIRSUTA (P. H. Carpenter)*

FIGURE 29, *c–e*

Antedon hirsuta P. H. CARPENTER, *Challenger* Reports, Zool., vol. 26, pt. 60, 1888, p. 188 (description; sta. 145); pl. 31, fig. 5.—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 143 (range.).—BATHER, Geol. Mag., Dec. 4, vol. 3, 1897, p. 120 (pinnules compared with those of *Millericrinus recubariensis*).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 405 (antarctic representative of the *Tenella* group).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888 = *Thaumatometra hirsuta*); Die Crinoïden der Antarktis, 1915, p. 105 (species so recorded by Andersson is an *Isometra*).—OHSHIMA and IKEDA, Proc. Imper. Acad. Japan, vol. 10, No. 2, 1934, p. 127 (alleged copulation; notice of Andersson, 1904).

Thaumatometra hirsuta A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (= *Antedon hirsuta* P. H. Carpenter, 1888); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (published references to specimens in the B.M.; *Challenger* sta. 145).

Eumorphometra hirsuta A. H. CLARK, Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (antarctic; range); Die Crinoïden der Antarktis, 1915, p. 106 (collected by the *Challenger;* recorded as *Antedon hirsuta*), p. 107 (in key to antarctic crinoids), p. 118 (synonymy; range), p. 119 (comparison with *E. concinna*), p. 168 (a shallow water antarctic species confined to the Gauss quadrant and adjoining islands; range), p. 169 (relationships), p. 192 (further discussion); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 232 (in key; range; references).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 10 (notes).—JOHN, *Discovery* Reports, vol. 18, 1938, p. 124 (Marion Island), p. 159 (notes on the type specimen).

Diagnostic features.—When the arm length is about 35 mm. there are about XL cirri, of which the interradial ones tend to be in distinct columns; the cirri have 25 to 30 segments; the division series exhibit no synarthrial tubercles, the IBr_1 having an almost straight distal edge; though slightly flared the proximal ossicles are not prominently spinous; P_1 and P_2 have the distal segments elongated; P_2 is a little smaller than P_1.

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* See also Addenda (p. 837) under 1963.

Description [modified by A.M.C.].—The centrodorsal is conical, 3.3 mm. in basal diameter and 2.1 mm. in vertical height, bearing about 35 cirrus sockets according to Carpenter [but having drawn the holotype, I put the number as 9 or 10 in each radial area, a total of about 45. A.M.C.]. The interradial cirri are in distinct vertical columns but the radial ones are more irregular in position (see fig. 29, p. 539).

The cirri had 25 to 30 segments (all the peripheral ones are now broken, 1957). The earlier segments are half again as long as broad, and the distal are broader than long with slight dorsal keels.

The radials are very short. The IBr_1 are short, about four times as broad as long, with slightly converging sides and but little excavated on the distal border. The IBr_2 (axillaries) are broadly rhombic, broader than long. These ossicles are flared at the distal edges and bear a few very fine spines, but these are so small as to be only visible under high magnification.

The 10 arms are about 35 mm. long, but all but two have not quite finished regenerating from the first syzygy and these two are broken at the seventh brachial. The first brachials are nearly oblong, and the second are relatively short and broad with a very obtuse proximal angle. The next few brachials are oblong, and the following become more wedge-shaped and finally cylindrical with slight lateral projections for the pinnule facets. The distal border of each brachial bears a small fringe of spines which projects forward over the base of its successor so as to give the arms a somewhat serrate appearance.

Syzygies occur between brachials 3+4, 7+8 or 9+10, and distally at rather irregular intervals, though they are generally separated by three or four muscular articulations. The length from the proximal edge of the IBr_1 to the second syzygy was probably about 8.5 mm. and the width at the first syzygy is 1.25 mm.

P_1 consists of 12 or 13 segments, of which the first three or four are short but the following ones become elongated; it measures about 4.5 mm.; P_2 is shorter, about 3.5 mm. long, with about 11 segments, which become elongated after the first two. On the arms which are not regenerating P_2 bears a gonad. The following pinnules are at first a little shorter and more slender than the first two but have relatively longer segments, after which the length gradually increases.

Notes.—Dr. D. Dilwyn John reexamined Carpenter's type specimen and added the following notes. The cirrus sockets are arranged in about 15 irregular columns; these are least regular near the proximal edge of the centrodorsal, around which there are about 20 sockets. The cirri are about XXXV, 25–30; the distal segments from about the tenth outward have a rounded dorsal keel, stronger than that of *E. fraseri*, which is not shown in Carpenter's figure. P_1 is long, stiff, and slender, 4.5 mm. long, with 12 evenly tapering segments, of which the first two are heavy and broader than long, the third and fourth are about as long as broad, and the remainder are elongated and become more and more slender to the tip of the pinnule; the distal edges of the segments are thorny. P_2 is about 4 mm. long, with 11 segments. Carpenter described it as carrying a gonad, but Dr. John says that if it is a gonad it is very small. The remaining pinnules arise from regenerating brachials and do not carry gonads.

Locality.—*Challenger* station 145; near Marion Island (lat. 46°43′00″ S., long. 38°04′30″ E.); 256 meters; volcanic sand; December 27, 1873 [P. H. Carpenter, 1888; A. H. Clark, 1913; John, 1938] (1, B.M.).

EUMORPHOMETRA CONCINNA A. H. Clark*

[See vol. 1, pt. 2, fig. 806, p. 378]

Eumorphometra concinna A. H. CLARK, Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (antarctic; range; *nomen nudum*); Die Crinoïden der Antarktis, 1915, p. 104 (new species collected by the *Gauss*), p. 107 (in key to antarctic crinoids), p. 118 (detailed description; locality; comparison with *E. hirsuta*), p. 168 (shallow water antarctic species; confined to the *Gauss* quadrant and adjoining islands; range), p. 169 (relationships), p. 192 (further discussion), pl. 2, figs. 2, 3; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 232 (in key; range; references); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 25 (ambulacral deposits); Sci. Rep. Australasian Antarctic Exped., 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 5 (listed), p. 8 (in key).—JOHN, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (not taken by *Discovery* Investigations vessels), p. 87 (brood pouch), p. 88; *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 126 (viviparous), p. 127 (brood pouches), p. 133 (in key), p. 154 (comparison with *E. aurora*), p. 160 (description of brood pouches and embryos); Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 203 (comparison with *E. aurora*).—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140.

Diagnostic features.—When the arms are about 30 mm. long, the cirri are about XXX, with up to 25 segments and 7 mm. long; the IBr_1 has the distal side markedly concave and the axillary is rhombic in shape; both these ossicles are distinctly spinous at the edges; P_1 is very small, only about 2 mm. long, with 9 segments.

Description.—The centrodorsal is regularly conical, about as high as broad, with the tip rounded. Its sides are nearly covered with about 30 cirrus sockets which are roughly arranged in irregular columns and are entirely separated from each other.

The cirri are about XXX, 20–23, 7 mm. long. The first two segments are short, the third is nearly as long as broad, the fourth to sixth are nearly twice as long as the median width, with expanded ends, and the following segments rapidly decrease in length, becoming as long as broad on the eleventh and after the fifteenth slightly broader than long. The longer earlier segments are centrally constricted, with rather strongly expanded ends, this feature diminishing as the segments become shorter distally. As the segments become shorter the dorsal surface becomes more and more sharply rounded so that on the short distal segments the dorsal surface is sharply carinate.

The radials are relatively rather long, 3 or 4 times as broad as long in the median line. The IBr series and brachials in general resemble those of *Antedon mediterranea*. The IBr_1 are about 3 times as broad as the lateral length, which is about twice the median length; the distal outer angles are rounded off, the dorsal surface is covered with fine spines, and the edges are bordered with very much longer spines. The IBr_2 (axillaries) are rhombic, slightly broader than long, with a very spinous dorsal surface and spinous borders; the proximal lateral angles are cut away. The very numerous fine spines thickly covering the dorsal surface of the elements of the IBr series are longer and more prominent in the median line, which is slightly elevated into a low well-rounded median carination.

The 10 arms are 30 mm. long. The brachials are slender with expanded articulations and rather strongly overlapping and spinous distal ends.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 oblique muscular articulations.

* See also Addenda (p. 837) under 1963

P_1 is 2 mm. long, very small and slender, with 9 segments, of which the first is short, the second is slightly longer than broad, the third is twice as long as broad or slightly longer, and the fourth and fifth are the longest, 4 or 5 times as long as broad; on some of the P_1 the remaining segments are of about the same length as the fourth and fifth, while on others they are much shorter. P_2 is similar, but slightly smaller and shorter. P_3 is 3.5 mm. long, with 9 segments, of which the fourth and following are much elongated; the segments have a spinous dorsal surface and expanded and overlapping distal ends which are fringed with spines; the third to fifth segments bear a large gonad. P_4 is 4 mm. long, with 10 segments, and is similar to P_3. P_5 is similar to P_4. P_6 sometimes possesses a small gonad, but usually is without one. The distal pinnules are very slender, 5 mm. long, with 17 segments, which beyond the third are much elongated with swollen articulations and slightly overlapping and finely spinous distal ends.

Notes.—February 15, 1903; 400 meters. One of the two specimens with this label is the one described above. In the other the arms are 45 mm. long and there are 20 to 25 cirrus segments.

January 31, 1903; 380 meters. The example is similar to the 2 just noticed.

April 17, 1902; 385 meters. The cirri are 7 mm. long, and are composed of 22 segments, of which the longest are nearly twice as long as the width of the proximal (narrower) end; the spines on the dorsal surface of the IBr series and lower brachials are especially long in the median line, so that the arms are subcarinate. The gonads are much enlarged.

December 12, 1902; 385 meters. The arms are 25 mm. long; the cirri are 6 mm. long and are composed of 17 to 19 segments, of which the longest are not quite twice as long as the width of the proximal end.

The small number of cirrus segments and the elongate form of the more proximal would suggest that this form might possibly be the immature of *Eumorphometra hirsuta;* but on the other hand the largest individual, which exhibits all the characters described for the type, is larger than *E. hirsuta*, which has an arm length of only 35 mm., and several are sexually mature with eggs extruded from the ovaries.

When he was studying the crinoids collected by various Antarctic expeditions Dr. D. Dilwyn John found that at least one of his new species of *Eumorphometra*, *E. aurora*, is viviparous. On hearing this, I reexamined the specimens of *E. concinna* at hand and discovered, much to my chagrin, that I had overlooked the fact that it too is viviparous, with brood pouches at the side of the ovaries. So I sent him a portion of the arm of a female to compare with his new species.

He found that the brood pouches lie on the aboral side of the pinnules, nearest the arm. The walls are so thin that the contents of the pouches can be seen through them. The eggs in the ovaries and the embryos in the brood pouches are of different sizes and at various stages of development. The largest eggs are oval and as much as 0.2 to 0.25 mm. long. The largest of the brood pouches contained thirteen embryos. Seven were without trace of skeletal plates or ciliated bands; they were spherical or irregularly oval, 0.21 to 0.29 mm. The other six were oval embryos with the beginnings of skeletal plates within them. The smallest of these was 0.34 mm. long with no ciliated bands. There were about fourteen small columnals and a very large terminal stem plate, and five orals and five basals, but no infrabasals. Three other embryos in good condition were slightly larger, 0.37 to 0.40 mm. long and 0.29 to 0.36 mm. broad, and possess ciliated bands. They have about eighteen columnals. In two of them there were two very small infrabasals; Dr. John could not see a third in either of them, or any infrabasals in the third embryo. The three posterior ciliated bands were hooplike and clear, but the first and second bands were difficult to follow; the former seemed to surround a depression, the apical pit, and the latter seemed to coalesce with it for a portion of its course.

Dr. John also noted that the distal edges of the brachials are raised into stronger spines than those of the corresponding brachials in *E. aurora*.

Along the pinnule ambulacra there are reduced rodlike side and covering plates like those of *E. aurora*, except that some are strongly thorny.

Locality.—*Gauss* (German South Polar Expedition) station, in the vicinity of Gaussberg (lat. 66°02′09″ S., long. 89°38′ E.); 380–400 meters. April 17, 1902; 385 meters (1, Berl. M.). December 12, 1902; 385 meters (2, U.S.N.M., E. 385). January 31, 1903; 380 meters (1, Berl. M.). February 15, 1903; 400 meters (2, U.S.N.M., E. 384; Berl. M.).

Remarks.—Only the original specimens collected by the German South Polar Expedition in 1902–03 are known.

In 1938 Dr. D. Dilwyn John described the brood pouches and embryos of one of the females in the type series.

EUMORPHOMETRA MARRI John*

FIGURE 30, *a–e*

Eumorphometra marri JOHN, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 129 (range), p. 157 (description; *Discovery* Investigations sta. 1948); text-fig. 8, a–e, p. 159, pl. 4, fig. 3.

Diagnostic features.—The cirri are about XL when the arm length is 25 mm.; they have 23 to 28 segments and are very irregular in position; the IBr_1 has the distal side markedly concave, the axillary being rhombic in shape; P_1 is about 4 mm. long, with 14 segments, of which the first three to five are not longer than wide; the genital pinnules have the segments alongside the gonads slightly expanded in the male holotype.

Description.—The centrodorsal is rounded conical with a rounded dorsal pole and the ventral border straight. The basal diameter is 1.6 mm. and the vertical height 1.0 mm. The cirrus sockets are irregularly arranged in two or three crowded rows.

The cirri are XLII, 23–28, up to 9 mm. long, the apical shorter and with fewer segments than the peripheral. The first segment is nearly twice as broad as long, the second is two-thirds as long as broad, the third and fourth are as long as broad, and the fifth is slightly longer than broad. The seventh and eighth are shorter than the fifth, though longer than broad. All the succeeding segments are slightly broader than long. From the twelfth onward they are broader distally than proximally and the dorsal side is rounded though not raised into a keel or spine. The opposing spine is strong, in the form of an equilateral triangle arising from the entire dorsal side of the penultimate segment. The terminal claw is moderately strong and curved.

The radials are very short, with a concave distal edge. The IBr_1 is four times as broad as the lateral length and is moderately incised by the axillary. It is not in contact with its neighbors. The IBr_2 (axillaries) are one-third again as broad as long; the proximal borders are slightly concave, the distal more strongly concave, the anterior

* See also Addenda (p. 837) under 1963.

angle being approximately a right angle. The radials and the elements of the IBr series are smooth.

The 10 arms are 25 mm. long with about 60 brachials. The first brachial is short, with a longer exterior than interior edge, and is slightly incised by the second, which is a little broader than long with a broadly rounded posterior projection and a concave distal edge; both these brachials are smooth. The interior edge of the first syzygial pair (composed of brachials 3+4) is considerably longer than the exterior. The brachials between the first and second syzygy are slightly broader than long. The fifth brachial is rectangular with its interior proximal corner produced downward. The following brachials are similar with the exterior and interior proximal corners produced downward alternately. They gradually change in shape so as to be wedge-shaped at the second syzygy. Beyond the second syzygy the brachials are triangular, a little longer than broad. Farther out on the arm they become quadrangular, with oblique proximal and distal edges, and more elongate. The distal edges of all the brachials beyond the first syzygy are everted and rough with spines.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 2 to 4 (usually 3) muscular articulations. The length from IBr_1 to the second syzygy is 6.0 mm. and the width at the first syzygy is 0.85 mm.

P_1 is longer and much more massive than P_2, reaching to the tip of the latter, 4 mm. long, with 14 segments, which are strong and rounded and a little longer than broad;

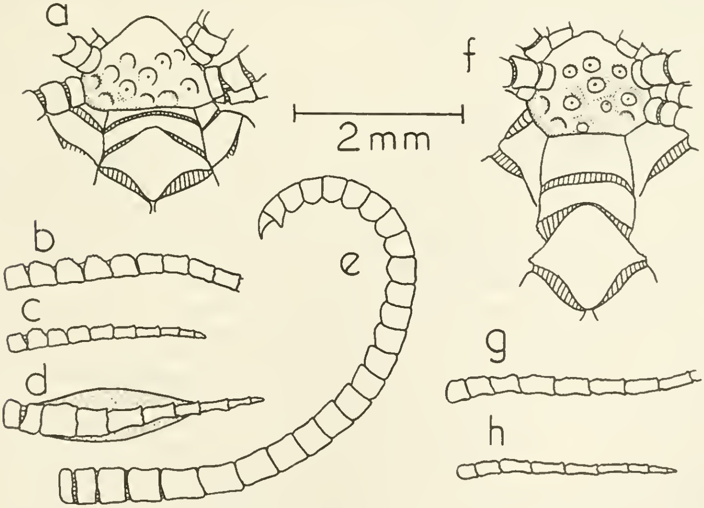

FIGURE 30.—*Eumorphometra marri* John, holotype: *a*, Lateral view; *b*, proximal part of P_1; *c*, P_3; *d*, P_4; *e*, cirrus. *E. aurora* John, holotype: *f*, lateral view; *g*, proximal part of P_1; *h*, P_3.

the dorsal surface and distal edges are rough. P_2 is 3 mm. long, with 10 segments, of which all but the first are longer than broad, the fourth and following twice as long as broad. P_3, the first genital pinnule, is about 3 mm. long with 10 to 12 segments and has an ambulacral furrow; the first two segments are short, the third to seventh, along which the testis (the specimen is a male) lies, are considerably longer and are slightly expanded, the third is as long as broad, the fourth is as broad but slightly longer, the fifth is not so broad as the fourth and is longer than broad, the sixth is narrower and about twice as long as broad, the seventh is more than twice as long as broad, and the remainder are narrow and elongated, about three times as long as broad. All the segments have strongly everted and spinous distal edges; the spines are strongest on the aboral edges of the expanded segments.

The genital pinnules extend to P_{18}. They resemble P_3 except that the expansion along which the testis lies gradually lessens, disappearing at about P_{10}. The genital pinnules gradually increase in length and in the number of segments. P_4 is 3,5 mm. long, with 10 segments; P_{10} is 4.5 mm. long, with 13 segments; P_{18} is 5 mm. long, with 14 segments. On the adoral side of each testis opposite the third segment of the genital pinnule there is a small papilla, through which presumably the spermatozoa pass to the outside. The distal pinnules are composed of 17 segments, all but the first two of which are two or three times as long as broad; all the segments have everted and spinous distal edges.

There are reduced rodlike side plates along the pinnule ambulacra. These may be simple smooth rods, or they may be knobbed, or have branched or reticulated ends. There are no spicules in the tentacles.

Sacculi are very numerous and conspicuous, regularly arranged along the pinnule ambulacra.

Locality.—*Discovery* Investigations station 1948; east of Clarence Island (N.E. of the tip of Graham Land) (lat. 60°49′24″ S., long. 52°40′ W.); 490–610 meters; January 4, 1937 [John, 1938] (1, B.M.).

History.—This species was described by Dr. D. Dilwyn John in 1938 from one male specimen and part of another dredged by the *Discovery* Investigations in 1937. He said that it differs from the other species of *Eumorphometra* by having the cirrus sockets arranged in two or three alternating rows instead of in columns, by the fact that P_1 is not only longer but much more massive than P_2 and by the slight expansion of the segments of the lower genital pinnules which carry the gonads.

[NOTE BY A.M.C.] Mr. Clark concluded from this that *E. marri* should be referred to the Bathymetrinae and more particularly to the genus *Isometra,* which he included in that subfamily. On paper this appears to be a reasonable move but an examination of the holotype of *marri* and a direct comparison with the species of *Isometra* and with the other material of *Eumorphometra* in the British Museum has convinced me that the original position of *marri* is more likely to be the correct one. The expansion of the segments of the genital pinnules is very slight compared with its development in *Isometra* even for a male, and despite the small size the specimen appears to be mature. The irregularity in position of the cirrus sockets is only a little more evident than in the other species of *Eumorphometra* and the brachials and pinnule segments are much more flared and spinous at their distal ends than in any specimen of *Isometra* I have seen.

EUMORPHOMETRA AURORA John*

FIGURE 30, *f–h*

Eumorphometra aurora JOHN, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 129 (range), p. 133 (in key), p. 152 (description; locality); text-fig. 6, a–d, p. 153; pl. 4, fig. 1; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 202 (B.A.N.Z.A.R.E. stations; supplementary description; viviparity), fig. 3.

Diagnostic features.—When the arms are about 30 mm. long, there are about XL cirri with up to 28 segments; the axillary is rhombic with a large proximal angle; the division series are distinctly spinous around the edges; all the segments of P_1 except the first one are longer than broad; the segments of the genital pinnules are not expanded.

Description.—The centrodorsal is rounded conical, 1.6 mm. in basal diameter and 1.4 mm. in vertical height, with the proximal border produced interradially into very low and wide angles. The cirrus sockets are arranged in 10 columns with an additional socket between the proximal ends of the 10 columns in four radial areas (see fig. 30,*f*, p. 545).

The cirri are about XLI, 17–28. The peripheral cirri are up to 10 mm. in length, with 27 to 28 segments. The apical cirri are about half as long, with 17 to 19 segments. The intermediate cirri are longer than the apical, with 21 to 23 segments. The first three cirrus segments are broader than long, the fourth is as long as broad, and the fifth to eighth or ninth are slightly longer than broad. All these have the distal end slightly flaring, more strongly on the dorsal than on the ventral side, so that they are a little wider distally than at the base. The more distal segments are about as long as broad. Their dorsal sides are raised into low keellike protuberances, highest near the end of the segments, making them broader distally than proximally. The opposing spine is small and the terminal claw is short.

The radials are nearly rectangular and fairly long, about half as long as broad. In profile the proximal half makes only a slight angle with the dorsoventral axis, but the distal half bends sharply outwards. The IBr_1 are not quite so long as the radials; they are widely separated from each other and are not deeply incised by the axillaries. The IBr_2 (axillaries) are slightly longer than broad.

The 10 arms are all broken; to the thirtieth brachial, approximately about three-fourths of their full length, they are 20 mm. long. The first brachials are about four times as broad as the median length, nearly as long exteriorly as broad, and widely separated interiorly. The fifth to eighth brachials, between the first and second syzygies, are nearly rectangular, about half again as broad as long. The brachials between the second and third syzygies are wedge-shaped and longer than broad. The more distal brachials are longer on one side than on the other and are slightly longer than broad. The distal edges of the radials, elements of the IBr series, and first two brachials are raised into very fine spines. The distal edges of all the brachials beyond the first syzygy are faintly raised and produced into short spines.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations. The length from the proximal edge of the IBr_1 to the second syzygy is 7.0 mm. and the width at the first syzygy is 1.0 mm.

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* See also Addenda (p. 837) under 1963.

Dr. John says that there is no strong contrast between the different kinds of pinnules. In all, the distal edges of the segments are faintly flared out and produced into spines; the flare is not strong enough to give the joints a swollen appearance. P_1 is slender and tapers evenly from the base to the tip, 4 to 5 mm. long, with 13 rounded segments, of which all but the first two or three are longer than broad, the distal more so than the proximal; the distal are up to three times as long as broad. P_2 is similar to P_1, about 3 mm. long with 8 to 9 segments; it tapers more rapidly and its distal segments are more elongated. In the genital pinnules the first two segments are short, the others longer than broad, the middle segments being more elongated than in the oral pinnules. P_3 is the first genital pinnule; it is slightly longer than P_2, 3 to 4 mm. long with 8 to 9 segments. It bears a large egg-shaped gonad on the third to fifth segments—a testis, for the specimen is a male. The genital pinnules extend to P_7 or P_8; they are all of about the same number of segments as P_3, but the distal are a little longer, up to 5 mm.; their gonads are more fusiform, being along the third to sixth segments. The pinnules immediately beyond the genital pinnules are about 5 mm. long with about 12 segments, the first two short, the others considerably longer than broad. There are no complete distal pinnules.

The disk is naked. Sacculi are few and inconspicuous.

Along the pinnule ambulacra there are small rods, three to each pinnule segment, which are perforated, forked, or branched at the end. They are very reduced side plates and are better developed along the middle than the proximal segments. At the ends of some, but not all, there are equally reduced cover plates. Dr. John says that both are similar to, but more reduced than, those of *Phrixometra nutrix*.

The color in alcohol is white.

Notes.—In 1939 Dr. John found two specimens among the B.A.N.Z.A.R.E. collections which he believed to be of this species. They are considerably smaller than the holotype, having the distance from the apex of the centrodorsal to the first syzygy only 4 mm. as opposed to 5.5 mm., and the width at the first syzygy is about 0.7 mm.

The centrodorsal is slightly shorter than its median diameter, which is about 1 mm. It is a rounded cone with its proximal border produced into small interradial angles. In one specimen the cirrus sockets are arranged in ten columns, which become irregular proximally; in the other the arrangement is indistinct. The sockets number XX–XXX.

The single cirrus remaining is a peripheral one, but Dr. John says that it is immature in appearance. It has 24 segments and is 7 mm. long. It is similar to, though smaller than, those of the type.

The radials are considerably wider distally than proximally. As in the type the distal half is bent outwards. The IBr_1 are much shorter, although, like the IBr_2 and lower brachials, they are similar in shape to those of the type. Except for the relatively greater length expected in a smaller specimen, the remaining brachials are also like those of the type. The edges of the radials and IBr_1 are spiny and the middorsal surfaces of the IBr_2 (axillaries) and lower brachials are raised into low spines.

In one of the two specimens P_1 is nearly 2.5 mm. long, with 9 segments. The first two segments are as long as broad, the third twice as long as broad, the rest three times. P_2 is of fewer segments and shorter, only 2 mm. long, with 7 segments, of which the third to sixth are three times as long as broad. The whole pinnule tapers evenly.

P_3 is the first genital pinnule. All are broken but a detached pinnule lacking ambulacral grooves is probably a P_3 or near it. With the two basal segments and probably one distal segment lost, it is estimated to have had about 11 segments when complete and been over 4 mm. long. The segments beyond the third are elongated, up to six times as long as broad, with flared and spinous distal ends. The gonad, an ovary, lies along the third to fifth and part of the sixth segments. A detached distal genital pinnule, with an ambulacral furrow, was, when complete, of 11 segments and about 5 mm. long. The segments are elongated as in P_3.

There is then a far greater difference in length between the oral and genital pinnules of this specimen than in those of the type, due to the greater elongation of the segments of the genital pinnules in this specimen.

P_1 and P_2 of the other specimen are shorter, with six segments and about 2 mm. long. P_3 is the first genital pinnule. The specimen is a male.

The pinnule ambulacra are lined by reduced rodlike side plates, two or three to each segment. The rods may be smooth, or one or both ends may be knobbed, branched or expanded into small reticulated plates. At the ends of some of the side plates are much shorter rods, usually studded with spikes, which are cover plates. There are no spicules in the tentacles. The side and cover plates are similar to, but better developed, than those of the type.

The female specimen shows that this species too is viviparous. The brood pouches lie on the ventral side of the ovaries, not alongside them as in *E. concinna*; they may be on the proximal or on the distal part of the ovary and they may overlap it at either end. The eggs in the ovaries vary in size up to 0.3 mm. Three of the genital pinnules examined, all of them proximal ones, were found to contain embryos in the brood pouch. In one pouch there were three embryos, none with skeletal plates. The other two each have two embryos which are irregular in shape and about 0.4 mm. long. None shows any trace of ciliated bands. Skeletal plates are beginning to appear in some. A terminal stem plate and a number of stem joints can be seen in one as well as some of the plates of the calyx. The brood pouches have such thin walls that they may easily be overlooked when collapsed. Judging from a number of pinnules in this condition, they often lie partly proximal to the ovary, on the third segment of the pinnule and partly on the ovary.

In the male specimen, a large triangular ossicle separates one of the radials from the centrodorsal and from one of the other radials.

Dr. John sent me the type specimen of *E. aurora* so that I might compare it with *E. concinna*. It is considerably larger than the latter, its centrodorsal is lower and broader with more numerous cirrus sockets, which are more irregularly arranged. Its longer cirri have more segments. The radials and axillaries are longer. The elements of the division series and brachials do not have their central portions abruptly elevated and prominently spinous as in *E. concinna*.

Dr. John was able to compare *E. aurora* directly with *E. hirsuta*. It is far less spinous than *hirsuta* on the arms and the shapes of the elements of the division series and first two brachials are quite different in the two species. The cirrus sockets of *E. hirsuta* are in about 15 irregular columns. Dr. John says that *E. aurora* is easily distinguished from *E. fraseri* by the smaller number of cirrus segments, and from *E. marri* by the fact that its cirrus sockets are in columnar arrangement, P_1 is not much more massive than P_2, and the segments of the lower genital pinnules carrying the gonads are not expanded.

Localities.—*Discovery* Investigations station 160; near Shag Rocks (lat. 53°43′40″ S., long. 40°57′ W.); 177 meters; bottom gray mud, stones and rock; February 7, 1927 [John, 1938] (1, B.M.). Type locality.

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 200 meters; bottom temperature −1.77° C., salinity 34.24‰; January 24, 1930 [John, 1939] (1, B.M.).

B.A.N.Z.A.R.E. station 42; off Enderby Land (lat. 65°50′ S., long. 54°23′ E.); 220 meters; January 26, 1930 [John, 1939] (1, B.M.).

History.—*Eumorphometra aurora* was described by Dr. D. Dilwyn John in 1938 from a single specimen dredged by the *Discovery* in 1927. In 1939 the same author was able to amplify his description and to show, from two further specimens taken by the B.A.N.Z.A.R. Expedition in 1930, that the species is viviparous.

Geographical range.—Shag Rocks area (53° S., 40° W.) and off Enderby Land (66° S., 53° E.).

Bathymetrical range.—From 177–220 meters.

Thermal range.—The single record is of −1.77° C.

Salinity range.—The single record is 34.24‰.

Genus HYBOMETRA A. H. Clark

Hybometra A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 54 (diagnosis; type species *H. senta*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Antedoninae); No. 16, p. 506 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 198 (in key; range), p. 217; Univ. Iowa, Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (confined to the West Indian region), p. 17 (in key); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (range), p. 52 (in key); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139.

Diagnosis.—A genus of Zenometrinae in which the centrodorsal is conical but not quite as high as wide; the cirrus sockets are in 20 columns but are not separated into radial groups; interradial columns are of four sockets each but the radial ones are abbreviated towards the apex and are slightly irregular; the cirri are unknown, also P_1; P_2 is very long and attenuate with about 27 segments; P_3 is much shorter, just over half as long as P_2, with 14 to 15 segments; the division series are slightly spinous and this increases on the distal brachials.

Type species.—*Hybometra senta* A. H. Clark, 1913.

Geographical range.—Only known from the coast of Brazil.

Bathymetrical range.—Only known from 42 meters.

HYBOMETRA SENTA A. H. Clark

FIGURE 31

Hybometra senta A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 54 (description; locality); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 217 (references); The Danish *Ingolf*-Exped., vol. 4, No. 5, 1923, Crinoidea, p. 41 (range); Mem. Soc. Cubana Hist. Nat. vol. 14, No. 2, 1940, p. 140 (in key), p. 144 (reference).

Description [by A.M.C.].—The centrodorsal is conical, 3.2 mm. in vertical height or 3.6 mm. from the apex to the interradial border and 4.1 mm. in basal diameter. There are about LXVI cirrus sockets of which 20 are peripheral, four corresponding to each radial area. The two outside ones in each area form the bases of regular columns of four sockets, which converge to meet near the apex of the centrodorsal. In the triangular area between them are two incomplete and less regular columns of two or three sockets each. The arrangement approaches that of *Poliometra prolixa* except that the centrodorsal is relatively lower and the columns are consequently shorter.

All the cirri are lost, not even stumps remaining.

The division series and proximal brachials are as shown in the figure and have a few fine spines along their distal edges. The brachials become much more spinous beyond the bases of the arms.

The arms were over 90 mm. in length. The longest remaining is of 88 brachials and measures 80 mm. Syzygies are present at brachials 3+4, 9+10, 14+15 and then at intervals of three (or four) muscular articulations. The width at the first syzygy is 2.0 mm. and the length from the proximal edge of IBr_1 to the second syzygy is 11.0 mm.

No P_1 is complete beyond the second joint.

A broken P_2 with 14 segments measuring 9 mm. remains, but a complete one, formerly concealed between the arms, was found to be very attenuate with 27 segments; it measures 14 mm. The segments are longer than broad after the first three and most are two to three times as long as wide. The distal ends of the longer segments are distinctly flared and spinous.

P_3 tapers evenly and is much shorter, 7.5 to 8.5 mm. long, with 14 or 15 segments.

P_4 measures 9.0 mm. and has 16 segments.

P_5 is 10.5 mm. long with 17 segments.

The distal pinnules are longer, P_{18} with 22 segments is 15 mm. long. It is much stouter than the oral pinnules.

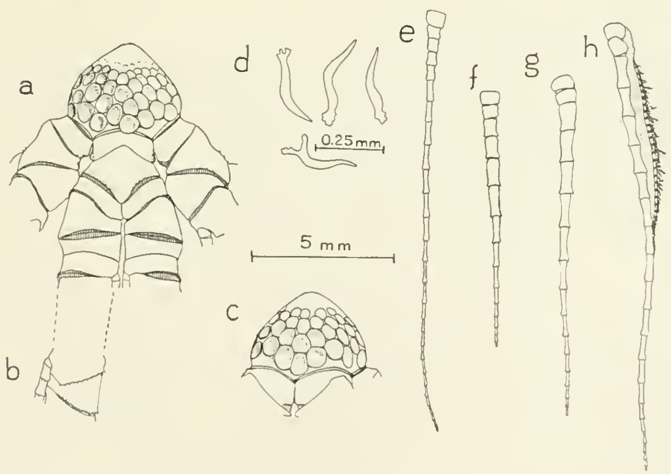

FIGURE 31.—*Hybometra senta* A. H. Clark, holotype: *a*, Radial view of calyx; *b*, twentieth arm segment; *c*, centrodorsal in interradial view; *d*, spicules from ambulacra of distal pinnule; *e*, P_2; *f*, P_3; *g*, P_5; *h*, P_{18}.

The first joint of all the pinnules is much wider than the second and following ones as the second segment is narrower distally than proximally.

The distal pinnules have a few simple ambulacral spicules in the form of rods bent near the middle like boomerangs, with one end tapered and the other claviform and more or less rugous. A few are forked.

The first genital pinnule is P_4 or P_5.

Locality.—33 miles east of Pernambuco, Brazil; 42 meters; V. K. Cornish [A. H. Clark, 1913] (1, B.M., No. 93.4.7.6).

Remarks [by A.M.C.].—The discovery that the arrangement of the cirrus sockets can better be described as columnar than alternating has necessitated the transfer of this genus from the Antedoninae to the Zenometrinae. Mr. Clark himself commented on the resemblance of the centrodorsal to that of *Hathrometra* (now *Poliometra*) *prolixa*.

Genus LEPTOMETRA A. H. Clark*

Alecto (part) J. Müller, Monatsb. Preuss. Akad. Wiss., 1841, p. 182, and following authors.

Comatula (*Alecto*) (part) J. Müller, Abh. Preuss. Akad. Wiss. for 1847, 1849, p. 253.

Comatula (part) Barrett, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 33, and following authors.

Antedon (part) Norman, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 104, and following authors.

Leptometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 129 (type *Alecto phalangium* J. Müller, 1841), p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted); Amer. Nat., vol. 42, No. 500, 1908, p. 542 (characteristic of the Mediterranean-northeast Atlantic fauna); No. 503, p. 724 (color); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Zenometrinae); Vid. Medd. Nat. Foren. København, 1909, p. 128 (East Indian in origin; most closely related to *Psathyrometra*); Proc. U.S. Nat. Mus., vol. 38, 1910, p. 331 (an Indian Ocean genus; an intrusion into the Atlantic area); vol. 40, 1911, p. 9 (with *Antedon* characterizes the European faunal area), p. 10 (closely related to the East Indian *Psathyrometra*); Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 131 (significance in the European fauna; origin); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 449 (Mediterranean species with long, Atlantic with short arms); Mem. Australian Mus., vol. 4, 1911, p. 726 (closely resembles *Psathyrometra;* route by which it reached Europe); Crinoids of the Indian Ocean, 1912, p. 13 (closely related to and derived from *Psathyrometra;* characteristic of the Mediterranean and east Atlantic faunas), p. 21 (route by which it reached Europe), p. 26 (range); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, p. 5 (origin and range); *in* Michaelsen and Hartmeyer, Beiträge zur Kenntnis der Meeresfauna Westafrikas, Echinod. II, Crinoidea, 1914, p. 311 (origin and range); Die Crinoïden der Antarktis, 1915, p. 114 (in key to the genera of Zenometrinae), p. 182 (range; eastern representative), p. 190 (occurrence in the Mediterranean); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Zenometrinae); No. 16, p. 509 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 222 (in key; range), p. 231 (key to the included species); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 28 (color).—Koehler, Faune de France, 1, Echinodermes, 1921, p. 192 (morphology), p. 193 (history), p. 194 (in key), p. 197 (diagnosis; beautiful green in life; French species).—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 53 (in key), p. 56 (key to species).—Gislén, Ark. Zool., vol. 15, No. 23, 1923, p. 15; Vid. Medd. Nat. Foren. København, vol. 83, 1927, pp. 6, 39.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key), p. 34 (diagnosis).—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 115 (green color), p. 116 (in key), p. 130 (diagnosis), p. 131 (key to species).—Rivera, Bol. Pesc. Madrid, vol. 14, 1929, p. 50 (in key).—Nobre, Echinodermes de Portugal, 1931, p. 164 (diagnosis), p. 165.—Buen, Bol. Soc. Esp. Hist. Nat., Madrid, vol. 34, 1934, pp. 440, 442, 443, 444.—Tortonese, Atti Soc. Ital. Sci. Nat., vol. 75, 1936, p. 280; Boll. Mus. Zool. Univ. Torino, vol. 46, ser. 3, No. 82, 1938, pp. 45, 46 (brief diagnosis).—Nobre, Echinodermes de Portugal, ed. 2, 1938, p. 186 (in key), p. 188.—Elias da Costa, Chaves dicotó-

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* See also Addenda (p. 838) under 1965.

micas para a classificação dos equinodermes Portugueses. IV. Crinóides, Porto, 1940, pp. 8 (in key), 13.—TORTONESE, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 14.—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 97 (common in deeper waters of Mediterranean).

Antedon (*Leptometra*) KOEHLER and VANEY, Bull. Mus. Hist. Nat. Paris, No. 1, 1910, p. 26.

Diagnosis.—A genus of Zenometrinae in which the centrodorsal is conical, usually about as high as broad at the base but often more or less broadly truncated and much lower; the cirrus sockets are usually closely crowded, and are arranged in 2, or 2 and a more or less developed third, columns beneath each radial, those in the apical third or half of the centrodorsal obsolete; the cirri are long with up to 51 segments, of which the longest are from 2 to 3 times as long as broad and the outer are either of similar proportions or shorter, sometimes even broader than long and somewhat swollen dorsally; much shorter apical cirri are occasionally present; the elements of the IBr series and the lower brachials are smooth, separated or in lateral contact; all the pinnules are present; P_1 and P_2 are similar and of the same length, slender and much elongated but with 3 to 5 basal segments not longer than broad; P_3 and the following pinnules are much shorter.

Geographical range.—From the Faroe Islands and western Scotland southward to Madeira, and Sierra Leone, including the Mediterranean and the Sea of Marmara.

Bathymetrical range.—From 46 to 1292 meters.

Thermal range.—From 9.61° C. to 18.2° C. (only 4 records).

KEY TO THE SPECIES OF LEPTOMETRA

[modified by A.M.C.]

a.[1] Cirri very long and slender, gradually tapering to a point distally, all of the component segments, except the basal, being about twice as long as broad, the outer with little, if any, modification of the distal dorsal edge, so that the dorsal profile remains smooth (fig. 32,*b*, p. 567); the terminal claw is almost straight; the arms are up to 165 mm. in length; the cirri may be over half as long (Mediterranean and the Sea of Marmara; 55–1292 meters)-------------**phalangium** (p. 553)

a.[2] Cirri proportionately shorter, usually less than half as long as the arms and not evenly tapered distally, composed in the proximal half of segments which are about twice as long as broad, but distally the segments are nearly always shorter, the penultimate about as long as broad to half again as long, rarely longer; the distal segments usually have the distal dorsal edge somewhat swollen so that the dorsal profile is slightly scalloped (fig. 32,*d*); the terminal claw is more or less curved; the arms are up to 125 mm. long; the cirri are usually 35–40 mm. long (Faroe Islands to Madeira and Sierra Leone; 46–1279 meters)--------------------------------**celtica** (p. 564)

LEPTOMETRA PHALANGIUM (J. Müller)*

FIGURE 32,*a*,*b*

[See also vol. 1, pt. 1, figs. 316 (p. 273), 381–382 (p. 301); pt. 2, figs. 290 (p. 221), 329–330 (p. 227)]

Alecto phalangium J. MÜLLER, Monatsb. Preuss. Akad. Wiss., 1841, p. 182 (Nice); Arch. Naturg., 1841, vol. 1, p. 142 (from preceding); L'Institut, October 21, 1841, p. 357 (from preceding); Abh. Preuss. Akad. Wiss. for 1841, 1843, p. 203.—PHILIPPI, Neues Jahrb. Min. 1844, p. 541.—P. H. CARPENTER, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 13 (compared with *Alecto alticeps*).

Comatula (*Alecto*) *phalangium* J. MÜLLER, Abh. Preuss. Akad. Wiss. for 1847, 1849, p. 253 (revised description).—LUDWIG, Mitt. Zool. Stat. Neapel, vol. 2, 1880, p. 53 (identified).

Comatula phalangium DUJARDIN and HUPÉ, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 198 (synonymy; description; Nice).—P. H. CARPENTER, Nature, vol. 15, 1877, p. 197 (centrodorsal compared with that of other species).—[LUDWIG], Mitt. Zool. Stat. Neapel, vol. 1, 1879, p. 349

* See also Addenda (pp. 836, 838) under 1958, 1959, 1965.

(in price list of animals for sale at the Naples Station).—W. Marshall, Die Tiefsee und ihr Leben, 1888, p. 241.

Antedon mediterraneus (not of Lamarck) Wyville Thomson, Proc. Roy. Soc. Edinburgh, vol. 7, 1872. p. 765.

Antedon phalangium Marion, Ann. Sci. Nat., Zool. ser. 6, vol. 8, No. 7, 1879, p. 40, pl. 18, fig. 11 (occurrence about Marseille).—Ludwig, Mitt. Zool. Stat. Neapel, vol. 1, 1879, p. 537 (Naples, Nice, Marseille; 70–80–200 meters; synonymy).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*); Quart. Journ. Geol. Soc., vol. 36, 1880, pp. 48, 551.—Ludwig, Mitt. Zool. Stat. Neapel, vol. 2, 1880, p. 53 (Naples; history of the species; comparison with *Antedon rosacea;* ambulacral plates; calyx pores), pl. 4, fig. 1, a, b (calcareous plates, a, from a marginal lappet, b, from the tentacle wall).—P. H. Carpenter, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 156 [p. 6 of separate] (includes *celtica;* no basal star in connection with the rosette), p. 165 (pinnulation of the young).—E. Graeffe, Arbeit zool. Inst., Wien, vol. 3, Heft 3, 1881, p. 339 (absent from the lesser depths in Trieste Bay).—P. H. Carpenter, Zool. Anz., vol. 4, 1881, p. 521 (Bay of Benzert, 50–100 fms.; Skerki Bank, 30–120 fms.; Marseille).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed) p. 534 (specific formula).—Perrier, *in* Milne-Edwards, Arch. Miss. Sci., ser. 3, vol. 9, 1882, p. 20 (collected by the *Travailleur* in the Mediterranean).—P. H. Carpenter, Proc. Zool. Soc. London for 1882, 1883, p. 746 (specific formula).—Marion, Ann. Mus. Hist. Nat. Marseille (Zool.), vol. 1, Mem. No. 1, 1883, p. 105; No. 2, pp. 41, 43, 48 (distribution about Marseille).—P. H. Carpenter, Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 361 (Bay of Benzert, 50–100 fms.; Skerki Bank, 30–120 fms.).—Carus, Prodromus faunae Mediterraneae, 1884, pt. 1, p. 85 (Marseille, Nice, Naples; 70–200 meters).—von Graff, Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 379 (host of *Myzostoma alatum* and of *M. pulvinar*); *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, pp. 13, 14, 18 (myzostomes).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1886, p. 475 (dimorphism of the cirri), p. 476 (Nice; Naples; Tunis coast, *Porcupine*, 1870; Marseille; Carthagena; detailed description of the cirri), pp. 477–480 (comparison of the cirri with those of the Scottish variety [*celtica*]), p. 480 (Tunis coast, 50–120 fms.; Marseille, 100–200 meters), pl. 57, figs. 7–9, 12, 17, 19; Bijdr. Dierkunde, vol. 14, 1887, p. 44 (comparison with *A. quadrata*), pp. 45–47 (comparison with *A. prolixa*), p. 49 (comparison of 2 pentacrinoids dredged by the *Varna* with this species).—von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 2 (off Carthagena, 80 fms.; myzostomes).—Braun, Centralbl. Bakteriol. Parasitenk., vol. 3, 1888, p. 185 (myzostomes).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 158, pl. 27, figs. 23–29, pl. 28, figs. 1–3 (detailed account).—Lo Bianco, Mitt. Zool. Stat. 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Wiss., Wien., math. nat., vol. 60, 1893, 1894, p. 3 (*Pola* stations).—Walther, Einleitung in die Geologie als historische Wiss., 1894, p. 298.—Wheeler, Zool. Anz., vol. 17, 1894, p. 178 (myzostomes).—Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 140 (comparison of arms with those of *A. rhomboidea* from Las Tres Marias).—von Marenzeller, Anz. Akad. Wiss., Wien, Jahrg. 1895, No. 18, p. 190 (first discovery in the Adriatic); Denkschr. Akad. Wiss., Wien, math. nat., vol. 62, 1895, Zool. Ergebn., vol. 5, Echinodermen, pp. 7, 23, 129 (details of *Pola* localities).—Pruvot, Arch. Zool. Exp. Gén., ser. 3, vol. 3, 1895, p. 652 (local distribution about Banyuls).—Lang, A text book of comparative anatomy, vol. 12, 1896, p. 375, fig. 336, *a*.—Ostroumoff, Bull. Acad. sci. St Petersburg, ser. 5, vol. 5, No. 1, June 1896, pp. 35, 51, 62, 64, 90 (*Selanik* stations in the Sea of Marmara).—Wheeler, Mitt. Zool. Stat. 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Aarb. for 1903, No. 5, 1904, p. 6 (replaces *glacialis* in the warmer basins of the Atlantic), p. 23 (La Ciotat; measurements), p. 25 (discussion), p. 28 (intersyzygial interval), p. 33 (portion of a pinnule showing sacculi, covering plates and tentacles), p. 34 (pinnules).—Döderlein, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 402 (synonymy; range; discussion; relation to antarctic types).—Minckert, Arch. Naturg., Jahrg. 71, vol. 1, 1905, Heft 1, p. 240 (regeneration; from Riggenbach).—Lo Bianco, Mitt. Zool. Stat. Neapel, vol. 18, 1906, p. 94 (immunity, on account of habitat, from the cinders from Vesuvius in 1906).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—Aranda y Millan, Mem. Real Soc. Espan. Hist. Nat., Madrid, vol. 5, Mem. 5a, 1908, p. 246 (Baleares; Banyuls; Blanes).—Schaxel, Arch. Mikros. Anat., vol. 76, Heft 3, Jan. 20, 1911, pp. 545, 563 (growth of the oocyte).—A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 86 (B.M., M.S.=*A. mediterranea* +*L. phalangium*).—Baldelli, Arch. Zool. Ital., vol. 7, 1914, pp. 83, 99 (*Washington* stations).—Vayssière, Ann. Mus. Marseille, vol. 17, 1919, p. 98 (locality), p. 105 (nature of bottom; depth) (? *phalangium*); Compt. Rend. Acad. Sci., vol. 170, No. 16, 1920, p. 916 (Gulf of Marseille).—Pallery, Bull. Soc. Hist. Nat. Afrique Nord, vol. 26, pt. 2, 1935, p. 49 (Gulf of Oran).—Parenzan, Boll. Idrobiol. Afr. Orient. Ital., Addis Ababa, vol. 1, 1940, pp. 129, 131, 135 (Gulf of Naples, 100–280 meters).

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Leptometra phalangium A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130 (listed); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 449 (long arms when compared with *celtica*); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 7 (Mediterranean coast), p. 9 (characteristic of the Mediterranean division of the European faunal area), p. 44 (compared with *L. celtica;* synonymy; Tunis; Bay of Benzert; Skerki Bank; occurs along French and Italian coasts of the Mediterranean; 30–120 fms.); vol. 43, 1912, p. 382 (cotype from Nice in U.S.N.M.; specimen from Sicily in U.S.N.M.), p. 383 (=*Alecto phalangium* J. Müller), p. 405 (Nice; Naples; Sicily; no locality); Crinoids of the Indian Ocean, 1912, p. 30 (=*Comatula* [*Alecto*] *phalangium* J. Müller); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 32 (Naples; Tunis; 50–100 fms.); vol. 61, No. 15, 1913, p. 55 (published references to specimens in the Brit. Mus.; Carthagena, *Porcupine,* 1870; La Ciotat; Naples; Skerki Bank, 30–120 fms., *Porcupine,* 1870; Skerki Banks, *Porcupine;* Bay of Benzert, 50–100 fms., *Porcupine,* 1870; Bay of Benzert, *Porcupine* 1870; Naples; characters of the specimens); Die Crinoiden der Antarktis, 1915, p. 117 (comparison of arms with those of *Psathyrometra antarctica*), p. 190 (occurrence in the Mediterranean); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 231 (in key; range).—Koehler, Faune de France, 1, Échinodermes, 1921, p. 11 (found by dredging in the Mediterranean), p. 194 (in key), p. 197 (description; occurrence); figs. 151, 152, p. 198; fig. 153 *a*, p. 199.—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range), p. 56 (in key).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, fig. 301, p. 217.—Ranson *in* Le Danois, Mem. (ser. spec.) Office Sci. Tech. Pêches Marit., vol. 3, pt. 1, 1925, Recherches sur les fonds chalutables des côtes de Tunisie, p. 55 (*Tanche* sta. 784); pt. 2, Recherches sur les fonds chalutables des côtes d'Algérie, p. 36, p. 54 (*Tanche* stas. 800, 821, 832); (also published in Ann. Sta. Océanogr. Salammbo, vol. 1, 1925).—Gislén, Göteborgs VetenskSamh. Handl., vol. 30, No. 6, 1926, p. 8.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 35.—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 131 (description; range), p. 133; pl. 11, figs. 4–6.—Rivera, Bol. Pesc. Madrid, vol. 14, 1929, p. 50 (in key); fig. 1.—Koehler, *in* Faune et flore Méditerranée, Paris, 1931 (pages not numbered) (diagnosis; distribution;

references).—Tortonese, Natura, Milano, vol. 24, 1933, pp. 163, 164 (depth range).—Rivera, Trab. Inst. Esp. Oceanogr., Madrid, No. 10, 1934, p. 83 (*Xauen* stas. 7, 19, 20).—Buen, Trab. Inst. Esp. Oceanogr., Madrid, No. 6, 1934, p. 27; Bol. Soc. Esp. Hist. Nat. Madrid, vol. 34, 1934, pp. 440, 442, 443 (*Xauen* sta. 7).—Pallary, Bull. Soc. Hist. Nat. Afrique Nord, vol. 26, pt. 2, 1935, p. 58.—Tortonese, Ann. Mus. Civ. Stor. Nat. Genova, vol. 57, 1935, p. 222 (listed), p. 265 (proportions; range); Atti Soc. Ital. Sci. Nat., vol. 75, 1936, p. 280.—Perrier, La faune de la France, vol. 1A, Paris, 1936, p. 95 (color; description).—Kolosvary, Folia zool. hydrobiol. Riga, vol. 9, 1936, p. 83; Festschr. für Embrik Strand, vol. 2, 1937, p. 469 (not taken by *Najade* Exped.).—Tortonese, Boll. Mus. zool. Univ. Torino, vol. 46, ser. 3, No. 82, 1938, p. 5 (listed), p. 46 (synonymy; range).—Jägersten, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 11, No. 8, 1940, p. 13.—Bacci, Publ. Staz. Zool. Napoli, vol. 20, 1947, p. 174 (bottom communities of the Gulf of Genoa).—Gislén, Göteborgs Handels Tidning, ser. B, vol. 5, No. 10, 1947, pp. 3, 4.—Cuénot, *in* Grassé, Traité de Zoologie, vol. 11, 1948, pp. 71, 274.—Tortonese, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4 (depth range), pp. 15, 16 (listed).—Dieuzeide, Bull. Stat. Aquic. Pêche, Castiglione, new ser., No. 2, 1950, p. 22 (very abundant locally).—Vatova, Nova Thalassia, vol. 1, No. 3, 1950, pp. 26, 63, 89 (ecology in Adriatic), table 32.—Tortonese, Atti Accad. Ligure, vol. 8, 1952, pp. 8, 9, 10 (distribution in Ligurian Sea).—Pérès and Picard, Compt. Rend. Acad. Sci., vol. 238, 1954, pp. 1252–54 (locally abundant).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 115 (local aggregations), p. 117 (myzostome parasite).—Tortonese, Bull. Stat. Aquic. Pêche, Castiglione, new ser., No. 7, 1955, pp. 204, 209.—Cherbonnier, Les échinodermes, Monte Carlo, 1955, p. 94.—Tortonese, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182 (localities).—Cherbonnier, Bull. Stat. Océanogr. Salammbo, No. 53, 1956, p. 4 (listed), p. 8 (sta. 5; occurrence off Tunisia).—Gautier-Michaz, Ann. Inst. Océanogr., Paris, new ser., vol. 34, 1958, pp. 146, 148 (*Calypso* stations), pp. 149, 155.—Gautier, Rec. Trav. Sta. Mar. Endoume, No. 26, 1959, p. 143 (*Gyf* station).—Zavodnik, Biol. Vestnik, Ljubljana, vol. 8, 1961, p. 49 (Adriatic, 100–150 meters).

Antedon adriatica, (not of A.H.C.), Boone, Bull. Vanderbilt Mar. Mus., vol. 4, 1933, pp. 69–70 (*Ara* stations), pl. 26.

Diagnostic features.—See key.

Description.—The centrodorsal is sharply to bluntly, rounded, or truncated conical, or even somewhat columnar, usually about as high as broad at the base, sometimes higher than broad, with the distal third or half without functional cirrus sockets, shallowly pitted, with a very irregular surface, or bearing numerous papillae. The cirrus sockets, which are elongate dorsoventrally, are arranged in 2, or 2 and a more or less developed third, usually somewhat irregular columns beneath each radial, and are usually closely crowded.

The cirri are XXV–XXXV, 45–51, up to 61 mm. in length, long, slender, and laterally compressed, in the distal portion tapering gradually to a fine point. In the proximal portion they are curved slightly ventrally, and in the outer half they turn very gradually dorsally. The first segment is about 4 times as broad as long, the second is not quite twice as broad as long, the third is about as long as broad, the fourth is half again as long as broad, the fifth is twice as long as broad, and the seventh and following are from 2 to 3 times as long as broad, the length decreasing slightly at the middle of the cirrus, then gradually increasing again in the terminal fourth. In the outer half of the cirri the dorsal profile of the segments is very slightly concave. There are no dorsal processes, and the opposing spine is absent. The terminal claw is not quite so long as the penultimate segment, and is slightly recurved in the distal half. The more distal cirri are shorter, with fewer and shorter segments. In an extreme case mentioned by Carpenter the longest cirrus measured 61 mm. and consisted of 48 segments while an apical cirrus was only a trifle over 5 mm. long.

The radials are very short, sometimes almost entirely concealed by the centrodorsal, with the lateral angles slightly separated by a narrow V-shaped notch. The IBr_1 are short, from 4 to 6 times as broad as long in the median line, with straight and parallel sides and the distal border more or less concave; sometimes the arched dorsal surface decreases in width distally, in which case there is a flangelike ventrolateral production of the laterodistal angles. The IBr_2 (axillaries) are about as long as broad, or a little broader than long, with slightly truncated lateral angles; the concave distal sides form a right angle with each other while the proximal angle is obtuse and broadly rounded. The sides of the IBr series are straight, and usually in contact throughout their length with those of their neighbors.

The 10 arms are up to 165 mm. in length, and consist of about 200 brachials. The first brachials are about 3 times as long exteriorly as interiorly, with the inner half of the distal border parallel to the proximal and the outer half curving broadly and extending far distally; the outer edge is straight; the inner edge is straight, entirely free, and making an angle of from 45° to 60° with that of its neighbor. The second brachials are much larger, about as long as broad, with the proximal angle broadly rounded. The first syzygial pair (composed of the third and fourth brachials) is longer interiorly than exteriorly, usually about as broad as long in the median line. The next 4 brachials are wedge-shaped, half again as broad as long, and the following become much more obliquely wedge-shaped, about as long as broad, and distally longer again, being terminally almost twice as long as broad with only slightly oblique ends.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 2 to 8, but most commonly 3 or 4, muscular articulations.

P_1 is very slender and delicate, 15 or 16 mm. long, with 30 to 35 segments, of which the first 4 or 5 are about as long as broad with their distal angles cut away and the following rapidly become elongated, the tenth being more than twice as long as broad and those in the outer half of the pinnule excessively elongated, though without an appreciable enlargement of the articulations. P_2 is similar and of the same length, but very slightly stouter in the earlier portion. P_3 is much shorter, about as stout basally as P_2 but tapering much more rapidly, 5 mm. long, with 12 segments, of which the first is slightly broader than long, the second and third are about as long as broad, the fourth is slightly longer than broad, the sixth is twice as long as broad, and those following rapidly become much elongated. The following pinnules resemble P_3, and those succeeding slowly increase in length and slenderness. The distal pinnules are exceedingly slender, 12 mm. long with about 20 segments, of which the second is longer than broad and the third and following are greatly elongated, though without noticeably expanded articulations.

Notes.—Carpenter (1888) wrote that the centrodorsal may be either a thick disk, columnar, hemispherical or conical, but whatever its shape, the functional cirrus sockets are limited to 2 or 3 rows about the equator, all the more apical portions of the centrodorsal having the sockets more or less completely obliterated.

Baldelli (1914) found from numerous counts that the cirrus segments in the specimens from *Washington* station III, haul 5, varied from 37 to 50, the average being 44. Grieg (1904) in a specimen from La Ciotat found the cirri to be from 51 to 53 mm. long, with 46 to 48 segments. According to Carpenter (1888), the longest cirrus on the *Porcupine* specimens from Tunis was 52 mm., with 47 segments.

Baldelli (1914) has paid especial attention to the distribution of the syzygies in this species, his studies having been made on the abundant material secured by the

Washington at station III, haul 5. The first syzygy he always found between brachials 3+4, and the second always between brachials 9+10. The third syzygy was usually between brachials 14+15, but varied from between brachials 13+14 to between brachials 16+17. The fourth syzygy was usually between brachials 17+18, but sometimes between brachials 18+19, or even brachials 20+21 or 21+22. Of the outer syzygies, he said that their position varies in different arms of the same individual as well as in different individuals, and that 3, 4, 5 or 6 muscular articulations may intervene between 2 succeeding syzygies, the numbers following each other in a wholly irregular manner. He noted (and in all the arms of one individual) one or more series of brachials made up of a syzygial pair with a brachial having a muscular articulation at each end; he says that this is a disposition which, with rare exceptions, is constant in normal specimens of *L. phalangium*, and he found it also, though very rarely, in *Antedon mediterranea.*

At Marseille, Marion (1879) found P_1 and P_2 to vary from 12 to 17 mm. in length.

In a specimen from La Ciotat, Grieg (1904) found P_1 to be 14 mm. long, with 34 segments (in 2 cases); P_2 13 mm. long with 30 to 33 segments; and P_3 4.0 to 4.5 mm. long, with 13 to 15 segments.

Carpenter (1888) says that he occasionally found P_3 to be almost as large as P_2.

Ludwig noticed (1880) that in each ambulacral lappet there is a delicate perforated plate averaging 0.13 mm. in length, and in the wall of the basal portion of the tentacles there are small calcareous rods beset with minute spinelets which are at the most 0.07 mm. long. Grieg (1904) found that over the first 5 or 6 pinnule segments there are no adambulacral deposits. Beyond this point these take the form of large irregular perforated plates which alternate with the sacculi, recalling the plates in *Heliometra glacialis*, from which they differ in being single and not in contact with each other. Carpenter remarked (1888) that the pinnule ambulacra are sometimes imperfectly protected by small and delicate plates. He found such plates in specimens from Tunis; but in others from Marseille these were reduced to small Y-shaped rods.

Grieg (1904) described the pinnule segments as long and slender, about 4 times as long as broad, without spines on the dorsal side; even the outermost segments, including their distal ends, are without spines.

[Notes by A.M.C.] In nine of Carpenter's *Porcupine* specimens from off Tunisia the centrodorsal varies in size from 1.3 to 3.2 mm. basal diameter and 1.2 to 3.1 mm. vertical height, the ratio of diameter to height being from 1: 0.50 to 1: 1.15 averaging 1: 0.86. The small specimens particularly have the centrodorsal sharply conical. The one in which the height is only half the diameter is large and has the centrodorsal very broadly truncated, the basal diameter being 3.0 mm. The longer proximal cirrus segments are usually almost cylindrical but in a few specimens may be notably constricted in the middle (see fig. 32,*a*, p. 567). The segments at about two-thirds of the length of the cirrus may have very slight dorsal processes but these are not as prominent as in *celtica*. The distal cirrus segments are always very long and there is no trace of an opposing spine on the penultimate. The terminal is barely, if at all, curved.

Localities.—Porcupine, 1870; off Cartagena, Spain; 146 meters [P. H. Carpenter, 1884, 1886; von Graff, 1887; A. H. Clark, 1913] (3, B.M.).

Blanes (north of Barcelona) [Aranda y Millan, 1908].

Balearic Islands [Aranda y Millan, 1908].

Xauen station 7; off Majorca (lat. 39°11′10″ N., long. 9°1′35″ E.); 133 meters [Rivera, 1934; Buen, 1934].

Xauen station 19; off Majorca (lat. 39°11′15″ N., long. 8°53′15″ E.); 211 meters [Rivera, 1934].

Xauen station 20; off Majorca (lat. 39°4′14″ N., long. 9°7′50″ E.); 125 meters [Rivera, 1934].

Southeast of San Feliu de Guixols; 135 meters [Pruvot, 1901].

Cape San Sebastian, province of Gerona; 190 meters [Pruvot, 1901]. Same, 491 meters [Pruvot, 1901].

North of Cape San Sebastian; 116–142 meters [Pruvot, 1901].

Banyuls (Laboratory Arago) and vicinity [Pruho, 1892; Pruvot, 1895, 1897; Aranda y Millan, 1908].

Marseille [Ludwig, 1879; P. H. Carpenter, 1881, 1886]. Same, 70–200 meters [Marion, 1879; Carus, 1884; Lo Bianco, 1903]. Same, 100–200 meters [P. H. Carpenter, 1886]. Same, 75–700 meters [Marion, 1883]. Same, 80–150 meters [Vayssière, 1919]. Same, 60–80 meters (Vayssière, 1920).

Cassis, canyon of Cassidagne; 100–110 meters; *Gyf* [Pérès & Picard, 1954]. *Gyf* station 289; off Cassis; "towards" 100 meters [Gautier, 1959].

La Ciotat [Grieg, 1904; A. H. Clark, 1913] (4, B.M.; Berg. M.). Same, 100 meters or deeper [Koehler, 1894].

Nice [J. Müller, 1841; Dujardin and Hupé, 1862; Ludwig, 1879; Carus, 1884; P. H. Carpenter, 1886, 1888; Lo Bianco, 1903; A. H. Clark, 1912] (5, Berl. M., 1044; U.S.N.M., 35673). Type locality.

Villafranca [Schaxel, 1911].

Off Cape Martin, near Monaco (4, M.O.M.).

Eider station 0299; 8980–8680 meters from Mont-Agel, near Monaco; 200–250 meters; March 6, 1908 (3, M.O.M.).

Gulf of Genoa, Portofino (4, Genoa M.) [Tortonese, 1935, 1952]. Same (1, Turin M.) [Tortonese, 1938]. Same, Ponente, 150–300 meters; Livorno, 200–250 meters [Tortonese, 1952, 1956] (7, Tortonese Coll.).

Washington station III, haul 5; opposite Cape Capraro, at the tip of l'Asinara (island), northwestern Sardinia (lat. 41°10′27″04‴ N., long. 8°15′04″07‴ E.); 168, 284 meters; temperature 18.2° C.; madrepores; August 4, 1881 [Marion, 1883; Baldelli, 1914].

Naples [Ludwig, 1879, 1880; Carus, 1884; P. H. Carpenter, 1886; A. H. Clark, 1912, 1913] (10, B.M.; Berl. M., 2377; H.M.; W.M.; S.Z.). Same, muddy bottoms to 600 meters [Lo Bianco, 1899; A. H. Clark, 1912].

Bay of Naples [Lo Bianco, 1903]. Same, 100–280 meters [Parenzan, 1940]. Same [Kolosvary, 1936].

Bay of Sorrento [Wheeler, 1896].

Puritan station 25; about 10 kilometers north of Punta Carena; 200 meters; February 27, 1902 [Lo Bianco, 1903].

Puritan station 8; about 2½ kilometers east of Lo Capo, Capri; 120 meters; February 12, 1902 [Lo Bianco, 1903].

Sicily [A. H. Clark, 1912] (9, U.S.N.M., 35674; Berl. M., 5343).

Calypso stations 532, 200 meters, 534, 220 meters, and 566, 150–140 meters; between Sicily and Tunisia [Gautier-Michaz, 1958].

Adriatic, 100–150 meters [Zavodnik, 1961].

Pola station 285; eastern Adriatic, between the islands of Andrea and Lissa (lat. 42°58′20″ N., long. 15°43′10″ E.); 133 meters; fine sand; 1894 [von Marenzeller, 1895].

Ara; 11 miles northwest of Lissa Island, Dalmatia; 118 meters [Boone, 1933].

Pola station 64; south of Cerigo (Cythera or Kytherion) Island, southern Greece (lat. 35°56′00″ N., long. 22°55′40″ E.); 660 meters; mud with sand; July 31, 1891 [Steindachner, 1891; von Marenzeller, 1894].

Pola station 197; between Cerigo and Crete (Candia) (lat. 35°45′ N., long. 23°11′ E.); 608 meters; yellow mud and rather coarse sand; July 26, 1893 [von Marenzeller, 1895] (3, U.S.N.M., 18282).

Pola station 99; southeast of Cape Malea (Malia), southeastern Greece (lat. 36°19′40″ N., long. 23°16′20″ E.); 1292 meters; sand, with a little mud; September 6, 1891 [Steindachner, 1891; von Marenzeller, 1894].

Pola station 101; between Cape Malea and the island of Milo (Melos) (lat. 36°40′30″ N., long. 23°51′00″ E.); 834 meters; loose mud, abundantly mixed with sand; September 7, 1891 [Steindachner, 1891; von Marenzeller, 1894].

Pola station 208; between the islands of Milo and Serpho (Seriphos), Cyclades (lat. 37°00′ N., long. 24°21′ E.); 414 meters; yellow mud with fine sand; July 31, 1893 [von Marenzeller, 1895].

Pola station 210; east of Serpho (lat. 37°12′ N., long. 24°43′ E.); 287 meters; light yellow mud with fine sand, somewhat clayey; August 1, 1893 [von Marenzeller, 1895].

Pola station 214; Aegean Sea, east of the island of Stampaglia (Astropalia), Sporades (lat. 36°37′ N., long. 26°43′ E.); 533 meters; yellow gray mud with sand and broken shells; August 12, 1893 [von Marenzeller, 1895].

Pola station 213; north of Stampaglia (lat. 36°47′ N., long. 26°29′ E.); 597 meters; fine sand and mud; August 12, 1893 [von Marenzeller, 1895].

Selanik station 10; Sea of Marmara; 111 meters; September 11, 1894 [Ostroumoff, 1895].

Selanik station 5; Sea of Marmara, off Prinkipo Island; 128 meters; September 10, 1894 [Ostroumoff, 1896].

Selanik station 9; Sea of Marmara; 155 meters; September 11, 1894 [Ostroumoff, 1896].

Selanik station 55; Sea of Marmara; 244 meters; October 6, 1894 [Ostroumoff, 1896].

Ara; 9½ miles E. by S.½ S. of Cape Bon Tunis; 183 meters [Boone, 1933].

Porcupine, 1870; Tunis coast [P. H. Carpenter, 1886; A. H. Clark, 1911].

Porcupine, 1870; Skerki Bank (Banc des Esquerquis); 55–220 meters [P. H. Carpenter, 1881, 1884, 1886; A. H. Clark, 1911, 1913] (10, B.M.).

Porcupine, 1870; Bay of Bizerta, Tunis; 91–183 meters [P. H. Carpenter, 1881, 1884; A. H. Clark, 1911, 1912, 1913] (15, U.S.N.M., 16368; M.C.Z., 46; B.M.; H.M.).

Tanche station 784; east of Sidi Daoud, Tunisia (lat. 36°37′–36°42′ N., long. 11°21′–11°22′ E.); 112–132 meters; gray mud; May 28, 1924 [Ranson, 1925].

Tanche station 800; Algeria (lat. 37°01′ N., long. 7°01′–7°05′ E.); 200 (228–155) meters; muddy bottom; June 11, 1924 [Ranson, 1925].

Tanche station 821; Algeria (lat. 35°54′ N., long. 0°03′ W.); 70 meters; muddy sand; June 24, 1924 [Ranson, 1925].

Tanche station 832; Algeria (lat. 35°15′ N., long. 2°45′ W.); 100 meters; mud; June 30, 1924 [Ranson, 1925].

Bay of Castiglione [Dieuzeide, 1950].

Gulf of Oran [Pallary, 1935].

Travailleur, Mediterranean [Perrier, 1882].

No locality (3, Berl. M., 1045).

Geographical range.—Entire Mediterranean basin as far east as the Sea of Marmara, and in the Adriatic as far north as Lissa (Vis) (lat. 42°58′ N.).

Bathymetrical range.—From 55 to 1292 meters; rare above 100 meters, becoming more common below 150 meters; the average depth is about 300 (292) meters.

Thermal range.—One record, 18.2° C.

Occurrence.—North of Cape San Sebastian, in the province of Gerona, Spain, the bottom in 116 to 142 meters is characterized by an extreme abundance of comatulids, *Antedon mediterranea* and *Leptometra phalangium*, the latter markedly predominating. More to the southward, southeast of San Feliu de Guixols, in 135 meters, this form occurs in great quantities, entirely replacing *Antedon mediterranea.* Great numbers also occur on the "flanc du recht" of San Sebastian, in 491 and 190 meters (Pruvot, 1901).

About Banyuls (Pruvot, 1895) this species inhabits the fourth faunal zone, the sandy bottoms off shore in the coastal, as contrasted with the littoral, region. The Roches Cannelots, near Banyuls, are remarkable for the extreme abundance of echinoderms and pennatulids; 170 of this species and 1500 *Antedon mediterranea* were brought up in a single haul in 90 meters.

In the northwestern part of the Gulf of Marseille (Marion, 1879) it is found on muddy bottoms, sparingly in 70 to 80 meters, becoming more abundant as one goes eastward, descending to 100, 108, and even 200 meters off Cassis, and isles Riou, Calseragno and Jaro.

In the broad muddy stretches in the northeastern part of the Gulf of Marseille (Marion, 1883) *L. phalangium* becomes rather frequent at 75 meters, and common below 90 meters. On the deepest muddy bottoms, on the line from Planier to Cape Couronne, it is very common. On the muddy gravel south of the island of Riou and Planier this species replaces *Antedon mediterranea* in 100 to 200 meters, and in some places, since such great numbers are brought up by the dredge, it must absolutely cover the bottom. Here it is the predominant echinoderm.

In the abyssal region beyond the cliffs of Peyssonnel in 500 to 700 meters it is still represented by a few individuals. It occurs everywhere on the deep sands and gravels between Isle Riou and La Cassidagne, and at the deepest station, in 234 to 250 meters, it forms a veritable carpet; the dredges were entirely filled with it.

At La Ciotat (Koehler, 1894) it is very common on certain muddy bottoms off shore where it is associated with *Luidia ciliaris* and *L. sarsii*, with *Terebratula vitrea*, and with *Antedon mediterranea;* but it is not met with at depths less than 100 meters.

Regnard (1891) mentions that a large number were brought up in a single haul by the *Talisman*, but does not give the locality.

It was abundant at *Washington* station III, haul 5, off northwestern Sardinia in 168 to 284 meters.

About Naples (Lo Bianco, 1899) this species lives on muddy bottoms down to 600 meters, and is sometimes brought up by hundreds. By reason of its different habitat (Lo Bianco, 1906) it was not affected by the rain of cinders from the eruption of Vesuvius in April 1906, which was so destructive to *Antedon mediterranea.*

According to P. H. Carpenter (1884) and Ranson (1925), it is very abundant off the Tunisian coast, specimens of all ages coming up on the tangles in great numbers, though unfortunately in a very mutilated condition. The *Porcupine* found it much less abundant off Carthagena.

E. Graeffe (1881) remarked its absence from the lesser depths in the Gulf of Trieste.

Judging from the results of the *Sclanik* dredgings (Ostroumoff, 1896), this species would appear to be relatively rare in the Sea of Marmara. Marion did not find it in the Bosphorus.

Occurrence of the pentacrinoids.—About Naples (Lo Bianco, 1899) mature eggs are found in January, and pentacrinoids on the cirri of the adults in June and September. The *Puritan* (Lo Bianco, 1903) dredged 2 pentacrinoids at station 25, in 200 meters, on February 27, 1902.

History.—Originally described as *Alecto phalangium* by J. Müller in 1841 from specimens obtained at Nice by Peters, it was not until 1879 that this species was again identified.

The credit for its rediscovery belongs equally to Professor A. F. Marion and to Professor Hubert Ludwig.

Professor Marion had found it abundantly in his dredging about Marseille, and in 1879 he published a detailed account of it with a figure, and discussed its local distribution, showing that it is an inhabitant of deeper water than the common *Antedon mediterranea.*

On March 30, 1878, a number of echinoderms were sent from the Naples station to Prof. Hubert Ludwig, then at Göttingen. Among them he found a few specimens of a comatulid differing from *Antedon mediterranea* in its more slender build and longer cirri. These he identified with Müller's *Alecto phalangium,* and in April 1879 *Comatula phalangium* was included in the list of marine animals obtainable from the station, the price being 5 francs each. Toward the end of the year, having now seen Marion's memoir, he included *Antedon phalangium* in his monograph on the echinoderms of the Mediterranean, but he merely gave the synonymy and listed the localities, Marseille among them, where it had been found.

In 1880 Ludwig published a detailed account of these specimens, calling attention to the fact that, while the calyx pores are as numerous as in *Antedon mediterranea,* the stone canals are relatively less numerous. He also described and figured the calcareous deposits in the ambulacral lappets and in the tentacles.

During the cruise of the *Porcupine* in the Mediterranean in 1870, this species had been dredged abundantly on the coast of Tunisia. But Sir Wyville Thomson mistook it for the one described as *Comatula mediterranea* by Lamarck. He wrote (1872) that "many examples of the form known to Continental naturalists under the name of *A. mediterraneus,* Lam., sp., were dredged in the Mediterranean off the coast of Africa. I do not feel satisfied that this is identical with *Antedon rosaceus* of the coast of Britain, though the two specific names are usually regarded as synonyms. There is a great difference between them in habit, a difference which it is difficult to define."

In 1881 P. H. Carpenter, having seen Marion's memoir and also having received some specimens from him, recognized this species in the *Porcupine* collections, and recorded it from the Bay of Bizerta and the Skerki Bank. In the same year E. Graeffe remarked its absence in shallow water in the Gulf of Trieste, and in 1882 Perrier noted that it had been found by the *Travailleur* in the Mediterranean, but did not give the localities.

In 1883 Marion gave a very detailed account of its occurrence about Marseille.

In 1884 Carpenter described the *Porcupine* collections in greater detail, adding Carthagena to the list of known localities, and Carus summarized its occurrence in the Mediterranean.

Carpenter in 1886 published a critical account of the cirri of this species and compared these organs with those of what he called the Scotch variety (*celtica*). A summary of all the information regarding it he presented in 1888.

In 1891 Steindachner recorded it from the *Pola* dredgings in the Aegean Sea, and in 1894 Koehler described in detail its distribution about La Ciotat.

Von Marenzeller in 1894 gave further details of its occurrence in the Aegean Sea, and in 1895 still further added to the information regarding its distribution in this region, and announced its discovery in the southern part of the Adriatic. At the same time Pruvot described minutely its occurrence about Banyuls-sur-Mer.

In 1896 Ostroumoff recorded it from various *Selanik* stations in the Sea of Marmara, and Wheeler mentioned it from the Bay of Sorrento. The local distribution about Naples and the breeding season were given by Lo Bianco in 1899, and in 1901 Pruvot described its occurrence on the Spanish coast south of Banyuls.

In 1903 Lo Bianco recorded it from some of the *Puritan* stations in the vicinity of Naples, and Grieg discussed various details of its structure and compared it with other species. Lo Bianco in 1906 remarked upon its immunity from damage as a result of the rain of cinders from the eruption of Vesuvius in April of that year, and in 1908 Aranda y Millan added Blanes and the Balearic Islands to its known range.

In 1908 the present author definitely separated *phalangium* from the Atlantic *celtica*, and in 1912 he recorded it from Sicily. In 1914 Baldelli described it from the dredgings of the *Washington*, thus confirming Marion's suspicion (1883) that the *Comatula mediterranea* recorded by Giglioli (1881, 1882) as having been obtained by this ship, might turn out, in part at least, to be this species.

Prof. René Koehler, also recognizing this species as distinct from the Atlantic *L. celtica*, as suggested by the author in 1908 for reasons given in 1911, 1912, 1913, and 1918—indeed we had talked the matter over together in his laboratory at Lyon in 1910—gave an excellent summary of its occurrence on the French Mediterranean coast in 1921.

In 1925 Ranson gave several records of this species from the collections of the *Tanche* off the coasts of Tunisia and Algeria. At several stations it was an important constituent of the bottom fauna.

Boone (1933) recorded it under the name *Antedon adriatica* from off the coast of Dalmatia and from Algeria, where it was collected by the *Ara*.

Rivera, in 1934, found it at three stations of the *Xauen* in the vicinity of Majorca.

Tortonese (1935, 1938, 1952, and 1956) has given several records from the Gulf of Genoa and from Naples in his surveys of the echinoderms of the Genoa and Turin Museums, as well as of his own collections.

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The ecological works of Bacci (1947), Dieuzeide (1950), and Vatova (1950) have described the communities and conditions in which *L. phalangium* is to be found in the Gulf of Genoa, Bay of Castiglione, near Algiers, and in the Adriatic, respectively.

LEPTOMETRA CELTICA (Barrett and McAndrew)*

FIGURE 32, *c–g*

[See also vol. 1, pt. 1, figs. 111 (p. 177), 219 (p. 243), 287 (p. 262), 383 (p. 303), 384–385 (p. 305), 500–501 (p. 369); pt. 2, figs. 582–583 (p. 303), 795, 799 (p. 372), pl. 4, figs. 1003–1005, pl. 34, fig. 1212, pl. 45, fig. 1311]

Comatula woodwardii (not of Forbes, 1852) BARRETT, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 33, pl. 7, fig. 1 (Sound of Skye, 25–40 fms.; gravel and mud; description).—DUJARDIN and HUPÉ, Histoire naturelle des zoophytes, Échinodèrmes, 1862, p. 199 (coasts of England).

Comatula celtica BARRETT and MCANDREW, Ann. Mag. Nat. Hist., ser. 2, vol. 20, 1858, p. 44 (new name for *C. woodwardii*, preoccupied).—P. H. CARPENTER, Rep. British Assoc. for 1881, 1882, p. 672 (identity).

Antedon celticus NORMAN, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 104 (from Barrett).—JEFFREYS, Geol. and Nat. Hist. Repertory, 1866, p. 306 (occurrence on dredge rope above the net).—WYVILLE THOMSON, Proc. Roy. Soc. Edinburgh, vol. 7, 1872, p. 765 (abundant in the Minch, 40–60 fms.; also in local patches to 150 fms. off the north coast of Scotland).—W. B. CARPENTER, Proc. Roy. Soc., vol. 24, 1876, p. 221 (brachial anatomy).—P. H. CARPENTER, Journ. Anat. Physiol., vol. 11, 1876, p. 89.—BATHER, Natural science, vol. 6, 1895, p. [214] (suggests that the individuals on the dredge rope mentioned by Jeffreys had been swimming free).

Antedon celtica P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 13, 1877, p. 445; Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 20 (listed as an *Antedon*), p. 61 (description of the centrodorsal), pl. 4, figs. 1–8; Quart. Journ. Geol. Soc., vol. 36, 1880, p. 37 (radial pits), p. 39 (variability of the axial opening), p. 42 (muscle plates of radials); Pop. Sci. Rev., new ser., vol. 4, No. 15, 1880, p. 202 (rosette and associated structures), pl. 6, figs. 6, 7 (calyx); Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 156 [p. 6 of separate] (identical with *phalangium;* no basal star in connection with the rosette); Quart. Journ. Micr. Sci., new ser., vol. 21, 1881, p. 190.—SLADEN, *in* Duncan and Sladen, Memoir on the Echinodermata of the Arctic Seas to the west of Greenland, 1881, p. 77, footnote (comparison of this species with that described as *celtica* in the report).—P. H. CARPENTER, Proc. Zool. Soc. London for 1882, 1883, p. 746 (specific formula); Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1886, p. 476 (Rosshire coast; Minch, 60–80 fms.; cirri); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 53 (confusion between this species and [*Poliometra*] *prolixa* explained).—A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 81 (of P. H. Carpenter [Zool. Anz., 1881]=*Heliometra glacialis;* of Duncan and Sladen 1881 and of P. H. Carpenter 1884=*Heliometra glacialis;* B.M., M.S.=*Heliometra glacialis*+*Hathrometra* [*Poliometra*] *prolixa*).

Antedon phalangium (not of J. Müller, 1841) P. H. CARPENTER, Quart. Journ. Geol. Soc., vol. 36, 1880, pp. 48, 551; Zool. Anz., vol. 4, 1881, p. 521 (Isle of Skye); Rep. British Assoc. for 1881, 1882, p. 672 (synonymous with *celtica*); Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 361 (detailed discussion; localities), p. 364 (pentacrinoid, possibly of this species), p. 368 (comparison with *hystrix*).—VON GRAFF, *Challenger* Reports, Zoology, vol. 10, pt. 27, 1884, pp. 18, 32, 42 (myzostomes).—PERRIER, Compt. Rend. Acad. Sci., vol. 98, No. 22, 1884, p. 1449 (found in great numbers in the Atlantic by the *Talisman;* axial organ; anatomy).—P. H. CARPENTER, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1886, pp. 475, 476, 477, 478, 479, 480 (cirri; localities), pl. 57, figs. 1–6, 10, 11, 13, 14–16, 18, 20–23; Bijdr. Dierkunde, vol. 14, 1887, p. 45 (comparison with *Poliometra prolixa*); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 158, pl. 27, figs. 23–29, pl. 28, figs. 1–3 (detailed account).—BRAUN, Centralbl. Bakteriol. und Parasitenk., vol. 3, 1888, p. 185 (myzostomes).—BELL, Ann. Mag. Nat. Hist., ser. 6, vol. 4, No. 24, December 1889, pp. [412], 432 (*Flying Fox* sta. IV; southwest coast of Ireland, 250 fms.).—PERRIER, Nouv. Arch. Mus. Hist. Nat., Paris, ser. 3, vol. 1, 1889, p. 170 (anatomy).—P.H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 54 (*celtica* a synonym of *phalangium;* records from Madeira).—BELL,

* See also Addenda (pp. 836–838) under 1962, 1963, 1965.

Sci. Proc. Roy. Dublin Soc., new ser., vol. 7, 1892, p. 522; Catalogue of the British echinoderms in the British Museum, 1893, p. 59 (synonymy; description; range; localities), p. 175 (range).—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 298.—CHUN, Aus den Tiefen des Weltmeeres, 1900, pp. 48, 487.—KOEHLER, Bull. Soc. Zool. France, vol. 26, 1901, p. 103 (*Princesse-Alice* station 970).—NICHOLS, Proc. Roy. Irish Acad., vol. 24, sect. B, pt. 3, April 1903, p. 246 (*Flying Fox* sta. IV).—GRIEG, Bergens Mus. Aarb. for 1903, No. 5, 1904, p. 6 (replaces *glacialis* in the warmer basins of the Atlantic).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, pp. 402–403 (detailed discussion).—KEMP, Rep. Fishery Board Ireland, 1902–03, pt. 2, No. 6, 1905, p. 187 (40–60 miles off Dursey Head).—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, 1905, p. 240 (regeneration).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, 1907, p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—KOEHLER, Resultats des campagnes scientifiques accomplies sur son yacht par Albert Ier, Prince souverain de Monaco, fasc. 34, 1909, p. 269 (*Princesse-Alice* stas. 465, 1894; 1242, 1901; 1990 [1900], 1904; 2034, 1905).—SCHAXEL, Arch. Mikros. Anat., vol. 76, Heft 3, 1911, pp. 545, 563–566 (Wimereux; egg).—CHADWICK, *in* Herdman, Journ. Linn. Soc. (Zool.), vol. 32, 1913, p. 172 (collected by the *Runa*); 1914, p. 270 (same).

Comatules PARFAIT, Rapport sur la campagne scientifique du *Talisman* en 1883, 1884, p. 39 (36°02′ N., 9°01′ E., 126 m. [*Talisman* sta. 6, 1883]), p. 49 (26°16′ N., 17°11′ W., 250 m. [*Talisman* sta. 68, 1883]).—RICHARD, Resultats des campagnes scientifiques accomplies sur son yacht par Albert Ier, Prince souverain de Monaco, 1900, p. 78 (Gorringe Bank, 175 m. [*Princesse-Alice* sta. 465, 1894]; abundance).

Antedon rosaceus (not of Fleming) DUREGNE, Compt. Rend. Soc. Linn. Bordeaux, vol. 43, 1889, p. x.

Leptometra celtica A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130 (listed); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 7 (characteristic of European-Atlantic division of the European faunal area), p. 43 (synonymy; localities; comparison with *phalangium*); Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 257 (Cadiz Bay, 126 meters); *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 449 (short arms as compared with *phalangium*); Smithsonian Misc. Coll., vol. 60, No. 10, 1912, p. 32 (*Porcupine* sta. 13); Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 2 (localities off southwestern Ireland); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 56 (specimens in the British Museum); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 231 (in key; range).—KOEHLER, Faune de France, 1, Échinodermes, 1921, p. 11 (found by dredging in the Atlantic), p. 194 (in key), p. 198 (differential characters; occurrence); fig. 153 *b*, p. 199.—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range), p. 56 (in key).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 82; fig. 88, p. 81; Göteborgs Handl., vol. 30, No. 6, 1926, p. 8.—CUÉNOT, Bull. Biol. Stat. Arcachon, Bordeaux, vol. 24, 1927, p. 295 (*Antedon rosaceus* of Durègne, 1889 = *L. celtica*).—KOEHLER, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 132 (diagnosis; range).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 34 (diagnosis; parasites; range); fig. 20, p. 35.—RIVERA, Bol. Pesc. Madrid, vol. 14, 1929, p. 50 (in key).—CUMANO, Arq. Mus. Bocage, Lisboa, vol. 5, 1934, p. 141 (common off Porto and the Berlangas).—NOBRE, Echinodermes de Portugal, ed. 2, 1938, pp. 188, 189 (references; brief description: Portuguese localities).—TORTONESE, Boll. Mus. Zool. Univ. Torino, vol. 46, ser. 3, No. 82, 1938, p. 46.—ELIAS DA COSTA, Chaves dicotómicas para a classificação dos equinodermes Portugueses. IV. Crinóides, Porto, 1940, pp. 13, 15 (in key).—NOBRE, Mem. Est. Mus. Zool. Univ. Coimbra, No. 138, 1942, p. 49 (Berlangas).—CUMANO, Arq. Mus. Bocage, Lisboa, vol. 16, 1945, p. 73 (distribution), p. 81 (listed).—GISLÉN, Göteborgs VetenskSamh. Handl., ser. B, vol. 5, No. 10, 1947, pp. 3, 4 (brief description; differences from *L. phalangium; Skagerak* station near Tangier).—LE DANOIS, Les profundeurs de la mer, Paris, 1948, pp. 115, 245.—CUÉNOT *in* Grassé, Traité de Zoologie, vol. 11, 1948, p. 71.—TORTONESE, Ann. Mus. Civ. Stor. Nat. Genova, vol. 68, 1956, p. 182.

Antedon (*Leptometra*) *phalangium* KOEHLER and VANEY, Bull. Mus. Hist. Nat. Paris, No. 1, 1910, pp. 26, 32 (*Travailleur* or *Talisman* records).

Leptometra phalangium (not of Müller) GRIEG, Sci. Res. *Michael Sars* 1910 Exped., 1921, p. 43 (sta. 39B; notes), p. 46 (listed).—NOBRE, Echinodermes de Portugal, 1931, p. 165 (diagnosis; occurrence in Portugal), pl. 1, figs. 5–7.

?*Antedon tenella* (not of Retzius) PAWSEY and DAVIS, Fish. Invest. Great Britain, ser. 2, vol. 7, 1924, p. 16 (Lousy Bank).—DOLLFUS, Bull. Inst. Océanogr. Monaco, No. 438, 1924, p. 12 (Rockall Bank).

Characters.—This species may be distinguished from *L. phalangium* by an examination of the cirri. These are proportionately shorter than those of *L. phalangium* and do not taper distally, so that their outer portion appears considerably stouter. While in the proximal third of the cirri the segments are of the same proportions as those in the comparable part of the cirri of *L. phalangium*, in the distal half they become shorter so that in the distal third they are usually only one-third again as long as broad, and may be shorter, nearly or quite as broad as long, or even broader than long. As the segments become shorter, the distal dorsal edge often becomes somewhat swollen so that the dorsal profile of the cirri is slightly scalloped and not smooth as in the cirri of *L. phalangium*.

In a series of 45 specimens from the Minch, off Ross-shire, which I examined at the British Museum, the cirri are XIV–XXIV, 43–50 (usually 43–47), from 30 to 40 mm. (usually between 35 and 40 mm.) in length. In 4 from off Cape Mondego, Portugal, the cirri are from 40 to 45 mm. long with 42 to 48 (usually 43 or 44) segments. Carpenter mentions a cirrus from a specimen from the Minch 47 mm. long with 51 segments, and another 35 mm. long with 48 segments. He records a cirrus from an example taken by the *Dacia* on the Seine bank with 57 segments; but this is very possibly a misprint for 51.

Carpenter noted that the figures which he gave of the articular faces of the radials of the Scottish *celtica* would serve equally well as illustrations of the same parts in *phalangium*, though in some Scottish individuals the oblique ridges separating the muscular fossae from the interarticular ligament fossae are less oblique than in those he figured, and he did not find this to be the case in any examples of *phalangium* which he examined.

In all the Scottish specimens studied by Carpenter the IBr_1 were oblong in their general outline and but little incised, while the axillaries were subtriangular, subquadrate, or more usually pentagonal with their bases curving slightly outwards. The deep incision of the IBr_1 by the axillaries sometimes seen in *phalangium* does not occur.

According to Carpenter the triangular brachials beyond the second syzygy are distinctly shorter in the specimens from the Seine Bank and from the Minch than in the Mediterranean *phalangium*, and this difference is still more marked in the outer part of the arm where the brachials become wedge-shaped.

The distal intersyzygial interval was determined in specimens from the Minch in 27 cases, and found to be: 2 muscular articulations, once; 3, 10 times; 4, 10 times; 5, 5 times; and 6, once.

Carpenter wrote that the length of the oral pinnules is usually somewhat less in the Scottish *celtica* than in the Mediterranean *phalangium*. Marion gave an average length of from 12 to 17 mm. for the 4 lowest pinnules. These reach 15 mm. in the largest example from the Seine bank, but Carpenter never saw any Scottish specimens in which any of the 4 lowest pinnules were more than 13 mm. long. The discrepancy between the first 2 pairs of pinnules and those succeeding is somewhat greater in *celtica* than in *phalangium*.

Carpenter noticed that the broadening of the first 2 segments of the distal pinnules is more marked in the Scottish *celtica* than in *phalangium*. The shape of the first segment is the same in both forms; but as a rule the second is relatively narrower in *phalangium* so that the distinction between it and its successors is less marked than

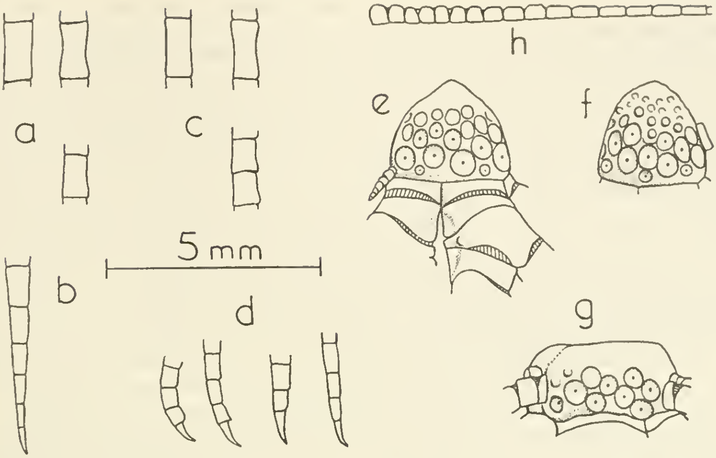

FIGURE 32.—*Leptometra phalangium* (J. Müller): *a*, Longest cirrus segments of two different specimens and a segment from two-thirds of the length from the base of one; *b*, cirrus tip. *L. celtica* (Barrett and McAndrew): *c*, Longest segments and two from two-thirds of the length; *d*, tips of cirri of three specimens, the two on the left from a single specimen, the one on the inside being a more apical cirrus; *e* and *f*, centrodorsals of two specimens from SW. Ireland, B.M., 1912.8.20.7–10; *g*, centrodorsal of specimen from the Minch, B.M., 98.5.4.998–1000; proximal part of P_1.

in *celtica*. But, he says, there is a considerable amount of variation in this respect, even in individual arms.

Notes.—Carpenter says that the long segmented cirri characteristic of *phalangium* are the prevailing kind in the specimens dredged off Cape Sagres and off Mondego by the *Porcupine;* but that, in those dredged by the *Dacia* on the Seine Bank, this type is very largely intermixed with another, the terminal segments of which are rather short and broad, somewhat as in those of the Ross-shire variety. Besides the more or less long segmented cirri typical of *phalangium*, the specimens dredged by the *Dacia* on the Seine Bank bore a number of cirri much more like those characteristic of the Ross-shire form. One of these cirri has 57 [surely a mistake for 51] segments which gradually decrease in length from the middle of the cirrus onward, and the short later ones are somewhat compressed laterally, but about as broad as long. In this cirrus there are dorsal spines on both the segments preceding the terminal claw, while in another there is a third spine on the segment preceding these. The relative shortness of the segments in the outer third of the cirri is very marked in all these specimens. This "square-jointed" type of cirrus, according to Carpenter, is the most common one found in the Scottish specimens.

Of a specimen from the Brazilian cable in Funchal Bay, Madeira, Carpenter says that it is generally similar to those obtained by the *Dacia* on the Seine Bank in 161 meters, excepting for the extreme shortness of the later cirrus segments. Carpenter also described specimens from the Minch with the later cirrus segments distinctly broader than long.

Of the 2 specimens from the Brazilian cable near Madeira in 914 to 1279 meters, one was described by Carpenter as fairly normal in its characters with relatively narrow rounded rays, which stand out well from the calyx; but in the other the rays are closely appressed and the sides of the IIBr series and of the first 2 brachials are laterally flattened, while the distal edges of the brachials and pinnulars are fringed with rather large spines. Carpenter remarks that he has noticed lateral flattening of the rays in other examples from shallow water, but that he never saw it so marked as in this example. I found a similar condition in a specimen dredged by the *Flying Fox* in 457 meters off southwestern Ireland. Carpenter never saw any other individual with spines on the brachials and pinnulars, and none has ever come to my notice.

In the 4 specimens taken by the *Porcupine* off Cape Mondego in 402 meters which I have examined, the arms are 70+ mm. long, and the cirri are from 40 to 45 mm. long, with 42 to 48 (usually 43 or 44) segments.

In the individual from the Sound of Skye in 46 to 73 meters the arms are 125 mm. long and the cirri are 40 mm. long, with 47 segments, of which those in the outer half are very slightly longer than broad, becoming slightly longer again terminally.

In the 4 examples taken off Cape Sagres in 82 meters which I have seen, the longest cirrus had 49 segments. [Note by A.M.C.] In the *Skagerak* specimens from the vicinity of Tangier, Gislén (1947) writes that the cirri are XXIII–XXX; 33–46 and 20–42 mm. long. The distal joints are scalloped and a third again as long as broad. The arms are 60 to 80 mm. long. The pinnules of the largest specimen are as follows: P_1 with 27 segments; 11 mm. long, the proximal 5 or 6 segments broader than long, the distal segments becoming 2 or 3 times as long as broad. P_2 29; 11 mm. P_3 23; 8.5 mm. P_4 15; 5 mm. P_5 13; 4.5 mm.

The British Museum specimens exhibit a great range of variation in the shape of the centrodorsal and arrangement of the cirrus segments. In 10 specimens from west of Ireland the centrodorsal is always conical, 2.1 to 2.8 mm. in basal diameter and 1.7 to 2.7 mm. high. The ratio of diameter to height varies from 1:0.76 to 1:1.09, averaging 1:0.95. In some of the specimens the obsolete apical cirrus sockets are overgrown by large, usually blunt, papillae. In 10 specimens from the Minch (west of Scotland) the centrodorsal is conical in only two, the other eight having it more or less truncated, in the most extreme cases the diameter of the completely flat dorsal pole being about 0.7 of the basal diameter. The ratio of the diameter to height in these 10 specimens varies from 1:0.49 to 1:1.0, averaging 1:0.67.

The cirrus sockets may be arranged in regular columns but frequently this is obscured in larger specimens.

As for the cirrus segments, in some specimens these approach those of *L. phalangium* in form with the distal segments distinctly longer than wide and tapering in shape, but usually the distal segments are more or less abbreviated and the penultimate juts out slightly at its distal dorsal end, rarely bearing a small spine. The longer proximal segments may be constricted centrally in some specimens as also in *L. phalangium*.

Unfortunately, so few of the British Museum specimens have both arms and peripheral cirri anything like complete that no worthwhile comparison of their proportions with those of *phalangium* can be drawn up.

Abnormal specimen.—In the single example recorded by Carpenter from the Brazilian telegraph cable in Funchal Bay, Madeira, P_3 on one of the arms was replaced by a small axillary ossicle from which 2 pinnules of the usual character arose, while a third pinnule was attached to the distal edge of the brachial on the dorsal side of the axillary.

Localities.—*Lightning* station 13, 1868; north of the Hebrides (lat. 59°05′ N., long. 7°27′ W.); 345 meters; temperature 9.61° C. [P. H. Carpenter, 1884].

Northern coast of Scotland, in local patches down to 274 meters [Wyville Thomson, 1872].

No locality; Sir Wyville Thomson, 1872 (16, C.M.).

[Lousy Bank, northwest of Scotland [Pawsey and Davis, 1924] ?this species, A.M.C.]

[Rockall (lat. 57°32′ N., long. 13°36′ W.); 90 meters [Dolfuss, 1924] ?this sp.]

The Minch (42, B.M.; C.M.). Same, 73–110 meters [Wyville Thomson, 1872]. Same, 110 meters [Jeffreys, 1866; A. H. Clark, 1913] (6, B.M.). Same, 110–146 meters [P. H. Carpenter, 1884, 1886; von Graff, 1884; Bell, 1893; A. H. Clark, 1913].

Ross-shire coast [P. H. Carpenter, 1886].

Runa; western coast of Scotland [Chadwick, in Herdman, 1913].

Sound of Skye; 46–73 meters; gravel and mud [Barrett, 1857; Norman, 1865; Bell, 1893; A. H. Clark, 1913] (1, B.M.). Type locality.

Porcupine, 1869; off Loch Scavaig, southern part of the Isle of Skye [P. H. Carpenter, 1884].

Helga station S.R. 360; west of Dingle Bay, southwestern Ireland (lat. 52°04′ N., long. 11°27′ W.); 198–220 meters; August 8, 1906 [A. H. Clark, 1912] (1, U.S.N.M., 36044).

Helga station S.R. 1173; off southwestern Ireland (lat. 51°50′ N., long. 11°47′ W.); 503 meters; May 19, 1911 [A. H. Clark, 1912] (41, U.S.N.M., 35770; Dublin M.).

Helga station S.R. 321; south of western Ireland (lat. 50°58′ N., long. 11°17′ W.); 380–878 meters; April 1906 [A. H. Clark, 1912] (2, Dublin M.).

Flying Fox station IV; off the southwestern coast of Ireland; 457 meters; 1889 [Bell, 1889, 1893; Nichols, 1903; A. H. Clark, 1913] (1, B.M.).

Forty to 60 miles W. ½ N. of Dursey Head, County Kerry; 457 meters [Kemp, 1905].

Wimereux-sur-Mer [Schaxel, 1911].

Portugal: Sezimbra, 141 meters; Berlangas; Funil de Albufeira, 172 meters [Nobre, 1938, 1942].

Porcupine station 13, 1870; off Cape Mondego, Portugal (lat. 40°16′ N., long. 9°37′ W.); 402 meters; temperature 11.11° C. [P. H. Carpenter, 1884, 1886; von Graff, 1884; A. H. Clark, 1912, 1913] (8, U.S.N.M., 17526; B.M.; H.M.).

Talisman station 6, 1883; south of Cape St. Vincent (lat. 36°20′ N., long. 9°01′ [6°41′] W.); 126 meters; mud and shells; June 9, 1883 [Parfait, 1884; Perrier, 1884; P. H. Carpenter, 1888; Koehler and Vaney, 1910; A. H. Clark, 1911] (59, U.S.N.M., 35671; P.M.).

Porcupine, 1870; off Cape Sagres (southeast of Cape St. Vincent); 82 meters; [P. H. Carpenter, 1884, 1886; A. H. Clark, 1913] (4, B.M.).

Princesse-Alice station 1900 [1990], 1904; Gorringe Bank (lat. 36°31′ N., long. 11°32′ W.); 90 meters; hard bottom; September 15, 1904 [Koehler, 1909].

Princesse-Alice station 465, 1894; Gorringe Bank (lat. 36°30′30″ N., long. 11°36′15″ W.); 175 meters; July 27–28, 1894 [Richard, 1900; Koehler, 1909].

Near the Gorringe Bank [A. H. Clark, 1911].

Princesse-Alice station 2034, 1905; Seine Bank, east of Madeira (lat. 33°47′ N., long. 14°21′ W.); 185 meters; July 26, 1905 [Koehler, 1909; Tortonese, 1956].

Princesse-Alice station 1242, 1901; Seine Bank; 240 meters; gravel and broken shells; September 10, 1901 [Koehler, 1909].

Dacia; Seine Bank; 150 meters [P. H. Carpenter, 1886, 1888; Chun, 1900].

Dacia; Seine Bank [A. H. Clark, 1913].

Seine Bank [A. H. Clark, 1911]. Near the Seine Bank [A. H. Clark, 1911].

Funchal Bay, Madeira; 183 meters [P. H. Carpenter, 1891; A. H. Clark, 1911].

Near Madeira; 914–1279 meters [P. H. Carpenter, 1891; A. H. Clark, 1911].

Talisman station 68, 1883; off Cape Bojador, southwestern Morocco (lat. 26°16′ N., long. 17°11′ [14°51′] W.); 250 meters; sand, shells and corals; July 8, 1883 [Parfait, 1884; Koehler and Vaney, 1910; A. H. Clark, 1911; Tortonese, 1956].

Michael Sars station 39B, 1910; off Cape Bojador (lat. 26°03′ N., long. 15° W.); 267–280 meters; fine gray sand [Grieg, 1921].

Skagerak; southwest of Cape Spartel, Tangier (lat. 35°43′ N., long. 6°12′ W.); 130 meters; temperature 14.70° C.; salinity 36.35°/oo; May 27, 1946 (13, ?Gothenburg M.) [Gislén, 1947].

West African Fisheries Research Institute station MB1/B5; off Sierra Leone (lat. 08°45′ N., long. 14°38′ W.); 800 meters. Station MB1/B1 (lat. 08°54′ N., long. 14°23′ W.); 68 meters. Station MB1/B2 (lat. 08°52′ N., long. 14°27′ W.); 110 meters. Station MB1/A5 (lat. 08°22′ N., long. 14°22′ W.); 132 meters. Station MB4/B5 (lat. 07°33′ N., long. 13°31′ W.); 140 meters. Station MB1/A7 (lat. 08°19′ N., long. 14°21′ W.); 286 meters. Station MB4/A5 (lat. 07°14′ N., long. 13° W.); 140 meters. Station MB1/A6 (lat. 08°21′ N., long. 14°22′ W.); 132 meters. Station MB1/B3 (lat. 08°50′ N., long. 14°29′ W.); 118 meters; Mr. A. R. Longhurst (30, B.M.).

Geographical Range.—From south of the Faroe Islands, northwestern Scotland and western Ireland southward to Madeira, Sierra Leone, and the western end of the Straits of Gibraltar.*

Bathymetrical range.—From 46 to 1279 meters; the average depth of habitat is 316 meters.

Thermal range.—There are only three records, 9.61° C., 11.11° C., and 14.70° C.

Salinity range.—The single record is of 36.35°/oo.

Occurrence.—The *Porcupine* in 1869 found this species abundant off Stornoway in moderate water and in local patches off the northern coast of Scotland down to 274 meters, and still more common in the Minch in 73 to 110 meters. The *Porcupine* records for the cold area, Faroe Channel, do not refer to this form, but to *Poliometra prolixa*.

Like *L. phalangium, L. celtica* is usually abundant wherever found. The *Helga* dredged it in large numbers off southwestern Ireland in 503 meters; the dredge of the *Talisman* was completely filled with specimens in a haul in 126 meters south of

*Tortonese (see Addenda for 1963) recorded as *L. celtica* specimens from off Morocco and Tunisia, in 427–510 meters, extending the range into the Mediterranean.

Cape St. Vincent, Spain; and the *Princesse-Alice* found it in great numbers on the Gorringe Bank in 90 and also in 175 meters, and on the Seine Bank in 240 meters.

Apparently this species usually occurs on a soft bottom of mud, or sand or gravel with mud, as otherwise it would not have been so frequently recorded as abundant. There are, however, only three bottom records, one of gravel and mud, one of gravel and broken shells, and one of hard bottom.

Prof. Jeffreys wrote (1866) that he had seen a number of this species clinging to the rope several feet from the dredge when it was taken up from about 110 meters, no part of the rope having lain upon the sea floor. Dr. F. A. Bather (1895) suggested that these individuals had been swimming free and had fastened on to the rope as it passed. But it is most likely that Jeffreys was mistaken in assuming that no part of the rope lay on the bottom, as I do not see how it is possible to keep the line in front of the net entirely clear of the ground.

Prof. Koehler (1909) states that this species has been recorded by P. H. Carpenter from Brazil, from a fragment of cable brought up from between 500 and 700 fathoms (915 and 1280 meters). He refers to the specimens recorded by Carpenter (1891) from near Madeira in 914 to 1279 meters which were found attached to the Brazilian cable. The same error has been made by others. So far as known this species is wholly confined to the eastern Atlantic.

Gislén (1947) explains the occurrence of *celtica* near Tangier (that is close to the threshold of the Mediterranean) by the hydrographic conditions in that area. There is a surface current about 100 meters deep passing into the Mediterranean, which has a salinity of about 35 to 36°/₀₀. Below this is an outgoing current with a salinity of 36.5 to 37°/₀₀, which follows the slope of the bottom downwards from the threshold at Gibraltar of 320 meters. He concluded that *celtica* was living in the mixed water between the two layers.

Within the last few years a number of specimens of *celtica* have been taken off Sierra Leone by Dr. A. R. Longhurst while working at the West African Fisheries Research Institute. These afford a considerable extension of the range to the southward.

Occurrence of the pentacrinoids.—The only known pentacrinoid of this species was dredged by the *Porcupine* in 1870, off Cape Mondego in 402 meters.

History.—This species was first noticed by Mr. Lucas Barrett, who described it in 1857 under the name of *Comatula woodwardii* from specimens he had dredged in the Sound of Skye. Unfortunately Prof. Edward Forbes in 1852 had described a small fossil from the Crag under the same name, so in 1858 this species was rechristened *Comatula celtica* by Messrs. R. McAndrew and Barrett.

The Rev. A. M. Norman's account of it in his monograph of the British echinoderms (1865) was taken from Barrett.

For over twenty years the real relationships of the species were quite misunderstood. Wyville Thomson (1872, 1873) and, following him, P. H. Carpenter (1877), Sladen (1877, 1878), and Nansen (1885) applied the name *celtica* to the species now known as *Poliometra prolixa* (see p. 590). The name was also used by Wyville Thomson (1872, 1873), P. H. Carpenter (1877), Sladen (1877), Stuxberg (1886) and von Marenzeller (1878) for small specimens of *Heliometra glacialis*.

In 1881 P. H. Carpenter was able to clear up the confusion regarding the name *celtica*. One of Barrett's original specimens had been discovered by Prof. F. Jeffrey

Bell in the British Museum, and a comparison between this and some of those dredged by the *Porcupine* in the North Minch in 1869 showed them to be identical, while a further comparison of both with specimens of *phalangium* sent him from Marseille by Prof. Marion convinced Carpenter that *celtica* was merely a somewhat dwarfed and less robust variety of the latter. He made the suggestion that, as McAndrew and Barrett's *celtica* is the same as *phalangium*, the name *celtica* be transferred to the species called *celtica* by Sladen (*Poliometra prolixa*).

In 1884 Carpenter recorded this species, under the name *phalangium*, from some *Lightning* and *Porcupine* stations off northwestern Scotland, and from off Cape Sagres. In the same year Perrier noted that it had been obtained in great quantities by the *Talisman*, but did not give the locality.

In 1886 Carpenter described the cirri in great detail, comparing them with those of the "Mediterranean variety" (*phalangium*), and recorded it from the Seine Bank, where it had been obtained by the *Dacia*.

In 1888 he published a monographic account of this species, united with the Mediterranean form under the name *phalangium*.

Prof. F. Jeffrey Bell in 1889 recorded it from off the southwestern coast of Ireland, where it had been dredged by the *Flying Fox*, and in 1891 Carpenter described in detail some specimens from Funchal, Madeira, and vicinity, which had been sent him by Mr. J. Y. Johnson of Funchal. In 1891 also Regnard mentioned that the *Talisman* had secured a large number at a single haul, undoubtedly referring to the same occurrence as Perrier in 1884.

Bell in 1892 repeated the record for southwestern Ireland, and in the following year published a monographic account of its occurrence in British waters.

Prof. Carl Chun in 1900 mentioned its occurrence in the Faroe Channel as well as on the Seine Bank, a repetition of Wyville Thomson's confusion of this species with *Poliometra prolixa*.

In 1905 Döderlein treated this species in detail, but added no new information, and Kemp again recorded it from southwestern Ireland.

In 1908 the present author definitely separated *celtica* from *L. phalangium* for reasons given in detail in 1913 and 1918. In 1909 Koehler recorded it from four *Princesse-Alice* stations, in 1910 Koehler and Vaney published the records from the *Travailleur* and *Talisman* collections, and in 1911 Schaxel mentioned its occurrence at Wimereux and the author gave it from the Bay of Cadiz in 126 meters.

Herdman in 1912 noted that it had been collected off the western coast of Scotland by the *Runa*, but gave no definite localities, and in the same year the writer listed two new localities off western Ireland.

The separation of *celtica* from *phalangium* suggested by the author in 1908 was confirmed by Koehler in 1921.

W. B. Carpenter in 1876 and his son in the same year mentioned certain points in the brachial anatomy of this species, and P. H. Carpenter in 1879, 1880, and 1881 described in considerable detail the centrodorsal and radials and associated structures. Perrier in 1884 also touched upon the anatomy, especially of the axial organ.

In recent years very few additional records for this species have been published. The most notable are those of Nobre of several localities off the coast of Portugal and an interesting record by Gislén (1947) from the vicinity of Tangier, where the species was taken by the *Skagerak* Expedition.

Genus POLIOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, *in* Duncan and Sladen, Ann. Mag. Nat. Hist., ser. 4, vol. 20, No. 120, 1877, p. 451, and following authors.

Hathrometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130, and following authors.

Poliometra A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, Sept. 22, 1923, p. 7 (diagnosis; type and only species *Antedon prolixa* Sladen, 1881; range; remarks), p. 42 (range), p. 53 (in key).—Gislén, Ark. Zool., vol. 15, No. 23, Oct. 5, 1923, p. 15 (discussion).—Mortensen, Danmarks Fauna, No. 27, 1924, p. 20, p. 21 (in key); Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key), p. 32 (diagnosis).—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 127.—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 6.—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.

Peliometra Djakonov, Trav. Soc. Nat. Leningrad, vol. 56, pt. 2, 1926, p. 107 (in key); Les échinodermes des mers arctiques (in Russian), Leningrad, 1933, p. 22 (in key).—Gorbunow, Trans. Arctic Institute, Leningrad, vol. 2, 1932, p. 95 and following (in Russian); vol. 7, 1933, p. 42 and following; vol. 8, 1933, p. 5 and following.—Schorygin, *in* Gaevskoy, Check list of the fauna and flora of the northern seas of the U.S.S.R., 1948, p. 470.

Diagnosis.—A genus of Zenometrinae in which the centrodorsal is conical with slightly swollen sides, about as high as broad at the base, its surface not divided into radial areas; in large specimens where the centrodorsal diameter is about 3 mm. the cirrus sockets under each radial are arranged peripherally in 4 columns and apically in 3, rarely in 3 columns throughout; the peripheral cirri are long and only slightly curved with 32 to 50 segments, of which the longest are 4 times as long as broad and the outermost are about twice as long as broad with a small terminal dorsal spine or tubercle; the apical cirri are about a fourth as long as the peripheral with 16 to 28 segments; the elements of the IBr series and lower brachials are narrow, not in lateral contact and without spines; all the pinnules are present; P_1 with 25 to 45 segments is much elongated and very slender, about 3 times as long as P_2 which has 11 to 17; while P_3 with 11 to 15 segments may be nearly twice as long as P_2.

Type species.—*Antedon prolixa* Sladen, 1881.

Geographical range.—Arctic regions; westward to Grinnel Land; southward to the vicinity of Godthaab, west Greenland, Cape Brewster, east Greenland, the vicinity of Jan Mayen, the cold deeps west, north and east of Iceland, the Faroe Channel, Finmark and eastward to Kara Bay and just east of Wilczek Land.

Bathymetrical range.—From 20 to 1960 meters.

Thermal range.—From −1.97° [? −2.10°] to +2.0° C. (to +3.0° C. according to Schorygin).

POLIOMETRA PROLIXA (Sladen)

FIGURE 33

[See also vol. 1, pt. 1, fig. 409(p. 317), pl. 1, figs. 519, 523, pl. 3, figs. 532, 535, 538, pl. 4, figs. 542, 544, pl. 6, figs. 559–564; pt. 2, figs. 101(p. 62), 584–585(p. 303), 775(p. 362), 940(p. 549), pl. 15, figs. 1066, 1067, pl. 27, fig. 1170, pl. 34, figs. 1210, 1213, pl. 37, fig. 1227, pl. 56, fig. 1353]

Antedon celtica (not of Barrett and McAndrew, 1858) P. H. Carpenter, *in* Duncan and Sladen, Ann. Mag. Nat. Hist., ser. 4, vol. 20, No. 120, 1877, p. 451 (listed), p. 468 (Discovery Bay, 25 fms., hard bottom), p. 469 (distribution [in part]).—Sladen, *in* Nares, Narrative of a voyage to the Polar Sea, vol. 2, 1878, p. 281 (Grinnel Land).—d'Urban, Ann. Mag. Nat. Hist., ser. 5, vol. 6, 1880, p. 271.—Nansen, Bidrag til Myzostomernes Anatomi og Histologi, 1885, pp. 3, 6, 7 (*Vøringen* sta. 343; myzostomes).

Antedon sarsii (not of Düben and Koren, 1846) von Marenzeller, Denkschr. Akad. Wiss. Wien, vol. 35, 1878, p. 381 (79°00′ N., 62°21′ E.; 183 meters).—d'Urban, Ann. Mag. Nat. Hist., ser. 5, vol. 6, 1880, p. 271 (from preceding).—Stuxberg, *Vega* Expeditionens vetenskapliga Arbeten, vol. 5, 1886, p. 162 (from von Marenzeller).—von Hofsten, Kungl. Svenska Vet., Akad. Handl., vol. 54, No. 2, 1915, p. 247.

Antedon prolixa Sladen, *in* Duncan and Sladen, Memoir on the Echinodermata of the Arctic Seas to the west of Greenland, 1881, p. 77 (description; Discovery Bay, 25 fms., hard bottom), pl. 6, figs. 7–10.—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed), p. 534 (specific formula).—Verrill, Amer. Journ. Sci., ser. 3, vol. 23, 1882, p. 247 (review of Duncan and Sladen).—P. H. Carpenter, Proc. Zool. Soc. London for 1882, 1883, p. 746 (specific formula); Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 367 (comparison with *hystrix*); Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1886, p. 475 (dimorphism of the cirri); Bijdr. Dierkunde, vol. 13, 1886, p. 10 (comparison with *barentsi*); vol. 14, 1887, p. 42 (comparison with *quadrata*), p. 44 (locality; characters of the specimens and comparisons with related species); figs. 2, 3.—von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 9 (myzostomes; correct name for *celtica* of Nansen).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 54, 136, 147, 156, 157, 162, 166–168, 173–178, 356, 367–369, 372, 377 (discussion and comparisons); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 55 (comparison with *sarsii* and *tenella*; detailed discussion and description of specimens), p. 68, footnote (occurs on both sides of the Atlantic), pl. 2, figs. 1–4.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 88.—Danielssen, Den Norske Nordhavs-expedition 1876–78, vol. 5, 1892, pp. 19, 23 (various localities).—Bell, Catalogue of the British echinoderms in the British Museum, 1893, p. 58 (synonymy; description; range; localities), p. 175 (range).—Rodger, Proc. Roy. Soc. Edinburgh, vol. 20, 1893, p. 162 (off Cape Raper, 60 fms.; sand and small stones).—Pfeffer, Zool. Jahrb., Syst. Ontog., vol. 8, 1894, p. 109 (Kükenthal's stas. 18, 23, 24, 126–139), p. 111 (sta. 18, data), p. 112 (stas. 23, 24, data), p. 116 (stas. 126–139, data), p. 122 (range).—Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 143 (range; related to *bigradata*), p. 146 (most nearly related to [*Psathyrometra*] *bigradata*), p. 147 (*Antedon*, sp. from *Albatross* sta. 3354 this or a closely related species).—Chun, Aus den Tiefen des Weltmeeres, 1900, p. 487 (Faroe Channel).—Springer, Mem. Mus. Comp. Zool., vol. 25, No. 1, 1901, p. 88 (both sides of the Atlantic).—Michailovskij, Ann. Mus. Zool. Acad. Sci. St. Petersburg, vol. 7, 1903, pp. 501, 535 (localities).—Mortensen, Medd. Grønland, vol. 29, 1903, p. 65 (localities), p. 67 (side and covering plates described in detail); pl. 1, figs. 1–3.—Grieg, Bergens Mus. Aarb. for 1903, No. 5, 1904, p. 3 (collected by the *Michael Sars*), p. 4 (range similar to that of *Gorgonocephalus eucnemis*), p. 5 (stas. 38, 38*a*; associates), p. 7 (represented in the warm area by *tenella*; local abundance), p. 20 (*Michael Sars*, 1900, stas. 9, 10, 25; 1902, stas. 55, 67, 74, 75, 95, 96, 38), p. 22 (measurements), pp. 24–37 (detailed discussion and comparisons), p. 28 (intersyzygial interval), p. 32, fig. 2, 1–4 (covering plates), p. 34 (pinnules), p. 35 (details of distribution), pp. 38, 39 (station data).—Appellöf, Havbundens dyreliv, Norges Fiskerier, vol. 1, pts. 1–2, 1905, pp. 93, 100.—Döderlein, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 401 (synonymy; Römer and Schaudinn stas. 36, 37, 39; discussion; measurements), p. 403 (distribution and relation to antarctic forms).—Michailovskij, Ann. Mus. Zool. Acad. Sci. St. Petersburg, vol. 9, 1905, p. 176 (*Jermak* stas. 76, 77, 82, 86).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Grieg, Nyt. Mag. Naturvidensk., vol. 45, 1907, Hefte 2, p. 132 (listed), p. 133 (*Belgica* sta. 32), p. 135 (*Belgica* sta. 45); Report of the second Norwegian Arctic Expedition in the *Fram*, 1898–1902, No. 13, 1907, p. 3.—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—Grieg, *in* Duc d'Orléans, Croisière oceanographic accomplie à bord de la *Belgica*, 1905, 1909, p. 54 (*Belgica* stas. 32, 45).—Koehler, Resultats des campagnes scientifiques accomplies sur son yacht par Albert 1er, Prince souverain de Monaco, fasc. 34, 1909, p. 270 (*Princesse-Alice* stas. 970, 1897, 1898; 1012, 1040, 1898), pl. 32, fig. 11.—A[ppellöf], *in* Murray and Hjort, The depths of the ocean, 1912, p. 519 (slope of the deep basin off the Norwegian coast; cold area, where the temperature falls below 0° C.), p. 529 (characteristic Arctic form).—Reichensperger, Zeitschr. wiss. Zool., vol. 101, 1912, Heft 1/2, p. 35 (structure; discussion of Mortensen).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 246 (referable to *Hathrometra*).—Gorbunow, Trans. Arctic Institute, Leningrad, vol. 8, 1933, pp. 76, 77 (identity).

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Diagnostic features.—The centrodorsal is subconical, about as high as broad at the base, with up to about LXXX cirrus sockets, which are arranged in each radial area peripherally in 4 columns and apically in 3; in small individuals and rarely in larger ones, there are 3 columns of cirrus sockets in each radial area. The peripheral cirri are very long, more than half the length of the arms (which are from 85 to 120 mm. in length), only slightly curved, and composed of 32 to 50 segments, of which the distal have the dorsal portion of the distal end slightly produced; the apical cirri are about a third the length of the peripheral in large individuals, with about half as many segments. P_1 is greatly elongated, very slender, but stiffened, usually 3 times as long as P_2, composed of 25 to 45 segments, of which all but the basal 5 to 7 are greatly elongated with spinous distal ends. The distal intersyzygial interval is 4 muscular articulations.

This species has frequently been confused with the species of *Hathrometra*, with *Heliometra glacialis*, and with *Leptometra celtica*.

In the species of *Hathrometra*, which resemble it in pinnulation and are of the same color, the cirrus sockets are arranged in crowded alternating rows instead of in columns, and the distal intersyzygial interval is 3 muscular articulations.

In *Heliometra glacialis*, which is bright yellow in life, sometimes with a tinge of purple, P_1 is rather stout, composed of relatively short segments, and more or less flexible; the centrodorsal is low, hemispherical, flattened dorsally; and the cirri, which are stouter, have more prominent dorsal spines on their distal ends.

In *Leptometra celtica*, which varies in color from green to white, the cirri, though generally similar, are much less numerous; there are only 2 or 3 columns of cirrus sockets in each radial area of the centrodorsal; and P_2 is as long as and resembles P_1, being greatly longer, instead of shorter, than P_3.

Description.—The centrodorsal is large, subconical, commonly about 4 mm. broad at the base and 4 mm. high, the sides in profile convex proximally but becoming straight distally. At the periphery of the centrodorsal the cirrus sockets are typically arranged in four columns in each radial area, the two outer of 5 or 6 sockets, the two central of 2 each (in the smaller specimens of 1) merging into a single column of 3 sockets, so that, whereas in the proximal portion of the centrodorsal there are 4 columns of cirrus sockets in each radial area, in the distal there are only 3. There is a slight tendency to develop bare low ridges, bare spaces, or shallow grooves in the interradial lines. Immediately about the dorsal pole there is an area in which the cirrus sockets are arranged in 2 or 3 alternating rows instead of in a continuation of the more proximal columns, and the sockets in these rows usually have slightly more prominent rims than the others. In the youngest specimens the cirri are in 2 or 3 alternating rows; later the more proximal appear in 3 columns, and when nearly full size has been reached in 4 columns, the median column becoming 2. The 4 columns appear when the arm length is about 110 mm. and the cirri are about 50 mm. long, with about 36 segments.

The cirri are numerous, L-LXXVIII, the peripheral 50 to 75 mm. long (usually between 50 and 60 mm.), with 32 to 50 (usually 35 to 45) segments, the apical 12 to 17 mm. long with 16 to 28 segments. While in fully developed individuals the cirri attain the dimensions just given, in the individuals as collected the peripheral cirri are perhaps most commonly from 35 to 50 mm. long, with 32 to 45 segments.

In the peripheral cirri the first two segments are somewhat over twice as broad as long, the third is about as long as broad, the fourth is nearly twice as long as broad, and the following gradually increase in length to about the eighth, which is about four times as long as the median diameter, after the fourteenth to sixteenth gradually decreasing again so that the terminal segments are about twice as long as broad. The penultimate segment is half again as long as broad, and gradually tapers distally. The opposing spine is minute, erect, terminal; the terminal claw is slightly longer than the penultimate segment, stout in the basal third but becoming very slender and nearly straight distally. The fourth and following segments are moderately constricted centrally, this feature becoming less marked as the segments decrease in length distally. After the fifth or sixth there is a slight dorsal overlap which becomes narrowed into a small spine on the distal segments.

The radials are just visible beyond the centrodorsal, forming a narrow even band, or they may be slightly produced in the interradial angles. The IBr_1 are very short in the median line, usually in fully developed specimens not visible in a direct lateral view because of the strong proximal process from the axillaries. The IBr_2 (axillaries) are shield-shaped with the borders, especially the two distal, concave, usually about as long as broad but in large specimens distinctly longer than broad.

The 10 arms are from 85 to 120 mm. (usually between 100 and 110 mm.) in length. The first brachial has long outer but very short inner borders due to the deep incision by the proximal process from the second, which sometimes in a direct lateral view completely conceals it in the median line. The second brachial is almost triangular. The third and fourth brachials together form a syzygial pair which is approximately oblong, and nearly or quite twice as broad as long. The following brachials are wedge-shaped, somewhat over twice as broad as long in the median line, after the second syzygial pair becoming almost or quite triangular, at first somewhat broader than long, then as long as broad, and wedge-shaped and elongate distally.

Syzygies occur usually between brachials 3+4, 9+10, and 14+15, and distally at intervals of about 4 muscular articulations. The second syzygy exceptionally is found between brachials 10+11, and the third between brachials 13+14, or more commonly between brachials 15+16. Carpenter and Grieg have determined the distal intersyzygial interval in 1,174 cases; they found 4 muscular articulations 627 times, 3 muscular articulations 398 times, 5 muscular articulations 109 times, 6 muscular articulations 35 times, and 7 muscular articulations 5 times.

P_1 is very slender, from 11 to 20 mm. (usually between 12 and 15 mm.) in length, composed of 25 to 45 (usually 30 to 35) segments, of which the basal five to seven

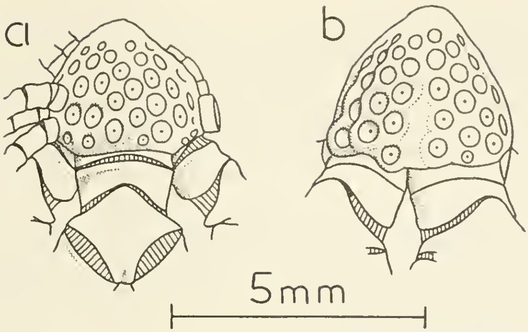

FIGURE 33.—*Poliometra prolixa* (Sladen): *a*, Paratype, B.M., 81.8.26.10–12, centrodorsal; *b*, B.M., 1957.10.31.4, Spitzbergen, centrodorsal.

are about as long as broad and the following very rapidly become elongated and excessively long and slender distally; the distal edges of the segments are everted and finely spinous, this feature becoming more prominent distally.

P_2 is from 3.5 to 6.5 mm. (usually 4 to 5.5 mm.) long, with 11 to 17 (usually 11 to 13) segments, of which the first three are about as long as broad and the following increase in length, though never becoming so elongate as those of P_1; P_2 is stiffer than P_1 and tapers less gradually.

P_3 is from 5 to 10 mm. (usually 6 to 7 mm.) long with 11 to 15 segments and resembles P_2; P_4 is 8 mm. long and resembles P_3.

The first inner pinnule, P_a, is 19 mm. long with 35 segments.

The distal pinnules are 15 mm. long.

Dr. Gislén has pointed out (1923) that there are two different types of ambulacral deposits in this species. Specimens from Greenland and the Faroe Channel have the spicules rather slender and smooth (var. *groenlandica*), while those from Nova Zembla, the Kara Sea and Taimyr have coarse and extremely spiny spicules (var. *siberica*). Specimens from Spitzbergen resemble those from Greenland in having slender spicules which, however, are somewhat spiny.

Dr. Th. Mortensen (1903) described the ambulacral deposits as long narrow curved rods, slightly broadened and with a few holes at the outer end; the proximal part is bent parallel to the pinnule segments and is sometimes slightly irregular, or even provided with a few holes. These deposits are not developed in the integument of the expanded portion of the genital pinnules.

He also noticed that the segments of the middle pinnules are rather long and slender. There is a thin keel on the inner side but the outermost 4 or 5 segments are quite cylindrical and without a keel. The outer side of the segments is smooth, and there is a circlet of spines about the distal end.

Gislén found that specimens from western Greenland seem to have rather spiny distal segments approaching in appearance those of *Hathrometra sarsi*.

There is no ambulacral groove on the 3 or 4 terminal pinnule segments.

Young individuals of this species have the borders of the elements of the IBr series and of the lower brachials prominently spinous.

[NOTES BY A.M.C.] A large specimen of *prolixa* found with a specimen of *Heliometra glacialis* taken by the *Diana* off Spitzbergen, has quite marked interradial spaces between the proximal cirrus sockets on the centrodorsal (fig. 33,*b*). The basal diameter of this is 3.9 mm. and the vertical height 3.5 mm. There are only three columns of cirrus sockets in each radial area, which are quite regular as they are not overcrowded apically.

Some measurements of specimens of *Poliometra prolixa* in the British Museum were made for me by Mr. M. J. Mann, now of the Fisheries Service, Uganda. The largest has the width at the first syzygy 2.6 mm. and the length from the proximal edge of the IBr_1 to the second syzygy 12.0 mm. Unfortunately the corresponding arm length could not be assessed, all being broken, but there were over LXX cirrus sockets and P_2 was as much as 6.5 mm. long.

Abnormal specimens.—One of the individuals from *Triton* station 4 has only 9 arms; on one of the postradial series the first and second brachials of the two arms are very close together and are followed by a common syzygial pair.

In a specimen from *Ingolf* station 116 the right anterior and right posterior radials are very closely united laterally; the right anterior radial bears the usual IBr series; the right posterior radial bears an ossicle about four times as broad as long with a muscular articulation of the "straight" type both proximally and distally, which is fused laterally with the IBr_1 of the right anterior; this is probably to be interpreted as an additional radial, for beyond it is the usual IBr series. The ossicles of the two rays are fused laterally as far as the first brachial on the right derivative from the right posterior ray, which is fused with the second brachial of the left derivative from the right anterior ray.

One of the 12 individuals in a jar in the Bergen Museum containing specimens from *Vøringen* stations 286, 337, 359, and 362 is 6-rayed, the additional ray being inserted between the left anterior and the left posterior as viewed ventrally.

Mortensen (1910) has recorded a specimen from East Greenland with a forked pinnule, the ramification occurring after the second joint.

Parasites and commensals.—In 1911 Mortensen described an endoproct, *Loxosomella antedonis*, found attached to the cirri of some specimens of *P. prolixa* taken by the *Danmark* expedition to northeast Greenland.

Localities.—Grinnell Land [Sladen, 1878].

Alert; Discovery Bay, Robeson Channel, Grinnell Land (lat. 81° 41′ N.); 46 meters; hard bottom [P. H. Carpenter, 1877; Sladen, 1881; A. H. Clark, 1913; Th. Mortensen, 1913] (5, B.M.). Type locality.

Falcon; Inglefield Gulf and Murchison Sound, western Greenland (lat. 77°30′ N.) [Ohlin, 1895].

Sofia station 542; Melville Bay, northwestern Greenland (lat. 75°26′ N., long. 67°27′ W.); 475 meters; hard clay with stones; July 29, 1883 [Gislén, 1923].

Ingegerd and *Gladan* station 17; Baffins Bay, west of Arpik, Greenland (lat. 72°32′ N., long. 58°05′ W.); 212 meters; stones; J. Lindahl, July 18, 1871 [Gislén, 1923].

Esquimaux; off Cape Raper, western side of Davis Strait (about lat. 70° N.); 110 meters; sand and small stones; September 9, 1892 [Rodger, 1893].

Tjalfe station 199; southwest of Disco Bay, western Greenland (lat. 68°28′ N., long. 54°47′ W.); 337 meters; August 18, 1908 [Mortensen, 1913] (2, C.M.).

Ingegerd and *Gladan* station 24; southwest of Disko Island (lat. 68°08′ N., long. 58°47′ W.); 309 meters; stones and mud; J. Lindahl, July 24, 1871 [Gislén, 1923].

Tjalfe station 431; southwest of Godthaab (lat. 63°24′ N., long. 53°10′ W.); 862 meters; June 9, 1909 [Mortensen, 1913] (4, C.M.).

Morrissey station XXI; off southeastern Greenland (lat. 61° N., long. 42°30′ W.); 146 meters; mud and pebbles; August 24, 1939 [A. H. Clark, 1940] (3, E.5736, U.S.N.M.).

Morrissey station 40; east Greenland, east of Scoresby Sound (lat. 70°21′ N., long. 16°30′ W.); 201 meters [A. H. Clark, 1936] (U.S.N.M.).

Morrissey station 41; off Wollaston Foreland (lat. 74°04′ N., long. 17°58′ W.) [A. H. Clark, 1936] (U.S.N.M.).

Kangerdlugsuak, S. E. Greenland; Scoresby Sound Committee's Second East Greenland Expedition, August 20, 1932; 175 and 450 meters [Heding, 1935].

Mikisfjord, S. E. Greenland; 175 meters; August 25, 1932 [Heding, 1935].

Belgica station 45; off Ile de France, northeastern Greenland (lat. 77°31′ N., long. 18°34′ W.); 200–275 meters; temperature (at 210 meters) −0.29° C.; salinity 34.93°/₀₀; August 3, 1905 [Grieg, 1907; Mortensen, 1913].

Danmark station 99; off Germania Land (lat. 77°00′ N., long. 18.5° W.); 304 meters; July 22, 1908 [Mortensen, 1910] (58, and pentacrinoids, U.S.N.M., 36285; C.M.).

Danmark station 104; off King William Land (lat. 76°06′ N., long. 13°26′ W.); 200–250 meters; July 28, 1908 [Mortensen, 1910, 1913] (6, C.M.).

Belgica station 32; off King William Land (lat. 75°58′05″ N., long. 14°08′ W.); 300 meters; temperature +0.40° C.; salinity 34.82°/₀₀; brown and gray clay; July 24, 1905 [Grieg, 1907; Mortensen, 1913].

Frithiof station 21; off Franz Josef's fjord, between Bontekoe Island and Mackenzie Bay; 250 meters; mud; August 8, 1900 [Gislén, 1923].

Antarctic; southeast of Sabine Island (near 75° N.); 210 meters; 1900 [Mortensen, 1903, 1913] (2, C.M.).

Swedish Greenland Expedition station 42; King Oscar's fjord (lat. 72°56′ N., long. 24°33′ W.); 125 meters; ooze and some gravel; August 24, 1899 [Gislén, 1923].

Hekla; off Traill Island (lat. 72°27′ N., long. 19°56′ W.); 220 meters; E. Bay, July 27, 1891 [Mortensen, 1913] (1, C.M.).

Frithiof station 16; east of eastern Greenland (lat. 72°25′ N., long. 17°56′ W.); 300 meters; stone and sand; 1900 [Gislén, 1923].

Antarctic; Forsblad Fjord (lat. 72° N.); 91 meters; 1900 (1, C.M.). Same, 91–164 meters [Mortensen, 1903, 1913] (1, C.M.).

Antarctic; Cape Hope; 220 meters; 1900 [Mortensen, 1903, 1913] (3, C.M.).

Antarctic; Cape Brewster (about lat. 70° N.); about 457 meters; August 29, 1900 [Mortensen, 1903, 1913] (2+, C.M.). Same, August 22, 1900 (6, C.M.).

Hekla; off Scoresby Sound (lat. 70°21′ N., long. 8°25′ W.); 292 meters; E. Bay, 1891 [Mortensen, 1913].

Ingolf station 116; south of Jan Mayen (lat. 70°05′ N., long. 8°26′ W.); 679 meters; temperature −0.4° C.; October 1, 1896 (202, C.M.).

Hekla; south of Jan Mayen (lat. 70°21′ N., long. 8°25′ W.); 291 meters; June 26, 1891 (1, C.M.).

Vøringen stations 224–226; off Jan Mayen (lat. 70°51′ N., long. 8°20′ W.); 174 meters; temperature −0.6° C. (3, Berg. M.).

Michael Sars station 25, 1900; Jan Mayen; 100 meters; temperature −0.40° C.; August 8, 1900 [Grieg, 1904].

East of Jan Mayen (lat. 72°05′ N., long. 0°36′ W.); 175 meters; July 24, 1891.

Swedish Greenland Expedition station 17; off Jan Mayen (lat. 71°12′ N., long. 8°28′ W.); 1275 meters; gray mud; June 24, 1899 [Gislén, 1923].

Pourquoi-Pas? station 79; off Jan Mayen (lat. 70°58′30″ N., long. 8°07′ W.); 160 meters [Vaney, 1914].

Jan Meyen; 180–400 meters [Fischer, 1886].

Northwest of Iceland (lat. 66°16′ N., long. 25°20′ W.) [Einarsson, 1948].

North Iceland (lat. 66°00′ N., long 11°41′ W.); 280 meters [Einarsson, 1948].

East Iceland (lat. 63°33′ N., long. 11°25′ W.); 317 meters [Einarsson, 1948].

Ingolf station 96; west of Iceland (lat. 65°24′ N., long. 29°00′ W.); 1344 meters; temperature +1.2° C. (2, C.M.).

Off northwestern Iceland (lat. 65°39′ N., long. 28°25′ W.); 1101 meters; Ryder; September 12, 1888.

Ingolf station 15; off northwestern Iceland (lat. 66°18′ N., long. 25°59′ W.); 603 meters; temperature −0.75° C. (1, C.M.).

Ingolf station 126; north of eastern Iceland (lat. 67°19′ N., long. 15°52′ W.); 536 meters; temperature −0.5° C. (4, C.M.).

Ingolf station 124; north of eastern Iceland (lat. 67°40′ N., long. 15°40′ W.); 905 meters; temperature −0.6° C. (46, C.M.).

Thor station 52; off northeastern Iceland (lat. 66°00′ N., long. 11°41′ W.); 280 meters; May 21, 1903 [Schmidt, 1904] (23, C.M.).

Thor station 51; off northeastern Iceland (lat. 66°02′ N., long. 11°05′ W.); May 25, 1903 (14, C.M.).

Michael Sars station 95, 1902; east of Iceland (lat. 64°56′ N., long. 11°48′ W.); 210 meters; temperature +1.03° C.; fine brown sand with clay; August 25, 1902 [Grieg, 1904].

Ingolf station 59; east of Iceland (lat. 65°00′ N., long. 11°16′ W.); 567 meters; temperature −0.1° C. (2, and a pentacrinoid, C.M.).

Michael Sars station 96, 1902; east of Iceland (lat. 64°58′ N., long. 11°12′ W.); 1005 meters; temperature −0.32° C.; mud; August 25, 1902 [Grieg, 1904].

Princesse-Alice station 1040, 1898; east of Iceland (lat. 65°21′ N., long. 10°42′15″ W.); 650 meters; mud; September 7, 1898 [Prince of Monaco, 1899; Koehler, 1901, 1909].

Ingolf station 119; northeast of Iceland (lat. 67°53′ N., long. 10°19′ W.); 1846 meters; temperature −1.0° C. (pentacrinoid, C.M.).

Ingolf station 3; between Iceland and the Faroe Islands (lat. 63°35′ N., long. 10°24′ W.); 497 meters; temperature +0.5° C. (6, C.M.).

Michael Sars station 10, 1900; east of Iceland (lat. 64°53′ N., long. 10°00′ W.); 630 meters; temperature −0.69° C.; July 28, 1900 [Grieg, 1904] (about 70, Berg. M.).

Thor station 51; between Iceland and the Faroes (lat. 62°02′ N., long. 11°05′ W.); 876–1009 meters; temperature +0.58° C.; soft clay; May 25, 1903 [Schmidt, 1904].

Between Iceland and the Faroes (lat. 63°15′ N., long. 9°35′ W.); 494 meters; Wandel; September 19, 1891 (1, C.M.).

Between Iceland and the Faroes (lat. 63°15′ N., long. 9°33′ W.); 505 meters; Wandel; September 19, 1891 (1, C.M.).

Thor station 64; east of Iceland (lat. 64°26′ N., long. 8°37′ W.); 1430 meters (1, C.M.).

Ingolf station 105; east of Iceland (lat. 65°34′ N., long. 7°31′ W.); 1393 meters; temperature −0.8° C. (5, C.M.).

Ingolf station 143; north of the Faroes (lat. 62°58′ N., long. 7°09′ W.); 710 meters; temperature −0.4° C. (13, C.M.).

Triton station 4; southwest of the Faroe Islands (lat. 60°22′40″ and 60°31′15″ N., long. 8°21′ and 8°14′ W.); 598–786 meters; temperature −1.11° to −0.28° C.; stones; mud [P. H. Carpenter, 1884; Bell, 1893; A. H. Clark, 1913] (1, B.M.).

Michael Sars station 75, 1902; south of the Faroe Islands (lat. 60°01′ N., long. 6°35′ W.); 1220 meters; temperature −0.41° C.; fine brownish black sand; August 11, 1902 [Grieg, 1904].

Porcupine station 54, 1869; north of the Hebrides (lat. 59°56′ N., long. 6°27′ W.); 663 meters; temperature −0.33° C. [P. H. Carpenter, 1884, 1888; Bell, 1893] (1, B.M.).

Porcupine station 55, 1869; south of the Faroe Islands (lat. 60°04′ N., long. 6°19′ W.); 1105 meters; temperature −1.22° C. [P. H. Carpenter, 1884, 1888].

Porcupine, 1869; cold area, Faroe Channel [P. H. Carpenter, 1884; von Graff, 1884; Bell, 1893; Chun, 1900; A. H. Clark, 1913] (1, B.M.).

Michael Sars station 74, 1902; southeast of the Faroe Islands (lat. 60°19′ N., long. 5°22′ W.); 1130 meters; temperature −0.03° C.; brown sand and small stones; August 10, 1902 [Grieg, 1904].

Michael Sars station 102, 1910; southeast of the Faroe Islands (lat. 60°57′ N., long. 4°38′ W.); 1098 meters; temperature +0.9° C.; dark sand and clay; August 9–10, 1910 [Grieg, 1921].

Silver Belle station 9; west of the Shetland Islands (lat. 60°18′ N., long. 4°43′ W.); 748 meters [A. H. Clark, 1912] (1, B.M.).

Michael Sars station 67, 1902; northeast of the Faroes (lat. 62°35′ N., long. 4°04′ W.); 620–640 meters; temperature −0.03° C.; clay; July 28, 1902 [Grieg, 1904] (1, Berg. M.).

Michael Sars station 55, 1902; northeast of the Faroes (lat. 62°40′ N., long. 1°56′ E.); 658 meters; temperature −0.21° C.; mud; July 19, 1902 [Grieg, 1904] (8, Berg. M.).

Michael Sars station 9, 1900; northeast of the Faroe Islands (lat. 63°55′ N., long. 6°22′ W.); 1960 meters; temperature −1.0° C.; July 26, 1900 [Grieg, 1904] (9, Berg. M.).

Swedish Greenland Expedition station 2; northwest of Bergen, Norway (lat. 62°15′ N., long. 0°37′ E.); 670 meters; mud and gravel; 1899 [Gislén, 1923].

Michael Sars stations 38 and 38*a*, 1902; west of Kristiansund, Norway (lat. 62°30′ N., long. 1°56′ E.); 503 meters; temperature −0.07° C.; coarse brown sand; June 29, 1902 [Grieg, 1904].

Vøringen station 18; northeast of the Shetlands (lat. 62°44′ N., long. 1°48′ E.); 753 meters; temperature −1.0° C.; clay; June 21, 1876 [Danielssen, 1892] (about 10, Berg. M.).

Vøringen station 31; north of the Shetlands (lat. 63°10′ N., long. 5°00′ E.); 763 meters; temperature −1.0° C.; sandy clay [Danielssen, 1892] (1, Berg. M.).

Finmark [A. H. Clark, 1913] (1, B.M.).

Spitzbergen [A. H. Clark, 1912].

Diana; Spitzbergen; A. E. Eaton (1, B.M.).

Blaafjeld station 39; off Spitzbergen (lat. 78°56′59″ N., long. 10°20′ E.); 40–237 meters; July 28–29, 1923 [Grieg, 1925].

Blaafjeld station 49; off Spitzbergen (lat. 76°35′ N., long. 13°43′ E.); 212–237 meters; August 6–7, 1923 [Grieg, 1925].

Blaafjeld station 50; off Spitzbergen (lat. 76°56′ N., long. 12°50′ E.); 242–301 meters; August 7, 1923 [Grieg, 1925].

Blaafjeld station 52; off Spitzbergen (lat. 77°41′ N., long. 11°20′ E.); 233–264 meters; August 8, 1923 [Grieg, 1925].

Tovik station 35; near Bear Island (lat. 73°47′ N., long. 18°20′ E.); 210–243 meters [Grieg, 1925].

Tovik station 79; off Spitzbergen (lat. 76°34′ N., long. 28°40′ E. to 76°37′ N., 28°16′ E.); 155–170 meters [Grieg, 1925].

Antarctic station 37; north of the Sju Islands, north of Northeast Land, Spitzbergen (lat. 81°14′ N., long. 22°50′ E.); 150 meters; temperature +2.0° C.; gray mud; August 20, 1898 [Gislén, 1923].

Yermak (*Jermak*) station 27 (55); north of Northeast Land (lat. 80°57′ N., long. 20°51′ E.); 195 meters; temperature +0.7° C.; mud; August 17, new style (5, old style), 1899 [Michailovskij, 1902].

Polhem and *Gladan* station 246; off Verlegen Hook, the northernmost point of Spitzbergen; 183 meters; July 3, 1873 [Gislén, 1923].

Polhem and *Gladan* station 257; north of Spitzbergen (lat. 80°11′ N., long. 16°10′ E.); 210 meters; mud; July 7, 1872 [Gislén, 1923].

Polhem and *Gladan* station 287; north of Spitzbergen (lat. 79°50′ N., long. 15°45′ E.); 183 meters; stones; July 16, 1872 [Gislén, 1923].

Antarctic station 38; entrance to Liefde Bay, north Spitzbergen (lat. 79°47′ N., long. 14°28′ E.); 140 meters; stony bottom with red algae; August 25, 1898 [Gislén, 1923].

Princesse-Alice station 1012, 1898; near the ice pack north of Spitzbergen (lat. 80°01′ N., long. 10°51′15″ E.); 430 meters; August 18, 1898 [Koehler, 1901, 1909].

Swedish Expedition to Spitzbergen, 1861; off northwestern Spitzbergen, about 20 miles from land (lat. 79°08′ N., long. 9°00′ E.); 183 meters; stony; September 14, 1861 [Gislén, 1923].

Vøringen station 363; off the northwestern coast of Spitzbergen (lat. 80°03′ N., long. 8°28′ E.); 475 meters; temperature +1.1° C.; clay; [Danielssen, 1892] (3, Berg. M.).

Vøringen station 362; west of Spitzbergen (lat. 79°59′ N., long. 5°40′ E.); 839 meters; temperature −1.0° C.; blue clay [Danielssen, 1892] (many, Berg. M.).

Vøringen station 366; off northwestern Spitzbergen (lat. 79°35′ N., long. 11°17′ E.); 112 meters; temperature −2.1° C. or −0.2° C.; dark gray clay [Danielssen, 1892; Michailovskij, 1903].

Vøringen station 373; Ice Fjord, Spitzbergen (lat. 78°10′ N., long. 14°21′ E.); 219 meters; dark clay [A. H. Clark, 1913] (2, Berg. M.; 2, B.M.).

Polhem and *Gladan* station 287; Green Harbor; 183 meters; stones and mud; July 16, 1873 [Gislén, 1923].

Vøringen station 360; off the Ice Fjord; August 1877 (4, Berg. M.).

Vøringen station 359; west of the Ice Fjord (lat. 78°02′ N., long. 9°25′ E.); 761 meters; temperature +0.8° C.; brown and gray clay [Danielssen, 1892] (several, Berg. M.).

Vøringen station 343; west of South Cape, Spitzbergen (lat. 76°34′ N., long. 12°51′ E.); 1358 meters; temperature −1.2° C.; clay [Danielssen, 1892] (many, U.S.N.M., 36212; Berg. M.; C.M.).

Vøringen station 337; off southwestern Spitzbergen (lat. 76°23′ N., long. 16°43′ E.); 37 meters; rock [Danielssen, 1892] (several, Berg. M.).

Vøringen station 312; west of Bear Island (lat. 74°54′ N., long. 14°53′ E.); 1203 meters; temperature −1.2° C.; gray clay; July 22, 1877 [Danielssen, 1892] (about 15, Berg. M.).

Vøringen station 286; southwest of Bear Island (lat. 72°57′ N., long. 14°32′ E.); 817 meters; temperature −0.8° C.; gray clay [Danielssen, 1892] (several, Berg. M.).

Kükenthal's stations 126–139; Deevie Bay, Edge Land, near Berentine Island; 24–27 meters; stones, with Laminariae; August 22–24, 1886 [Pfeffer, 1894; A. H. Clark, 1912] (fragment, H.M.).

Princesse-Alice station 970, 1898; near Hope Island (lat. 76°30′ N., long. 25°27′15″ E.); 48 meters; gravel and shells; July 31, 1898 [Koehler, 1901, 1909].

Kükenthal's station 18; 2 miles north of Ryk Ys Island; 100 meters; fine mud with small stones and mussel shells; June 22, 1886 [Pfeffer, 1894; Michailovskij, 1903].

Kükenthal's stations 23, 24; 3 miles east of West Thymen Strait; stones and mud; 73 meters; June 26, 1886 [Pfeffer, 1894; Michailovskij, 1902; A. H. Clark, 1912] (2, H.M.).

Kükenthal's station 32; near Bastians Island; 55 meters; stones with blue-gray mud; a few small Florideae; June 30, 1886 [Pfeffer, 1894; Michailovskij, 1902; A. H. Clark, 1912] (1, H.M.).

Eastern Spitzbergen (2, H.M.).

Helgoland station 36; eastern side of Northeast Land, about 4 miles (nautical) from the glacier (lat. 79°35′ N., long. 28°00′ E.); 66 meters; a little blue mud, small and large stones, up to the size of a man's head, rounded or sharply angled; August 6, 1898 [Döderlein, 1905] (numerous specimens from the several *Helgoland* stations have been examined: U.S.N.M. 35883; Berl. M., 4386, 4387, 4389, 4390, 4391).

Helgoland station 37; Great Island, off northeastern Spitzbergen, about 6 miles (nautical) northeast (lat. 80°15′ N., long. 30°00′ E.); 95 meters; a little yellow mud, and many stones up to the size of a fist; August 8, 1898 [Döderlein, 1905].

Helgoland station 39; off northern Spitzbergen (lat. 81°00′ N., long. 21°21′ E.); 140 meters; yellow mud with heavy stones larger than a man's head; August 10, 1898 [Döderlein, 1905].

Franz Josef archipelago; Aberdare Channel, between McClintock and Hall Islands, east of Alger Island; Baldwin-Ziegler Expedition; June 1901 (1, U.S.N.M., 36036).

Yermak station 82(8): east of Wilczek Land, or south of Graham Bell Land (lat. 80°26′ N., long. 64°14′ E.); 204 meters; mud; August 16 (3), 1901 [Michailovskij, 1905; Gorbunow, 1933] (1, M.C.Z., 398).

Tegetthoff; south of Wilczek Land (lat. 79°0.4′ N., long. 62°29.7′ E.); 183 meters; mud; June 3, 1873 [von Marenzeller, 1878; d'Urban, 1880; Stuxberg, 1887].

Yermak station 77(4); between Franz Josef Land and northwestern Nova Zembla (lat. 78°21′ N., long. 61°15′ E.); 311 meters; temperature −0.1° C.; mud; August 14 (1), 1901 [Michailovskij, 1905].

Yermak station 76(10); between Franz Josef Land and Nova Zembla (lat. 77°53′ N., long. 61°29′ E.); 356 meters; temperature −1.2° C.; mud; August 14 (1), 1901 [Michailovskij, 1905].

Yermak station 86(1); northwest of northern Nova Zembla (lat. 77°31′ N., long. 64°34′ E.); 280 meters; temperature −1.1° C.; mud; August 17 (4), 1901 [Michailovskij, 1905; Gorbunow, 1933].

Dijmphna; Kara Sea (1, C.M.).

Station 16b; Barents Sea (lat. 77°36′ N., long. 63°18′ E.); 300 meters; mud with stones and concretions; August 21, 1921 [Schorygin, 1925].

Station 98; Barents Sea (lat. 70°47′ N., long. 48°35′ E.); 325 meters; cinnamon colored mud with stones and concretions; August 31, 1923 [Schorygin, 1925].

Vega; Belouscha Bay, Matotschkin Scharr, Nova Zembla; 110–128 meters; muddy bottom; August 2, 1876 [Gislén, 1923].

Ymer station 181; Kara Sea (lat. 75°23′ N., long. 65°15′ E.); 73–91 meters; muddy bottom; August 24, 1875 [Gislén, 1923].

Vega station 38; Kara Sea (lat. 73°38′ N., long. 63°45′ E.); 146 meters; shell bottom; September 5–6, 1876 [Gislén, 1923].

Varna station 18; off the mouth of Kara Bay (lat. 71°04′ N., long. 64°05′ E.); 105 meters; temperature −1.2° C.; density 1.024; February 14, 1883 [P. H. Carpenter, 1887].

Varna station 50; off the mouth of Kara Bay (lat. 71°38′ N., long. 64°52′ E.); 91 meters; temperature −1.5° C.; density 1.026; gray mud mixed with brown; April 29, 1883 [P. H. Carpenter, 1887].

Vega stations 39 and 40; off the Taimyr peninsula (lat. 76°52′ N., long. 116°00′ E., and lat. 76°40′ N., long. 115°30′ E.); 66 and 64 meters; muddy bottom; 1878 [Gislén, 1923].

Zarnitza station 11; Witnej Bay (lat. 76°12′30″ N., long. 68°02′ E.); 20 meters; bottom temperature −0.12° C.; clay; August 24, 1925 [Gorbunow, 1933].

Zarnitza station 12; Blagopolutschja Bay (lat. 75°30′ N., long. 63°45′ E.); 115 meters; bottom temperature −1.53° C.; gray mud; August 27, 1925 [Gorbunow, 1933].

Malygin station 16b; (lat. 77°36′ N., long. 63°18′ E.); 300 meters; bottom temperature −0.71° C.; mud, stones, and concretions; August 21, 1921 [Gorbunow, 1933].

Sedow station 48; northern Kara Sea (lat. 79°[?′] N., long. 78°30′ E.); 95 meters; bottom temperature −1.60° C.; loose brown mud; August 18, 1930 [Gorbunow, 1933].

Sedow station 49; northern Kara Sea (lat. 78°55′ N., long. 79°15′ E.); 148 meters; bottom temperature −1.66° C.; loose brown mud and stones; August 19, 1930 [Gorbunow, 1933].

Sedow station 56; northern Kara Sea (lat. 79°25′ N., long. 89°00′ E.); 138 meters; bottom temperature −1.38° C.; loose brown mud; August 30, 1930 [Gorbunow, 1933].

Sedow station 57; northern Kara Sea (lat. 79°55′ N., long. 88°58′ E.); 185 meters; bottom temperature −1.24° C.; loose brown mud and gray clay; August 31, 1930 [Gorbunow, 1933].

Sedow station 58; northern Kara Sea (lat. 80°26′ N., long. 85°57′ E.); 170 meters;

bottom temperature −1.36° C.; loose brown mud, gray clay, and stones; August 31, 1930 [Gorbunow, 1933].

Sedow station 59; northern Kara Sea (lat. 80°47′ N., long. 89°50′ E.); 52 meters; bottom temperature −1.48° C.; presumably stones and lithothamnion; August 31, 1930 [Gorbunow, 1933].

Sedow station 60; northern Kara Sea (lat. 79°00′ N., long. 87°04′ E.); 180 meters; loose brown mud; September 1, 1930 [Gorbunow, 1933].

Sedow station 61; northern Kara Sea (lat. 78°31′ N., long. 86°20′ E.); 119 meters; bottom temperature −1.82° C.; very sandy brown mud and stones; September 2, 1930 [Gorbunow, 1933].

Sedow station 62; northern Kara Sea (lat. 78°02′ N., long. 86°30′ E.); 108 meters; very sandy brown mud and stones; September 2, 1930 [Gorbunow, 1933].

Sedow station 68; northern Kara Sea (lat. 76°36′ N., long. 74°48′ E.); 157 meters; loose brown mud, stones, and mussels; September 4, 1930 [Gorbunow, 1933].

Lomonossow station 71; northern Kara Sea (lat. 77°32′ N., long. 70°05′ E.); 320 meters; bottom temperature −1.97° C.; stones; September 2, 1931 [Gorbunow, 1933].

Lomonossow station 72; northern Kara Sea (lat. 77°48′ N., long. 70°10′ E.); 290 meters; bottom temperature −0.95° C.; gray mud; September 2, 1931 [Gorbunow, 1933].

Lomonossow station 77; northern Kara Sea (lat. 78°08′ N., long. 73°47′ E.); 446 meters; bottom temperature −0.98° C.; brown mud; September 6, 1931 [Gorbunow, 1933].

Lomonossow station 79; northern Kara Sea (lat. 77°39′ N., long. 74°00′ E.); 300 meters; bottom temperature −0.97° C.; brown mud; September 7, 1931 [Gorbunow, 1933].

Arctic Ocean (fragments, U.S.N.M., 36190).

North Atlantic Ocean [A. H. Clark, 1912] (2, Berl. M., 3082).

Erroneous locality.—Dr. T. Gislén gives the following record for this species: "South of the Färö-Iceland ridge: A. H. Clark, 1923, 1317 M., +2.4° C.;" but there is no such record in the *Ingolf* report, the memoir to which reference is made. In his synonymy he includes a citation to the *Ingolf* report, giving page 6 as the page upon which this species is considered, whereas the account of the species is found on p. 8.

These discrepancies arose through the fact that Dr. Th. Mortensen sent to Dr. Gislén the uncorrected proofs of the *Ingolf* report in which *Ingolf* station 46, west of the Faroe Islands (lat. 61°32′ N., long. 11°36′ W.), 1317 meters, temperature +2.4° C., was inadvertently included in the list of localities from which this species had been obtained. This station was struck out in the proof, and before the final printing the pagination was changed so that *Poliometra prolixa* appears on page 8 instead of on page 6 as given by Gislén.

Geographical range.—Arctic regions; westward to Grinnell Land, southward to the vicinity of Godthaab, west Greenland (lat. 63°24′ N.), Kangerdlugsuak, east Greenland (lat. 68° N.), the vicinity of Jan Mayen, the cold deeps west, north, and east of Iceland, the Faroe Channel, and Finmark, and eastward to the Kara Sea and just east of Wilczek Land.

Bathymetrical range.—From 20 to 1960 meters.

Thermal range.—From −1.97° C. to +2.00° C. (a record for −2.10° C. is doubtful) (Schorygin, 1928, gives the range as up to +3° C.); less than a quarter of the records are above 0° C.

Salinity.—Mr. G. Gorbunow found the salinity range in the North Kara Sea to be from 34.47 to 34.99 per thousand. A record of 37.01 per thousand at *Lomonossow* station 71 is apparently an error. He said that the salinity of the different layers in the vicinity of Franz Joseph Land seemed to play absolutely no part in the distribution of the echinoderms, though the fresher water that may be found in the higher layers may be of significance for this species, also *Korethraster hispidus* and *Ophiopus arcticus.*

Occurrence.—Like the other Arctic comatulid *Heliometra glacialis*, this species frequently occurs in dense masses, completely carpeting the sea bottom. It was extraordinarily abundant at *Danmark* station 99 off eastern Greenland, at *Ingolf* station 116 south of Jan Mayen, at *Thor* station 52, *Ingolf* station 124, and *Michael Sars* station 10 (1900) all northeast and east of Iceland, at *Michael Sars* station 55 (1902) northeast of the Faroes, at *Vøringen* station 312 west of Bear Island, at *Vøringen* stations 343 and 362 west of Spitzbergen, and at *Sedow* station 57 in the north Kara Sea. It was also found abundantly about eastern Spitzbergen by the *Helgoland*. These localities range in depth from 185 to 1358 meters, and in temperature from −1.24° to −0.40° C. It was common and possibly abundant at *Thor* station 51 off northeastern Iceland, *Ingolf* station 143 north of the Faroe Islands, *Vøringen* station 18 northeast of the Shetlands, *Vøringen* station 286 southwest of Bear Island, *Vøringen* stations 359 and 337 off western Spitzbergen, and *Yermak* (*Jermak*) station 76(10) north of Nova Zembla. The depth at these stations varied between 37 and 817 meters, and the temperature ranged from −1.20° to +0.80° C. Apparently, therefore, this species thrives best in the deeper and colder portions of its habitat. The average temperature of the habitat is considerably lower in the eastern than in the western portion of the range.

Although occurring in relatively shallow water, this species is essentially an inhabitant of the open sea and does not enter gulfs or fjords. The only partially enclosed waters from which it is known are the Aberdare Channel in the Franz Joseph archipelago, Discovery Bay in Grinnell Land, Inglefield Gulf and Murchison Sound in northwestern Greenland (there is some doubt regarding this record), and the Ice Fjord, Spitzbergen, where it was dredged by the *Vøringen*, though Prof. von Hofsten in his detailed survey of that region failed to find it. Gorbunow says that this species is very widely, though patchily, distributed in the northern half of the Kara Sea, occurring in great quantities on all suitable bottoms. As his investigations in 1931 showed, it ranges on the border of the Kara Sea along the Nova Zembla channel as far south as lat. 71° N.

Poliometra prolixa is preeminently an inhabitant of soft bottoms, on which it is supported by its long cirri. These are relatively inflexible, very brittle, and poorly adapted to clinging to stones or arborescent organisms. Half the bottom records are mud or clay, and most of the rest are mud or clay mixed with sand, gravel, or stones. There are a few records of hard bottom, but it is not certain that the animals lived on the spot from which the bottom sample came.

The largest specimens, with arms more than 100 mm. in length or with more than 45 cirrus segments, are from Discovery Bay, *Danmark* station 104, Jan Mayen, *Thor* station 51, *Ingolf* stations 124, 59 and 143, and the Faroe Channel.

These stations are in Grinnell Land, and off northeastern Greenland, Jan Mayen, northeastern Iceland, and the Faroes, in 46 to 905 meters, with bottom temperatures between −0.1° C. and −0.6° C.

Though this species is so excessively brittle that data gathered from museum specimens must be used with great care, it is probably true that it reaches a larger size in the western and southern portions of its range than in the northeastern, since it is also more abundant in the same area.

[NOTE BY A.M.C.] Blacker (1957) has commented on the fact that the *Ernest Holt* failed to take this species in the Bear Island-Spitzbergen area during her many cruises since 1949. He concluded from this that there has been a limitation of the range of this species among others due to the increase in temperature in this area.

Occurrence of the pentacrinoids.—The pentacrinoid young of this species have been found at the following localities: *Danmark* station 99, off northeastern Greenland, 304 meters; Kangerdlugsuak, southeastern Greenland, 175 meters; Jan Mayen, 180 to 400 meters; east of Jan Mayen (lat. 72°05′ N., long. 0°36′ W.), 175 meters; *Ingolf* station 119, northeast of Iceland, 1846 meters; *Ingolf* station 59, east of Iceland, 567 meters; and in the "cold area" of the Faroe Channel. A detailed description of the pentacrinoids was given in part 2, p. 559. Heding (1935) has added some remarks and a figure of a pentacrinoid from Kangerdlugsuak. The specimens from that locality were not fixed to crinoids but to polyzoa. They were conspicuous for their size, the smallest one measuring 48 mm., while the largest is a third again as large. The stem of the smallest consists of 57 to 58 columnals, those nearest to the calyx being discoidal. Several of the columnals towards the calyx are formed of a stem syzygy. The end of the distal columnal extends to a rather large digitate mass, which expands over the surface of the object of attachment. The calyx is well-developed with a few cirri, which are broken. The arms are also broken but some pinnules were developed. A columnar fragment found on a polyzoan shows that this species may develop processes to assist in attachment from the columnals above the terminal ones.

Occurrence compared with that of Heliometra glacialis.—Whereas *Poliometra prolixa* does not occur about southern Greenland, farther west than Grinnell Land, or farther east than Wilczek Land, *Heliometra glacialis* ranges southward to Massachusetts, westward to Hudson Bay, and eastward to Wrangel Island, near Bering Strait, while it is also found slightly farther to the southward about Iceland and on the Finmark coast.

There are no less than 101 records for *Heliometra glacialis* beyond the area from which *Poliometra prolixa* is known, and the fact that within this area there are 228 records for *Heliometra glacialis* as against only 87 for *Poliometra prolixa* would seem to show the more uniform distribution of the former over the sea floor even when allowance is made for the lesser size, less striking color, and greater brittleness of the latter, which render it much less attractive as an object for preservation.

The bathymetric range of *Poliometra prolixa* is 596 meters greater than that of *Heliometra glacialis*, but on the other hand the thermal range is about 4° less.

The average depth of the habitat of *Poliometra prolixa* is 311 meters deeper than that of *Heliometra glacialis*, and the average temperature 0.87° less.

The average depth of the occurrence in maximum abundance for *Poliometra prolixa* is 473 meters deeper than for *Heliometra glacialis*, and the average temperature is 0.51° less. Whereas *Poliometra prolixa* has not been found in great quantities at a lesser depth than 280 meters, *Heliometra glacialis* occurs very abundantly in 46 meters.

History.—This species was first taken by the Austrian steamer *Tegetthof* south of Wilczek Land in 1873. Two years later it was dredged by the *Discovery* in Discovery Bay, Grinnell Land. On examining the specimens brought back for Mr. W. Percy Sladen by the *Discovery*, Dr. P. H. Carpenter believed that he had before him the *Comatula woodwardii* which had been described by Barrett in 1857 from the Sound of Skye and in the following year renamed *Comatula celtica* on account of the preoccupation of the specific name *woodwardii*. This species is therefore given as *Antedon celtica* in the earlier references (Duncan and Sladen, 1877; Nares, 1878) to the *Discovery* collections.

Prof. von Marenzeller in 1878 recorded the specimens taken by the *Tegetthof* under the name of *Antedon sarsii*.

Before the publication of the final report on the *Discovery* collections, presented as a memoir on the echinoderms of the Arctic seas west of Greenland, Carpenter had learned the true relationships of *Comatula celtica* as a result of the rediscovery of J. Müller's *Alecto phalangium* by Marion and Ludwig independently in 1879, and Sladen thus was able therein to describe the present species as new under the name of *Antedon prolixa* (Duncan and Sladen, 1881).

In 1884 Carpenter again described the species, under the name of *Antedon hystrix*, from two specimens which had been dredged in the cold area of the Faroe Channel by the *Porcupine* in 1869, and one from *Triton* station 4. At the same time he described a pentacrinoid from the cold area which he considered as possibly of this species.

In 1885 Dr. Nansen described the myzostomes affecting this species which, on Carpenter's authority, he called *Antedon celticus*. His material came from *Vøringen* station 343, off southwestern Spitzbergen.

In 1886 Fischer recorded this species from Jan Mayen where he had found 3 small specimens among vast numbers of *Heliometra glacialis*. For it he used the name *quadrata* proposed by Carpenter in 1884 for a small variety of *Heliometra glacialis* which had been dredged by the *Triton* in 1882. In the same year Carpenter discussed the dimorphism of the cirri. In 1887 Carpenter recorded it from the *Varna* collections under the name of *Antedon prolixa*, and Prof. von Graff, on Carpenter's authority, corrected Nansen's identification.

In the *Challenger* report (1888) Carpenter recognized both *prolixa* and *hystrix* as valid species; but in 1891 he admitted the identity of the two, which was also announced by Hartlaub, acting on a suggestion by Carpenter, in the same year.

In 1892 Danielssen recorded this species from a large number of new localities in the Norwegian Sea and about Spitzbergen, where it had been dredged by the *Vøringen*, and in 1893 Rodger recorded it from off Cape Raper, Baffin Land, and Bell summarized all the British records.

Pfeffer in 1894 cited a number of new localities about Spitzbergen, where it had been found by Kükenthal, and in the year following Ohlin added other localities off northwestern Greenland.

The Prince of Monaco in 1899 mentioned it from east of Iceland in 650 meters under the name of *Antedon phalangium*, the identification having been made by Prof. Koehler; and in 1901 Koehler himself recorded it under the same name from 4 *Princesse-Alice* stations.

In 1903 Dr. Th. Mortensen added a number of new localities in eastern Greenland and described the ambulacral deposits in detail; Michailovskij discussed its occurrence about Spitzbergen; and Grieg recorded it from numerous stations of the *Michael*

Sars expeditions of 1900 and 1902, and gave a very detailed discussion of its characters, at the same time correcting Koehler's records.

Michailovskij in 1904 listed it from 4 *Yermak* stations, and Döderlein published an excellent monographic account of the species in 1905, adding new localities resulting from the work of the *Helgoland.* In 1907 Grieg recorded it from the Second Norwegian Arctic Expedition in the *Fram*, 1898–1902, and from two stations of the *Belgica* cruise of 1905, repeating these last records in 1909.

In 1910 Mortensen recorded it from two stations of the *Danmark* expedition and described some pentacrinoids in great detail. In 1912 the present author recorded it from the dredgings of Dr. Wolfenden's yacht *Silver Belle*, in 1917 Mortensen summarized its occurrence about Greenland, in 1914 Vaney noted it in the collections of the *Pourquoi-Pas?*, in 1917 Stephensen discussed its range, and in 1921 Grieg recorded it from one of the stations of the 1910 expedition of the *Michael Sars.*

In 1923 the author decided that this species was really nearer to the species included in the Zenometrinae than to *H. tenella*, the type species of *Hathrometra*, to which genus it had previously been referred; he therefore removed it to that subfamily under the new generic name of *Poliometra.* At the same time, he recorded it from a number of new localities where it had been found by the *Ingolf* and gave a summary of its range.

Two weeks after the appearance of this memoir Dr. T. Gislén published a notable contribution to the study of *prolixa*, recording it from no less than 19 new localities and discussing its characters and affinities in great detail. He accepted the new genus *Poliometra* and the reference of the species to the Zenometrinae, though with the reservation, on the characters of the oral pinnules and cirri, that it is closely related to the species of *Hathrometra.* He also suggested the recognition within the species of two varieties on the basis of differences in the spicules in the pinnules. One of these varieties, from Greenland and the Faroe Islands, with rather slender and smooth spicules, he called var. *groenlandica* (that is, typical *prolixa*); the other, with coarse and extremely spiny spicules, from Taimyr and the Kara Sea, he called var. *sibirica.* He noted that specimens from Spitzbergen resembled those from Greenland in having slender spicules which are, however, somewhat spiny.

During the middle 1920's, Mortensen and Koehler gave accounts of the characters and range of this species in their various works on European echinoderms. Some additional records were provided by Grieg (1925) in his report on the collections of the *Blaafjeld* and *Tovik* from the Spitzbergen Bank.

In 1925 A. A. Schorygin recorded *Hathrometra prolixa* from two stations in the Barents Sea, giving the depth and the character of the bottom. He noted that this species is easily distinguished from *Heliometra glacialis* by the length of the proximal pinnules as well as by the general form.

In his memoir on the echinoderms of the Barents Sea published in 1928, Schorygin said that *Poliometra prolixa* occurs only in the northern and central parts of that sea. He gave the bathymetric range as from 0 to 2000 meters, with the greatest representation at 800 meters, the temperature range from −2.0° to +3.0° C., with the largest representation at −1.0° C., and the bottom on which the species is found ranging from mud through mud and stones to stones, with the largest number of records on mud and stones.

A single specimen of *prolixa* was recorded by Mortensen in 1932 among the collections of the Godthaab expedition in the deep basin of Baffin Bay, west of Greenland.

In 1932 G. P. Gorbunow published an account of the echinoderm fauna of Franz Joseph Land and the Queen Victoria Sea based on work done in 1927, 1929, and 1930 by the motor ship *Zarnitza* (*Elding*) and the icebreaker *Georgi Sedow*. He recorded *Peliometra* (sic) *prolixa* from two stations. In a paper on the echinoderm fauna of the inshore waters of the North Island of Nova Zemblya published in 1933 he recorded it from two additional stations. In a paper on the echinoderms of the northern half of the Kara Sea also published in 1933 he recorded it from 14 stations giving the localities, depth, character of bottom, temperature, and salinity, and also a general account of its occurrence in this region.

In 1933 Mr. A. M. Djakonov included a general account of *Peliometra* (sic) *prolixa*, with a figure of the proximal portion, in his memoir on the echinoderms of the Arctic seas.

In 1935 Heding recorded the species from Kangerdlugsuak and Mikisfjord in King Christian IX's Land in the southeast of Greenland, where it was collected by the Scoresby Sound Committee's second East Greenland Expedition in 1932. A number of pentacrinoids of conspicuously large size were also taken.

In a report on some echinoderms from Franz Josef Land, Victoriaøya, and Hopen collected on the Norwegian Scientific Expedition of 1930, published in 1935, James A. Grieg noted that *Poliometra prolixa* had been recorded from Franz Josef Land by Marenzeller, Michailovskij, and Gorbunow.

In a report on a collection of echinoderms made by Capt. Robert A. Bartlett in the seas about Baffin Land and Greenland which appeared in 1936 I recorded this species from two localities off east Greenland. In a paper on additional collections by Captain Bartlett published in 1940 I recorded it from one additional locality.

Finally, in 1948, Einarsson found *P. prolixa* at several stations around the coasts of Iceland, particularly on the north and eastern sides. They were taken on hard bottoms, stones and gravel predominantly, according to Einarsson, which is contrary to the majority of records of habitat.

Genus EOMETRA A. H. Clark

Psathyrometra (part) A. H. Clark, Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81; Die Crinoïden der Antarktis, 1915, pp. 104, 107, 116, 170, 171.

Eometra A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (diagnosis; type species *Psathyrometra antarctica* A. H. Clark, 1915.).—John, *in* Vaney and John, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, pp. 668–670 (*E. weddelli* sp. nov.).—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.

Diagnosis.—A genus of Zenometrinae in which the centrodorsal is small, conical with somewhat swollen sides, about as high as broad at the base, or nearly so, and almost completely covered with cirrus sockets, which are arranged in 10 closely crowded columns of 2 or 3 each; the cirri are slender and only slightly curved distally, gradually tapering to a fine point, with all the segments except the basal much elongated and without dorsal processes; the elements of the IBr series and lower brachials are smooth and not in lateral contact; all the pinnules are present; P_1 and P_2 are similar, the latter the longer; P_3 and the pinnules following are much longer than P_2.

Type species.—*Psathyrometra antarctica* A. H. Clark, 1915.

Geographical range.—Known from the Antarctic in the vicinity of Gaussberg and southeast of the South Orkney Islands in the Weddell Sea.

Bathymetrical range.—Only known from 2725 and 3426 meters.

KEY TO THE SPECIES OF EOMETRA

a^1. Cirri with 26–31 segments, the longest of which are at least five times as long as broad; P_1 slender and delicate, with 11–12 segments, of which the fourth and fifth are four times as long as broad; no interradial processes on the radials (near Gaussberg; 2725 meters) ..... **antarctica** (p. 593)

a^2. Cirri probably with about 18 segments of which the longest are four times as long as broad; P_1 tapering distally, the fourth and fifth of the 10 segments three times as long as broad; the radials produced interradially alongside the IBr_1 (Weddell Sea; 3426 meters) .... **weddelli** (p. 594)

EOMETRA ANTARCTICA (A. H. Clark)

[See vol. 1, pt. 2, fig. 765, p. 362]

Psathyrometra antarctica A. H. Clark, Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (Antarctic; range; *nomen nudum*); Die Crinoiden der Antarktis, 1915, p. 104 (collected by the *Gauss*), p. 107 (in key), p. 116 (detailed description; Antarctic, 2725 meters; comparison with related species), p. 170 (deep water Antarctic species to south of the Indian Ocean), p. 171 (systematic and geographical relationships), pl. 2, figs. 1, 2; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 225 (in key), p. 230 (references); Smithsonian Misc. Coll., vol. 72, 1921, No. 7 pl. 2, fig. 23.

Eometra antarctica A. H. Clark, Proc. U.S. Nat Mus., vol. 83, 1936, p. 248 (type species of new genus *Eometra*).—John, *in* Vaney and John, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, p. 669 (comparison with *E. weddelli*).—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 140.—Tortonese, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4 (depth range).

Diagnostic features.—The centrodorsal has the height about equal to the basal diameter, which is 2.5 mm. in the type specimen; the cirri are about XX, 26–31 and from 30 to 45 mm. in length; the radials are short with no interradial processes; P_1 is delicate, about 5 mm. long, with 11 to 12 segments, of which the fourth and fifth are four times as long as broad; P_2 is 6.5 mm. long, with 13 to 15 segments and P_3 is even longer, about twice as long as P_1.

Description.—The centrodorsal is small, rounded conical, about 2.5 mm. in diameter at the base and about 2.5 mm. high, with the base in dorsal view rounded pentagonal in outline. The cirrus sockets, which almost completely cover the sides of the centrodorsal, are closely crowded, and are arranged in 10 columns of 2 or 3 each.

The cirri are XX, 26–31, from 30 to 45 mm. long, slender with greatly elongated segments and distally tapering to a fine point. In general they resemble the cirri of such species as *Pentametrocrinus varians* or *P. japonicus*. The first segment is about 4 times as broad as long and the following gradually increase in length to the third, which is half again as broad as long, the fourth, which is half again as long as the median width, and the fifth, which is about 3 times as long as the median width; the following segments are much elongated. In the distal third the cirri gradually taper to a point. There are no dorsal processes. The terminal claw is small and conical.

The radials are short, about 4 times as broad as long in the median line. The IBr_1 are about 4 times as broad as long in the median line, moderately arched dorsally, with the laterodistal angles broadly rounded off; the distal border is incised by a proximal process from the axillary. The IBr_2 (axillaries) are about as long as broad with all the sides rather strongly concave, the distal and proximal angles equal and similar, and the synarthrial tubercles broad and rounded.

The IBr series and arm bases in general resemble those of the smaller and more slender specimens of *Leptometra phalangium.*

The 10 arms are about 80 mm. long.

Syzygies occur between brachials 3+4, 9+10, and 16+17, and distally at intervals of 3 or 4 muscular articulations.

P_1 is very slender and delicate, 5 mm. long, with 11 or 12 segments, of which the first is broader than long, the second is slightly longer than broad, the third is twice as long as broad, and the following are much elongated. P_2 is similar to P_1, 6.5 mm. long, with 13 to 15 segments. P_3 is 10 mm. long, with 15 to 16 segments, which after the third become very greatly elongated; the fourth to seventh bear a fusiform gonad. The following pinnules are similar to P_3, the gonad disappearing after P_8. The distal pinnules are extremely slender, 15 mm. long, with about 22 segments, which beyond the second are very greatly elongated with swollen articulations.

Locality.—*Gauss* (German South Polar Expedition) station in the vicinity of Gaussberg (lat. 66°02′ S., long. 89°38′ E.); 2725 meters; February 24, 1903 [A. H. Clark, 1915] (1, Berl. M.).

EOMETRA WEDDELLI John

Eometra weddelli John, *in* Vaney and John, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, pp. 668–670 (Weddell Sea, 3426 meters; description; comparison with *E. antactica*); fig. 2, p. 669.—Tortonese, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4 (depth range).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56.

Diagnostic features.—The centrodorsal is a third again as wide at the base as it is high; the cirrus sockets are XXII–XXVII, the cirri about 18 mm. long, probably with about 18 segments, of which the fifth to eighth are four times as long as broad; the lateral corners of the radials are produced into interradial processes alongside the proximal two-thirds of the IBr_1; P_1 has 10 segments, tapering evenly, the fourth and fifth segments are three times as long as broad; P_3 is between half again and twice as long as P_1.

Description.—The centrodorsal is conical, with slightly rounded sides. The base is a third again as wide as it is high, the diameter being 3 mm. The cirrus sockets are arranged in 10 slightly irregular columns, their number is XXII–XXVII. The dorsal pole is smooth and rounded.

Only a single detached cirrus was found. This has 18 segments and measures about 18 mm. in length. After the first two segments, all are longer than wide, the fifth to eighth, which are the longest, being four times as long as broad. The distal segments become progressively shorter. The distal ends of the elongated segments are slightly wider than the proximal ends but there are no dorsal processes. The terminal claw is short, curved and hyaline at the tip. There is no opposing spine.

The lateral corners of the radials are produced into long interradial processes running up alongside the IBr_1 for about two-thirds or more of their length. In the midline the radials are only a quarter as long as wide, but laterally they are four-fifths as long as wide. The IBr_1 are narrower than the radials and the IBr_2 (axillaries) which incise them quite deeply. The axillaries are about as long as wide, with all four sides concave.

Syzygies occur between brachials 3+4, 9+10 (exceptionally 10+11), and 15+16 or 16+17. A detached distal part of an arm shows syzygial pairs separated by two brachials.

The first brachials are short and separated by the distal projection of the axillary. They are fairly deeply incised by the second brachials, which are roughly triangular and longer than broad. The first syzygial pair is about as long as broad. The brachials between the first two syzygies are rectangular and broader than long. Between the second and third syzygies the brachials are wedge-shaped and about as long as broad. Distally they become relatively longer. The arm bases and arms are quite smooth.

P_1 of a small specimen is complete. It has 10 segments tapering evenly from the base to the tip and measures 2.5 mm. in length. The first segment is slightly longer than broad, the rest increasing in relative length. The fourth and fifth are three times as long as broad.

P_2 of that specimen is broken. An incomplete P_2 of a larger specimen has eight segments and is 4.5 mm. long.

P_3 of the small specimen which is nearly complete has eight segments and is 4 mm. long, the third segment being four times and the fourth five times as long as broad.

All the syntypes are broken. The largest measures 15 mm. from the dorsal pole to the second syzygy, which is a little more than in the type specimen of *E. antarctica*, where the total length is estimated at about 80 mm.

Locality.—Scotia, March 18, 1903; Weddell Sea, S.E. of the South Orkney Islands (lat. 62°10′ S., long. 41°20′ W.); 3426 meters (3, B.M.; 5, Roy. Scottish M.) [Vaney and John, 1939].

Genus CARYOMETRA A. H. Clark

Adelometra (part) A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 212 (occurs in the West Indies), p. 236 (*A. tenuipes* sp. nov.); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 13 (West Indies and Indo-Pacific), p. 16 (in key); The Danish *Ingolf*-Exped., vol. 4, pt. 5, Crinoidea, 1923, p. 42 (range), p. 53 (in key).

Coccometra (part) A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41.

Psathyrometra (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 91, No. 4, 1934, p. 1.

Caryometra A. H. CLARK, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 247 (diagnosis; type species *Adelometra tenuipes* A. H. Clark, 1908); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 142 (in key; *C. monilicirra, atlantidis, spinosa, alope* and *lisa* spp. nov.).—GISLÉN, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54, footnote.

Cariometra A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 156.

Diagnosis.—A genus of Zenometrinae including small to medium-sized species, with the arms up to 70 mm. long, in which the conical centrodorsal is without interradial ridges, grooves or spaces, the 10 or 15 columns of cirrus sockets not distinctly segregated into radial groups; the peripheral cirri have 22 to 35 much elongated segments; the elements of the division series and the brachials have smooth or slightly spinous borders; P_1 has 10 to 24 segments of which the outer ones are elongated; P_2 has 10 to 15 segments; P_3 is similar or shorter.

Type species.—*Adelometra tenuipes* A. H. Clark, 1908.

Geographical range.—Cuba and Puerto Rico and ? southward to Grenada.

Bathymetrical range.—From 338 (?165) to 777 (?914) meters.

Remarks [emended from those for *Adelometra* including *Caryometra*, by A.M.C.].—In 1908 Mr. Clark described a new species from off Cuba under the name *Adelometra tenuipes*.

In 1912 Dr. Clemens Hartlaub described *Antedon liarthra* from a much-mutilated specimen dredged by the *Blake* off Grenada. Its identity is uncertain but Mr. Clark believed latterly that it may be the same as his *Caryometra atlantidis* described in 1940. Hartlaub also described *Antedon arcana* from a *Blake* specimen of unknown locality in the Caribbean region. Mr. Clark subsequently believed this to be a synonym of *Adelometra tenuipes* although in his *Ingolf* report he listed them separately.

In 1934 Mr. Clark described and figured *Psathyrometra acuta* from off Puerto Rico, which he has since recognized as another synonym of *tenuipes*.

The genus *Caryometra*, with type species *Adelometra tenuipes* A. H. Clark, 1908, was diagnosed in 1936. In the following year Mr. Clark added to it a new species, *C. robusta*, from off the Maldive Islands collected by the John Murray Expedition which I [A.M.C.] am now referring to the subfamily Perometrinae.

[Austin H. Clark] In 1939 Dr. Hubert Lyman Clark requested me to describe the species of the family Antedonidae that had been collected in the waters about Cuba by the *Atlantis* of the Woods Hole Oceanographic Institution in 1938. In this collection I was surprised to find no less than five apparently quite distinct new species of the genus *Caryometra—monilicirra, atlantidis, spinosa, lisa,* and *alope*. The only species previously known from the Caribbean region (*tenuipes*) was not represented. On reviewing this genus I found that Hartlaub's *Antedon arcana* and my *Psathyrometra acuta* were synonyms of *tenuipes*, and also that Hartlaub's *Antedon liathra* was probably the same as *Caryometra atlantidis*. My report on this collection was published in Cuba in 1940.

Unfortunately, the specimens collected by the *Atlantis* had been dried, and the few representatives of each species sent to Washington by Dr. Clark were much broken in transit. Most of the records for *Adelometra alope* and *A. atlantidis* and one of the two for *A. spinosa* are based on identifications made by Dr. Clark after receipt of the descriptions of the new species and return of the specimens submitted.

TABLE 14.—*Main numerical characters of the species of* Caryometra

Character	*alope*	*lisa*	*spinosa*	*tenuipes*	*monilicirra*	*atlantidis*
Arm length (mm.)	c. 60	c. 45	–	c. 40	30	c. 70
Cirrus columns	15	15	15	2½ x 5	10	10
Cirri	LXV	LX	XXX	XXX	XXX	XX
Cirrus segments	24–34	17–28	27–34	30–34	19–24	22
Max. length cirri (mm.)	23	30	33	18	9	25
P_1 segments	24	24	21+	20	13	10
P_1 length (mm.)	7	8	8	5	4	5
P_2 segments	13	12+	–	10	12	–
P_2 length (mm.)	6	5	–	5	3	–

[NOTE BY A.M.C.] Finally in 1954, Mr. Austin Clark included the species of *Caryometra* in his fauna list of the echinoderms of the Gulf of Mexico. It can be seen from the table that the first five species tend to form a descending series of size and numbers of segments, though with some values out of phase, such as the relatively smaller number of cirrus segments in *lisa* at a size of about 45 mm. arm length. The proportions of the cirrus segments probably vary to some extent with size, the smaller specimens having relatively longer and narrower segments. It is also likely that there is some variation in the elaboration of the spicules from the distal pinnules. The number of columns of cirrus sockets probably increases with size as well as the total number of cirri. *C. monilicirra* and *atlantidis* appear to be the only well-marked species, distinguished by either very small or very few cirri relative to the size.

In his preliminary report on the comatulids of the *Blake* collection Dr. P. H. Carpenter said that of all the *Antedon* species dredged by the U.S. Coast Survey the one with the widest range within the Caribbean Sea is the little 10-armed *A.* (*Coccometra*) *hagenii*. He wrote that it was obtained by the *Blake* on the Yucatan Bank and also at various stations between Dominica and Grenada at different depths between 75 and 291 fathoms, while Mr. Pourtalès dredged it in great abundance at several localities in the Florida Straits. He noted that the original type specimens were obtained off Sand Key, and several individuals from Barbados and Grenada differ so much both from them and from one another that he was at first inclined to regard them as representing two new species, but a more careful examination did not confirm this impression. It is probable that some, at least, of these specimens represented species of *Caryometra* and *Antedon*.

KEY TO THE SPECIES OF CARYOMETRA

a^1. Cirri with the distal segments shorter than the elongate proximal, the penultimate and more or fewer of those preceding being not more than half again as long as broad, and usually not longer than broad; an opposing spine present; terminal claw as long as, or longer than, the penultimate segment and curved.

b^1. Cirrus sockets arranged in 15 columns, 3 beneath each radial.

c^1. Elements of the division series and brachials without prominently everted and spinous distal ends, these being smooth or at most finely serrate.

d^1. Cirri with 30–35 segments; spicules in the perisome of the pinnules short, slender, usually straight rods with unmodified ends, or occasionally with the distal end bifurcate (Cuba and Puerto Rico; 386 meters) ---------- **tenuipes** (p. 597)

d^2. Cirri with 17–28 (usually 20–25) segments; spicules abundant, slightly thorny, the distal end occasionally forked or expanded and perforated (Cuba; 713 meters) --- **lisa** (p. 603)

c^2. Elements of the division series and lower brachials with prominently everted and spinous distal ends; 24–34 cirrus segments.

d^1. Cirri with the outermost 5 or 6 segments about as long as broad; $\mathrm{IBr_1}$ narrow with distally converging lateral borders beyond which the lateral angles of the axillaries extend for a considerable distance; spicules in the perisome of the pinnules slender and nearly straight rods (Cuba; 338–777 meters) ---------- **alope** (p. 605)

d^2. Cirri with the distal segments longer than broad; $\mathrm{IBr_1}$ broad with parallel lateral borders which are not overhung by the lateral angles of the axillaries; spicules in the perisome of the pinnules stout, branched at both ends (Cuba; 338–484 meters) -- **spinosa** (p. 608)

b^2. Cirrus sockets in 10 columns, 2 beneath each radial; cirri with 19–24 (usually 20) segments, strongly incurved distally, the last 10 or 12 segments about as long as broad, the outer half of the cirri moniliform (Cuba; 466 meters) ---------- **monilicirra** (p. 610)

a^2. Cirri very slender, only slightly curved distally, tapering to a fine point, the outermost segments greatly elongated; no opposing spine; terminal claw minute and conical; 22 cirrus segments (Cuba; ?Grenada; 366–530 meters) ---------- **atlantidis** (p. 612)

CARYOMETRA TENUIPES (A. H. Clark)

Figure 34

[See also vol. 1, pt. 1, fig. 380, p. 301]

Adelometra tenuipes A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 236 (description; *Albatross* station 2348); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 233 (in key; range; references); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (locality).

Antedon arcana Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (in *Blake* collection), p. 402 (description; locality unknown), pl. 9, figs. 1, 2, 5–9, pl. 15, fig. 5.

Coccometra arcana A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 41 (listed).

Psathyrometra acuta A. H. Clark, Smithsonian Misc. Coll., vol. 91, No. 4, Feb. 7, 1934, p. 1 (description; *Caroline* station 102); pl. 1, figs. 1, 2.

Caryometra tenuipes A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, March 14, 1936, p. 247 (listed); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 98 (compared with *C. robusta*); Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 142 (in key), p. 151 (synonymy; description of the spicules); Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—The cirri are long and slender, with 30 to 35 segments, of which the longest proximal are about three times as long as broad and the distal are about as long as broad, arranged in 15 columns at the base of the centrodorsal; the arms are probably 40 to 50 mm. long; P_1 is 5 to 7 mm. long, with about 20 segments; P_2 is about the same length or longer but stouter and stiffer with 10 to 15 segments.

Description.—The centrodorsal is sharply conical, and may be as much as half again as high as broad at the base. In each radial area the cirrus sockets are arranged in 2 lateral columns of about 6 each, of which only the proximal 4 are usually functional; between them in the proximal half of the centrodorsal is a median column of 2 to 4 sockets, beyond which there may be a long and narrow triangular bare area reaching toward the dorsal pole. All of the columns of cirrus sockets are in close contact with their neighbors, and the sockets in adjacent columns usually alternate.

The cirri are about XXX, 30–35, from 13 to 18 mm. long. The first segment is short, the second is about as long as broad, the third is twice as long as its distal width, the fourth to tenth are about 3 times as long as the distal width, and the following gradually decrease in length so that the sixteenth or seventeenth and following are about as long as broad. The elongate proximal segments have their distal ends expanded and funnel-shaped with the dorsal side somewhat produced, sometimes forming a small spine, this feature becoming less marked as the segments become shorter. The fourteenth bears distally a sharp dorsal spine which on the following segments progressively occupies more and more of the dorsal surface after 4 or 5 segments arising from the entire dorsal surface. As the dorsal spines increase in size, the ventral overlap decreases so that on the terminal segments the ventral profile is smooth. The opposing spine forms an equilateral triangle not quite so high as the width of the penultimate segment and situated slightly beyond the center of its dorsal surface. The terminal claw is about as long as the penultimate segment, moderately stout and moderately curved.

The ends of the basal rays are visible as small rhombic areas in the angles of the calyx but are difficult to see as they are not raised above the general surface.

The radials are prominent, about 3 times as broad as long, distally separated interradially by a small cleft. The IBr_1 are short, trapezoidal, narrower distally than proximally, and with the anterior border strongly concave. The IBr_2 are rhombic, about as long as broad, with a rounded proximal prolongation incising the IBr_1 and the distal angle rather broad and truncated. The IBr_2 are rather disproportionately large and nearly twice as broad as the distal ends of the IBr_1.

The 10 arms are probably about 40 mm. long. The first brachials are short, 3 or 4 times as long exteriorly as interiorly, widely separated interiorly by the truncated distal angle of the IBr_2, and incised by the second brachials which are large and roughly

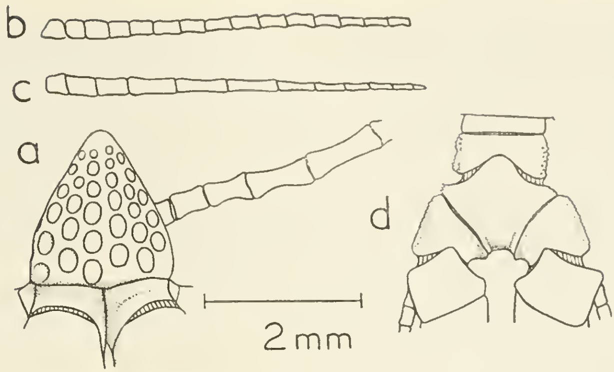

FIGURE 34.—*Caryometra tenuipes* (A. H. Clark), paratype of *Psathyrometra acuta*, U.S.N.M., E. 3123, *Caroline* station 102: *a*, Centrodorsal; *b*, proximal part of P_1; *c*, P_2; *d*, proximal ossicles.

squarish. The third brachials (hypozygals of the first syzygial pairs) are wedge-shaped, much longer interiorly than exteriorly; the fourth brachials (epizygals of the first syzygial pairs) are oblong, rather over twice as broad as long. The fifth to eleventh brachials are oblong or very slightly wedge-shaped, not so long as broad, and the following become more obliquely wedge-shaped and about as long as broad. The distal portion of the arms is lacking.

Syzygies occur between brachials 3+4, again about 9+10 and 14+15, and distally at intervals of 2 or 3 muscular articulations.

P_1 is 5 mm. long, with 20 segments, of which the first 4 or 5 are about as long as broad and the following gradually become elongated with the distal ends more and more prominent until distally the segments are greatly elongated and exceedingly slender with much enlarged articulations. P_2 is of about the same length but stouter and stiffer, with 10 segments, of which the first is about as long as broad, the second is rather longer than broad, the third is 3 times as long as broad or even longer, and the following become progressively more slender and more elongated; the sixth segment bears a small gonad. The following pinnules to about P_6 are similar, but rather shorter. P_7 and the following pinnules are 6 mm. long, little, if at all, more slender than those preceding, but with shorter segments, of which the first is not so long as broad, the second is about as long as broad, and the remainder become progressively elongated. The segments have expanded, overlapping and finely spinous distal ends contrasting with the smooth ends of the segments of the preceding pinnules, and the first 2 are not broadened.

The spicules in the perisome of the pinnules are short, slender, usually straight rods with unmodified ends, or occasionally with the distal end bifurcated. They are approximately a quarter the length of a pinnule segment or less.

Notes.—A reexamination of the type specimen of *tenuipes* showed that I had made a mistake in describing the arrangement of the cirrus sockets on the centrodorsal. They are not in 2 columns in each radial area but in 2 converging lateral columns with an incomplete median column between the proximal halves of the two lateral columns. This discovery at once suggested reexamining the description and figures of Hartlaub's *Antedon arcana*, which previously I had tentatively assigned to the genus *Coccometra*. I find that Hartlaub's description applies perfectly well to *tenuipes*. In his figure 1 on plate 9 the arrangement of the cirrus sockets in 3 columns is shown, but the median column is complete. The delineation of the centrodorsal is not quite correct, however, as is seen by a comparison with the photograph reproduced as figure 5 on plate 15. This photograph shows a specimen more robust and more mature than the type of *tenuipes*, though undoubtedly belonging to the same species.

Antedon arcana was thus described by Dr. Clemens Hartlaub: The centrodorsal is slender-conical with the apex blunt, 2.5 mm. high. There are about 70 to 80 strikingly flat cirrus sockets. The rim of the centrodorsal is deeply concave under each radial. According to Carpenter's drawing reproduced by Hartlaub the cirri are arranged in 15 crowded columns.

The cirrus stumps preserved are confined to the proximal two-thirds of the centrodorsal. The very weak impressions on the distal third make it apparent that from these sockets the cirri were early lost. The cirri decrease in size toward the apex of the centrodorsal, and already in the middle they are only half as stout as those at the base. No entire cirrus is preserved, only a few stumps. Carpenter's figures published by Hartlaub may show cirri belonging to the type specimen. One of the cirri shown has 19 segments which in the proximal half are much elongated, the fourth to seventh being nearly or quite three times as long as broad; the distal end of the elongated segments is expanded and overlaps the base of the segments following. The other cirrus shown has 35 segments and a much larger number of short segments, which are broader than long, in the distal half. Hartlaub said that in both cirri the distal segments are markedly shorter than in *Poliometra prolixa* or in *Hathrometra tenella*, in which also the segments are not so strongly set off from each other.

The radials are visible, and are short-discoidal. The IBr_1 are also short, especially in the middle, where they are deeply incised for the reception of the proximal process from the axillary; there is a weak synarthrial tubercle on the articulation between the IBr_1 and the axillary. The IBr_2 (axillaries) are approximately square with the sides, especially the distal, concave. The anterior angle separates the bases of the first brachials. The IBr series are laterally free, but the IBr_1 shows laterally a trace of "wall-sidedness."

The 10 arms are estimated as about 50 mm. long; the disk reaches as far as the seventh brachial. The brachials are of average length and have a smooth surface. The first brachials are similar to the IBr_1 and are deeply incised by the strong proximal process of the second. The second brachials are markedly longer than the first, about four times as long exteriorly as interiorly, the inner side being very short, and are not in contact with those on neighboring arms. They are distorted rhombic with arched sides, proximally elongated and drawn out to a point. The first syzygial pair (composed of brachials 3+4) is shorter and is longer interiorly than exteriorly. Then follow a number of approximately discoidal, or more precisely trapezoidal, brachials which are broader than long and are in contact only at two points, on one side with an alternating posteriorly directed tooth on the proximal border, on the other side with a distally directed process of the preceding brachial. From the tenth onward the brachials pass over from the markedly trapezoidal form to triangular which, however, is not always fully attained. At the arm tips the brachials become longer than broad.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations. The syzygial pairs are in general short, scarcely exceeding the single brachials in length.

P_1 is 7 mm. long, slender and filiform. The first seven segments are short with the articulations constricted and the outer elongated, about twice as long as broad. P_a is similar, with 21 segments which increase in length toward the tip. The pinnule is extremely slender, becoming as fine as a hair at the tip. The segments are in complete and full contact with each other. In the middle of the pinnule the segments develop dentate distal ends which overlap somewhat the bases of the segments following. P_2 is 10 mm. long, with about 11 to 15 segments of which the two basal are short and those following are greatly elongated; it is quite different in structure from P_1. P_3 is similar to P_2. On P_4 a decrease in the length of the segments is noticeable. It is markedly shorter than the preceding pinnules. Sometimes there are 9 rather long segments and sometimes there are 11 which are shorter than those in the 9-segmented pinnules. The middle pinnules have about 12 segments which, with the exception of the two basal, are elongated. The development of the gonads begins with P_2 on which the gonad is on the fifth and sixth segments. Later it moves basally so that on the pinnule of the twelfth brachial it is on the third to sixth segments and later on the third to fifth. The segments of the genital pinnules are much more rounded than are those of *Hathrometra tenella* and *Poliometra prolixa*.

The perisome of the pinnules is without calcareous spicules.

The disk is about 7 mm. in diameter. Closely placed sacculi are prominent everywhere.

The description of *Psathyrometra acuta* is as follows. The centrodorsal is sharply conical, the sides in profile straight in the proximal two-thirds, thence very gradually and slightly turning outward and running to the pointed tip, higher than broad, 2.7 mm. broad at the base and 3.5 mm. high, measured along the sides interradially. The cirrus sockets are closely crowded all around the centrodorsal, which shows no trace of division into radial areas. There are proximally three columns of cirrus sockets in each radial area; the two outer columns consist usually of 9 sockets which diminish gradually in size from the base to the tip; the median column is incomplete, consisting of 3 or 4 sockets only and ending slightly beyond the middle of the centrodorsal.

The cirri are lacking.

The ends of the basal rays are indicated by low, broad, and inconspicuous tubercles in the interradial angles of the calyx.

The radials are visible as curved bands with parallel sides from six to eight times as broad as long just above the centrodorsal. The anterolateral angles of adjacent radials are separated by a slight notch, the sides of which make an angle of about 90° with each other. There are no subradial clefts, but the line of junction between the centrodorsal and the radials is slightly and narrowly incised. The IBr_1 are about three times as broad as their lateral length with the lateral edges, as viewed dorsally, approximately straight and parallel and separated from those of their neighbors by a narrow interval. The proximal border is straight, but the distal is deeply incised in the median portion by the proximal projection of the axillary, which reaches a point between a third and a half the distance to the proximal edge. The IBr_2 (axillaries) are longer than broad and are more or less rhombic in shape. The proximal sides are rather strongly concave, and the distal sides are broadly S-shaped, curving inward from the lateral angles and thence gradually outward, becoming almost parallel on the sides of the unusually produced anterior angle, which is broadly truncated.

There are 10 arms. The first brachials are at least four times as long exteriorly as interiorly. The proximal border is broadly S-shaped, following the curve of the adjoining border of the axillary. The distal border runs inward from the outer anterolateral angle approximately at right angles to the longitudinal axis of the arm to a point somewhat beyond the midradial line, then curves outward and runs at a very slight angle to the proximal border to the inner anterolateral angle. The second brachials are larger than the first and are irregularly quadrate with their lower angle rather deeply incising the first brachial. The third brachials (the hypozygals of the first syzygial pairs) are low triangular, the inner border being about twice as long as the median length and the outer border being reduced almost or quite to a point. The arms are not preserved beyond the third brachial.

The width of the animal at the level of the third brachials is about 6.5 mm.

A second specimen from the same locality resembles the preceding but is very slightly smaller.

In a third specimen from the same locality the cirri are 10 mm. long, with 27 segments, of which the first is from twice as broad as long to about as long as broad, the second is about as long as broad or slightly longer than broad, the third is about three times as long as the median width, the fourth is still longer, and the fifth and sixth are five or six times as long as the median width; those following decrease in length so that the last 12 are only about one third again as long as broad. The elongate earlier segments have expanded ends, the distal end being somewhat produced, especially dorsally, and slightly overlapping the base of the segments following. On the short and more compressed distal segments the production of the distal edge dorsally becomes narrowed and accentuated so that the dorsal profile of the outer portion of the cirri is strongly serrate, whereas the ventral profile is smooth. The opposing spine is triangular, erect, arising from the entire dorsal surface of the penultimate segment, equal to half the width of the segment in height, and much higher than the production of the distal edge of the segments preceding. The terminal claw is small, conical, and scarcely curved.

P_1 is 4.4 mm. long, with 17 segments, and is slender and evenly tapering. The first three segments are about as long as broad, and those following slowly increase in length so that the seventh is about twice as long as broad, the tenth is about three times as long as the median width, and the outermost are about four times as long as the median width. From the tenth onward the segments are constricted centrally, and the slightly projecting distal edge is finely spinous dorsally. P_2 is 4.3 mm. long, with 12 segments, of which the first is about as long as broad, the second is about one third again as long as broad, the third is somewhat more than twice as long as broad, and those following are greatly elongated with slightly produced and very finely spinous distal ends. The pinnule is about as stout basally as P_1 but tapers rather more rapidly, the distal half being very slender though not flagellate. P_3 resembles P_2 and is of about the same length or slightly shorter, with about 10 segments. It is about as stout basally as P_2

but tapers more gradually and evenly so that it appears stouter in the proximal half. It bears a gonad, which extends from the middle of the fourth to the end of the proximal third of the sixth segment. The next three pinnules are similar to P_3. The distal pinnules are 6 mm. long, with 17 segments which, except for the first two, are much elongated and very slender.

At the time *Psathyrometra acuta* was described, its relationship with my earlier *Adelometra tenuipes* and to Hartlaub's *Antedon arcana* was completely overlooked. I remarked that no species of the genus *Psathyrometra* had heretofore been known from the Atlantic though it is represented in the Indian and Pacific Oceans by 14 species, including one from Panama and the Galapagos Islands. I said that *P. acuta* appears to be most closely related to *P. major* and *P. mira,* which are found on the western coast of the Malay Peninsula and southward to the Lesser Sunda Islands in from 185 to 434 fathoms of water.

Localities.—Albatross station 2348; off Havana, Cuba (lat. 23°10′39″ N., long. 82°20′21″ W.); 386 meters; coral; January 20, 1885 [A. H. Clark, 1908, 1923, 1936, 1940] (1, the holotype, U.S.N.M., 22677). Type locality.

Caroline station 102; northeast of Puerto Rico (lat. 18°51′ N., long. 64°32′ W.); 165–914 meters; March 4, 1933 [A. H. Clark, 1934, 1940] (3, U.S.N.M., E.3121 [type of *Psathyrometra acuta*], E.3122, E.3123).

No locality; *Blake* [Hartlaub, 1912; A. H. Clark, 1923, 1940] (1, type of *Antedon arcana*, ?M.C.Z.).

History.—Under the name of *Adelometra tenuipes* this species was very inadequately described in 1908 from a specimen from *Albatross* station 2348. In 1912 Dr. Clemens Hartlaub described and figured a specimen without locality from the *Blake* collection under the name of *Antedon arcana.* He sent me a proof of his lithographic plate, which had originally been prepared by Carpenter, and I agreed with him that figures 2 and 6 probably were cirri from the specimen shown in figure 1. But I entirely failed to associate *Antedon arcana* with my *Adelometra tenuipes.* In 1923 in a list of the crinoids of the Atlantic basin I included *Adelometra tenuipes* and *Coccometra arcana,* with the localities. At that time I placed more reliance on the short segments of P_1 shown in Hartlaub's figure than on the characters of the centrodorsal. In 1934 I described *Psathyrometra acuta,* which had been dredged by the yacht *Caroline* of the Johnson-Smithsonian Deep-Sea Expedition at station 102, failing to notice its relationship with *Adelometra tenuipes* and *Antedon areana.* In 1936 *Adelometra tenuipes* was made the type of the new genus *Caryometra.*

In a revision of the species of the family Antedonidae occurring in the west tropical Atlantic published in 1940 *Antedon* [*Coccometra*] *arcana,* and *Psathyrometra aeuta* were placed in the synonymy of *Caryometra tenuipes,* though without any explanation.

CARYOMETRA LISA A. H. Clark

Caryometra lisa A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 142 (in key), p. 154 (description; *Atlantis* station 2990), pl. 21, fig. 6; text fig. 5, p. 156.—H. L. Clark, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 12 (*Atlantis* station 2990; notes), p. 13 (taken with *Atelecrinus balanoides*).—A. H. Clark, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).
Caryiometra lisa A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 156, legend for fig. 5.

Diagnostic features.—The cirri are long and very slender, with 17 to 28 (usually 20 to 25) segments, of which the longest proximal are about five times as long as broad and the distal are half again as long as broad, arranged in 15 columns on the centrodorsal; the arms are about 45 mm. long; P_1 is 8 mm. long, with 24 segments; P_2 is about 5 mm. long, with 12+ segments.

Description.—The centrodorsal is conical, 2.2 mm. in diameter at the base and 2.1 mm. from the apex to the rim. The tip, in side view the apical fourth, is papillose, the obsolete cirrus sockets being occupied by stout cylindrical papillae with spinous or roughened tips. The cirrus sockets are arranged in 15 crowded but regular columns of 3 or 4 each; the outer columns of the radial areas are less closely crowded against those of adjacent radial areas than they are against the central column.

The cirri are about LX, 17 to 28 (usually 20 to 25), from 15 to 30 mm. long. The first segment is short, the second is nearly or quite as long as broad, the third is twice as broad as the median width or longer, and the fourth to sixth or seventh are about five times as long as broad. Those following slowly decrease in length so that the terminal are about half again as long as broad. The longer proximal cirrus segments have the distal end slightly enlarged and slightly overlapping. As the segments decrease in length this feature becomes somewhat more pronounced on the dorsal side, forming a narrowly rounded production of the distal dorsal edge that appears as a slight spine in lateral view. The opposing spine is small and poorly developed, terminal in position. The terminal claw is about as long as the penultimate segment, moderately slender and moderately and evenly curved.

The distal edge of the radials is even with the rim of the centrodorsal in the radial line but interradially is much produced anteriorly, so that the anterolateral angles of the radials separate slightly the bases of the IBr_1. The IBr_1 are short, about six times as broad as the median length and twice as long laterally as in the median line; the dorsal surface is slightly concave and the proximal and distal edges are narrowly prominent, but unmodified. The lateral borders curve inward so that the IBr_1 are narrower distally than proximally. The lateral borders make with those of the adjacent IBr_1 an angle of about 45°. The IBr_1 are turned outward so that the mid-dorsal line lies at an angle of about 90° with the dorsoventral axis of the animal. The IBr_2 (axillaries) are rhombic, slightly broader than long, with the distal and lateral angles acute and the distal sides strongly concave. A strong rounded proximal process incises the IBr_1. The lateral angles extend beyond the laterodistal angles of the IBr_1.

The 10 arms are about 45 mm. long. The first brachials are short, about three times as long externally as internally. The proximal and distal edges are parallel from the inner side to the middle line, then diverge rather strongly to the outer side. The inner sides lie at right angles to the midradial line, the inner sides of two adjacent first brachials lying in the same plane. The second brachials are much larger than the first and are irregularly quadrate. Their inner angles are in contact over the procumbent inner sides of the first brachials, forming a large triangular water pore. The first syzygial pair (composed of brachials 3+4) is slightly broader than long and slightly longer interiorly than exteriorly; the sides are slightly concave and the distal border is somewhat thickened and finely spinous. The next four brachials are about half again as broad as long with a concave dorsal surface and sides and the distal edge everted and finely spinous. The second syzygial pair (composed of brachials 9+10) is about as broad as the median length and half again as long outwardly as inwardly; the distal edge is everted and finely spinous. The brachials following are obliquely wedge-shaped, about as long as broad, soon becoming longer than broad and distally elongated and less obliquely wedge-shaped. The distal ends of the brachials are moderately spinous, this feature continuing to the arm tips.

Syzygies occur between brachials 3+4, 9+10, and 14+15 (sometimes 13+14), and distally at intervals of 2 muscular articulations.

P_1 is 8 mm. long, rather slender and flexible throughout, though especially so in the basal third. It is composed of 24 segments, of which the first is short and those following gradually increase in length, becoming about as long as broad on the seventh and twice as long as broad distally. The earlier segments have their corners cut away and all the segments are somewhat constricted centrally with the distal end armed with a row of rather long, stout, sharp spines, which are especially prominent on the segments in the distal half. P_2 is about 5 mm. long, with 12+ segments. In the basal half it is about as stout as P_1 and the segments are similar though somewhat longer; beyond the seventh the segments become very slender and much elongated. All the segments have spinous ends, and the fifth to seventh bear a gonad.

The spicules are difficult to make out satisfactorily from the dried specimen. Along the edge of each pinnule segment there are, on each side, three slender spicules each about a third as long as the pinnule segment directed upward and distally. These spicules are slightly waved or irregularly and very slightly sinuous and are usually, though not always, slightly bent outward at about the middle. The proximal three-quarters is smooth, or, rarely, with a few widely scattered low points; the distal quarter bears a number of short conical points, and may be broadened with a central perforation. Along the outer border of the lappets runs a broad band of shorter, highly irregular, interlacing spicules. These are straight or more or less strongly curved and are rather thickly studded with conical projections, which are often elongated into spines sometimes with forked tips that occasionally are joined into a loop. The spicules may be forked or more or less extensively branched distally, or may bear one or more irregular flangelike lateral expansions pierced by a hole. Rarely in the forked spicules do the two arms of the fork unite distally.

The color (dry) is yellowish white, the cirri white.

Notes.—Dr. H. L. Clark wrote that this apparently uncommon comatulid was taken by the *Atlantis* once in 1938 but it was not seen in 1939. The two specimens are in fairly good condition, the disk 3 or 4 mm. across, the arms 60 mm. long, and the cirri 25 to 30 mm. long, but stouter than those of *C. atlantidis*. Both were taken at station 2990.

Locality.—*Atlantis* station 2990; off Puerto Sagua la Grande, Nicholas Channel, Santa Clara Province, Cuba (lat. 23°15′ N., long. 80°08′ W.); 713 meters; March 14, 1938 [A. H. Clark, 1940; H. L. Clark, 1941] (2, M.C.Z., 1012 [holotype] and one other).

CARYOMETRA ALOPE (A. H. Clark)

Caryometra alope A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 143 (in key), p. 156 (description; *Atlantis* station 2989), pl. 21, fig. 7; text fig. 6, p. 158.—H. L. Clark, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 11 (*Atlantis* stations 2982, 2982C, 2989, 2990A, 3320, 3406, 3463, 3469; notes).—A. H. Clark, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—The cirri are slender and of moderate length, with 24 to 34 (the longer with about 30) segments, of which the longest proximal are nearly four times as long as the median width and the terminal are about as long as broad; they are arranged in 15 closely crowded columns on the centrodorsal; the arms are about 60 mm. long in the holotype; P_1 is about 7 mm. long, with about 24 segments; P_2 is about 6 mm. long, with about 13 segments.

Description.—The centrodorsal is conical, 2 mm. broad at the base and 2.5 mm. from the apex to the midradial edge. The cirrus sockets are arranged in 15 closely crowded columns, 3 in each radial area, each column having 4 or sometimes 5 sockets. The tip of the centrodorsal beyond the functional cirrus sockets is finely spinulose.

The cirri are about LXV, 24–34 (the longer usually about 30), from 10 to 23 mm. long, slender and slightly curved distally. The first segment is twice as broad as long, the second is half again as broad as long, the third is about two and a half times as long as its median width, and the fourth to sixth are nearly four times as long as the median width. The segments following slowly decrease in length so that the outermost five or six are about as long as broad. The third and following segments increase slowly in width distally, and the somewhat produced distal edge overlaps slightly the base of the segments succeeding. The longer earlier segments have the proximal end slightly enlarged. On the third and following segments the central dorsal portion of the distal edge is produced outwardly and distally. Distally this production gradually narrows, at the same time involving more and more of the dorsal surface of the segment. On the outermost segments of the longest cirri it becomes a high, more or less narrow, subcarinate or even sometimes carinate elevation with a convex crest, the dorsal end of which rises for some distance above and overlaps the base of the segment succeeding. The opposing spine is long, conical, sharp, and glassy, about as long as the distal end of the penultimate segment, from almost the entire dorsal surface of which it arises. The terminal claw is longer than the penultimate segment, rather slender and moderately curved.

The radials are just visible beyond the rim of the centrodorsal in the midradial line. Their distal border is very strongly concave, the lateral portions being extended far upward separating the bases of the IBr_1. The IBr_1 are very narrow and bandlike, curved strongly upward laterally, five or six times as broad as the median length. The distal border is produced and armed with rather long fine webbed spines. The IBr_2 (axillaries) are rhombic, broader than long, with all the sides concave, especially the two distal, the distal angle narrow and much produced, and the lateral angles also narrow and produced, considerably overhanging the laterodistal angles of the IBr_1. The distal borders are everted and armed with evenly spaced rather long broadly webbed spines.

The 10 arms are about 60 mm. long. The first brachials are between four and five times as broad as the median width. The inner half tapers from the median line almost to a point, and the proximal and distal edges of the outer half diverge so that the outer side is about twice as long as the length in the median line. The proximal border is slightly everted and smooth, and the distal border is strongly everted and armed with a row of webbed spines. The second brachial is irregularly quadrate, about half again as broad as long. The inner border curves inward over the inner ends of the first brachial forming a conspicuous water pore. The distal border is strongly everted and armed with webbed spines. The first syzygial pair (composed of brachials 3+4) is not quite twice as broad as long, and is half again as long interiorly as exteriorly. The hypozygal is wedge-shaped, about three times as long interiorly as exteriorly. The inner and outer sides of the epizygal are of about the same length, and the distal edge is rather strongly concave, strongly everted, and armed with webbed spines. The next four brachials are twice as broad as long, almost oblong with somewhat concave lateral borders and the central portion of the distal edge raised into a high erect frill of webbed spines. The brachials following the second syzygy are very obliquely wedge-shaped, longer than broad, with the central portion of the distal edge armed with a high frill of webbed spines that disappears after about the twenty-fifth brachial. Distally the brachials become longer with slightly concave sides and smooth ends.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is about 6.8 mm. long, slender, very flexible basally, becoming filiform and less flexible distally. It is composed of about 24 segments, of which the first five or six are about as long as broad with the corners cut away, the eighth or ninth is twice as long as the median width, with the distal end strongly flaring and overlapping and the proximal end somewhat enlarged, and those following slowly increase in length, the distal being very slender and five or six times as long as broad or even longer. The elongated segments have expanded distal ends that overlap slightly the somewhat enlarged bases of the segments succeeding. The short proximal segments have tufts of webbed spines on the convex side toward the arm tip. P_2 is about 5.7 mm. long with about 13 segments, of which the first is broader than long, the second and third are about as broad as long, and those following gradually increase in length, becoming much elongated distally. The pinnule is about as stout basally as P_1, but it tapers more slowly and consequently appears considerably stouter in its distal half. The distal ends of the segments are more or less produced, and some of the proximal segments bear fine spines on the distal ventral border and a single large spine on the distal end of the side toward the arm tip. The slender distal segments have swollen ends, the distal ends being overlapping and finely spinous. The fourth to eighth segments bear a gonad. The distal pinnules are 9 mm. long, with about 20 segments, of which the first two are short and broad and those following rapidly become elongated and very long and slender distally. The distal ends of the segments are overlapping and very finely spinous.

Spicules in the perisome of the pinnules appear to be very scarce. They consist of very slender straight or slightly curved rods with unmodified ends.

The color (dry) is yellowish white, the cirri white.

Notes.—Dr. Hubert Lyman Clark wrote that this long-armed, delicate comatulid seems to be rather uncommon, though it was taken on both *Atlantis* cruises, in 1938 and in 1939. It occurs along the northern coast of Camaguey, Santa Clara, and Matanzas Provinces, Cuba, in 195 to 425 fathoms, and also on the southern coast of the island at Bahia de Cochinos in 185 fathoms. He said that the largest and best preserved of the nine specimens has arms 75 to 80 mm. long.

Localities.—*Atlantis* station 2982; north of Punta Alegre, Camaguey Province (lat. 22°48′ N., long. 78°50′30″ W.); 383 meters; March 11, 1938 [H. L. Clark, 1941].

Atlantis station 2982C; north of Punta Alegre, Camaguey Province (lat. 22°48′ N., long. 78°50′ W.); 383 meters; March 11, 1938 [H. L. Clark, 1941].

Atlantis station 2989; north of Puerto Sagua la Grande, Santa Clara Province (lat. 23°10′ N., long. 80°04′ W.); 658 meters; March 14, 1938 [A. H. Clark, 1940; H. L. Clark, 1941] (1, M.C.Z., 1010). Type locality.

Atlantis station 2990A; north of Puerto Sagua la Grande, Santa Clara Province (lat. 23°16′30″ N., long. 80°11′ W.); 759 meters; March 14, 1938 [H. L. Clark, 1941].

Atlantis station 3320; Bahia de Cochinos, Santa Clara Province (lat. 22°13′ N., long. 81°11′ W.); 338 meters; April 4, 1939 [H. L. Clark, 1941].

Atlantis station 3406; northwest of Cayo Coco, Camaguey Province (lat. 22°42′ N., long. 78°38′ W.); 366 meters; April 29, 1939 [H. L. Clark, 1941].

Atlantis station 3463; Bahia de Matanzas (lat. 23°09′ N., long. 81°26′ W.); 420 meters; May 9, 1939 [H. L. Clark, 1941].

Atlantis station 3469; Bahia de Matanzas (lat. 23°12′ N., long. 81°22′ W.): 777 meters; May 9, 1939 [H. L. Clark, 1941].

Geographical range.—Coasts of Cuba.

Bathymetrical range.—From 338 to 777 meters.

CARYOMETRA SPINOSA A. H. Clark

Caryometra spinosa A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 143 (in key), p. 151 (description; *Atlantis* station 2990; also station 3320), pl. 21, fig. 5.—H. L. Clark, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 12 (*Atlantis* stations 3320, 3326; not found at station 2990; notes).—A. H. Clark, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—The cirri are long and slender, with 27 to 34 segments, of which the longest proximal are six times or more as long as the median width, and the terminal are longer than broad, arranged in 15 columns on the centrodorsal; the brachials have strongly everted and serrate distal ends; P_1 is about 8 mm. long, with 21+ segments; P_2 is much stouter than P_1.

Description.—The centrodorsal is rounded conical, 2.3 mm. wide at the base and 2.5 mm. high. The cirrus sockets are arranged in 15 columns, 3 in each radial area, the columns being separated by ridges which are the appressed lateral portions of the elevated rims of the cirrus sockets. The interradial ridges are not distinguishable from the two radial, so that there are 15 equally spaced columns of cirrus sockets about the centrodorsal. The cirrus sockets are laterally flattened, rather deeply excavated with high rims, and have a central transversely oval elevation pierced by the transversely oval central canal. There are 2 functional cirrus sockets in each column. The obsolete cirrus sockets in the distal half of the centrodorsal are filled with dense tufts of long fine spicules, which give it the appearance of being covered with rather long glassy hairs indistinctly segregated into tufts.

The cirri are XXX, 27–34, from 30 to 33 mm. long, slender and delicate, straight proximally and slightly curved in the distal portion. The first segment is between two and three times as broad as long, the second is about twice as broad as the median length, about twice as long ventrally as dorsally, with a strongly concave distal border, and the third is from two to three times as long as its median width with a slightly expanded proximal and much expanded distal end. The succeeding segments rapidly become elongated, the sixth and following being six times as long as the median width or even longer, gradually increasing in width in the distal half so that the produced distal edge overlaps the base of the segment succeeding. On the third and following segments the median dorsal portion of the distal edge is produced into a point which slowly increases in length and prominence, becoming a distally directed dorsal spine. The distal overlapping ends of the segments have a narrow glassy border which is widest in the dorsal half where it runs to the dorsal spine. In the distal third of the cirri the segments gradually decrease in length so that the ninth from the end of the cirrus is about twice as long as broad, and the penultimate is only slightly longer than broad. The opposing spine is conical, glassy, arising from most of the dorsal surface of the penultimate segment and with its apex in the same line as the distal border of that segment. The terminal claw is somewhat longer than the penultimate segment and is moderately and evenly curved.

The radials are visible as narrow strongly curved bands above the rim of the centrodorsal. Each radial is separated from those on either side by a V-shaped notch. The IBr_1 are short, about six times as broad as long in the median line, with the lateral borders about twice as long as the median length. The IBr_2 (axillaries) are rhombic, about as long as broad, with the distal angle produced and acute and the distal sides strongly concave. The distal edges of the IBr_1 and IBr_2 and the lateral portions of the proximal edge of the IBr_2 are strongly everted and coarsely and irregularly serrate. The IBr series are well-rounded dorsally and are not in lateral contact.

There are 10 arms. The first brachials are four or five times as long exteriorly as interiorly. The portion from the inner end to the median line is narrow with parallel sides; from the median line to the outer border the proximal and distal edges diverge rapidly. The distal edge is strongly everted and serrate. The second brachials are much larger than the first, irregularly quadrate with a strong rounded proximal process deeply incising the first brachials. The distal edge is strongly everted and serrate. The first syzygial pair (composed of brachials 3+4) is slightly broader than long; the distal border is armed with a row of conspicuous and rather long and broad more or less webbed spines. The next five or six brachials have the distal edge very strongly spinous, but on those following the distal edge is smooth and not produced.

Syzygies occur between brachials 3+4 and 10+11, or 3+4, 9+10, 13+14, and 16+17, in the two arms preserved beyond the base.

P_1 is about 8 mm. long, slender and becoming very delicate and filiform distally, with 21+ segments. The first five segments are roughly about as long as broad with broadly rounded angles and small tufts of spines on the middle of the distal ends. The following segments rapidly become elongated, those in the distal third of the pinnule being five or six times as long as broad with expanded and overlapping distal ends. P_a is similar to P_1. P_2 and the following pinnules are much stouter than P_1—about twice as broad in the proximal portion—but only the bases are preserved. The earlier segments bear a conspicuous broad spine or tuft of spines at the distal end on the side toward the arm tip.

The spicules in the perisome of the pinnules are conspicuous and very characteristic. There is only a single row. The spicules are long, about two-thirds as long as the pinnule segments, rather slender, and abruptly bent or curved upward at a slight angle at about the middle. In some cases the upper branch of the bifurcation bears two long spines on the outer side and ends in a shortly bifurcated tip while the lower branch, which is about half as long as the upper, bears a single spine about half as long as the spines on the upper branch and ends in a bifurcated tip; the upper branch of the bifurcation is nearly a quarter the length of the spicule. In other cases the upper branch of the bifurcation bears two processes each with a bifurcated tip and itself ends in a bifurcated tip, while the lower bears one branch with a bifurcated tip, or is without a lateral branch.

This proximal bifurcation of the spicule with the upper branch more developed than the lower is, so far as I am aware, unique. The distal ends of the spicule bifurcate, the branches of the fork being from a third to half as long as the distance from the bifurcation to the central angle of the spicule. The upper branch of the fork is smooth and ends in a sharp point; the lower branch, which is slightly longer, bears in its outer half many slender spines projecting from it at right angles. In the proximal portion of the pinnule the upper branch of the bifurcation usually bears spines on the upper half and the lower branch bears a long, downward pointing, sharp spine at about the middle, or is itself bifurcated. At the pinnule tips the spicules become reduced to long slender rods curved slightly in the middle with the lower end bifurcated, the branches of the bifurcation being very short, and the upper end undivided and sharply pointed and bearing a few small lateral spines. There are occasional, though rare, modifications. At the pinnule base the earliest spicules are often somewhat curved or sinuous simple rods pointed at the lower end and somewhat roughened at the distal end. One spicule was found in the shape of a Y with all the branches of equal length.

The color (dry) is yellowish white, the perisome brown.

Notes.—Dr. Hubert Lyman Clark said that this is another scarce novelty taken only in 1939, and then only in the Bahia de Cochinos on the southern coast of Santa Clara Province, Cuba, in 185 to 265 fathoms (*Atlantis* stations 3320 and 3326). The more or less everted minutely spinous upper margin of the brachials and the extremely long (35 to 45 mm.) cirri are distinctive. In none of the five specimens are any of the arms approximately whole, but the fragments indicate that they were at least 75 to 80 mm. long in life. Dr. Clark said that the holotype came from station 3320, not 2990 as stated by me. The species was not found at station 2990.

Localities.—*Atlantis* station 3320; Bahia de Cochinos, south coast of Santa Clara Province, Cuba (lat. 22°13′ N., long. 81°11′ W.); 338 meters; April 4, 1939 [A. H. Clark, 1940; also given by error as station 2990; H. L. Clark, 1941] (2, the holotype [M.C.Z., 1014] and one other). Type locality.

Atlantis station 3326; Bahia de Cochinos (lat. 22°09′ N., long. 81°09′ W.); 484 meters; April 4, 1939 [H. L. Clark, 1941].

Geographical range.—Known only from Bahia de Cochinos on the south coast of Santa Clara Province, Cuba.

Bathymetrical range.—From 338 to 484 meters.

CARYOMETRA MONILICIRRA A. H. Clark

Caryometra monilicirra A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 143 (in key), p. 144 (description; *Atlantis* station 3435), pl. 21, fig. 1; text figs. 1, 2, p. 147.—H. L. Clark, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 12 (*Atlantis* station 3435; notes).—A. H. Clark, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—The cirri are short, strongly curved in the distal half, with 19 to 24 (usually 20) segments, of which the longest proximal are five or six times as long as the median width and the distal are about as long as broad, arranged in 10 columns on the centrodorsal; the arms are 30 mm. long in the holotype; the brachials have prominently everted and spinous distal ends; P_1 is 4 mm. long, with 13 segments; P_2 is 3 mm. long, with 12 segments.

Description.—The centrodorsal is rounded conical with slightly convex sides, 1.2 mm. broad at the base and about the same distance from the apex to the rim. The cirrus sockets are arranged in 10 closely crowded columns of from 2 to 4 (usually 3) each; the pairs of columns in each radial area are not separated from those in adjacent radial areas. The apical portion of the centrodorsal bears a number of cylindrical papillae apparently occupying obsolete cirrus sockets.

The cirri are about XXX, 19–24 (usually 20), the longest 9 mm. long; all the cirri are strongly incurved in the distal half. The first segment is about twice as broad as long, the second is not quite so long as the width of the expanded distal end, the third is somewhat over three times as long as the median width, or twice as long as the width of the expanded distal end, and the fourth, or fourth and fifth, are between five and six times as long as the median width. Those following decrease rather rapidly in length, the last ten or twelve being about as long as broad. The earlier segments have the proximal end slightly expanded and the distal end much expanded and flaring, somewhat more so on the dorsal than on the ventral side, the free edge that overlaps the base of the segment following being finely serrate. The short outer segments are half again as broad distally as proximally. The ventral profile is gently and almost regularly concave; the dorsal profile is straight in the proximal half or third, then strongly convex, so that the dorsal distal end is about a third the width of the base of the segment succeeding below it. The dorsal extension of the distal ends of the outer segments is rounded and not carinate, and is finely spinous with often a somewhat enlarged central spine. On the outer segments the entire distal edge is produced and overlapping with a glassy border, though this is much less conspicuous in the lateral and ventral portions than dorsally. The opposing spine is long, slender, conical, and erect, terminally situated, reaching a height about equal to the distal width of the penultimate segment and arising from nearly the entire dorsal surface of the segment. The terminal claw is somewhat longer than the penultimate segment and is rather slender and moderately curved. The curious knobby appearance of the cirri in their outer portion is very characteristic. The surface of the cirrus segments is marked with very numerous fine spots.

The distal border of the radials is just visible beyond the rim of the centrodorsal, from which their outer surface extends outward at right angles to the dorsoventral axis. In the interradial angles the radials are produced distally, separating the bases of the IBr_1; the laterodistal angles of the radials are separated by a slight notch. The IBr_1 are short, over six times as broad as long in the midradial line, slightly longer laterally then in the midline. They are entirely separated laterally, but their lateral borders are parallel. The dorsal surface is concave. The proximal border is prominent, but smooth. The distal border is slightly produced and finely spinous. The IBr_2 (axillaries) are rhombic, short and broad, half again as broad as long, with the distal edges strongly and the proximal borders less strongly concave. The distal borders are everted and spinous, this spinous eversion having a somewhat stronger curve than the distal edge; the outer portion of the proximal borders bears a few minute spines. The sharp lateral angles of the axillaries are in contact laterally, forming an irregular water pore beneath them.

The 10 arms are 30 mm. long. The first brachials are about three times as long exteriorly as interiorly. From their inner ends the proximal and distal borders run almost parallel to the midline, then diverge rapidly to the outer border. The proximal border is slightly everted but unmodified. The distal border is everted and armed with a frill of webbed spines. The inner ends of two adjacent first brachials diverge at an angle of 90°. The second brachials are much larger than the first and are irregularly quadrate. The distal border is everted and strongly spinous, and there are some smaller spines on the inner and outer ends of the proximal border. The first syzygial pair (composed of brachials 3+4) is slightly longer than broad, oblong or very slightly longer interiorly than exteriorly; the distal border is everted and strongly spinous, and there is a line of lower spines just below the syzygial line. The next four brachials are slightly broader than long, roughly oblong, with the central portion of the distal edge everted and strongly spinous. The brachials following the second syzygy are very obliquely wedge-shaped, longer than broad, with the central portion of the distal edge bearing a frill of spines which gradually diminishes in width and height and disappears at about the middle of the arm, though it may be represented in the outer portion of the arm by a few small glassy spines on the distal edge of the brachials. The brachials following the third syzygy are obliquely wedge-shaped, longer than broad, gradually becoming elongated distally.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is 4 mm. long, slender and gradually tapering, becoming filiform distally. It is composed of 13 segments, of which the first is short, the second is about as long as broad, the third is half again as long as broad, the fourth is twice as long as broad and the fifth is nearly four times as long as broad. The segments following rapidly become longer, and exceedingly elongated and slender distally. The second and third segments have a prominent tuft of spines on the side toward the arm tip, and those following have flaring and spinous distal ends. P_2 is 3 mm. long, with 12 segments, of which the first is broader than long, the second is about as long as broad, the third is half again as long as broad, and those following rapidly become elongated, the distal being excessively long and slender. The second, third, and fourth segments have a coarse spine on the distal dorsal end, and those following have overlapping and spinous distal ends. The pinnule is somewhat stouter basally than P_1, but tapers more rapidly in the basal third. The pinnules immediately following appear to resemble P_2.

The spicules in the perisome of the pinnules are long, about two-thirds the length of a pinnule segment, and are slightly bent in the middle. The proximal half, lying parallel to the pinnule segment, is usually slightly swollen. The lower end is pointed. The upper end carries several sharp spines of various lengths at right angles to the shaft, of which the most proximal are the longest. Occasionally the first or second spine on the lower side is enlarged and greatly elongated, nearly half the length of the entire spicule, and recurved so that its distal end, which lies along the pinnule segment, is parallel to the main shaft. Very rarely the distal end of the spicule is bifurcated, the bifurcation having short branches.

The color (dry) is yellowish white, the perisome brown.

Notes.—Dr. Hubert Lyman Clark said that this seems to be a rare species for it was not taken in 1938 and only once in 1939. A single specimen with arms about 25 mm. long and the cirri 7 or 8 mm. long was dredged at station 3435. It is easily distinguished by the curious short and almost moniliform cirri.

Locality.—*Atlantis* station 3435; north of Caibarien, Santa Clara Province, Cuba (lat. 23°05′ N., long. 79°25′ W.); 466 meters; May 2, 1939 [A. H. Clark, 1940; H. L. Clark, 1941] (1, M.C.Z., 1013 [holotype]).

CARYOMETRA ATLANTIDIS A. H. Clark

?*Antedon liarthra* HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 399, pl. 7, figs. 8–10, pl. 15, fig. 1.

Caryometra atlantidis A H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p 142, p. 143 (in key), p. 148 (description; *Atlantis* stations 3391, 3394, 3412), pl. 21, figs. 2–4; text fig. 3, p. 149.—H. L. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 11 (*Atlantis* stations 2960, 2963D, 2983A, 3385, 3386, 3389, 3391, 3392, 3393, 3394, 3401, 3404, 3405, 3412, 3413, 3416, 3421, 3427; notes).—A. H. CLARK, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Diagnostic features.—The cirri are long, very slender, scarcely curved distally, tapering to a fine point without an opposing spine, with 22 segments, of which the longest proximal are about six times as long as the median width and the distal are much longer than broad, arranged in 10 columns on the centrodorsal, large specimens with incipient radial columns; the arms were probably about 70 mm. long in the holotype; P_1 is 5 mm. long, with 10 segments; P_2 appears to resemble P_1.

Description.—The centrodorsal is low conical, broader at the base than high, with the apex slightly blunted. The apical third is free of cirrus sockets and is finely roughened. The cirrus sockets are arranged in two columns of 2 each in each radial area. The two columns in each radial area are somewhat closer together than the columns of adjacent radial areas. The upper cirrus sockets are oval, the lower egg-shaped with the more pointed end downward. They are rather deep with a rather high and broad raised rim, and the central portion of the median cavity is abruptly raised into a transversely oval elevation. The sockets in each column alternate with those in the columns adjacent.

The cirri are XX, 22, 25 mm. long. They are slender, and in the distal third taper to a fine point. The first segment is more than twice as broad as long, the second is shorter dorsally but longer ventrally, and the third is about twice as long as the median width and is centrally constricted. Those following are greatly elongated, about six times as long as the median width; they increase slowly in width toward each end, more toward the distal than toward the proximal. After the middle of the cirrus the segments become slightly shorter with the dorsal and ventral profiles straight and parallel; on the last four segments the length progressively increases and the segments taper distally, so that the last segment ends in a fine point terminated by a minute, conical, glassy terminal claw. The cirri are entirely smooth dorsally.

The ends of the basal rays are visible as broad low rhombic elevations in the interradial angles.

The radials are short, about six times as broad as long, with the distal border straight. Interradially their laterodistal angles are separated by a notch, the sides of which make approximately a right angle with each other. The IBr_1 are about four times as broad as the median length, half again as long interradially as in the midradial line. Their lateral edges are parallel and are widely separated from those of their neighbors. The proximal, distal, and lateral borders are smooth and unmodified. The IBr_2 (axillaries) are rhombic, half again as broad as long; the lateral angles overhang the laterodistal angles of the IBr_1. The distal edges are slightly and evenly concave and the distal angle is sharp, the lines from the distal apex to the lateral angles making with each other an angle of about 120° or somewhat more.

The 10 arms are probably about 70 mm. long. The first brachials are about three times as broad as the median length, half again as long exteriorly as interiorly, with the distal border slightly and evenly concave. The inner proximal angles are just in contact over the distal angle of the axillary, and the inner sides make with each other an angle of about 70°. The second brachials are nearly twice as large as the first, with the proximal border smoothly and rather strongly convex. The first syzygial pair (composed of brachials 3+4) is about half again as long as broad, slightly longer interiorly than exteriorly. The fifth brachial is nearly as long as the preceding syzygial pair, but the sixth, seventh, and eighth are only slightly longer than broad. The second syzygial pair (composed of brachials 9+10) is not quite twice as long as broad; the syzygial line is slightly raised. After the second syzygy the brachials become very obliquely wedge-shaped and longer than broad. The ends of the brachials are unmodified.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 or 4 muscular articulations.

P_1 is 5 mm. long, moderately slender, composed of 10 segments, of which the first is about as broad as long, the second is twice as long as broad with the distal end slightly enlarged, and the third is three times as long as broad or longer; those following are greatly elongated and slender except the last, which is minute, not a fourth as long as that preceding. P_2 appears to resemble P_1.

The broadly exposed interbrachial areas of the disk bear numerous small rounded granules in the central portion.

In the perisome of the pinnules there are two rows of spicules, an inner along the pinnule segments and an outer, of which the inner ends overlap the outer ends of the spicules of the inner row. The spicules of the inner (lower) row are about half as long as the pinnule segments, slender, and bent, or more or less broadly curved in the middle. The lower ends are occasionally bifurcated, the long pointed branches of the bifurcation diverging at an angle of about 90°, and the upper or outer ends are more or less broadened, sometimes fanlike, and pierced with from one to three holes, more rarely simply or twice bifurcated, the bifurcations with short branches. The outer spicules are about half as long as the inner and correspondingly more slender. The lower end is usually pointed, rarely bifurcated; the upper (outer) end is expanded into a delicate network usually surrounding three large holes; sometimes there are only two holes, or a single hole, and rarely the tip is simply doubly bifurcated.

The color (dry) is yellowish white, the cirri clearer white, the perisome brown.

Notes.—The largest specimen from station 3391 has the arms about 90 mm. long. There are three columns of cirrus sockets in each radial area on the centrodorsal, but one column is represented by only a single socket. P_1 is 6 mm. long with 10 to 12 segments. P_2 is 5 mm. long, about as stout basally as P_1, smooth and tapering evenly to a delicate tip, with 12 segments, of which the first is oblong, half again as broad as long, the second is half again as long as broad, the third is twice as long as broad, and those following gradually elongate, becoming about six times as long as broad distally. The distal pinnules are long and slender, 11 mm. long, with 22 segments.

In the specimens from stations 3391 and 3412, which are preserved in alcohol, the perisome is very light, grayish or dirty yellowish white, and translucent. The interbrachial areas are naked or more or less thickly beset with small calcareous granules, especially in the central portion. The distal intersyzygial interval is usually 3, though frequently 4, muscular articulations.

Dr. H. L. Clark wrote that this dainty little comatulid is apparently common on both coasts of Cuba, as it was taken by the *Atlantis* in 1938 and even more frequently in 1939. It was found at no fewer than 18 stations at depths of from 200 to 290 fathoms. He said that it is extremely delicate and fragile, and all of the 44 specimens are badly damaged. Not one is approximately whole, but it is possible to determine that large specimens have the disk 3 or 4 mm. across, the arms 90 to 100 mm. long, and the threadlike cirri 25 to 30 mm. long. The color is apparently white or pale yellowish. The holotype (M.C.Z., 1011) is from station 3394 in the Old Bahama Channel off Camaguey, in 200 fathoms.

Hartlaub's *Antedon liarthra* undoubtedly belongs to the genus *Caryometra*, but the specimen from which it was described was so very badly broken as to render its recognition a matter of considerable uncertainty. The columnar arrangement of the cirrus sockets on the centrodorsal is not shown in the drawing (plate 7, figure 8) but is evident in the photograph (plate 15, figure 1). Hartlaub gives the cirri as about XXXV, and the best preserved P_1 as 10 mm. long, with 13 segments; the total length of P_1 was estimated as about 12 to 13 mm.

From the description and figures there is seen to be a fairly close agreement between *Antedon liarthra* and *Caryometra atlantidis*, but the type of the former is larger with the centrodorsal 4.3 mm. in diameter, with more numerous cirri, and with a longer P_1 which is composed of more numerous segments. It is probable that *Antedon liarthra* is the same as *Caryometra atlantidis*, but this is not demonstrable on the evidence at present available. *Antedon liarthra* was dredged by the *Blake* at station 262 off Grenada in 92 fathoms in a bottom temperature of 62° F. (16.7° C.).

Hartlaub described *Antedon liarthra* as follows: The centrodorsal is conical with a sharp apex and a broad base. The apex of the centrodorsal is free of cirri for a short distance. There are about 35 cirrus sockets which are small, from which it is inferred that the cirri are slender. All the cirri have been lost.

Only a small portion of the radials is visible. The IBr_1 are slightly trapezoidal, broader than long; the proximal border is broader than the distal border, and the latter is narrower than the axillary. The distal border has a small vertical elevation which, together with the point of the distal border of the axillary, makes a synarthrial tubercle on the articulation between the two ossicles. The IBr_2 (axillaries) are only a little longer than the IBr_1, rhombic rather than hexagonal as the lateral edges are short. The IBr_1 and the axillaries are entirely free laterally.

The 10 arms are probably about 90 mm. long. The rather short first brachials are interiorly in contact only by their lower corners. They are somewhat longer exteriorly than interiorly. The second brachials are pentagonal, markedly longer than the first in the median line and with the proximal border produced into a median angle. There is a synarthrial tubercle on the articulation between the first two brachials. The first syzygial pair (composed of brachials 3+4) is squarish or often somewhat broader than long. The brachials following are shorter than the syzygial pair and are slightly trapezoidal with somewhat oblique articulations. From the fragments of the arms that have been preserved it may be inferred that the dorsal surface of the brachials is never triangular but remains trapezoidal or bluntly wedge-shaped. Toward the end of the arms the brachials, with the exception of the very long syzygial pairs, appear to be as long as broad. The arms everywhere are entirely smooth. The ambulacral surface of the arms has a rather characteristic appearance as a result of the way in which the musculature is interrupted, in the proximal arm region through fine, in the distal region stronger tongue-shaped or bandlike lateral processes of the brachials which extend inward to the middle of the ambulacral side.

The first syzygy is between brachials 3+4; on an arm preserved as far as the fourteenth brachial the second syzygy is between brachials 9+10 and the third is between brachials 13+14. The distal intersyzygial interval is usually 4, less commonly 3, and very seldom 5 muscular articulations.

P_1 is estimated to have about 15 segments with only one short basal segment; the second segment is already somewhat longer than broad, and the following segments are slender and greatly elongated, up to 1.5 mm. in length. No pinnule is entire. The best preserved is 10 mm. long, with 13 segments. The length of an uninjured pinnule is estimated as about 12 to 13 mm. No P_a is entire. The best preserved has 10 segments, of which the first is short and those following are as in P_1. Apparently P_a is not shorter than P_1. P_2 is in no case entire. The best preserved also has elongated segments with the exception of the two short basal ones. There are in all 7 segments preserved. Apparently P_2 is smaller and more slender than P_1. Of the later pinnules, of which a few segments are preserved, it can only be said that the two basal segments are short, those following elongate. In addition it may be noted that on the distal arm fragments the pinnules show a peculiar condition in the second short basal segment. The distal border is not straight but is drawn out into a small proximally directed point; besides, the articulation between the first and second segments is broader than the others.

The disk is 9 mm. in diameter, unplated and not incised. The arms are free beyond the third brachial. Sacculi were not found.

In color the skeleton is uniform white, the disk gray, and the brachial ambulacra yellow brown.

The single specimen upon which this species is based was badly broken, and Hartlaub said that it was only after long hesitation that he decided to describe it. Also, Carpenter to all appearances had considered it as representing a new species, as was shown by the figure he had prepared. Carpenter left no specific designation with the specimen, only the *Blake* label having been found with it. But Hartlaub considered that the characters given in his description were sufficient to justify the establishment of a new species.

Localities.—Atlantis station 2960; south coast of Cuba; Bahia de Cochinos, Santa Clara Province (lat. 22°07′ N., long. 81°08′30″ W.); 493 meters; February 18, 1938 [H. L. Clark, 1941].

Atlantis station 2963D; south coast of Cuba; Bahia de Cochinos, Santa Clara Province (lat. 22°07′ N., long. 81°08′ W.); 402–502 meters; February 25, 1938 [H. L. Clark, 1941].

Atlantis station 3385; Old Bahama Channel north of Camaguey Province, Cuba (lat. 22°33′ N., long. 78°02′ W.); 530 meters; April 26, 1939 [H. L. Clark, 1941].

Atlantis station 2983A; Santaren Channel, north of Santa Clara Province, Cuba (lat. 23°11′ N., long. 79°08′ W.); 429 meters; March 12, 1938 [H. L. Clark, 1941].

Atlantis station 3386; Old Bahama Channel, north of Camaguey Province, Cuba (lat. 22°33′ N., long. 78°11′30″ W.); 402 meters; April 26, 1939 [H. L. Clark, 1941].

Atlantis station 3389; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°32′ N., long. 78°08′ W.); 402 meters; April 27, 1939 [H. L. Clark, 1941].

Atlantis station 3391; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°34′ N., long. 78°14′ W.); 402 meters; April 27, 1939 [A. H. Clark, 1940; H. L. Clark, 1941] (4, M.C.Z.).

Atlantis station 3392; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°35′ N., long. 78°16′ W.); 411 meters; April 27, 1939 [H. L. Clark, 1941].

Atlantis station 3393; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°36′ N., long. 78°19′ W.); 402 meters; April 27, 1939 [H. L. Clark, 1941].

Atlantis station 3394; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°34′ N., long. 78°14′ W.); 366 meters; April 27, 1939 [A. H. Clark, 1940; H. L. Clark, 1941] (3, M.C.Z., including the holotype, 1101). Type locality.

Atlantis station 3401; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°36′ N., long. 78°19′ W.); 429 meters; April 28, 1939 [H. L. Clark, 1941].

Atlantis station 3404; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°37′ N., long. 78°23′30″ W.); 393 meters; April 28, 1939 [H. L. Clark, 1941].

Atlantis station 3405; north of Cayo Coco, Camaguey Province, Cuba (lat. 22°38′ N., long. 78°25′ W.); 429 meters; April 28, 1939 [H. L. Clark, 1941].

Atlantis station 3412; north of Punta Alegre, Camaguey Province, Cuba (lat. 22°49′ N., long. 78°48′ W.); 429 meters; April 29, 1939 [A. H. Clark, 1940; H. L. Clark, 1941] (9, M.C.Z.).

Atlantis station 3413; north of Punta Alegre, Camaguey Province, Cuba (lat. 22°50′ N., long. 78°50′ W.); 393 meters; April 29, 1939 [H. L. Clark, 1941].

Atlantis station 3416; north of Punta Alegre, Camaguey Province, Cuba (lat. 22°50′ N., long. 78°55′ W.); 366 meters; April 30, 1939 [H. L. Clark, 1941].

Altantis station 3421; northeast of Caibarien, Santa Clara Province, Cuba (lat. 22°49′ N., long. 79°07′ W.); 429 meters; April 30, 1939 [H. L. Clark, 1941].

Atlantis station 3427; north of Caibarien, Santa Clara Province, Cuba (lat. 22°52′30″ N., long. 79°20′ W.); 439 meters; May 1, 1939 [H. L. Clark, 1941].

Doubtful locality.—*Blake* station 262; off Grenada (lat. 12°01′45″ N., long. 61°47′25″ W.); 168 meters; bottom temperature 16.66° C.; fine sand; March 1, 1879 [Hartlaub, 1912; A. H. Clark, 1940].

Geographical range.—Coasts of Cuba; ?Grenada.

Bathymetrical range.—From 366 to 530 meters.

History.—In his report on the comatulids of the *Blake* Expedition published in 1912 Dr. Clemens Hartlaub described and figured *Antedon liarthra* from a much-broken specimen from station 262. It is possible that *Antedon liarthra* represents the present species, but there is no definite proof of this.

Caryometra atlantidis was described and figured in 1940 from a specimen from *Atlantis* station 3394. In addition to the type, two other specimens from station 3394 were recorded as well as four from station 3391 and nine from station 3412, and notes on them were given. In 1941 Dr. Hubert Lyman Clark recorded this species from fifteen additional stations and gave brief notes on them.

Subfamily ISOMETRINAE

Isometrinae A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 127 (includes only *Isometra*); No. 16, p. 504 (in key), p. 510 (*Isometra* only); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 196 (in key), p. 239 (includes only *Isometra*); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 49 (in key).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 91, 232; Ark. Zool., vol. 19, No. 32, 1928, p. 11.—JOHN, *Discovery* Reports, vol. 18, 1938, pp. 123, 124, 174; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 206.—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.

Diagnosis [by A.M.C.].—A subfamily of Antedonidae in which the cirrus sockets are arranged in alternating rows on the conical to hemispherical centrodorsal; the cirri are stout and well-developed, the peripheral ones with usually 30 to 40 segments, exceptionally (*Isometra hordea*) up to 75; the cirrus segments are short, the longest being barely longer than the median width, rarely up to twice as long as wide; the division series and lower brachials are always closely apposed with straight sides; the proximal pinnules are relatively short, usually tapering evenly from a wide base, with fairly stout segments not conspicuously expanded and thorny at their distal ends but on the contrary often tapering; P_1 has 5 to 17 segments and may be longer or shorter than P_2 which has 6 to 14 segments; the genital pinnules are particularly characteristic, the mature ones with at least two markedly expanded segments towards their bases forming a brood pouch in the female for the developing young, the species being viviparous; a similar expansion occurs in the males but is longer, involving more segments, and less abrupt; the first genital pinnule varies in position from P_2 to P_7, but the position, within a limit of two or three pinnules, appears to be characteristic of the species.

Geographical range.—Known from the South Atlantic off the southern tip of Brazil southwards to the Falkland-Magellanic region, the Shag Rocks near South Georgia, the South Shetlands, Graham Land and the shores of Antarctica.

Bathymetrical range.—Known from 79 to 1097 meters.

Remarks [by A.M.C.].—In the manuscript Mr. Clark had included *Isometra* in the subfamily Bathymetrinae. He gave no explanation of his reason for this change, presumably made about 1923 when the major part of this work appears to have been written, and as far as I can see his only published intimation of this move is in his report of the crinoids of the Australasian Antarctic Expedition (1937), where he lists *Isometra vivipara* under the heading Bathymetrinae.

It is possible that he was influenced by Mortensen's description (1918) of *Phrixometra*, a genus of Bathymetrinae with a pouchlike marsupium on each genital pinnule of the female, although this does not involve an expansion of the pinnule segments themselves as there is in *Isometra*. However, in my opinion, this analogy does not constitute a sufficient link to justify amalgamation of the subfamilies Isometrinae and Bathymetrinae. Not only do the species of *Isometra* have this very distinctive modification of the segments of the genital pinnules but also the relatively short, stout, tapering oral pinnules of *Isometra* are very different from the slender ones of the Bathymetrinae with their markedly elongate outer segments. The cirri too of *Isometra* are much more stout with relatively shorter segments than those of most species of the Bathymetrinae. In fact, in comparing the subfamilies of Antedonidae, I found the Isometrinae as clearly marked off from the Bathymetrinae as the other subfamilies, if not more so. The new species of *Isometra* collected by the *Discovery* Investigations and B.A.N.Z.A.R.E. show a constancy of characters linking them closely with the older species.

There is evidence that Mr. Clark himself had second thoughts about merging the Isometrinae and the Bathymetrinae, as in the list of species for the Contents of this work, which he made subsequent to Dr. Dilwyn John's *Discovery* Report (1938), the Isometrinae is included separately.

Genus ISOMETRA A. H. Clark *

Antedon (part) P. H. CARPENTER, Proc. Roy. Soc. London, vol. 28, 1879, p. 384, and following authors.

Isometra A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 133 (diagnosis; type species *Antedon lineata* P. H. Carpenter, 1888), p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae); Amer. Nat., vol. 42, 1908, No. 500,

* See also Addenda (p. 836) under 1962.

p. 542 (faunal affinities); No. 503, p. 725 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 603 (faunal affinities); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Heliometrinae); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (range); Die Crinoïden der Antarktis, 1915, p. 145 (synonymy; diagnosis; range), p. 182 (range); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 127 (referred to the Isometrinae); No. 16, p. 510 (only genus in the subfamily Isometrinae).—MORTENSEN, Vid. Medd. Nat. Foren. København, vol. 68, 1917, p. 207 (discussion); Wiss. Ergeb. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, p. 13 (discussion).—A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 239 (only genus in the Isometrinae).—MORTENSEN, Studies in the development of crinoids, vol. 16, 1920, p. 31 (discussion).— BATHER, Nature, vol. 107, 1921, pp. 132, 133 (review of Mortensen).—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 56, 94, 100, 101.—MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, vol. 12, 1928, p. viii. 108 (care of brood).—MORTENSEN, Kongl. Danske Vid. Selsk. Skr., nat. math., ser. 9, vol. 7, No. 1, 1937, p. 63 (comparison of larvae with those of *Lamprometra*).—A. H. CLARK, Sci. Rep. Australasian Antarctic Exped., 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 6 (range).—JOHN, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (brood pouch, sexual differentiation); *Discovery* Reports, vol. 18, 1938, p. 125 (3 new species), p. 127 (only genus in which skeleton is modified by viviparity), p. 130 (4 Antarctic and 2 South American species), pp. 174–175 (*lineata*, the type species, not a synonym of *angustipinna*), p. 184 (covering plates), pp. 190, 192; Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 26.—CUÉNOT *in* Grassé, Traité de zoologie, vol. 11, 1948, p. 55; DAWYDOFF in the same work, pp. 315, 355, 356 (larva).—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.

Type species.—*Antedon lineata* Carpenter, 1888 (*non* Pomel, 1887), renamed *A. challengeri* by A.H.C. in 1907.

Geographical range.—From off the southern tip of Brazil to the Falkland Islands area, the Shag Rocks, the South Shetlands and Graham Land, around the Antarctic continent to the Ross Sea and Enderby and MacRobertson Lands.

Bathymetrical range.—From 79 to 1097 meters.

Thermal range.—From −1.90° C. to +8.30° C.

Salinity range.—From 33.79 to 34.85 parts per thousand.

Remarks [by A.M.C.].—In the manuscript Mr. Clark had included *I. challengeri* (*lineata*) in the synonymy of *angustipinna*. Since John (1938) showed that the two are distinct, although the holotypes were from the same *Challenger* station, I have modified this section accordingly.

No key to the species had been made and I found some difficulty in preparing one, especially since two of the seven species—*challengeri* and *angustipinna*—are known only from single specimens, the holotype of the latter having an arm length of only about 25 mm. It seems to me that *challengeri* is very close to *vivipara* (which has also been recorded from off Uruguay but in less deep water). It appears to differ only in having relatively fewer segments in the first two pinnules at a comparable size.

A study of the range of variation of the species of *Isometra* arising from the attempt to construct a key has forced me to erect a new species, *Isometra johanni*, for the B.A.N.Z.A.R.E. specimens named *graminea* by Dr. Dilwyn John in 1939, which I am unable to reconcile with his original *Discovery* specimens of *graminea*.

Some idea of the relative proportions and variations with size of certain characters can be obtained from table 15, prepared from a number of specimens in the British Museum collections. Some of the data have also been plotted on a scatter diagram (see Addenda, p. 835) to illustrate the relative proportions of P_1 and P_2 in the species where more than one specimen is known.

TABLE 15.—*Details of some specimens of* Isometra *in the British Museum collection*

[See also Table 16, for *I. vivipara*, on p. 635.]

Species	Width at 3+4 (mm.)	IBr_1 to 9+10	Longest cirrus		1st genital pinnule	P_1		P_2	
			Segments	Length (mm.)		Segs.	Length (mm.)	Segs.	Length (mm.)
graminea	1. 2	8. 0	36	14	4, 5	9	3. 8	9	4. 0
	1. 1	8. 0	38	15	(4)5	7(8)	2. 9	7, 8	3. 1
	1. 6	10. 0	37	15	4, 5	9	5. 0	10	5. 6
	1. 1	8. 0	30	c. 12	4(5)	9	3. 0	9	3. 5
	1. 3	8. 8	36	14	4	9	3. 5	10	4. 0
	1. 0	8. 0	–	–	4	8	2. 8	10	3. 2
	1. 2	8. 5	c. 32	13	–	8	3. 0	9	3. 3
flavescens	1. 3	8. 5	29	12	4♂	11	4. 5	7	2. 3
	1. 5	10. 0	32	14	3♂	10	5. 0	8	3. 0
	1. 7	10. 0	33	15	3♂	10	6. 0	8	4. 0
	1. 7	10. 0	35	15	3♂	13	7. 0	8	4. 0
	1. 4	9. 0	30	9	4♂	10	4. 5	6	2. 5
	1. 4	8. 5	27	9	3, 4♀	–	–	6	4. 0
	1. 3	8. 5	34	11	4♀	12	5. 5	7	3. 0
	1. 4	9. 5	–	–	3♀	11	6. 0	8	4. 0
	1. 3	9. 0	32	11	3, 4♀	12	5. 5	8	3. 0
challengeri	1. 5	9. 0	32+	16+	6, 7	8, 9	4. 5	8, 9	3. 5
hordea	2. 6	11. 0	62	30	5	10	3. 5	11	5. 0
	2. 7	11. 5	57	28	5	9	3. 5	10	4. 5
	1. 5	8. 5	41	17	–	7	2. 2	8	3. 2
	3. 0	15. 5	75	47	5	12	5. 0	14	7. 5
	1. 8	13. 5	61	33	5	12	5. 0	12	6. 0
	3. 0	16. 5	58	38	–	11	5. 0	13	7. 5
	1. 7	10. 5	53	25	5	9	3. 5	10	4. 0
angustipinna	1. 1	7. 0	27	9. 5	2, 3	5	1. 8	6	2. 0
								gen.	5. 0
johanni	1. 3	9. 0	33	12	5(6)	10, 11	5. 0	7, 8	3. 0
	0. 9	7. 5	30	11	5	9	3. 5	7	2. 5
	1. 1	8. 5	33	12	(5)6	10, 11	5. 5	8	3. 5

KEY TO THE SPECIES OF ISOMETRA

[by A.M.C.]

a^1. P_2 similar to, or larger than, P_1.

b^1. The first genital pinnule is P_2 or P_3; P_1 and P_2 (when not genital) each with 5 or 6 segments and about 2 mm. long, P_1 slightly smaller (only known from off Uruguay; 1097 meters).
angustipinna (p. 621)

b^2. The first genital pinnule is P_4 or P_5; P_1 and P_2 each with 8 or more segments.

c^1. Cirri XL–LXII, 25–75; in the female the third to seventh segments of the genital pinnules are expanded; a very robust species, most of the specimens taken having the length IBr_1 to Br_9 (inclusive) from 11–16 mm. (from Clarence Island and the South Shetland area; 117–490+ meters) ---------- **hordea** (p. 622)

c^2. Cirri XXVI–XLIII, 28–41; in the female only the third and fourth (rarely also the fifth) segments of the genital pinnules are expanded; a species of moderate size, the length from IBr_1 to Br_9 (inclusive) being 8–10 mm. in most specimens (from Graham Land, Bransfield Strait and the Ross Sea; 130–567 meters) graminea (p. 627)

a^2. P_2 smaller than P_1.

b^1. The first genital pinnule is usually P_5 or P_6 (rarely P_4 or P_7).

c^1. The division series and proximal brachials with a distinct keel in the dorsal midline; longest cirrus segments about twice as long as wide, constricted in the middle and flared at the distal ends (from off Enderby and MacRobertson Lands, 50–60° E.; 209–300 meters). johanni (p. 629)

c^2. No keel on the division series and proximal brachials; cirrus segments not constricted in the middle and the longest ones not much longer than wide.

d^1. P_1 with about 9 segments when the length IBr_1 to Br_9 (inclusive) is 9 mm. (known from off Uruguay; 1097 meters) challengeri (p. 631)

d^2. P_1 with about 12 or 13 segments when IBr_1 to Br_9 (inclusive) is about 9 mm. (from off the southern tip of Brazil to the Falkland-Magellanic region and the northwest Weddell Sea; 79–242 meters) vivipara (p. 632)

b^2. The first genital pinnule is usually P_3 or sometimes P_4 (known from the Shag Rocks west of South Georgia; 177 meters) flavescens (p. 644)

ISOMETRA ANGUSTIPINNA (P. H. Carpenter)

Antedon, sp. P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 384 (*Challenger* sta. 320).

Antedon angustipinna P. H. Carpenter, *Challenger* Reports, Zool., vol. 26, pt. 60, 1888, p. 189 (description; sta. 320), pl. 29, figs. 1–4.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).

Isometra angustipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 133 (listed), p. 134 (the young of *Antedon lineata*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 64 (published references to specimens in the B. M.; *Challenger* sta. 320); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (Antarctic; range); Die Crinoïden der Antarktis, 1915, p. 105 (*Antedon hirsuta* of Andersson, not of Carpenter, near this species; collected by the *Challenger* and recorded as *Antedon lineata*+*A. angustipinna*), p. 107 (in key to antarctic crinoids), p. 146 (synonymy; localities), p. 168 (shallow water antarctic type; Magellanic), p. 192 (further discussion).—Mortensen, Vid. Medd. Nat. Foren. København, vol. 68, 1917, p. 208 (compared with *I. vivipara*); Wiss. Ergeb. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, pp. 13, 14 (compared with *I. vivipara*); Studies in the development of crinoids, 1920, p. 31.—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 11 (pinnules).—John, *Discovery* Reports, vol. 18, 1938, p. 124, pp. 177, 178 (redescription of type specimen; distinct from *lineata*); fig. 14, p. 177.

Diagnostic features.—The cirri are about XXX, with probably up to 30 segments, of which most are flared and the distal ones have a dorsal keel; the first two pinnules are small and similar, with about 6 segments in the unique holotype, but P_2 may be a genital pinnule, in which case it is more than twice the length of P_1.

Description (from John, 1938).—The arms are all broken but were probably about 25 mm. long when complete. The length IBr_1 to Br_9 (inclusive) is 7 mm. and the width at the first syzygy (3+4) is 11 mm.

The centrodorsal is low conical and is almost completely covered by the cirri which number about XXX. The longest remaining cirrus has 27 segments but appears to be immature, according to Dr. John; an apparently mature one with 22 segments has the third to eighth segments longer than broad. The distal ones become shorter, about as long as broad with a slight dorsal keel. Most of the segments are flared at the distal end. The opposing spine is large and the terminal claw curved.

The distal edge of the radials is visible beyond the rim of the centrodorsal. Each IBr_1 is oblong, almost free laterally and strongly incised on the distal border by the IBr_2 (axillary), which is rhombic, broader than long. The division series and proximal brachials have conspicuously flattened lateral faces.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of two muscular articulations. The brachials beyond the fifth have spiny distal edges.

P_1 is very short, about 2 mm. long or slightly less. It has 5 or 6 segments, most, if not all, of which are attached to the disk by a web of tissue. On some of the arms P_2 is similar, with 6 segments and measuring 2 mm., but usually it is a genital pinnule and much larger, 5 mm. long. The third and fourth segments of the genital pinnules are more strongly and less symmetrically expanded than those of *challengeri*, the expansion being greater on the distal side. The gonads are fully developed and appear to be testes.

The arms being broken off rather short, the nature of the ambulacral skeleton is difficult to determine. There appear to be two sets of plates, of which one is of rod-like plates with branched bases and the other of plates which are more fanlike distally. No spicules can be seen in the tentacles.

Remarks [by A.M.C.].—Since Dr. Dilwyn John (1938) has demonstrated that *lineata* (i.e., *challengeri*) is distinct from *angustipinna* and the differences in the two type specimens are not attributable to the great size discrepancy, I have emended the typescript accordingly. When Mr. Clark concluded that the two were synonymous in 1908, no other species, or indeed specimens, of what is now the genus *Isometra* had been fully described, so that nothing was known of the extent of variation.

Both of the holotypes of *angustipinna* and *challengeri* are mature, though the former has an arm length of only about 25 mm., and both are males. The size and number of segments in the first two pinnules are comparable, allowing for the much greater size of the specimen of *challengeri*, but the fact that the first genital pinnule is P_2 (or sometimes P_3) in *angustipinna* as opposed to P_6 or P_7 in *challengeri* is too great a discrepancy to be accounted for in that way, judging from observations on a number of specimens of *I. vivipara* of varying sizes in which there seems to be no correlation between size and the position of the first genital pinnule. The cirri are very different as a comparison of Carpenter's figures shows. There is also a difference in the texture of the brachials, those of *angustipinna* beyond the fourth or fifth having the distal edge more or less thorny, whereas in *challengeri* the arms are smooth. However, this character is probably less reliable.

Locality.—*Challenger* station 320; off Monte Video, Uruguay (lat. 37°17′ S., long. 53° 52′ W.); 1097 meters; temperature 2.89° C.; green sand; February 14, 1876 [P. H. Carpenter, 1888; A. H. Clark, 1913; John, 1938] (1, B.M.).

ISOMETRA HORDEA John*

Isometra hordea John, *Discovery* Reports, vol. 18, 1938, p. 132 (in key), p. 188 (stations; description; viviparity); text figs. 18, 21, 22; pl. 5, figs. 7, 8.—[Not *I. hordea* Forest, Beautés du fond des mers, Paris (Larousse), 1955, pl. 50a, which is a Comasterid.]

Diagnostic features.—The cirri are XL–LXII, 25–75; the first two pinnules are relatively small, especially P_1, which does not exceed 5 mm. in length; the first genital pinnule is usually P_5; in the female the third to seventh segments of the genital pinnules

* See also table 15 (p. 620), scatter diagram (p. 835), and Addenda (p. 837) under 1963.

are usually expanded; this is a very large species with the length from the proximal edge of the IBr_1 to the second syzygy at 9+10 up to 17 mm. (In the other species it does not appear to exceed 12 mm.)

Description (from John, 1938).—The centrodorsal of the most massive specimen is a high rounded cone. LII cirri in three or four rows round the ventral edge are present, while the rest of the surface except for the small smooth dorsal pole is modified with a honeycomb-like growth of stereom. In the other specimens the cirri are XL–LX, 25–75. The peripheral cirri may be twice as long as the short apical ones. The latter in smaller specimens are of 25 to 35 segments and 10 mm. long and the peripheral cirri are of 38 to 50 segments measuring about 20 mm. or more. In the larger specimens the apical cirri may have up to 50 segments and be 16 mm. long, while the peripheral ones are up to 40 mm.

A large peripheral cirrus has the first four segments much broader than long, the sixth to about the twelfth are very slightly longer than broad. The next four or five are as long as broad, the segments decreasing in length distally, so that the shortest are twice as broad as long. In the region of the twelfth to fifteenth segments a small swelling appears at the distal end of the dorsal edge. By about the twenty-fifth segment it has developed into a long low keel with a straight edge occupying the distal three-quarters of the dorsal edge. On the shorter distal segments the keel has also become shorter with a curved edge. It is reduced on the few segments before the penultimate. The opposing spine is usually strong and erect, the terminal claw moderately strong. There is a sharp difference in color between the first six to ten segments, which are yellow, and the rest, which are white. In two specimens the four or five most distal segments are a deep brown. [NOTE BY A.M.C.] After 20 years in alcohol the color has been lost.

The radials are short even in young specimens. They are wider distally than proximally and have concave distal margins. The IBr_1 are three to four times as broad as long. They are not incised by the IBr_2 since its posterior projection overlies them. The axillary is considerably broader than long in younger specimens but nearly as long as broad in the older ones, where the posterior projections are well developed. The lateral edges of the IBr_1 series are straight and sharp.

The proximal syzygies are at brachials 3+4, 9+10, and 15+16 (or 14+15) but there are numerous irregularities. After the third syzygy the interval is three or four, rarely two or up to seven, muscular articulations.

The outer edges of the lower brachials are sharp and their sides flat. Their surfaces are smooth but not flat, the inner distal corner of the fourth brachial is raised together with the inner proximal corner of the fifth brachial, into a prominence. Similarly the outer distal corner of the fifth brachial with the contiguous corner of the sixth one are raised, and so on. From the second to the fourth syzygies the brachials become more wedge-shaped. The distal edges of the outermost may be slightly everted and produced into fine spines. The shape of the brachials then becomes that of a rounded triangle, producing a very zigzag appearance. In the distal brachials the shape again becomes more quadrangular; the distal edges remain everted and spiny.

The pinnules gradually increase in length towards the tip of the arm. P_1 is short and stout, 4 to 5 mm. long and of 9 to 12 smooth rounded segments, which are longer than broad. P_2 is similar but may have up to 14 segments and be nearly 8 mm. long. P_3 is similar but may be longer, likewise P_4 if that is not a genital pinnule. These oral pinnules are joined to the disk or sides of the arms by webs of tissue from the first four or five segments.

The species is viviparous. P_5 is usually the first genital pinnule, rarely P_4 or P_6. It has up to 15 segments and is about the same length as the last oral pinnule. The genital pinnules extend to P_{13} in smaller specimens, to P_{18} in larger ones and the outermost may be of 18 to 26 segments and 9 to 14 mm. long. The first two segments of the genital pinnules are short and stout with the aboral portions of their distal edges produced into spines. The segments carrying the gonads are much more strongly expanded in the female than in the male. In the smallest specimen, which has arms 35 mm. long, none of the segments of the genital pinnules is expanded.

In the largest male the testes of the middle genital pinnules lie along the third to eighth segments and they are expanded, more strongly on the aboral than the oral side. The testes of the lower and outer genitals of big males and those of younger males are smaller and, consequently, fewer segments are expanded. The third or the fourth segments are the widest and longest. The remaining segments along which the testes lie decrease in width gradually. The expanded segments are raised into a keel-like ridge in the midline. The narrow portion of the distal edge which is a part of this ridge may be thorny. The distal segments beyond the gonad are strongly compressed.

In a small female only the third to fifth segments of the genital pinnules are expanded, but in the largest many of the genital pinnules have the third to the seventh segments expanded and in a few pinnules even the eighth. The expansion of the segments of a pinnule may be uneven; sometimes the sixth segment is very narrow on the aboral side with the corner of the fifth segment produced alongside it towards and sometimes meeting the seventh. There may be other irregularities. As in the male the expanded segments are raised into a ridge in the midline. The ovary is a long fusiform body lying along the adoral side of the pinnule. It is longer than the brood pouch and the strongly expanded segments. In a pinnule where the brood pouch lies along the third to sixth segments, which are strongly expanded, the ovary extends to the eighth segment. In the largest female the brood pouches are empty. In a medium-sized one they are crowded with embryos and so large that they bulge out beyond the edges of the expanded segments. A transverse depression runs across the face of the brood pouch ventrally, which is due to a septum dividing the pouch into two equal compartments. It appears to act as a support since the contents of the two compartments are similar. In a moderate-sized specimen the proximal compartment of a brood pouch contained fourteen embryos, of which thirteen were young and without skeletal plates. The distal compartment contained ten embryos, also without plates. In a smaller specimen the proximal compartment had four embryos, including one with plates and the distal had three with plates and one without.

The embryos vary from 0.5 to 0.8 mm. in length. Some of the younger ones are distorted by the lack of space. In the largest the sucking disk and vestibulum are clearly marked; the oral and basal plates are nearly in contact with one another. There are about 20 stem plates and a very large terminal plate. The basal circle embraces the stem. Some of the embryos have bands of cilia around them.

Most of the distal pinnules are similar in length and number of segments to the outer genital pinnules but they become shorter towards the end of the arm.

The disk appears to be naked in the few specimens where parts of it can be seen. The anal cone is high.

Sacculi are abundant and conspicuous, regularly arranged on the disk, the arms, and the pinnules; in some of the specimens they retained a red color in spirit for a few years.

Along the pinnule ambulacra of the small and moderate sized specimens there are heavy, well-developed side plates, about three pairs to each segment, but no cover plates, The side plates are finely reticulated. Spicules occur in most of the tentacles; they may be smooth rods but are more often very thorny and sometimes branched.

The color in life of five of the specimens was noted. Four were lighter in the proximal than the distal part; the proximal third to half varied from straw yellow to bright orange yellow and the distal part from a delicate pink to a deep orange brown. The fifth specimen was orange yellow.

Pentacrinoid larvae [from John, 1938].—Fifteen pentacrinoid larvae from *Discovery* Investigations station 170, off Clarence Island, form a series. Dr. John assumed they belonged to this species since they were taken with adults of it and they are distinct from pentacrinoids of *Promachocrinus* and *Notocrinus*, which were also in the same haul. Also the shapes and proportions of the primibranchs and brachials of the oldest ones are similar to those of *hordea* and the distal brachials of the largest larva have a zigzag appearence similar to that found on the middle part of the arms of the adult. The pinnule ambulacra have side plates and the tentacles have numerous spicules similar to those of *hordea*.

The youngest specimen is in the cystid or prebrachial stage. The crown is 0.9 mm. long and the column with 26 segments is 3.4 mm. long. The distal part of the column is narrower than the proximal. The first four or five columnals are very short and discoidal, much shorter than wide but increasing in length. The middle columnals are nearly as long as wide, the distal are slightly longer. All are considerably wider in the middle, where they are encircled by a narrow girdle. The terminal plate is thick and rounded.

The basal cup is considerably wider at the base than the topmost columnals. The sides are slightly convex. The height of the cup is two-thirds of its distal width. The orals form a cup slightly higher than the basals. The lateral edges of the orals are strongly bent outwards to produce a high double ridge along each of the sutures between them. When the crown is seen with these ridges in profile, the oral cup has more strongly convex sides than the basal.

A second specimen has the five radials and the radianal plate present. The crown is about 1 mm. long, the column 5.8 mm., consisting of 28 columnals and a terminal plate. The middle columnals are girdled and slightly longer than broad. The articular faces of the longer columnals are broadly oval, the long axes of the two ends of one columnal being in planes at right angles, while the long axes of the two opposing faces of contiguous columnals coincide. The terminal plate is thick and rounded. The base of the basal cup is not wider than the topmost columnals. Its height is equal to that of the oral cup and is considerably less than its distal diameter. The lateral edges of the oral plates are more strongly bent outwards, especially proximally where a furrow lies between those of adjacent plates, than in the prebrachial stage. A small rounded radial plate is present in each of the angles between the basals and the orals. Below and to the left of one of them, which is smaller than the others, is the radianal plate. In this radius the suture between the basals and that between the orals are not in line with one another as they are in other radii.

A third specimen has the radials very much bigger than in the last; the corners of the basals are cut away to receive them. The right posterior radial is very asymmetrical, being undeveloped on the left side, where the much smaller radianal plate is present. Each of the radials except the right posterior bears a small IBr_1 and a smaller axillary; they lie in the furrow between the strongly turned-out lateral edges of the oral plates but are massive enough to project beyond the edges of them in profile. The right posterior radial bears no ossicles.

In the fifth specimen the radials and division series are relatively larger and the axillary bears the two first brachials, though these are still very small.

The eighth specimen has the crown 1.4 mm. long and column 7.7 mm. There are 31 columnals, of which the middle ones are longer than broad and have nearly lost the encircling girdle. The sides of the basiradial cup are nearly straight. The radials almost meet in the interradii except the posterior one, where the radianal separates them. The anterior arms are of four brachials and curl in over the orals.

In the tenth specimen, with the crown 3.2 mm. long, the proximal corners of the posterior radials meet, cutting off the radianal plate from contact with the basal. The other radials all meet broadly. There are 12 or 13 brachials present.

The twelfth specimen has the crown 5.6 mm. long. The first columnal is short and as wide as the basal cup to which it is closely attached. It bears the beginnings of five radially situated cirri, with about three to five segments. The radials are longer than the basals and are in broad and complete lateral contact. The oral plates are hard to distinguish between the arms, which are of about 20 brachials with pinnules of up to 8 segments from the ninth brachial onwards. There are a few sacculi and there appear to be small side plates along the arm ambulacra.

In the fourteenth specimen, with the crown 6.8 mm., there are two alternating whorls of cirri, the interradial ones being very small and arising from the proximal half of the first columnal.

The fifteenth specimen has the crown about 11 mm. long. There are three whorls of cirri, of which the longest have 27 segments. The basal plates are very reduced. The pinnules beyond the tenth brachial have 12 or more segments and P_1 is beginning to appear on the second brachials.

Localities.—Discovery Investigations station 170; off Cape Bowles, Clarence Island (lat. 61°25′30″ S., long. 53°46′ W.); 342 meters; at 335 meters, temperature −0.42° C., salinity 34.47°/₀₀; rock; February 23, 1927 [John, 1938] (3 adults, 15 pentacrinoid larvae, B.M.).

Discovery Investigations station 1873; off Cape Bowles, Clarence Island (lat. 61°21′ S., long. 54°04′ W.); 117 meters; rock and stones; November 13, 1936 [John, 1938] (1, B.M.).

Discovery Investigations station 1948; east of Clarence Island (lat. 60°49′ S., long. 52° 40′ W.); 490–610 meters; January 4, 1937 [John, 1938] (4, B.M.).

Discovery Investigations station 1955; north of the South Shetland Islands (lat. 61°35′ S., long. 57°23′ W.); 410–440 meters; January 29, 1937 [John, 1938] (4, B.M.).

All the above specimens are syntypes. The type locality can therefore be taken as the Clarence Island-South Shetland area, about 60½–61½° S. and 52–57½° W.

Geographical range.—Off Clarence Island and the South Shetlands.

Bathymetrical range.—From 117 to 490 (?610) meters.

ISOMETRA GRAMINEA John*

Isometra graminea John, *Discovery* Reports, vol. 18, 1938, p. 132 (in key), pp. 185–187 (stations; description); text fig. 17, p. 186; pl. 5, figs. 5, 6. (Not *I. graminea* John, Rep. B.A.N.Z. Antarctic Res. Exped., ser. B, vol. 4, pt. 6, 1939, p. 206, which is here distinguished as *I. johanni* sp. nov.).

Diagnostic features.—The cirri are XXVI–XLIII, 28–41; P_2 is slightly larger than P_1, with usually one more segment, 8–10 as opposed to 7–9 in P_1; the first genital pinnule is P_4 or P_5 and in the female usually only the third and fourth segments are expanded.

Description (from John, 1938).—A female specimen from the Bransfield Strait has the arms 48 mm. long. They taper evenly from the base. At the first syzygy the width is 1.3 mm. From IBr_1 to the second syzygy is 8.8 mm.

The centrodorsal is a rounded cone with its ventral edge produced into very slight interradial corners. Most specimens have a bare dorsal pole. The cirrus sockets are closely set in alternating rows, which may be irregular.

The cirri are XXVI–XLIII, 28–41. There is some variation in the specimens from different localities, those from the Ross Sea have the first three or sometimes four segments considerably stouter than the succeeding segments, a feature not shown by the specimens from the Graham Land area. In general the fourth or fifth to the eighth or ninth segments are distinctly longer than broad and may be slightly constricted in the middle. The following segments decrease in length and the distal ones are produced into a moderate or strong, rounded dorsal spine. In the longer cirri these may be keel-like.

The radials vary in length. In the smaller specimens they are longer in the midline than the IBr_1 but are shorter in larger specimens. The distal edge is wider than the proximal and is concave. The IBr_1 of adjacent rays are not in contact with one another. They are incised by the posterior projections of the IBr_2 (axillaries), which may form slight shoulders with them. In one of the syntypes the IBr series and the lower brachials are raised into a keellike ridge in the midline. These ossicles in all the specimens are relatively smaller than those of *I. vivipara.* Their side edges are sharp and straight. The brachials are similar in shape to those of *I. vivipara,* also the positions of the syzygies are alike. The distal edges of the outer brachials are raised into moderately strong spines.

The first three pinnules increase slightly in size from P_1 to P_3. P_1 has 7 to 9 segments and is from 3 to 5 mm. long. P_2 may have one more segment than the corresponding P_1 or the same number and is usually about 0.5 mm. longer. In the Bransfield Strait specimen P_1 has 9 segments and measures 3.5 mm., while P_2 has 10 segments and measures 4 mm. P_3 has 9 to 12 segments in most specimens and measures up to 7 mm. The lowest segments of these pinnules are attached by a web of tissue to the disk or sides of the arms.

The first genital pinnule is P_4 or P_5 and has 10 to 12 segments; the last is P_{13} to P_{16} where there are about 15 segments and the length is 7 to 9 mm. The species is brood-protecting and the third and fourth segments of the genital pinnules of the females are enormously expanded, mainly on the aboral side, to cover the ovary and brood pouch. Also the fifth segment on the middle genital pinnules may be slightly expanded. Similarly the third and following segments of the genital pinnules of the

* See also table 15 (p. 620), scatter diagram (p. 835), and Addenda (p. 837) under 1963.

males are expanded, but to a lesser extent and consequently less asymmetrically than in the females.

In one brood pouch examined by Dr. John there is one egg, a larva similar to that of *vivipara* figured by Mortensen as a full grown larva (1920, pl. 22, fig. 8) and three other larvae with the plates better developed so that the orals and basals are in contact. Similar larvae were found in the brood pouches of the female from the Ross Sea, one of which contained seven larvae.

Some of the syntypes have a sharp calcareous plate on the disk at the apex of each interradius with its apex projecting over the peristome. The sides are curled upwards. The bases of the plates are not distinct but appear to be straight. Dr. Dilwyn John concluded that these plates are secondary perisomic orals. There are no other plates on the disk.

The sacculi are inconspicuous. They are often fairly regular on the pinnules, less so on the arms; they also occur on the disk.

The pinnule ambulacra are protected by large side and cover plates, of which there are three pairs to each segment. The side plates overlap, forming a continuous wall so that the individual ones are hard to distinguish. The cover plates are more rounded with a fanlike system of supporting rods terminating in peripheral spikes. They thus resemble the cover plates of *I. challengeri*, *angustipinna*, *vivipara* and *flavescens*. The tentacles contain strongly knobbed spicules.

The color in life varied from "pale dirty yellow-white" through "pale straw yellow" and "pale yellow brown" to "deep orange brown." The bases of the cirri may be darker in color and the perisome have a faint greenish tinge.

[Note by A.M.C.] In 1939 Dr. Dilwyn John referred to *I. graminea* some specimens taken by the B.A.N.Z.A.R.E. off Enderby and MacRobertson Lands on the far side of the Antarctic continent from both the Graham Land peninsula and the Ross Sea. These differ from the types most notably in having P_1 larger than P_2 and with at least two more segments rather than one less. The relative proportions of the first two pinnules seem to be subject to such small variation in the three other species of *Isometra* where more than a few specimens are known (namely *vivipara*, *flavescens* and *hordea*) that I cannot agree with this inclusion. I am therefore separating off these B.A.N.Z.A.R.E. specimens as a distinct species, *Isometra johanni*.

Localities.—*Discovery* Investigations station 190; Bismarck Strait, Palmer Archipelago (lat. 64°56′ S., long. 65°35′ W.); 93–130 meters; at 100 meters, temperature −0.31° C., salinity 33.89‰; ?stones, mud and rocks; March 24, 1927 [John, 1938] (1 female, 1 broken specimen and fragments, B.M.).

Same station, 100–130 meters (1 male, B.M.).

Discovery Investigations station 1652; Ross Sea (lat. 75°56′ S., long. 178°35′ W.); 567 meters; at 540 meters, temperature −1.90° C., salinity 34.85‰; mud; January 23, 1936 [John, 1938] (3 males, 1 female, B.M.).

Discovery Investigations station 1872; Bransfield Strait (lat. 63°30′ S., long. 54°03′ W.); 247 meters; at 200 meters, temperature −1.66° C., salinity 34.53‰; soft mud; November 12, 1936 [John, 1938] (1 female, B.M.).

Type locality.—All the specimens recorded above are syntypes. Since the three stations are widely separated it is desirable that a restricted type locality should be given and a lectotype selected. I therefore select the specimen from station 1872 in the Bransfield Strait; this is the fifth one given in table 15 (p. 620).

Geographical range.—Known from the Palmer Archipelago, Bransfield Strait and the Ross Sea.

Bathymetrical range.—From 130 (93) to 567 meters.

Thermal range.—From $-1.90°$ to $-0.31°$ C.

Salinity range.—From 33.89 to 34.85 parts per thousand.

ISOMETRA JOHANNI sp. nov., A. M. Clark*

FIGURE 35

Isometra graminea (not *I. graminea* John, 1938) JOHN, Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 191 (listed), pp. 206–207 (stations; description; pentacrinoid larva).

Diagnostic features.—The cirri are about XXV with the fourth and fifth of the 21 to 33 segments about twice as long as their median width, distinctly constricted in the middle and flared distally; the division series and proximal brachials have a keellike ridge in the dorsal midline; P_2 is smaller than P_1, which has 9 to 11 segments; the first genital pinnule is P_5 or P_6.

Description.—Holotype B.M. reg. no. 1948.1.7.197, B.A.N.Z.A.R.E. station 40.

The arms are about 50 mm. in length. From the proximal edge of the IBr_1 to the second syzygy is 9.0 mm. and the width at the first syzygy is 1.3 mm.

The conical centrodorsal is 2.1 mm. in basal diameter and 1.7 mm. in vertical height.

The cirri are about XXV, up to 12 mm. long, with 21–33 segments, of which the longest, the fourth and fifth, are twice as long as broad. The longer segments are also notable in having a narrowed waist from which they flare out towards the distal end. The first three segments are not conspicuously heavier than the others. On the distal segments which are shorter, there is a dorsal crest but no distinct spine.

The division series and the proximal brachials are distinctly carinate, particularly the first two brachials. The keels of each pair of arms fuse at the axillary. The first four brachials have very straight sides. Beyond them the arm rapidly narrows. The brachials between the first and second syzygial pairs each have a markedly raised triangular area in the midline of the distal edge. The brachials beyond have strongly everted and spiny distal edges.

P_1 is very long and slender, its tip extending distally as far as that of P_2. P_1 has 11 segments and measures 5 mm. in length, while P_2 has 7 or 8 segments and is only 3 mm. long. In the paratypes these pinnules have similar relative proportions (see table 15, on p. 620). It appears that P_1 is regularly at least half as long again as P_2 and has at least two more segments.

The first genital pinnule is usually P_5, sometimes P_6 on odd arms. The last is P_{10-12}. The holotype is a female with the third and fourth segments of the genital pinnules abruptly and conspicuously expanded. The brood pouches of the females contain two or three embryos and a small number of eggs. There were no embryos with skeletal plates among those examined.

The pinnule ambulacra are lined with side and cover plates similar to those of *graminea* and the tentacles contain knobbed spicules.

The type carries a pentacrinoid larva on a cirrus.

Pentacrinoid larvae.—Dr. John described two larvae from B.A.N.Z.A.R.E. station 107, of which the larger has about 23 brachials on each arm. The first columnal (centrodorsal) bears three whorls of cirri, the longest of which have 12 to 13 segments

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* See also scatter diagram (p. 835).

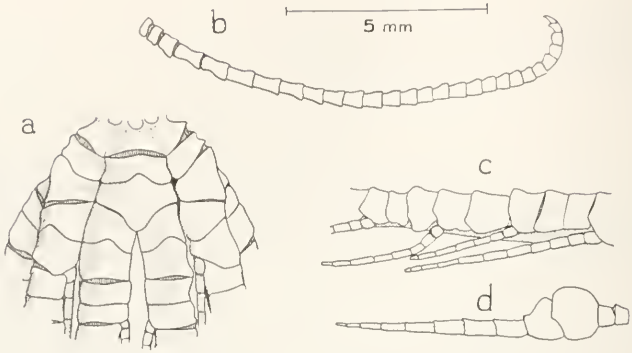

Figure 35.—*Isometra johanni* sp. nov.: *a*, Holotype, calyx less centrodorsal; *b*, B.M., 1948.1.7.196, B.A.N.Z.A.R.E. station 40, cirrus; *c*, holotype, part of arm with P_1 to P_3; *d*, P_6.

and are 3 mm. in length. The stem is incomplete, having 31 columnals. It is of the bourgueticrinoid type. The second columnal is very short and is produced into a lobe in each interradius. The third and fourth are narrower but equally short. The fifth is about half as long as broad. The following columnals are elongated, about three times as long as broad. Towards the end of what remains of the stem they again become shorter. The smaller pentacrinoid is much younger. The broken stem has 25 columnals. The first is short, with a depression in each radius, from four of which the rudiments of the first cirri arise. The longest columnals are about twice as long as broad. The sides of the basiradial cup are nearly straight. The basals and the radials are of about the same length. The articulation of the IBr_1 occupies about half the distal border of the radial. The orals are in contact with the radials and in contact with one another by their lateral edges, so that they form a dome over the disk. The radianal rests on the posterior oral near the IBr_1 of the right posterior ray. The arms are of 13 to 14 brachials. They have strong side plates and sacculi are present. There are no pinnules. The complete crown is about 4.5 mm. long.

A young specimen also from station 107, has most of the arms broken at 5 to 6 mm. from the base but two are nearly 10 mm. long and were probably at least 12 mm. long when complete. The single mature cirrus has 19 segments and is similar to those of the adult. There is a complete, though narrow, circlet of basal plates. The radials are massive; each is produced on either side into a long interradial process which runs up alongside the IBr_1 for the whole of its length. In the midline the distal edge of the radial is everted into a prominent lip. The division series and lower brachials are slightly carinate in the midline. Their lateral edges are straight. The only oral pinnule developed is P_1, which is about 1.5 mm. long and has 6 segments, of which the third to fifth are about four times as long as broad. The next pinnule is P_5 on the twelfth brachial. It has 9 segments and is 3 mm. long.

Localities.—B.A.N.Z.A.R.E. station 40; off Enderby Land (lat. 66°12′ S., long. 49°37′ E.); 300 meters; January 17, 1930 [John, 1939] (1 female, the holotype and 1 male, B.M.; 2 females, 1 immature, Austr. M.). Type locality.

B.A.N.Z.A.R.E. station 41; off Enderby Land (lat. 65°48′ S., long. 53°16′ E.); 180–209 meters; at 200 meters, temperature −1.77° C., salinity 34.24°/₀₀; January 24, 1930 [John, 1939] (1 male, Austr. M.).

B.A.N.Z.A.R.E. station 107; off MacRobertson Land (lat. 66°45′ S., long. 62°03′ E.); 219 meters; February 16, 1931 [John, 1939] (1 male, 1 juvenile, B.M.; 2 pentacrinoids, Austr. M.).

ISOMETRA CHALLENGERI (A. H. Clark)

Antedon lineata (not *Antedon lineatus* Pomel, 1887) P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 183 (description; sta. 320), pl. 13, figs. 4, 5.—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 480 (renamed *challengeri*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (synonym of *Isometra angustipinna*).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, pp. 398, 399 (compared with *A.* [*Analcidometra*] *armata*).

Antedon challengeri A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (new name for *Antedon lineata* P. H. Carpenter, 1888, not *A. lineatus* Pomel, 1887); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 480 (same).

Isometra lineata JOHN, *Discovery* Reports, vol. 18, 1938, pp. 174–176 (distinct from *angustipinna;* redescription of holotype); fig. 13, p. 176.

Diagnostic features.—The cirri are about XXV, with up to about 30 segments, of which the longest are only slightly longer than broad; P_2 is slightly smaller than P_1, each having 8 to 9 segments; the first genital pinnule is P_6 or P_7.

Nomenclature [by A.M.C.].—Since Pomel's name *Antedon lineatus* for a fossil invalidated by a year *A. lineata* of P. H. Carpenter, A. H. Clark substituted the name *challengeri* in 1907, but the following year submerged the name in the synonymy of *angustipinna*. However, John (1938), after re-examining both the type specimens, decided that the species are, after all, distinct. I have accordingly modified the typescript.

Description.—The centrodorsal is almost completely hidden by the stumps of the broken cirri.

The cirri are about XXV, the longest with at least 30 segments and over 16 mm. in length; they have a slight distal taper. The fifth segment is the longest, slightly longer than broad; the segments in the terminal third of the cirri are broader than long. All of the segments overlap slightly on the dorsal side and the outer gradually acquire a faint dorsal keel with a rather prominent dorsal spine.

The radials are partially visible. The IBr_1 are oblong, not united laterally, with the distal border slightly excavated. The IBr_2 (axillaries) are pentagonal and somewhat broader than long. The elements of the IBr series are elevated in the middle line, decreasing in height laterally.

The 10 arms are about 90 mm. long. The first brachials are somewhat incised by the second, which are relatively short and broad. The following brachials are smooth and obliquely wedge-shaped, becoming rather elongated toward the arm tips.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of from 2 to 5 (usually 3 or 4) muscular articulations.

The length from the IBr_1 to the second syzygy is 9.0 mm. and the width at the first syzygy is 1.5 mm.

P_1 consists of 8 to 9 longish segments and measures about 4.5 to 5 mm. P_2 usually has 8 segments and is about 3.5 mm. long; likewise P_3. The first genital pinnule is P_6 or P_7; they are of about 9 segments and about 5 mm. long. The third and fourth segments of the genital pinnules are slightly and almost symmetrically expanded but still longer than broad. The specimen is a male.

The distal pinnules have side and cover plates, two or three pairs to each segment, along the ambulacra. They are figured by Dr. John (1938, fig. 13*c*). The side plates are rods with branching and reticulate ends. The cover plates are bush-shaped, with a short stem. Some of the tentacles contain knobbed spicules.

Locality.—*Challenger* station 320; off Monte Video, Uruguay (lat. 37°17′ S., long. 53°52′ W.); 1097 meters; temperature 2.89° C.; green sand; February 14, 1876 [P. H. Carpenter, 1888; A. H. Clark, 1913; John, 1938] (1, B.M.).

ISOMETRA VIVIPARA Mortensen *

FIGURE 36

[See also vol. 1, pt. 2, pl. 38, figs. 1238–1240, pl. 49, figs. 1328–1331]

Antedon hirsuta (not of P. H. Carpenter, 1888) ANDERSSON, Zool. Anz., vol. 27, 1904, No. 19, p. 662 (care of the brood); Wiss. Ergebn. schwed. Südpolar-Exped. 1901–1903, vol. 5, Lief 1, 1904, pp. 1–7 (structure and anatomy of ovaries and marsupium; care of the brood; Burdwood Bank; 135–150 meters), pls. 1, 2; *in* Gregory, Geogr. Journ., vol. 32, No. 1, 1908, p. 42 (care of the brood).

Feather Stars WILTON, PIRIE AND BROWN, Rep. Sci. Res. S.Y. *Scotia*, vol. 4, Zool., 1908, p. 21.

Crinoids (part) WILTON, PIRIE AND BROWN, Rep. Sci. Res. S.Y. *Scotia*, vol. 4, Zool., 1908, p. 61.

Isometra sp. A. H. CLARK, Die Crinoiden der Antarktis, 1915, p. 106 (collected by the *Antarctic*).

?*Isometra angustipinna* (not *Antedon angustipinna* of P. H. Carpenter) A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 146 (identification of Andersson's specimens).

Isometra vivipara MORTENSEN, Vid. Medd. Nat. Foren. København, vol. 68, 1917, p. 208 (characters); Wiss. Ergebn. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, pp. 10–15, figs. 6–13, pl. 1, figs. 6–10, pl. 2, figs. 5–7 (detailed account); Studies in the development of Crinoids, 1920, pp. 13, 16 (comparison with *Tropiometra* development), p. 29 (development of brachials and pinnulars), pp. 31–48 (embryology and development), pp. 60 and following (care of brood; discussion of the embryology), pls. 14–23 (except pl. 21, fig. 7); Vid. Medd. Nat. Foren. København, vol. 71, 1920, pp. 155, 156.—A. H. CLARK, Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 23 (cannibalism); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 28, footnote 1, p. 44 (articulations), pp. 74, 82 (articulations), p. 194, p. 271 (cannibalism); figs. 85–86, p. 81; fig. 112, p. 93; fig. 188, p. 98; figs. 289–292, p. 217.—KOEHLER, Les échinodermes des mers d'Europe, vol. 1, 1924, p. 35 (brooding of young).—MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, vol. 12, 1928, p. viii. 86 (cannibalism).—TORTONESE, Natura, Milano, vol. 24, 1933, p. 165.—MORTENSEN, *Discovery* Reports, vol. 12, 1936, p. 208 (cannibalism of young).—A. H. CLARK, Sci. Rep. Australasian Antarctic Exped. 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 5 (listed), p. 8 (in key).—JOHN, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (Antarctic; also Burdwood Bank and Patagonian coast), p. 87 (brood protection), p. 88; *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 124 (pentacrinoid larvae found), pp. 125, 126, 128 (care of the brood), pp. 129, 131, p. 132 (in key), pp. 178–181 (*Discovery* stations; distribution; descriptive remarks), p. 183 (comparison with *I. flavescens*), pp. 185, 186, 187 (comparison with *I. graminea*), pp. 191, 192 (comparison with *I. hordea*); fig. 15, p. 180; pl. 5, figs. 1, 2.—VANEY, Sci. Res. Voy. S.Y. *Scotia*, vol. 59, pt. 3, 1939, p. 661.—DAWYDOFF *in* Grassé, Traité de Zoologie, vol. 11, 1948, p. 321.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, fig. 28F (pinnule with marsupium), p. 75 (sperm present in genital tube of ovary), fig. 35 (development of the arms), p. 87 (embryology).

* See also scatter diagram (p. 835) and Addenda (p. 837) under 1963.

Diagnostic features.—The cirri are XXV–LX, 26–43, the longest segments hardly, if at all, longer than wide; P_1 is up to 10.5 mm. long with 10 to 17 segments while P_2 is usually 1.5 to 2.0 mm. shorter with 9 to 14 segments and not more than 8.5 mm. long; P_5 is usually the first genital pinnule.

Description [modified by A.M.C.].—The centrodorsal is rounded conical, broader than high, with a smooth rounded dorsal pole and with the rim extended into prominent interradial angles. The cirrus sockets are rather closely set, irregularly arranged or partly forming irregular rows.

The cirri are up to LX, 26–43. The component segments are short, the fourth to tenth being somewhat longer than the remainder, about as long as broad, sometimes a little longer. Beyond the middle of the cirri the segments develop a dorsal carination, the profile of which is more or less sharply convex; this almost disappears on the outermost segments. The opposing spine is erect. The terminal claw is short and strongly curved. The peripheral cirri are turned upward, protruding between the arms over the disk.

The radials form a narrow band beyond the rim of the centrodorsal. The IBr_1 are more than twice as broad as long with the lateral borders parallel and the distal edge incised. The IBr_2 (axillaries) are a third again as broad as long, rhombic, with the lateral angles truncated and all the sides concave. The IBr series and lower brachials are in lateral contact and have sharply flattened sides.

The distal edges of the outer brachials are smooth but somewhat thickened, giving the arms a serrate profile.

Syzygies normally occur between brachials 3+4 and 9+10 and distally at intervals of from 2 to 6 (usually 3 or 4) muscular articulations, but there are often irregularities, even in the positions of the first two syzygies.

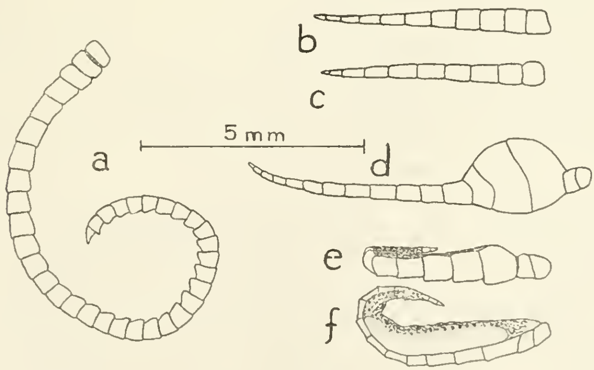

FIGURE 36.—*Isometra ?vivipara* Mortensen, B.M., 1938.12.7.121, *Discovery* Investigations station 175, Bransfield Strait: *a*, Cirrus; *b*, P_1; *c*, P_2. *I. vivipara*, B.M., 1938.12.7.124–5 and 126–133, stations W.S. 81 and W.S. 83: *d*, P_8 of ♀; *e* and *f*, lateral and distal views of P_8 of ♂.

The first three pinnules are fairly robust; P_1 is from 5 mm. to 10.5 mm. in length and composed of 10 to 17, usually 13 to 14, segments, which are short and smooth. P_1 is always longer and usually stouter than P_2 and P_3. P_2 is of 9 to 14, usually 10 to 12 segments and 4 to 8.5 mm. long. P_3 is of 9 to 14, usually 10 to 12 segments and 4 to 7 mm. long. P_3 generally has the ambulacral groove developed.

The first genital pinnule is P_4, P_5, or P_6, usually P_5. The last may be as far out as P_{26} or even further, so that only some 6 or 7 pinnules at the arm tips are devoid of genital organs. Often pinnules without the usual expansion occur among the genital pinnules. According to Mortensen these are regenerated pinnules, as may be inferred from their occurrence at different stages of growth. The very characteristic appearance of the female genital pinnules is due to the enormous widening of the third and fourth segments, forming a brood chamber; this widening is mainly on the aboral side of the segments. In the lower part of the arms the fifth segment is also slightly broadened. Further out on the arm the broadening diminishes, first the fifth then the fourth segment assuming the normal appearance, the broadening of the third alone remaining. A corresponding development of the genital pinnules takes place with the growth of the individual, the young having only the third segment on the genital pinnules of the lower part of the arm broadened, the more distal pinnules showing no broadening at all.

In the males the genital pinnules are distinctly broadened, though this is not so extensive as in the female. It begins on the third segment, which is the widest, and continues, gradually diminishing, to about the middle of the pinnule, being almost equally developed on both sides of the segments. The distal segments of the genital pinnules are fairly slender and smooth, the distal ends of the outer ones being only slightly spiny. The articulations are not swollen.

The distal pinnule ambulacra have side and cover plates of which the former are more or less rodlike, sometimes branching at the outer end and the latter are irregularly fenestrated; both series may be reduced or even absent. The tentacles usually have some thorny rods but these too may be absent.

Sacculi are in general fairly regularly developed on the pinnules, less so on the arms; they appear to be entirely wanting along the ambulacral furrows on the disk. They are very pale and inconspicuous in the preserved specimens.

The disk is naked. The mouth is slightly excentric. The anal cone is near the oral angle of the posterior interradius. The interradial areas may be quite narrow, pressed inward by the cirri rising between the arms.

Abnormal specimens.—In one instance P_4 is double, a small additional pinnule being developed at its base but independent of it, and running downward along the arm. This supplementary pinnule possesses an ambulacral groove.

Mortensen also found a pinnule which bifurcated on the fourth segment.

Variations [by A.M.C.].—Since *I. vivipara* is one of the few species of the genus known from more than a few specimens, I give here a table enumerating some measurements of specimens in the British Museum as well as of two of the syntypes. I am indebted to Mr. P. A. Andersson of the Stockholm Museum, who sent me most of the type material. Unfortunately, only the specimen from Swedish South Polar Expedition station 58 and four of those from station 59 have retained their station numbers, both of these being on the Burdwood Bank. The other stations from which the types came range from off southern Brazil to the colder water of the Weddell Sea but, nevertheless, all the remaining specimens appear to be of the same species. Thanks to Dr. F.

TABLE 16.—*Measurements of specimens of* Isometra vivipara *in the British Museum, the Stockholm Museum, and the Copenhagen Museum.*

Specimen (Reg. No.)	Arm length when complete	Arm breadth at 1st syzygy	IBr_1 to second syzygy	Longest cirrus		P_1		P_2		First genital P
				Segments	Length (mm.)	Segments	Length (mm.)	Segments	Length (mm.)	
BM 1938.12.7.121	50+	1. 6	(9–10) 9. 5	37	11	12	5. 7	10	4. 8	3
BM 1938.12.7.123	c. 33	1. 3	7. 5	33	19	11	5. 2	9	4. 0	5
	–	1. 7	8. 0	34	17	12	6. 5	11	4. 6	5
	c. 32	1. 4	7. 4	33	17	13	6. 0	9	4. 2	5
	c. 36	1. 8	8. 0	34	16	13	6. 0	11	4. 5	5
	–	1. 7	9. 0	35	19	12	6. 0	10	4. 5	5
	–	1. 4	7. 9	34	18	12	5. 7	10	4. 3	5
	30	1. 2	7. 0	30	14	11	4. 8	10	3. 3	5
	–	1. 4	7. 3	35	19	13	6. 0	11	4. 3	6
	c. 35	1. 5	7. 7	30	16	12	5. 2	10	4. 0	5
	–	1. 9	9. 0	35	19	14	7. 2	12	5. 1	4
	c. 38	1. 6	8. 0	33	17	13	6. 4	11	4. 6	7
	c. 40	1. 4	7. 0	30	15	13	6. 0	10	4. 0	5
	c. 40	1. 4	7. 4	35	18	14	5. 5	11	4. 0	5
	c. 38	1. 4	8. 3	35	18	13	6. 0	11	5. 0	5
BM 1938.12.7.	–	2. 2	12. 0	37	20	14	10. 5	12	8. 2	5
126–133	–	1. 9	10. 0	35	18	16	9. 7	13	8. 3	5
	–	1. 7	9. 5	–	–	13	7. 2	11	5. 0	–
	–	2. 2	11. 5	–	–	15	9. 7	12	8. 1	5
	–	2. 1	11. 0	42	20	15	10. 0	10	7. 0	5
	–	2. 1	12. 0	–	–	–	–	14	8. 5	5
BM 1938.12.7.	70+	2. 0	9. 5	37	18	14	8. 0	10	4. 5	5
124–125	c. 35	0. 9	7. 0	28	11	10	4. 0	8	2. 5	–
	–	1. 1	7. 0	28	12	11	4. 0	9	3. 0	5
BM 1938.12.7.	–	2. 5	12. 2	40	22	14	9. 5	12	7. 8	6
137–138	–	2. 5	13. 0	43	22	15	9. 5	12	7. 5	5
BM 1938.12.7.122	c. 45	1. 9	8. 7	35	16	14	8. 0	12	5. 5	5
BM 1938.12.7.139	–	1. 2	8. 5	37	16	17	10. 0	14	6. 0	5
SM 242, Syntype	c. 55	1. 8	9. 5	33	18	14	7. 0	12	5. 0	5
CM, Syntype	–	1. 8	8. 5	34	22	17	9 0	14	7. 5	5

Jensenius Madsen of the Copenhagen Museum, I have also been able to study a syntype definitely from station 5, within the Antarctic, which, like the rest, has P_5 usually the first genital pinnule and P_1 larger than P_2.

Another antarctic record is that from *Discovery* Investigations station 175 in the Bransfield Strait which Dr. Dilwyn John included in *Isometra vivipara* although it shows some differences from the subantarctic material taken by the same source.

The specimen is a female and on all the arms P_3 is the first genital pinnule, though it may be only slightly swollen. In all the other known specimens of *vivipara* the first genital pinnule is at P_5 or beyond, rarely P_4. Also Dr. John noted that the extension of the segments of the genital pinnules is not so great as in the subantarctic specimens. The brood pouches contain many fewer eggs and embryos, two examined by Dr. John each having only three embryos and one egg. The position of the second syzygy is abnormal, on eight of the arms it is between brachials 11 and 12, on one between 6 and 7 and on the last between 12 and 13. Finally, the side plates of the pinnule ambulacra, which are well developed together with the cover plates, are platelike rather than rodlike. There are few spicules in the tentacles. The first two pinnules have about the same relative lengths as in most specimens of *vivipara*, with P_1 about 0.5 mm. longer than P_2, but P_1 is very little stouter at the base (see fig. 36, *b* and *c*).

This specimen is the first one at the top of table 16 and is the one marked x in the scatter diagram on page 835 illustrating the relative proportions of the first two pinnules. In the key to the species of *Isometra* it runs down to *I. flavescens*, known from the Shag Rocks, but differs from that species in the smaller size difference between the first two pinnules (shown clearly in the graph) and the more complex ambulacral deposits.

More material from the Bransfield Strait area is needed before a definite conclusion on the identity of this specimen can be reached.

Early stages.—The eggs are about 0.3 mm. in diameter, very rich in yolk, and quite opaque. They are found in various stages of development in the ovary, and are liberated as they become ripe and not all at once as is usually the case in the crinoids. Thus one may find fully formed larvae together with embryos in the first cleavage stages in the same marsupium. Andersson did not find more than 5 embryos in a marsupium, and generally only 3; Mortensen, however, found as many as 8 eggs and embryos together, while John (1938) found up to 6 eggs and 21 embryos in a single marsupium.

Andersson found that in each ovary there is a space filled with spermatozoa, and Mortensen concluded from this that fertilization probably takes place within the ovary itself. But neither he nor Andersson found any fertilized eggs in the ovary, nor did he find any unfertilized eggs in the marsupia.

The egg membrane is very thin and quite simple, without any special structure. The embryos remain within the membrane during the whole course of their development and do not escape from it until they leave the marsupium as fully formed larvae.

The cleavage corresponds, according to Mortensen, to the superficial type characteristic of arthropods. The egg as a whole does not divide at all; only the nuclei divide and scatter irregularly in the yolk mass. In the youngest stage found, a few nuclei are seen lying in the middle and a few near the surface. These gradually multiply so that a number of nuclei are found irregularly scattered in the mass of yolk with no traces of cell walls. The nuclei arrange themselves about the periphery, with another group, less distinct, in the middle of the embryo. Mortensen could not determine whether an actual wandering outward of the nuclei takes place, or whether the peripheral nuclei are derived exclusively from those lying near the surface in the youngest stages and the inner from those lying in the middle.

In the next stage represented the superficial nuclei form a fairly regular layer and cell limits have begun to appear so that there is now a distinct typical ectoderm of high cylindrical cells, full of rounded yolk granules clearly delimited from the entoderm. The nuclei in the middle of the embryo have assembled in a more definite group, and in the center of this group the archenteron appears as a small narrow slit, which soon grows in size, the nuclei arranging themselves more regularly around it and cell limits appearing. An important differentiation is beginning to take place in the yolk substance. While the whole of the entoderm and ectoderm is uniformly filled with yolk granules, some of these are collecting into distinct balls of various sizes which lie between the ectoderm and the entoderm. These groups of yolk granules remain a very characteristic feature in the following developmental stages.

There is some variation in the order of appearance of the ectoderm and entoderm. In one case the nuclei of the ectoderm still form a simple nearly regular layer, though the delimitation of the cells is well advanced, while the entoderm is fairly well along in development; in another the nuclei of the ectoderm are much more numerous and are not arranged in a simple layer, the delimitation of the cells is less advanced, and the entoderm is in a considerably younger developmental stage, the cavity having only just appeared. In another embryo of a stage corresponding exactly to the first of these two there is a distinct indication of cilia in one place.

The differentiation of the archenteron proceeds as in *Antedon* and *Tropiometra*. A median constriction separates the archenteron into an upper or anterior section with a very large lumen, the enterohydrocoele, and a lower or posterior section, the coelomic sac, which divides into a right and left enterocoele vesicle. There is no trace of the downward prolongations from the anterior vesicle, which in *Antedon* embrace the narrow transverse canal that connects the two enterocoelic vesicles. Mortensen could not make out the formation of the hydrocoele in all its details; but it is formed from the anterior vesicle as in *Antedon* and *Tropiometra*. The parietal canal is formed in the usual way as a constriction from the hydrocoele vesicle.

The ectoderm consists of high epithelial cells, the nuclei of which lie chiefly in the middle forming a more or less definite layer. The entoderm also is made up of cylindrical epithelial cells with the nuclei lying chiefly at the base and the whole interior of the cells filled with yolk spherules. The enterocoelic vesicles show the same epithelial structure. At the stage at which the formation of the archenteron begins mesenchyme cells appear. Whether they originate from the entodermal epithelial cells or from the nuclei originally lying scattered in the yolk mass cannot be made out; but from the fact that they lie at first mainly at the upper end of the archenteron and do not fill the blastocoele cavity, which has now become very large, the evidence is decidedly in favor of their originating from the entodermal epithelium as in *Antedon* and in *Tropiometra*. Eventually the blastocoele cavity becomes completely filled with mesenchyme cells. From the first these are filled with yolk spherules, like all the other cells. But gradually the yolk spherules collect in rounded groups which lie scattered irregularly, mainly in the mesenchyme. The nuclei of the ectoderm, entoderm and mesenchyme cells are not distinctly different in size.

Important structural changes now take place leading to the organization of the fully developed larva. In its external appearance the embryo becomes more elongate. The vestibulary invagination appears as a depression on the ventral side, and another depression is formed at the anterior end of the embryo representing the suctorial disk. The ciliated bands are developing, the nuclei being arranged in more or less distinct groups corresponding to the bands. Glandular cells have developed in the ectoderm, especially at the anterior end, but they may be numerous also in other places. The nervous system has just begun to differentiate.

The entoderm shows a marked difference from the condition in the preceding stage. The lumen has now become very small, or is even completely obliterated. The cell limits have mostly disappeared, and it is especially important to notice that the cells are not distinctly delimited from the lumen of the entoderm as they are in the preceding stage. As a result of this, the yolk spherules wander into the lumen, where they are evidently being absorbed. The nuclei, which in the stage preceding were lying fairly regularly along the inner border of the entoderm, are now spread over the whole entodermal mass without any apparent order, evidently as a result of having undergone division.

The hydrocoele is now assuming the shape of a horseshoe, open downward; its walls consist of high cylindrical cells which form a regular columnar epithelium. The parietal canal has developed into a large sac with a lining of flattened endothelial cells. It has a large anterior prolongation reaching to just below the suctorial disk, where it may be a little widened. At its lower end it is constricted into a long narrow pore canal, which may have an external opening, the hydropore, situated between the third and fourth ciliated bands. In some of the specimens studied by Mortensen there was no hydropore; he ascribes this to variability in the time of appearance of this structure.

The enterocoelic vesicles have now reached their definitive positions, the left (the future oral coelome) at the posterior end, the right (the future aboral coelome) at the dorsal and anterior side of the entoderm, forming a mesentery at the point of union. From the right enterocoelic vesicle or aboral coelome are developing prolongations into the anterior part of the embryo which are the rudiments of the chambered organ. The epithelial lining of the enterocoele vesicles has for the most part assumed an endothelial character.

In the mesenchyme there are often found globular masses of yolk spherules of different sizes, sometimes very large. More rarely such yolk globules are also found in the ectoderm. In the entoderm the yolk spherules are usually not united into definitely delimited globules.

The fully formed larva still within the egg membrane is from 0.5 to 0.6 mm. in length—about the size of the corresponding larva of *Antedon adriatica*, and about twice the size of the larvae of *Tropiometra carinata* or of *Antedon serrata*. In shape it is markedly different from the other known crinoid larvae. It is flattened on the ventral side and has a distinct constriction in the middle of the body between the oral and basal circlets. The vestibular invagination is in the form of a narrow slit. Its depression is not sharply delimited from that of the suctorial disk. The latter is very distinct and often has thickened edges which causes the anterior end of the animal to appear prominent and almost snoutlike. The ciliated bands are very well developed, 4 in number with traces of an anterior band which is very indistinct and only visible on the dorsal side. The second (prevestibular) band may be interrupted in the ventral median line between the suctorial disk and the vestibule. The next band is forced far posteriorly by the vestibule, reaching almost to that following which also is slightly curved posteriorly in the midventral line. The posterior band may curve slightly anteriorly in the midventral line. At the anterior end of the vestibule a band may proceed laterally, like an additional rudimentary ciliated band. This, however, is not constantly present, and there may be only a simple widening of the thickened epithelium at the anterior end of the vestibule.

The ectoderm is only very exceptionally distinct from the mesoderm; usually no delimitation can be made out between them. It is evidently at this stage that the dissolution of the ectoderm as a separate layer takes place. The nuclei of the cells of the ciliated bands are arranged in conspicuous groups, though rarely showing any regular arrangement within these groups. The glandular cells have become enormously developed, especially on the ventral side and along the vestibule. Within the vestibule a regular arrangement of the glandular cells is apparent. At the anterior end they occupy the bottom of the furrow while the sides are occupied by simple cells seen in sections as very conspicuous masses of nuclei. Proceeding downwards the nuclear masses gradually pass down into the furrow, narrowing the glandular space at the bottom until it disappears entirely and the nuclear masses occupy the bottom. At the same time new glandular masses appear along the sides of the furrow, these in their turn again passing deeper down into the furrow narrowing the nuclear mass to a restricted area in the middle of the furrow, while new nuclear masses appear along the sides, these last, however, remaining less conspicuous. The epithelium of the vestibule is distinctly ciliated. In sections the cuticle is seen to be perforated while a regular layer of fine grains occurs just below it.

The suctorial disk is large and deep. Its cells contain a finely granular substance. A slimy mass fills the cavity of the disk, probably representing cilia destroyed by preservation. The cuticular structure observed in the vestibule cannot be distinguished here. There is no indication of an anterior tuft of cilia.

Pigmentation begins to develop in the skin of the larva before it leaves the egg membrane in the form of fine dark specks, which give the larva a faint grayish tint.

The nervous system is fairly well developed. Mortensen was unable to make out the details, but he says that there is no reason to doubt its complete conformity with that in other crinoids.

The vestibular invagination is remarkably narrow, deepest at the anterior end. Closure begins at the posterior end and is completed while the embryo is still within the egg membrane. In closing, the lumen is so nearly obliterated that in sections merely a line is seen indicating the boundary between the epithelium of the roof and that of the floor. The last vestige of the invagination is a very narrow opening in the form of a deep canal at the anterior end just below the suctorial disk. According to Mortensen, the walls of the vestibule must later separate, since eventually the vestibule acquires the typical form.

The hydrocoele has begun to differentiate, the 5 primary tentacles (or radial canals) having appeared. The stone canal is forming, but has not yet opened into the parietal canal. The hydropore is about to disappear, or has become entirely closed. The anterior prolongation of the parietal canal is still distinct.

There is but little change in the coelomic vesicles. The left or oral coelome has developed two prolongations directed upward on the ventrolateral side so that in transverse sections two small spaces appear at the side of the hydrocoele, its whole dorsal portion being occupied by the right or aboral coelome. This has acquired a somewhat complicated form because of a deep notch in the upper side of the stomach.

The axial organ has begun to develop as a thickening of the coelomic epithelium in the notch at the vertical mesentery.

The entoderm still remains in the same histological condition as in the preceding stage, the lumen being more or less indefinite or entirely obscured through the passage inward of the yolk masses. The stomach is now somewhat lobed because of the notches from the aboral coelome. One of these lobes, according to Mortensen, is probably destined to form the intestine.

Mortensen remarks that the fact that the ciliated bands of the larva are well developed proves that the free-swimming stage has not been entirely obliterated; but because of the relatively great development of the skeletal elements, the larva must be rather heavy and a poor swimmer so that it probably sinks almost directly downward where it meets the tip of the upturned cirrus and attaches itself. According to Mortensen, the fact that the pentacrinoids are not found attached to all the upturned cirri but generally to only 2 or 3 of them would seem to indicate a slight amount of swimming, as otherwise one would expect them to be attached to the cirrus just below the point of origin.

Mortensen found that quite a large percentage of the pentacrinoids contain in their stomachs the half-digested but still perfectly recognizable remains of larvae. He even saw quite young pentacrinoids with the vestibule just opened and the arms not yet developed with an embryo almost of their own size in their mouths. He says that, because of the large number of pentacrinoids found attached in clusters to the tips of the upturned cirri—Andersson counted no less than 99 on one adult—this danger to the embryos is very real and probably quite a large number thus perish.

In the recently attached pentacrinoids the vestibule has now assumed its normal position at the formerly posterior (now anterior) end, and has a distinct lumen. The tentacles have not yet become free. In sections the little pentacrinoid is seen to differ conspicuously from the larva in the histological character of the entoderm. A single fairly regular layer of nuclei is seen along its outer surface while the whole inner part is filled with a dense mass of small granules that stain very deeply in haematoxylin. Mortensen believes that the mass occupying the entoderm consists of wandering cells derived from the mesoderm which take an active part in the histolysis of the entoderm that occurs during the metamorphosis.

With the removal of the vestibule from the ventral side of the embryo to the posterior end, the hydrocoele and the coelomic cavities have also come to occupy their definitive positions. The inner wall of the vestibule is very thick, and between the nuclei there are many of the granules just mentioned, scattered or in dense groups. A slight concavity in the middle of the floor of the vestibule is the first indication of the future esophagus. Below this, the ectoderm and entoderm are fusing in the center of the still open hydrocoele ring.

The stone canal has not yet opened into the parietal canal, and the pore canal is closed off from the exterior. In the mesentery within the parietal canal there is a slight accumulation of nuclei which probably represents Russo's "primary gonad."

In a somewhat more advanced stage the tentacles have protruded into the vestibule, which is about to open, a depression having appeared in the middle of its outer wall and the 5 oral valves being about to separate. The mouth and esophagus have been formed, and in the stomach a lumen is beginning to appear, the granular mass being about to be absorbed. The intestine now has been differentiated, but the anal opening has not as yet been formed. The stone canal has opened into the parietal canal, but no external opening of the pore can be discerned. The chambered organ is beginning to assume its typical form and the axial organ is distinct. It appears as if the parietal canal had opened into the oral coelome, but Mortensen could not definitely determine this.

The next important change is the opening of the vestibule. The young pentacrinoid now begins to feed directly, having until now subsisted on the yolk contained in the egg. Diatoms, chiefly of the *Coscinodiscus* type, are found in the stomach, and in some cases also larvae.

In a later stage, at which the arms are branching, the epithelium of the oral surface has become thin, in marked contrast to the stage before the opening of the vestibule. The mouth may protrude above the oral surface like a small funnel so as to appear in transverse sections as a ring. In one case Mortensen found a thickening of the esophageal wall in the posterior interradius which made a distinctly delimited furrow that ultimately closed into a narrow canal. The thickening began at the level of the hydrocoele ring and continued for some distance below the rectum, ending as a small ridge that rose into the lumen of the stomach. Mortensen was at a loss to explain this structure, which may, he said, be some abnormality perhaps due to the fact that the stomach in this individual was strongly distended by the embryo which it had eaten. In another case there was a thickening of the esophageal wall in the posterior interradius; but in this in passing downward it soon broadened and passed gradually over into the normal condition of the entodermal epithelium.

The stomach is provided with folds. In the strongly dilated stomach of the individual that had eaten an embryo these folds had disappeared.

The anal opening has been formed.

The hydrocoele ring is not yet completely closed; numerous trabeculae have been formed in its lumen. A thickening of the epithelium over the upper side of the hydrocoele ring is the rudiment of the nerve ring; below this is an indication of circular muscle fibers. The stone canal has lengthened considerably, and the pore canal has again acquired an opening to the exterior. The parietal canal has opened into the oral coelome. In the aboral coelome some irregularly disposed trabeculae are seen.

The "primary gonad" is distinct.

The axial organ has developed into a conspicuous cord, and the chambered organ is very distinctly quinquelocular with a fairly large lumen.

In the arms of the larger pentacrinoids the primary (azygous) tentacle is seen situated in the fork. As it remains here it must ultimately be resorbed. The radial canals of the arm branches originate as lateral offshoots from the primary radial canal a little below the free azygous tentacle. In each triplet of tentacles the distal is the first to develop.

At the first stage in the development of the skeleton the orals and basals, as branching spicules, are arranged in two circlets, the plates of the basal circlet lying almost exactly below the corresponding plates of the oral circlet. The terminal stem plate has been formed, and a few columnals are indicated by very small spicules. Infrabasals are wholly lacking.

In the fully formed larva the orals and basals are large fenestrated plates arranged in 2 regular semicircles leaving a broad open gap on the ventral side. The two semicircles are at first widely separated from each other, the orals occupying the posterior and the basals the anterior end of the larva. The terminal stem plate is large and fenestrated, and the columnals have increased considerably in size and number. Their exact number is difficult to ascertain because they lie so close together.

Finally, the oral and basal plates increase in size until they are in contact with each other and reach to near both the poles. This stage was observed by Dr. John in the *Discovery* material.

The freshly attached pentacrinoid is very completely enclosed by the orals and basals. The columnals are still very short, and so closely crowded that it is impossible to count them. The proximal third of the column is still enclosed by the basals.

The columnals now increase in length, and their number, 18, can be determined. They are still quite short, with the central annulus projecting strongly, which gives the column a serrate appearance. Now only the youngest columnals lie within the basal ring.

Contemporaneously with the lengthening of the stalk, the orals begin to acquire prominent lateral borders.

In the next stage the characters of the orals are much more marked, the upturned lateral borders being broad and thickened; generally speaking, the calyx plates are unusually thick and massive, and are finely tuberculated. Along the lower edge of the orals, a zone of growth is very distinct, indicated by the linear disposition of the holes, which are very small. The radials have appeared, and also the radianal, which is slightly larger than the corresponding radial, and thus has been formed prior to the latter. The columnals have lengthened considerably, especially the lower ones, and are now more rounded in outline, the median annulus being much less prominent. There are 21 of them.

In the following stage the radials have increased considerably, and, like the orals and basals, show a distinct zone of growth. The IBr_1 have formed and have assumed the shape of an elongate scale. Within the tentacles elongate spicules have developed. The radianal has already been exceeded by the corresponding radial; it covers the corner of the latter and of the adjacent oral. It is of the same dense structure as the other calyx plates. The columnals are about to assume their final form, but the median annulus still projects slightly. There are 24 columnals, of which the short proximal are somewhat broader than the others. The terminal stem plate is slightly lobed.

In the most advanced stage found, the first pinnule has appeared, on the twelfth brachial. The first whorl of cirri, radial in position, has been formed. The radials and the IBr_1 have become much broader, and are about to assume their final shape. The orals, lying in the middle of the disk which has increased considerably in size, are widely separated from the basals. The radianal remains small and is no longer in contact with the adjoining radial and oral. Along the arms some branching spicules are seen, representing the side and covering plates. The stem contains 24 columnals, which are slightly thickened at the ends. The upper half of the stem is stouter and more robust than the lower half. The 4 topmost columnals are quite short and increase in width to the centrodorsal, which is the broadest.

In another specimen there are 3 pinnules on each arm, and a second whorl of cirri is beginning to develop alternating with the first. The cirri in the first whorl are now fully formed, with 14 segments and a terminal claw.

Localities.—Antarctic (Swedish South Polar Expedition) station 5; southeast of Seymour Island, in the Graham Land region, south of Cape Horn (lat. 64°20′ S., long. 56°38′ W.); 150 meters. [Mortensen, 1918] (1, C.M.).

Antarctic station 5a; same locality and depth [Mortensen, 1918].

Antarctic station 59; Burdwood Bank, south of the Falkland Islands (lat. 53°41′ S., long. 61°10′ W.); 137–150 meters; bottom temperature 3.20° C. [Andersson, 1904, 1908; Mortensen, 1918] (4, S.M.).

Antarctic station 58; Burdwood Bank (lat. 52°29′ S., long. 60°36′ W.); 197 meters; bottom temperature 4.30° C. [Mortensen, 1918] (1, S.M.). Restricted type locality.

Antarctic station 2; off the Rio de la Plata (lat. 37°50′ S., long. 56°11′ W.); 100 meters [Mortensen, 1918].

Antarctic station 1; southeast of Rio Grande do Sul, Brazil (lat. 33°00′ S., long. 51°10′ W.); 80 meters [Mortensen, 1918].

[*Discovery* Investigations station 175; Bransfield Strait, South Shetlands (lat. 63°17′20″ S., long. 59°48′15″ W.); 200 meters; at 190 meters, temperature −0.48° C., salinity 34.34°/₀₀; mud, stones and gravel; March 2, 1927 [John, 1938] (1 female, B.M.) ?*vivipara*.]

Discovery Investigations station 652; Burdwood Bank (lat. 54°04′ S., long. 61°40′ W.); 169–171 meters; at 172 meters, temperature 6.10° C., salinity 34.10°/₀₀; March 14, 1931 [John, 1938] (15 males, 3 females, 1 pentacrinoid, B.M.).

Discovery Investigations station WS 81; 8 miles N. 11° W. of North Island, West Falkland Island (from lat. 51°30′ S., long. 61°15′ W. to lat. 51°30′30″ S., long. 61°10′ W.); 81–82 meters; at 75 meters, temperature 8.22° C., salinity 33.89°/₀₀; sand; March 19, 1927 [John, 1938] (3, B.M.).

Discovery Investigations station WS 83; 14 miles S. 64° W. of George Island, East Falkland Island (from lat. 52°28′ S., long. 60°06′ W. to lat. 52°30′ S., long. 60°09′30″ W.); 137–129 meters; at 120 meters, temperature 7.60° C., salinity 33.83°/₀₀; fine green sand and shells; March 24, 1927 [John, 1938] (12, B.M.).

Discovery Investigations station WS 85; 8 miles S. 66° E. of Lively Island, East Falkland Island (from lat. 52°09′ S., long. 58°14′ W. to lat. 52°08′ S., long. 58°09′ W.); 79 meters; at 75 meters, temperature 8.30° C., salinity 33.79°/₀₀; sand and shell; March 24, 1927 [John, 1938] (2, B.M.).

Discovery Investigations station WS 212; north of the Falkland Islands (lat. 49°22′ S., long. 60°10′ W.); 242–249 meters; at 230 meters, temperature (at midday) 5.84° C., (at 8 a.m.) 5.69° C., salinity 34.03°/₀₀; green sand, mud and pebbles; May 30, 1928 [John, 1938] (1, B.M.).

Discovery Investigations station WS 228; northeast of the Falkland Islands (lat. 50°50′ S., long. 56°58′ W.); 229–236 meters; at 230 meters, temperature 5.31° C., salinity 34.12°/₀₀; coarse white sand; June 30, 1928 [John, 1938] (1, B.M.).

Discovery Investigations station WS 248; off the Falkland Islands (lat. 52°40′ S., long. 58°30′ W.); 210–242 meters; at 235 meters, temperature 5.28° C., salinity 33.98°/₀₀; fine green sand, pebbles and shells; July 20, 1928 [John, 1938] (4, B.M.).

Discovery Investigations station WS 824; Falkland Islands (lat. 52°29′ S., long. 58°27′ W.); 137–146 meters; at 140 meters, temperature 5.45° C., salinity 33.87°/₀₀; green speckled sand and shells; January 19, 1932 [John, 1938] (2, B.M.).

Discovery Investigations station WS 877; off the Falkland Islands (lat. 52°35′30″ S., long. 61°04′ W.); 350 (−0) meters; at 340 meters, temperature 4.86° C., salinity 34.15°/₀₀; April 4, 1932 [John, 1938] (11 and pentacrinoids, B.M.).

Scotia; Burdwood Bank [Vaney, 1939].

Geographical range.—Known from the northwest Weddell Sea, the Burdwood Bank and Falkland Islands area north to 33° S., off the southern tip of Brazil, and ? from the Bransfield Strait.

[NOTE BY A.M.C.] No type locality was given by Mortensen since he did not select a holotype from among his specimens. In view of the wide range of localities covered by the type material, it is desirable that a lectotype should be selected, the best specimen for this purpose being the male one from the Swedish South Polar Expedition station 58 on the Burdwood Bank, Stockholm Museum number 242, figured by Mortensen on plate 1, figure 6.

Bathymetrical range.—From 79 to 242 (? 350) meters.

Thermal range.—From 3.20° to 8.30° C. (−0.48° for the doubtful Bransfield Strait specimen). [NOTE BY A.M.C.] No bottom temperature was obtained from the Swedish South Polar Expedition station 5, to the east of Graham Land in the Weddell Sea, but at the neighboring station 11 at 400 meters the temperature was −1.10° C.

Salinity range.—From 33.79 to 34.15 parts per thousand. (34.34 for the Bransfield Strait Specimen).

History.—This species was first mentioned under the name of *Antedon hirsuta* by Dr. K. A. Andersson in 1904 and 1905 in a special study on the viviparity of some specimens taken by the Swedish South Polar Expedition with the *Antarctic* on the Burdwood Bank.

In 1915 I commented that Andersson's material belonged to a species closely related to *Isometra angustipinna* if not identical with it.

The detailed description and recognition of the species as new was carried out by Dr. Th. Mortensen in 1917 and 1918. He recorded it from six *Antarctic* stations, two of which were on the Burdwood Bank, two off Graham Land, and two much farther north off southern Brazil.

In 1920 Mortensen followed this by a very detailed account of the embryology and development of the species.

Gislén in 1924 included this species among those of which he studied the articulations of the arms.

The species was not found among the collections of the *Terra Nova*, German South Polar Expedition, the *Belgica*, the Australasian Antarctic Expedition or the B.A.N.Z.A.R.E. However, a number of specimens were taken by the *Discovery* Investigations again on the Burdwood Bank as well as in the vicinity of the Falkland Islands. Details of these were given by Dr. Dilwyn John in 1938.

Some specimens were also obtained by the *Scotia* on the Burdwood Bank, but Vaney in 1939 gave no details about them.

ISOMETRA FLAVESCENS John*

Isometra flavescens JOHN, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 124 (with *Myzostomum*), p. 126 (range), p. 132 (in key), pp. 182–184 (station 160; description; comparisons), p. 187 (comparison with *I. graminea*), p. 192 (comparison with *I. hordea*); fig. 16, p. 182.

Diagnostic features.—The cirri are up to LX, 25–35; P_1 is much larger than P_2 (averaging 1.7 times the length of P_2 in eight specimens) with 9 to 14 segments; P_2 has 6 to 9 segments; P_3 (or P_4) is the first genital pinnule; the ventral surface of the disk, except between the arm bases, is plated.

Description (modified from John, 1938).—The species is fairly small but robust. The arms of all the twelve type specimens were broken but probably measured just over 40 mm. in length when complete. The length from IBr_1 to the second syzygy is from 8.5 to 10.5 mm. in ten specimens measured.

The centrodorsal is conical and closely covered with cirrus sockets, which may, however, leave free a small, bare, flattened dorsal pole. The sockets are arranged in

* See also table 15 (p. 620), scatter diagram (p. 835), and Addenda (p. 837) under 1963.

rows which are regular near the apex but less so near the periphery. The proximal edge is slightly produced interradially.

The cirri are XXXVII–LX; 25–35. Most of the segments are wider than long. The opposing spine is strong and erect, the terminal claw short and curved.

In the three smaller syntypes, the radials are nearly as long as the IBr_1 but in the larger ones they are relatively shorter. The IBr_2 (axillary) may form a slight shoulder-like projection with the IBr_1 where it incises it. The lateral edges of the ossicles of the IBr series and the first two brachials have sharp and nearly straight sides. The other brachials are less smooth, becoming progressively more thorny towards the distal end of each one.

The first and second syzygies are usually between brachials 3+4 and 9+10 but there are many exceptions to this.

P_1 is longer and stouter than P_2, usually having 10 to 13 segments and measuring 4.5 to 7.5 mm. in length; the first four to six of the segments are attached to the disk and may be distinctly heavier than the following segments. P_2 is of 7 to 9, usually 8 segments, 2.5 to 4.5 mm. long; the first two segments are webbed to the arm. In 10 specimens measured, P_1 was over half again as long as P_2.

The species is viviparous and the middle segments of the genital pinnules are expanded. In the females this expansion is limited to the third and fourth segments but in the males it extends for about five segments and is mainly on the aboral side. P_3 is usually the first genital pinnule but on some arms or specimens it may be P_4. In the female, P_3, when it is a genital, measures 4 to 5 mm. and has about 9 segments while in the male it has 10 segments and measures 5 mm. The following genital pinnules increase in length and number of segments; P_{11} of a female has 14 segments and measures 8 mm. and P_{15} of a male has 18 segments and is also 8 mm. long. The segments of all the pinnules, except those of P_1 and sometimes also of P_2, have strongly thorny distal edges. On the expanded segments of the genital pinnules the thorny part is limited to the midline and the adoral side of the distal edges, being absent from the aboral side where the main expansion lies.

The embryos in the brood pouches were found to be similar to those of *Isometra vivipara*, the largest having the oral and basal plates in contact with one another and measuring 0.5 to 0.6 mm. in length.

The ventral surface of the disk, except between the arm bases, is plated, the disk ambulacra being lined by strong plates. At the apices of two of the interradii there are large plates like orals in the single specimen sacrificed for examination, but these appear to be absent from the apices of the other interradii. Otherwise, the interradii are occupied by plates of different sizes. In the anal interradius there are two plates of conspicuous size, one resting on the perisome and the other, in contact and in line with it, on the base of the anal cone, on which there are other plates. In nine other specimens some plates could be seen on the disk.

Sacculi are numerous, regular and conspicuous on the arms and pinnules of the dusky coloured males, but inconspicuous on the others.

The distal pinnules of some specimens have no ambulacral skeleton, but those of others have reduced side and cover plates. The most elaborate have side plates in the form of rods, which may be simple or forked; the cover plates fan out from a simple stem at the base. There may be some smooth or knobbed spicules in the tentacles.

None of the female syntypes bore pentacrinoids on the arms.

Most of the specimens were infested with *Myzostomum*, usually on the disk.

The color in life was described as mustard yellow.

Locality.—*Discovery* Investigations station 160; near Shag Rocks (lat. 53°43′40″ S., long. 40°57′ W.); 177 meters; at 170 meters, temperature 1.42° C., salinity 34.22°/₀₀; gray mud, stones and rock; February 7, 1927 [John, 1938] (11, B.M., six males and five females).

Subfamily Bathymetrinae

Bathymetrinae A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 177 (includes *Bathymetra* and *Thaumatometra*); Crinoids of the Indian Ocean, 1912, p. 6 (distribution of species included), p. 26 (range in detail; 80–2900 fms.), p. 61 (in key); Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7–8 (temperature relations); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., 1914, pp. 6 and following (Atlantic and corresponding Indo-Pacific genera); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges); No. 20, p. 582 (relation to temperature of habitat); vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance); Die Crinoïden der Antarktis, 1915, p. 146 (diagnosis; geological, geographical, bathymetrical and thermal ranges; species of this subfamily in some ways resemble the young of the species of Heliometrinae); Amer. Journ. Sci., vol. 40, 1915, p. 68 (detailed discussion of bathymetrical range); Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (includes *Orthometra*, *Tonrometra*, *Fariometra*, *Trichometra*, *Hathrometra*, *Nepiometra*, *Phrixometra*, *Thaumatometra* and *Bathymetra*); No. 16, p. 505 (in key), p. 510 (key to the included genera); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. VIII (3 new species of *Psathyrometra* almost bridge gap between this subfamily and Zenometrinae), p. 197 (in key), p. 244 (key to the included genera).—Mortensen, Wiss. Ergebn. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, Crinoidea, 1918, p. 17.—A. H. Clark, Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (represented in the West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 2.—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, pp. 10, 139, 140, 144, 147.—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 49 (in key), p. 53 (key to Atlantic genera).—Gislén, Ark. Zool., vol. 15, No. 23, 1923, p. 15; Zool. Bidrag Uppsala, vol. 9, 1924, pp. 88, 91 (articulations), p. 232 (characters), p. 184 (no side and covering plates).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key).—A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 662; Ann. Mag. Nat. Hist., ser. 10, vol. 10, No. 58, 1932, p. 383; Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (*Boleometra* and *Retiometra*, genera nov.); Sci. Rep. Australasian Antarctic Exped. 1911–14, vol. C8, pt. 4, 1937, p. 5.—John, *Discovery* Reports, vol. 18, 1938, pp. 123, 124, 164.—Gislén, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 34, No. 17 (Kungl. Fysiograf. Saalsk. Handl., N.F., vol. 49, No. 17), 1939, p. 10.—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 141 (in key).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (depth range).

Batymetrinae Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 10.

Diagnosis.—A subfamily of Antedonidae in which the cirrus sockets are arranged in alternating transverse rows or are closely and irregularly crowded on a conical to hemispherical or even almost discoidal centrodorsal; the cirri are well developed, but never very long or very stout, with rarely more than 45 (usually 15 to 35) segments, of which the longer proximal ones are always longer than wide and may be up to 6 times as long as wide; the distal segments are shorter and tend to be carinate dorsally, usually bearing more or less prominent dorsal spines; P_1 is always stiffened, but very slender, and is composed for the most part of much elongated segments, often constricted in the middle and flared and spinous at their distal ends; P_2 is usually shorter than P_1 but may be similar to it or even longer and with or without a gonad; it usually resembles P_3; all of the pinnules are invariably present, and the genital pinnules may bear a marsupium.

Geographical range.—The species of this subfamily occur in deep water everywhere except in the Arctic seas (north of the Wyville Thomson ridge and 65° N. in Davis Strait) and in the Mediterranean.

Bathymetrical range.—From 28 to 5301 meters.

The species of this subfamily are chiefly inhabitants of deep water. Of the 11 included genera, only one (*Hathrometra*) has been found in less than 50 meters. Seven (*Hathrometra*, *Retiometra*, *Phrixometra*, *Boleometra*, *Trichometra*, *Fariometra* and *Thaumatometra*) are found between 200 and 500 meters, while 8 occur in water of over 1000 meters. Five genera (*Fariometra*, *Tonrometra*, *Trichometra*, *Thaumatometra* and *Bathymetra*) occur in water of more than 2000 meters; of these *Tonrometra* and *Thaumatometra* extend to over 3000 meters, while *Bathymetra* is only known at 4753 and 5301 meters.

Several of the included genera are remarkable for their great vertical distribution. Thus *Thaumatometra* ranges through 3093 meters, *Trichometra* through 1937 meters, *Fariometra* through 1990 meters, *Hathrometra* through 1755 meters, and *Retiometra* through 980 meters.

Thermal range.—From −0.48° C. to +15.67° (?15.83°) C.

The species of this subfamily are almost exclusively inhabitants of cold water. The maximum representation is between 2° and 6°. Of the genera for which temperature records are available only one is found below 0° C. and only 2 (*Hathrometra* and *Trichometra*) above 8°.

It is interesting that the genus (*Thaumatometra*) with the greatest vertical range, 3093 meters, appears to have only a limited thermal range, from 0.39° to 5.95°, or 5.56°.

The maximum thermal range, 13.27°, is shown by *Trichometra*, though *Hathrometra* has a range of 11.89°.

The thermal range of the other genera so far as we know, is very much more restricted, that of *Fariometra* being 5.34°, of *Retiometra* 3.1°, and of *Bathymetra* only 0.78°.

Characters.—The centrodorsal in the Bathymetrinae varies from conical, slightly higher than broad at the base with straight or slightly convex sides through rounded conical to hemispherical and even to much flattened and almost discoidal. It is most commonly rounded conical to hemispherical, and from half again to twice as broad at the base as high.

In most species the numerous cirrus sockets, which may be as many as 100 in number, but are usually between 25 and 50, almost completely cover the sides of the centrodorsal. They are in most cases arranged in several closely crowded alternating rows, those of succeeding rows decreasing very slowly in size toward the dorsal pole. Sometimes they are less numerous and less crowded, and more irregular in their arrangement, and the number of rows may decrease to about 3, or even to a single irregular row of 10 to 15 sockets situated either about the dorsal pole or about the periphery, as in *Bathymetra*.

As a rule the bare dorsal pole is very small though in one species (*Retiometra alascana*) it reaches a diameter of about a third that of the base of the centrodorsal. It is ordinarily convex to more or less sharply pointed and smooth or nearly so. In a few species it is roughened or pitted, in one (*Thaumatometra minutissima*) it bears several rather long spines, and in another (*Thaumatometra tenuis*) it is more or less concave.

The cirri range in number from 10 to about 100, but are usually between 30 and 60. There is always some difference between those about the periphery of the centrodorsal and those about the dorsal pole; when the cirri are very numerous the apical ones may be only a third as long as the peripheral with not more than half as many segments, which are more uniform and more generalized in structure.

The cirri are always of moderate size, sometimes rather slender but never very stout, and vary from about 10 to 40 percent of the arm length. They are most commonly between 25 and 35 percent of the arm length, or from a quarter to a third the length of the arms.

As a rule they are rather delicate and fragile and easily detached from the centrodorsal, especially in those species in which the centrodorsal is conical. They are always laterally compressed, more strongly in the distal than in the proximal portion, and are sometimes, especially in some species of *Thaumatometra*, much flattened.

The number of segments in the cirri varies from 8 to 10 in *Bathymetra abyssicola*, 10 in *Thaumatometra septentrionalis*, and 10 to 12 in *Thaumatometra parva* and in *Retiometra alascana*, up to 40 to 45 in *Trichometra vexator*. The majority of the species have between 15 and 30.

The distal segments are always shorter than the earlier segments. The longest segments vary from about as long as broad to about 6 times as long as broad, and are most commonly 2 or 3 times as long as broad. The distal segments are usually about as long as broad, but may be broader than long, or when the cirrus segments are all much elongated the penultimate may be as much as twice as long as broad.

Generally the longer segments are more or less strongly constricted centrally with expanded distal ends which overlap the base of the segment succeeding, this feature dying away as the segments become shorter and giving place to a sharp carination in the middorsal line which at the distal end may be produced into a spine. Sometimes the distal edges of the long earlier segments are spinous. Rarely the segments are neither enlarged nor overlapping at the ends.

The radials in the Bathymetrinae for the most part are very short, extending only very slightly beyond the rim of the centrodorsal in the median line and forming low triangles in the interradial angles. In some large species, as in *Boleometra clio*, they may be entirely concealed in the median line and only visible as low interradial triangles, while in the small species a relatively greater proportion of the dorsal surface is exposed. This reaches its maximum in the species of *Bathymetra*, in which the radials appear externally as relatively large plates twice as broad as long in the median line, extending far forward interradially where they separate the bases of the IBr_1.

The radials are never carinate or tubercular in the median line, and the distal border is almost invariably smooth, only very exceptionally showing a few fine spinules.

The disk is almost uniform throughout. It is large, with the interradial borders convex, straight, or slightly concave, and the surface is without visible calcareous deposits.

Sacculi are abundant along the ambulacral grooves of the pinnules, less numerous along those of the arms, and still less numerous along those of the disk.

The IBr series show a considerable amount of variation. The IBr_1 are short, usually from 3 to 5 times as broad as long in the median line, sometimes from 8 to 10 times as broad as long and rarely only twice as broad as long, usually with parallel or more or less strongly convergent lateral borders and the distal border more or less deeply excavated by a posterior process from the axillary, sometimes so much so that when viewed at right angles to the dorsoventral axis the IBr_1 appears bisected. The IBr_2 (axillaries) are usually rhombic and about as long as broad, frequently somewhat broader than long, in one case as much as half again as broad as long, but rarely longer than broad. The distal sides are more or less strongly concave, and the proximal sides are usually somewhat less concave. The distal angle is usually sharp, but often truncated, the truncation sometimes with a notch from which a shallow groove runs backward over the dorsal surface. The lateral angles may extend considerably beyond the laterodistal angles of the IBr_1.

The IBr series usually have a high and strongly arched dorsal surface and rounded sides; when the sides of the IBr_1 converge distally the lateral angles of the axillaries project for some distance beyond their laterodistal angles. The IBr series may be widely separated, or the lateral angles of adjacent axillaries may be in contact, with large rhombic open spaces below them. Sometimes the IBr series are much broadened and less convex dorsally and the edges of the component ossicles are everywhere in contact with those of their neighbors against which they may even be broadly and sharply flattened.

The proximal and distal borders of the elements of the IBr series are usually smooth, but there may be a greater or lesser development of spines, especially at and near the lateral angles of the axillaries. In only a single species (*Tonrometra brevipes*) is the dorsal surface studded with small spinules.

The arms are invariably 10 in number; no case of an individual with more than 10 arms has ever come to light, nor is there any record of an individual with less than 10 arms.

In length the arms range up to 130 mm., being most commonly between 20 and 60 mm. In only 3 or 4 species does the arm length exceed 90 mm.

The first brachials are always very short, with the outer edge from half again to 4 or even 5 times (usually about twice) as long as the inner, and the distal border more or less deeply excavated. The inner borders are usually entirely free, but they may be basally in contact, or even united for half their length.

The second brachials are irregularly 4-sided or triangular and much larger than the first, usually about as long as broad, rarely longer than broad.

The first syzygial pair is usually somewhat longer interiorly than exteriorly, and in extreme cases the interior length may be as much as twice the exterior. The proximal edge of the hypozygal is always more oblique than the distal edge of the epizygal. Generally this pair is nearly oblong, somewhat broader than long, but it may be as long as broad, or even almost twice as long as broad, as in *Bathymetra*.

The 4 to 6 brachials following the first syzygial pair are oblong to more or less wedge-shaped, broader than long to nearly as long as broad, and the following become very obliquely wedge-shaped or triangular, about as long as broad or slightly longer than broad, and distally gradually less obliquely wedge-shaped and elongate, finally centrally constricted with swollen ends.

The ends of the oblong or wedge-shaped earlier brachials may be smooth or bordered with fine spines; they are sometimes abruptly everted, standing out at right angles to the dorsal surface as high spinous ridges, or they may be thickened and smooth. The distal edges of the outer brachials are usually somewhat produced and finely spinous, more rarely coarsely spinous.

Only rarely are the synarthrial tubercles noticeable, while articular tubercles only occur in robust individuals of *Thaumatometra tenuis*, the largest species in the subfamily.

In all the included species syzygies occur between brachials 3+4, 9+10, and 14+15; the distal intersyzygial interval is from 2 to 6 muscular articulations, 2 in about 44 percent, 3 in about 30 percent, and 4 in about 17 percent; only exceptionally and by variation do 5 and 6 occur.

P_1 varies from about 10 to as much as 28 percent of the arm length, averaging 18 percent, or nearly a fifth; the number of segments varies from about 10 in some small species of *Thaumatometra*, possibly also in the species of *Bathymetra*, to 42 in *Hathrometra sarsi*, the average number being 20. The pinnule is usually very slender, with all the segments but the first 3 or 4 greatly elongated. Usually from 2 to 4 of the basal segments are no longer than broad; but in some species only the first segment is no longer than broad, while in *Boleometra clio* and *Thaumatometra tenuis* from 5 to 7 of the basal segments are broader than long with their corners cut away so that the pinnule, which in these forms has up to 35 segments, resembles somewhat the corresponding pinnule in the Heliometrinae. The outer segments of P_1 are always more than twice as long as broad, sometimes, as in *Boleometra*, not much more, but more often, as in *Hathrometra* and in *Trichometra*, excessively elongated. The longer segments almost always have more or less prominent spinous distal ends.

P_1 is longer than P_2 in about 60 percent of the species in which the pinnules have been described, varying from only slightly longer to a little more than 3 times as long and being mostly from a third to a half again as long. In about 20 percent of the species it is of the same length as P_2, and in the same number of species it is somewhat shorter.

P_2 when shorter than P_1, as it usually is, consists of from 8 to 20 segments, averaging 13, and has up to 15 segments less than the corresponding P_1. When of the same length as P_1, P_2 usually consists of about the same number of segments. P_2 is much more uniform in structure throughout the group than P_1, and usually resembles P_3. In only 3 or 4 cases is it intermediate in character between P_1 and P_3. In over a third of the species it bears a gonad.

P_3 is nearly always a genital pinnule, but in *Fariometra parvula* and *Thaumatometra isis* the first genital pinnule is P_4 or P_5. The genital pinnules are quite uniform throughout the group, varying only slightly in the number of segments, their relative length and the development of spines on their distal ends. There is a sudden departure from the usual structure, however, in *Phrixometra*, in which the genital pinnules of the females bear a pouchlike marsupium.

The distal pinnules are always very slender with all but the first 2 segments, which are short and broad, much elongated with more or less spinous distal ends. They are usually as long as P_1 and consist of from 15 to 20 segments.

The calcareous deposits in the ambulacral lappets most commonly consist of long, slender or stout more or less curved or bent rods with the outer ends usually expanded and spinulose and often pierced with a few holes. They may, however, be entirely absent.

The tentacles commonly contain a line or band of spicules along their outer side which may be inconstant, reduced to a few scattered spicules, or altogether absent.

For the details of the ambulacral deposits see vol. 1, part 2, pp. 274, 275.

Relationships of the genera.—In the subfamily Bathymetrinae the characters by which the genera are differentiated are distributed among the oral pinnules, the cirri, the centrodorsal, the genital pinnules and the brachials; in other words, the members of this subfamily are unusually well balanced forms and do not show one or two sets of structures highly diversified while others remain generalized, as do all the other comatulid groups.

There is a great temptation to consider the Bathymetrinae as a subfamily including generalized or "primitive" types and forming a complex from which the other subfamilies of the Antedonidae have been derived. Thus the Heliometrinae might seem to be an offshoot from the Bathymetrinae near the genus *Boleometra;* the Zenometrinae, as is shown by the young of *Psathyrometra mira* (see p. 525) pass through a bathymetrine stage in their development suggesting certain species of *Thaumatometra* besides which *Poliometra* and *Hathrometra* have much in common; the Thysanometrinae recall *Thaumatometra tenuis;* the Perometrinae are more or less similar to a small group of genera within the Bathymetrinae; and there is no very sharp line of demarcation between the Antedoninae and the Bathymetrinae.

Yet, heterogenous as the subfamily Bathymetrinae appears to be, there is a certain uniformity of structure throughout the group whereby any specimen may at once be recognized as belonging to it, and the diversity shown in all the structural features may better be interpreted as indicating the most virile and plastic of all the comatulid groups and the one which, as a result of its plasticity, has been able to adapt itself to the greatest ecological range, rather than as indicating any phylogenetic inferiority.

Standing somewhat apart from the rest of the Bathymetrinae are 2 genera, *Thaumatometra* and *Bathymetra*, in which the cirrus segments are much elongated and the cirri much compressed laterally. These live on ooze or mud in deep still water, and their highly specialized cirri are well adapted to such a habitat. *Bathymetra* has been assumed to be a very primitive type on account of its long radials; but the length of the radials results from the specialization of the centrodorsal which increases in length instead of in breadth, and this, taken in connection with the curious cirri, shows that it cannot be considered more primitive than any other genus in the group.

The species of *Thaumatometra* vary from species approaching those of *Bathymetra*, such as *Th. septentrionalis* and *Th. abyssorum*, to species like *Th. isis*, which approach the species of *Trichometra* and allied genera.

The occurrence of a marsupium on the female genital pinnules in which the young develop is an interesting feature of the genus *Phrixometra*, which otherwise is in no way remarkable.

Great elongation of P_1, which is slender and hairlike, but stiffened, and composed of numerous segments, while P_2 resembles P_3, characterizes *Hathrometra* and *Retiometra*. In the former the centrodorsal is conical, as in *Fariometra*, while in the latter it is hemispherical, as in *Trichometra* and other related genera. In *Retiometra* P_2 is a genital pinnule, as in certain species of *Thaumatometra* and other allied genera, while in *Hathrometra* it is not.

In *Boleometra* and in *Thaumatometra tenuis*, P_1 has numerous segments of which the basal 5 to 7 are not longer than broad and have the corners cut away as in the corresponding pinnule in the Heliometrinae. In *Thaumatometra tenuis* P_2, which is only a little shorter than P_1, is a genital pinnule, but in *Boleometra* it is distinctly shorter than P_1, though not a genital pinnule.

While the cirrus segments in *Thaumatometra* and *Bathymetra* are all elongated, those of *Orthometra* and *Tonrometra* are all relatively short, though of a different type in each genus.

Trichometra is peculiar in the constant presence of an abrupt spinous eversion of the distal edges of the earlier brachials, though this condition is approached by species in related genera.

[Notes by A.M.C.] In the typescript, Mr. A. H. Clark had made *Phrixometra*, including only *P. longipinna* (P. H. Carpenter), a synonym of *Nepiometra*. However, John (1938) pointed out that the original description of the pinnules of *longipinna* and hence the diagnosis of *Phrixometra* by Mr. Clark (1917), were erroneous, the pinnules following P_2 being in fact distinctly different from the first two pinnules and not similar to them. Also Carpenter did not perceive the marsupia. *P. longipinna* cannot therefore be reconciled with the diagnosis of *Nepiometra* and accordingly I have reinserted the genus *Phrixometra*. As for *Thaumatometra nutrix* Mortensen, which was included in *Phrixometra* by John, together with a new species *P. rayneri*, Mr. Clark had previously erected a new genus for it in the typescript, which was distinguished by the presence of the marsupium. There is now no distinction between *longipinna* and *nutrix* on this count and although *nutrix* has the genital pinnules similar to the preceding oral ones, unlike *longipinna*, *P. rayneri* is intermediate in this respect. A new genus for *nutrix* therefore appears to be unwarranted and in addition the existing material of these three species is so inadequate that it seems inadvisable to complicate the nomenclature further.

I have also included in the genus *Phrixometra* the species *Antedon exigua* P. H. Carpenter from off Marion Island in the Southern Ocean. This was included in *Retiometra* when that genus was described by Mr. Clark in 1936, but a comparison with the type specimen of *R. alascana* and with specimens of *Phrixometra longipinna* has convinced me that *exigua* is congeneric with the southern rather than the northern species.

In checking Mr. Clark's key to the genera of this subfamily, I found that most of it no longer holds good according to the data now available, new specimens and species having been described since it was written. The following artificial key was drawn up with some difficulty and I was unable to avoid using several characters, such as the proportions of the cirrus segments and numbers of pinnule segments, which are somewhat variable with size.

Two species—*Tonrometra spinulifera* (transferred here from the genus *Florometra* of the Heliometrinae) and *Thaumatometra tenuis*—stand so far apart from the other species of *Tonrometra* and *Thaumatometra* in the characters used in the key that they have had to be dealt with separately. Although I have no doubt that *spinulifera* is congeneric with the type species of *Tonrometra*, *T. remota*, *Thaumatometra tenuis* is so well marked off from the other species of the genus by the numerous segments of P_1 (about 35 as opposed to 10 to 20 in all the rest) that I think it should be isolated from them. A new generic name would then be necessary for the other species now included in *Thaumatometra* since *tenuis* is itself the type species.

It was also found necessary to key out the genus *Phrixometra* twice over to cover male specimens lacking the characteristic marsupium and, since its species may have the proportions of the cirrus segments intermediate between those found in the other genera, three alternatives rather than the usual two were inserted at this point (*b*).

Finally the genus *Orthometra* is so little known, particularly with regard to the pinnules, that I cannot find any character to support the geographical range which will distinguish it from all the species of *Tonrometra*.

KEY TO THE GENERA OF BATHYMETRINAE

[modified by A.M.C.]

a^1. The female with a marsupium in the form of a pouch on each genital pinnule (off Uruguay to the South Shetlands, South Georgia and Marion Island; 137–1097 meters)__**Phrixometra** ♀ (p. 653)

a^2. No marsupium present.

b^1. The longest segments of the peripheral cirri two to three times as long as broad, the distal segments as long as broad or a little longer; Southern Ocean; P_1 with markedly flared and spinous distal ends to the segments; up to 25 cirrus segments (off Uruguay to the South Shetlands, South Georgia and Marion Island; 137–1097 meters)____________**Phrixometra** ♂ (p. 653)

b^2. Longest cirrus segments up to three times as long as broad, distal segments not longer than broad; if from the Southern Ocean then P_1 has the segments hardly at all enlarged at the joints and the peripheral cirri have 25–37 segments.

c^1. P_1 with over 20 segments.

d^1. Peripheral cirri with up to 30 segments; P_1 with about 30 segments of which the first five to seven are not longer than broad (SW. Japan; 195 meters)______**Boleometra** (p. 665)

d^2. Peripheral cirri with 30–45 segments; P_1 with up to 25 segments of which not more than three (or four) are not longer than wide.

e^1. P_2 distinctly shorter than P_1 and with many fewer segments (Cuba to Greenland, Iceland, the Faroes and south to Portugal; 256–2193 meters)________**Trichometra** (p. 668)

e^2. P_2 similar in size and number of segments to P_1 (Antarctic; 1266 meters).
Tonrometra spinulifera (p. 686)

c^2. P_1 with up to 20 segments.

d^1. Division series and proximal brachials with smooth distal edges (Meangis Islands, East Indies; 914 meters)______________________________________**Nepiometra** (p. 678)

d^2. Division series and proximal brachials more or less flared and spinous at the distal edges.

e^1. NE. Atlantic; 698–987 meters_______________________________**Orthometra** (p. 680)

e^2. Southern Ocean and East Indies; 1089–3426 meters____________**Tonrometra** (p. 682)

b^3. Longest cirrus segments two and a half to six times as long as broad, the distal segments also longer than broad.

c^1. Only X–XV cirri (south from Australia and north from Midway Island, North Pacific; 4753–5301 meters)____**Bathymetra** (p. 691)

c^2. XXV or more (usually XXX–XL) cirri.

d^1. P_1 with 25 or more segments.

e^1. P_2 much shorter than P_1.

f^1. 12–20 cirrus segments (off Alaska; 291–1270 meters)___________**Retiometra** (p. 695)

f^2. 24–33 cirrus segments (Chesapeake Bay to southern Greenland, Iceland, Ireland, north of Scotland and the Scandinavian coast from western Sweden to East Finmark; 28–1783 meters)______________________________**Hathrometra** (p. 698)

e^2. P_2 little shorter than P_1 (Japan Sea area; 146 (?100)–1500 meters).
Thaumatometra tenuis (p. 744)

d^2. P_1 with less than 25 segments.

e^1. Cirri with 21–36 segments (East Indies, Arabian Sea and southern India and from Panama to Southern California; 204–2194 meters)_____________**Fariometra** (p. 723)

e^2. Cirri with 10–20 segments (from the Southern Ocean to India, the East Indies, Japan, north to the Bering Sea, from Greenland to Iceland, from Brazil and from north of New Zealand (? from Panama); 274–3239 meters)________**Thaumatometra** (p. 742)

Genus PHRIXOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 185, 186, pl. 30, figs. 1–3.

Thaumatometra (part) Mortensen, Wiss. Ergebn. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, p. 15; Studies in the development of crinoids, 1920, pp. 56–58 (development), fig. 8, pl. 28.—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (locality), p. 56 (in key).

Phrixometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae), p. 131 (diagnosis; type species *Antedon longipinna* P. H. Carpenter, 1888; range; included species); No. 16, p. 511 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 246 (in key; range), p. 253.—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86; *Discovery* Reports, vol. 18, 1938, p. 125 (genus previously known only from off the river Plate), pp. 164–174 (includes *P. longipinna* with the new variety *antarctica, nutrix* (Mortensen) and *rayneri* sp. nov.).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (depth range).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 75.

Diagnosis.—A genus of the Bathymetrinae with the cirri XXX–L, 12–25, the peripheral cirri with the longest segments two to about three times as long as their median width and the distal ones about as broad as long, rarely longer; the brachials are more or less spinous at their distal ends; the oral pinnules have up to 30 segments, which, after the first one or two, are longer than broad and the outer ones are markedly flared and spinous at their distal ends; the genital pinnules of the female each have a pouchlike marsupium alongside the ovary.

Type species.—*Antedon longipinna* P. H. Carpenter, 1888.

Geographical range.—Known from off Uruguay to the Burdwood Bank, Clarence Island and the Bransfield Strait area, the Shag Rocks, South Georgia, and off Marion Island.

Bathymetrical range.—From 137 (?91) to 1097 meters.

Thermal range.—From −0.48° to +3.20° C.

Salinity range.—From 34.22 to 34.34 parts per thousand.

Remarks [by A.M.C.].—The presence of a marsupium made of skin on each genital pinnule of the female of *Antedon longipinna* and *Thaumatometra nutrix* is enough to distinguish them generically from the other species of the subfamily. The question is whether each should be isolated in a distinct genus on the grounds of the similarity of the oral and genital pinnules in *nutrix* as opposed to their marked difference in size in *longipinna*. Only a single small specimen of the third species *P. rayneri* is known. It has P_2 longer than P_1 and P_3, the latter being the first genital pinnule. Dr. Dilwyn John was convinced of a close relationship between the three species, so I am accordingly leaving them together. At the same time I am including in this genus *Antedon exigua* P. H. Carpenter as explained on p. 652. Female specimens are not known but except for larger numbers of pinnule segments and longer cirrus segments the characters agree well with those of the species of *Phrixometra*.

KEY TO THE SPECIES AND SUBSPECIES OF PHRIXOMETRA

[by A.M.C.]

a^1. Cirri with 20–25 segments (off the coast of Uruguay; 1097 meters).
longipinna longipinna (p. 655)

a^2. Cirri with up to 20 segments.

b^1. Cirri about XLV or more.

c^1. The first genital pinnule shorter and with fewer segments than the preceding oral pinnule.

d^1. P_1 with about 18 segments (off South Georgia and Clarence Island; 236–490 meters).
longipinna antarctica (p. 656)

d^2. P_1 with up to 30 segments (off Marion Island; 137 (?91)—255 meters)----**exigua** (p. 658)

c^2. The first genital pinnule similar in length and number of segments to the preceding oral pinnule (Burdwood Bank and the Bransfield Strait; 150–200 meters)-------------**nutrix** (p. 661)

b^2. Cirri about XXX (Shag Rocks; 177 meters)-------------------------------**rayneri** (p. 664)

PHRIXOMETRA LONGIPINNA LONGIPINNA (P. H. Carpenter)

Antedon longipinna P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 185, pl. 30, figs. 1–3.—Bather, Geol. Mag., vol. 3, 1897, p. 119 (pinnules compared with those of *Millericrinus recubariensis*).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579.

Thaumatometra longipinna A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (published reference to specimen in the B.M.; *Challenger* sta. 320).

Phrixometra longipinna A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 131 (listed); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 253 (references); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (locality), p. 53 (in key).—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (range), p. 87 (protection of brood); *Discovery* Reports, vol. 18, 1938, p. 124, pp. 169–170 (redescription of type specimens).

Diagnostic features.—The cirri number about XXX, with 20 to 25 segments; the lower pinnules are all long, P_1 reaching to about the twelfth brachial and having 12 to 18 segments, measuring about 7 mm. in length while the first genital pinnule, usually P_3, has 9+ segments and is from 4 mm. long.

Description.—The centrodorsal is rounded conical, broader than high, with about 30 cirrus sockets arranged in fifteen slightly irregular columns alternating in level.

The cirri are about XXX, 20–25 (according to Carpenter). The longest segments are just over twice as long as broad and slightly constricted centrally; the last five are about as long as broad. The distal ends of the segments are slightly produced and overlapping.

The distal edges of the radials are just visible beyond the rim of the centrodorsal. The IBr_1 are short, laterally free, and each is deeply incised by a rounded proximal projection from the IBr_2. The latter are rhombic, about as long as broad, with a sharp distal angle which separates the inner proximal angles of the first brachials.

The 10 arms are about 20 mm. long in the largest of the three specimens. The brachials are rather long, the inner ones smooth, but the outer with thorny distal edges.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 2 muscular articulations.

According to Carpenter the first pinnules measured about 7 mm. and had 18 segments. In the largest specimen all the proximal pinnules are now broken. In one of the two smaller specimens a P_1 of 12 segments, 5 mm. long, remains intact, also a P_2 of 12 segments but 6 mm. long and a P_3, which is the first genital pinnule, of about 9 segments, 4 mm. long. The ambulacral furrow first appears on P_5. The distal pinnules have about 18 segments and are about 6.5 mm. long.

The one female specimen has a marsupium alongside each ovary on the third to fifth segments of the genital pinnules. Each is split open for the whole of its length, exposing the embryos within, which are arranged in a single layer and number up to 30. They are irregularly spherical, 0.18 to 0.24 mm. in diameter. All appear to be at the same early stage of development, having no skeletal plates within them and no bands of cilia around them.

Remarks [by A.M.C.].—Dr. Dilwyn John has described a subspecies *antarctica* of *P. longipinna* from off South Georgia and Clarence Island. It is distinguished from the types of *longipinna* by the smaller number of cirrus segments, the more irregular arrangement of the cirrus sockets and the relatively shorter pinnule segments.

Locality.—*Challenger* station 320; off the mouth of the river Plate (lat. 37°17′ S., long. 53°52′ W.); 1097 meters; temperature 2.89° C.; green sand; February 14, 1876 [P. H. Carpenter, 1888; John, 1938] (3, B.M.).

PHRIXOMETRA LONGIPINNA ANTARCTICA John*

Phrixometra longipinna var. *antarctica* JOHN, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 126 (in distribution table), p. 127 (brood pouches alongside and distal to the ovaries), p. 129 (distribution), p. 132 (in key), pp. 164–169 (stations; description of females and male differences); text-fig. 10, p. 166; pl. 4, figs. 5, 6.

Diagnostic features.—The cirri are about XLV, 17–19; the first genital pinnule, P_2 or P_3, is about half as long as the preceding one.

Description.—Female from *Discovery* Investigations station 156, now designated as lectotype.

The centrodorsal is a rounded cone with the dorsal pole large and rough. The cirrus sockets are closely crowded and arranged in indistinct columns more irregular than those of the types of *longipinna*. The ventral edge of the centrodorsal is produced into interradial corners.

Cirri about XLV, 17–19. The second segment is as long as broad, the third nearly twice as long as broad, a little constricted in the middle and considerably wider at the distal end than proximally. The fourth to sixth segments are the longest, up to two and a half times as long as broad; like the third they are constricted in the middle and expanded at the distal end. The following segments are progressively shorter but all are longer than broad. In addition they are laterally compressed so that the distal part of the cirrus is considerably wider than the median part. The opposing spine is strong, standing out at right angles to the penultimate segment. The terminal claw is also strong and is curved.

The radial is short. The IBr_1 is much longer; it is narrowed distally and is deeply incised by the posterior projection of the axillary, IBr_2. The latter is about as long as broad; the proximal edges are straight, the distal deeply concave. The adjacent IBr series are not in lateral contact.

On three of the arms one or more of the proximal syzygies are irregular in position, otherwise they are between the usual brachials.

The 10 arms were probably about 25 to 30 mm. long when complete. The longest remaining one has 35 brachials and is 20 mm. long.

The first brachials are short and incised by the second ones, which are slightly longer than broad and roughly triangular with the inner and distal edges concave, the outer convex. The brachials between the first two syzygies are roughly rectangular, those between the second and third syzygies are longer on one side than on the other and a little longer than broad. The distal brachials are more elongate and rectangular.

After the first four brachials, which are smooth, the distal edges become slightly raised and produced into spines which become conspicuous on the outer part of the arm.

* See also Addenda (p. 837) under 1963.

The first two segments of all the pinnules are short; the others are longer than broad and may be very elongated; their distal edges are strongly flared and spiny so that the joints have a swollen appearance. The oral pinnules are the longest, nearly twice as long as the first genital ones and about one and a third times as long as the outer pinnules. P_1 is broken in every case. P_a, P_2 and P_b are of 18 to 19 segments, 8 mm. long. P_3 is the first genital; it has about 10 segments and is about 4 mm. long; P_5 is similar but with a larger gonad; P_8 has 14 segments about 6 mm. long, and P_9, the last genital pinnule, is of 17 segments, 6 mm. long. The ambulacral furrow is only present on the outer genital pinnules. The distal pinnules have about 17 segments and measure about 6 mm. in length. The elongated segments of the oral pinnules are up to three times as long as broad; those of the lower genital pinnules may be relatively longer; those of the distalmost pinnules are shorter, only up to twice as long as broad.

Sacculi are fairly conspicuous, more numerous and more regularly arranged on the outer than on the genital pinnules. There are no side or cover plates along the pinnule ambulacra, but some of the tentacles have numbers of rodlike spicules.

The color in spirit was pale straw, except for the syzygial pairs which were dusky and gave a banded effect to the arm.

This subspecies is also brood protecting. The embryos undergo their development in marsupia placed on the aboral sides of the genital pinnules, alongside the ovaries. The ovaries and marsupia of the middle genital pinnules lie along the third to fifth segments. Both can be seen at the same time from the outside and their walls are so thin as to be transparent. The ambulacral furrow of the outer genital pinnules lies along the dividing line on the ventral side. The wall of each marsupium is split open for the whole of its length exposing the embryos within. There are 10 or 11 in each pouch, arranged in one layer and lightly attached to the floor of the chamber, the dividing septum, by an extremely thin membrane. They are roughly spherical, except that one end is strongly flattened to form the suctorial disk, from 0.21 to 0.24 mm. in diameter. All the embryos seem to be at the same developmental stage. The vestibulum is clearly marked. There are 4 bands of cilia, one lying around the edge of the suctorial disk. The skeleton consists of about 18 stem joints and a larger terminal plate, and of five oral and five basals, which are openly branching and may be nearly in contact.

Female from station 1948, which is much smaller:

The centrodorsal is a low rounded cone, with a large bare dorsal pole. The cirrus sockets appear to be arranged partly in columns and partly in alternating rows.

The cirri are L, 12–17. They are smaller than those of the first specimen and the opposing spine is reduced.

The distal edges of the lower brachials are more strongly everted and spiny than in the other specimen.

The pinnules are also similar but P_2 is the first genital pinnule. P_1 has 18 segments, about 5 mm. long. The segments after the second are just over twice as long as broad. P_2 has 8 segments, 2.5 to 3 mm. long. The third and following segments are nearly four times as long as broad. The gonad lies along the third to fifth segments. P_4 with 10 segments is 3.5 mm. long and its ovary and marsupium extend to the sixth segment. P_6 is the last genital pinnule.

There are rodlike side and cover plates with perforated or branched ends along some of the pinnule ambulacra and some of the tentacles contain large numbers of smooth and knobbed rodlike spicules.

The color of the first four or five cirrus segments was yellow, the rest were dusky; otherwise the specimen was light yellow.

The marsupia are very large and extend further distally than the ovaries. The transparent walls are often ruptured. The ovary lies a little to the adoral side of the pinnule, with the marsupium mainly on the aboral side but extending distally across the ventral side of the ovary onto the adoral side, so that it is comma-shaped. The embryos are in various stages of development, but the most highly developed are towards the distal end, which appears to be the most easily ruptured part. A large marsupium has about 17 embryos, which are arranged in an irregular double layer and are in various developmental stages. Since the most advanced are at the distal end, it is presumed that the eggs pass from the ovary into the proximal part of the pouch. The fully formed larvae are similar to, but larger than, those of the first specimen, being 0.30 to 0.36 mm. long.

Some males also from station 1948 are larger, with the ossicles of the division series and lower brachials relatively wider and more massive. The cirri are longer. In two specimens P_3 is the first genital, in the third it is P_2. P_1 has 19 to 20 segments, and is 5 or 6 mm. long. When P_2 is genital it has 12 segments, 4 mm. long. The testes are long fusiform bodies, the biggest lying along the third to eighth segments of the genital pinnules. The disk is naked, the anal cone high.

Localities.—*Discovery* Investigations station 156; off South Georgia (lat. 53°51′ S., long. 36°21′ W.); 200–236 meters; rock; January 20, 1927 [John, 1938] (1, the lectotype, B.M.). The type locality as now restricted.

Discovery Investigations station 1948; east of Clarence Island (lat. 60°49′ S., long. 52°40′ W.); 490–610 meters; January 4, 1937 (4 syntypes, B.M.).

Geographical range.—From South Georgia and the Bransfield Strait area.

Bathymetrical range.—From 200 to 610 meters.

PHRIXOMETRA EXIGUA (P. H. Carpenter)*

FIGURE 37

Antedon exigua P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 178, pl. 32, figs. 1–4 (description; localities; affinities); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 61 (intersyzygial interval).—HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 143 (range).—GRIEG, Bergens Mus. Aarb. for 1903, No. 5, 1904, p. 28 (intersyzygial interval).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 405 (antarctic representative of the *Tenella* group).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (of Carpenter, 1888=*Thaumatometra exigua*); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 246 (referable to *Hathrometra*).

Thaumatometra exigua A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (=*Antedon exigua*), p. 246 (synonymy; localities); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (published reference to specimens in the B.M.; *Challenger* sta. 145).

Hathrometra exigua A. H. CLARK, Bull. Inst. Océanogr. Monaco, No. 285, 1914, p. 20 (closely related to *H. tenella;* range); Journ. Washington Acad. Sci., vol. 5, No. 3, 1915, p. 81 (Antarctic; depth); Die Crinoïden der Antarktis, 1915, p. 105 (collected by the *Challenger*), p. 107 (in key to Antarctic crinoids), p. 144 (synonymy; localities; discussion), p. 168 (range), p. 169 (relationships).—GISLÉN, Ark. Zool., vol. 15, No. 23, 1923, p. 16 (in key), p. 30 (range); vol. 19, No. 32, 1928, p. 11 (notes).

Retiometra exigua A. H. CLARK, Proc. U. S. Nat. Mus., vol. 83, 1936, p. 248 (listed).

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* See also Addenda (p. 837) under 1963.

Diagnostic features.—The cirri have up to 20 segments, of which the longest are about three times as broad in the peripheral cirri and the distal part of each cirrus is distinctly wider dorsoventrally than the proximal part; P_1 has up to 30 segments; P_2, the first genital pinnule, is shorter, with fewer but longer segments.

Description [modified by A.M.C.].—The three syntypes are all badly broken. The one from station 145 has no cirri and in the two from shallower water off Marion Island no complete peripheral cirri remain and the proximal pinnules are all more or less broken. All three specimens appear to be males though the gonads are hard and shrunken in the one from station 145.

The centrodorsal in the syntype lacking cirri is hemispherical, 2.2 mm. in basal diameter and 1.4 mm. in vertical height, viewed interradially. The periphery is produced interradially. There are L-LX cirrus sockets all over the centrodorsal except for a small rough central patch. No special arrangement of the sockets is evident though some tend to form vertical lines. There are about four sockets in each line.

No complete peripheral cirrus remains; according to Carpenter and to a manuscript note by Dr. Dilwyn John, they had about 20 segments. A stump of seven segments has the longest segment about three times as long as the median width. A cirrus once removed from the periphery has 17 segments and is about 7 mm. long. The basal segments are relatively more slender than those of the peripheral stump, the longest (the fifth) being nearly four times as long as wide. The five or six segments before the penultimate are distinctly widened dorsoventrally relative to the first nine or ten segments, at the same time being considerably shorter, but the antepenultimate is still a little longer than wide. The opposing spine is moderate in size and the terminal claw curved and acute. The peripheral cirri would have had all the segments relatively shorter, to judge from the proximal part, so that the distal segments would probably not have been longer than wide. The apical cirri are much smaller and more slender.

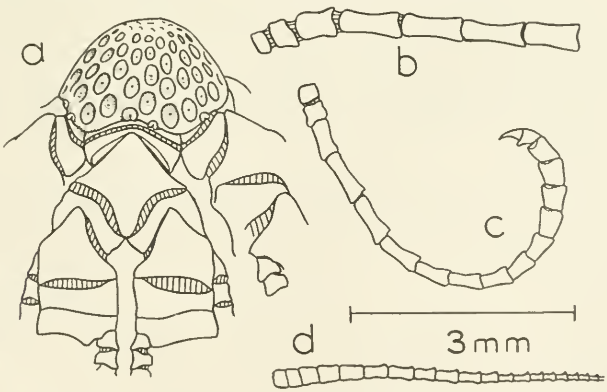

FIGURE 37.—*Phrixometra exigua* (P. H. Carpenter), syntype: *a*, Lateral view of calyx; *b*, proximal part of peripheral cirrus; *c*, cirrus from second row above periphery; *d*, P_1 (*incomplete*).

The radials are almost or quite concealed by the centrodorsal. The IBr_1 are short with slightly converging sides, almost concealed in the midline by the proximal processes of the axillaries which are rhombic and as long as broad with the lateral angles extending beyond the edges of the IBr_1.

The ten arms were about 85 mm. long. The first brachial is deeply incised in the median line by the proximal angle of the second. Inwardly the two first brachials just meet beyond the distal apex of the axillary. The brachials between the first two syzygies are oblong, about twice as broad as the median length, and the following ones are very obliquely wedge-shaped, almost triangular, gradually becoming elongate distally. The distal edges of the brachials are finely spinous.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of three muscular articulations. In one syntype from station 145 the first syzygy is 1.2 mm. in width. The other two specimens are of similar magnitude.

P_1 is greatly elongated, with 30 or more segments; all are now (1958) broken. The segments are relatively short, not more than twice as long as their proximal widths and conspicuously flared and rugous at their distal ends, especially dorsally. P_a is similar, sometimes with rather stouter segments. P_2 and P_b are considerably shorter and stouter according to Carpenter. They are certainly stouter and with much longer segments than P_1, still flared distally but not to the same extent. P_2 is the first genital pinnule. In one specimen the gonads are swollen but in the others they are more slender. The following pinnules appear to be similar to P_2.

Localities.—*Challenger* station 145; off Marion Island (lat. 46°43′00″ S., long. 38°04′30″ E.); 255 meters; volcanic sand; December 27, 1873 (3, B.M.).

Challenger; off Marion Island; 91–137 meters.

Remarks.—Carpenter wrote (1888) that this species differs from the Atlantic species of *Hathrometra* in the shortness of the later cirrus segments and in the characters of the lower pinnules, of which the second pair is relatively large and stout with more or less developed genital glands which do not appear in *Hathrometra* until the fourth or even the fifth pair. These are especially large and well developed in the two examples from the lesser depth, and the segments of the pinnules which bear them are proportionately stout. Another point of difference from *Hathrometra* is the greater posterior projection of the axillaries, so that the IBr_1 are almost entirely concealed in the middle line of the ray, while there is but little modification of the basal segments of the distal pinnules.

When I established the genus *Thaumatometra* in 1908, I assigned this species to it because of the occurrence of a gonad on P_2. But further study led me to believe that this is not a feature of prime importance, and on the basis of Carpenter's description and comments I adopted his view that this form is the southern representative of *Hathrometra tenella* and *H. sarsi*.

The discovery early in 1924 of a closely allied species in the Gulf of Alaska and the southeastern Bering Sea enabled me to determine that these two forms represent a distinct genus showing affinites with such genera as *Trichometra* and *Fariometra* and quite different from *Hathrometra*.

Remarks [by A.M.C.].—I cannot agree with Mr. Clark that *exigua* is congeneric with the North Pacific *Retiometra alascana*. Although the descriptions of the two are not unlike and the numbers of cirrus and pinnule segments are similar, a comparison of the actual type specimens has shown a number of differences in the shape of the centrodorsal, size of the dorsal pole, form of the division series, and ornamentation of the pinnule segments. Though the proportions of the cirrus segments may be similar, the distal enlargement of the cirri in *exigua* is not shared by *alascana*, whereas it does occur in some specimens of *Phrixometra*, notably of *P. longipinna antarctica*. Although confirmation from examination of the female genital pinnules is needed, I have little doubt that *exigua* should be referred to *Phrixometra*. It differs from the other species of the genus mainly in the shorter, more numerous segments of P_1 and the relatively longer cirrus segments.

PHRIXOMETRA NUTRIX (Mortensen)*

[See vol. 1, pt. 2, pl. 38, figs. 1232–1237]

Thaumatometra nutrix Mortensen, Wiss. Ergebn. schwed. Südpolar-Exped. 1901–1903, vol. 6, Lief. 8, 1918, pp. 15–18, pl. 5, figs. 1–7.—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (locality), p. 56 (in key).—Gislén, Zool. Bidrag. Uppsala, vol. 9, 1924, p. 28 footnote 1, p. 195 —A. H. Clark, Sci. Rep. Australasian Antarctic Exped., 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 5 (listed), p. 6 (doubtful member of genus), p. 8 (in key).—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (Antarctic and from Burdwood Bank), p. 87 (protection of brood), p. 88 (brood pouches and larvae).—Cuénot *in* Grassé, Traité de Zoologie, vol. 11, 1948, p. 55.—Dawydoff *in* Grassé, Traité de Zoologie, vol. 11, 1948, p. 353 (larva).

Phrixometra nutrix John, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 125 (viviparous), p. 126 (in table), p. 128 (brood pouches on adoral or aboral side of pinnules; young emerge in comatulid form; pentacrinoids within pouch), p. 129 (distribution table), p. 132 (in key), pp. 170–172 (station; description of new material); fig. 11, p. 171.—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, fig. 28E (pinnule with pentacrinoids), p. 75 (free swimming larval stage suppressed).

Diagnostic features.—The cirri are about XLV, with less than 20 segments; P_1 has about 14 segments; P_2 is usually the first genital pinnule and similar in length and number of segments to P_1.

Description.—The centrodorsal is rounded conical, about half as high as broad at the base, with the dorsal pole convex and a little roughened and the cirrus sockets closely crowded. The rim is regular, and not produced interradially.

The cirri are about XLV. Only a few of the peripheral ones which are not yet fully developed remain; judging from these the number of segments is about 20. No dorsal spines are developed on these young cirri, but, judging from the cirri of the pentacrinoids, there must be at least an opposing spine on the fully developed cirri. The proximal segments of the cirri are longer than broad, the distal much shorter; but it is uncertain whether this is also true of fully developed cirri.

The radials are very short in the median line, but their interradial angles are somewhat produced. The IBr_1 are short with rounded lateral edges which are not in contact with those of their neighbors. The IBr_2 (axillaries) are as broad as long.

The arms are 10 in number; the brachials have a row of short spines along the raised distal edge.

Syzygies occur between brachials 3+4, 9+10, and 14+15, thence at intervals of 2 muscular articulations.

P_1 is from 3 to 4 mm. long, composed of 14 slender and somewhat elongated segments, the distal edges of which are fringed with spines. P_2 is exactly like P_1, but bears a gonad. P_3 and P_4 are a little shorter, with only 9 segments and without an

* See also Addenda (pp. 836, 837) under 1962 and 1963.

ambulacral furrow. P_5 is 3.5 mm. long with 10 segments. P_7 is slightly longer with 11 segments, and has no gonad. None of the pinnules beyond P_7 or P_8 are preserved. All of the pinnules have the distal ends of the segments thickened and spiny.

There are no calcareous deposits along the ambulacral grooves, nor in the tentacles.

The disk is naked; the anal cone is high, situated near the oral angle of the interradial area.

The ambulacral furrows on the basal part of the arms are very inconspicuous, merely a narrow shallow groove apparently devoid of tentacles. Further out, from about P_4, the tentacles are distinct.

The sacculi are few and inconspicuous on the disk and lower part of the arms, becoming more numerous further out. On the genital pinnules they are somewhat irregularly arranged, but on the distal pinnules they are quite regular and fairly conspicuous.

[Notes by A.M.C.] A male specimen taken by the *Discovery* Investigations in the Bransfield Strait, which is south of the Antarctic convergence, was ascribed to this species by Dr. Dilwyn John. The type specimen of *nutrix* was from the Burdwood Bank, which is not an antarctic locality and which has a fauna distinct in the main from that of the South Shetlands—Bransfield Strait area.

The Bransfield Strait specimen has most of the cirri present and complete but the arms are badly broken.

The centrodorsal is low and rounded with a rather large, slightly rough dorsal pole. The cirrus sockets are closely set and indistinctly arranged in columns.

The cirri are about XLVII, 12–18. After the first two segments, which are very short, the segments are longer than broad, though the distal are only slightly so. The third to about the seventh are the longest; they are slightly constricted in the middle, more strongly on the dorsal than on the ventral side. The following segments are wider at their distal ends than proximally but no dorsal spines are developed. The distal segments are noticeably wider than the middle segments. The terminal claw is strong but the opposing spine is weak.

The IBr_1 are more conspicuously narrowed distally than in the type specimen and are also more deeply incised by the IBr_2. The distal edges of the brachials beyond the first syzygy are flared and thorny.

The first two segments of all the pinnules are short; the rest are elongated with their distal ends flared and thorny. P_1 has 14 segments, as in the type, and is about 5 mm. long. P_2 is a genital pinnule. None is complete, the longest having 9 segments measuring about 4 mm. Dr. John estimated that there were probably about 14 segments as in P_1. The large fusiform gonad lies along the third to sixth segments. P_3 is of 10 segments and 4 to 5 mm. long. P_5 with 11 segments is the same length. It has an ambulacral furrow. The outer pinnules have about 12 segments.

The disk is naked, the anal cone high. Sacculi are conspicuous, irregularly arranged on the lower part of the arms and the genital pinnules, regularly arranged on the outer pinnules.

Simple rodlike side and cover plates are present to the number of three pairs along each middle segment of the outer pinnules. No such plates were found in the type.

Pentacrinoid young.—On the single broken specimen secured by the *Antarctic* there was a fairly complete series of pentacrinoids from the youngest stage to the stage at which they are ready for detachment.

A few eggs were found in the marsupia, but none of these were fertilized so that no information was afforded concerning the cleavage and the larval development.

In the youngest larva the vestibule is not yet open and the orals and basals are still in a rather embryonic condition, their central portion retaining the original character of a branching spicule; this feature, however, remains distinct, especially in the oral plates, until a much later stage. There is a distinct naked space left between each of the basals and the oral above it, and it appears as if these plates never join completely in the midradial line. Infrabasals cannot be made out, and apparently do not exist in this species. There is no trace of radials, or of the radianal. The column consists of 11 segments which are in a very undeveloped stage, the central annulus in all being still very conspicuous. There is no terminal stem plate. This specimen is attached to the upper edge of the marsupial wall.

In the next stage the vestibule has opened and the primary tentacles are protruding. The orals and basals have increased considerably, the zones of growth being indicated by the regular arrangement of the holes. The orals have begun to assume the usual form, with the edges turned outward. The radials have appeared, and are peculiar in having an unfenestrated central portion. The columnals have increased somewhat and are now very difficult to distinguish from one another so that their exact number cannot be given.

In the next stage the radials have increased somewhat and have assumed a triangular form. The IBr_1 has appeared and is visible as a branching spicule. The radianal lies wholly outside the midradial line, and has scarcely any influence on the shape of the adjoining radial. The columnals in the upper part of the stem cannot be made out; those in the lower part are assuming their definitive shape.

In the following stage the arms have begun to form. The radials have come into contact, separating the basals from the orals. The radianal is still small, but the radial to the right of it is now considerably influenced by it; a naked space only partially filled by the radianal separates this radial from the one to the left. The posterior oral has undergone some resorption. The IBr_1 are long and narrow with the original spicule still discernible in the center. The IBr_2 are somewhat shorter, and beyond them the first brachials are making their appearance as transverse spicules sending out processes proximally and distally. The proximal columnals are still indistinctly separated from one another.

In a slightly more advanced stage the arms have grown considerably, about 6 brachials being developed. The IBr_2 has assumed its definitive shape with two oblique distal edges, though the primary spicule is still distinct both in the IBr_1 and in the IBr_2. The columnals are also taking on their definitive form in the upper portion of the column; they are still only 11 in number.

In the most developed stage represented a pinnule has appeared on the twelfth brachial. The orals, which are of somewhat larger size than usual, are widely separated from the calyx plates. The anal cone is present, and the radianal remains distinct close to the adjoining oral. The cirri are very far advanced in development; those of the first whorl, radial in position, consist of 12 segments with a conspicuous opposing spine and terminal claw; those of the second whorl, alternating with those of the first, are about to develop. The columnals have now attained their definitive form. They are rather short, and are not constricted centrally. The proximal 5 are gradually broadening, the topmost, bearing the cirri, being the broadest.

There is considerable variation in the column in regard to both the number and the shape of the component columnals.

In one column there are only 8 segments remaining, the ninth having been the centrodorsal of the young comatulid which has broken away. In another fully developed column the lowest segment is small and wedge-shaped. In a third the lowest segment is also somewhat wedge-shaped, but apparently would have become considerably larger than those following. In a fourth the 2 lowest segments would apparently have become larger than those following. In one the lowest segment is much smaller than the next.

These differences are correlated more or less with the manner and place of attachment. A wedge-shaped first columnal results from attachment in the narrow space between 2 pinnulars. When the first columnal is attached on a normal surface, either on the middle or on the end of a pinnular, it acquires the usual form.

Localities.—Antarctic (Swedish South Polar Expedition) station 59; Burdwood Bank (lat. 53°41′ S., long. 61°10′ W.); 137–150 meters; bottom temperature 3.20° C. [Mortensen, 1918] (1, Stockholm M.). Type locality.

Discovery Investigations station 175; Bransfield Strait, South Shetlands (lat. 63°17′20″ S., long. 59°48′15″ W.); 200 meters; at 190 meters, temperature −0.48° C., salinity 34.34‰; mud, stones and gravel; March 2, 1927 [John, 1938] (1, B.M.).

Geographical range.—The Burdwood Bank, near the Falkland Islands, and from the Bransfield Strait.

Bathymetrical range.—150 (?137) to 200 meters.

PHRIXOMETRA RAYNERI John*

Phrixometra rayneri John, *Discovery* Reports, vol. 18, 1938, p. 123 (listed), p. 129 (distribution table), p. 132 (in key), pp. 172–174 (station; description); fig. 12, p. 173; pl. 4, fig. 8.

Diagnostic features.—The cirri are about XXX, 14–17; P_1 (in the single specimen known) has 11 to 12 segments and is 3 mm. long; P_2 with 13 to 14 segments is 4 mm. long and P_3, the first genital pinnule, with 9 segments is 3 mm. long.

Description.—The centrodorsal is small, low and rounded; its dorsal pole is rather large and rough. The edge is produced into slight corners interradially. The cirrus sockets are closely set in two rows around the periphery. Their arrangement is impossible to determine with so many of the cirri intact, or at least with their basal segments remaining. According to Dr. John they are in columns, but if so these are not very regular. So flared are the basal cirrus segments and so closely crowded are their sockets that I [A.M.C.] can distinguish no regular arrangement.

The cirri are about XXX, 14–17. Those of the peripheral row are the longest, about 6 mm. long while the more apical ones are about 5 mm. The second segment is about as long as broad, the first one being much shorter. The third to the fifth are the longest, they are slightly constricted in the middle, a little more strongly on the dorsal than on the ventral side. The distal ends of the second to the fourth or fifth segments are expanded very noticeably and thorny. The outer segments are

* See also Addenda (p. 837) under 1963.

flared only on their dorsal sides and to a much lesser extent as well as lacking the thorns. There are no dorsal spines. The segments beyond the sixth or seventh are conspicuously wider and heavier than the proximal segments. All remain longer than wide. The terminal claw is short; the opposing spine small, with its distal edge convex rather than concave.

The radials have concave distal edges and so are short in the midline but longer interradially. The IBr_1 are considerably longer and are deeply incised by the IBr_2 (axillaries). Their lateral edges are rounded, not in apposition. The axillaries are about as long as broad, their distal edges strongly concave; the lateral corners are finely thorny.

The arms were about 20 mm. long. The first brachials are incised by the second ones. The distal edges of all the brachials beyond the first syzygy are raised into a row of strong spines, much longer than those of *Phrixometra nutrix.* Between the first and second syzygies the brachials are roughly rectangular, about as long as broad; the distal ones are elongated, roughly oblong. The proximal syzygies are between the usual brachials, distally they occur at intervals of two muscular articulations.

The first segment of all the pinnules is short, the second as long as or a little longer than broad. The rest are elongated and somewhat constricted in the middle, the distal ones more markedly so than the proximal; the distal edge of each is expanded into a wide spiny flare around the base of the next, giving the joints a swollen appearance. P_1 has 11 to 12 segments, about 3 mm. long. P_2 has 13 to 14 segments, about 4 mm. long. P_3 is the first genital pinnule and is shorter than P_2; it has 9 segments, about 3 mm. long. There are only three pairs of genital pinnules, all similar to P_3. The long yellow gonad lies along the third to sixth segments. The specimen is a male. P_5 is the first pinnule to have an ambulacral furrow. The outer pinnules have up to 14 or 15 segments, 4 to 5 mm. long.

The disk cannot be seen in the type specimen. The anal cone seems to be high.

The sacculi are fairly conspicuous, irregularly arranged along the genital pinnules, regularly along the outer.

There are no side or cover plates along the ambulacra of the distal pinnules, nor any spicules in the tentacles.

Locality.—Discovery Investigations station 160; near Shag Rocks, west from South Georgia (lat. 53°43′40″ S., long. 40°57′ W.); 177 meters; at 170 meters, temperature 1.42° C., salinity 34.22‰; gray mud, stones and rock; February 2, 1927 [John, 1938] (1, B.M.).

Genus BOLEOMETRA A. H. Clark

Antedon (part) A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 79.

Heliometra (part) A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351.

Cyclometra (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 24, 1911, p. 88.—GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 51.

Boleometra A. H. CLARK, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (diagnosis; type species *Antedon clio* A. H. Clark, 1907).

Diagnosis.—A genus of Bathymetrinae in which P_1 has about 30 segments, the first 5 to 7 of which are as broad as, or broader than, long; there are not more than 30 cirrus segments of which the distal ones are not longer than broad; the brachials and pinnule segments have smooth distal edges; there is no marsupium on the genital pinnules.

Type species.—*Antedon clio* A. H. Clark, 1907.

Geographical range.—Southwestern Japan.

Bathymetrical range.—Known only from 195 meters.

BOLEOMETRA CLIO (A. H. Clark)

FIGURE 38

Antedon clio A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 79 (description; *Albatross* sta. 4904); Proc. Biol. Soc. Washington, vol. 24, 1911, p. 88 (referred to the genus *Cyclometra*).

Heliometra clio A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 351 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (Japan).

Cyclometra clio A. H. CLARK, Proc. Biol. Soc. Washington, vol. 24, 1911, p. 88 (listed; synonymy, habitat and depth given); Crinoids of the Indian Ocean, 1912, p. 239 (synonymy; range); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (southern Japanese species; range and its significance); Die Crinoïden der Antarktis, 1915, p. 126 (range); Unstalked crinoids of the *Siboga* Exped., 1918, p. 244 (in key; range, references).—GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, pp. 50, 51 (comparison with *Florometra mariae*).

Boleometra clio A. H. CLARK, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (type species of new genus); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 105.

Description [modified by A.M.C.].—The centrodorsal is rounded conical with a large bare polar area, 1.9 mm. in vertical height, viewed radially, and about 2.8 mm. in basal diameter. The crowded cirrus sockets tend to be arranged in vertical columns.

The cirri are XL–L, 25–30, up to 17 mm. long. The fourth to fifteenth segments are much longer than broad, the longest just over twice as long as their median widths, and the following ones are shorter, becoming about as long as broad. The distal segments do not bear dorsal spines.

The radials are visible in the interradial angles; their distal angles are slightly separated. The IBr_1 are very short, widely separated laterally, standing out at right angles to the dorsoventral axis to meet the large proximal angle of the rhombic axillaries. The latter are slightly longer than broad, with the distal angle somewhat open.

The 10 arms are 55 mm. long. The first brachial is very short and like the IBr_1 is erected to meet the proximal angle of the succeeding ossicle; it has the interior edges much shorter than the exterior. The second brachial is irregularly quadrate, produced distally on the outer side of the arm and proximally in the median line. The first syzygial pair is more than twice as long interiorly as exteriorly, the epizygal being quadrate with the inner side longer than the outer and the hypozygal triangular with the short side on the inner side of the arm and the apex on the outer side. The next five brachials are irregularly oblong, the following five or six wedge-shaped and the succeeding ones triangular, about as long as broad, becoming wedge-shaped again distally.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 to 5, usually 4, muscular articulations. The width at the first syzygy is 1.4 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 8.0 mm.

The lower brachials are raised distally, giving the profile of the lower part of the arm a distinctly serrate appearance; the edges of the outer brachials are slightly roughened but do not overlap.

P_1 is 9 to 10 mm. long, very slender, composed of about 30 to 32 segments; the basal 5 to 7 of these are short and wide, the following becoming more elongated and

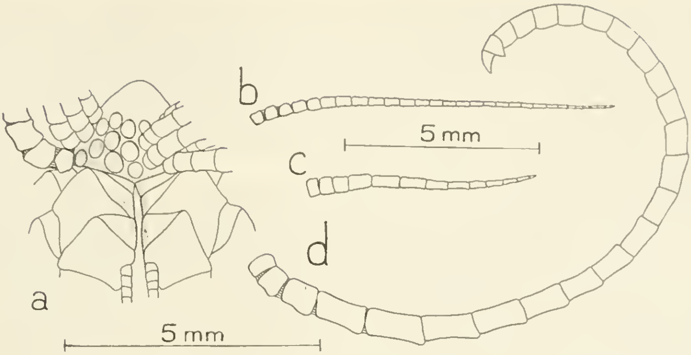

FIGURE 38.—*Boleometra clio* (A. H. Clark), holotype: *a*, Lateral view of calyx; *b*, P_1; *c*, P_2; *d*, cirrus.

slightly constricted in the middle, up to about three times as long as wide. P_2 is much shorter, 6 to 7 mm. in length, and stouter, especially basally, with 13 to 15 tapering segments, of which the first three are short and the remainder greatly elongated. The following pinnules are a little stouter but in general similar to P_2; P_3 and P_4 have about 13 segments and measure 6 mm. in length; they bear long slender gonads; the pinnules gradually decrease in length to about P_7, then become more slender and increase in length distally where they are 8 mm. long with about 20 slender segments, all of which except the two basal are greatly elongated.

Locality.—*Albatross* station 4904; Eastern Sea, southwest of the Goto Islands; Ose Saki Light bearing N. 27° E., 6 miles distant (lat. 32°31′20″ N., long. 128°32′40″ E.); 195 meters; fine gray sand and broken shells; August 10, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 22618).

Remarks.—Only a single specimen of this species is as yet known.

First described in the genus *Antedon* in 1907, this species was transferred to *Heliometra* upon the establishment of that genus in 1908 on the basis of the relatively short segments of P_1, especially at the base, the relatively large size and the general appearance. When the genus *Cyclometra* was described in 1911, *clio* was placed within it. Later it was decided that *clio* is not congeneric with *Cyclometra flavescens* and in 1936 the new genus *Boleometra* was erected to accommodate it.

[NOTES BY A.M.C.] It is surprising that Gislén found nothing referable to *clio* in the collections of either Sixten Bock or Mortensen from southern Japan, including Kiu Shiu. Gislén himself in 1927 made the suggestion that *clio* might be the young of *Florometra mariae*, which species Mortensen had taken off southern Japan. He had previously communicated this idea to Mr. Clark, as a result of which the latter made some comments in this typescript, maintaining, however, that *clio* is distinct on the grounds of differences in the texture of the brachials and on the coloration. Gislén's relatively young specimens of *mariae* with arm lengths of 85 and 95 mm. (55 mm. in *clio*) do have the brachials much smoother than larger specimens but at the same time they have the synarthrial tubercles on the division series and first brachials very reduced compared with the prominent ones of *clio* and of larger *mariae*. The shapes of the cirrus segments are not unlike and the greater number in *mariae* might be attributable to size, but the elongate distal segments of P_1 with a complete lack of dorsal processes in *clio* are very different from those found in *mariae*. Consequently I must agree with Mr. Clark that *clio* is probably distinct. Nevertheless, until a good series of small specimens of *Florometra mariae* has been described, the possibility that *clio* represents the juvenile form cannot be forgotten.

Gislén also described a specimen lacking cirri collected by Mortensen in the Sagami Sea under the designation *Thaumatometra* cf. *tenuis*. Its arm length is about 40 mm. The centrodorsal is subconical, 1.7 mm. in diameter by 1.0 mm. high, which is very similar in relative height to that of the type of *clio*. The dorsal pole is a smooth cone and the division series and first pairs of brachials have prominent synarthrial tubercles in both. However, there are some differences with regard to the pinnules; P_1 has only 17 to 18 segments in Gislén's specimen (30 to 32 in *clio*) and although P_2 is shorter in both with a comparable reduction in the number of segments, P_3 and P_4 are much longer than P_2 in Gislén's specimen, though similar to it in *clio*. The reduction in size of P_2 in the former might be attributable to its being the first genital pinnule, whereas in the type of *clio* it is P_3 which bears the first gonad.

Genus TRICHOMETRA A. H. Clark

Antedon (part) Pourtalès, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 356, and following authors.

Trichometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (diagnosis; type species *Antedon aspera* A. H. Clark, *nomen nudum*), p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 212 (occurs in the West Indies and the Hawaiian Islands); Amer. Nat., vol. 42, No. 503, 1908, p. 724 (color); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 176 (referred to the Heliometrinae); Mem. Australian Mus., vol. 4, 1911, p. 727 (parent genus from which *Hathrometra* arose); Notes Leyden Mus., vol. 34, 1912, p. 148 (cirri compared with those of *Thaumatometra alcyon*); Crinoids of the Indian Ocean, 1912, p. 5 (East Indian genus, represented by local species and by the genus *Hathrometra* in the Atlantic), p. 10 (occurs in Hawaii; absent from Japan), p. 11 (represented in the Ceylon region), p. 26 (range; allied to *Hathrometra*), p. 62 (in key), p. 239 (original reference; type species); Fisheries, Ireland, Sci. Invest., pt. 4, 1913, p. 3 (relation to *Hathrometra*; discussion); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 5 and following (both Atlantic and Indo-Pacific; represents *Hathrometra* in part; range); Die Crinoïden der Antarktis, 1915, p. 145 (synonymy; diagnosis; range), p. 182 (both Atlantic and Indo-Pacific; in the Indo-Pacific represents the Atlantic *Hathrometra*); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae); No. 16, p. 511 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 245 (in key; range), p. 246 (key to the included species); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 13 (West Indian and Indo-Pacific), p. 18 (in key); The Danish *Ingolf*-Exped., vol. 4, No. 5, 1923, p. 11 (range), p. 43 (range), p. 53 (in key), p. 56 (key to the Atlantic species).—Gislén, Ark. Zool., vol. 15, No. 23, 1923, p. 15 (flexible P_1).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key), p. 37 (diagnosis), p. 38.—Ekman, Tiergeographie des Meeres, 1935, p. 360.—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139 (cosmopolitan in deep water).—Elias da Costa, Chaves dicotómicas para a classificação dos equinodermes Portugueses. IV. Crinóides, Porto, 1940, p. 9 (in key), p. 13.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56 (depth range).

Diagnosis.—A genus of the Bathymetrinae in which the centrodorsal is hemispherical to broadly rounded conical; the longest cirri have 33 to 45 segments, of which the longer earlier segments are two to three times as long as broad and the distal are about as long as broad; the lower brachials have the distal borders abruptly and strongly everted and spinous; P_1 is elongated and exceedingly slender with 20 to 25 segments, of which not more than three or four of the basal ones are as broad as long; P_2 is much shorter with many fewer segments; there is no marsupium on the genital pinnules of the female.

Type species.—Trichometra aspera A. H. Clark, 1908, a synonym of *Antedon cubensis* Pourtalès, 1869.

Geographical range.—From the eastern part of the Gulf of Mexico and northern Cuba northward to Davis Strait, eastward to south of Iceland and the Faroe Islands and southwards to Portugal; also from the Hawaiian Islands.

Bathymetrical range.—From 256 (?252) to 2193 meters.

Thermal range.—From 2.40° C. to 15.67° (?15.83°) C.

Remarks [by A.M.C.].—The species *Bathymetra minutissima* A. H. Clark, though named *Trichometra* by Mr. Clark in 1918 and 1940, is placed in the genus *Thaumatometra* in the typescript, with the name *Trichometra* erased. Though this was probably done some years previous to 1940, I believe it represents Mr. Clark's considered opinion and certainly *minutissima* conforms more to the diagnosis of *Thaumatometra* as it stands. I have accordingly left it within that genus.

KEY TO THE SPECIES OF TRICHOMETRA

a^1. More than 40 cirrus segments; cirri XL–LX, 40–45, 20 mm. long, the last 15–20 segments about as long as broad; arms 60–65 mm. long; IBr series and lower brachials narrow, entirely free laterally (Hawaiian Islands; 256 [?252]–590 [?648] meters)..................**vexator** (p. 669)

a^2. 25–35 cirrus segments.

- b^1. Elements of the IBr series and first two brachials only slightly convex dorsally and sharply and broadly flattened against their neighbors; arms up to 65 mm. long; cirri with 25–35 segments, 15–22 mm. long; P_1 with 20–25 segments, 6 mm. long; P_2 with 10 segments, 4 mm. long (from the eastern part of the Gulf of Mexico and northern Cuba northward to Davis Strait, thence eastward to south of Iceland and to the Faroe Islands; 293–2193 meters)..**cubensis** (p. 671)
- b^2. Elements of the IBr series and first two brachials strongly convex dorsally and laterally, just in lateral contact with their neighbors but not flattened against them; arms 30–40 mm. long in the three specimens detailed; cirri with 27–33 segments; P_1 with 21–23 segments; P_2 with 13 segments, and half as long as P_1 (from the coast of Portugal and the Bay of Biscay to southwest of Iceland; 960–2075 meters)..................................**delicata** (p. 676)

TRICHOMETRA VEXATOR A. H. Clark

[See vol. 1, pt. 1, fig. 220, p. 243]

Trichometra vexator A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 132 (*nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 213 (in key), p. 217 (description), p. 218 (*Albatross* stations 3859, 3865, 3883, 3910, 3925 [type locality], 4105); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 232 (compared with *T.* [*Fariometra*] *explicata*); Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 259 (arms compared with those of *T. delicata*); Crinoids of the Indian Ocean, 1912, p. 240 (synonymy; Hawaiian Is., 138–355 fms.); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 246 (in key; range), p. 247 (references).

Diagnostic features.—This species is easily distinguished from all the others in the genus by the relatively larger number of cirrus segments combined with the narrow IBr series and arm bases which are not in lateral contact.

Description.—The centrodorsal is subconical, about twice as broad as high, bearing from 40 to 60 cirrus sockets which are closely crowded and without definite arrangement; there is a moderately large bare polar area.

The cirri are XL–LX, the peripheral about 20 mm. long, with 40 to 45 segments, the apical about half as long with 25 to 30 segments. In the peripheral cirri the first segment is short, the second is about as long as broad, the third and fourth are about half again as long as broad, and the fifth and following to about the fifteenth are about twice as long as broad; after about the fifteenth the segments gradually decrease in length so that the last 15 or 20 are about as long as broad. The distal ends of the elongate proximal segments project slightly on the dorsal side, and the dorsal surface of the short distal segments is rather strongly convex. The opposing spine is prominent and sharp, terminally situated, triangular, in length about equal to the width of the penultimate segment.

The radials are concealed by the centrodorsal. The IBr_1 are short and broad with the lateral edges produced and in apposition and the anterior border strongly concave in the median line. The IBr_2 (axillaries) are about as broad as long with all the sides somewhat concave and a rounded posterior projection incising the IBr_1.

The 10 arms are from 60 to 65 mm. in length. The first brachials are short, with the distal border concave and the inner borders united in their proximal half. The second brachials are larger and triangular. The first syzygial pair (consisting of the third and fourth brachials) is about as long as broad, rather longer interiorly than exteriorly, the hypozygal being somewhat wedge-shaped. The following six brachials are oblong, broader than long, those succeeding becoming triangular and about as long as broad and elongate with somewhat swollen ends distally.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

The lower pinnules are badly broken in all the specimens. P_1 and P_a are exceedingly slender and greatly elongated, with all but a few of the basal segments extremely long. P_2 also has much elongated segments. The pinnules following P_1 and P_a are much shorter and P_3 and those succeeding bear gonads. The segments of P_3 and the pinnules following are not especially long.

Localities.—*Albatross* station 3859; Hawaiian Islands; Pailolo Channel, between Molokai and Maui; Mokuhooniki Islet bearing N. 18° E., 5.6 miles distant; 252–256 meters; temperature 15.67°–15.83° C.; fine sand and mud; April 9, 1902 [A. H. Clark, 1908] (fragments, U.S.N.M., 36045).

Albatross station 3865; Pailolo Channel; Mokuhooniki Islet bearing S. 79° W., 6.9 miles distant; 468–517 meters; temperature 7.11°–7.22° C.; fine volcanic sand and rock; April 10, 1902 [A. H. Clark, 1908] (21, U.S.N.M., 36031; L.S.).

Albatross station 3883; Pailolo Channel; Mokuhooniki Islet bearing S. 80°30′ W., 7.8 miles distant; 506–519 meters; temperature 7.33° C.; globigerina ooze; April 16, 1902 [A. H. Clark, 1908] (10, U.S.N.M., 35881).

Albatross station 3910; off the southern coast of Oahu, near Honolulu; Diamond Head Light bearing N. 7° E., 12.5 miles distant; 568–616 meters; temperature 6.50° C.; fine gray sand and mud; May 5, 1902 [A. H. Clark, 1908] (5, U.S.N.M.).

Albatross station 3925; near Honolulu; Diamond Head Light bearing N. 29°30′ E., 10.2 miles distant; 590–546 meters; temperature 6.50° C.; fine gray sand, mud and rocks; May 7, 1902 [A. H. Clark, 1908] (2, U.S.N.M., 36139). Type locality.

Albatross station 4105; off Molokai; Lae-o Ka Laau Light, Molokai, bearing S. 45°30′ E., 10.6 miles distant; 574–648 meters; temperature 6.56° C.; fine coral sand and foraminifera; July 24, 1902 [A. H. Clark, 1908] (6, U.S.N.M., 36048).

Geographical range.—This species is only known from the Hawaiian Islands.

Bathymetrical range.—From 256 (?252) to 590 (?648) meters; the average of 6 records is 505 meters.

Thermal range.—From 6.50° C. to 15.67° (?15.83°) C.; the average of 6 records is 9.09° C.

TRICHOMETRA CUBENSIS (Pourtalès)

[See vol. 1, pt. 1, figs. 221 (p. 243), 291 (p. 262), 389 (p. 307); pt. 2, figs. 99–100 (p. 62), 766 (p. 362)]

Antedon cubensis Pourtalès, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 356 (*Bibb* sta. 139P); vol. 5, No. 9, 1878, p. 214 (type of *cubensis*, but not the other specimens mentioned, which are *Atelecrinus balanoides*).—P. H. Carpenter, Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*); Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 165 (explanation of Pourtalès' confusion of this form with *Atelecrinus balanoides*).—Bell, Proc. Zool. Soc. London, 1882, p. 533 (listed).—P. H. Carpenter, Proc. Zool. Soc. London, for 1882, 1883, p. 746 (specific formula).—Minckert, Arch. Naturg., Jahrg. 71, vol. 1, Heft 1, 1905, p. 167, footnote (syzygies).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 466.—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (listed), pp. 385–389 (detailed description and discussion), pl. 9, figs. 6, 10–12, pl. 15, fig. 4 [fig. 13, pl. 9 and fig. 3, pl. 15 represent *Coccometra nigrolineata*].

Antedon aspera A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 131 (*nomen nudum*).

Trichometra aspera A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 132 (*nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 218 (compared with *T. vexator*), p. 229 (description; *Albatross* sta. 2666); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 232 (compared with *T.* [*Fariometra*] *explicata*); Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 259 (proximal pinnules compared with those of *T. delicata*); Notes Leyden Mus., vol. 34, 1912, p. 146 (compared with *T. delicata* [*Nepiometra io*]).

Trichometra, sp. A. H. Clark, Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 3 (eastern coast of North America; related to T. [*Orthometra*] *hibernica*, but has considerably longer cirri composed of longer segments).

Trichometra cubensis A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 247 (in key; range; detailed synonymy), p. 248 (*Albatross* stas. 2400, 2415, 2661, 2663, 2666, 2668, 2669, 2528; 43°16′ N., 60°35′ W., 630 m.; SW. part of Banquereau, 540 m.; Banquereau, 450 m.; Fishing Banks); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 11 (*Ingolf* stas. 24, 25, 27, 45, 64, 73, 84, 85; notes), p. 43 (range), p. 56 (in key).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 38 (range); Medd. Grønland, vol. 79, No. 2, 1932, p. 50 (range).—A. H. Clark, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 141 (in key), p. 159 (references).—H. L. Clark, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 12 (*Atlantis* sta. 3305).—Einarsson, The zoology of Iceland, vol. 4, pt. 70, 1948, p. 6 (Iceland records), p. 48 (member of the fauna of the Atlantic slope and deep sea), pp. 58, 61 (distribution).—A. H. Clark, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).—Hyman, The invertebrates, vol. 4, Echinodermata, New York, 1955, p. 113.

Diagnostic features.—In this species the cirrus segments are 25–35, fewer than in *T. vexator*, but about the same in number as in *T. delicata*; it is distinguished from the latter by the sharp flattening of the sides of the IBr series and lower brachials, by the superior size, and by the stouter cirri in which the segments beyond the twelfth are about as long as broad.

From *Hathrometra tenella*, with which this species has been confused, it may easily be distinguished by the much shorter earlier cirrus segments, the close apposition and lateral flattening of the elements of the IBr series and the earlier brachials, and by the prominent spinous eversion of the distal ends of the earlier brachials.

[Note by A.M.C.] The following description appears to have been taken from that of the type of *aspera* from *Albatross* station 2666, with minor modifications of size and number of cirrus segments.

Description.—The centrodorsal is hemispherical or rounded conical, nearly covered with cirrus sockets; the dorsal pole is commonly studded with papillae.

The cirri are XL–LX, 23–35 (usually 23–28), 15 or 16 mm. long. The first segment is short, the second is about as long as broad, and the third to eighth are about twice as long as the proximal width, rather strongly constricted centrally with flaring and overlapping distal ends, the overlap being especially prominent in the median dorsal portion, though the segments cannot be called spinous; the following segments increase in width from the proximal to the distal end, which is slightly overlapping, and gradually decrease in length, from the twelfth onward being about as long as broad and more or less strongly carinate in the median dorsal line. The opposing spine is terminal, rather less than the width of the penultimate segment in height, and arises from the entire dorsal surface of the latter. The terminal claw is usually rather longer than the penultimate segment, moderately stout and comparatively slightly curved. There are usually a few small cirri situated near the dorsal pole of the centrodorsal which may be less than half as long as the peripheral cirri and are composed of 10 to 12 very slender and much elongated segments with greatly expanded articulations.

The distal edges of the radials are even with the rim of the centrodorsal and are only very gently concave, not extending up into the angles of the calyx interradially. The IBr_1 are very short, six or eight times as broad as long, bandlike, with a rounded notch in the middle of the distal border. The IBr_2 (axillaries) are rhombic, about half again as broad as long, with a rounded posterior projection incising the IBr_1; the anterior sides are moderately concave, but the anterior angle is not especially prominent. The ossicles of the IBr series and the first two brachials are closely crowded against their neighbors and laterally flattened.

The 10 arms are from 35 to 60 mm. (usually between 50 and 55 mm.) in length. The first brachial is very short, much longer exteriorly than interiorly, and almost bisected by a posterior projection from the second brachial, which is irregularly quadrate and considerably larger. The first syzygial pair (third and fourth brachials) is about half again as broad as long, slightly longer on the inner than on the outer side. The following brachials to the eleventh are wedge-shaped, much broader than long, with the proximal and distal borders strongly concave; those succeeding become more obliquely wedge-shaped and after the sixteenth or seventeenth triangular, as long as, or rather longer than, wide, after the proximal third of the arm becoming wedge-shaped again and more elongate, slightly constricted centrally, and distally still more elongate with the ends less and less oblique, and gradually more constricted centrally. The lower brachials have the distal ends strongly and abruptly everted and spinous, standing out perpendicularly and giving the arms a characteristic scalloped dorsal profile; this condition dies away after about the sixteenth brachial, the distal edges of the ossicles becoming almost smooth, though under strong magnification they are seen to bear a fringe of short fine spines.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 (more rarely 3) muscular articulations.

P_1 is 6 mm. long, very slender, with 20 to 25 segments, of which the first 3 or 4 are about as long as broad and those following become progressively elongated and exceedingly long and slender distally; after the fourth or fifth the distal ends of the segments become greatly expanded and widely flaring, overlapping the bases of those succeeding. This expansion of the distal ends of the segments, which arises rather abruptly, causes the distal end to appear about twice the diameter of the remainder of the segment.

P_2 is 4 mm. long, considerably stouter than P_1 and tapering evenly from the base to the tip, with 10 segments, of which the first 3 are about as long as broad and those following become progressively elongated. The distal ends of the segments are not especially prominent.

P_3 is of about the same length, but rather stouter, especially distally, and much stiffer, with 10 segments, of which the first is not so long as broad, the second and third are about as long as broad, and the following become progressively elongated. The fourth, fifth, sixth, and proximal half of the seventh bear a large gonad.

The following pinnules to P_7 or P_8 are similar, but slowly become longer and stouter. After P_9 the pinnules develop more or less centrally constricted segments with prominent distal ends, showing more or less of a contrast with the smoother genital pinnules.

The distal pinnules are 6 mm. long, with the first segment short and wedge-shaped, the second about as long as broad, slightly trapezoidal, and the remainder much elongated with prominent articulations and protruding distal ends.

P_a may be similar to P_1, or it may be of the same character but twice as long.

[NOTE BY A.M.C.] In 1912 Hartlaub published a description of Pourtalès' type specimen of this species. There are some differences between this and the foregoing description which should be noted. The cirrus sockets are given as numbering 70 to 80. Also the proximal pinnules appear to have many fewer segments though they are similar in length to those described above. P_1 has about 12 segments and measures 7 mm. P_2 is shorter with 8 segments. P_3 is similar in size and bears a gonad. Though Pourtalès might not have recognized an incomplete pinnule it is unlikely that Hartlaub would not. It seems to me that the discrepancy in the segments of P_1 is too great to be accounted for by variation alone and a reexamination of the specimens involved is called for.

Localities.—*Albatross* station 2400; Gulf of Mexico, southeast of Pensacola, Florida (lat. 28°41′00″ N., long. 86°07′00″ W.); 309 meters; March 14, 1885 [A. H. Clark, 1918] (fragments, U.S.N.M., 16910).

Bibb station 139P; off Cojima, near Havana, Cuba; 823 meters; March 4, 1869 [Pourtalès, 1869, 1878; P. H. Carpenter, 1881, 1888; Hartlaub, 1912]. Type locality.

Albatross station 2661; between the Bahamas and Cape Fear, North Carolina (lat. 29°16′30″ N., long. 79°36′30″ W.); 801 meters; temperature 7.50° C.; May 4, 1886 [A. H. Clark, 1918] (1, U.S.N.M., 14701).

Albatross station 2663; between the Bahamas and Cape Fear (lat. 29°39′00″ N., long. 79°49′00″ W.); 770 meters; temperature 5.95° C.; May 4, 1886 [A. H. Clark, 1918] (5, U.S.N.M., 14700, 14711).

Albatross station 2415; between Savannah, Georgia, and Cape Charles (lat. 30° 44′00″ N., long. 79°26′00″ W.); 805 meters; temperature 7.56° C.; April 1, 1885 [A. H. Clark, 1918] (23, U.S.N.M., 14707, 34608).

Albatross station 2666; between the Bahamas and Cape Fear (lat. 30°47′30″ N., long. 79°40′00″ W.), 494 meters; temperature 9.05° C.; May 5, 1886 [A. H. Clark, 1918] (15, U.S.N.M., 14703, 22678).

Albatross station 2667; between the Bahamas and Cape Fear (lat. 30°53′00″ N., long. 79°42′30″ W.); 500 meters; temperature 9.28° C.; May 5, 1886 (4, U.S.N.M., 14704).

Albatross station 2668; between the Bahamas and Cape Fear (lat. 30°58′30″ N., long. 79°38′30″ W.); 538 meters; temperature 7.95° C.; May 5, 1886 [A. H. Clark, 1918] (7+, U.S.N.M., 14697, 34636; M.C.Z. 350).

Albatross station 2669; between the Bahamas and Cape Fear (lat. 31°09′00″ N., long. 79°33′30″ W.); 644 meters; temperature 6.50° C.; May 5, 1886 [A. H. Clark, 1918] (2, U.S.N.M.).

Atlantis station 3305; off Playa Baracoa, Havana Province, Cuba; 603 meters [H. L. Clark, 1941].

Albatross station 2528; south of Cape Sable, Nova Scotia (lat. 41°47′00″ N., long. 65°37′30″ W.); 1238 meters; temperature 3.72° C.; July 13, 1885 [A. H. Clark, 1918] (1, U.S.N.M., 24085).

Albatross station 2429; off Newfoundland (lat. 42°55′30″ N., long. 50°51′00″ W.); 861 meters; temperature 3.72° C.; June 23, 1885 (6, U.S.N.M., 4723).

South of Sable Island (lat. 43°16′ N., long. 60°35′ W.); 640 meters; Gloucester Donation 547 [A. H. Clark, 1918] (1, U.S.N.M., 35891).

Fishing Banks (lat. 44° N., long. 58°30′ W.); 293 meters; schr. *Andrew Leighton;* Gloucester Donation 436 (1 U.S.N.M., 4562).

Fishing Banks; schr. *Wauchusett;* Gloucester Donation 367 [A. H. Clark, 1918] (5, U.S.N.M., 35889).

Southwestern part of Banquereau; schr. *Epes Tarr;* Gloucester Donation 546 [A. H. Clark, 1918] (1, U.S.N.M., 35890).

Banquereau; 458 meters; schr. *Willie M. Stevens;* Gloucester Donation 476 [A. H. Clark, 1918] (2, U.S.N.M., 35892).

Southwestern edge of the Grand Banks; schr. *Notice;* Gloucester Donation 837 (1, U.S.N.M., 4846).

Ingolf station 24; southwest of Godthaab, western Greenland (lat. 63°06′ N., long. 56°00′ W.); 2193 meters; temperature 2.4° C. [A. H. Clark, 1923] (1, C.M.).

Ingolf station 27; northwest of Godthaab (lat. 64°54′ N., long. 55°10′ W.); 719 meters; temperature 3.8° C. [A. H. Clark, 1923] (1, C.M.).

Ingolf station 25; southwest of Godthaab (lat. 63°30′ N., long. 54°25′ W.); 1064 meters; temperature 3.3° C. [A. H. Clark, 1923] (4, U.S.N.M., E. 1070; C.M.).

Ingolf station 84; off the southwestern coast of Iceland (lat. 62° 58′ N., long. 25°24′ W.); 1103 meters; temperature 4.8° C. [A. H. Clark, 1923] (1, C.M.).

Ingolf station 85; off the southwestern coast of Iceland (lat. 63°21′ N., long. 25°21′ W.); 311 meters [A. H. Clark, 1923] (1, C.M.).

Ingolf station 73; off the southwestern coast of Iceland (lat. 62°58′ N., long. 23°28′ W.); 889 meters; temperature 5.5° C. [A. H. Clark, 1923] (3, U.S.N.M., 1066; C.M.).

Ingolf station 64; south of Iceland (lat. 62°06′ N., long. 19°00′ W.); 1904 meters; temperature 3.1° C. [A. H. Clark, 1923] (1, C.M.).

South of Iceland (lat. 63°21′ N., long. 25°21′ W.); 311 meters [Einarsson, 1948].

Ingolf station 45; west of the Faroe Islands (lat. 61°32′ N., long. 9°43′ W.); 1176 meters; temperature 4.17° C. [A. H. Clark, 1923] (1, C.M.).

Geographical range.—From the eastern part of the Gulf of Mexico and northern Cuba northward to Davis Strait, as far as lat. 64°54′ N., thence eastward to south of Iceland and to the Faroe Islands.

Bathymetrical range.—From 293 to 2193 meters; the average of 22 records is 842 meters.

Thermal range.—From 2.40° C. to 9.28° C.; the average of 15 records is 5.39° C.

History.—This species was originally described as *Antedon cubensis* by Count Pourtalès from two specimens dredged by the *Bibb* in 1869 off Cojima, Cuba, in 823 meters. The description given by Count Pourtalès, though short, is quite sufficient for its identification, especially when taken in connection with his comparison with *Hathrometra sarsi.* He says at first that the centrodorsal is "conical", but later that it is "flatter" than the centrodorsal of *H. sarsi*, which conveys the impression that it is rounded conical. P_1 he gives as "not much longer than" P_2; probably the tip was broken off, as in this species P_1 is exceedingly delicate and somewhat stiffened.

In 1878 Pourtalès recorded under this name two additional specimens from *Blake* station 43; but what he says about them does not at all accord with the original description.

The explanation of this discrepancy is that the smaller of the two original specimens, which was very badly broken, was not of the same species as the larger and more nearly intact from which the description was made, but was an example, the first to come to light, of *Atelecrinus balanoides*, and the two from *Blake* station 43 represented the same species.

In his preliminary report on the comatulids collected by the *Blake* Dr. P. H. Carpenter called attention to this confusion of two entirely distinct species. It was in this paper (1881) that he first proposed the generic name *Atelecrinus*, using the specific name *cubensis* for Pourtalès' second specimen from the *Bibb* station and including the two from *Blake* station 43 with others from various localities under the name *balanoides*.

In 1908 I described under the name of *Trichometra aspera* an interesting little comatulid which had been dredged by the *Albatross* in 1886 between the Bahamas and the North Carolina coast in 494 meters, and at the same time designated by the manuscript name *Trichometra americana* another form from the fishing banks off Newfoundland which I believed to be distinct. The specimens of the latter I had found in the U.S. National Museum collection bearing the name *Antedon dentata.* It was these that I had in mind when discussing the relationships of *Trichometra* (*Orthometra*) *hibernica* (1913).

Dr. Clemens Hartlaub in 1912 published a detailed description and figures of a specimen which he had found in the *Blake* collection with the name *Antedon cubensis* in Carpenter's hand writing. He remarked that at least this had the "arm joints with imbricated serrated edges," and I have no doubt whatever that it is really Pourtalès' original type specimen. Another specimen also labeled *Antedon cubensis* by Carpenter was figured by Hartlaub; but this is quite different from the first and represents *Coccometra nigrolineata*.

Hartlaub's redescription and figure of Pourtalès' type specimen enabled me at once to recognize its specific identity with my *Trichometra aspera*, while a reexamination of all the material at hand showed that *Trichometra americana* (MS) also represented the same species.

In the *Siboga* report (1918) I recorded *Trichometra cubensis* from 12 localities, ranging from the Gulf of Mexico to the fishing banks off Newfoundland.

Among the collections brought together by the Danish steamer *Ingolf* there were several specimens of a species of *Trichometra* from 8 stations between Davis Strait and the Faroe Islands. These specimens I had designated (again MS) as *T. ingolfiana*. But a detailed study of all the available material made after the receipt of Hartlaub's memoir convinced me that *ingolfiana* is not separable from *americana* or from *aspera*, and that all these names fall in the synonymy of *cubensis*.

In 1941, H. L. Clark recorded a fine specimen of *cubensis* from the *Atlantis* collections off Cuba.

The most recent record from the North Atlantic is that of Einarsson from south of Iceland in 1948.

TRICHOMETRA DELICATA A. H. Clark

Antedon sarsii (part) Wyville Thomson, Proc. Roy. Soc. Edinburgh, vol. 7, 1872, p. 764 (the southern specimens); The depths of the sea, 1873, p. 124 (same).—de Folin, Sous les mers, 1887, p. 126 (near Santander, 960 and 1081 meters).

Antedon dentata (part) P. H. Carpenter, Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 363 (*Porcupine* station 17A, 1870).—Filhol, La vie au fond des mers, 1885, p. 213.

Antedon tenella (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 171 (*Porcupine* sta. 17A, 1870); Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 53.

Trichometra delicata A. H. Clark, Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 258 (description; *Travailleur* sta. XIII, 2030 meters); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 247 (in key; range), p. 248 (references); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (range), p. 56 (in key), p. 58 (*Ingolf* sta. 18).—Elias da Costa, Chaves dicotómicas para a classificação dos equinodermes Portugueses. IV. Crinóides, Porto, 1940, p. 13.—Le Danois, Les profundeurs de la mer, Paris, 1948, pp. 176, 245. (Not *T. delicata* A. H. Clark, 1913, nor Mortensen and Koehler, 1927, which are all *Orthrometra hibernica*.)

Diagnostic features.—This species resembles *T. cubensis* in the number of the cirrus segments, but the cirri are more slender and the segments do not become as long as broad until about the twentieth. The elements of the IBr series and the earlier brachials are strongly convex dorsally and just in lateral contact, but not laterally flattened. *Trichometra delicata* appears to be a smaller species than *T. cubensis*.

Description.—The cirri are very numerous, composed of 27 to 33 segments, of which the two first are very short, the third is slightly broader than long, and the fifth is the longest, three times as long as the median width; the following segments gradually decrease in length, after about the twentieth becoming about as long as broad. The longer proximal segments are very strongly constricted centrally, with the ends much expanded, the distal ends overlapping the bases of the segments succeeding. The short distal segments are strongly carinate dorsally.

The distal borders of the radials just reach the edge of the centrodorsal; their interradial angles are moderately produced. The IBr_1 are very short, four or five times as broad as long, with their lateral edges parallel. The IBr_2 are lozenge-shaped, half again as broad as long, with the anterior angle very sharp. The ossicles of the IBr series are strongly rounded dorsally and laterally and in intimate contact with their neighbors on either side, though not laterally flattened. Their proximal and distal edges are prominently spinous.

The 10 arms are 37 mm. in length; they resemble those of *T. vexator*, but the brachials are relatively slightly longer. The oblong brachials at the base of the arms have their distal borders abruptly and strongly everted and fringed with long spines; the triangular brachials have their distal borders moderately produced and overlapping the bases of those succeeding.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 2 (more rarely 3) muscular articulations.

P_1 is composed of 21 to 23 segments, of which those in the distal half are about three times as long as broad with the distal edges expanded, spinous, and overlapping; the second and third segments have dorsal carinate processes. The pinnule is extremely slender, like the corresponding pinnule of *T. cubensis*. P_2 is at the base almost as stout as P_1, but it reaches only half the length of that pinnule; it is composed of 13 segments, of which the second and third bear carinate processes and the distal become greatly elongated; a gonad extends from the third to the sixth segments. The three following pinnules are similar; on those succeeding, the gonad begins to decrease in size, disappearing after P_7. From this point onward the pinnules become very slender with much elongated segments, and increase in length.

Notes.—The preceding description is based entirely upon the type specimen which I studied in the Paris Museum.

In the larger specimen from *Ingolf* station 18 the arms are 35 mm. long, and in the smaller the arm length is 30 mm. There are only 15 to 16 cirrus segments; but all the peripheral cirri are lacking.

Localities.—*Travailleur* station 13; 2030 meters [A. H. Clark, 1911] (1, P.M.). Type locality.

Porcupine station 17A, 1870; off Cape Carvoeiro, Portugal (lat. 39°39′ N., long. 9°39′ W.); 1353 meters; temperature 9.61° C. [Wyville Thomson, 1872, 1873; P. H. Carpenter, 1884, 1888; A. H. Clark, 1923].

Travailleur station 55, 1880; Bay of Biscay, north of Bilbao, Spain (lat. 43°35′40″ N., long. 2°46′30″ W.); 1081 meters; mud; July 27, 1880 [Marquis de Folin, 1887].

Travailleur station 56, 1880; Bay of Biscay, north of Bilbao, Spain (lat. 43°36′45″ N., long. 2°45′15″ W.); 960 meters; mud; July 27, 1880 [Marquis de Folin, 1887].

Ingolf station 18; southwest of Iceland (lat. 61°44′ N., long. 30°29′ W.); 2075 meters; temperature 3.0° C. (2 U.S.N.M., E.1092; C.M.).

Geographical range.—From the coast of Portugal and the Bay of Biscay northwestward to southwest of Iceland.

Bathymetrical range.—From 960 to 2075 meters; the average of 5 records is 1499 meters.

Thermal range.—The two records are 3.0° C. and 9.61° C.

History.—In his account of the work of the *Porcupine* Sir Wyville Thomson (1872) mentioned that more or less complete fragments of *Antedon sarsii* were obtained at nearly every one of the deep hauls from the Faroe Islands to Gibraltar. The only definite *Porcupine* record ever published for the region south of the British Isles, however, was for *Porcupine* station 17A, 1870, off Cape Carvoeiro, Portugal, in 1353 meters (P. H. Carpenter, 1884, 1888).

In 1887 the Marquis de Folin mentioned *Antedon sarsii* as having been dredged near Santander, Spain, in 960 and 1081 meters, which depths correspond with *Travailleur* stations 55 and 56, 1880, in the southern part of the Bay of Biscay.

When visiting the Paris Museum in 1910, I found a small but well-preserved individual of a new species of *Trichometra* with the label "Expedition du *Travailleur*, Dragage XIII; profondeur 2030 metres." This I described as new under the name of *Trichometra delicata*. As yet I have not been able to find out the exact location of this station; but I believe that it was one of those occupied on the cruise in 1882, located on the coast of northern Spain or Portugal.

This specimen seemed to show that the records under the names of *Antedon sarsii*, *A. dentata* or *A. tenella* for this region, in which *Hathrometra sarsi* would be among associations entirely different from those in which it is normally found, were based in reality upon this species of *Trichometra*, a genus normally occurring among the conditions here obtaining, and I therefore feel little hestitation in grouping these records under this specific head.

In 1912 I inadvertently described under the name *Trichometra delicata* a new species (*Fariometra io*) which had been dredged by the *Siboga* in the East Indies.

In 1913 I recorded *Trichometra delicata* from *Helga* station CXX, southwest of Ireland in 698 meters; but I now believe that the specimen in question is in reality a small individual of *Orthometra hibernica*.

In 1923 I recorded this species from southwest of Iceland where it had been dredged by the *Ingolf* in 2075 meters.

Genus NEPIOMETRA A. H. Clark

Antedon (part) P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 179, 187, and following authors.

Thaumatometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128.

Nepiometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae), p. 130 (diagnosis; type species *Antedon laevis* P. H. Carpenter, 1888; range; included species); No. 16, p. 511 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 245 (in key; range), p. 251 (key to the included species). (Not *Nepiometra* Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55, which refers to *Phrixometra longipinna*).

Diagnosis.—A genus of Bathymetrinae in which the cirri are about XXX, with up to 30 segments, of which the longest are less than twice as long as broad and the distal ones, which have slight dorsal keels, are no longer than broad; laterally the axillaries are rugous, if not spinous, but otherwise the division series and proximal brachials are smooth; the oral and genital pinnules are not abruptly differentiated from each other; P_1 has about 15 segments, of which the third is already longer than broad and the following ones are progressively longer; the succeeding pinnules have slightly longer and fewer segments; there are no marsupia on the genital pinnules.

Type species.—*Antedon laevis* P. H. Carpenter, 1888.

Geographical range.—Known only from the Meangis Islands near the Philippines.

Bathymetrical range.—914 meters.

[Notes by A.M.C.] Since four out of five species included in this genus at its inception by Mr. Clark have now been transferred to the genus *Fariometra*, only the type species—*Nepiometra laevis*, known from a single specimen—is left. This has no very marked characters and were it not for the relatively shorter cirrus segments I would have merged it also in the synonymy of *Fariometra*. Of the species which have the longest cirrus segments less than twice as long as broad, *laevis* seems to have most in common with *Tonrometra multicirra*, also from the East Indian area, though the other species of *Tonrometra* are from the Southern Ocean. Both species have about 30 cirrus segments of comparable shape (allowing for the smaller size of the type of *laevis*) and proximal pinnules of similar proportions, P_1 having about 15 segments. But *multicirra* has the joints of the longer pinnule segments markedly swollen and spinous whereas the segments are hardly flared at all in *laevis*. Also the axillaries of *multicirra* are quite smooth at the sides with no rugous patches. In some of the other species of *Tonrometra* such as *T. remota* the pinnule segments are cylindrical as in *laevis* but those of the proximal pinnules are more numerous, numbering over 20.

NEPIOMETRA LAEVIS (P. H. Carpenter)

FIGURE 39

Antedon laevis P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 187 (description; sta. 214), pl. 31, fig. 6.—NICHOLSON and LYDEKKER, Manual of palaeontology, 1889, p. 411, fig. 286B.—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579.—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888 = *Thaumatometra laevis*).

Thaumatometra laevis A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (= *Antedon laevis* P. H. Carpenter, 1888), p. 247 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (published references to specimens in the B.M.; locality).

Nepiometra laevis A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 251 (in key; range), p. 252 (synonymy).—GISLÉN, Ark. Zool., vol. 19A, No. 32, 1928, p. 12 (notes).

Description [by A.M.C.].—The centrodorsal is concealed by the cirri but appears to be hemispherical rather than conical. The cirri are crowded close together in alternating rows. They number about XXX, with up to 30 segments, of which the longest, the fifth or sixth, is about two-thirds again as long as broad. The relative length decreases in the distal segments, which are about as long as broad or may be shorter. They have a slight dorsal keel but no dorsal spine. The opposing spine is small but acute.

The radials are short. The IBr_1 are convex and barely incised by the proximal angles of the IBr_2 (axillaries), which are slightly broader than long, rhombic in shape with the proximal sides convex and the distal ones concave. The distal angle is slightly produced. The IBr_1 are a little narrowed at the distal end and the axillaries project laterally beyond them so that adjacent axillaries nearly touch. At the apex of each lateral angle the ossicle is markedly rugous and on some axillaries a number of small, sharp spines are developed. The first brachials are barely incised by the second ones. As far out as the second syzygy the brachials are oblong in shape but broader than long; the following ones become longer than broad. All the brachials are smooth.

The 10 arms are all broken but were probably 25 to 30 mm. long. The length from the proximal edge of the IBr_1 to the second syzygy (9+10) is 6.4 mm., while the width at the first syzygy (3+4) is 1.0 mm. Distally the syzygies occur at intervals of 3 muscular articulations.

The longest remaining P_1 has 12 cylindrical segments, probably 3 or 4 more when complete. The total length probably exceeded 5.5 mm. The first segment is short, the second as long as broad and the following ones are progressively more elongated. No P_2 is quite complete but one with 11 segments may lack only 1 or 2. The 11 segments total 4.3 mm. The second segment is already longer than wide and the succeeding ones are also relatively longer than the corresponding segments of P_1. As P_1 lies alongside P_2 the adjacent segments are almost exactly comparable in their proportions, for example the seventh segment of P_1 and the third segment of P_2. Since the degree of tapering appears to be similar, their tips were probably almost level. P_3 has at the most 9 segments left, approximately 3 having been lost; when complete it would have been about 4 mm. long. One P_a is complete; it has 12 segments similar in proportions to those of P_1. The pinnules following P_2 are all more or less broken; their segments

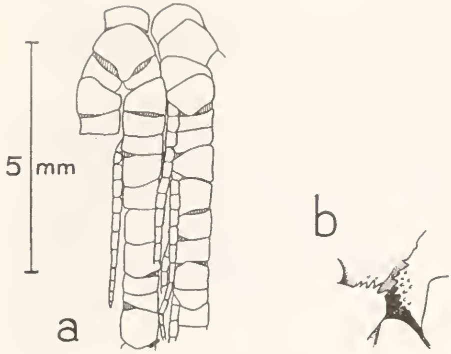

Figure 39.—*Nepiometra laevis* (P. H. Carpenter), holotype: *a*, Parts of two postradial series; *b*, diagonal view of lateral angles of two adjacent axillaries.

are relatively longer and narrower than those of the first two pinnules but are still cylindrical in shape with only the slightest trace of flared ends on some of the very long outer segments. The gonads are undeveloped but there appears to be an incipient one on P_3.

Locality.—Challenger station 214; off the Meangis Islands, south of Mindanao, Philippines (lat. 4°33′ N., long. 127°06′ E.); 914 meters; temperature 5.44° C.; blue mud; February 10, 1875 [P. H. Carpenter, 1888; A. H. Clark, 1913] (1, B.M.).

Genus ORTHOMETRA A. H. Clark

Trichometra (part) A. H. Clark, Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 2.
Orthometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae), p. 129 (diagnosis; type species *Trichometra hibernica* A. H. Clark, 1913), p. 130 (range; included species); No. 16, p. 510 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 244 (in key; range), p. 258; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range), p. 53 (in key).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 26 (in key), p. 38 (diagnosis).—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 6; Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.

Diagnosis.—A genus of Bathymetrinae in which the cirri are composed of numerous (25 to 33) segments, of which the longest are but slightly longer than broad and only slightly constricted centrally without overlapping distal ends and the distal are broader than long; the IBr_1 have converging sides and are not in contact; and P_1 has less than 20 segments, of which not more than 2 or 3 are as broad as long.

Type species.—Trichometra hibernica A. H. Clark, 1913.

Geographical range.—From the Bay of Biscay to western Ireland and thence to south of the Faroes.

Bathymetrical range.—From 698 to 997 meters.

Thermal range.—One record, 4.8° C.

ORTHOMETRA HIBERNICA (A. H. Clark)

Trichometra hibernica A. H. Clark, Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 2 (description; discussion; *Helga* sta. S.R. 151), p. 3 (sta. 223).—Le Danois, Les profundeurs de la mer, Paris, 1948, p. 245.

Trichometra delicata A. H. CLARK, Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 3 (*Helga* sta. CXX). (Not *T. delicata* A. H. Clark, 1911).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 38 (diagnosis; range); fig. 23, 1, p. 38.—KOEHLER, Echinodermes des mers d'Europe, vol. 2, 1927, p. 133.

Orthometra hibernica A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 258 (references); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 42 (range), p. 57 (*Ingolf* sta. 44).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 39 (diagnosis; habits); fig. 23, 2, p. 38 (cirrus).—KOEHLER, Echinodermes des mers d'Europe, vol. 2, 1927, p. 133.

Description.—In the type specimen the centrodorsal is concealed by the cirri.

The cirri are very numerous, probably about 13 mm. long, composed of 25 to 33 (usually nearer the latter) segments, of which the third to fifth are the longest, a third again (rarely so much as a half again) as long as broad; the following segments decrease in length, the third to fifth beyond these and those succeeding being about as long as broad and the distal slightly, though not much, broader than long. The longer proximal segments are slightly constricted centrally with rather prominent distal ends, and the short distal segments have a median dorsal carination.

The IBr_1 are not in contact basally, and their converging sides make an angle of about 60° with those of the adjacent IBr_1. The IBr_2 (axillaries) and the lower brachials are widely free laterally.

The elements of the IBr series and the proximal brachials have everted and serrate distal edges.

[NOTE BY A.M.C.] The arms of the holotype are all broken at the first or second syzygy. The width at the first syzygy is 1.0 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is about 7.0 mm. The pinnules are all broken. P_1 has 7++ elongated segments.

Notes.—The two other specimens from *Helga* station S.R. 151 resemble the one described, but are smaller; one of them has the arms about 25 mm. and the cirri about 11 mm. in length.

The single individual from *Helga* station CXX has the arms about 20 mm. long and the cirri 7 mm. long, with 15 to 20 segments, of which the longest are three times as long as the median width. At first I regarded this as an example of *Trichometra delicata*, and so recorded it; but the small specimens of that species from *Ingolf* station 18 have the cirri much more slender with the segments much more elongated and with less abruptly expanded ends.

In the specimen from *Huxley* station 13 the cirri are about XXX. 25–26, about 9 mm. in length. The first segment has a dull surface, and the second seems to be a transition segment, similar to these segments in the cirri of the Thalassometridae. The longest segments are only slightly longer than broad, with somewhat expanded distal ends. The short distal segments have a dorsal keel and in lateral view their dorsal profile is strongly and evenly convex.

The IBr_1 are very short, about four times as broad as long. The IBr_2 are rather low, slightly broader than long, the very short lateral borders making an angle of about 90° with each other so that beneath the first brachials, which just touch their neighbors outwardly, there is a considerable rhombic space between the IBr series.

Localities.—*Huxley* station 13; off Brittany (lat. 48°07′30″ N., long. 8°13′ W.); 753 meters; sand, mud and hard ground; August 1906 (1, Mar. Biol. Assoc., Plymouth).

Helga station S.R. 223; off southwestern Ireland (lat. 53°07′ N., long. 14°50′ W.); 749–914 meters [A. H. Clark, 1913] (2, Dublin M.).

Helga station CXX; off southwestern Ireland (lat. 53°58′ N., long. 12°24′ W.); 698 meters; May 24, 1901 [A. H. Clark, 1913] (1, U.S.N.M., 35778).

Helga station S.R. 151; off southwestern Ireland (lat. 54°17′ N., long. 11°33′ W.); 709 meters; August 27, 1904 [A. H. Clark, 1913] (3, U.S.N.M., 35774, 35775, 35901). Type locality.

Ingolf station 44; southwest of the Faroe Islands (lat. 61°42′ N., long. 9°36′ W.); 997 meters; temperature 4.8° C. [A. H. Clark, 1923] (1, C.M.).

Geographical range.—From the northern part of the Bay of Biscay to southwestern Ireland, and northward to southwest of the Faroes.

Bathymetrical range.—From 698 to 997 meters; the average of 5 records is 803 meters.

Thermal range.—The single record is 4.8° C.

History.—This species was first described in 1912 from 5 specimens which had been dredged by the Irish Fisheries steamer *Helga* in 1904 and 1905, and at the same time a sixth was recorded, under the name of *Trichometra delicata*, which had been taken by the same ship in 1901.

But the species had first been taken some years before, for in the *Ingolf* collection I found one from station 44 which I recorded in 1923.

Some years ago Dr. E. J. Allen, then Director of the Marine Biological Association station at Plymouth, England, was so kind as to send me for examination some of the specimens of *Neocomatella europaea* which had been dredged off the coast of Brittany by the *Huxley* in 1906, and among them I found another example of this little species.

Genus TONROMETRA A. H. Clark

Antedon (part) P. H. Carpenter, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386, and following authors.

Thaumatometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128.

Trichometra (part) A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 147.

Tonrometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae), p. 130 (diagnosis; type species *Antedon remota* P. H. Carpenter, 1888; range; included species); No. 16, p. 510 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 244 (in key; range), p. 258 (key to the included species); Journ. Linn. Soc. (Zool.), vol. 36, 1929, p. 662.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.

Diagnosis.—A genus of Bathymetrinae in which the centrodorsal is hemispherical or rounded conical with the cirrus sockets alternating or in irregular vertical columns; there are 18 to 37 cirrus segments, of which the longest are strongly constricted centrally with very prominent ends and may be over twice as long as their median widths; the distal segments may be shorter or longer than wide; the IBr series and arm bases are in close lateral contact; the brachials are more or less spinous at their distal edges; P_1 is very long and delicate with 13 to about 21 segments, of which not more than two or three at the base are as broad as long; P_2 is usually similar but may be slightly shorter; there are no marsupia on the genital pinnules.

Type species.—*Antedon remota* P. H. Carpenter, 1888.

Geographical range.—In the Southern Ocean between Marion Island and the Crozets, the South Orkney Islands and from off Princess Elizabeth Land, also from east of Halmahera and the Lesser Sunda Islands in the East Indies.

Bathymetrical range.—From 1089 to 3426 meters.

Remarks [by A.M.C.].—A comparison of the two Southern Ocean species *Tonrometra remota* (P. H. Carpenter) and *Florometra spinulifera* John (subfamily Heliometrinae) leads me to the conclusion that the two are congeneric. Both have cirri with the longer segments flared and the distal ones with rounded dorsal processes, division series of comparable form, the centrodorsal of similar proportions with the sockets tending to be arranged in columns and broad-based oral pinnules tapering markedly at first but attenuated and prolonged in the outer part. I found it hard to decide whether *spinulifera* should be referred to *Tonrometra*, or *remota* to *Florometra*. The relatively small numbers of cirrus and pinnule segments compared with those found in most species of *Florometra* might be explicable by the relatively small size (40 to 60 mm. arm length) of the known specimens of the two species in question. On the other hand the elongated outer segments of P_1 would seem to preclude both of them from inclusion in the Heliometrinae. The specimens of *Florometra* usually taken are almost invariably larger, two of the smallest of *F. mawsoni* in the British Museum (with the exception of juveniles from the Ross Sea) having the arm length about 55 and 60 mm. with the widths at the first syzygy 1.2 and 1.4 mm. The middle segments of P_1 are relatively a little longer than in larger specimens of *F. mawsoni* but are still not more than twice as long as wide (fig. 40,*e*, p. 686) and the distalmost segments are again shorter and more flared in shape, quite unlike the long cylindrical outer segments in the two species in question. *Florometra mawsoni* itself is also marked off from *remota* and *spinulifera* by the very sharp distal edges of the cirrus segments. With the present material it seems best to refer *spinulifera* to *Tonrometra.*

KEY TO THE SPECIES OF TONROMETRA

[by A.M.C.]

a^1. Segments of the oral pinnules expanded and spinous at the ends; longest cirrus segments not more than half again as long as their median widths; East Indian area.

- b^1. Cirri about XXX, 18–20 (Molucca Islands; 1089 meters)..................**brevipes** (p. 683)
- b^2. Cirri XL–L, 25–33 (lesser Sunda Islands; 1280 meters)..................**multicirra** (p. 684)

a^2. Segments of the oral pinnules straight, not expanded or notably spinous at the ends; longest cirrus segments twice or more their median width in length; Southern Ocean.

- b^1. Cirri with up to 37 segments, the longest of which are two and a half times their median width (off Princess Elizabeth Land, Antarctic; 1266 meters)..................**spinulifera** (p. 686)
- b^2. Cirri with up to 30 segments, the longest of which are twice as long as their median width (between Marion Island and the Crozet Islands and near the South Orkney Islands; 2925 and 3426 meters)..................**remota** (p. 688)

TONROMETRA BREVIPES (A. H. Clark)

Trichometra brevipes A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 147 (description; *Siboga* sta. 150); Die Crinoïden der Antarktis, 1915, p. 145 (comparison with *T. remota*).

Tonrometra brevipes A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 258 (in key; range; detailed description; sta. 150), p. 273 (listed), pl. 26, fig. 92.

Diagnostic features.—The cirri are about XXX, 18–20, the longer segments not longer than their maximum diameter; P_1 with all but the first few segments greatly elongated and with expanded and finely spinous joints.

Description.—The centrodorsal is low conical, twice as broad at the base as high. It bears about 30 closely crowded and irregularly placed cirrus sockets which have very prominent rims.

The cirri are about XXX, 18 to 20, about 4 mm. long. The second segment is about as long as its median diameter; the third to fifth or sixth are the longest, about as long as the diameter of their expanded distal ends [presumably about a third again as long as their median widths—A.M.C.] the following segments gradually decreasing in length so that the outermost nine or ten are slightly broader than long. The longer earlier segments are constricted centrally, slightly carinate dorsally, with greatly expanded and overlapping and very spinous distal ends, these features rapidly decreasing as the segments become shorter. The short outer segments are subcarinate dorsally and bear a slight dorsal spine.

The radials are concealed by the centrodorsal.

The IBr_1 are extremely short, in close lateral apposition, with the lateral edges slightly everted. The IBr_2 (axillaries) are nearly as broad as long, almost triangular, the lateral edges just in apposition with the lateral angles of the adjacent axillaries, and bearing a moderately developed rounded proximal process. There is a faint shallow median groove on both ossicles and their edges are prominently everted and spinous.

The dorsal surface of the lower brachials is more or less thickly covered with very fine spines which form prominent frills at the distal edges.

The width of the first syzygy is 0.5 mm.

P_1 is excessively delicate; the segments after the third are greatly elongated with expanded and finely spinous distal ends.

Locality.—*Siboga* station 150; east of Halmahera (Gilolo), Molucca Islands (lat. 0°06′ N., long. 129°07′12″ E.); 1089 meters; yellow gray mud and sand; stones; evidently very rough bottom; August 11, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam Mus.).

Remarks.—In 1957 the type specimen was found to be in very poor condition, the centrodorsal, cirri, pinnules and arms beyond the first few brachials having been lost.

TONROMETRA MULTICIRRA A. H. Clark

Tonrometra multicirra A. H. Clark, Journ. Linn. Soc. (Zool.), vol. 36, No. 249, 1929, p. 635 (listed), p. 662 (south of Lombok; 700 fms.; description; comparisons), pl. 42, fig. 8, pl. 44, fig. 16; Ann. Mag. Nat. Hist., ser. 10, vol. 10, No. 58, 1932, p. 378 (listed), p. 383 (south of Lombok; 600 fms.; description); Proc. Biol. Soc. Washington, vol. 47, 1934, p. 10.

Diagnostic features.—Cirri XL–L, 25 to 33, the longest segments half again as long as broad; P_1 with 13–16 segments, the joints markedly swollen and spiny.

Description.—The centrodorsal is rounded conical and is almost completely covered with cirrus sockets which decrease markedly in size from the periphery to the apex.

The cirri are about XL, 25 to 28 and about 12 mm. long. The apical cirri are about a fourth the length of the peripheral ones and with as few as 14 segments. In the long peripheral cirri the second segment is half again as broad as long, the third is a third again as long as broad and the fourth and fifth, which are the longest, are half again as long as broad. The following segments decrease in length, becoming as long as broad by the ninth and very slightly broader than long in the outer third of the cirrus. The second to fourth segments are somewhat constricted centrally with flaring and slightly overlapping ends. From about the eighth onwards, the segments have a rather broad median carination in the middorsal line, the crest of which in profile is at first evenly convex, the maximum convexity being displaced toward the distal end on the outer segments. The opposing spine is prominent, conical, arising from the entire dorsal surface of the penultimate segment, with the apex median to subterminal. The terminal claw is rather stout, slightly longer than the penultimate segment, and strongly curved. In the small apical cirri the longest earlier segments are about half again as long as broad and the outer are about as long as broad.

The distal border of the radials is even with the rim of the centrodorsal. The IBr_1 are short with strongly converging lateral borders and the distal border incised by the posterior prolongation from the axillary. The latter is broadly pentagonal, about as long as broad. The lateral edges are about as long as those of the IBr_1, with which they make a broadly obtuse angle.

The 10 arms are about 45 mm. long. From the proximal side of the IBr_1 to the second syzygy (9+10) measures 6.5 mm. and the width at the first syzygy is 0.9 mm. The first brachials are very short, wedge-shaped, interiorly united in the basal third. Between the first two syzygies the brachials are slightly wedge-shaped and about twice as broad as the median length. After the second syzygy the brachials become triangular, slightly longer than broad and soon very obliquely wedge-shaped and longer than broad, the elongation increasing distally. The distal ends of the brachials are not produced or modified.

Syzygies are placed as usual between brachials 3+4, 9+10, and 14+15, and distally at intervals of two muscular articulations.

P_1 is 4.5 mm. long, exceedingly slender, with 16 segments, of which the first is much broader than long, the second is broader than long, the third is nearly as long as broad, the fourth is longer than broad and those following are progressively more elongated with expanded and finely spinous distal ends.

P_2 resembles P_1, but is slightly stouter basally and somewhat shorter, with 14 segments, of which the second is as long as broad and the third longer than broad.

P_3 is markedly stouter than the first two pinnules and appears to be slightly shorter than P_2. It is the first genital pinnule.

[NOTES BY A.M.C.] A second specimen in the British Museum from a neighboring locality is slightly larger than the type. It has the arms broken at 50 mm. length from the base; when complete they were probably about 60 mm. long. The length from the proximal side of the IBr_1 to the second syzygy (brachials 9+10) is 8.0 mm. and the width at the first syzygy is 1.4 mm.

The hemispherical centrodorsal is almost completely covered with the cirri which number about L and of which all but the apical ones seem to be arranged in irregular vertical columns. The longest cirri have up to 33 segments and measure 14 to 16 mm. in length. Their longest segments are only a third again as long as their median widths, otherwise they are similar in shape to those of the type with flared ends to the longer segments and a convex profile to the dorsal side of the distal segments.

The brachials and division series all have a frill of spines along their distal edges but are not notably flared or constricted in the middle.

P_1 has 13 segments and measures 5.0 mm. The fourth segment is as long as broad and the relative length increases so that the seventh segment is twice as long as broad and the tenth is four times as long as broad. Each segment has a small spiny frill at the distal end. The next two pinnules are the same length as P_1 and with the same number of segments. The only difference is that the spiny frills become better developed. P_3 is the first genital pinnule, the last being in the vicinity of P_{15}, which has 15 segments all of which are expanded at both ends to a much greater extent than are the segments of the oral pinnules; its length totals 7 mm.

Localities.—South of Lombok, Lesser Sunda Islands (lat. 9°06′15″ S., long. 116° 27′10″ E.); 1280 meters; C.S. *Cable* [A. H. Clark, 1929, 1932] (1, B.M.). Type locality.

South of Lombok (lat. 8°59′54″ S., long. 115°50′48″ E.); 1097 meters; C.S. *Cable* [A. H. Clark, 1932] (1, B.M.).

TONROMETRA SPINULIFERA (John)

FIGURE 40, *a–d*

Florometra spinulifera JOHN, Rep. B.A.N.Z. Antarctic Res. Exped. 1929–31, ser. B, vol. 4, pt. 6, 1939, p. 191 (listed), pp. 199–201 (locality; description; comparison with *F. mawsoni*); fig. 2, p. 200.

Diagnostic features.—The cirri have up to 37 segments in the unique holotype, the longest segments being two and a half times as long as their median widths; the elongate distal segments of the oral pinnules are not conspicuously expanded or spinous at their distal ends.

Description.—The centrodorsal is rounded conical with a smooth dorsal pole. The basal diameter is about 2 mm. The cirrus sockets are arranged in 15 fairly distinct vertical rows.

The cirri are about XL with 24 to 37 segments. Only a single peripheral one remains intact. The cirri of the second row have about 32 segments, of which the third is longer than broad and somewhat constricted in the middle, wider at the distal end than the proximal. The fourth and fifth segments are the longest, about two and a half times as long as their median width. The following segments decrease in length; the tenth is less than twice as long as broad and the twentieth and those following are as

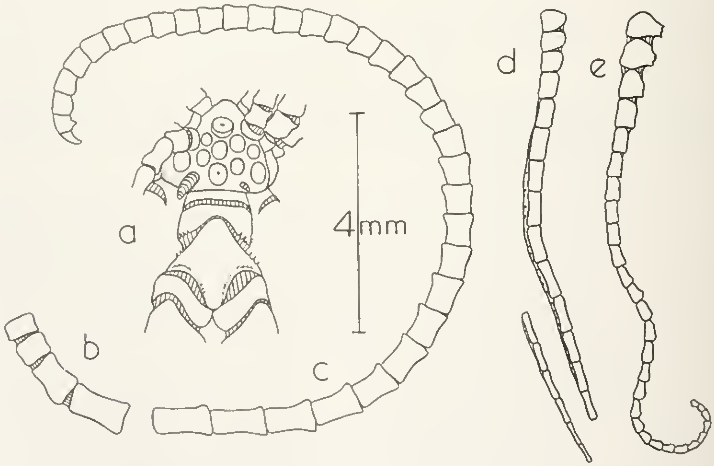

FIGURE 40.—*Tonrometra spinulifera* (John), holotype: *a*, Centrodorsal and division series; *b*, base of peripheral cirrus; *c*, detached part of another; *d*, P_1, in two parts, lacking the tip. *Florometra mawsoni* A. H. Clark, B.M., 1938.12.7.88, width of first syzygy 1.4 mm.: *e*, P_1 for comparison.

broad as long. At about the fifteenth the segments change their shape. The proximal portion of the dorsal edge ceases to be parallel with the ventral edge; it diverges from it. The distal swelling occupies a greater portion of the dorsal edge. On the most distal segments it comes to have the shape of a rounded keellike dorsal spine, two-thirds the length of the segments. The opposing spine is strong, the terminal claw sharply curved. The first 7 to 10 segments of the cirri are a dull yellow, the rest are lighter colored (in alcohol).

The 10 arms are all incomplete. The longest remaining one is nearly complete; it consists of 70 brachials and is about 55 mm. long.

The radials are short in the midline. They are smooth, with concave distal edges. The IBr_1 are not in apposition. They are fairly deeply incised by the axillaries, and are about four times as wide as the length in the midline. The rhombic axillary is as wide as long; the proximal edges are slightly, the distal strongly, concave; the proximal angle is broadly rounded. The edges of both ossicles are roughened with fine spines.

Syzygies occur between brachials 3+4, 9+10, 14+15 and thereafter, with few exceptions, at intervals of three muscular articulations. The width at the first syzygy is 1.0 mm. and the length from the IBr_1 to the second syzygy is 8.5 mm.

The first brachial is short and incised by the second. The second is roughly triangular, and about as long as broad. The brachials between the first and second syzygial pairs are nearly rectangular, the more proximal wider than long, the distal as long as broad. Immediately beyond the second syzygy the brachials are wedge-shaped and longer than broad. Farther out on the arm they gradually become more elongated; the distal are rectangular and about as long as broad. A small triangular area of the dorsal surface of the fifth to eighth brachials is raised into a spine-patch. The distal edges of the brachials beyond the second syzygy are everted and produced into a small number of low inconspicuous spines.

The oral pinnules are long and flagellate, the genital and distal pinnules shorter and more rigid. No P_1 is quite complete. One which appears to be nearly so is of 21 segments and 9 mm. long. The first three or four segments are somewhat compressed from side to side, and more massive than the remainder. The rest of the pinnule tapers evenly, and is very flexible. The first and second segments are broader than long, the third about as long as broad, the remainder longer than broad. The fifth is twice, the fifteenth three times, as long as broad; the most distal segments are five times as long as broad. Beyond the first three or four, which are compressed, the segments are regularly cylindrical; their dorsal surfaces are rounded, not raised and spiny; their distal edges are only slightly swollen. P_1 and the other oral pinnules are abundantly supplied with sacculi.

P_2 is of 21 segments and similar to P_1. P_3 may be an oral pinnule, similar to P_1 and P_2, except that its proximal portion is somewhat heavier, or it may be the first genital pinnule.

P_4, a genital pinnule, is of 13 segments and 6 mm. long. The gonad lies along the fifth to eighth segments. The first two segments are short, the others longer than broad. The third and fourth segments are twice, the fifth two and a half times, the sixth and seventh three times as long as broad. The part of the pinnule beyond the gonad is delicate and tapering, of segments about four times as long as broad. There is no ambulacral furrow. P_5 is similar to P_4 except that the gonad lies along the fourth to eighth segments and that it may or may not have an ambulacral furrow.

The genital pinnules extend to P_9 or P_{10}, which have small gonads on the fourth and fifth segments. P_9 is of 14 segments and 6 mm. long. The first two segments are short; the remainder are regular, cylindrical and elongated; the third segment is more than twice, the distal segments more than four times, as long as broad. The whole pinnule tapers evenly to a fine point. Few distal pinnules remain. They are of about 16 segments and 8 mm. in length, generally similar to P_9.

Sacculi, somewhat irregularly arranged, are abundant on the arms and pinnules, including the oral pinnules.

Two pinnules were examined by Dr. John for the presence of an ambulacral skeleton. Reduced side plates, one or two to a segment, are present along a part of one pinnule, absent from the other. They are in the form of curved or straight rods, with the distal end bifurcated. There are numerous spicules of diverse shapes and sizes in the tentacles of both specimens.

Remarks [by A.M.C.].—I have removed this species from the genus *Florometra* as the very elongated segments of the oral pinnules could not be reconciled with the diagnosis of the subfamily Heliometrinae. It might have been supposed that the arrangement of the cirrus sockets in vertical rows (even though these are not perfectly regular) would indicate a position in the subfamily Zenometrinae, more particularly perhaps near the southern genus *Eumorphometra.* However, no species of *Eumorphometra* has oral pinnules with more than 13 segments and *spinulifera* has a much greater resemblance to *Tonrometra remota.* Except for the slightly more numerous and relatively longer cirrus segments in *spinulifera*, the differences between them are slight.

Locality.—B.A.N.Z.A.R.E. station 29; off Princess Elizabeth Land (lat. 66°28′ S., long. 72°41′ E.); 1266 meters; December 25, 1929 [John, 1939] (1, B.M.).

TONROMETRA REMOTA (P. H. Carpenter)

FIGURE 41

Antedon remota P. H. CARPENTER, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386 (*nomen nudum*; sacculi largely developed); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 184 (description), pl. 29, figs. 5–9.—BATESON, Materials for the study of variation, 1894, p. 421 (specimen with only 2 radials on one ray).—SHIPLEY, Antarctic manual, 1901, ch. 18, p. 269.—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 405 (antarctic representative of the *Tenella* group).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888=*Thaumatometra remota*).

Thaumatometra remota A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (=*Antedon remota* P. H. Carpenter, 1888), p. 245 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (published references to specimens in the B. M.; *Challenger* sta. 174).—TORTONESE, Natura, Milano, vol. 24, 1933, p. 164.

Trichometra remota A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 147 (compared with *T. brevipes*); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (antarctic; range); Die Crinoiden der Antarktis, 1915, p. 105 (collected by the *Challenger*; recorded as *Antedon remota*), p. 107 (in key to antarctic comatulids), p. 145 (synonymy; locality; comparison with *T. brevipes*), p. 170 (a deep water antarctic species; antarctic region south of the Indian Ocean), p. 171 (systematic and geographical relationships).

Tonrometra remota A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 258 (in key; range), p. 259 (references); Journ. Linn. Soc. (Zool.), vol. 36, No. 249, 1929, p. 664 (compared with *T. multicirra*).—JOHN, *in* Vaney and John, Sci. Res. Voy. *Scotia*, 1902–04, Crinoidea, 1939, p. 670 (*Scotia* station; description),

p. 671 (comparison with syntypes); text-fig. 3.—TORTONESE, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4 (depth range).—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56 (depth range).

Diagnostic features.—The cirri are XXX–XL, 19 to 29, with the longer segments about twice as long as their median widths; P_1 has about 20 segments, of which the distal ones are not expanded or spinous at the ends.

Description [modified by A.M.C.].—The centrodorsal is broadly rounded conical, the blunted apex distinctly rugous; the well-defined cirrus sockets tend to form irregular vertical columns. All the cirri are now lost but for one which is nearly apical on the syntype with the arms broken off short. There are XXX–XL sockets. The single cirrus has 20 segments, of which the more proximal are strongly constricted centrally with the distal ends flared. The longest segments are about twice as long as their median widths or about a third again as long as their maximum widths. Beyond the tenth the segments are as broad as long or broader and have a slight dorsal keel. The peripheral cirri would have been longer with possibly half again as many segments.

The distal edges of the radials are just visible beyond the rim of the centrodorsal. The IBr_1 are nearly oblong, three or four times as broad as long, rather strongly convex dorsally and considerably incised by the broadly rounded proximal angle of the IBr_2 (axillaries). The latter are rhombic, broader than long, with a slightly prolonged distal angle and strongly concave distal sides. The IBr_2 and the first two brachials have traces of spinous lateral processes, which in one syntype form a kind of frill.

The 10 arms were probably about 40 mm. long. The first syzygy is respectively 0.85 and 1.0 mm. wide in the two syntypes and in the larger the length from the proximal edge of the IBr_1 to the second syzygy at 9+10 is 7.0 mm. The second syzygy may be beyond brachials 9 and 10 and the third one is even more irregular. Distally the interval is from three to five muscular articulations.

The first two pairs of pinnules are very long, slender and delicate, and were probably about equal in length. All are broken, but one P_a is almost complete; it has 20 segments, of which the outer ones are very attenuate, more than six times as long as broad. The joints are only slightly expanded. The first two or three segments are compressed laterally and enlarged dorsoventrally so that in side view the tapering is very noticeable. The total length is about 7 mm. No P_1 is complete beyond the tenth segment or P_2 beyond the fifteenth but each probably had a total of at least 20 segments. P_3 is the first genital pinnule. All are broken. The outer segments of the following genital pinnules are so attenuate as to be almost transparent.

Notes.—Some additional specimens were taken by the *Scotia* off the South Orkney Islands in the Weddell Sea. These were described and figured by Dr. Dilwyn John. They are similar in size to the syntypes.

The centrodorsal is hemispherical, about twice as broad as high. Its ventral edge is nearly straight. The cirrus sockets are arranged in alternate rows around the sides leaving the dorsal pole smooth and rounded.

The cirri are about XL, 20–29, the peripheral considerably longer than the apical ones. A peripheral cirrus has the first two segments short, the third longer than broad and the fifth twice as long as the median diameter. Beyond the fifth the segments decrease in length to become only a little longer than wide. The third to the ninth segments are constricted in the middle and expanded at the distal ends, though not as much as in the apical cirrus of the syntype, or indeed as in the apical cirri of the same

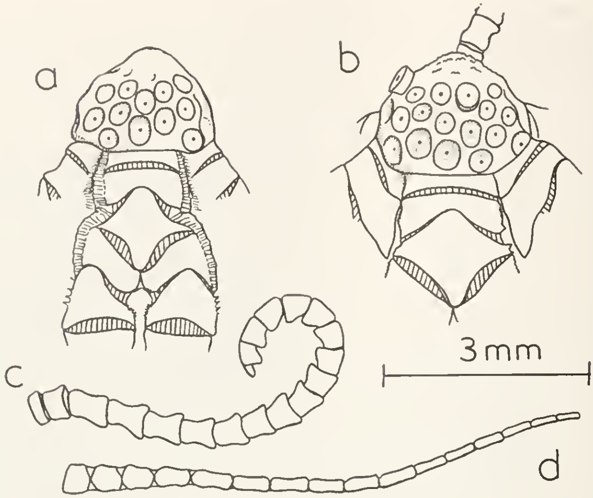

FIGURE 41.—*Tonrometra remota* (P. H. Carpenter), syntypes: *a*, With spinous 'frill' on proximal ossicles; *b*, with reduced ornamentation; *c*, apical cirrus of third row from periphery; *d*, P_a, tip lost.

specimen. The peripheral cirri also have no distinct dorsal keel on the distal segments unlike the apical cirri.

The radials are short in the midline, with the distal margins concave. The division series are much as in the types. The syzygies are more regular than in the types, the first three being as usual 3+4, 9+10, and 14+15.

The brachials between the first and second syzygies are oblong and slightly broader than long; the following ones become a little longer than broad and tend to be wedge-shaped. The edges of all the brachials are everted and produced into small spines.

P_1 is long and tapering, of 20 segments and 7 mm. long. The first four to six segments are laterally compressed so that the dorsal edge is thin and crestlike. The first segment is short, the second and third about as long as broad, the fourth longer than broad. The following segments become progressively longer relative to their width, the longest being about five times as long as broad. No P_2 is complete. They were probably similar to P_1. P_3 is the first genital pinnule. It has no ambulacral furrow. The most complete one remaining has 9 segments about 4 mm. long. The first four segments are stout and somewhat compressed, the third and fourth are slightly longer than broad and the remaining segments are cylindrical and more elongated. The gonad is fusiform and extends from the distal part of the fourth to the seventh segments.

The anal cone is high.

Localities.—Challenger station 147; between Marion Island and the Crozets, Southern Ocean (lat. 46°16′ S., long. 48°27′ E.); 2925 meters; temperature 1.22° C.; diatom ooze; December 30, 1873 [P. H. Carpenter, 1887, 1888; A. H. Clark, 1913; Vaney and John, 1939] (2½, B.M.). Type locality.

Scotia, March 18, 1903; SE. of the South Orkney Islands, Weddell Sea (lat. 62°10′ S. long. 41°20′ W.); 3426 meters [Vaney and John, 1939] (2, Edinburgh M.).

Genus BATHYMETRA A. H. Clark

Antedon (part) P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 384, and following authors.

Bathymetra A. H. Clark, Proc. Biol. Soc. Washington, vol 21, 1908, p. 132 (diagnosis; type species *Antedon abyssicola* P. H Carpenter, 1888), p. 136 (referred to the Antedonidae); Amer. Nat., vol. 42, 1908, No. 500, p. 542 (characteristic oceanic genus); No. 503, p. 718 (only comatulid beyond 2000 fms.), p. 725 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 603 (oceanic genus), p. 604 (found beyond 2000 fms.); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted); vol. 36, 1909, p. 366 (radials compared with those of *Comotilia*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 177 (referred to the Bathymetrinae); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 12 (occurs in deep water in the Atlantic, but never intrudes on the territory of the Polar-Pacific species [reference is to *Thaumatometra minutissima*]); Crinoids of the Indian Ocean, 1912, p. 11 (occurs both east and west of Ceylon), p. 15 (characteristic of the oceanic fauna; absent from the north Atlantic), p. 26 (range; 1200–2900 fms.; also occurs off the Brazilian coast [*Thaumatometra minutissima*]), pp. 61, 63 (in key), p. 244 (original reference; type); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 7 and following (occurs in both Atlantic [refers to *Thaumatometra minutissima*] and Indo-Pacific; range and its significance); Die Crinoïden der Antarktis, 1915, p. 147 (synonymy; range; as here considered included *abyssicola, brevicirra, carpenteri, minutissima* and a species mentioned by Hartlaub from Panama), p. 182 (both Atlantic [*Thaumatometra minutissima*] and Indo-Pacific; range); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae); No. 16, p. 512 (in key; range); Unstalked Crinoids of the *Siboga*-Exped., 1918, p. 246 (in key; range), p. 253 (key to the included species).—Pelseneer, Bull. Soc. Zool. France, vol. 53, 1928, p. 172 (parasites).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.

Diagnosis.—A genus of the Bathymetrinae in which all the cirrus segments but the first one are longer than broad; the cirri are only X–XV in number; the radials are conspicuous, about twice as broad as long; there is no marsupium on the genital pinnules.

Type species.—*Antedon abyssicola* P. H. Carpenter, 1888.

Geographical range.—Known from south of Australia and from north of Midway Island, North Pacific.

Bathymetrical range.—From 4753 to 5301 meters.

Thermal range.—From 1.05° C. to 1.83° C.

Remarks [by A.M.C.].—In his previous diagnoses of this genus Mr. Clark wrote that all the cirrus segments are longer than broad. In fact Carpenter's artist omitted the short basal segment from his figures.

KEY TO THE SPECIES OF BATHYMETRA

a^1. Centrodorsal with the cirrus sockets spaced out around its sides; radials nearly horizontal, making a distinct angle with the base of the centrodorsal in side view (west of Tasmania; 4753 meters). carpenteri (p. 692)

a^2. Centrodorsal bearing cirri only around the dorsal pole, the basal half being smooth and bare; radials making a continuous curve or a wide angle with the base of the centrodorsal in side view (east of Japan; 5300 meters) .... abyssicola (p. 692)

BATHYMETRA CARPENTERI A. H. Clark

FIGURE 42

Antedon abyssicola (part) P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 191 (description, in part; *Challenger* sta. 160), pl. 33, fig. 2; similarly included under the same name by subsequent authors.

Bathymetra carpenteri A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 132 (listed; *nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 235 (*Antedon abyssicola* P. H. Carpenter, 1888, specimen from *Challenger* sta. 160, shown on pl. 33, fig. 2; characters); Mem. Australian Mus., vol. 4, 1911, p. 796 (*Challenger*, SW. of Melbourne, 2600 fms.); Crinoids of the Indian Ocean, 1912, p. 33 (=*Antedon abyssicola* P. H. Carpenter, 1888, in part), p. 245 (synonymy; west of Tasmania, 2600 fms.); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (published references to the specimen in the B.M.; *Challenger* sta. 160); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (Antarctic; range); Die Crinoïden der Antarktis, 1915, p. 106 (collected by the *Challenger;* recorded as *Antedon abyssicola*), p. 107 (in key to Antarctic crinoids), p. 147 (synonymy; range), p. 170 (a deep water Antarctic species), p. 171 (systematic and geographical relationships); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 254 (in key; range; references).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 11 (note); Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56 (depth range).

Diagnostic features.—The centrodorsal has a flattened dorsal pole with the cirrus sockets alternating irregularly around the sides, some close to the base; the radials are aligned at a distinct angle with the base of the centrodorsal in side view; the brachial articulations are hollowed out dorsally to an unusual extent; the cirri and pinnules are unknown.

Description [by A.M.C.].—The holotype and only known specimen is small. The arms are all broken but were probably less than 20 mm. in length. From the proximal edge of the IBr_1 to the second syzygy measures 6.0 mm. and the width at the first syzygy is 0.55 mm.

The centrodorsal is low hemispherical with the dorsal pole raised but truncated into a broadly flattened apex. There are 10 cirrus sockets arranged in a zigzag row around the sides except for one which is placed almost directly above another. They are spaced out from each other. Carpenter's figure in the *Challenger* Report (pl. 33, fig. 2) is incorrect in the shape of the centrodorsal, which is shown as unnaturally flattened. In fact it is almost two-thirds as high as wide at the base.

All the cirri are lost.

The radials appear to be short in side view, owing to foreshortening, as they project from the base of the centrodorsal almost horizontally. They are rounded dorsally.

The IBr_1 are deeply incised by the apex of the arrowhead-shaped IBr_2 (axillaries) which are widest towards the distal end and have a broadly truncated distal angle with the two distal sides deeply concave. They are slightly longer than wide.

The articulations between the brachials are hollowed out on the dorsal side to an unusual extent allowing particularly free dorsoventral movement.

All the pinnules are broken off at the base.

Locality.—*Challenger* station 160; west of Tasmania (lat. 42°42′ S., long. 134°10′ E.); 4753 meters; temperature 1.05° C.; red clay; March 13, 1874 [P. H. Carpenter, 1888] (1, B.M.).

BATHYMETRA ABYSSICOLA (P. H. Carpenter)

FIGURE 43

Antedon abyssicola P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 191 (description, in part; *Challenger* sta. 244 [the specimen from sta. 160 = *B. carpenteri*]), pl. 33, fig. 1

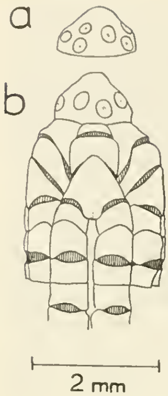

FIGURE 42.—*Bathymetra carpenteri* A. H. Clark, holotype: *a*, Centrodorsal; *b*, calyx viewed from the other side.

[fig. 2 = *B. carpenteri*].—BATHER, Quart. Journ. Geol. Soc., vol. 45, 1889, p. 154 (interradia projection of radials homologous with petals, spearheads or spines in the Eugeniacrinidae; exactly paralleled in many Larviforma).—P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 59 (considered an embryonic type).—HARTLAUB, Nova Acta Acad. German., vol. 58, 1891, No. 1, p. 14.—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 298 (after Carpenter).—THOMPSON, Proc. Roy. Soc. Edinburgh, vol. 22, 1899, p. 321 (evidence in support of the bipolar theory).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 454 (determination of the type locality); Crinoids of the Indian Ocean, 1912, p. 33 (of Carpenter, 1888 = *B. abyssicola* + *B. carpenteri*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 79 (same).—KOEHLER, Les echinodermes des mers d'Europe, vol. 1, 1924, p. 58 (depth).

Bathymetra abyssicola A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 132 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 235 (restricted by the description of one of the two specimens as *B. carpenteri*); Crinoids of the Indian Ocean, 1912, p. 33 (=*Antedon abyssicola* P. H. Carpenter, 1888, in part), p. 244 (synonymy; north Pacific, 2900 fms.); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (published references to the specimen in the B.M.; *Challenger* sta. 244); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (Antarctic type; range and its significance); Die Crinoïden der Antarktis, 1915, p. 148 (synonymy; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 254 (in key; range; references).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 11 (note).—TORTONESE, Natura, Milano, vol. 24, 1933, p. 164.—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56 (depth).

Diagnostic features.—The centrodorsal has no cirri around the base but around the dorsal pole there are 10 to 15 which are directed vertically in the two known specimens; the radials form a continuous curve with the base of the centrodorsal and are not very foreshortened in side view; the articulations of the brachials are not unusually free dorsally; the pinnules are unknown.

Description [by A.M.C.].—The centrodorsal is probably low hemispherical, but the shape is concealed by the bases of the cirri which are concentrated around the dorsal pole leaving bare the peripheral half.

The X–XV cirri are now all broken by the sixth segment and no detached distal parts remain. Carpenter gave the number of segments as 8 to 10. According to his figure, the second segment is already much longer than broad. In fact it is not more than half again as long as broad on any of the remaining cirrus bases. The third segment, however, is markedly longer than the preceding one, about four times as long as its median width and the fourth and fifth segments are up to six times as long as their median widths. Carpenter described the following segments as slowly decreasing in length, the penultimate being scarcely longer than wide and bearing a small opposing spine. Probably his figure is reasonably correct except that a basal segment has been omitted from each cirrus (pl. 33, fig. 1).

The radials are not overlaid by the centrodorsal with which they form a continuous curve or wide angle since they are aligned at no more than 45° to the dorsoventral axis and so are not so much foreshortened in side view as are the radials of *Bathymetra carpenteri*. They are about twice as broad as long in the median line with the distal border strongly concave and the interradial angles produced so as entirely to separate the bases of the IBr_1. These are about the same size as the radials and are deeply incised by the IBr_2. The latter are arrowhead-shaped with the apex directed proximally, the proximal sides are slightly convex and the shorter distal sides very concave. The distal angle is truncated. In the larger of the two specimens the axillary is as broad as long, in the smaller one it is relatively longer.

The arms of the larger specimen were probably about 25 mm. long. From the proximal edge of the IBr_1 to the second syzygy is 7.5 mm. and in the smaller specimen 6.5 mm.; the widths at the first syzygy are respectively 0.8 and 0.6 mm.

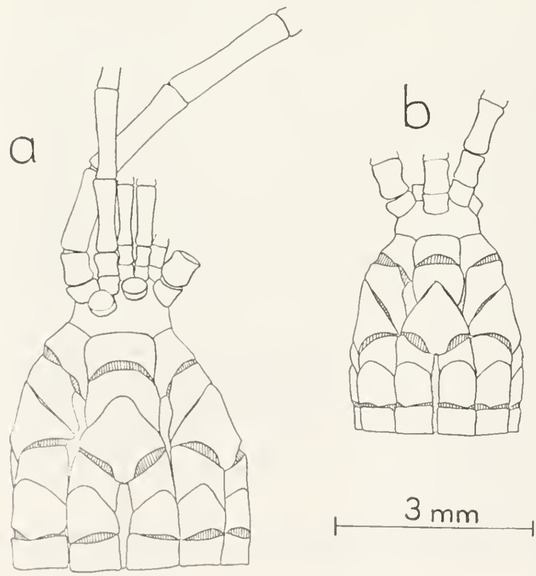

FIGURE 43.—*Bathymetra abyssicola* (P. H. Carpenter), *a*, larger and *b*, smaller syntypes.

Syzygies occur between brachials 3+4, 9+10, and 14+15 or 15+16, and distally at intervals of from 3 to 5, usually 4, muscular articulations.

Carpenter says that in the types the pinnules are much broken, but the proximal ones seem to have been slender and delicate.

Locality.—*Challenger* station 244; northeast of Midway Island (lat. 35°22′ N., long. 169° 53′ E.); 5301 meters; temperature 1.83° C.; red clay; June 28, 1875 [P. H. Carpenter, 1888] (2, B.M.).

Remarks.—The specific name *abyssicola* used by Carpenter for the two specimens from *Challenger* station 244 and also the one from *Challenger* station 160 was restricted in 1908 so as to cover only the former.

Station 244 was chosen as the type locality for the reason that in the place where the characters of *abyssicola* were first mentioned (in the key to the species of the "*Tenella* group") the only feature given was the number of cirrus segments, and the single specimen from station 160 had no cirri.

Genus RETIOMETRA A. H. Clark

Retiometra A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (diagnosis; type species *R. alascana* sp. nov.).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.

Diagnosis.—A genus of the Bathymetrinae, in which the centrodorsal is low hemispherical; the numerous cirri are short with up to 20 segments, of which the longest are about three times as long as broad and the distal are a little longer than broad; the brachials have slightly produced and spinous distal ends; P_1 is much elongated, considerably longer than the genital P_2, and is composed of 20 to 30 segments; there is no marsupium on the genital pinnules.

Type species.—*Retiometra alascana* A. H. Clark, 1936.

Geographical range.—Southeastern part of the Bering Sea and the Gulf of Alaska.

Bathymetrical range.—From 291 to 1270 meters.

Remarks [by A.M.C.].—A comparison of the type specimens of *R. alascana* and *Antedon exigua* P. H. Carpenter has convinced me that the two are not congeneric. The centrodorsal is much higher in *exigua* with only a small roughened area free of sockets, rather than a large smooth dorsal pole; the cirri, though superficially alike in number of segments and their proportions, differ in their distinct distal enlargement in *exigua*; the axillaries and second brachials have very slight proximal angles in *alascana* but prominent ones in *exigua*, and the oral pinnules, though similarly elongate, have much more flared segments in *exigua*. I am transferring Carpenter's species to the genus *Phrixometra* although in the absence of female specimens the presence of brood pouches on the genital pinnules, characteristic of that genus, cannot be ascertained. The three known species of *Phrixometra* are also from the Southern Ocean (or South Atlantic). *A. exigua* agrees with them in the form of the cirri, though the segments are relatively longer, in the shapes of the division series and in the flared pinnule segments.

RETIOMETRA ALASCANA A. H. Clark

Figure 44

Retiometra alascana A. H. Clark, Proc. U.S. Nat. Mus., vol. 83, 1936, p. 248 (description; *Albatross* sta. 3330; southeastern Bering Sea and Gulf of Alaska; 291 [?197] —1270 meters).—Baranova, Invest. Far-East Seas U.S.S.R., No. 4, 1957, p. 152 (occurrence in Bering Sea; distribution), p. 248.

Description.—The centrodorsal is flattened hemispherical with a broad bare dorsal pole equal in width to about one third of the total diameter. The 45 to 60 cirrus sockets are closely crowded around the sides. The peripheral ones are distinctly larger than the apical.

The cirri are XLV–LX; a complete middle one has 12 segments and is 8 mm. long (fig. 44*c*). The first segment is from half again to twice as broad as long; the second is nearly twice as long as broad; the third and fourth are nearly three times as long as the median width, slightly constricted centrally; and those following slowly decrease in length so that the antepenultimate is not quite twice as long as broad, at the same time losing the median constriction so that they appear slightly broader in lateral view. The penultimate segment is half again as long as broad. The opposing spine is small, terminal, and directed obliquely forward; its dorsal profile makes practically a straight line with that of the penultimate segment. The terminal claw is about as long as the penultimate segment, rather stout at the base, evenly tapering, and evenly and strongly curved. Judging from the stouter basal segments, the peripheral cirri were somewhat larger.

The distal edges of the radials are even with the rim of the centrodorsal. The IBr_1 are extremely short, about six times as broad as long in the median line, just in contact basally, with the lateral edges very strongly convergent. The IBr_2 (axillaries) are triangular, broader than long, the anterior angle, which is not produced, approximately a right angle, the anterior sides only slightly concave, the lateral angles extending far beyond the anterolateral angles of the IBr_1, yet widely separated from those of the adjacent axillaries, and with a slight well-rounded process in the median portion of the proximal border.

The 10 arms are from 55 to 75 mm. in length. The first brachials are very short, twice as long exteriorly as interiorly, with the proximal half of the inner edges of those of each arm pair in contact and the distal halves diverging at first in a straight line which later turns abruptly upward in a slightly rounded right angle. The second

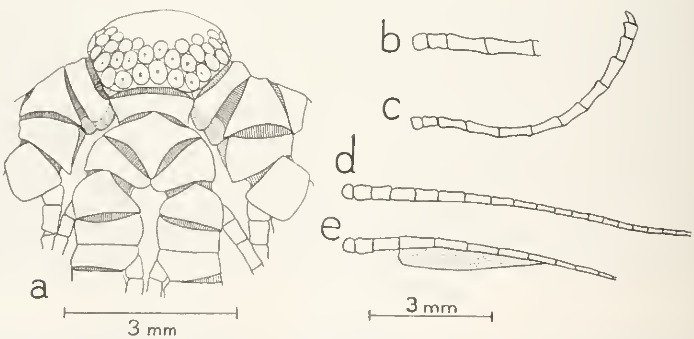

FIGURE 44.—*Retiometra alascana* A. H. Clark, holotype: *a*, Laterodorsal view of calyx; *b*, base of peripheral cirrus; *c*, detached, probably middle, cirrus; *d*, P_1 (incomplete); *e*, P_2.

brachials are much larger and are irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is slightly longer interiorly than exteriorly, and about as broad as the median length. The next five brachials are almost oblong, and about half again as broad as long. The following brachials become almost or quite triangular, about as long as broad, and gradually wedge-shaped and elongate distally. The distal edges of the brachials are slightly produced and finely spinous, giving the profile of the arm a regularly serrate appearance.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 (rarely 3) muscular articulations. The width at the first syzygy is 1.0 mm. and the length from the IBr_1 to the second syzygy 7.0 mm.

In the type specimen P_1 is 10 mm. long with 20+ segments, slender but not attenuated; the first segment is short, the second is about as long as broad, the fourth and fifth are twice as long as broad, and the distal are about four times as long as broad. The elongated segments have slightly produced and overlapping distal ends which are armed with very fine spines. P_2 is 8 mm. in length, with 13 segments, of which the first is broader than long, the second is about as long as broad, the third is twice as long as broad, and the remainder are much elongated with produced and finely spinous ends. It bears a gonad. P_3 and the following pinnules are similar to P_2. After P_5 the gonads gradually become smaller, disappearing after P_{10}.

In another specimen from *Albatross* station 2853, P_1 is 14 mm. long with 30 segments; P_2 is 8 mm. long with 15 segments; P_3 is 7 mm. long with 13 segments; P_4 is 7 mm. long with 12 segments and the distal pinnules are 9 mm. long with 21 segments.

Remarks.—In all but two cases this species has been dredged together with large numbers of *Florometra asperrima*, the young of which it much resembles superficially. The very long P_1 composed of more elongated segments and the distal intersyzygial interval of only 2 muscular articulations serve at once to distinguish it.

From *Fariometra parvula*, which occurs similarly associated with *Florometra asperrima* off the coast of southern California and southward, it is readily told by the low hemispherical instead of conical centrodorsal and the much shorter P_2, which is of the same length as P_3 and bears a gonad.

Localities.—*Albatross* station 3330; north of Unalaska (lat. 54°00′45″ N., long. 166° 53′50″ W.); 642 meters; temperature 3.22° C.; black sand and mud; August 21, 1890 [A. H. Clark, 1936] (1, U.S.N.M., E. 1141). Type locality.

Albatross station 3331; north of Unalaska (lat. 54°01′40″ N., long. 166°48′50″ W.); 640 meters; mud; August 21, 1890 (1, U.S.N.M., E. 1142).

Albatross station 3338; between Unalaska and Kadiak (lat. 54°19′00″ N., long. 159°40′00″ W.); 1142 meters; temperature 2.95° C.; green mud and sand; August 28, 1890 (7, U.S.N.M., E. 1138).

Albatross station 3340; east of the Shumagin Islands (lat. 55°26′00″ N., long. 155°26′00″ W.); 1270 meters; temperature 2.67° C.; mud; August 29, 1890 (1, U.S.N.M., E. 1140).

Albatross station 2853; south of the Trinity Islands, Alaska (lat. 56°00′00″ N., long. 154°20′00″ W.); 291 meters; temperature 5.00° C.; gray sand; August 9, 1888 (2, U.S.N.M., E. 1143).

Albatross station 2858; southwest of the Kenai peninsula, Alaska (lat. 58°17′00″ N., long. 148° 36′00″ W.); 420 meters; temperature 4.33° C.; blue mud and gravel; August 24, 1888 (1, U.S.N.M., E. 1139).

Albatross station 4230; in the vicinity of Naha Bay, Behm Canal, southeastern Alaska; Indian Point bearing N. 70° E., 5 miles distant; 197–438 meters; temperature 5.78° C.; rocky bottom; July 7, 1903 (1, U.S.N.M., 35823).

Geographical range.—Southeastern Bering Sea and the Gulf of Alaska.

Bathymetrical range.—From 291 (?197) to 1270 meters; the average of 7 records is 630 meters.

Thermal range.—From 2.67° C. to 5.78° C.; the average of 6 records is 2.99° C.

Remarks.—An examination in detail of the numerous lots of *Florometra asperrima* in the collection of the National Museum revealed a number of small specimens which previously had been overlooked as the young of that species, but which possessed fully developed gonads. These were segregated and laid aside for future study. In 1936 they were described under the specific name *alascana*, which was made the type species of the new genus *Retiometra*.

Genus HATHROMETRA A. H. Clark

Asterias (part) Retzius, Kongl. Svenska Vet.-Akad. Handl., vol. 4, 1783, p. 241.

Comatula (part) Lamarck, Histoire naturelle des animaux sans vertèbres, vol. 2, 1816, p. 530, and following authors.

Alectro Say, Journ. Acad. Nat. Sci. Philadelphia, vol. 5, 1825, pt. 1, p. 153 (editorial error).

Alecto (part) Düben and Koren, Kongl. Svenska Vet.-Akad. Handl. for 1844, 1846, p. 231, and following authors.

Comatula (*Alecto*) (part) J. Müller, Abh. Preuss. Akad. Wiss. for 1847, 1849, p. 254.

Antedon (part) Norman, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 103, and following authors.

Comatulus Linville and Kelly, A text book in general zoology, 1906, p. 247 (editorial error).

Hathrometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130 (type species *Alectro dentata* Say, 1825), p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted); Amer. Nat., vol. 42, No. 500, 1908, p. 542 (belongs to the Polar-Pacific fauna; confined to north); No. 503, p. 724 (color); Geogr. Journ., vol. 32, 1908, No. 6, p. 603 (occurs in Arctic section of the Polar-Pacific region); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 84 (centrodorsal compared with that of *Eumetra indica*), p. 176 (referred to Heliometrinae); Proc. U.S. Nat. Mus., vol. 36, 1909, pp. 362, 366 (cirri resemble those of *Comatilia iridometriformis*); vol. 40, 1911, p. 652 (no infrabasals in young); Mem. Australian Mus., vol. 4, 1911, p. 727 (route by which this genus reached the Arctic and north Atlantic from the Bay of Bengal; directly descended from *Trichometra*); Proc. U.S. Nat. Mus., vol. 43, 1912, p. 406 (general discussion); Crinoids of the Indian Ocean, 1912, p. 6 (origin), p. 26 (closely allied to *Trichometra*); Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 3 (relation to *Trichometra;* discussion); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, p. 6 (range; discussion); Die Crinoïden der Antarktis, 1915, p. 143 (synonymy; diagnosis; range), p. 168 (range), p. 182 (range; represented in Indo-Pacific by *Trichometra,* in part); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, p. 23 (stem of young compared with that of Apiocrinidae); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 77 (common to Atlantic and Arctic, and Atlantic and Antarctic); vol. 7, 1917, No. 5, p. 128 (referred to Bathymetrinae); No. 16, p. 511 (in key; range).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper No. 102, 1917, p. 23 (percentage of magnesium carbonate); No. 124, 1922, p. 20 (same).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 245 (in key; range), p. 246 (included species); Smithsonian Misc. Coll., vol. 72, 1921, No. 7, p. 28 (color); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, pp. 8, 42 (range), p. 53 (in key), p. 56 (key to species).—Gislén, Ark. Zool., vol. 15, No. 23, 1923, pp. 8, 9, 14, 15 (comparison with *Poliometra*), p. 16 (in key), pp. 23–30 (detailed discussion); Zool. Bidrag Uppsala, vol. 9, 1924, p. 275 (ambulacral ciliary currents).—Mortensen, Danmarks Fauna, No. 27, 1924, p. 21 (in key; diagnosis); Handbook of the echinoderms of the British Isles, 1927, p. 27 (in key), pp. 38, 39 (diagnosis).—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 116 (in key), p. 126 (diagnosis; key to species).—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 6.—Ekman, Tiergeographie des Meeres, 1935, p. 378.—Elias da Costa, Chaves dicotómicas para a classificação dos equinodermes Portugueses, No. 4, Crinóides, Porto, 1940, p. 9 (in key), p. 13.—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55.

Hathrometrea MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, vol. 12, 1928, p. viii. 125.

Harthrometra DJAKONOV, Les échinodermes des mers arctiques (in Russian), Leningrad, 1933, p. 22 (in key).

Hatrometra NOBRE, Echinodermes de Portugal, ed. 2, 1938, p. 189.

Diagnosis.—A genus of Bathymetrinae in which P_1 is much elongated, between two and three times as long as P_2, composed of 30 to 40 segments, of which a few of the basal are short and the remainder slender and greatly elongated; the proximal brachials do not have strongly produced and prominently spinous distal ends; the centrodorsal is conical with convex sides; and the proximal cirrus segments are much elongated, over three times as long as the median diameter, the distal being almost or quite as broad as long with overlapping dorsal borders and dorsal spines.

Type species.—Alectro dentata Say, 1825, a synonym of *Asterias tenella* Retzius 1783.

Geographical range.—From Chesapeake Bay northward to southwestern Greenland (lat 65°14′ N.), thence eastward to Iceland, Ireland, Scotland, and the Scandinavian coast from western Sweden to East Finmark (Øxfjord).

Bathymetrical range.—From 28 to 1783 meters.

Thermal range.—From 2.00° C. to 13.89° C.

Remarks [by A.M.C.].—Since Mr. Clark wrote this part of the typescript, most authors, including Gislén, Mortensen, and Koehler, have considered *tenella* and *sarsi* to be no more than subspecifically distinct. However, since Mr. Clark himself must have studied more material of these two forms than any European worker, I have made no alteration to the text. No records of *tenella* seem to have been published in the last 30 years.

KEY TO THE SPECIES OF HATHROMETRA

a^1. Cirri with 24–33 (usually 27–30) segments; arms 75–110 (usually 85–100) mm. long (Chesapeake Bay to Newfoundland; 46–891 meters) **tenella** (p. 699)

a^2. Cirri with 14–24 (usually about 20) segments; arms rarely over 85 mm. long (from off New York, in deep water, to Greenland, thence eastward to Iceland, Ireland, Scotland, and the Scandinavian coast; 28–1783 meters) **sarsi** (p. 711)

HATHROMETRA TENELLA (Retzius)

[See vol. 1, pt. 1, figs. 290 (p. 262), 401 (p. 309), 509 (p. 373); pt. 2, figs. 102–105 (p. 67), 289 (p. 221), 749 (p. 349)]

Asterias tenella RETZIUS, Kongl. Svenska Vet.-Akad. Handl., vol. 4, 1783, p. 241 (description; St. Croix).—GMELIN, Systema Naturae, ed. 13, pt. 6, 1788, p. 3166, No. 32 (Santa Cruz).—GEBAUER, Systematisches Verzeichniss der Seesterne, Seeigel, 1802, p. iv.—BOSC, Histoire naturelle des vers, vol. 2, 1802, p. 114 (diagnosis; habitat).—RETZIUS, Dissertatio sistens species cognitas asteriarum, Lundae, 1805, p. 33 (diagnosis; oceano Americano).

Alectro dentata SAY, Journ. Acad. Nat. Sci. Philadelphia, vol. 5, 1825, p. 153 (description; Great Egg Harbor, New Jersey).—POURTALÈS, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 355 (after Say).

Alecto eschrichtii (not of J. Müller, 1841) STIMPSON, Synopsis of the marine invertebrate fauna of Grand Manan, 1853, p. 12 (near Duck Id., 25 fms.; size and color).—LÜTKEN, Oversigt over Grønlands Echinodermata, 1857, p. 84 (Grand Manan).—M. SARS, Oversigt af Norges Echinodermer, 1861, p. 2.—E. C. and A. AGASSIZ, Seaside studies in natural history, Boston, 1865 [and 1871], p. 121 (Eastport, Maine; young).—VERRILL, Amer. Journ. Sci., ser. 3, vol. 23, 1882, p. 248 [the 2 inverted] (after Stimpson).—GANONG, Bull. Nat. Hist. Soc. New Brunswick, No. 7, 1888, p. 18 (history).

Antedon (*Alecto*) *dentata* VERRILL, Proc. Boston Soc. Nat. Hist., 1866, p. 339 (possibly identical with *meridionalis*).

Antedon eschrichtii VERRILL, Proc. Boston Soc. Nat. Hist., vol. 10, 1866, p. 343 (after Stimpson).—PACKARD, Zoology, 1879, p. 107 (after Stimpson).—GANONG, Bull. Nat. Hist. Soc. New Brunswick, No. 7, 1888, p. 29 (after Stimpson).

Antedon dentatus VERRILL, Proc. Boston Soc. Nat. Hist., vol. 10, 1866, p. 339 (possible dentity with [*Comactinia*] *meridionalis*); Report of the Commissioner, U.S. Comm. Fish and Fisheries for 1871–72, 1873, pt. 1, p. 722 (possibly occurs on the southern coast of New England).—COE, Bull. State Geol. and Nat. Hist. Surv., Connecticut, No. 19, Echinoderms of Connecticut, 1912, p. 13 (absent in Long Island Sound)

Antedon sarsii (not of Düben and Koren, 1846) VERRILL, Amer. Journ. Sci., vol. 7, 1874, pp. 410, 413, 504 (localities); Amer. Journ. Sci., vol. 16, 1878, p. 214 (associated with *Asterias stellionura* [*Urasterias linckii*]).—PACKARD, Zoology, 1879, p. 107 (New England).—VERRILL, Preliminary check-list of the marine invertebrates of the Atlantic coast, from Cape Cod to the Gulf of St. Lawrence, 1879, p. 15 (listed); Amer. Journ. Sci., vol. 20, 1880, p. 401 (stations); Proc. U.S. Nat. Mus., vol. 3, 1880, p. 359, footnote (one of most abundant echinoderms from off southern New England).—P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 155 [p. 5 of separate] (*Blake* station; confirmation of Agassiz' determination; characters of the species; discussion), p. 156 (no basal star), p. 164 (comparison of pentacrinoids with those of [*Comactinia*] *meridionalis*).—[VERRILL], Report of the Commissioner, U.S. Comm. Fish and Fisheries for 1879, 1882, p. 817 (44°30′ N., 57°08′ W.; 200 fms.); VERRILL, Amer. Journ. Sci., ser. 3, vol. 23, 1882, p. 135 (over 10,000 specimens at sta. 1038), p. 248 (review of Duncan and Sladen).—A. AGASSIZ, Bull. Mus. Comp. Zool., vol. 15 (reprinted as "Three Cruises of the *Blake*"), pt. 2, p. 118.

Comatula sarsii A. AGASSIZ, Bull. Mus. Comp. Zool., vol. 6, Nos. 8–9, September 1880, p. 150 (off Georges Bank, beyond 1000-fm. line).

Antedon dentatum VERRILL, Amer. Journ. Sci., ser. 3, vol. 23, 1882, pp. 219, 222 (numerous localities given; synonymy; history; abundant off New Jersey at moderate depths; Cashe's Ledge; fishing grounds off Nova Scotia).—[VERRILL], Report of the Commissioner, U.S. Comm. Fish and Fisheries for 1886, 1889, p. 860 (Nantucket; off Martha's Vineyard).—W.N.L., Amer. Nat., vol. 24, No. 278, February 1890, p. 185 (review of Verrill).—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 298 (after Verrill).—BATHER, *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, p. 132, fig. xlix, No. 8 (stem).

Antedon dentata P. H. CARPENTER, Proc. Zool. Soc. London, for 1882, 1883, p. 746 (listed); Proc. Roy. Soc. Edinburgh, vol. 12, 1884, pp. 362, 373 (New England records).—VERRILL, Report of the Commissioner, U.S. Comm. Fish and Fisheries for 1882, 1884, pp. 657, 661 (numerous localities; notes); for 1883, 1885, p. 521 (very common; collected by the *Albatross*, 1883), pl. 21, fig. 58 (pentacrinoid).—P. H. CARPENTER, Bijdr. Dierkunde, vol. 13, 1886, p. 9 (New England records).—BATHER, Proc. London Amateur Sci. Soc., vol. 1, Nos. 1 and 2, July 1890, p. 33 (abundance on the American coast).—P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 54 (identical with *tenella* and *sarsii*).—HOWE, Bull. U.S. Fish Comm., vol. 19, for 1899, 1901, p. 239 (new localities).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).

Antedon tenella P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 169 (Nova Scotia to New Jersey), pl. 31, figs. 2, 4; Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 53 (detailed discussion and comparison with *prolixa*), p. 68, footnote (occurs on both sides of the Atlantic), pl. 2, figs. 6, 7.—D'ARCY THOMPSON, Proc. Roy. Soc. Edinburgh, vol. 22, 1899, p. 322 (wide distribution).—SPRINGER, Mem. Mus. Comp. Zool., vol. 25, No. 1, 1901, p. 88 (occurs on both sides of the Atlantic).—WHITEAVES, Catalogue of the marine invertebrates of eastern Canada, Canadian Geol. Survey, 1901, p. 43 (various localities off Nova Scotia, on the fishing grounds).—GRIEG, Bergens Mus. Aarb. for 1903, No. 5, 1904, p. 7 (abundance on the New England coast), p. 21 (size), p. 25 (number of cirrus segments), p. 36 (distribution).—DÖDERLEIN, Fauna Arctica, vol. 4, Lief. 2, 1905, pp. 400, 403 (synonymy; summary of records; ranges; relation to antarctic forms).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 280 (listed), pp. 405–406 (synonymy; localities; discussion).

Comatula rosacea (not of Fleming, 1828) W. MARSHALL, Die Tiefsee und ihr Leben, 1888, p. 241 (New England coast).

Hathrometra tenella A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130 (listed); Amer. Nat., vol. 42, No. 503, 1908, p. 719; Proc. U.S. Nat. Mus., vol. 43, 1912, p. 407 (confined to the west Atlantic, never intruding on the territory occupied by [*Poliometra*] *prolixa*); Bull. Inst. Océanogr. Monaco, No. 285, 1914, p. 20 (occurrence in water of less than 25 fms. in the Gulf of Maine); Die Crinoïden der Antarktis, 1915, p. 203 (occurs in the Gulf of Maine; significance); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 43 (range), p. 56 (in key).—MORTENSEN, Danmarks Fauna, No. 27, 1924, p. 23 (range; comparison with *H. sarsi*); Handbook of the echinoderms of the British Isles, 1927, p. 41 (range; comparison with *H. sarsi*).—HYMAN, The invertebrates, vol. 4, Echinodermata, New York, 1955, p. 114 (occurs in dense aggregations).

Hathrometra dentata A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 130; Proc. U.S. Nat. Mus., vol. 43, 1912, p. 408 (east of New York); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 63 (published references to specimens in the B.M.; localities).—F. W. CLARKE and WHEELER, U.S. Geol. Surv. Prof. Paper 90–D, 1914, p. 34 (inorganic constitutents of the skeleton); No. 102, 1917, p. 20 (same); No. 124, 1922, p. 17 (same).—VINOGRADOV, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (skeletal composition).

Hathrometra tenella var. *tenella* GISLÉN, Ark. Zool., vol. 15, No. 23, 1923, pp. 12–14, p. 16 (in key), pp. 17, 18, pp. 23–25 (synonymy; records; distribution); figs. 28–30, p. 10; Zool. Bidrag Uppsala, vol. 9, 1924, p. 195; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 5 (abundance off Massachusetts).

Hathrometra tenella var. *typica* KOEHLER, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 129.

Diagnostic features.—See the key on p. 699.

Description.—The centrodorsal is conical, the sides in profile slightly to markedly convex, usually about as high as broad at the base or somewhat lower, more rarely higher. The surface is entirely covered with very numerous closely crowded cirrus sockets showing no regular arrangement which decrease in size, more evidently in the apical half, to the dorsal pole. [NOTE BY A.M.C. The side view figures of the centrodorsals of two specimens given on p. 67 of part 2 of this work show the cirrus sockets in regular vertical columns. As the same is true of the other species illustrated on that page, none of which belongs to the Zenometrinae, it is probable that the artist falsely regularized the positions of the sockets throughout.] There are usually five or six peripheral sockets corresponding to each radial. The edges of the sockets and the raised rims about the central canals are rather prominent.

The cirri are very numerous, L–LXXX, 24–33 (commonly 27–30), from 25 to 35 mm. (usually 28 to 30 mm.) in length, delicate, slender and very brittle. The apical cirri are 9 to 10 mm. long, with 18 to 20 segments. The peripheral cirri have the first segment more than twice as broad as long, the second almost or quite as long as broad, the third from half again to twice as long as its median diameter, the fourth from two and a half to three times as long as wide, and the fifth, which is the longest, four to five times as long as the median diameter; the sixth, or sixth and seventh are of the same proportions as the fifth. The following segments gradually decrease in length so that the last three to five are only slightly, and on the shorter cirri not at all, longer than broad. The elongate earlier segments are constricted centrally with prominent ends and similarly and evenly concave dorsal and ventral profiles; though very evident, this constriction is not particularly strong.

As the segments shorten distally, the expansion of the proximal ends gradually disappears so that the short outer segments increase gradually in lateral diameter from the anterior to the posterior ends, the dorsal profile being nearly straight and the ventral slightly convex with the height of the convexity toward the distal end. The distal borders of the shorter outer segments usually project ventrally, considerably beyond the bases of the succeeding segments, and may be armed with a minute but sharp forward projecting spine. The smaller cirri nearer the dorsal pole resemble the longer peripheral cirri, but the decrease in the length of the segments distally is much more rapid so that there are more of the short outer segments, and these are also shorter. The opposing spine is terminal, usually rising from the whole dorsal surface of the penultimate segment, its distal edge continuing in the same line as the distal border of that segment than which its height is slightly to considerably less. The terminal claw is longer than the penultimate segment, slender, evenly tapering, and evenly curved.

The distal edge of the radials is even with the proximal border of the centrodorsal, or appears just beyond it. The IBr_1 are very short, about four times as broad as their slightly convergent lateral borders which are not quite or only just in contact basally and diverge at an angle of 60° or even more, and very deeply incised in the median line by a posterior projection from the IBr_2 (axillaries) which are rhombic, usually about as long as broad, with all the sides concave, and rise to a slight rounded tubercle on the articulation with the IBr_1.

The 10 slender arms are from 75 to 110 mm. (most commonly between 85 and 100 mm.) in length. The first brachials are very short, just meeting basally over the anterior angle of the IBr_2, longer outwardly than inwardly, very deeply incised in the median line by a posterior projection from the second brachial, which last is rather large and irregularly quadrate. The third and fourth brachials together form a syzygial pair which is slightly longer interiorly than exteriorly, as broad as its interior length. The following four brachials are wedge-shaped, about twice as broad as their median lengths, with the anterior and posterior borders very concave. The second syzygial pair, formed of the ninth and tenth brachials, is similar, but slightly longer. The following brachials are very obliquely wedge-shaped, almost triangular, about as long as broad, distally gradually becoming more elongate, and terminally long with swollen articulations.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations, with rare exceptions.

In a specimen with arms about 80 mm. long, P_1 is 15.5+ mm. long, with 28+ (probably 30), segments, excessively slender and threadlike, though stiff; the first three segments are broader than long, the fourth is slightly longer than broad, and the following rapidly become exceedingly long and slender with everted and spinous ends. P_2 is 6 mm. long, with 12 segments, stouter basally than P_1, and tapering evenly to the extremely delicate tip; the first segment is short, the next two are about as long as broad, and the following rapidly become elongated. P_3 is 6.5 mm. long with 14 segments, resembling P_2. P_4 is 7 mm. long with 14 segments, tapering more slowly than P_3 and with a more or less developed genital gland. The distal pinnules are 12 mm. long with 20 segments, very slender; the first segment is trapezoidal, broader than long, the second is trapezoidal with the base against the base of the preceding, tapering distally, about as long as broad basally, and the following segments are greatly elongated with rather abruptly everted and finely spinous distal ends.

In a specimen from off Martha's Vineyard, Gislén found P_a to be 15 mm. long with 26 segments, and P_b to be 4 mm. long with 10 segments.

Differential characters.—So far as I am able to see the only reliable character separating this form from *H. sarsi* is the difference is the cirri.

P. H. Carpenter noted that in *tenella* the distal ends of the segments in the elongated oral pinnules are fringed with strong spines so that they appear to overlap the bases of their successors, this feature being much less developed in European specimens of *sarsi*, while on the other hand the delicate calcareous rods at the sides of the ambulacra which Sars described in the larva are larger in specimens from Norway than in examples from deep water, and are sometimes entirely absent in *tenella*.

According to Carpenter, *tenella* is also remarkable for the want of constancy in the proportions of the second pair of pinnules. In some examples he found that these have only a dozen segments and are not more than 5 mm. long, or only a third the length of the first pair; but in others they reach 7 or 8 mm. and have as many as 20 segments, a condition he did not notice in any specimens of *sarsi* from the eastern Atlantic.

Localities.—*Albatross* station 2264; between Cape Hatteras and Nantucket (lat. 37°07′50″ N., long. 74°34′20″ W.); 305 meters; temperature 8.22° C.; gray sand; October 18, 1884 (3, U.S.N.M., 8350, 8537).

Fish Hawk station 898; off Chesapeake Bay (lat. 37°24′00″ N., long. 74°17′00″ W.); 549 meters; temperature 6.67° C.; mud; November 16, 1880 (2, U.S.N.M., 9644).

Fish Hawk station 897; off Chesapeake Bay (lat. 37°25′00″ N., long. 74°18′00″ W.); 288 meters; temperature 8.89° C.; sand and mud; November 16, 1880 [Verrill, 1882, 1884] (32. U.S.N.M., 9643, 35868).

Albatross station 2022; off Cape May (lat. 37°32′00″ N., long. 74°13′20″ W.); 891 meters; temperature 4.44° C.; blue mud; May 21, 1883 (8, U.S.N.M., 6387).

Fish Hawk station 1048; off Delaware Bay (lat. 38°29′ N., long. 73°21′ W.); 796 meters; temperature 4.44° C.; mud; October 10, 1881 [Verrill, 1884] (1, U.S.N.M., 35861).

Fish Hawk station 1047; off Delaware Bay (lat. 38°31′ N., long. 73°21′ W.); 285 meters; temperature 9.44° C.; sand; October 10, 1881 [Verrill, 1882, 1884] (65, U.S.N.M., 4123, 24091, 35858).

Albatross station 2232; off Cape Hatteras (lat. 38°37′30″ N., long. 73°11′00″ W.); 444 meters; temperature 6.00° C.; green mud; September 12, 1884 (1, and 1 pentacrinoid, U.S.N.M., 24104, 24108).

Fish Hawk station 1043; off the Capes of Delaware (lat. 38°39′ N., long. 73°11′ W.); 238 meters; temperature 9.44° C.; soft mud; October 10, 1881 [Verrill, 1882, 1884] (1, U.S.N.M., 35822).

Albatross station 2590; between Cape May and Cape Sable (lat. 38°53′30″ N., long. 72°52′00″ W.); 348 meters; temperature 8.67° C.; green mud and sand; September 21, 1885 (1, U.S.N.M., 12310).

Albatross station 2589; off Cape May, New Jersey (lat. 38°55′00″ N., long. 78°50′30″ W.); 422 meters; temperature 6.78° C.; green mud and sand; September 21, 1885 (1, U.S.N.M., 12291).

Off New Jersey [Verrill, 1882; P. H. Carpenter, 1884].

Great Egg Harbor, New Jersey [Say, 1825; Verrill, 1866].

Albatross station 2175; between Cape Hatteras and Nantucket (lat. 39°33′00″ N., long. 72°18′30″ W.); 827 meters; temperature 4.72° C.; green mud; July 22, 1884 (5, U.S.N.M., 35875).

Fish Hawk station 1139; off Martha's Vineyard (lat. 39°37′ N., long. 71°55′ W.); 532 meters; temperature 6.67° C.; mud; September 8, 1882 [Verrill, 1884] (25, U.S.N.M., 9662).

Fish Hawk station 1138; off Martha's Vineyard (lat. 39°39′ N., long. 71°54′ W.); 307 meters; temperature 7.78° C.; fine sand and pebbles; September 8, 1882 [Verrill, 1884] (49, U.S.N.M., 9661).

Fish Hawk station 1137; off Martha's Vineyard (lat. 39°40′ N., long. 71°52′ W.); 316 meters; temperature 7.78° C.; fine sand and pebbles; September 8, 1882 [Verrill, 1884] (38, U.S.N.M., 9660).

Fish Hawk station 880; off Martha's Vineyard (lat. 39°48′30″ N., long. 70°54′00″ W.); 461 meters; temperature 6.11° C.; mud; September 13, 1880 [Verrill, 1880, 1882, 1884].

Fish Hawk station 1025; off Martha's Vineyard (lat. 39°49′ N., long. 71°25′ W.); 395 meters; temperature 7.22° C.; green mud; September 8, 1881 [Verrill, 1882, 1884] (3, U.S.N.M., 9652, 24090).

Fish Hawk station 879; off Martha's Vineyard (lat. 39°49′30″ N., long. 70°54′00″ W.); 411 meters; temperature 5.56° C.; sand and blue mud; September 13, 1880 [Verrill, 1880, 1882, 1884] (2, U.S.N.M., 24093, 24097).

Albatross station 2582; south of Cape Sable (lat. 39°50′00″ N., long. 71°43′00″ W.); 250 meters; temperature 8.44° C.; green mud; September 18, 1885 (117, U.S.N.M., 12282, 35878 [part], 36140 [part]).

Albatross station 2583; south of Cape Sable (lat. 39°50′45″ N., long. 71°43′00″ W.); 240 meters; green mud and sand; September 18, 1885 (12+, U.S.N.M., 12303, 35878 [part], 36140 [part]).

Fish Hawk station 1026; off Martha's Vineyard (lat. 39°50′30″ N., long. 71°23′00″ W.); 333 meters; temperature 8.61° C.; green mud and sand; September 8, 1881 [Verrill, 1882, 1884; Gislén, 1923] (42, U.S.N.M., 9653, 35856; M.C.Z., 255).

Fish Hawk station 1098; off Martha's Vineyard (lat. 39°53′ N., long. 69°43′ W.); 285 meters; temperature 6.39° C.; fine sand; August 11, 1882 [Verrill, 1884] (1. U.S.N.M., 24103).

Fish Hawk station 1096; off Martha's Vineyard (lat. 39°53′ N., long. 69°47′ W.); 580 meters; temperature 4.44° C.; soft green mud; August 11, 1882 [Verrill, 1884] (fragments, U.S.N.M., 35879).

Fish Hawk station 939; off Martha's Vineyard (lat. 39°53′00″ N., long. 69°50′30″ W.); 483 meters; temperature 8.33° C.; green mud and sand; August 4, 1881 [Verrill, 1882, 1884] (179+, U.S.N.M., 9646, 9657).

Fish Hawk station 940; off Martha's Vineyard (lat. 39°54′00″ N., long. 69°51′30″ W.); 245 meters; temperature 11.11° C.; hard sand and sponges; August 4, 1881 [Verrill, 1882, 1884] (5, U.S.N.M., 9647).

U.S. Fish Commission; off Martha's Vineyard, 334–472 meters [Gislén, 1923].

Albatross station 2547; between Cape May and Cape Sable (lat. 39°54′30″ N., long. 70°20′00″ W.); 713 meters; temperature 4.22° C.; green mud; August 8, 1885 (fragments, U.S.N.M., 25024).

Albatross station 2262; off Nantucket (lat. 39°54′45″ N., long. 69°29′45″ W.); 457 meters; temperature 5.33° C.; green mud and sand; September 28, 1884 (2, U.S.N.M., 8266).

Fish Hawk station 925; off Martha's Vineyard (lat. 39°55′00″ N., long. 70°47′00″ W.); 421 meters; temperature 5.56° C.; sand and mud; July 16, 1881 [Verrill, 1882, 1884] (1, U.S.N.M., 9645).

Fish Hawk station 878; off Martha's Vineyard (lat. 39°55′00″ N., long. 70°54′15″ W.); 260 meters; temperature 11.11° C.; mud; September 13, 1880 [Verrill, 1880, 1882, 1884].

Fish Hawk station 1095; off Martha's Vineyard (lat. 39°55′00″ N., long. 70°54′15″ W.); 261 meters; temperature 11.11° C.; soft green mud; September 13, 1880 [Verrill, 1884] (7, U.S.N.M., 24095, 35867).

Fish Hawk station 946; off Martha's Vineyard (lat. 39°55′30″ N., long. 71°14′00″ W.); 451 meters; temperature 8.33° C.; green mud and sand; August 9, 1881 [Verrill, 1882, 1884] (6, U.S.N.M., 9651).

Fish Hawk station 1112; off Martha's Vineyard (lat. 39°56′ N., long. 70°35′ W.); 448 meters; temperature 6.11° C.; green mud and sand; August 22, 1882 [Verrill, 1884].

Fish Hawk station 1032; off Martha's Vineyard (lat. 39°56′ N., long. 69°22′ W.); 380 meters; temperature 7.78° C.; yellow mud; September 14, 1881 [Verrill, 1882, 1884] (16, U.S.N.M., 9654).

Fish Hawk station 1033; off Martha's Vineyard (lat. 39°56′ N., long. 69°24′ W.); 335 meters; sand and gravel; September 14, 1881 [Verrill, 1882, 1884] (695, U.S.N.M., 4137, 9655, 31001, 35859).

Fish Hawk station 877; off Martha's Vineyard (lat. 39°56′00″ N., long. 70°54′18″ W.); 230 meters; temperature 13.89° C.; soft sticky mud; September 13, 1880 (1, U.S.N.M., 13367).

Albatross station 2536; south of Martha's Vineyard (lat. 39°56′15″ N., long. 70°47′30″ W.); 287 meters; green mud and fine sand; August 7, 1885 (62, U.S.N.M., 11540, 11543).

Fish Hawk station 895; off Martha's Vineyard (lat. 39°56′30″ N., long. 70°59′45″ W.); 435 meters; temperature 5.56° C.; soft mud; October 2, 1880 [Verrill, 1882, 1884] (1, U.S.N.M., 24092).

Albatross station 2537; between Cape May and Cape Sable (lat. 39°56′45″ N., long. 70°50′30″ W.); 285 meters; temperature 7.89° C.; green mud and fine sand; August 7, 1885 (5, U.S.N.M., 35874).

Albatross station 2246; south of Nantucket (lat. 39°56′45″ N., long. 70°20′30″ W.); 223 meters; temperature 9.33° C.; green mud; September 26, 1884 (7, U.S.N.M., 8265, 35877).

Fish Hawk station 1035; off Martha's Vineyard (lat. 39°57′ N., long. 69°28′ W.); 220 meters; temperature 8.33° C.; sand; September 14, 1881 [Verrill, 1882, 1884] (1, U.S.N.M., 9250).

Albatross station 2199; off Nantucket (lat. 39°57′30″ N., long. 69°41′10″ W.); 143 meters; gray sand; August 6, 1884 (fragments, U.S.N.M., 7705).

Fish Hawk station 875; off Martha's Vineyard (lat. 39°57′00″ N., long. 70°57′30″ W.); 230 meters; temperature 11.67° C.; soft sticky mud; September 13, 1880 [Verrill, 1880, 1882, 1884].

Fish Hawk station 876; off Martha's Vineyard (lat. 39°57′00″ N., long. 70°56′00″ W.); 220 meters; temperature 11.67° C.; soft sticky mud; September 13, 1880 [Verrill, 1880, 1882, 1884] (fragments, U.S.N.M., 35896).

Albatross station 2541; off Martha's Vineyard (lat. 39°57′45″ N., long. 70°50′30″ W.); 245 meters; temperature 8.72° C.; green sand and broken shells; August 7, 1885 (1, U.S.N.M., 11545).

Albatross station 2183; between Cape Hatteras and Nantucket (lat. 39°57′45″ N., long. 70°56′30″ W.); 357 meters; temperature 6.95° C.; green mud and sand; August 2, 1884 (3, U.S.N.M., 7703).

Fish Hawk station 945; off Martha's Vineyard (lat. 39°58′00″ N., long. 71°13′00″ W.); 379 meters; temperature 6.67° C.; green mud and sand; August 9, 1881 [Verrill, 1882, 1884] (11, U.S.N.M., 9650, 24088).

Fish Hawk station 1150; off Martha's Vineyard (lat. 39°58′ N., long. 70°37′ W.); 256 meters; temperature 8.33° C.; sand; October 4, 1882 [Verrill, 1884] (11, U.S.N.M., 5545).

Fish Hawk station 1152; off Martha's Vineyard (lat. 39°58′ N., long. 70°35′ W.); 210 meters; temperature 8.89° C.; sand; October 4, 1882 [Verrill, 1884] (6, U.S.N.M., 9664, 24107).

Fish Hawk station 1038; off Martha's Vineyard (lat. 39°58′ N., long. 70°06′ W.); 267 meters; temperature 8.33° C.; sand and shells; September 21, 1881 [Verrill, 1882, 1884] (80, U.S.N.M., 9656, 21650).

Fish Hawk station 1092; off Martha's Vineyard (lat. 39°58′ N., long. 69°42′ W.); 369 meters; temperature 5.00° C.; gray sand; August 11, 1882 [Verrill, 1884] (1, U.S.N.M., 35857).

Fish Hawk station 1151; off Martha's Vineyard (lat. 39°58′30″ N., long. 70°37′00″ W.); 229 meters; temperature 8.89° C.; sand; October 4, 1882 [Verrill, 1884] (4+, U.S.N.M., 5544, 9663).

Albatross station 2089; south of Cape Sable (lat. 39°58′50″ N., long. 70°39′40″ W.); 307 meters; temperature 7.22° C.; gray sand; September 20, 1883 (29, U.S.N.M., 6190, 35873).

Fish Hawk station 1116; off Martha's Vineyard (lat. 39°59′ N., long. 70°44′ W.); 264 meters; temperature 7.78° C.; green mud and sand; August 22, 1882 [Verrill, 1884] (5, U.S.N.M., 24086).

Albatross station 2088; south of Cape Sable (lat. 39°59′15″ N., long. 70°36′30″ W.); 262 meters; temperature 8.89° C.; yellow sand; September 20, 1883 (63, U.S.N.M., 6188, 6191).

Blake station 311 Ag.; south of Martha's Vineyard (lat. 39°59′20″ N., long. 70°11′30″ W.); 262 meters; temperature 7.50° C.; green sand with black specks; July 1, 1880 [A. Agassiz, 1880, 1888; P. H. Carpenter, 1881; Hartlaub, 1912 "West Atlantic"] (67, M.C.Z., 49, 257).

Albatross station 2212; between Cape Hatteras and Nantucket (lat. 39°59′30″ N., long. 70°30′45″ W.); 783 meters; temperature 4.44° C.; green mud; August 22, 1884 (1 pentacrinoid, U.S.N.M., 36081).

Albatross station 2090; south of Cape Sable (lat. 39°59′40″ N., long. 70°41′10″ W.); 256 meters; temperature 9.17° C.; gray sand and broken shells; September 20, 1883 (10, U.S.N.M., 6189, 6193).

Off Martha's Vineyard, 80–88 miles (nautical) south of Gay Head (lat. 39°58′30″ to 40°04′00″ N., long. 70°16′ to 70°21′ W.); 174–362 meters; temperature 9.22°–11.33° C.; September 1, 1899 [Howe, 1901].

Fish Hawk station 1027; off Martha's Vineyard (lat. 40°00′ N., long. 69°19′ W.); 170 meters; temperature 9.17° C.; fine sand; September 14, 1881 [Verrill, 1882, 1884] (1, U.S.N.M., 35870).

Fish Hawk station 943; off Martha's Vineyard (lat. 40°00′00″ N., long. 71°14′30″ W.); 287 meters; temperature 9.44° C.; mud, sand and shells; August 9, 1881 [Verrill, 1882, 1884] (10, U.S.N.M., 9648).

Fish Hawk station 874; off Martha's Vineyard (lat. 40°00′00″ N., long. 70°57′00″ W.); 155 meters; temperature 10.56° C.; soft sticky mud; September 13, 1880 [Verrill, 1880, 1882, 1884].

Albatross station 2542; between Cape May and Cape Sable (lat. 40°00′15″ N., long. 70°42′20″ W.); 236 meters; temperature 8.44° C.; sand and broken shells (1, U.S.N.M., 35984).

Albatross station 2185; between Cape Hatteras and Nantucket (lat. 40°00′45″ N., long. 70°54′15″ W.); 236 meters; temperature 10.56° C.; green mud and sand; August 2, 1884 (4, U.S.N.M., 7704).

Fish Hawk station 944; off Martha's Vineyard (lat. 40°01′00″ N., long. 71°14′30″ W.); 234 meters; temperature 10.56° C.; mud, sand and shells; August 9, 1881 [Verrill, 1882, 1884] (8, U.S.N.M., 9649).

Albatross station 2245; south of Nantucket (lat. 40°01′15″ N., long. 70°22′00″ W.); 179 meters; temperature 10.50° C.; green mud and black specks; September 26, 1884 (6, U.S.N.M., 9148).

Fish Hawk station 1111; off Martha's Vineyard (lat. 40°01′33″ N., long. 70°35′00″ W.); 227 meters; temperature 8.33° C.; fine sand; August 22, 1882 [Verrill, 1884] (1, U.S.N.M. 24102).

Fish Hawk station 868; off Martha's Vineyard (lat. 40°01′42″ N., long. 70°22′30″ W.); 296 meters; temperature 8.33° C.; fine sand and black specks; September 4, 1880 [Verrill, 1884].

Albatross station 2091; off Nantucket (lat. 40°01′50″ N., long. 70°59′00″ W.); 214 meters; temperature 9.44° C.; green mud; September 21, 1883 (2, U.S.N.M., 6196).

Albatross station 2025; off Cape May, New Jersey (lat. 40°02′00″ N., long. 70°27′00″ W.); 437 meters; temperature 4.72° C.; green mud and fine sand; May 25, 1883 (11, U.S.N.M., 24109, 6325, 6750).

Fish Hawk station 873; off Martha's Vineyard (lat. 40°02′N., long. 70°57′ W.); 183 meters; temperature 10.56° C.; soft sticky mud; September 13, 1880 [Verrill, 1880, 1882, 1884] (6, U.S.N.M., 35866).

Fish Hawk station 869; off Martha's vineyard (lat. 40°02′18″ N., long. 70°23′06″ W.); 350 meters; temperature 10.00° C.; fine sand; September 4, 1880 [Verrill, 1882, 1884] (5, U.S.N.M., 35864).

Fish Hawk stations 869–870; off Martha's Vineyard (lat. 40°02′18″ N., long. 70°23′06″ W., and lat. 40°02′36″ N., long. 70°22′58″ W.); 283–350 meters; temperature 10.00° C.; mud and fine sand; September 4, 1880 (1, U.S.N.M., 24096).

Fish Hawk station 870; off Martha's Vineyard (lat. 40°02′36″ N., long. 70°22′58″ W.); 283 meters; mud and fine sand; September 4, 1880 [Verrill, 1880, 1882, 1884] (61, U.S.N.M., 24098, 35869).

Fish Hawk station 871; off Martha's Vineyard (lat. 40°02′54″ N., long. 70°23′40″ W.); 210 meters; temperature 9.44° C.; mud and fine sand; September 4, 1880 [Verrill, 1880, 1882, 1884] (43, U.S.N.M., 24087, 24099, 24101, 35865).

Josie Reeves station 1146; off Martha's Vineyard (lat. 40°02′ N., long. 70°41′ W.); 293 meters; soft mud; September 21, 1882 [Verrill, 1884] (1 U.S.N.M., 35863 [part]).

Fish Hawk station 949; off Martha's Vineyard (lat. 40°03′00″ N., long. 70°31′00″ W.); 183 meters; temperature 11.11° C.; yellow mud; August 23, 1881 [Verrill, 1882, 1884].

Josie Reeves station 1145; off Martha's Vineyard (lat. 40°03′ N., long. 70°28′ W.); 247 meters; soft mud; September 21, 1882 [Verrill, 1884] (1, U.S.N.M., 35863 [part]).

Fish Hawk station 1121; off Martha's Vineyard (lat. 40°04′ N., long. 68°49′ W.); 428 meters; temperature 5.28° C.; fine sand and stones; August 26, 1882 [Verrill, 1884] (1, U.S.N.M., 35860).

Fish Hawk; off Martha's Vineyard (27, U.S.N.M., 9659, 35871).

Albatross station 2086; off Nantucket (lat. 40°05′05″ N., long. 70°35′00″ W.); 126 meters; temperature 11.39° C.; blue mud and gray sand; September 20, 1883 (fragments, U.S.N.M., 6195).

Albatross; east of New York (5, Berl. M., 3244).

Albatross station 2068; off Nantucket (lat. 42°03′00″ N., long. 65°48′40″ W.); 240 meters; temperature 5.56° C.; sand, fine gravel and clay; September 1, 1883 (2, U.S.N.M. 6985, 9225).

Albatross station 2062; off Nantucket (lat. 42°17′00″ N., long. 66°37′15″ W.); 274 meters; temperature 5.56° C.; sand and gravel; August 31, 1883 (2, U.S.N.M., 16788).

Albatross, 1883 [Verrill, 1885].

Off Martha's Vineyard [Verrill, 1889; A.H. Clark, 1913] (4, B.M.). Same, 335–472 meters [A.H. Clark, 1913] (3, B.M.).

Off Nantucket [Verrill, 1889].

Albatross station 2520; off Nova Scotia (lat. 42°41′00″ N., long. 64°55′30″ W.); 113 meters; temperature 4.78° C.; rocky; July 12, 1885 (1, U.S.N.M., 11631).

Bache station 21B; Gulf of Maine, 6 to 15 miles south of Cashe's Ledge (lat. 42°49′ N., long. 68°50′ W.); 95–165 meters; temperature 6.11° C.; rocky; September 16, 1873 [Verrill, 1874, 1882] (1, U.S.N.M., 23568).

Bache station 6B; 15 miles southeast of Monhegan Island, Maine (lat. 43°38′ N., long. 69°01′ W.); 150 meters; brown mud; September 3, 1873 [Verrill, 1874] (1, and part of another, U.S.N.M., 4961, 4962).

Speedwell station 38; Gulf of Maine (lat. 42°42′ N., long. 66°58′ W.); 205 meters; gravelly; August 20, 1877 (1, U.S.N.M., 23565).

Albatross, 1885; off St. Johns, Newfoundland (1, U.S.N.M., 35893).

Albatross station 2429; off Newfoundland (lat. 42°55′30″ N., long. 50°51′00″ W.); 861 meters; temperature 3.72° C.; gray mud; June 23, 1885 (8, U.S.N.M., 4723, 24084).

New England coast [P. H. Carpenter, 1884, 1886; W. Marshall, 1888; Grieg, 1904].

Near Duck Island, Grand Manan; 46 meters; shelly ground [Stimpson, 1853· Lütken, 1857; M. Sars, 1861; E. C. and A. Agassiz, 1865, 1871, "Eastport, Maine" Verrill, 1866, 1882; Packard, 1879; Ganong, 1888; A. H. Clark, 1914, 1915].

St. Croix(?Dochet or Neutral Island) [Retzius, 1783; Gmelin, 1788, "Santa Cruz"]. Type locality.

No data; Gloucester donation (1, U.S.N.M., 5910).

Banquereau; schr. *Marion*; September 1878; Gloucester donation 237 (fragments, U.S.N.M., 35895).

Banquereau; 366–549 meters; Gloucester donation 129 (fragments, U.S.N.M., 35898).

Fishing Banks (lat. 44°30′ N., long. 57° 08′ W.); 366 meters; schr. *Polar Wave*; Gloucester donation 364 [Verrill, 1882] (1, U.S.N.M., 35983).

Off Nova Scotia, on the fishing grounds [Verrill, 1882; Whiteaves, 1901].

Off Nova Scotia (lat. 44°32′ N., long. 57°10′ W.); 366 meters (19, U.S.N.M., 35872).

Nova Scotia to New Jersey [P. H. Carpenter, 1888].

Geographical range.—Coast of eastern North America from Chesapeake Bay (lat. 37°07′ N.) northward to the Banks of Newfoundland, where it probably passes over into the following form (*sarsi*).

Bathymetrical range.—From 46 to 891 meters; the average of ninety-seven records is 347 meters.

Thermal range.—From 3.72° C. to 13.89° C.; the average of eighty-one records is 7.82° C.

Occurrence.—This is one of the most abundant echinoderms off southern New England (Verrill, 1880), and over ten thousand have been brought up in a single haul of the dredge (Verrill, 1882).

It was found to be abundant at U.S. Fish Commission stations 897, 939, 1033, 1092, 1138, and 1150, and very abundant at station 1038, which was the station at which more than ten thousand were secured (Verrill, 1882, 1884).

All of these stations but one (897, off Chesapeake Bay) are off Martha's Vineyard, Massachusetts; all are in depths between 256 and 483 meters, with temperatures ranging from 7.78° C., to 8.89° C., three of them having the temperature 8.33° C. The temperature given for station 1092 (5.00° C.) is probably erroneous.

In this same region Howe (1901) in 1899 found it by hundreds in from 174 to 362 meters, in temperatures between 9.22° and 11.33° C.

While very common and widely distributed between Chesapeake Bay and Cape Cod it appears to be much less frequent in the more northern portions of its range, from which there are relatively few records, each based upon a small number of individuals.

The bottom frequented by this animal is mostly soft, mud, or mud and sand. Of the 90 records 30 are for mud only, 24 are for mud and sand, and 17 are for sand. Of the remaining 19, 2 are for rocky bottom, 1 is for shelly bottom, and 1 for gravel; the others are for mixed bottoms, with mud or sand as one of the ingredients.

Occurrence of the pentacrinoids.—The pentacrinoids of this species have been twice found, at *Albatross* station 2212, between Cape Hatteras and Nantucket, in 783 meters, and at *Albatross* station 2232, off Cape Hatteras, in 444 meters. These were described in part 2, p. 563.

History.—This species was first described by Retzius in 1783, the origin of his specimen being given as St. Croix. In 1788 Gmelin cited the locality as "Santa Cruz," while Retzius in his later work (1805) gave merely "American Ocean."

P. H. Carpenter examined the type specimen at Lund, and there is no doubt whatever about its identity; but he was unable to say just where St. Croix is. He found it difficult to believe that it is the St. Croix or Santa Cruz in the Virgin Islands, since he was unable to identify the type with any of the West Indian species in the extensive *Blake* collection, but he had no other suggestion to offer.

In "Les Voyages du Sieur de Champlain" (Paris, 1613) Champlain specifically mentions the occurrence of sea urchins in 1604 on the island of St. Croix. This St. Croix is the island now known as Dochet or Neutral Island off the coast of New Brunswick. It is not unlikely that, as this species occurs in this region in shallow water (as is shown by Stimpson's record from Grand Manan nearby), Champlain himself may have found a specimen on the shore (as Mr. Peale did many years later on the New Jersey coast), or on the anchor rope, or have secured one there in some other way which he took back with him to Paris. Retzius, although he did not travel himself was very widely known and had many friends in foreign lands. If Champlain actually brought back a specimen with him to Paris it would have been quite likely to have found its way into the possession of Retzius.

We have no direct evidence that this actually happened, but it is not unlikely that something of the sort did occur, and at any rate Dochet or Neutral Island was probably the place of origin of the type specimen, being the only St. Croix past or present, except for the St. Croix river in the same region, within the range of the species, or at least within the district where the species occurs in shallow water.

The second specimen was found by Mr. Titian Peale on the beach at Great Egg Harbor, New Jersey, and was described by Mr. Thomas Say in 1825 under the name of *Alectro dentata*. The description was short and unsatisfactory, and in 1866 Prof. Addison E. Verrill suggested that possibly it might prove to be identical with the *Comatula meridionalis* which had been described by E. C. and A. Agassiz in the preceding year from the coast of South Carolina.

The third specimen was dredged in 1852 in 46 meters near Duck Island, Grand Manan, by Mr. William Stimpson who recorded it in 1853 under the name of *Alecto eschrichtii*, of which he considered it a young example. The size ("nearly four inches in diameter") and the color as given by him are sufficient to identify it with the *tenella* of Retzius and the *dentata* of Say.

In 1873 Prof. Verrill ventured the statement that Say's *dentata* possibly occurs on the southern coast of New England, a statement which was soon confirmed in a most remarkable manner.

In 1874 Verrill recorded *Antedon sarsii* from off Monhegan Island and Cashe's Ledge in the Gulf of Maine, where it had been dredged by the *Speedwell*, and in 1880 he listed it from 9 additional stations. In the same year Mr. Alexander Agassiz recorded *Comatula sarsii* from a *Blake* station off Georges Bank, his determination being confirmed by P. H. Carpenter in 1881.

In 1882 Verrill discovered the identity of the species he had been calling *sarsii* with Say's *dentata*, and recorded it under the latter name from a large number of additional Fish Commission stations between Cape Cod and Chesapeake Bay, materially increasing the number of records in 1884. In that year P. H. Carpenter adopted the name *dentata* as including both American and European specimens, *dentata* having about 20 years precedence over *sarsii*.

In 1885 Verrill noted that the *Albatross* had obtained this species off the northern coast of the United States in 1883, but he gave no details.

On examining the type specimen of Retzius' *Asterias tenella* at Lund, Carpenter found it to be identical with Say's *dentata*; in 1888 he therefore substituted the name *tenella* for *dentata*.

Although Carpenter recognized the fact that the American form is larger than the European, with more cirrus segments, he always united the two under the same specific name, in which procedure he has been followed by all succeeding workers.

In 1901 Howe recorded this species again—for the last time—from off Martha's Vineyard.

Grieg in 1903 published a detailed comparison between this type and its European representative, Hartlaub in 1912 discussed it in considerable detail, on the basis of the specimens previously recorded by Agassiz (1880), from which the label had been lost, and in 1914 and 1917 F. W. Clarke and Wheeler published analyses of its skeleton.

HATHROMETRA SARSI (Düben and Koren)

[See vol. 1, pt. 1, figs. 315 (p. 273), 394–399 (p. 309), 407, 413 (p. 317), pl. 1, figs. 520, 522, 524, pl. 2, fig. 530, pl. 3, figs. 534, 536, 537, 539–541; pt. 2, figs. 586–587 (p. 303), pl. 13, fig. 1046, pl. 27, fig. 1174, pl. 35, figs. 1216–1219, pl. 36, figs. 1220–1225, pl. 46, fig. 1322]

Comatula mediterranea (not of Lamarck, 1816; in part) M. Sars, Beskrivelser og Jagstagelser, Bergen, 1835, p. 40, pl. 8, figs. 19*a–g*; Arch. Naturg., 1836, vol. 2, p. 206.

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Antedon sarsii Wyville Thomson, Phil. Trans. Roy. Soc., vol. 155, 1865, p. 516 (discussion of Sars' observations on the young).—Norman, Ann. Mag. Nat. Hist., ser. 3, vol. 15, 1865, p. 103 (Shetland; also 40 miles E. of Whalsey Skerries, Shetland, 90 fms.; gregarious).—W. B. Carpenter, Phil. Trans. Roy. Soc., vol. 156, 1866, p. 690 (Sars' observations on the larvae).—M. Sars, Memoires pour servir a la connaissance des crinoides vivants, 1868, p. 1 (frequently met with at localities where *Rhizocrinus lofotensis* was found [near the fishery at Skraaven, 720 feet]), p. 37 (comparison of the pentacrinoid with *Rh. lofotensis*), pp. 47–63 (detailed descriptions of the pentacrinoids), p. 47 (Brettesnaes, Lofoten, 100–200 fms.), p. 51 (Guldbrand Is., 100 fms.; Skraaven, 300 fms.), p. 60 (Manger; occurrence in the Lofotens of two stages of pentacrinoids from March to June), pls. 5, 6; Ann. Mag. Nat. Hist., ser. 4, vol. 3, No. 14, February 1869, p. 171 (review of preceding); No. 18, June 1869, p. 426 (Norway, 300 fms.).—Claus, Grundzüge der Zoologie, 1872, p. 230 (example of the genus).—Wyville Thomson, Proc. Roy. Soc. Edinburgh, vol. 7, 1872, p. 764 (resemblance to a larva taken by the *Porcupine;* frequent occurrence; pentacrinoids taken in Faroe Channel); The depths of the sea, 1873, p. 124 (found in most hauls of the *Porcupine* in the cold area).—Möbius and Bütschli, Zool. Ergebn. Nordseefahrt vom 21 Juli bis 9 September 1872, 1874, p. 144 (stas. 55, 215).—Claus, Grundzüge der Zoologie, 1876, p. 279.—Ludwig, Zeitschr. wiss. Zool., vol. 28, 1877, p. 258.—Storm, Kongl. Norske Vid. Selsk. Skr., 1877, p. 246 (Trondheim fjord).—P. H. Carpenter, Quart. Journ. Micr. Sci., new ser., vol. 18, 1878, p. 373 (centrodorsal); Trans. Linn. Soc. London (Zool.), ser. 2, vol. 2, 1879, p. 29 (listed as an *Antedon*), p. 75 (long pentacrinoid stage; centrodorsal); Quart. Journ. Geol. Soc., vol. 36, 1880, p. 38 (stem retained until a late stage); 1881, pp. 129, 135 (pentacrinoid, after Sars).—Leslie and Herdman, Proc. Roy. Phys. Soc. Edinburgh, vol. 6, 1881, p. 86 (may be looked for in the seaward limit of the Firth of Forth).—P. H. Carpenter, Rep. British Assoc. for 1881, 1882, p. 672 (a British species).—Claus, Traité de Zoologie, vol. 4, 1884, p. 412 (general account).—P. H. Carpenter, Bijdr. Dierkunde, vol. 13, 1886, p. 3 (synonym of *dentata*).—de Folin, Sous les mers, 1887, p. 126 (near Santander, 960 and 1081 meters).—Brunchorst, Bergens Mus. Aarsb. for 1890, No. 5, 1891, p. 30.—Buckley, Proc. and Trans. Liverpool Biol. Soc., vol. 6, 1892, p. 89.—Seeliger, Zool. Jahrb., Anat. Ontog., vol. 6, 1892, p. 166 (length of larval life; breeding season), p. 333 (anatomy).—Walther, Einleitung in die Geologie als historische Wiss., 1894, p. 298.—Bather, *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, fig. xlix, 8, 9, p. 132.—Minckert, Arch. Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 191 (syzygies).

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Hathrometra tenella var. *sarsii* GISLÉN, Ark. Zool., vol. 15, No. 23, 1923, pp. 7–18, 25–30 (discussion; localities; characters of specimens); Zool. Bidrag Uppsala, vol. 9, 1924, p. 28, footnote, pp. 68, 82 (articulations), p. 195 (development of cirri known), p. 205 (centrodorsal in development), p. 214 (extent of disk), p. 271; fig. 93, p. 87; figs. 114–115, p. 93; figs. 261–268, p. 199.—MORTENSEN, Danmarks Fauna, No. 27, 1924, p. 23; Handbook of the echinoderms of the British Isles, 1927, p. 41.—KOEHLER, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 129.—MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, vol. 12, 1928, p. viii. 86 (food).—ELIAS DA COSTA, Chaves dicotómicas para a classificação dos equinodermes Portugueses. No. 4, Crinóides, Porto, 1940, pp. 13, 15.—GISLÉN, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 80.

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Hathrometra tenella norvegica KOEHLER, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 129.

Hathrometrea sarsi MORTENSEN and LIEBERKIND, Die Tierwelt der Nord- und Ostsee, vol. 12, 1928, p. viii. 125 (host of parasite).

Hathometra tenella RIVERA, Bol. Pesc. Madrid, vol. 14, 1929, p. 50 (in key).

Harthrometra sarsi DJAKONOV, Les échinodermes des mers arctiques (in Russian), Leningrad, 1933, p. 22 (in key), p. 25 (characters; range); fig. 12B, p. 25.

Diagnostic features.—This form seems to differ from *H. tenella*, of which it represents a northern and northeastern variety, only in being smaller with fewer cirrus segments, which number from 14 to 24, and are usually about 20.

Hathrometra sarsi has frequently been confused both with *Poliometra prolixa* and with *Heliometra glacialis*. Some of the records for this species can only be explained on the assumption that it has been confused also with species of *Trichometra*.

From *Poliometra prolixa*, which resembles it in color and has P_1 similarly elongated, it is at once distinguished by the difference in the arrangement of the cirri on the centrodorsal, the cirrus sockets being in closely crowded alternating rows, whereas in *Poliometra* they are in definite columns, and by the distal intersyzygial interval which is 3 muscular articulations and not 4 as in *Poliometra*.

From small individuals of *Heliometra glacialis* it is distinguished by the more or less sharply conical instead of flattened hemispherical centrodorsal, by the color, which in *Heliometra* is bright yellow, by the distal intersyzygial interval, which is 3 muscular articulations instead of 4 as in *Heliometra*, and by the character of P_1, which is exceedingly slender, but stiffened, with all the segments except the basal greatly elongated with prominent spines on their distal ends.

The absence of the prominent spinous eversion of the distal ends of the earlier brachials easily distinguishes this form from any of the species of *Trichometra*.

Description.—The centrodorsal resembles that of *H. tenella*, but is usually somewhat lower, and the cirrus sockets are not so numerous.

The cirri are XL–LXX, 14–24 (most frequently 17–21) from 11 to 17 mm. (usually between 13 and 15 mm.) in length, resembling those of *H. tenella* but more slender with the earlier segments usually more elongate.

The radials, post-radial series and arms resemble those of *H. tenella*. The arms are from 35 to 90 mm. (usually between 40 and 65 mm., and rarely over 70 mm.) in length.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 3 muscular articulations, very exceptionally 4. In a tabulation of 85 cases the intersyzygial interval was found to be 3 muscular articulations in 76, 4 in 5, and 2 in 4.

P_1 is from 10 to 16 mm. (usually about 13 mm.) in length, with 25 to 42 (usually between 30 and 35) segments. The first three segments are about as long as broad, the fourth is about half again as long as broad, and the following rapidly become elongated and exceedingly slender and from three to four times as long as broad distally; the fourth and following segments have somewhat flaring and overlapping distal ends set with fine spines. P_2 is from 3 to 5 mm. (usually between 4 and 5 mm.) long with 8 to 12 (usually 9 or 10) segments, basally slightly stouter than P_1 and tapering rapidly to a very delicate tip; the first segment is not quite so long as broad, the second is about as long as broad, the third is rather longer than broad, the fourth is about twice as long as broad, and the remainder gradually become elongated and slender, and excessively long and slender distally.

P_3 is from 3 to 5 mm. (averaging 3.8 mm.) long with 8 to 13 (usually 12) segments, resembling P_2.

In the distal pinnules the first segment is short and trapezoidal with the outer (longest) edge concave, the second is about twice as long as the first and trapezoidal, the third is about two and a half times as long as broad, and the fourth and following are about three times as long as broad, becoming somewhat longer distally. On the third and following segments the distal ends are everted and armed with fine spines.

Grieg (1913) says that in life this species is light grayish brown with narrow darker bands; Alder (1860) describes it as light grayish brown.

Localities.—*Fish Hawk* station 1124; off Martha's Vineyard (lat. 40°01′ N., long. 68°54′ W.); 1170 meters; temperature 3.89° C.; fine sand, green mud, and calcareous nodules [Verrill, 1884] (2, U.S.N.M., 24105, 35876).

Blake station 309 Ag.; east of New York (lat. 40°11′40″ N., long. 68°22′00″ W.); 556 meters; temperature 4.72° C.; dark gray mud and sand; June 30, 1880 (1, M.C.Z., 260).

Blake station 306 Ag.; south of Nova Scotia (lat. 41°32′50″ N., long. 65°55′00″ W.); 958 meters; temperature 4.17° C.; dark gray mud, sand and stones; June 29, 1880 (4, M.C.Z., 259).

Albatross station 2429; south of Newfoundland (lat. 42°55′30″ N., long. 50°51′00″ W.); 861 meters; temperature 3.72° C.; gray mud; June 23, 1885 (126, U.S.N.M., 4723, 11541, 24084).

Michael Sars station 70, 1910; south of Newfoundland (lat. 42°59′ N., long. 51°15′ W.); 1100 meters; temperature 3.7° C. [Grieg, 1921].

Albatross station 2471; off Nova Scotia (lat. 44°34′00″ N., long. 56°41′45″ W.); 400 meters; temperature 4.67° C.; gray mud and sand; July 4, 1885 (122, U.S.N.M., 11542, 36211).

Cable repair ship *Minia;* south of Newfoundland (lat. 44°38′ N., long. 54°06′ W.); 1042 meters [Honeyman, 1889].

Ingolf station 27; Davis Strait (lat. 64°54′ N., long. 55°10′ W.); 721 meters; temperature 3.8° C. [A. H. Clark, 1923] (10, C.M.).

Ingolf station 28; Davis Strait (lat. 65°14′ N., long. 55°42′ W.); 768 meters; temperature 3.5° C. (1, C.M.).

Ingolf station 25; Davis Strait (lat. 63°30′ N., long. 54°25′ W. or lat. 63°51′ N., long. 53°03′ W.); 249 or 1064 meters; temperature 3.3° C. (12, C.M.).

Rink station 55; Bredefjord, southwestern Greenland (lat. 60°34′ N., long. 46°45′ W.); 310–330 meters; temperature 3.5°–2.0° C.; salinity 34.7–34.4 per m.; clay with a few small stones; July 20, 1912 [Mortensen, 1913; Stephensen, 1917] (1, C.M.).

Rink station 121; Bredefjord (lat. 60°32′ N., long. 46°51′ W.); 700 meters; clay; August 25, 1912 [Mortensen, 1913; Stephensen, 1917] (1, C.M.).

Ingolf station 93; off eastern Greenland (lat. 64°24′ N., long. 35°14′ W.); 1220 meters; temperature 1.46° C. (1, C.M.).

Ingolf station 94; off eastern Greenland (lat. 64°56′ N., long. 36°19′ W.); 373 meters; temperature 4.1° C. (1, C.M.).

Thor station 151; off northern Iceland (lat. 66°17′ N., long. 21°14′ W.); 180 meters; July 2, 1903 (1, C.M.).

Off northwestern Iceland (lat. 66°16′ N., long. 25°20′ W.); 525 meters; Wandel, September 19, 1881 (8, C.M.).

West of Iceland (lat. 64°42′ N., long. 27°43′ W.); 781 meters; Wandel, October 5, 1889 (1, C.M.).

Ingolf station 9; west of Iceland (lat. 64°18′ N., long. 27°00′ W.); 540 meters; temperature 5.8° C. (3, and a pentacrinoid, C.M.).

Ingolf station 78; southwest of Iceland (lat. 60°37′ N., long. 27°52′ W.); 1461 meters; temperature 4.5° C. (1, C.M.).

Ingolf station 81; southwest of Iceland (lat. 61°44′ N., long. 27°00′ W.); 887 meters; temperature 6.1° C. (3, and a pentacrinoid, C.M.)

Ingolf station 67; south of western Iceland (lat. 61°30′ N., long. 22°30′ W.); 1783 meters; temperature 3.0° C. (fragments, C.M.).

Thor station 171; off southwestern Iceland (lat. 63°15′ N., long. 22°23′ W.); 216–326 meters; 1903 (8, C.M.).

Thor station 167; off southwestern Iceland (lat. 63°05′ N., long. 20°07′ W.); 557 meters; July 14, 1903 (5, C.M.).

Thor station 168; off southwestern Iceland (lat. 63°12.5′ N., long. 20°06′ W.); 510 meters; November 20, 1903 (1, C.M.).

Thor station 57; off southeastern Iceland (lat. 63°21′ N., long. 16°22′ W.); 500–560 meters; May 26, 1905 (4, and a pentacrinoid, C.M.).

Ingolf station 54; off southeastern Iceland (lat. 63°08′ N., long. 15°40′ W.); 1282 meters; temperature 3.9° C. (38, C.M.).

Ingolf station 55; off southeastern Iceland (lat. 63°33′ N., long. 15°02′ W.); 578 meters; temperature 5.9° C.; May 19, 1896 (1, C.M.).

Southeast of Iceland (lat. 64°16′ N., long. 11°14′ W.); 347 meters (pentacrinoid, C.M.).

Southeast of Iceland (lat. 64°16′ N., long. 11°04′ W.); 350 meters (pentacrinoid, C.M.).

North of Iceland (lat. 66°17′ N., long. 21°14′ W.); 180 meters [Einarsson, 1948].

Southeast of Iceland (lat. 64°25′ N., long. 12°30′ W.) [Einarsson, 1948].

Lónsdjúp, Iceland (lat. 64° N., long. 14° W.); 200 meters [Einarsson, 1948].

Southeast of Iceland (lat. 64°15′ N., long. 14°22′ W.); 124 meters [Einarsson, 1948].

Southwest of Iceland (lat. 63°18′ N., long. 21°30′ W.); 178 meters [Einarsson, 1948].

Southwest of Iceland (lat. 63°15′ N., long. 22°23′ W.); 216–326 meters [Einarsson, 1948].

Ingolf station 51; off eastern Iceland (lat. 64°15′ N., long. 14°22′ W.); 124 meters; temperature 7.32° C. (11, C.M.).

Ingolf station 52; off eastern Iceland (lat. 63°57′ N., long. 13°32′ W.); 768 meters; temperature 7.87° C. (14, C.M.).

Ingolf station 57; off eastern Iceland (lat. 63°37′ N., long. 13°02′ W.); 640 meters; temperature 3.4° C. (5, C.M.).

Michael Sars station 86, 1902; west of the Faroe Islands (lat. 62°59′ N., long. 10°37′05″ W.); 460 meters; temperature 3.36° C.; gray sand; August 21, 1902 [Grieg, 1904] (6, Berg. M.).

Michael Sars station 98, 1902; west of the Faroe Islands (lat. 63°29′ N., long. 10°12′ W.); 385 meters; temperature 3.15° C.; fine gray sand and stones; August 27, 1902 [Grieg, 1904] (1, Berg. M.).

Ingolf station 2; northwest of the Faroe Islands (lat. 63°04′ N., long. 9°22′ W.); 481 meters; temperature 5.3° C. (3, C.M.).

Michael Sars station 85, 1902; northwest of the Faroe Islands (lat. 62°53′ N., long. 9°06′ W.); 448 meters; August 20, 1902 (14, C.M.).

Ingolf station 44; southwest of the Faroe Islands (lat. 61°42′ N., long. 9°36′ W.); 997 meters; temperature 4.8° C. (1, C.M.).

Thor station 78; southwest of the Faroe Islands (lat. 61°07′ N., long. 9°30′ W.); 835 meters; 1904 (1, C.M.).

Triton station 5, 1882; southwest of the Faroe Islands (lat. 60°11′25″ and 60°20′15″ N., long. 8°15′ and 8°08′ W.); 521–792 meters; temperature 4.89°–6.39° C.; hard ground; stones [P. H. Carpenter, 1884, 1888; von Graff, 1884; Bell, 1893; A. H. Clark, 1913] (2, B.M.).

Porcupine station 51, 1869; south of the Faroe Islands (lat. 60°06′ N., long. 8°14′ W.); 805 meters; temperature 5.5° C. [P. H. Carpenter, 1884, 1888; Bell, 1893] (1, B.M.).

Faroe Channel [Wyville Thomson, 1872].

Faroe Bank [Grieg, 1904].

Triton station 2, 1882; north of the Hebrides (lat. 59°37′30″ N., long. 6°19′00″ W.); 969 meters; temperature 7.89° C.; mud [P. H. Carpenter, 1884, 1888].

Michael Sars station 43, 1902; southeast of the Faroe Islands (lat. 62°30′ N., long. 5°10′ W.); 456 meters; brown sand and clay; July 2, 1902 [Grieg, 1904] (1, Berg. M.).

Southeast of the Faroe Islands (lat. 61°23′ N., long. 5°04′ W.); 466 meters; Wandel, 1890 (2, C.M.).

Porcupine station 74, 1869; west of the Shetland Islands (lat. 60°39′ N., long. 3°09′ W.); 341 meters; temperature 8.67° C. [P. H. Carpenter, 1884, 1888].

Michael Sars station 60, 1902; between the Faroe and Shetland Islands (lat. 62°18′ N., long. 4°14′ W.); 370 meters; fine brown sand and stones; July 23, 1902 [Grieg, 1904] (1, Berg. M.).

Between the Faroe and Shetland Islands; 923 meters; Wandel, 1890 (2, C.M.).

Shetland Islands [A. H. Clark, 1913] (2, B.M.). Same, off the Hauf, deep water [Alder, 1860; M. Sars, 1861; Norman, 1861, 1865]. Same, 40 miles east of Whalsey Skerries; 164 meters [Norman, 1865].

Helga station S.R. 353; off SW. Ireland (lat. 50°38′ N., long. 11°32′ W.); 457–991 meters; August 6, 1906 [A. H. Clark, 1913] (1, Dublin M.).

Helga station S.R. 506; off southwestern Ireland (lat. 50°34′ N., long. 11°19′ W.); 1209–1229 meters; September 12, 1907 [A. H. Clark, 1913] (1, Dublin M.).

Michael Sars, 1904; "southern part of the depression, between 58° and 59° N."; 292 meters; temperature 5.83° C. [Appelløf, 1912].

Northern Norway [Grieg, 1904]. Finmark [Lütken, 1857] (1, K.M.). East Finmark [Grieg, 1902]. Øxfjord, East Finmark [Grieg, 1904]. Same, 146 meters; rocky bottom [Danielssen, 1859]. Same, 183 meters [M. Sars, 1861].

Øxfjord to Hardangerfjord (Grieg, 1902].

Norway [A. H. Clark, 1913] (4, B.M.; C.M.). Same, M. Sars, 1862 (1, M.C.Z., 256). Same, G. O. Sars (2, C.M.). Same, 92 meters (2, K.M.). Same, 1462 meters [A. H. Clark, 1913] (1, B.M.).

Tranø, Finmark [Gislén, 1923].

Tromsø (1, Berg. M.).

Malangen, Tromsø [Grieg, 1904]. Same, 100–200 meters [Grieg, 1902] (16, Berg. M.).

Tromsø to Bergen; to over 183 meters; coralline bottom [Lütken, 1857].

Vaagsfjord [Grieg, 1898]. Same, Halnaesvik and vicinity [Grieg, 1898]. Same, southern part, Slaaken and Stegene [Grieg, 1898].

Johan Hjort station 137; Vestfjord, off Risvaer; 122–140 meters [Grieg, 1931].

Tysfjord; 500 meters [Grieg, 1902].

Lofoten Islands. Near Skraaven (lat. 68°11′ N.); 219 meters [M. Sars, 1868]. Same, 274–366 meters; G. O. Sars [Gislén, 1923] (11, K.M.). Same, 366–549 meters (2, U.S.N.M., 35771; M.C.Z., 48). Same, 457 meters (about 15, K.M.). Same, 548 meters [M. Sars, 1868, 1869]. Brettesnaes, 184–220 meters (1, K.M.). Same, 183–365 meters [M. Sars, 1868].

Guldbrand Islands; 183 meters and 184–220 meters [M. Sars, 1868]. Same, 184–220 meters (pentacrinoids, K.M.).

Skjaerstadtfjord; 330–490 meters [Grieg, 1902]. Same, temperature 3.2° C. [Grieg, 1904].

Beierfjord; temperature 3.2° C. [Grieg, 1904].

Beisfjord; 30–150 meters [Grieg, 1902].

Herløfjord [Appelløf, 1896; Grieg, 1896].

Strømfjord. Same, southern part, 274–366 meters [Grieg, 1896, 1912]. Same, about Husøen; 91–366 meters [Grieg, 1896]. Same, Lyktvor, 120–600 meters [Grieg, 1912]. Same, Eiterelv, 80–200 meters [Grieg, 1912]. Same, Limesand, 80–200 meters [Grieg, 1912]. Same, Svartdal, 80–200 meters [Grieg, 1912]. Same, Djupevik, 80–200 meters [Grieg, 1912]. Same, Smedenes, 80–200 meters [Grieg, 1912]. Same, Hanevik, 80–200 meters [Grieg, 1912].

Bodøfjord [A. H. Clark, 1912] (1, Berl. M., 3618).

Borgestrøm (2, K.M.).

Argo station XIV; Lekøfjord (lat. 65°05′ N.); 238 meters; gravel; July 15, 1891 [Buckley, in Herdman, 1892].

Trondhjemsfjord [Norman, 1893; Grieg, 1904]. Same, 55–550 meters [Storm, 1877]. Same, 274–548 meters [A. H. Clark, 1913] (24, B.M.). Trondhjem (8, K.M.). Off Rødberg, about 150–200 meters; Th. Mortensen, July 17, 1911 (20, C.M.). Off Rødberg, 200–300 meters; T. Gislén, 1920 [Gislén, 1923]. Off Rødberg, 200–400 meters [Arndt, 1913]. Off Rødberg, 548 meters; July 16, 1891 (*Argo* station XV) [Buckley, in Herdman, 1892]. Skarnsund, pebbly bottom [Nordgaard, 1893]. Skarnsund, 110 meters [Nordgaard, 1893]. Skarnsund, 100–200 meters; Hj. Östergren, September 1898 [Gislén, 1923]. Skarnsund, 150–200 meters [Arndt, 1913]. Skarnsund, about 150–200 meters; Th. Mortensen, July 21, 1911 (2, C.M.). Off Tautra, about 200 meters; Th. Mortensen, July 31, 1911 (8, C.M.). Galgenaes, 300 meters; T. Gislén, July 1921 [Gislén, 1923]. Leksen [Grieg, 1904] (1, Berg. M.). Leksviken, 200 meters; T. Gislén, August 1920 [Gislén, 1923].

Soot-Ryen's Foldenfjord station 12a; 250–350 meters; 1923 [Grieg, 1928].

Soot-Ryen's station 12b; 250–285 meters [Grieg, 1928].

Argo station VI; outer part of Trondhjemsfjord; the haul began in the middle of the fjord in 548 meters, soft bottom, and at the end the net was dragged toward a rocky promontory on the north side near Aarlotnes, and then hauled up in shallow water; July 6, 1891 [Buckley, in Herdman, 1892].

Princesse-Alice station 1052, 1899; coast of Norway (lat. 65°41′ N., long. 9°30′15″ E.); 440 meters; mud; July 10, 1899 [Koehler, 1901, 1909].

Scheeren [Grieg, 1904].

Four miles north of Kristiansund; 28–37 meters (1, Berg. M.).

Michael Sars station 53, 1902; off Kristiansund (lat. 62°36′ N., long. 3°21′ E.); 360 meters; temperature 6.54° C.; sand and stones; July 16, 1902 [Grieg, 1904] (1, Berg. M.).

Christiansund; 91–183 meters; stony bottom [M. Sars, 1861].

Michael Sars station 85, 1902; west of Kristiansund (lat. 62°53′ N., long. 9°06′ W.); 450 meters; 3.98° C.; gray sand and small stones; August 20, 1902 [Grieg, 1904] (11, Berg. M.; U.S.N.M., 35887).

Michael Sars station 58, 1902; off Aalesund (lat. 62°26′ N., long. 4°49′ W.); 420 meters; about 5.00° C.; fine black sand and stones; July 21, 1902 [Grieg, 1904] (1, Berg. M.).

Søndfjord [Grieg, 1896] (1, Berg. M.).

Kruko, Husø, Langnuen, Strømfjord and Moldøen (27, Berg. M.).

Husø, 368 meters (10, Berg. M.; U.S.N.M., 35886).

Skaergehavn (8, K.M.).

Florøen; 91–183 meters; stony bottom [M. Sars, 1861].

Vøringen station 8; entrance to Sognefjord (lat. 61°00′ N., long. 4°49′ E.); 366 meters; temperature 6.6° C.; clay, sand and stones [Danielssen, 1892].

Six miles west of Sognefjord (1, Berg. M.).

Sognefjord [Grieg, 1896]. Same, Husø, at the entrance [Grieg, 1904, 1912]. Same, Husø, 183 meters; temperature 5.6° C. [Danielssen, 1892]. Same, Kraakoskallen, Husø; 190–360 meters [Grieg, 1912]. Vik [Greig, 1904]. Limesand and Vik, 110–146 meters (1, Berg. M.); 110–184 meters (1, Berg. M.); 184 meters (1, Berg. M.). Tveidt and Vik; 184–311 meters (3, Berg. M.).

Mangerfjord [Grieg, 1896]. Manger [M. Sars, 1868] (25, K. M.). Same, 92 meters (1, and a pentacrinoid stalk, K.M.).

Florvaagsolhavet, near Bergen (1, Berg. M.).

Bergen to Kristiansund [Düben and Koren, 1846]. Type locality.

North-northwest of Bergen; G. Nilsson, 1880 [Gislén, 1923]. Same, 164–311 meters; M. Uddström, 1880 [Gislén, 1923]. Same, 164–366 meters; M. Ohlsson, 1879 [Gislén, 1923]. Same, 183 and 274 meters; collected by fisherman from Käringön [Gislén, 1923].

The great fishing bank northwest of Bergen; 183–274 meters; T. Andersson, 1874 Gislén, 1923].

Bergensfjord [Grieg, 1896]. Bergen [M. Sars, 1861; Brunchorst, 1891] (2, Berg. M.). Same, voyage of Prince Napoleon, 1856 (2, P.M.). Same, 91–183 meters; stony bottom [M. Sars, 1861].

Hjeltefjord [Grieg, 1896].

Korsfjord [Grieg, 1896].

Bjørnefjord [Grieg, 1896].

Selbøfjord [Grieg, 1896].

Samlefjord, 274 meters; rocky bottom; Bovallius, 1880 [Gislén, 1923].

Hardangerfjord [Grieg, 1895]. Same, 100–500 meters; hard bottom [Grieg, 1913]. Same, 549 meters (3, Berg. M.). Jondals Bay [Grieg, 1913]. Jondal; 40–400 meters (22, Berg. M.). Urevik [Grieg, 1912]. Kirken [Grieg, 1912]. Jonanes [Grieg, 1912]. Tryglavik; fine clay mixed with shell sand [Grieg, 1912]. Eidsvaag and Augestad, northern side of Straumastein [Grieg, 1912]. Utne, 600 meters; Danielssen [Grieg, 1912].

Boknfjord; 140–343 meters, and 450–707 meters (3, Berg. M.).

Hellefjord; 184–368 meters (6, Berg. M.).

Bukkenfjord; between Skudesnaes and Hvitingsø; 140–343 meters; Nordgaard, 1901 [Grieg, 1904]. Same, between Noremsø and Tungenaes; 450–700 meters; Nordgaard, 1901 [Grieg, 1904].

Thor station 3; southwest of Stavanger (lat. 58°32′ N., long. 4°18′ E.), 280 meters; April 4, 1903 (4, and pentacrinoids, C.M.).

Southwest of Stavanger (lat. 58°11′ N., long. 4° E.); 119 meters; Captain Örsted, May 2, 1897 (5, C.M.).

Jaederen, 183–274 meters; B. Ohlsson, 1874 [Gislén, 1923].

Northwest of Ekersund, 183 meters; collected by fishermen from Käringön in 1873 [Gislén, 1923].

Northeastern corner of the fishing banks west of Listerfjord; 113 meters; Captain Örsted, May 13, 1908 (1, C.M.).

West of Listerfjord (lat. 58°12′ N., long 4°00′ E.); 115 meters; Captain Örsted, April 19, 1901 (8, C.M.).

North Sea Commission July–September 1872 station 215; west of Hanstholm, Denmark, in long. 6°51′ E.; 170 meters; gray muddy sand with small stones and many empty worm tubes [Möbius and Bütschli, 1872].

North Sea Commission July–September 1872 station 55; off Sølsvig, Denmark, 183 meters; gray calcareous mud [Möbiüs and Bütschli, 1872].

Kristianiafjord [Grieg, 1902] (1, K.M.).

Drøbak (about 20, K.M.).

North of the Jutland Bank; 183–366 meters; B. Westergren, 1879 [Gislén, 1923].

Väderöarna, Bohuslän, Sweden; 110 meters; muddy bottom; Gunhild Expedition, July 13, 1877, station 19 [Gislén, 1923].

East of Storön, Väderöarna; 130 meters; T. Gislén, July 29, 1918 [Gislén, 1923].

East-northeast of Väderöarna; 50 meters; rocky bottom; T. Gislén, July 30, 1918 [Gislén, 1923].

West of Hanstholm, Denmark [Mortensen, 1950].

North Atlantic Ocean (1, L.M.).

Ingolf; no locality (1, C.M.).

No locality; J. Müller (6, Berl. M., 1052, 1053, 5337).

No locality [A. H. Clark, 1912] (22, C.M.; 2 pentacrinoids, Berg. M.).

Erroneous localities.—Near Santander, Spain; 960 and 1081 meters [de Folin, 1887] (probably *Trichometra delicata*).

Porcupine station 17*a*, 1870; off Cape Carvoeiro, Portugal (lat. 39°39′ N., long. 9°39′ W.); 1010 meters; temperature 9.61° C. [P. H. Carpenter, 1884, 1888] (probably *Trichometra delicata*).

Sir Wyville Thomson remarks that this species was found "in nearly every deep haul of the dredge" from the Faroe Islands to Gibraltar. Probably the specimens taken in the Bay of Biscay and southward represented *Trichometra delicata* which has a very close superficial resemblance to this species.

Jarzynsky (1870) recorded this species from various fjords on the Murman coast, and his records were repeated by Wagner (1885); the species referred to was undoubtedly *Heliometra glacialis.*

P. H. Carpenter's record (1888) of *tenella* from the Kara Sea, based upon material in the *Varna* collection, also refers to a young individual of *Heliometra glacialis.*

P. H. Carpenter's records for *Porcupine* stations 54 and 55 (1884), Pfeffer's record (1895) from eastern Spitzbergen, Schmidt's record (1904) for *Thor* station 52, and Vaney's record for Jan Mayen (1914) are based upon *Poliometra prolixa.*

[NOTE BY A.M.C.] The records of Pawsey and Davis (1924) from the Lousy Bank area and of Dollfus (1924) from Rockall are probably mistakes for *Leptometra celtica;* the Rockall depth is much shallower (90 meters) than other records of *H. sarsi* from the neighboring areas.

Geographical range.—From off New York and Massachusetts in deep water to southern Greenland, as far as Bredefjord and lat. 65°15′ N. in Davis Strait, and eastward to Iceland, the Faroe and Shetland Islands, southwest Ireland and the coasts of Scandinavia from Øxfjord in East Finmark southward to the full length of the Skagerrak.

Bathymetric range.—From 28 to 1783 meters, the average depth at which it occurs being 398 meters.

Thermal range.—From 2.00° C. (a single record of 1.46° C. being probably erroneous) to 8.67° C., the average temperature of the habitat being 4.21° C.

TABLE 17.—*The minimum, maximum, and average depths and temperatures for* Hathrometra sarsi *in different parts of the range.*

Area	Depth (meters) Min.	Max.	Mean	Temperature (° C.) Min.	Max.	Mean
About Newfoundland	861	1100	1001	3. 70	3. 72	3. 71
About Greenland	310	1220	686	2. 00	4. 10	3. 40
About Iceland	124	1783	678	3. 00	7. 87	5. 31
About the Faroes and Shetlands	164	997	571	3. 15	8. 67	5. 55
On the Norwegian coast	28	1462	255	3. 20	6. 60	4. 60
About southwestern Ireland	457	1209	971	-	-	-
Entire range	28	1783	398	2. 00	8. 67	4. 21

Occurrence.—Sir Wyville Thomson wrote (1872) that more or less complete specimens or fragments of this species came up in nearly every one of the deep hauls of the dredge from the Faroe Islands to Gibraltar during the cruises of the *Porcupine.*

Prof. Michael Sars said (1861) that this species is not rare on the western coast of Norway (Bergen, Florøen, Christiansund), though never present in great numbers, in from 91 to 183 meters and more, on stony bottom. On his trip to the northern country in 1857 he found it in Øxfjord in 183 meters, the specimens being as large (75 mm. in diameter) as those found at Bergen.

In the Hardangerfjord (Grieg, 1913) this species is scarcer than *Antedon petasus,* yet it cannot be called rare as it has been recorded from a number of localities on both sides of the fjord in from 100 to 500 meters on hard bottom.

In Hardangerfjord Jondalsbugt, which is a bay about 2.5 kilometers broad between Jonanes and Saetveit, is bounded on the north by the steep land between Jonanes, Kirken, and Urevik. From the depths of the fjord a deep channel cuts in along the shore to Urevik where close to land depths of from 100 to 200 meters are found. The land falls abruptly toward the channel, and only here and there the descent is broken by small terraces. The sides of the cliffs and these terraces support a rich and varied fauna including this species.

Tryglavik, just to the north of Jonanes, has a relatively rich fauna, including this species, on a bottom of fine clay mixed with shell sand.

On the northern side of Straumastein, across the fjord from Jondalsbugt, the narrow terraces along the side of the fjord gradually become broader and along by Eidsvaag and Augestad assume the character of plateaus which slope gradually from the land to a depth of from 200 to 400 meters, thence falling abruptly to the depths of the fjord. Further from land the bottom consists of shell sand more or less mixed with muddy clay and stones. Here is found an extraordinarily rich and varied fauna, including *Hathrometra sarsi.*

According to Grieg (1912) this species is rather common at Lyktvor in 120 to 600 meters. It is also found at Eiterelv, Limesand, Svartdal, Djupevik, Smedenes and Hanevik, in 80 to 200 meters. At Husø at the entrance to Sognefjord it was extraordinarily abundant in certain localities, as near Kraakøskallen in 190 to 360 meters.

In the southern part of Stromfjord (Grieg, 1895) this species in 1889 and 1891 occurred only very sparingly between 150 and 200 fathoms; but in 1895 it was present everywhere in the waters around Husøen in great numbers. In several localities the sea bottom appeared to be densely covered with it, and twice the dredge came up filled exclusively with this crinoid. The reverse was the case with *Myriotrochus rinki* which is found in the same localities at Husøen as *Hathrometra sarsi;* in 1889 it was very numerous, but in 1895 only a few individuals were found.

Nordgaard (1893) says that this species is common at Skarnsundet on pebbly bottom, where it is predominantly found attached to sponges.

Occurrence of the pentacrinoids.—The pentacrinoids of this species are known from the following localities: *Ingolf* station 9, west of Iceland, 540 meters; *Ingolf* station 81, southwest of Iceland, 887 meters; *Thor* station 57, off southeastern Iceland, 500 to 560 meters; southeast of Iceland (lat. 64°16′ N., long. 11°14′ W.), 347 meters; off southeastern Iceland (lat. 64°16′ N., long. 11°04′ W.), 350 meters; Brettesnaes, Lofoten Islands, 183 to 367 meters; Skraaven, Lofoten Islands, 548 meters; Guldbrand Islands, 183 and 184 to 220 meters; Manger, 92 meters; Husøen, Sognefjord, 183 meters, temperature 5.6° C. (given by mistake in part 2, p. 573, with the data of *Vøringen* station 8); *Thor* station 3, southwest of Stavanger, 280 meters. For a description of the pentacrinoids see part 2, p. 564.

Genus FARIOMETRA A. H. Clark

Antedon (part) Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 144, and following authors.
Thaumatometra (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128.
Trichometra (part) A. H. Clark, Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 232.
Nepiometra (part) A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 130.
Fariometra A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 128 (referred to the Bathymetrinae), p. 130 (type species *Trichometra explicata* A. H. Clark, 1908; diagnosis; range; included species); No. 16, p. 510 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 245 (in key; range), p. 248 (key to the included species).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 11; Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (depth).

Diagnosis.—A genus of Bathymetrinae in which the centrodorsal is conical; there are XXX or more cirri, of which the longest have 21 to 36 segments; the longer cirrus segments are at least two and a half times as long as broad and even the shorter distal ones are usually longer than broad; the brachials have spinous distal ends; P_1 has up to 23 segments, of which not more than three or four of the basal ones are as broad as long; the genital pinnules of the female do not bear marsupia.

Type species.—Trichometra explicata A. H. Clark, 1908.

Geographical range.—From the Arabian Sea to the East Indian region, and off the west coast of America from Panama to southern California.

Bathymetrical range.—From 204 to 2194 meters.

Thermal range.—From 2.44° to 7.88° C.

Remarks.—As originally outlined in 1917 the genus *Fariometra* included only the species *explicata, scutifera* and *dione*; this interpretation was followed in the *Siboga* report in 1918. But of the species assigned at the same time to the genus *Nepiometra* I now believe that all but the type, *N. laevis*, should be placed in the genus *Fariometra*.

The treatment of this genus as detailed in the following pages must be regarded as purely provisional because of the paucity and fragmentary condition of the available material in most of the included species.

[Note by A.M.C.] Following an attempt to summarize the characters of the species of the subfamily Bathymetrinae, I decided that *Thaumatometra sokotrae* John is more nearly allied to the species of *Fariometra* with their longer cirri of more numerous segments than to those of the genus in which it was first placed. I have accordingly modified the following key to include *sokotrae* and at the same time to give less prominence to the (somewhat variable) proportions of the centrodorsal in defining the species. *Fariometra scutifera* and *F. obscura* have been removed from the key since their cirri and pinnules are unknown, the arms of the type specimens having been broken at the first syzygy. The former is distinguished by having the second brachials unusually long.

KEY TO THE SPECIES OF FARIOMETRA

a^1. Elements of the IBr series with straight, more or less parallel sides, the IBr_1 not cut away or narrowed distally.

- b^1. Longest cirri with up to 36 segments (Arabian Sea; 2194 meters) **sokotrae** (p. 725)
- b^2. Longest cirri with less than 30 segments.
  - c^1. Cirri with 25–28 segments; sides of the IBr series and lower brachials sharply and broadly flattened (Philippine Islands; 509–1314 meters) **explicata** (p. 728)
  - c^2. Cirri with 21–22 segments; sides of the IBr series and lower brachials with projecting spinous patches, not flattened (south of Celebes and north of New Guinea; 1158–1956 meters). **io** (p. 729)

a^2. The sides of the IBr_1 converging, the lateral angles of the axillaries being produced beyond them to define a conspicuous, usually rhombic, pore in each interradius.

- b^1. Longest cirrus segments not more than three times as long as broad.
  - c^1. P_2 only about two thirds the length of P_1; centrodorsal nearly twice as wide at the base as it is high (Maldive area; 797 meters) **sewelli** (p. 732)
  - c^2. P_2 similar in size to, or larger than, P_1; centrodorsal only a quarter to a half again as wide at the base as it is high.*
    - d^1. Peripheral cirri with about 21 segments; P_1 and P_2 similar in length.
      - e^1. P_1 with about 16 segments; the two first brachials of each pair of arms not in contact; centrodorsal only a quarter again as wide at the base as it is high (Makassar Strait and the Kei Islands; 245–724 meters) **dione** (p. 734)
      - e^2. P_1 with about 21 segments; the first brachials in contact inwardly; centrodorsal about half again as wide at the base as high (south of Lombok, Lesser Sunda Islands; 1097 meters) **nicippe** (p. 737)
    - d^2. Peripheral cirri with about 28 segments; P_2 larger than P_1 (southeast of Ceram; 204 meters). **alcyon** (p. 736)
- b^2. Longest cirrus segments five or six times as long as broad (Panama to southern California; 590 (?343)–1788 meters) **parvula** (p. 738)

FARIOMETRA SCUTIFERA A. H. Clark

Fariometra scutifera A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 130 (listed; *nomen nudum*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 248 (in key; range), p. 249 (detailed description; sta. 119), p. 273 (listed).

Fariometra scudifera A. H. Clark. Unstalked crinoids of the *Siboga*-Exped., 1918, pl. 24, fig. 93.

**F. obscura* from the Laccadive Islands in 786 meters, probably belongs in this section of the key. Its cirri and pinnules are unknown. It is dealt with on p. 731 (A.M.C.).

Diagnostic features.—The second brachials are shield-shaped and much longer than broad; the pinnules and cirri are unknown.

Description.—The centrodorsal is sharply conical with straight sides, 3.5 mm. in diameter at the base and 3.0 mm. from the apex to the interradial border [or 2.5 mm. in vertical height—A.M.C.]. It is thickly covered with very numerous cirrus sockets [which appear to be arranged in vertical rows at least interradially—A.M.C.].

The cirri are unknown.

The distal borders of the radials are even with the rim of the centrodorsal in the median line, and slightly produced, very much less than in most related species, in the interradial angles. The distal angles of the radials are slightly separated.

The IBr_1 are very short, from eight to ten times as broad as the median length, the proximal border parallel with the curved border of the radials, the distal border on either side of the median line convex, nearly parallel with the concave proximal sides of the axillaries; in direct lateral view (viewed at right angles to the dorsoventral axis) the IBr_1 appear almost or quite bisected by the proximal process of the axillaries. The bases of the IBr_1 are widely free laterally. The IBr_2 (axillaries) are about as broad as long with the distal angle considerably produced; the lateral angles project somewhat beyond the distal angles of the IBr_1 so that narrow elongate water pores are formed. Neither of these two ossicles have ventrolateral processes.

The 10 arms are all broken at the first syzygy, though some pieces remain attached in one syntype. The first brachial is extremely short in the median line, very slightly longer in inner length, but four or five times as long externally; the inner sides of two adjacent first brachials diverge at approximately a right angle. The second brachial is longer than broad, rather sharply convex dorsally, with the proximal sides rather strongly concave so that a relatively long and narrow process incises the first brachial. There is little or no eversion of the distal edges of the brachials, which are almost or quite smooth.

The width of the arm at the first syzygy is 1.6 mm. and the length from the proximal edge of the IBr_1 to the second syzygy at 9+10 is about 10.5 mm. in the syntype in the Amsterdam Museum.

Locality.—*Siboga* station 119; Celebes Sea (lat. 1°33′30″ N., long. 124°41′ E.); 1901 meters [A. H. Clark, 1918] (2, U.S.N.M., E. 438; Amsterdam M.).

FARIOMETRA SOKOTRAE John

Thaumatometra, sp. A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, p. 51 (lat. 14° 20′ N., long. 52° 30′ E.); Crinoids of the Indian Ocean, 1912, p. 247 (same); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 71 (same); Die Crinoïden der Antarktis, 1915, p. 147 (same); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 102 (same), pp. 104, 105.

Thaumatometra sokotrae John, Ann. Mag. Nat. Hist., ser. 10, vol. 20, 1937, p. 169 (description); fig. 3, p. 170; pl. 3, fig. 3.

Diagnostic features.—The centrodorsal is conical, almost as high as it is wide at the base; the cirri are about LX, 21–36, the longest segments about four times as long as their median widths and even the distalmost segments are still slightly longer than wide; the IBr series have more or less straight sides, the IBr_1 not being narrowed distally.

Description.—The centrodorsal is a high cone, nearly as high as it is broad at the base, with almost straight sides. The apex is rounded in the four larger specimens, truncated in the smaller. The ventral edge is produced into strong interradial angles in the larger specimens. The dorsal pole is large and very rough, being thickly covered with tuftlike protuberances. The cirrus sockets are closely set, arranged in slightly irregular columns of from three to five, usually four, sockets. There are three columns to each radial area so that the number of sockets is about sixty.

Cirri about LX, 21–36, up to 20 mm. in length, long and slender. The first segment is short, the second is about as long as broad, and the third is about twice as long as broad and slightly constricted centrally. The fourth to the tenth or so are considerably longer than broad—the earlier may be four times as long as the least width. They are slightly constricted centrally and the distal end of each is expanded so as to form a flare around the base of the next. The outer segments are shorter, but even the most distal are slightly longer than broad. Each is broader distally than proximally, the greater width being on the dorsal side so that the side of the end of the cirrus has a serrated appearance. The shorter distal segments are slightly broader than the elongated proximal segments, so that the end of the cirrus is a little heavier in appearance than the rest. The opposing spine may be weak or moderately strong and may be directed obliquely forward or stand out at right angles to the penultimate segment. The terminal claw is strong.

The radials are visible in the midradial line, though very short. They are produced into high angles, and more clearly seen, laterally. The distal edge is strongly concave. The IBr_1 are from four to six times as broad as long, only slightly incised by the axillaries, and not in contact laterally although their sides are straight or even slightly divergent. The IBr_2 (axillaries) are about as broad as long with the distal edges strongly concave, the proximal only slightly so. The distal edges of the elements of the IBr series may be raised into slight finely thorny ridges.

The arms are broken in all the specimens. The longest remaining, in two of the larger specimens, measure 15 to 17 mm. from the axillaries and consist of 20 brachials. The first brachials are short and somewhat wedge-shaped, much shorter interiorly than exteriorly. They are incised, though not deeply, by the second brachials. The proximal margin of the second brachial is a broadly rounded triangle. The interior edge is very short and the exterior about three times as long, so that the distal edge, which is concave, runs back obliquely. The first syzygial pair (composed of brachials 3+4) is longer interiorly than exteriorly. The four brachials (the fifth to the eighth) between the first and second syzygial pairs alternate in that the interior edge of one and the exterior of the next is the longer. The difference between the interior and exterior lengths is greater in the fifth to seventh than in the eighth brachials. Each is about as broad as its greatest length. In the fifth brachial the proximal interior corner is produced backwards and the distal interior corner strongly produced forward so that the interior edge is much longer than the exterior and the proximal and distal edges are oblique; the latter is slightly concave. On the sixth brachial the proximal exterior corner is strongly produced backwards, the distal exterior corner produced forwards. The proximal interior corner of the seventh brachial is strongly produced backwards. The distal interior corner may be slightly produced forwards. The eighth brachial is less irregular; the proximal exterior corner is slightly produced backwards; the brachial reaches slightly farther forward on the interior than on the exterior side, but the corner is not produced. The edges of these brachials may be slightly raised and produced into fine inconspicuous spines. The brachials beyond the second syzygial pair are of a different shape from the lower. One lateral edge, alternately the interior and the exterior on successive brachials, is much longer than—as much as four times as long as—the other; the proximal and distal edges are strongly oblique, the former slightly concave, the latter faintly convex and armed with small spines. It seems likely, according to Dr. John, that the distal brachials of this species are strongly spinous.

Syzygies occur between brachials 3+4, and usually 9+10 and 14+15. In the few arms that remain unbroken some little way beyond the third syzygy the syzygial pairs in that region are separated by one or two brachials only. The length from the proximal edge of the IBr_1 to the second syzygy is 8.0 mm. and the width at the first syzygy is 1.2 mm. in the larger syntypes.

In none of the specimens are any of the pinnules complete. P_1 is not nearly complete in any of them; it has the first 4 segments short but the fifth is slightly longer than broad. The following are descriptions of the best preserved pinnules of one large specimen. P_a is about 4 mm. long and is composed of 11+ segments. The first segment is short, the second to fifth are as long as broad and a little compressed from side to side, and the sixth to eleventh are more rounded and become progressively longer and more slender. The sixth is nearly, the eleventh a little more than, twice as long as broad. P_2, a genital pinnule, is about 4 mm. long and consists of 9+ segments. In another specimen it consists of 12 segments and appears to be nearly complete. The first segment is broader than long, the second and third are about as long as broad and of an irregular shape having a narrow dorsal edge, and the fourth and fifth are longer than broad. The sixth is more than twice as long as broad and narrower distally than proximally. The remaining segments become progressively more slender and are three or more times as long as broad. The small gonad lies on the fourth to sixth segments. P_b is very like P_2. P_c is about 5 mm. long with 10+ segments. The first and second segments are slightly broader than long, the third is as long as broad, the fourth is nearly, the fifth quite, twice as long as broad, and the sixth is more than twice as long as broad. The seventh to tenth are more slender and three or more times as long as broad. There is a large gonad on the fourth to fifth segments. P_5 of another specimen is 4 mm. long, with 8+ segments, of which the first is broader than long, the second and third are slightly longer than broad, the fourth is twice and the fifth more than twice as long as broad, and the sixth to eighth are three or more times as long as broad.

There are no side- or covering-plates on the one pinnule examined for them.

Remarks.—Dr. John said that this is a small species, represented by five specimens, all with the arms broken, one considerably smaller than the others. He remarked that this species appears to be best placed in *Thaumatometra* although the number of cirrals is greater than in any other species of the genus, in none of which, so far as is known, do they exceed 22, as opposed to up to 30 in this species.

[NOTE BY A.M.C.] As noted under the heading of *Fariometra*, I cannot agree with this inclusion of *sokotrae* in *Thaumatometra*. The discrepancy in number of cirrus segments seems to me to be too great to allow it. The majority of the species of *Thaumatometra* have only about 15 segments in the longest cirri, although the very large *T. tenuis* may have up to 22. As for the proportions of the cirrus segments, most of the species of *Fariometra* have the outer segments slightly longer than broad also. However, the longest segments are relatively longer in *sokotrae* than in any species of *Fariometra* except *F. parvula*, which is also marked off geographically from the rest of the genus. Although the total number of cirrus segments is greater in *sokotrae* than in the species of *Fariometra*, the difference is less than that between *sokotrae* and the species of *Thaumatometra*. There seem to me to be no characters of much significance distinguishing between the two genera other than those furnished by the cirri.

Locality.—Northwest of Sokotra, Arabian Sea (lat. 14°20′ N., long. 52°30′ E.); 2194 meters; cable repair ship *Electra;* July 10, 1909 [A. H. Clark, 1911, 1912, 1913, 1915, 1937; John, 1937] (5, B.M.).

History.—During a visit to the British Museum in 1910 I examined the five specimens upon which this species is based, but did not have time to draw up a description of them. I mentioned them as *Thaumatometra*, sp. in several papers, including the report of the John Murray Expedition in 1937, which prompted Dr. Dilwyn John to describe and name the species later in the same year.

FARIOMETRA EXPLICATA (A. H. Clark)

[See vol. 1, pt. 1, fig. 224, p. 243]

Trichometra explicata A. H. Clark, Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 232 (description; *Albatross* sta. 5123); Proc. U.S. Nat. Mus., vol. 39, 1911, p. 563 (*Albatross* sta. 5349); Crinoids of the Indian Ocean, 1912, p. 239 (synonymy; Philippine Is., 283–730 fms.).

Fariometra explicata A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 249 (in key; range), p. 250 (synonymy; *Albatross* stas. 5123, 5115, 5349).

Diagnostic features.—The ossicles of the division series and the first two brachials are in close lateral contact throughout and sharply and broadly flattened laterally; the cirri have up to 28 segments.

Description.—The centrodorsal is conical, in lateral view an equilateral triangle with slightly convex sides.

The peripheral cirri are composed of 25 to 28 segments, of which the longest are from 2 to 3 times as long as the diameter of the much expanded, produced, and overlapping distal ends [presumably about 4 times the median diameter—A.M.C.], and the last 7 to 10 are about as long as broad.

The distal borders of the radials are even with the rim of the centrodorsal. The IBr_1 are short, in lateral contact with their neighbors, and much incised in the median line. The IBr_2 (axillaries) are rhombic, and nearly as long as broad.

The ossicles of the IBr series and the first two brachials are in lateral apposition and laterally flattened. The synarthrial tubercles are slightly developed. The ossicles of the IBr series and the lower brachials have abruptly everted and finely spinous distal edges; after the second syzygy this eversion of the distal edge of the brachials gradually becomes more and more recumbent, taking the form of an overlapping of the distal edges of the brachials which gradually dies away, disappearing after about the twentieth brachial. The spinous eversion of the distal borders of the earlier brachials is somewhat broader than in *Trichometra cubensis*, and does not stand out so high.

The 10 arms are about 50 mm. long. The first brachial is about twice as broad as long exteriorly, those of each arm pair being inwardly united at the base. The second brachials are much larger, irregularly quadrate. The first syzygial pair (third and fourth brachials) and the following brachials are wedge-shaped, about as long as broad, after the tenth becoming very obliquely wedge-shaped and considerably longer than broad, the length gradually increasing distally.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is 10 mm. long with 20 segments, resembling the same pinnule in *Trichometra cubensis* but proportionately stouter. P_2 is 7 mm. long with 16 segments, more slender than P_1; the first three segments are about as long as broad, and the following gradually increase in length. P_3 is 7 mm. long with about 20 segments, rather stouter than P_2; the first three segments are about as long as broad. P_4 is 7 mm. long and carries a small gonad. The following pinnules are similar, but have larger gonads. The distal portion of the arms is lacking in all the specimens.

Localities.—Albatross station 5349; Palawan Passage, Philippine Islands; Point Tabonan bearing N. 85° E., 45.2 miles distant (lat. 10°54′00″ N., long. 118°26′20″ E.); 1334 meters; temperature 4.78° C.; December 27, 1908 [A. H. Clark, 1911, 1918] (1, U.S.N.M., 36043).

Albatross station 5123; eastern coast of Mindoro, Philippine Islands; Malabrigo Light bearing N. 44° W., 32.5 miles distant (lat. 13°12′45″ N., long. 121°38′45″ E.); 517 meters; green mud; February 2, 1908 [A. H. Clark, 1908, 1918] (1, U.S.N.M., 25452). Type locality.

Albatross station 5115; Verde Island Passage, Philippines; Sombrero Island bearing N. 49° E., 7.3 miles distant (lat. 13°37′11″ N., long. 120°43′40″ E.); 621 meters; density 1.02454; January 20, 1908 [A. H. Clark, 1918] (1, U.S.N.M., 36014).

Geographical range.—Northern Philippine Islands.

Bathymetrical range.—From 517 to 1334 meters.

Thermal range.—One record, 4.78° C.

FARIOMETRA IO (A. H. Clark)

FIGURE 45

Antedon alternata (part) P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 179 (specimen from sta. 218), pl. 32, fig. 6; similarly included in *alternata* by following authors.

Thaumatometra alternata (part) A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 265 (additional element in a IBr series in the *Challenger* specimen compared to the same in a Japanese specimen of *Poecilometra acoela* [*scalaris*]); Crinoids of the Indian Ocean, 1912, p. 246 (New Guinea).

Trichometra delicata (not *T. delicata* A. H. Clark, 1911) A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 146 (description; *Siboga* sta. 211; includes *Antedon alternata* P. H. Carpenter, 1888, in part); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 252 (=*Nepiometra io*).

Trichometra ?delicata A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 64 (published reference to the specimen in the B.M.; *Challenger* sta. 218).

Nepiometra io A. H. CLARK, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 251 (in key; range), p. 252 (synonymy; detailed description; sta. 211), p. 274 (listed), pl. 26, fig. 97; Ann. Mag. Nat. Hist., ser. 10, vol. 10, No. 58, 1932, p. 388 (compared with *N. nicippe* sp. nov.).

Diagnostic features.—In the two known specimens the arms are only 30 mm. long; the cirri are about XL, 20–22, with the longest segments about twice as long as the width of the expanded distal ends [or nearly three times the median diameter—A.M.C.]; the sides of the division series are more or less parallel but rugous, the IBr_1 having the sides slightly divergent, not narrowed at the distal end.

Description [modified by A.M.C.].—The centrodorsal is rounded conical, 1.4 mm. in basal diameter and 1.1 mm. in vertical height. There are nearly forty well-defined cirrus sockets arranged in shallow diagonal rows, though some tendency to alignment in vertical columns is evident on the peripheral half of the centrodorsal. The apex is covered with a number of thorny-tipped papillae.

The cirri are about XL. No complete peripheral ones remain but the longest of those in the next row has 22 segments. Most of the segments have very flared distal and to a lesser extent proximal ends. The second one is already longer than its median width and the fourth and fifth, which are the longest, are three times as long as their median widths or twice the width of their distal ends. The last 5 or 6 segments before the terminal claw are little, if at all, longer than wide. These last segments are much less flared and develop a slightly carinate dorsal spine.

The radials are very short in the median line, but extend well up in the angles of the calyx so that the bases of the IBr_1 are not in apposition.

The IBr_1 are very short, about five times as broad as long in the median line, slightly longer laterally than centrally; the lateral borders are parallel; the distal edges, except in the median line, are everted and finely spinous; the proximal border is slightly everted; there is a tuft of spines on each of the distal angles. The IBr_2 (axillaries) are almost triangular with only a moderate proximal angle and slightly broader than long; the distal edges are slightly everted and very finely spinous; the lateral angles are covered with spines; the IBr series and lower brachials are in lateral contact except for small "+" shaped water pores between adjacent articulations.

FIGURE 45.—*Fariometra io* (A. H. Clark), holotype.

The 10 arms are about 30 mm. long; the brachials have only very slightly produced and very finely spinous distal ends. Syzygies occur at brachials 3+4 and 9+10 and the distal intersyzygial interval is two muscular articulations. The width at the first syzygy is 0.9 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 5.5 to 6.0 mm.

No complete P_1 is present. P_2 has 9+ segments, probably about 12. The longest segments are up to four times as long as broad. P_b or P_3 is the first genital pinnule.

Abnormal specimen.—The single individual from *Challenger* station 218 is peculiar in having an additional ossicle in one of the IBr series inserted between the two normal elements. This ossicle is about half as high as the IBr_1, and appears to be connected with the IBr_1 by a straight muscular articulation and with the IBr_2 by synarthry.

Notes [by A.M.C.].—The *Challenger* specimen has the centrodorsal low, rounded conical; 1.5 mm. in basal diameter and 1.0 mm. in height. The cirrus sockets are arranged in 15 almost perfectly regular vertical columns of usually 3 sockets in each so that the total number is XL–XLV. No cirri remain. The figure in the *Challenger* Report, pl. 32, fig. 6, does not bring out the columnar arrangement of the cirrus sockets.

As in the *Siboga* specimen the rugous patches on the sides of the division series and proximal brachials are very conspicuous and the water pores are again notably "+"-shaped. The width at the first syzygy is 1.0 mm. and the length from IBr_1 to Br_9 is 7.0 mm.

The longest remaining P_1 has 11 segments and measures 4 mm. When complete it probably had about 15 segments and was at least 1 mm. longer.

P_2 has 10 segments and is 3.5 mm. long. The segments are about four times as long as wide after the first two, whereas in P_1 even the eleventh segment is still relatively shorter than this and the more proximal ones are mostly less than twice as long as wide.

P_3 has 7+ segments, probably about 10 and bears a gonad.

P_5 has 9 segments and measures 3.8 mm. in length. All the segments are very elongated.

Localities.—*Siboga* station 211; east of Saleyer (south of Celebes) (lat. 5°40′42″ S., long. 120°45′30″ E.); 1158 meters; coarse gray mud, with the superficial layer more fluid and brown; September 25, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.). Type locality.

Challenger station 218; north of New Guinea (lat. 2°33′ S., long. 144°04′ E.); 1956 meters; temperature 2.44° C.; blue mud; March 1, 1875 [P. H. Carpenter, 1888; A. H. Clark, 1913, 1918] (1, B.M.).

Remarks.—P. H. Carpenter's figure of the specimen of "*Antedon alternata*" dredged at *Challenger* station 218 shows that it belongs to a species of *Fariometra*, and it seems to agree in its characters with *F. io*.

In 1912 I described a new species which I called *Trichometra delicata*, based upon a single specimen which had been dredged by the *Siboga* at station 211, overlooking the fact that in the year preceding I had described under the same name a very different species which had been taken by the *Travailleur* in the Atlantic.

In 1918 the new species from the *Siboga* collection was redescribed and figured under the name of *Nepiometra io*.

FARIOMETRA OBSCURA (A. H. Clark)

[See vol. 1, pt. 1, fig. 222, p. 243]

Trichometra obscura A. H. Clark, Proc. Biol. Soc. Washington, vol. 22, 1909, p. 149 (description; 7°17′30″ N., 76°54′ E., 430 fms.); Crinoids of the Indian Ocean, 1912, p. 240 (synonymy; detailed description; locality), fig. 45, p. 240.

Nepiometra obscura A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 245 (in key; range; references).

Diagnostic features.—The single known specimen is of large size, with the centrodorsal measuring 3.5 mm. in basal diameter by 3 mm. in height; there are conspicuous water pores between the division series, the IBr_1 having convergent lateral edges. The cirri and pinnules are unknown.

Description.—The centrodorsal is conical, with the sides slightly convex, 3.5 mm. broad at the base and 3.0 mm. high.

The cirri are lacking.

The distal edges of the radials are even with the rim of the centrodorsal. The IBr_1 are very short and bandlike, not quite in contact basally, with the lateral edges converging rather sharply. The IBr_2 (axillaries) are slightly broader than long, with the anterior and lateral angles rather strongly produced and with a rounded posterior process incising the IBr_1.

The 10 arms are all broken off at the base; the longest stump measures 9 mm. to the tenth brachial.

The pinnules a e all broken.

Locality.—*Investigator* station 232; Laccadive Sea, southwest of Cape Comorin, India (lat. 7°17′30″ N., long. 76°54′30″ E.); 786 meters; temperature 3.3° C.; gray mud; August 19, 1897 [A. H. Clark, 1909, 1912] (1, I.M.).

Remarks.—The only known specimen of this species is so fragmentary that perhaps it should never have been described. It was dredged by the *Investigator* in 1897 and described in 1909, and again, in more detail and with a figure, in 1912.

FARIOMETRA SEWELLI A. H. Clark

FIGURE 46

Fariometra sewelli A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 87 (listed), pp. 96, 97 (sta. 143; description; remarks), p. 102 (listed), p. 103, pl. 1, fig. 5.

Diagnostic features.—The centrodorsal is large, conical, twice as broad at the base as it is high; the cirri number about LV, with about 26 segments, of which the longest are nearly three times as long as their proximal breadths and the last four or five about as long as wide or shorter; the division series are modified to leave conspicuous water pores between them; P_1 has about 23 segments, of which the first 5 are not longer than broad; P_2 has about 15 segments, is about two-thirds the length of P_1, and is a genital pinnule in the unique type specimen.

Description.—The centrodorsal is conical with straight sides and a quite sharply rounded papillose apex. It is 3.5 mm. in basal diameter and about 1.7 mm. high. The cirrus sockets number about 55; they are rather small and well-spaced, and tend to occur in vertical rows. There are about 4 sockets under each radial.

A single detached cirrus which presumably belongs to this specimen was found wedged between the arms. It has 26 segments and measures 13 mm. in length. The first segment is very short, the second not quite as long as wide, the third is three-quarters again as long as wide. The fifth and sixth are the longest and are just under three times as long as broad at their proximal ends and the following segments become progressively shorter so that the fifth one from the tip is only as long as broad and the penultimate is a little shorter. In shape, all the segments are somewhat expanded at their distal ends, particularly on the dorsal side of the distal segments. The antepenultimate segment has a small tubercle on the middle of the dorsal side. The opposing spine on the penultimate segment has a double apex; it is very well developed. The terminal claw is strong and curved.

The radials are even with the rim of the centrodorsal in the midradial line, but extend well up in the interradial angles, where their distal angles are separated by a notch. One radial is malformed, divided into three swollen parts, as indicated on the right in fig. 46,*a*. The IBr_1 are very short, about eight times as broad as the median length with the distal edge slightly concave in the middle, rather strongly everted and armed with fine spines laterally. The lateral borders are somewhat convergent and slightly convex and are widely separated from those of their neighbors. The IBr_2 (axillaries) are rhombic, with the two proximal sides slightly and the two distal sides strongly concave; they are about half again as broad as long; the distal angle is produced and narrow. The lateral angles of adjacent IBr_2 meet over the broad gap between the lateral borders of the IBr_1, forming a conspicuous pore. The distal edges and the outer portions of the proximal edge are everted and finely spinous.

The 10 arms are about 50 mm. long. From the proximal side of the IBr_1 to the second syzygy (9+10) is 9 to 9.5 mm. and the width at the first syzygy (3+4) is 1.5 mm. The first brachials are short, nearly or quite three times as broad as the outer (greater) length. The proximal and distal borders are parallel from the inner side to the midradial line and then the latter diverge. The distal border, except in the middle, is everted and finely spinous. The inner edges of adjacent first brachials are united in their proximal halves while their distal halves diverge forming a right angle. The second brachials, which are slightly broader than long, approximate inwardly in a manner comparable to the axillaries forming another pore with the first brachials like that between the division series in each interradius. The brachials following the first syzygy are at first wedge-shaped and then become triangular and longer than broad. The distal edges of the brachials, though scarcely produced, are finely spinous, and those of the proximal ones are somewhat thickened.

Syzygies occur distally at intervals of about two muscular articulations.

P_1 is 10 mm. long with 22 to 23 segments, of which the first is rhombic, about twice as broad as long. The next four are similar but increase in length with the edge toward

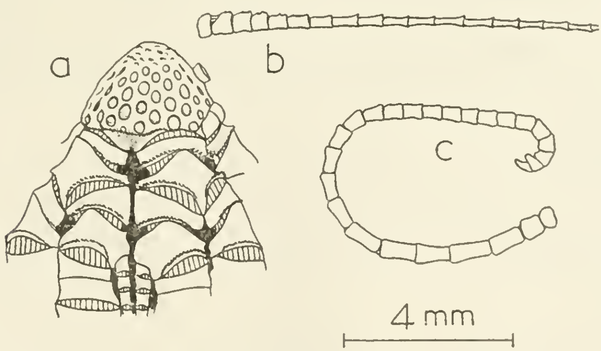

FIGURE 46.—*Fariometra sewelli* A. H. Clark, holotype: *a*, Lateral view of calyx, *b*, P_1, lacking the tip; *c*, cirrus.

the arm tip produced into a high triangular process. The sixth segment is slightly longer than broad, without a carinate process. The segments following gradually increase in length so that the outer are greatly elongated, about six times as long as their expanded ends. The pinnule is long and very slender, becoming filiform distally. The distal ends of the segments are produced and finely spinous.

P_a is longer, probably about 13 mm. long and with 25 segments; the 21 segments, which are the most that remain, measure 12 mm. The segments are relatively more attenuate than those of P_1.

P_2 is slightly stouter than P_1, 7 mm. long and with 14 segments, of which the first is rhombic, twice as broad as long, after which the length increases so that the fourth is slightly longer than broad and the fifth is half again as long as broad. The segments following are more slender and attenuate. The third and following segments have everted and finely spinous distal ends. A large fusiform gonad occupies the entire inner border of the sixth to eighth segments.

Locality.—John Murray Expedition station 143; Maldive area (from lat. 5°15′48″ N., long. 73°22′48″ E. to 5°13′42″ N., 73°23′36″ E.); 797 meters; at 770 meters, temperature 7.88° C.; bottom, sand [A. H. Clark, 1937] (1, B.M.).

Remarks [by A.M.C.].—Mr. Clark compared this species with *Fariometra dione* from the Moluccas, but when fitting it into the key I found that it has more in common with *F. obscura* from off the adjacent Laccadives, only the lower centrodorsal serving as a slight distinction as far as is known, since the cirri and pinnules of the single specimen of *obscura* were lost.

FARIOMETRA DIONE A. H. Clark

Fariometra dione A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 249 (in key; range), p. 250 (detailed description; sta. 85), p. 272 (listed), pl. 26, fig. 85; John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 97 (comparison with *F. sewelli*).

Diagnostic features.—The centrodorsal is conical, in the type it is 2.2 mm. high by 2.6 mm. basal diameter; the cirri are XLV–C, with up to 21 segments, at least when the smaller number is present; the longest segments are up to three times as long as their median widths; the sides of the IBr_1 converge distally and the lateral angles of the axillaries are produced beyond them defining a water pore in each interradius; the two first brachials of each pair of arms are not in contact inwardly; P_1 has about 16 segments, of which the first three are broader than long; P_2 and P_3 are stouter than P_1 but similar to it in length.

Description.—The centrodorsal is conical, the sides practically straight, just curving in at the base; in the type it is 2.6 mm. in basal diameter, 2.6 mm. from the apex to the interradial border and 2.2 mm. in vertical height. The type also has about 100 cirrus sockets almost completely covering the centrodorsal [arranged in fairly distinct vertical rows—A.M.C.]; all the cirri are lost. In another specimen the cirri are given as XLV–L, 17–21, and up to 15 mm. long. In the long peripheral cirri the first segment is very short, the second is twice as broad as long, the third is slightly longer than broad, the fourth is twice as long as its median width or even longer, and those following are between two and a half and three times as long as broad. After the eighth the length decreases, so that the terminal four or five are only very slightly, if at all, longer than broad. The segments from about the twelfth onward have the dorsal surface sharply carinate and the distal dorsal edge slightly produced, overlapping the base of the succeeding segment, but this production is not everted, so that the profile of the cirrus is not serrate. The opposing spine is small, arising from the entire dorsal surface of the penultimate segment, with the apex terminal. The terminal claw is slightly longer than the penultimate segment, moderately stout and moderately and evenly curved. The apical cirri of the same specimen are exceedingly small and weak, from 2 to 3 mm. long, with 8 to 10 segments.

The radials are just visible beyond the rim of the centrodorsal in the median line, but extend well out into the angles of the calyx; their distal angles are slightly separated.

The IBr_1 are very convex in dorsal profile; they are about five to six times as broad as long; the distal angles are broadly rounded off and finely spinous. The lateral edges converge distally. The rhombic IBr_2 (axillaries) are about as broad as long with concave sides and the proximal angle broadly rounded. The lateral angles project sideways so as nearly to meet the adjacent axillaries. This formation of the division series produces a conspicuous water pore between them in each interradius.

The 10 arms are broken off near the base in the type specimen; the first brachial is very short, the inner two-thirds very narrow and bandlike, the outer third rapidly decreasing in length so that the outer border is from three to four times as long as the inner, or the median length; interiorly the bases of two adjacent first brachials are not in apposition, and their inner edges diverge at rather more than a right angle. The second brachial is irregularly quadrate, somewhat broader than long; the inner angles of the two in each post-radial series are just in contact and, together with the widely diverging inner edges of the first brachials, form large rhombic water pores similar to those between the division series; the first syzygial pair is a little longer inwardly than outwardly. The distal edges of the brachials are only slightly everted and finely spinous.

The width of the arm at the first syzygy is 1.4 mm. and the length from the proximal edge of the IBr_1 to the second syzygy is 9.0 mm. in the type specimen.

P_1 in the type has the first three segments broader than long, the fourth and fifth slightly longer than broad and the remainder elongated, very much so distally. All are incomplete. In the other specimen, P_1 has 15 to 16 segments, 6.5 mm. long, with the first four or five segments not longer than broad, the rest rapidly increasing in length so that the sixth is about twice as long as broad and those in the outer half of the pinnule greatly elongated. The second and following segments have everted and finely spinous distal ends. P_2 in this specimen is about the same length as P_1, but is considerably broader at the base and tapers less rapidly so that it is markedly stouter. In the type, P_2 has about 15 segments and measures 7 mm. In the other specimen, P_3 is 6.5 mm. long with 13 segments, resembling P_2 but stouter basally. Both these pinnules have the outer segments greatly elongated and excessively slender.

[NOTE BY A.M.C.] The above description was compounded from that of the type and a manuscript description made by Mr. Clark from a specimen collected by the Danish Expedition to the Kei Islands at station 56, with a few additional notes on the type by me.

Localities.—Siboga station 85; Makassar Strait (lat. 0°36′30″ S., long. 119°29′30″ E.); 724 meters [A. H. Clark, 1918] (1, Amsterdam M.). Type locality.

Danish Expedition to the Kei Islands station 3; 245 meters; sand; March 3, 1922 (C.M.).

Danish Expedition to the Kei Islands station 56; 345 meters; May 10, 1922 (C.M.).

Geographical range.—Known from east of Celebes and from the Kei Islands.

Bathymetrical range.—From 245 to 724 meters.

FARIOMETRA ALCYON (A. H. Clark)

Thaumatometra alcyon A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 148 (description; *Siboga* sta. 251).

Nepiometra alcyon A. H. Clark, Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 251 (in key; range; detailed description; sta. 251), p. 274 (listed), pl. 26, fig. 86.

Diagnostic features.—The sides of the IBr_1 converge so that the lateral angles of the axillaries extend for some distance beyond the anterolateral angles of the IBr_1; the centrodorsal is half again as broad at the base as high, the peripheral cirri have about 28 segments, of which the longest are about three times as long as broad; P_2 is larger than P_1 though with fewer segments; P_1 has the first four segments about as long as broad.

Description.—The centrodorsal is conical with the sides slightly rounded, half again as broad at the base as high and almost entirely covered with closely crowded cirrus sockets arranged in alternating rows.

The cirri are L–LX, 27–28 (usually 28), 18 mm. long. The longest segments are about three times as long as the median diameter, or about twice as long as the lateral diameter of the somewhat expanded distal ends; the terminal six or seven segments are slightly longer than broad. The short outer segments are laterally compressed, though not carinate dorsally. The median portion of the distal border on the dorsal side is produced distally into a broad rounded overlapping process with a serrate border.

The edges of the radials are just visible beyond the rim of the centrodorsal; their distal angles are slightly separated.

The IBr_1 are extremely short and bandlike, four times as broad as the lateral length, which is nearly or quite twice as great as the median length; the sides are distinctly convergent. The IBr_2 (axillaries) are rhombic, about as broad as long, with all the sides deeply concave; their lateral angles project a considerable distance beyond the distal angles of the narrow IBr_1.

The 10 arms were probably about 60 mm. long. The first brachial is very short, the two on each post-radial series basally not quite in apposition internally, while their inner edges diverge in almost a straight line. As a whole the division series and arms resemble those of *Thaumatometra tenuis*. All the brachials have slightly everted and finely spinous distal edges.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of about two muscular articulations.

P_1 is weak and slender, from 7 to 9 mm. long, with 19 to 23 segments, of which the first four are about as long as broad and the following slowly increase in length so that the outer are twice as long as broad or somewhat longer, with moderately produced and spinous distal ends, and the terminal are slender and much elongated. P_2 is about 10 mm. long, with 16 segments, of which the first two are about as long as broad, the third and fourth are twice as long as the median diameter, and the following are greatly elongated. The pinnule is considerably stouter than P_1, and may bear a fusiform gonad on the fifth to eighth segments. The distal pinnules are 10 mm. long with about 15 segments, which have much-expanded proximal and overlapping and finely spinous distal ends.

Locality.—*Siboga* station 251; southeast of Ceram (lat. 5°28′24″ S., long. 132°-00′12″ E.); 204 meters; hard coral sand; December 8, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.).

FARIOMETRA NICIPPE (A. H. Clark)

Nepiometra nicippe A. H. CLARK, Ann. Mag. Nat. Hist., ser. 10, vol. 10, No. 58, 1932, p. 378 (listed), p. 386 (south of Lombok; 600 fms.; description; comparison); Proc. Biol. Soc. Washington, vol. 47, 1934, p. 10.

Diagnostic features.—The cirri have 19 to 21 segments, of which the longest are two to three times as long as their median widths; both the division series and the first two brachials of each pair of arms are modified to form water pores between those of adjacent series; the centrodorsal is low conical, about two-thirds as high as wide at the base; P_1 and P_2 both have about 20 segments and are similar in length, though P_2 is stouter and bears a gonad; the two first brachials of each pair of arms are in close contact.

Description.—The centrodorsal is largely concealed by the bases of the numerous cirri. It is probably about 2.5 mm. wide at the base and over 1.5 mm. high. The cirrus sockets are arranged in three and a partial fourth closely crowded rows. The dorsal pole is finely papillose.

The cirri are about L, 19–21, up to 13 mm. in length. The second segment is about as long as its maximum diameter at the distal end and the fifth to about the eighth or ninth are twice as long as the maximum width, or longer. The following segments decrease in length so that the outermost ones are only about a third as long again as broad. In dorsal view each segment appears to be expanded at the proximal as well as the distal end, but in side view only a distal expansion is evident, the longer segments having quite flared, overlapping, and finely spinous distal ends.

The distal edges of the radials, which are rather strongly concave, are even with the rim of the centrodorsal. The IBr_1 are very short and bandlike, seven or eight times as broad as long. The proximal and distal edges are slightly and narrowly thickened and the lateral edges are somewhat produced, broadly rounded, and in contact basally. The IBr_2 (axillaries) are triangular, nearly twice as broad as long, with the distal sides slightly concave and the middle of the proximal border broadly convex. Their lateral angles are nearly in contact so delimiting a small but distinct water pore between them and the two preceding IBr_1.

The 10 arms were about 50 mm. long. From the edge of the radial to the second syzygy (9+10) is 7 mm. and to the third syzygy (14+15) is 10 mm. The first brachials are short, wedge-shaped, and about three times as long exteriorly as interiorly. Their inner sides are in close contact and their outer sides are covered with densely packed excessively fine spinules. The proximal and distal edges are slightly everted and are covered with excessively fine spinules. The second brachials are larger than the first, irregularly quadrate and wider than long. There is a rather conspicuous water pore beneath the apposed inner angles of the second brachials of each pair of arms. The first syzygial pair (3+4) is longer interiorly than exteriorly, and is half again as broad as long in the median line. The next four brachials are oblong, but with their borders curved broadly outward to the ends of the fulcral ridges, and are about twice as broad as the median length. After the second syzygy the brachials are triangular, about as long as broad, later becoming very obliquely wedge-shaped and slowly increasing in length, at the same time becoming somewhat constricted centrally. The brachials have the distal edge armed with excessively fine spines. Distally syzygies occur at intervals of two or three muscular articulations.

P_1 is 7 mm. long, with 21 segments, of which the first three are about as long as broad and those following rapidly become elongated, being about four times as long as broad in the outer half of the pinnule, or even longer distally. The first segment bears a transverse band of spinules just before the middle. The second to fifth segments are studded with spinules and bear a coarsely spinous crest which is highest on the third segment. As the segments elongate, their surface becomes gradually more finely spinous, and they develop abruptly and widely flaring and overlapping distal ends. The pinnule is slender and tapers evenly from the base to a very delicate and hairlike tip.

P_2 is about 7 mm. long, with 20 segments, resembling P_1 but somewhat stouter basally. It bears a long fusiform gonad on the fourth to eighth segments.

P_3 is about 5 mm. long, with a few more than 11 segments, very slightly stouter than P_2 but otherwise resembling it. It bears a long fusiform gonad.

Locality.—South of Lombok, Lesser Sunda Islands (lat. 8°59′54″ S., long. 115°-50′48″ E.); 1097 meters; C.S. *Cable* [A. H. Clark, 1932] (1, B.M.).

Remarks [by A.M.C.].—I have removed this species from *Nepiometra* to *Fariometra* in the absence of any indication from Mr. Clark since he believed it to be closely related to *Fariometra io*, which he himself transferred. It seems to me to be closely allied to *F. alcyon* from the neighboring Banda Sea, the longer cirri of *alcyon* with more numerous segments serving to distinguish them.

FARIOMETRA PARVULA (Hartlaub)

Antedon parvula Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 144 (description; *Albatross* sta. 3363), pl. 3, fig. 21.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, pp. 1579, 1580.

Antedon, sp. Hartlaub, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 147, pl. 4, fig. 27 (*Albatross* sta. 3354).

Thaumatometra parvula A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Crinoids of the Indian Ocean, 1912, p. 247 (synonymy; Panama, 978 fms.).

Nepiometra parvula A. H. Clark, Journ. Washington Acad. Sci., vol. 7, No. 5, 1917, p. 130 (listed); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 251 (in key; range), p. 253 (references).

Trichometra europacifica H. L. Clark, Bull. American Mus. Nat. Hist., vol. 48, Art. 6, Oct. 5, 1923, p. 148 (*Albatross* sta. 5692).

Diagnostic features.—*Fariometra parvula* is the only species of the genus known from the eastern Pacific. It seems to be closely related to *F. alcyon*, from which it differs in having the centrodorsal an equilateral triangle in lateral view, and in having the longest cirrus segments about 6 instead of 3 times as long as the median width. From *F. dione* it differs in having the basal segments of P_1 about as long as broad instead of broader than long. From *F. explicata* and *F. io* it differs in having the IBr series and lower brachials not in lateral contact. From *F. scutifera* it differs in its much shorter second brachials. The centrodorsal is smaller than that of *F. obscura* with less swollen sides.

At three of the four known localities *F. parvula* was found associated with *Florometra serratissima*. From the young of that species, which it much resembles in form and color, it is easily distinguished by the conical centrodorsal, by the distal intersyzygial interval of only 2 muscular articulations, and by the much elongated distal segments of the oral pinnules, which are very slender and almost hairlike.

Description.—The centrodorsal is conical, in lateral view approximately an equilateral triangle; the dorsal pole is thickly set with somewhat elongated papillae. The cirrus sockets are uniformly distributed over the surface, not crowded, somewhat irregularly arranged, neither in definite columns nor rows.

The cirri are about LX, 28–29 (usually the latter), 25 mm. long, and rather slender. The first segment is twice as broad as long, the second is slightly longer than broad, the third is about 4 times as long as the median width, and the fifth and sixth are the longest, nearly or quite 6 times as long as the median width. The following segments slowly decrease in length so that the last 10 to 15 are only slightly longer than broad. The elongate proximal segments have somewhat, but not conspicuously, expanded ends; as the segments become shorter, the distal dorsal edge becomes prominent, in distal view rising to an apex. On the short distal segments the dorsal profile gradually rises from the proximal to the distal end, which projects considerably beyond the base of the segment succeeding so that in lateral view the dorsal profile is strongly serrate; but the segments are not carinate dorsally. The opposing spine is long, prominent, and erect, rising to a height about equal to the terminal width of the penultimate segment. The terminal claw is stout basally, becoming more slender and more strongly curved in the distal third.

The distal edges of the radials extend slightly beyond the rim of the centrodorsal; the sides of the articular faces are well separated interradially so that the bases of the IBr_1 are separated from each other by a distance about equal to their median length.

The IBr_1 are short, 5 or 6 times as broad as long, with the lateral borders convergent and slightly convex and the distal border nearly or quite straight, everted, and armed with coarse denticulations or spines. The IBr_2 (axillaries) are rhombic, about as long as broad, with the anterior angle produced, the lateral angles extending well beyond the anterolateral angles of the IBr_1, and the two distal edges slightly everted and finely spinous.

The 10 arms are slender, 85 mm. long. The first brachials are about twice as long exteriorly as interiorly, the inner edges, which make an angle of about 120° with those of the other first brachial of the same arm pair, are not quite in contact basally; the distal edge is everted and finely spinous. The second brachials are much larger and irregularly quadrate, with the distal edges everted and finely spinous. The first syzygial pairs (composed of brachials 3+4) are slightly longer than the median width, rather strongly constricted centrally with both the proximal and distal edges, especially the latter, everted and finely spinous. The next 5 or 6 brachials are wedge-shaped, somewhat broader than long, constricted centrally, with the distal ends strongly everted and spinous and the proximal ends more finely spinous. The following brachials become much more obliquely wedge-shaped, longer than broad, with serrate or finely spinous distal ends, the length of the brachials slowly increasing and the obliquity of their ends slowly decreasing distally so that terminally the brachials are more than twice as long as broad with only very slightly oblique distal ends.

Syzygies occur between brachials 3+4, 9+10, 14+15, 18+19, and thence at intervals of 2 muscular articulations.

P_1 is very slender, but stiffened, about 9 mm. long with 20 to 22 segments, of which the first 3 are about as long as broad, the fourth is half again as long as broad, and the seventh and following are greatly elongated, becoming 5 or 6 times as long as broad distally; the distal ends of the segments are expanded and finely spinous.

P_2 is 11 mm. long, with 22 segments, exactly resembling P_1 but proportionately stouter.

P_3 is 8.5 mm. long, with 16 segments, tapering less rapidly than P_2 and hence appearing less slender; the third segment is about twice as long as broad and those beyond the fifth are greatly elongated. As in the preceding pinnules all the segments have spinous distal ends.

P_4 is about 7 mm. long, with 14 segments, resembling P_3. P_5 is similar, with a fusiform gonad on the fifth to sixth segments. P_6 is similar, with the gonad on the fifth to seventh segments. The distal pinnules are long and very slender, 13 mm. long, with 20 segments, most of which are greatly elongated.

The color in life is bright yellow.

Description of the type specimen.—Hartlaub's description of the single specimen which he examined is as follows:

The centrodorsal is approximately conical with slightly convex sides.

The cirri are XX–XXX, about 20, from 5 to 6 mm. long. The third to fifth segments are greatly elongated, and constricted centrally; those following rapidly become shorter. The distal border of all the cirrus segments is produced, and the dorsal profile of the cirri is strongly serrate. The distal ends of the cirri are somewhat compressed.

The radials are somewhat shorter than the IBr_1, laterally free, with slightly concave distal borders. The IBr_1 are short, free laterally, and not incised. The IBr_2 (axillaries) are rhombic.

The 10 arms are apparently about 30 mm. long. The first brachials are short, discoidal, not in contact. The second brachials are almost twice as long, and of variable shape, sometimes more triangular, sometimes more quadrate. The first syzygial pair (third and fourth brachials) is longer than the second brachial; each of its two elements is as long as the first brachial. The 4 following brachials are almost oblong. The second syzygial pair (ninth and tenth brachials) is longer than the preceding segments. The following brachials are trapezoidal.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of 2 muscular articulations.

P_1 is very slender; the segments in the middle and toward the end are fairly strongly elongated and have produced and finely spinous distal borders. No P_1 is preserved entire, but one retains as many as 15 segments. P_2 is 6 mm. long, with about 15 segments, of which the majority are strongly elongated. P_3 is shorter and is composed of about 10 much elongated segments. P_4 appears to be the shortest. The segments of all the following pinnules are much elongated.

Localities.—*Albatross* station 3363; near the Cocos Islands, off Panama (lat. 5°43′00″ N., long. 85°50′00″ W.); 1788 meters; temperature 3.05° C.; white globigerina ooze; February 26, 1891 [Hartlaub, 1895]. Type locality.

Albatross station 3354; off Mariato Point, Panama (lat. 7°09′45″ N., long. 80°50′ 00″ W.); 589 meters; temperature 7.78° C.; green mud; February 23, 1891 [Hartlaub, 1895].

Albatross station 5692; southwest of San Diego, California (lat. 31°23′45″ N., long. 118°31′30″ W.); 1967 meters; temperature 2.83° C.; density 1.02534; gray mud; April 25, 1911 [H. L. Clark, 1923] (1, U.S.N.M., E. 1121).

Albatross station 4363; off San Diego, California; Point Loma Light House bearing N. 81° E., 11.1 miles distant; 378–636 meters; temperature 6.00° C.; green mud and fine sand; March 15, 1904 (2, U.S.N.M., 35844).

Albatross station 4341; off San Diego; south point of South Coronado Island bearing N. 79° E., 3.3 miles distant; 343–590 meters; temperature 7.78° C.; gray sand with black specks; March 11, 1904 (1, U.S.N.M., 35845).

Albatross station 4383; off San Diego; north point of North Coronado Island bearing S. 79° E., 2.3 miles distant; 525–722 meters; temperature 5.28° C.; green mud; March 18, 1904 (1, U.S.N.M., 35846).

Geographical range.—Southwestern coast of North America, from Panama northward to San Diego, California.

Bathymetrical range.—From 589 (?343) to 1967 meters.

Thermal range.—From 2.83° C. to 7.78° C.

Remarks.—This species was originally described by Dr. Clemens Hartlaub in 1895 from a single much-broken individual dredged by the *Albatross* in 1788 meters near the Cocos Islands in 1891. Hartlaub's description is rather general and he figures only a single cirrus.

As *Antedon*, sp., he recorded and figured at the same time the centrodorsal and arm bases of a comatulid from off Mariato Point, Panama, in 589 meters, which so far as can be seen appears to be identical with the four small comatulids from off San Diego mentioned below and which I refer to this species.

In my rearrangement of the species of Antedonidae in 1908 I assigned *parvula* to the genus *Thaumatometra*, being guided largely by Hartlaub's comparison between it and Carpenter's *Antedon alternata*. In 1917 I found that it could have nothing to do with *alternata* and placed it in the genus *Nepiometra*.

In 1923 Dr. H. L. Clark described a new species, which he called *Trichometra europacifica*, which had been dredged at *Albatross* station 5692, southwest of San Diego, California. He wrote that he was inclined to list this comatulid as *Thaumatometra parvula* in spite of the obviously different cirri, but the fact that I suggested to him that the arms were evidently the arms of a *Trichometra*, plus the combination of characters shown by the cirri, pinnules, and arms, clearly indicated an undescribed species.

At the time we examined the small broken specimen together I knew *parvula* only from Hartlaub's very insufficient description, and it was not until some time later that I discovered the specimens in the collection of the National Museum and learned how much like a species of *Trichometra* it really is.

Four small comatulids taken by the *Albatross* off San Diego together with numbers of *Florometra serratissima* appear to belong to this species. They are considerably larger than Hartlaub's type and have more numerous cirrus segments, but they seem to agree in the characters of the cirri and lower pinnules, in having P_4 shorter than the preceding pinnules and in the rather unusual distal spacing of the syzygies, so that there is little doubt that they are conspecific with the type.

The description given was drawn up from the specimen from *Albatross* station 4383.

[Notes by A.M.C.] Mr. Clark writes that he removed *parvula* from the genus *Thaumatometra* after comparison (?with the description only) with *T. alternata*, but it is *T. tenuis* from northern Japan which is the type species and therefore the criterion of *Thaumatometra*. Unfortunately, there are no specimens of either *parvula* or *tenuis* in the British Museum for comparison. Judging from the written descriptions, it is possible that they are congeneric and certainly *parvula*, with all its cirrus segments (except the first one) longer than broad, runs down to *Thaumatometra* in the key to the genera of Bathymetrinae left by Mr. Clark. However, there are a number of differences, notably in the shape of the centrodorsal and the proportions of the outer cirrus segments, the penultimate of *tenuis* being twice as long as broad while the longest segments are about four times as long as broad, compared to "slightly longer than broad" in *parvula* when the longest segments are nearly six times as long as broad. There are also some differences in the shapes of the division series and brachials.

Dr. H. L. Clark thought that his *europacifica* (i.e., *parvula*) is closely related to *Trichometra minutissima* from Brazil, which Mr. Austin Clark has since removed to the genus *Thaumatometra*.

F. parvula differs from the other species of *Fariometra* in the much longer cirrus segments, the longest ones being nearly six times as long as broad, whereas in the others these segments are rarely more than three times as long as broad. Geographically also *parvula* is marked off from the exclusively Indo-West Pacific species of *Fariometra*, whereas *Thaumatometra* does include species from north of Japan and the Bering Sea, faunal areas more closely allied to the East Pacific fauna.

Genus **THAUMATOMETRA** A. H. Clark

Antedon (part) P. H. Carpenter, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386, and following authors.

Thaumatometra A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 127 (diagnosis; type species *Antedon ciliata* A. H. Clark, 1907=*A. tenuis* A. H. Clark, 1907), p. 128 (reaches the maximum size in the northern part of the Sea of Japan), p. 136 (referred to the Antedonidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 211 (referred to the Antedonidae, restricted), p. 212 (range), p. 274 (comparison with *Decametrocrinus* [*Thaumatocrinus*] and *Pentametrocrinus*); Amer. Nat., vol. 42, 1908, No. 503, p. 721 (large size in the Sea of Japan), p. 725 (color); Geogr. Journ., vol. 32, No. 6, 1908, p. 603 (range), p. 605 (ecology); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 177 (referred to the Bathymetrinae); Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (characteristic of the Japanese fauna; significance); Notes Leyden Mus., vol. 34, 1912, p. 148; Crinoids of the Indian Ocean, 1912, p. 11 (occurs both east and west of Ceylon), p. 12 (represented in the Red Sea region; doubtless occurs in the southeast African region), p. 17 (significance of the conditions in this genus in southern Japan), p. 26 (range), p. 61 (in key), p. 245 (original reference; type species); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (occurs in both Atlantic and Indo-Pacific; range); Die Crinoïden der Antarktis, 1915, p. 147 (synonymy; range; as here used includes *abyssorum, alternata, comaster, cypris, isis, parva, parvula, tenuis* [including *ciliata*], *thysbe*, and 2 undescribed species), p. 182 (both Atlantic and Indo-Pacific; range); Journ. Washington Acad. Sci., vol. 7, 1917, No. 5, p. 128 (referred to the Bathymetrinae); No. 16, p. 512 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 246 (in key; range), p. 254 (key to the included species).—Bather, Nature, vol. 107, 1921, pp. 132, 133 (early stages).—Gislén, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 144, p. 147 (no dorsal prominences on distal cirrus segments of small species).—A. H. Clark, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, pp. 12, 43 (range), p. 53 (in key), p. 56 (key to the Atlantic species).—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, pp. 51, 52.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, pp. 26, 27 (in key).—Ekman, Tiergeographie des Meeres, 1935, p. 360.—John, Proc. Linn. Soc. London, sess. 149, pt. 2, 1937, p. 86 (discussion), p. 87 (doubtful position of Antarctic species).—A. H. Clark, Sci. Rep. Australasian Antarctic Exped. 1911–14, ser. C, vol. 8, pt. 4, 1937, p. 6 (widely distributed; *nutrix* doubtfully in this genus); Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 218 (in key), p. 222 (in Russian), pp. 229, 230 (in English version).—Djakonov, Bull. Pacific

Inst. Fish. Oceanogr., Vladivostok, vol. 30, 1949, p. 13 (in key).—GISLÉN, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.
Trichometra (part) A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 240.

Diagnosis.—A genus of Bathymetrinae in which the cirri are at least XXV in number with 10 to 22 segments, all of which but the first one are longer than broad; P_1 has up to 20 segments in all the species except *tenuis*, where it has about 35; P_2 may be longer but is usually a little shorter than P_1.

Type species.—*Antedon ciliata* A. H. Clark, 1907, a synonym of *A. tenuis* A. H. Clark, 1907.

Geographical range.—From the region of Marion Island in the Southern Ocean, southern India, the East Indies, southern and northern Japan, the colder parts of the Sea of Japan and the Gulf of Tartary, the western Aleutian Islands, Panama, the Kermadec Islands and northeast New Zealand, and in the Atlantic from Iceland to the Davis Strait and from Brazil.

Bathymetrical range.—From 146 to 3239 meters.

Thermal range.—From 0.39° C. to 5.95° C.

Remarks [by A.M.C.].—A re-examination of the type specimen of *Thaumatometra cypris* A. H. Clark, 1913, has revealed no significant differences between it and *T. parva* A. H. Clark, 1908, in my opinion. Both types were from Sagami Bay, Japan. *T. cypris* therefore becomes a synonym.

Unfortunately many of the species of *Thaumatometra* are only known from one or a very few specimens. The following key should therefore be used with reservations since some of the characters contained in it, particularly the number and proportions of the cirrus segments as well as of the cirri themselves, tend to vary with size and to some extent individually. *T. plana* from off southern India has been removed from the key since its cirri are unknown. It is distinguished by having the centrodorsal much flattened, LV–LX cirri and a rather small number of segments in the proximal pinnules, P_1 having 13 in the type specimen and P_2 only 8.

As explained under the heading of *Fariometra*, I have removed the species *Thaumatometra sokotrae* John, 1937, to that genus.

KEY TO THE SPECIES OF THAUMATOMETRA

(For *T. plana* from the Laccadive Sea, see remarks above, and page 765.)

a^1. Size large, the arms 110–130 mm. long; P_1 20 mm. long with about 35 segments of which the proximal 12 are short and broad, mostly broader than long, and the remainder are elongated and slender; P_2 slightly shorter with 20 segments of which the two basal are broader than long and the remaining ones are much elongated, the basal 10 segments carinate; the following pinnules similar to P_2 (Gulf of Tartary and the Sea of Japan south to Nanao, Japan, and Cape Duroch, Korea; 146–1500 meters) .... **tenuis** (p. 744)

a^2. Smaller, the arms not known to exceed 70 mm. in length and rarely over 40 mm.; P_1 with not more than 20 segments.

- b^1. Cirrus segments much elongated, subequal, the antepenultimate about three times as long as the proximal width, the penultimate twice as long as broad; distal edges of the cirrus segments much expanded.
  - c^1. Cirri about XXX, 15–18; arms 30–40 mm. long; P_2 with a gonad (between Marion Island and the Crozets, Southern Ocean; 2925 meters) .... **abyssorum** (p. 749)
  - c^2. Cirri about XLV, 12–15; arms about 13 mm. long in the unique holotype; P_3 bears the first gonad (coast of Brazil; 1495 meters) .... **minutissima** (p. 751)
- b^2. Earlier cirrus segments much elongated, but the distal shorter so that the antepenultimate is not more than twice as long as its proximal width and the penultimate is shorter.

c^1. Cirri relatively long, the ratio of arm length to cirrus length being about 2.5:1; only about 10 cirrus segments, which are very long, the longest up to six times as long as broad (Baffin Bay to Iceland; 2075–2623 meters) ---------- **septentrionalis** (p. 752)

c^2. Cirri of moderate size, the arms 3–4 times as long; the longest cirri with 12–16 segments of which the longest are rarely more than four times as long as broad.

d^1. P_1 with only about 11 segments (western Bering Sea; 3229 meters) ---------- **brevicirra** (p. 754)

d^2. P_1 with 15 or more segments.

e^1. Cirri XL–LX (south of Sumbawa, lesser Sunda Is. and from the Kei Islands; 385–959 meters) ---------- **thysbe** (p. 755)

e^2. Cirri XXV–XXX.

f^1. P_1 with about 20 segments (the Kermadec Islands and northeast of New Zealand; 1152–1279 meters) ---------- **alternata** (p. 756)

f^2. P_1 with about 15 segments (southern Japan; 274–1417 meters) ---------- **parva** (p. 758)

c^3. Cirri relatively short, the arms at least five times as long; 16–20 segments in the longest cirr

d^1. P_4 the first genital pinnule; about 20 cirrus segments (southern Japan; 660–1186 meters). **isis** (p. 762)

d^2. P_2 the first genital pinnule; about 16 cirrus segments (northeastern Japan; 548–974 meters). **comaster** (p. 763)

THAUMATOMETRA TENUIS (A. H. Clark)

FIGURE 47

[See also vol. 1, pt. 1, figs. 30 (p. 71), 298 (p. 264), 510 (p. 373); pt. 2, figs. 108–111 (p. 67), 128 (p. 79)]

?*Antedon*, sp. VON GRAFF, *Challenger* Reports, Zoology, vol. 10, No. 27, 1884, p. 79 (Vladivostok; myzostomes).

Antedon tenuis A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 80 (description; *Albatross* station 4997); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 127 (=*A. ciliata*, the type species of *Thaumatometra*).—SOWERBY, The naturalist in Manchuria, Tientsin, vol. 5, 1930, p. 79.

Antedon ciliata A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 81 (description; *Albatross* station 4982); Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—SOWERBY, The naturalist in Manchuria, Tientsin, vol. 5, 1930, p. 79.

Antedon stella A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (new name for *Antedon tenuis* A. H. Clark, 1907, not of P. H. Carpenter, 1887); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 495 (*Antedon tenuis* P. H. Carpenter a *nomen nudum* so that it does *not* invalidate *Antedon tenuis* A. H. Clark).

Thaumatometra tenuis A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 275, fig. 4 (centrodorsal and base of a post-radial series); vol. 35, 1908, p. 117, fig. 11 (arm structure); Vid. Medd. Nat. Foren. København, 1909, p. 191 (synonymy, includes *ciliata*; new localities); Crinoids of the Indian Ocean, 1912, p. 245 (synonymy; range); Proc. Biol. Soc. Washington, vol. 26, 1913, p. 182 (new locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (comparison with *T. abyssorum*); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 80 (range and its significance); No. 6, p. 213 (faunal relationships; origin), p. 215 (faunal affinities; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 254 (in key; range), p. 256 (references).—GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 52 (Mortensen's specimen probably the young of this species).—A. H. CLARK, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 221 (localities old and new; range), p. 222 (association) (in Russian), pp. 228–230 (in English version).—DJAKONOV, Bull. Pacific Inst. Fish. Oceanogr., Vladivostok, vol. 30, 1949, p. 13 (in key).

?*Thaumatometra* cf. *tenuis* GISLÉN, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (sta. 20, 108 meters), pp. 51–52 (description), p. 69 (listed); fig. 41, p. 44.

Thoumatometra tenuis A. H. CLARK, Explorations des mers de l'U.R.S.S., vol. 23, 1937, p. 229.

Diagnostic features.—The large size of this species, which has an arm length of up to 130 mm., together with the form of P_1, composed of about 35 segments, of which the proximal 12 are short, and P_2, which is nearly as long, but with only about 20 mostly elongated segments, serve to distinguish *tenuis* at once from the other species of the genus.

Description.—The centrodorsal is hemispherical to only slightly convex, almost completely covered with closely crowded cirrus sockets of which the apical are not very much smaller that the peripheral. The usually rather small polar area is more or less concave.

The cirri are XL–L, 18–22 (usually about 20), from 25 to 35 mm. long. [NOTE BY A.M.C. In the type specimen of *Antedon ciliata* there are about LXX cirrus sockets.] The first segment is short, the second is rather longer than broad, the third is rather more than twice as long as broad, and the fifth, which is the longest, is about four times as long as broad. The following segments are similar; after about the eleventh the segments very gradually decrease in length so that the antepenultimate is about twice as long as broad and the penultimate is about half again as long as broad. The opposing spine is small, usually about a quarter the width of the penultimate segment in length, terminally situated and directed obliquely forward. The terminal claw is about as long as the penultimate segment, moderately stout and moderately curved. The cirri are laterally compressed for their entire length, this condition gradually becoming more marked distally. The distal ends of the segments are slightly enlarged, and the median portion of the distal border dorsally tends to project somewhat.

The distal edges of the radials are even with the rim of the centrodorsal. The IBr_1 are short, three or four times as broad as the lateral length, broader proximally than distally, with the distal border slightly concave and rising to a small rounded tubercle with the posterior border of the IBr_2; the sides are rounded, and each IBr_1 is widely separated from those on adjacent radials. The IBr_2 (axillaries) are pentagonal, about as broad as long.

The 10 arms are from 110 to 130 mm. in length. The first brachials are short, over twice as long exteriorly as interiorly, with the distal border concave; the interior edges are united for about half their length, the united and free portions of these edges being at right angles to each other. The second brachials are much larger, irregularly quadrate, with a convex posterior border incising the first. The first syzygial pair

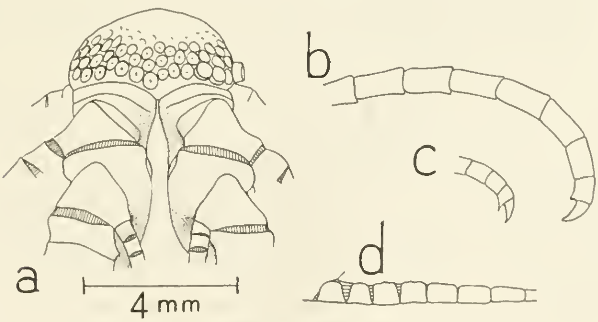

FIGURE 47.—*Thaumatometra tenuis* (A.H. Clark), type of *Antedon ciliata*, U.S.N.M., 22616, *Albatross* station 4982: *a*, Lateral view of calyx; *b*, tip of peripheral cirrus; *c*, tip of apical cirrus; *d*, proximal part of P_1.

(composed of the third and fourth brachials) is not quite so long as broad. The following brachials are slightly wedge-shaped, not quite so long as broad, after about the sixteenth becoming triangular, not quite so long as broad, and after the middle of the arm gradually becoming wedge-shaped again and then elongate, the terminal brachials being about twice as long as broad or even longer. Beginning with the second brachial, strong articular tubercles are developed; in some individuals these are much more conspicuous than in others, and in small specimens they may even be wanting. These die away after the tenth brachial and the arms become smooth until the outer half (or two-thirds in the smaller individuals) when the articulations begin to become prominent, the brachials distally becoming markedly constricted centrally.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 or 3 muscular articulations.

P_1 is 20 mm. long, composed of 35 segments, of which the first four or five are about as long as broad with the corners cut away and the following become progressively elongated. P_2 is 18 mm. long, with 20 segments, of which the first two are about as long as broad, the next two are longer than broad, and the remainder, which are more slender, rapidly become elongated. P_2 basally is about as stout as P_1, but it tapers less rapidly and therefore appears somewhat stouter with more elongate segments, though the portion extending beyond the large gonad which it bears is slender and filiform like the distal portion of P_1. The following pinnules to P_7 or P_8 are similar and of the same length. The remaining pinnules have no gonad and become more slender and more elongate. The distal pinnules are 21 mm. long, with the first segment short and broad, the second longer than broad and trapezoidal, and the remainder much elongated with swollen articulations.

Notes.—Gislén (1927) has described under the name *Thaumatometra* cf. *tenuis* a specimen collected by Dr. Mortensen in the Sagami Sea, which is small compared with the other known specimens of *tenuis*, having the arm length only 40 mm. It has also lost all the cirri, thus rendering certain identification difficult.

The centrodorsal is subconical, 1.7 mm. in diameter and 1.0 mm. in height. There are about XLV cirrus sockets arranged in three or four close alternating whorls, leaving free a low smooth dorsal cone 0.5 mm. in diameter.

The radials protrude slightly at the corners. The IBr_1 are four times as broad as long and are incised by the stout backward prolongation of the IBr_2 (axillaries). The latter are rhombic, broader than long, with concave sides. The proximal and distal extensions are about equal in size.

The arms are smooth. Their bases are rather close together but are not wall-sided. The syzygial interval is three muscular articulations. The first brachial is deeply incised by the very large backward synarthrial projection of the second brachial.

P_1 has 17–18 segments, 4 mm. long. The third or fourth segment is squarish, the sixth is half again as long as broad and the longest segments are two and a half times as long as broad. P_2 has 10 segments and is 2.5 mm. long. The third segment is slightly longer than broad and the longest segment is three times as long as broad. P_3 has 17 segments and is 4.5 mm. long. P_4 has 12 segments, and is also 4.5 mm. long. Either P_3 or P_4 is the first genital pinnule with a small gonad. P_a with 10 segments is 2 mm. long. P_b also with 10 segments is 3 mm. long.

The disk is 3.7 mm. in diameter and the anal cone is about 4 mm. high.

The color is brownish, the dorsal side "brighter" (? lighter).

Gislén compared this specimen with one of *Trichometra isis* (here included in *Thaumatometra*) and found that the latter, though larger, had much less well-developed synarthrial tubercles, and much more elongated pinnule segments. Apparently Mortensen's specimen closely resembles the one called *Thaumatometra comaster* by Gislén in 1922 (here referred to *T. parva*) except that the latter has a large swollen gonad on P_2. Since the gonads of Mortensen's specimen are smaller, Gislén concluded that it is an immature example of a much larger species of *Thaumatometra*, probably *T. tenuis*, since that is the only large Japanese species of the genus. However *T. tenuis* has only been recorded in Japanese waters from the northwest side of Honshu (as well as further north and west) and always from soft bottoms unlike Mortensen's specimen. [NOTE BY A.M.C. Mr. Clark has left no indication of his opinion on the identity of this specimen but I doubt whether it should be included in *tenuis*. Some further comments are included under the headings of *T. isis* (p. 763) and *T. parva* (p. 760).]

Localities.—Albatross station 4997; Gulf of Tartary, off the southwestern coast of Sakhalin (lat. 47°38′40″ N., long. 141°24′30″ E.); 581 meters; temperature 0.44° C.; green mud; September 23, 1906 [A. H. Clark, 1907] (9, U.S.N.M., 22615, 35909, 36173). Type locality.

Albatross station 4993; off Rishiri Island, west of the northwestern end of Yezo; Bomasiri Shima (off the northern end of Rubun To) bearing N. 47° E., 5 miles distant (lat. 45°25′30″ N., long. 140°53′00″ E.); 259 meters; temperature 1.72° C.; gray mud, sand and gravel; September 22, 1906 (1 U.S.N.M., 35911).

Albatross station 4992; off Rishiri Island; Bomasiri Shima bearing N. 52° E., 8 miles distant (lat. 45°24′00″ N., long. 140°49′10″ E.); 594 meters; green mud; September 22, 1906 (1, U.S.N.M., 35912).

Albatross station 4991; off Rishiri Island; Bomasiri Shima bearing N. 50° E., 9.2 miles distant (lat. 45°23′20″ N., long. 140°48′00″ E.); 594 meters; temperature 0.56° C.; green mud; September 22, 1906 (10, U.S.N.M., 35910).

Albatross station 4986; off Iwanai, southwestern Yezo; Benkei Mizaki Light bearing N. 35° E., 15 miles distant (lat. 43°01′40″ N., long. 140°22′40″ E.); 314 meters; temperature 1.05° C.; fine black sand and black mud; September 19, 1906 (6, U.S.N.M., 35914).

Albatross station 4983; off Iwanai; Benkei Mizaki Light bearing S. 2° E., 12 miles distant (lat. 43°01′35″ N., long. 140°10′40″ E.); 782 meters; temperature 0.39° C.; green mud; September 19, 1906 (4, U.S.N.M., 35913).

Albatross station 4982; off Iwanai; Benkei Mizaki Light bearing S. 3° E., 10.5 miles distant (lat. 43°00′00″ N., long. 140°10′30″ E.); 713–782 meters; temperature 0.39° C.; green mud; September 19, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 22616).

Albatross station 4981; off Iwanai; Benkei Mizaki Light bearing S. 9° E., 8.8 miles distant (lat. 42°58′15″ N., long. 140°09′10″ E.); 713–742 meters; temperature 0.39° C.; green mud; September 19, 1906 (1, U.S.N.M., 35908).

Rossinante station, Japan Sea, June 17, 1930; 310–315 meters [A. H. Clark, 1937].

Rossinante station 255; Japan Sea (lat. 42°30′ N., long. 132°52′ E.); 918–1128 meters; Oct. 3, 1931 [A. H. Clark, 1937].

Rossinante station 14; Japan Sea; 373–494 meters; Iwanow, June 8, 1931 [A. H. Clark, 1937].

Rossinante station 269; Japan Sea (lat. 42°26′ N., long. 131°52′ E.); 370–516 meters; Oct. 5, 1931 [A. H. Clark, 1937).

Rossinante station 277; Japan Sea (lat. 42°22′ N., long. 131°27′ E.); 600–630 meters; Oct. 6, 1931; K. Derjugin [A. H. Clark, 1937].

Rossinante station 74; Japan Sea (lat. 48°15′ N., long. 140°52′ E.); 576–592 meters; August 6, 1931; Iwanow [A. H. Clark, 1937].

Number 301; Japan Sea; 1500 meters; May 30, 1932; K. Derjugin [A. H. Clark, 1937].

Number 308; Japan Sea; 900 meters; June 12, 1932; K. Derjugin [A. H. Clark, 1937].

Station 405; Japan Sea; 420–1095 meters; July 13, 1932; N. Tarasov [A. H. Clark, 1937].

Off Siwutsch Bay, northeastern Korea (lat. 41°58′ N., long. 130°30′ E.); 1133 meters; Captain Suensson [A. H. Clark, 1913] (1, C.M.).

Off Kjöng-Söng, Korea (lat. 41°30′ N., long. 129°33′ E.); 914–1462 meters; Schönau, May 10, 1893 [A. H. Clark, 1909] (1, C.M.).

?Vladivostock [von Graff, 1884].

Off Siöng-Tschin, Korea (lat. 40°23′ N., long. 129°33′ E.); 256 meters; Captain Suensson, 1882 [A. H. Clark, 1909] (3, C.M.).

Off Cape Duroch, southeast of Gen-San, Korea (lat. 38°21′ N., long. 128°33′ E.); 146 meters; Schönau, April 10, 1897 [A. H. Clark, 1909] (1, C.M.).

Albatross station 4822; off Nanao, Japan; No Saki bearing S. 8° W., 4.5 miles distant (lat. 37°08′10″ N., long. 137°08′00″ E.); 237 meters; temperature 4.11° C.; green mud; July 21, 1906 (1, U.S.N.M., 36221).

?Locality; purchased at Shanghai by M. E. Deschamps [A. H. Clark, 1909] (1, U.S.N.M., 35907).

[Dr. Mortensen's station 20; Sagami Sea, Okinose; 110 meters; hard bottom [Gislén, 1927] (? this species)].

Geographical range.—Gulf of Tartary and the Sea of Japan, south to Cape Duroch, Korea and Nanao on the west coast of Honshu, Japan (? from the Sagami Sea).

Bathymetrical range.—From 146 (?110) to 1500 meters; the average of 22 records is 642 meters.

Thermal range.—From 0.39° to 4.11° C.; the average of 8 records is 1.13° C.

Occurrence.—This species, like the others in the genus, seems to be an inhabitant of muddy bottoms. In 7 instances the bottom is recorded as green mud, in one as gray mud, sand and gravel, and in one as black mud and fine black sand.

Thaumatometra tenuis was taken by the *Albatross* at 9 stations, at 7 of which it was associated with *Heliometra glacialis maxima*. In life it is easily distinguished from the young of *Heliometra* by the duller and more brownish color, by the more delicate and translucent cirri which are composed of elongate segments, and by the more rugged appearance.

The association of this species in the Gulf of Tartary and in the Sea of Japan with *Heliometra glacialis maxima* is especially interesting in contrast with the association of the very different *Poliometra prolixa* and *Heliometra glacialis* in the Arctic seas.

On the western coast of North America the species of *Florometra* are associated with a species of *Fariometra* in the south and with a species of *Retiometra* in the north.

History.—It is quite possible that the small form of *Antedon* from Vladivostock mentioned by Prof. von Graff in 1884 as the host of an undetermined myzostome was this species, as this is the only comatulid known from that region except for the very much larger *Heliometra glacialis maxima.*

In a preliminary account (1907) of the comatulids secured by the *Albatross* during the cruise of 1906, I described as new *Antedon tenuis* and *Antedon ciliata.* Subsequently coming across the name *Antedon tenuis* in one of Carpenter's papers, I proposed the alternative name *Antedon stella* for my *tenuis* later in the same year. But Carpenter's *Antedon tenuis* is a *nomen nudum* and is therefore without effect so far as my *tenuis* is concerned (A. H. Clark, 1908).

In 1908, on proposing the new genus *Thaumatometra* with *Antedon ciliata* as the type, I included in that species *Antedon tenuis* which seemed, on further study, to be based on immature individuals of *ciliata.* The name *tenuis* was selected for the species, however, because of page priority. In another paper published in the same year I figured the centrodorsal and the base of one of the post-radial series.

In 1909 I recorded *Thaumatometra tenuis* from 3 additional localities on the Korean coast where it had been obtained by Suensson and Schönau, and in 1913 I added another locality where it had been found by Suensson.

In a memoir on the crinoids of the Okhotsk and Japan Seas published in 1937, I gave the complete synonymy of this species and a number of new localities, together with a complete list of the previous records and the geographical, bathymetrical, and thermal ranges; also a general account of its associations.

THAUMATOMETRA ABYSSORUM (P. H. Carpenter)

Antedon abyssorum P. H. Carpenter, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386 (*nomen nudum;* sacculi largely developed); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 190 (description; sta. 147), pl. 29, figs. 10–13.—Hartlaub, Nova Acta Acad. German., vol. 58, No. 1, 1891, p. 14 (deep sea; 1,600 fms.).—Shipley, Antarctic manual, 1901, ch. 18, p. 269.—Döderlein, Fauna Arctica, vol. 4, Lief. 2, 1905, p. 405 (antarctic representative of the *Tenella* group).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888 = *Thaumatometra abyssorum*).

Thaumatometra abyssorum A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Crinoids of the Indian Ocean, 1912, p. 33 (= *Antedon abyssorum* P. H. Carpenter, 1888), p. 246 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (published references to specimens in the B.M.; *Challenger* sta. 147; comparison with *T. tenuis*); Journ. Washington Acad. Sci., vol. 5, 1915, No. 3, p. 81 (antarctic; range); Die Crinoiden der Antarktis, 1915, p. 106 (collected by the *Challenger;* recorded as *Antedon abyssorum*), p. 107 (in key to antarctic crinoids), p. 147 (synonymy; locality), p. 170 (deep water antarctic species; occurs in the region south of the Indian Ocean), p. 171 (systematic and geographical relationships); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 256 (references).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 11 (centrodorsal).

Diagnostic features.—There are 15 to 18 cirrus segments which are subequal, much elongated, the antepenultimate being about three times as long as its proximal width and the penultimate twice as long as wide; P_1 and P_2 have about 10 segments; P_2 bears a gonad. When the arms are about 35 mm. long the longest cirri are at least 12 mm.

Description [by A.M.C.].—The centrodorsal is conical with the apex quite acute in one of the three syntypes and blunted in the others. In the two larger ones it is about 2 mm. in basal diameter and 1.5 mm. high. In the smaller one the height is less than half the basal diameter. The cirri number about XXV in two and XXX in the third. Their sockets do not have conspicuously raised rims.

According to Carpenter the cirri have 15 to 18 segments. No complete cirri with more than 13 segments now remain (1957). The one with 13 segments measures 10 mm. in length. It arises from the middle row of sockets on the centrodorsal, above the peripheral row in the specimen with XXX cirri. The second segment is already slightly longer than wide. The fifth and sixth segments are the longest and are just under four times as long as their median widths. The outer segments are relatively shorter, the antepenultimate is about three times as long and the penultimate twice as long as its median width. The fifth segment of a broken peripheral cirrus, much larger than the complete one, is over four times as long as wide, while the proximal segment of a detached peripheral cirrus measuring 11 mm. in length and lacking both ends is nearly four and a half times as long as broad. A detached apical cirrus with 10 segments, probably lacking about 4 at the base, measures 5.5 mm. Its segments are all more or less expanded on the dorsal side at their outer ends, more particularly the distal segments. This flaring of the segments is much less marked in the longer cirri.

The distal edges of the radials extend only very slightly beyond the rim of the centrodorsal. The IBr_1 are short, rather strongly convex dorsally, deeply incised in the median line and only partially free laterally. The IBr_2 are rhombic, as long as or longer than broad, the proximal angle being very pronounced. The distal borders are concave.

The 10 arms were probably about 35 mm. long. From the proximal edge of the IBr_1 to the second syzygy at 9+10 measures 7.5 mm.; the width at the first syzygy is 1.1 mm. The brachials are fairly smooth. In one of the larger syntypes the brachials are thickened and slightly flared at their distal ends while in the other the dorsal profile of the arm is quite smooth.

The third syzygy is rather irregular in position but is most often between brachials 16+17. The distal interval is usually 3 or 4 muscular articulations but may be more or less.

The proximal pinnules are slender and tapering, the segments of P_1 particularly having very little expansion at the joints. According to Carpenter P_1 and P_a have 10 to 12 segments but a P_1 with 9 segments, as shown in the *Challenger* report figure, appears to be complete or only lacks a single segment, though a P_a with 9 segments may have lost one or two. Both these pinnules measure 3 mm. in length. The first segment of P_1 may be as long as wide or longer and the following segments are progressively longer. P_2 in the two larger specimens bears a well-developed gonad, usually on the third to fifth segments. There are 8+ segments, probably about 10, which are relatively narrower than those of P_1 and a little more swollen at the joints. The length is a little greater than that of P_1. The distal pinnules are longer.

Locality.—*Challenger* station 147; between Marion Island and the Crozets, south of the western Indian Ocean (lat. 46°16′ S., long. 48°27′ E.); 2925 meters; temperature 1.22° C.; diatom ooze; December 30, 1873 [P. H. Carpenter, 1887, 1888] (3, B.M.).

Remarks.—Eleven specimens of this species were taken by the *Challenger*, of which three are preserved in the British Museum.

Carpenter's figures are quite good but additional cirri of rather uniform length appear to have been added. From the few remaining there seems to be much more difference in size between the peripheral and apical cirri than is shown.

THAUMATOMETRA MINUTISSIMA (A. H. Clark)

[See vol. 1, pt. 1, fig. 403, p. 311]

Bathymetra minutissima A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 132 (listed; *nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 233 (description; *Albatross* sta. 2761).

Trichometra minutissima A. H. CLARK, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 247 (in key; range), p. 248 (references).—H. L. CLARK, Bull. Amer. Mus., vol. 48, 1923, p. 149 (comparison).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 38 (Brazil).—A. H. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 14, No. 2, 1940, p. 139, p. 141 (in key), p. 159.

Diagnostic features.—Thaumatometra minutissima has only 12 to 15 cirrus segments, all of which are much elongated, the antepenultimate being over three times as long as its proximal width and the penultimate about twice as long as broad; P_3 bears the first gonad. The arms are about 13 mm. long, and the cirri 4 mm. in the unique holotype.

Description.—The centrodorsal is rather small, hemispherical, with the dorsal pole furnished with several rather long spines; the cirrus sockets are closely crowded, about 9 in each radial area.

The cirri are about XLV, 12–15, 4 mm. long. The first segment is rather less than half as long as broad, the second is over twice as long as its proximal diameter, increasing rapidly in width from about the middle so that the breadth of the distal end is nearly twice that of the proximal, and the third and following are very slender and greatly elongated, increasing in breadth in each direction, but especially distally; the fourth segment is similar to the third; the following gradually decrease in length, their proximal ends becoming less and less enlarged, but their distal ends remaining enlarged and funnel-shaped. The antepenultimate segment is over three times as long as its proximal breadth, increasing in width from the base to the tip, most rapidly in the outer two-thirds. The penultimate segment is about twice as long as broad with a long triangular opposing spine arising from the whole of the dorsal surface, of which the distal edge is perpendicular to the longitudinal axis of the segment. The terminal claw is about equal in length to the penultimate segment, moderately slender and moderately curved.

The radials are rather short in the median line with a very strongly concave distal border and strongly produced interradial angles which, however, do not separate the bases of the IBr_1. The IBr_1 are very short, their lateral edges, which are about twice the middorsal length, being not much more than a third of their width. The distal border is broadly fringed with fine spines, and the dorsal surface is finely granulose.

The IBr_2 (axillaries) are rhombic, broader than long, with the edges, especially the anterior, strongly concave; the dorsal surface is finely granulose, and fine spines are developed laterally. The ossicles of the IBr series, the first two brachials exteriorly and the first three interiorly, are in close apposition with their neighbors and laterally flattened, and have very finely spinous lateral borders.

The 10 arms are 13 mm. in length. The first brachials are short, with the outer edge rather longer than the inner and the distal edge strongly concave; the dorsal surface is granulose, and the anterior border carries a strong fringe of very fine spines.

The second brachials are irregular in shape, with a strong rounded posterior projection. The third and fourth brachials, which together form the first syzygial pair, are together about half again as long as broad. The following brachials are rather longer than broad, gradually becoming more elongate and in the outer part of the arm reaching a length of about three times their width. The brachials are all remarkable for their strong central constriction and large and expanded ends which, from the sixth brachial onward, bear a fringe of rather large spines.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is very slender and filiform; the first three segments are about as long as broad, strongly concave dorsally with prominent ends; the following segments rapidly become elongated with broadly flaring distal ends. The tip of the pinnule is broken. P_3 and the following pinnules bear large gonads on the fifth to seventh segments, which are slender and much elongated. The distal pinnules are exceedingly slender with the first segment nearly as long as broad, the second about twice as long as broad, wider proximally than distally, and the remainder very slender and greatly elongated with expanded ends.

Locality.—Albatross station 2761; off the coast of Brazil, east of the Abrolhos Islands (lat. 15°39′00″ S., long. 38°32′54″ W.); 1495 meters; temperature 3.89° C.; pteropod ooze; December 26, 1887 [A. H. Clark, 1908] (1, U.S.N.M., 22671).

Remarks.—As yet this species is known only from the single specimen which was originally described under the name of *Bathymetra minutissima* in 1908 and transferred to the genus *Trichometra* in 1918.

[Note by A.M.C.] Mr. Clark himself altered the typescript to include this species in the genus *Thaumatometra*, presumably concluding that, even allowing for the very small size, the much longer but many fewer cirrus segments preclude its inclusion in *Trichometra* but ally it with *Thaumatometra.*

THAUMATOMETRA SEPTENTRIONALIS A. H. Clark

[See vol. 1, pt. 2, fig. 759, p. 353]

Thaumatometra, sp. A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 147 (undescribed species from the region southwest of Iceland).

Thaumatometra borealis A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 144 (north Atlantic species) (*nomen nudum*).—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 133 (*nomen nudum*).

Thaumatometra septentrionalis A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 256 (in key; range), p. 258 (references; description in press); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 12 (description; sta. 18), p. 43 (range), p. 58 (stas. 11, 36), p. 56 (in key).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 26; Medd. Grønland, vol. 79, No. 2, 1932, p. 50 (range).—Tortonese, Bull. Inst. Océanogr. Monaco, No. 956, 1949, p. 4 (bathymetrical range).

Diagnostic features.—The cirri are about XXX, with about 10 segments, of which the longest are six times as long as broad, the antepenultimate is twice as long as broad and the penultimate little, if at all, shorter; when the arms are about 15 mm. long the cirri are 6 mm.; the segments of the proximal pinnules are long, the third one of P_1 being already twice as long as broad.

Description.—The centrodorsal is hemispherical, with a small bare dorsal pole.

The cirri are about XXX, about 10, approximately 6 mm. long. The first segment is very short, the second is somewhat longer than broad, the third is about four times as long as the proximal breadth, and the fourth and fifth, which are the longest, are nearly or quite six times as long as the proximal breadth with expanded and overlapping very finely spinous distal ends. The following segments slowly decrease in length so that the third from the terminal claw is three times as long as broad, the antepenultimate is twice as long as broad, and the penultimate is from half again to twice as long as the distal width. The opposing spine is represented by a small terminal tubercle. The terminal claw is moderately slender and rather feebly curved.

The radials project slightly beyond the rim of the centrodorsal. The IBr_1 are very short, about four times as broad as the lateral length, deeply incised in the median line by a posterior process from the IBr_2, not in contact basally, and bear tufts of fine spines on the anterolateral angles which are continued inward, decreasing in size, along the distal border. The IBr_2 (axillaries) are broader than long, with all the sides strongly concave and the anterior and lateral angles strongly produced; a prominent rounded posterior process incises the IBr_1; the lateral angles are armed with short but prominent spines; the anterior edges are slightly everted and are armed with fine spines. The anterolateral angles of the IBr_1 are more or less cut away, leaving a V-shaped notch in the sides of the IBr series. The sides of the IBr series and of the first two brachials are flattened, but are not in apposition.

The 10 arms are about 15 mm. long. The first brachials are about three times as long exteriorly as interiorly, and are deeply incised by the second; the inner edges are entirely free, diverging from each other at an angle of about 60°; the outer border is straight, with a broad band of very fine spines. The second brachials are much larger, irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is longer interiorly than exteriorly, and about as broad as long in the median line. The next four brachials are almost triangular, about as long as broad or slightly longer than broad, those following becoming somewhat less oblique and longer distally. The distal edges of the brachials are produced and armed with prominent, though fine, spines.

Syzygies occur between brachials 3+4, 9+10, and 16+17.

P_1 has the first segment short, the second longer, the third twice as long as broad, and the following much elongated with expanded and spinous distal edges. P_2 is somewhat longer and stouter than P_1 with longer segments of which the third to fifth bear a fusiform gonad. The following pinnules resemble P_2.

Localities.—*Ingolf* station 36; southwest of Godthaab, Greenland (lat. 61°50′ N., long. 56°21′ W.); 2623 meters; temperature 1.5° C. [A. H. Clark, 1923] (1, U.S.N.M., E. 1069).

Ingolf station 11; west of Faxafjord, Iceland (lat. 64°34′ N., long. 31°12′ W.); 2376 meters; temperature 1.6° C. [A. H. Clark, 1923] (1, C.M.).

Ingolf station 18; southwest of Iceland (lat. 61°44′ N., long. 30°29′ W.); 2075 meters; temperature 3.0° C. [A. H. Clark, 1923] (1, C.M.). Type locality.

Geographical range.—Extreme northwestern Atlantic, from Baffins Bay to Iceland.

Bathymetrical range.—From 2075 to 2623 meters; the average of 3 records is 2358 meters.

Thermal range.—From 1.5° C. to 3.0° C.; the average of 3 records is 2.0° C.

THAUMATOMETRA BREVICIRRA (A. H. Clark)

[See vol. 1, pt. 1, fig. 402, p. 311]

Bathymetra brevicirra A. H. Clark, Proc Biol. Soc. Washington, vol. 21, 1908, p. 132 (listed; *nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 234 (description; *Albatross* sta. 4766); Crinoids of the Indian Ocean, 1912, p. 245 (synonymy; locality).—Baranova, Invest. Far East Seas U.S.S.R., No. 4, 1957, p. 153 (distribution), p. 248.

Thaumatometra brevicirra A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 257 (references).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56 (depth).

Diagnostic features.—The cirri are composed of about 14 segments, of which the longest are about three times as long as their proximal widths and the last two before the terminal claw are about twice as long as the widths of their proximal ends; P_1 has about 11 segments. In the unique holotype the arms are 23 mm. long and the cirri are 6 mm.

Description.—The centrodorsal is rather low hemispherical, bearing about 45 crowded cirrus sockets.

The cirri are XXX–XLV, 14, 6 mm. long. The first segment is rather less than half as long as broad, the second is rather longer than broad, sometimes about as long as broad, the third is rather more than twice as long as its proximal width, centrally constricted with expanded ends, and the fourth is about three times as long as its proximal width, also strongly constricted centrally. The following segments decrease gradually in length, the proximal ends becoming less and the distal rather more expanded; the antepenultimate segment is about twice as long as the width of the proximal end, and the penultimate is rather shorter, with the opposing spine, which is not so long as the width of the segment, arising from its distal half. The terminal claw is short, conical, slightly curved, its length being from a half to three-quarters of that of the penultimate segment.

The radials are short with a strongly concave distal border and produced interradial angles. The IBr_1 are short, over twice as broad as the lateral and over three times as broad as the median length, with a concave distal and straight proximal border. The IBr_2 are practically square, with the sides very little concave. The elements of the IBr series and the first two brachials are closely appressed against those on either side and laterally flattened.

The 10 arms are about 25 mm. long. The first brachials are short, longer outwardly than inwardly, with the distal edge concave. The second brachials are about twice as large, irregularly quadrate. The first syzygial pair (formed of the third and fourth brachials) is somewhat longer than broad, with the epizygal oblong and the hypozygal wedge-shaped or almost triangular with the longer side in. The following brachials are about as long as broad, after the ninth becoming wedge-shaped, longer than broad, and more elongate distally. All of the brachials have a more or less concave surface, this becoming more marked after the ninth, when the distal edges begin to project somewhat.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 or 4 muscular articulations.

P_1 is long and filiform with 11 segments, the first 2 about as long as broad, the following becoming rapidly elongated and exceedingly long and slender distally. The distal pinnules have the first segment wedge-shaped or almost crescentic, broader than long, the second wedge-shaped, longer than broad, and the following becoming progressively elongated.

Locality.—Western Aleutian Islands; Koniuji Island bearing S. 22°30′ W., 27 miles distant (lat. 52°38′00″ N., long. 174°49′00″ W.); 3229 meters; May 31, 1906 [A. H. Clark, 1908] (1, U.S.N.M., 22672).

THAUMATOMETRA THYSBE A. H. Clark

Thaumatometra thysbe A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 149 (description; *Siboga* sta. 52); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 257 (detailed description; sta. 52), p. 271 (listed), pl. 26, fig. 98.

Diagnostic features.—The cirri are XL–LX, the longest with 13 to 16 segments, of which the maximum length is from three to six times the median width; the antepenultimate is not more than twice as long as broad and the penultimate is only a little longer than broad; P_1 has over 15 segments. When the arms are 30 mm. long, the cirri are about 9 mm. [NOTE BY A.M.C. In the key given in the *Siboga* report, Mr. Clark included *thysbe* in the section with the third and fourth cirrus segments from the end at least twice as long as wide although in his description of the type of *thysbe* he writes that the two segments before the penultimate are only a third to a half again as long as wide. I have altered the position of *thysbe* in the present key accordingly.]

Description.—The centrodorsal is small and rounded conical in shape.

The cirri are about XL, 15–16, 9 mm. long. The first segment is short, the second about as long as the diameter of the expanded distal end, the third twice as long its distal diameter and the fourth slightly longer [presumably about three times as long as its median diameter—A.M.C.]. The following segments gradually decrease in length so that the last two before the penultimate are from a third to a half again as long as broad. The earlier segments have greatly enlarged ends, the distal end being much expanded and overlapping the base of the succeeding segment; as the segments become shorter, the dorsal and ventral profiles become straighter and the egments become compressed laterally so that they appear broader in lateral view; on the distal short segments the median portion of the distal edge on the dorsal side projects slightly over the base of the following segment.

The radials are just visible in the median line beyond the edge of the centrodorsal, but extend well out in the interradial angles; their distal angles are slightly separated so that the bases of the IBr_1 are not quite in apposition.

The IBr_1 are very short, almost oblong, about four times as broad as the exterior length, which is slightly greater than the median length; the lateral borders of adjacent IBr_1 make an angle of about 90° with each other; the distal edges are narrowly everted and very finely spinous. The IBr_2 (axillaries) are about as broad as long; the distal edges make approximately a right angle with each other; the distal angle is not produced; a broad proximal angle incises the IBr_1; the lateral angles extend considerably beyond the distal angles of the IBr_1; the distal edges are evenly and very finely spinous.

The 10 arms are 30 mm. long, resembling those of the other species of the genus. The distal edges of the brachials are moderately everted and finely spinous.

Syzygies occur between brachials 3+4, 9+10, 14+15, and distally at intervals of two muscular articulations.

P_1 is excessively delicate, about 6.5 mm. long, composed of somewhat more than 15 segments, of which the first is very short, the second is longer, the third is about as long as broad, the fourth is half again as long as broad, and the following become exceedingly elongated with swollen, produced and overlapping spinous distal ends. P_2 is stouter than P_1, composed of 11 or 12 segments, of which those beyond the third are excessively elongated, becoming exceedingly slender distally; the fourth to seventh segments bear a large gonad.

Notes.—A specimen from station 59 of the Danish Expedition to the Kei Islands [named and described in MS by Mr. Clark] has the centrodorsal very low, conical, with the sides making a very broadly obtuse angle with each other. Over a rather large polar area the cirrus sockets are more or less completely obliterated. Around the base the sockets are very closely crowded, with about six corresponding to each radial along the edge. Towards the apex the sockets are smaller. The cirri number about LX, 10–13, up to 10 mm. long. The second segment is about as long as broad, the third is nearly or quite three times as long as broad in the middle, the fourth to sixth are five or six times as long as their median widths. The following segments rapidly decrease in length so that the antepenultimate is about twice as long as broad and the penultimate is scarcely as long as broad. The elongate earlier segments have the dorsal and ventral profiles concave and the shorter outer segments also have the dorsal and ventral sides divergent at least in the outer half. The opposing spine is minute and terminal. The terminal claw is about as long as the penultimate segment, rather stout and moderately curved. [Note by A.M.C.: Unfortunately the remainder of this manuscript description is lost.]

Localities.—*Siboga* station 52; south of Java (lat. 9°03′24″ S., long. 110°56′42″ E.); 959 meters; globigerina ooze; April 20, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam M.). Type locality.

Danish Expedition to the Kei Islands station 59; 385 meters; coral; May 12, 1922 (1, C.M.).

THAUMATOMETRA ALTERNATA (P. H. Carpenter)

Antedon tenuis P. H. Carpenter, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386 (*Challenger* sta. 170; sacculi; *nomen nudum*).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 497.

Antedon alternata P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 179 (description, in part; stas. 169, 170A [specimen from sta. 218=*Fariometra io;* specimens from sta. 236=*T. parva*]), pl. 18, figs. 1–3 (pl. 32, figs. 5, 7–9=*T. parva;* fig. 6=*Fariometra io*).—Farquhar, Proc. Linn. Soc. New South Wales, vol. 12, pt. 3, 1898, p. 305.—Thompson, Proc. Roy. Soc. Edinburgh, vol. 22, 1899, p. 322 (distribution and its bearing on bipolarity).—Hutton, Index faunae Novae Zealandiae, 1904, p. 290.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1579 (listed).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 457 (type locality determined as *Challenger* sta. 169); Notes Leyden Mus., vol. 34, 1912, p. 146 (*Challenger* Report, pl. 32, fig. 6=*Trichometra delicata* [*Fariometra io*]); Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888=*Thaumatometra alternata*, in part); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 80 (*Challenger* Report, pl. 32, fig. 6=*Trichometra delicata* [*Fariometra io*]; pl. 32, figs. 5, 7–9=*T. cypris* [*parva*]); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 252 (specimen from *Challenger* sta. 218=*Nepiometra* [*Fariometra*] *io*).

Thaumatometra alternata A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Notes Leyden Mus., vol. 34, 1912, p. 149 (specimen from *Challenger* sta. 170A compared with *T. thysbe*); Crinoids of the Indian Ocean, 1912, p. 33 (=*Antedon alternata* P. H. Carpenter, 1888), p. 246 (synonymy; New Zealand [other localities refer to *T. cypris* [*parva*] and *Nepiometra* [*Fariometra*] *io*; probably includes more than one species); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (published references to specimens in the B.M.; *Challenger* stas. 169, 170A); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 256 (references).—Gislén, Ark.

Zool., vol. 19, No. 32, 1928, p. 11 (notes).—FELL, New Zealand Science Congress, 1947, p. 209 (listed; range); Tuatara, Wellington, New Zealand, vol. 3, No. 2, 1950, p. 84 (in key), text-fig. 14 (calyx and arm bases).

Diagnostic features.—The cirri are about XXX, with 12 to 16+ segments, of which the longest are about four times as long as their median width, the antepenultimate is about a third again as long as broad and the penultimate is hardly, if at all, longer than broad; P_1 has about 20 segments, of which the first two or three are not longer than broad but the following ones become very elongate with expanded and spiny joints; P_2 is probably shorter and may bear a gonad. When the arms are about 25 mm. long the cirri are 7 to 8 mm.

Description.—The centrodorsal is broadly rounded conical, 1.2 mm. in diameter and 0.8 mm. high, with the well-marked cirrus sockets irregularly placed and crowded.

The cirri are XXV–XXX, a middle one has 16 segments and is 7 mm. long; the apical ones are shorter with fewer segments and the peripheral (which are all lost) were probably a little longer. The first segment is about as long as broad, the second is half again as long as broad, the third to sixth are nearly or quite four times as long as the median width, and the following slowly decrease in length to the penultimate which is slightly or not at all longer than broad. The longer segments are centrally constricted and distally flared, especially on the shorter cirri, and the distal are laterally compressed. The opposing spine is well-developed, terminal, and directed obliquely forward. The terminal claw is strongly curved.

The distal edges of the radials are just visible beyond the rim of the centrodorsal. The IBr_1 are very short, about four times as broad as the lateral length, with the anterior border somewhat incised. The IBr_2 (axillaries) are rhombic, broader than long, with the distal edges concave.

The 10 arms were probably not more than 25 mm. long. The first brachials are twice as long exteriorly as interiorly, with the inner half of the distal border parallel to the proximal border and the outer half running upward at a considerable angle, while the inner borders barely meet over the sharp anterior angle of the axillaries. The second brachials are much larger, and irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is half again as long as broad, and nearly oblong. The following brachials to the second syzygy are oblong or almost square, those succeeding becoming almost triangular, longer than broad, and distally more elongate with gradually less and less oblique and more and more swollen ends.

From the proximal edge of the IBr_1 to the second syzygy is 5.0 mm. and the width at the first syzygy is 0.6 mm.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2 muscular articulations.

P_1 is slender, about 7 mm. long, and consists of 20 elongated segments, of which the longer outer ones are expanded and spiny at the joints. P_a is similar, but shorter. P_2 and P_b are still shorter, but have stouter segments and one or both of them bear a well-developed gonad. The following pinnules gradually increase in length, becoming slender and delicate with the two basal segments more or less flattened.

The above description is mainly of the syntype from station 169, with the exception of the cirri which are only present in the specimen from station 170A.

Localities.—*Challenger* station 170A; near the Kermadec Islands, north of New Zealand (lat. 29°45′ S., long. 178°11′ W.); 1152 meters; temperature 4.17° C.; volcanic mud; July 14, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1913] (1, B.M.).

Challenger station 169; northeast of New Zealand (lat. 37°34′ S., long. 179°22′ E.); 1279 meters; temperature 4.44° C.; blue mud; July 10, 1874 [P. H. Carpenter, 1888; A. H. Clark, 1913] (1, B.M.). Type locality.

History.—Carpenter's first mention of this species (1887) is in a discussion of the sacculi of crinoids, wherein the name *Antedon tenuis* appears with the locality *Challenger* station 170. By a process of elimination *Antedon tenuis* is found to cover the specimens from station 170A referred to *Antedon alternata* in the *Challenger* report (1888), but the name as it is given is a *nomen nudum*.

Carpenter's original account of *Antedon alternata* (1888) was based upon 1 specimen from *Challenger* station 169, 2 from station 170A, 1 from station 218, and 4, of which 2 were young, from station 236. Specimens from stations 170A, 218 and 236 were figured.

Carpenter remarked that he was at first inclined to separate specifically the individuals taken at stations 170A and 169 from those taken at station 236, but that the additional experience of variable specific characters in these animals gained between 1879 and 1887 had led him to abandon the idea. However he gave in some detail the differences between the specimens from station 170A and those from station 236.

In 1908 I selected *Challenger* station 169 as the type locality for *alternata*, avoiding station 170A because of the fact that the specimens from this locality had previously been mentioned under the name of *tenuis*. Carpenter's description of *alternata* covers all his specimens; but in 1887 von Graff, on Carpenter's authority, published the name *alternata* as the host of a myzostome from station 236, which, taken in connection with the appearance in the same year of the name *tenuis* covering specimens from station 170, would seem to indicate that originally Carpenter had designated the northern form *alternata* and the smaller southern form *tenuis*.

In studying the *Siboga* collection, I found a new species which in 1912 I described under the name of *Trichometra delicata*, recognizing as conspecific the specimen from *Challenger* station 218 figured by Carpenter. The name *Trichometra delicata* having been used for a very different species from the Atlantic in the preceding year, this form was redescribed and figured under the name of *Nepiometra io* in the *Siboga* report (1918). It has since been referred to the genus *Fariometra*.

On examining the comatulids in the British Museum in 1910, it seemed to me that the specimens from *Challenger* stations 169 (1) and 170A (2) differed sufficiently from that from station 236 to necessitate the recognition of a new species. Station 169 having previously been selected as the type locality, I bestowed the name *Thaumatometra cypris* (1913) upon the form from station 236, leaving *alternata* covering only the specimens from stations 169 and 170A. [Note by A.M.C. *T. cypris* is now referred to the synonymy of *T. parva*.]

THAUMATOMETRA PARVA A. H. Clark

Antedon alternata von Graff, *Challenger* Reports, Zoology, vol. 20, pt. 61, 1887, p. 6 (sta. 236; myzostomes; *nomen nudum*).—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 179 (part; sta. 236 [specimens from stas. 169 and 170A = *T. alternata*, and from sta. 218 = *Fariometra io*]), pl. 32, figs. 5, 7–9 (pl. 18, figs. 1–3 = *T. alternata*, pl. 32, fig. 6 = *Fariometra io*).—Thompson, Proc. Roy. Soc. Edinburgh, vol. 22, 1899, p. 322 (part).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, abt. 3, 1907, p. 1579 (part).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (part); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 318 (southern Japan); Crinoids of the Indian Ocean, 1912, p. 246 (part [record from New Zealand = *T. alternata* and from New Guinea = *Fariometra io*]).

Thaumatometra parva A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed; *nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 231 (description; *Albatross* sta. 3697), p. 318 (Japan); Crinoids of the Indian Ocean, 1912, p. 247 (synonymy; locality); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (southern Japanese species; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 256 (in key; range), p. 257 (references).

Thaumatometra cypris A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 65 (*Challenger* sta. 236; new name for *Antedon alternata* P. H. Carpenter, 1888, in part; *Challenger* Report, pl. 32, figs. 5, 7–9); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japan, range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 256 (references).—GISLÉN, Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 147 (comparison with *T. comaster*); Ark. Zool., vol. 19, No. 32, 1928, p. 11 (notes).

Thaumatometra comaster GISLÉN (not of A. H. Clark), Nova Acta Reg. Soc. Sci. Upsaliensis, ser. 4, vol. 5, No. 6, 1922, p. 5 (localities), p. 144 (description), pp. 180, 181 (listed); figs. 153–156, p. 146 (cirrus; pinnules); Zool. Bidrag Uppsala, vol. 9, 1924, p. 275 (shape of mouth), p. 283 (ambulacral groove); Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 52.

Diagnostic features.—The cirri are XXX–XL, 9–15, the longest segments three or four times as long as their median width when the arms are about 30 mm. long and even longer, relatively, in smaller specimens; the antepenultimate segment is less than twice as long as broad; P_1 has 15 or more segments, 5 to 7 mm. long; P_2 is shorter but stouter and bears a gonad. The cirri are about 9 mm. long when the arms are 30 mm. but may be relatively shorter.

Description.—The centrodorsal is rather small, hemispherical or low conical, with the cirrus sockets closely set in two or three crowded rows, leaving only a small portion of the dorsal pole bare.

The cirri are about XXX, 10–12, 9 mm. long. The first segment is about as long as broad, the second is about half again as long as broad, the third and fourth are between three and four times as long as broad, and the following gradually decrease in length so that the oblong antepenultimate is about twice as long as broad, and the penultimate is about half again as long as broad. The opposing spine is very small, in height less than a third the width of the penultimate segment, terminally situated and directed obliquely forward. The terminal claw is about as long as the penultimate segment, rather stout and moderately curved. The second to fifth segments are constricted centrally with expanded ends. Beyond the fourth the segments gradually become broader dorsoventrally and laterally compressed.

The distal edges of the radials are even with the rim of the centrodorsal. The IBr_1 are short, oblong, about four times as broad as long, somewhat narrower distally than proximally, quite rounded dorsally and well separated laterally. The IBr_2 (axillaries) are rhombic, somewhat broader than long, with concave distal borders and a rather sharp distal angle, and with a rounded posterior projection rising to a slight tubercle.

The 10 arms are apparently about 30 mm. long. The first brachials are wedge-shaped with the exterior borders longer than the interior, and entirely free interiorly. The second brachials are much larger and irregularly quadrate. The first syzygial pair (composed of brachials 3+4) is somewhat longer than broad, and slightly longer interiorly than exteriorly. The fifth to eighth brachials are oblong, about half again as broad as long, and the following become wedge-shaped and about as long as broad. Only the proximal third of the arms remains.

Syzygies occur between brachials 3+4, 9+10, and 14+15.

P_1 is very slender, 6 mm. long, with 15 segments, of which the first is very short, the second and third are about as long as broad with their corners cut away, the fourth and fifth are about half again as long as broad and more slender than those preceding, and those following become rapidly elongated with swollen articulations so that the pinnule is very slender and filiform distally. P_2 is very slightly shorter with the first segment broader than long, the second about as long as broad, the third about half again as long as broad, and the remainder becoming progressively elongated. This pinnule is about as stout basally as P_1 but does not taper so rapidly, so that it appears considerably stouter; a large gonad occupies the fourth to eleventh segments. The following pinnules, so far as they are preserved, resemble P_2.

Notes [BY A.M.C.].—In the largest syntype of *T. cypris* the centrodorsal is similar to that of the type of *parva*, but there are XXXV–XL cirrus sockets and the remaining cirri have up to 13 segments, which appear to be similar in proportions to those described above. The arms were about 30 mm. long and the length from IBr_1 to the second syzygy is 6.5 mm. The breadth of the arm at the first syzygy is 0.8 mm.

The longest remaining P_1 has 15 segments and measures 5.5 mm., probably three or four segments are lacking. P_2 is stouter and probably shorter but all are broken; in most cases it carries a small gonad. On the succeeding pinnules the segments become progressively more attenuate.

The two remaining syntypes of *cypris* are smaller. One has the length IBr_1 to the second syzygy 5 mm. The other is still smaller and has no gonads. They have respectively up to 11 and up to 9 cirrus segments which are relatively longer than in the larger specimen and which have more prominent opposing spines.

In 1922 Dr. Torsten Gislén recorded a specimen from Sagami Bay in 731 meters which he named *Thaumatometra comaster*. In the typescript Mr. Clark had referred this to *T. isis* but the reexamination of the types of *cypris* has revealed even greater similarities, notably the fact that in both Gislén's specimen and in the largest type of *cypris*, as in the type of *parva*, P_2 is the first genital pinnule. The relatively shorter cirrus and pinnule segments in Gislen's specimen are probably attributable to its larger size, the arm length being about 45 to 50 mm. The centrodorsal is very low conical, 2 mm. broad at the base and 0.6 mm. high, the bare dorsal pole measures 1.1 mm. in diameter.

The cirri are about XXXV, 12–15, from 7 to 8 mm. long, arranged in two rows on the centrodorsal. The first cirrus segment is short, the second is about as long as broad, the third is twice as long as broad, the fourth to sixth are three times as long as broad, the seventh is two and a half times as long as broad, and the antepenultimate is very slightly longer than broad. The terminal claw is about as long as the penultimate segment.

The IBr_1 are three or four times as broad as long laterally. The axillaries are as long as broad, produced both proximally and distally, the proximal projection being longer than the distal. The lateral angles are produced beyond the anterolateral angles of the IBr_1.

The 10 arms are between 45 and 50 mm. in length. The first brachials are three times as long exteriorly as interiorly and interiorly in contact basally. The second brachials have a strong posterior process. The first syzygial pair (composed of the third and fourth brachials) is a little longer interiorly than exteriorly. The following brachials are about as long as broad, slightly wedge-shaped. The distal brachials are somewhat longer than broad with swollen articulations.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 7 mm. long with 15 segments, of which the first and second are short, the third is from two to two and a half times as long as broad, and those following are from three to four times as long as broad. P_2 is 4 mm. long with 8 segments, of which the third or fourth to seventh bear a gonad. P_3 is 4.5 mm. long with 9 segments, bearing a gonad on the third to seventh; the distal segments are a little spiny distally. The distal pinnules are from 6 to 7 mm. long with about 16 segments.

Doctor Gislén also assigned to *T. comaster* another very young specimen from Sagami Bay in 274 meters. The centrodorsal is low and flattened, almost hidden by the cirri, which are about XXVI, 7–10, from 2 to 3 mm. long, arranged in 2 rows. The second cirrus segment is three-quarters again as long as broad, and those following are four times as long as broad, and expanded distally; the antepenultimate segment is three-quarters again as long as broad, and the penultimate is as long as broad with an indistinct opposing spine.

The IBr_1 are three times as broad as long; the axillaries are a third broader than long, the posterior process about twice as long as the distal angle. The 10 arms are 10+ mm. long. The first brachials are almost free anteriorly, the second brachials have a posterior process. P_1 is 1.8 mm. in length with about 10 segments which are two and a half times as long as broad. There is a gap between P_1 and the distal pinnules. The disk is 1.3 mm. in diameter. The anal cone is 1 mm. high, narrowly sausage-shaped.

Localities.—*Albatross* station 3697; Sagami Bay, Japan; Manazuru Zaki bearing N. 26° W., 6.0 miles distant; 219–484 meters; gray mud and volcanic sand; May 5, 1900 [A. H. Clark, 1908] (1, U.S.N.M., 22694). Type locality.

Challenger station 236; off Sagami Bay, Japan (lat. 34°58′ N., long. 139°29′ E.); 1417 meters; temperature 3.11° C.; green mud; June 5, 1875 [von Graff, 1887; P. H. Carpenter, 1888; A. H. Clark, 1913] (3, B.M.).

Dr. Sixten Bock's station 4, Misaki, Sagami Bay, Japan; on the "*Metacrinus* shoal"; 274 meters; May 5, 1914 [Gislén, 1922] (1, Stockholm M.).

Dr. Sixten Bock's station 37; Okinose, Sagami Bay; 731 meters; July 8, 1914 [Gislén, 1922] (1, Stockholm M.).

Geographical distribution.—This species is only known from the vicinity of Sagami Bay, near Tokyo, on the southeast coast of Japan.

Bathymetrical distribution.—From 274 (?219) to 1417 meters.

History [by A.M.C.].—The first mention of this species is by von Graff (1887), who gave *Antedon alternata* as the host of a myzostome (*Myzostomum cornutum*) from *Challenger* station 236.

In the following year Carpenter described *alternata* but mainly from specimens taken near New Zealand which Mr. Clark later found to be distinct and, accordingly, in 1913 provided the new name *cypris* for the specimens from *Challenger* station 236. However, in 1908 he had described a new species, *Thaumatometra parva*, from a specimen taken by the *Albatross* also in Sagami Bay, which description has proved to be indistinguishable from a newly drawn up one of the largest syntype of *T. cypris*.

The only other records for the species are those of two specimens collected by Dr. Sixten Bock in Sagami Bay named *T. comaster* by Gislén in 1922, but it is not inconceivable that the specimen from the Sagami Sea in 110 meters which Gislén (1927) named *T.* cf. *tenuis* (under which heading it is described here) is also referable to *parva*.

Certainly on zoogeographical grounds it is more likely, since the fauna of the southern coast of Honshu appears to be quite distinct from that of the Japan Sea (Ekman, 1953), though morphologically there are several characters, such as the apparently well-developed synarthrial tubercles on the division series and the shorter P_1, which may distinguish this specimen from *T. parva.* Unfortunately its cirri were lost.

THAUMATOMETRA ISIS (A. H. Clark)

Antedon isis A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 82 (description; *Albatross* sta. 4917); Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 353 (listed).

Thaumatometra isis A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 233 (comparison with *T. comaster*); Vid. Medd. Nat. Foren. København, 1909, p. 191 ("Korea"); Crinoids of the Indian Ocean, 1912, p. 246 (synonymy; Sea of Japan, 361 fms.; Korea); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (southern Japanese species; range and its significance).

Trichometra isis A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 247 (in key; range), p. 248 (references).—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 51; fig. 42, p. 44 (arm and cirrus bases).

Diagnostic features.—The cirri are XXX–XL, with about 20 segments, of which the longest is little more than twice as long as broad and the distal ones are only slightly longer than broad; P_1 has about 20 segments; P_2 and P_3 are shorter with about 12 segments; P_4 is the first genital pinnule. The cirri are relatively short, only about 10 mm. long when the arms are 65 mm.

Description.—The centrodorsal is hemispherical and bears between 30 and 40 cirrus sockets.

The cirri are XXX–XL, 20, 10 mm. long. The longest segment, the fourth, is slightly more than twice as long as broad, and the distal are only slightly longer than broad. All of the segments are enlarged distally, slightly overlapping the bases of those succeeding.

The radials are visible only in the interradial angles. The IBr_1 are narrow and much curved. The IBr_2 (axillaries) are about as long as broad, almost square, with the four sides concave.

The 10 arms are 65 mm. long and very slender. The first brachials are short with a long outer and a short inner edge. The second brachials are irregularly quadrate. The first syzygial pair (composed of the third and fourth brachials) is longer inwardly than outwardly. The following brachials are slightly wedge-shaped, becoming more obliquely wedge-shaped and elongate and centrally constricted distally. The brachials have produced and spinous distal ends.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 2, more rarely 3, muscular articulations.

P_1 is 7 mm. long, moderately slender, composed of about 20 segments, of which the basal 3 or 4 are short and the remainder are longer than broad. P_2 is somewhat shorter, with about 12 segments, of which the proximal 4 are short and the remainder are longer than broad. P_3 resembles P_2 and is of the same length. P_4 and the following pinnules bear large gonads. The distal pinnules are 9 mm. long, very slender, with 15 segments, of which the first 2 are short and broad and the remainder much elongated.

Localities.—*Albatross* station 4917; Eastern Sea, about 90 miles WSW. of Kagoshima Gulf; Gwaja Shima bearing S. 39° E., 37 miles distant (lat. 30°24′ N., long. 129°06′ E.); 660 meters; temperature 5.95° C.; gray sand, globigerinae and broken shells; August 13, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 22617). Type locality.

Albatross station 4916; Eastern Sea, about 90 miles WSW. of Kagoshima Gulf; Gwaja Shima bearing S. 37° E., 37.5 miles distant (lat. 30°25′ N., long. 129°06′40″ E.); 660 meters; temperature 5.95° C.; globigerinae and broken shells; August 13, 1906 (2, U.S.N.M., 35926).

?Korea; Capt. Suensson, 1893 [A. H. Clark, 1909] (1, C.M.).

Albatross station 4971; Linschoten Strait, between Shikoku and Honshu; Shio Misaki Light bearing N. 75° E., 9.6 miles distant (lat. 33°23′30″ N., long. 135°34′00″ E.); 1186 meters; temperature 3.39° C.; brown and green mud and foraminifera; August 30, 1906 (1, U.S.N.M., 36080).

Geographical range.—Southwestern Japan from southwest of Kyushu to the Linschoten Strait (? Korea).

Bathymetrical range.—From 660 to 1186 meters.

Thermal range.—From 3.39° C. to 5.95° C.

Remarks [by A.M.C.].—The only specimen of *T. isis* which has been described has the arms 65 mm. long, so that a direct comparison with the sympatric species *parva* is difficult. The largest specimen of the latter, that from Sagami Bay in 731 meters named *comaster* by Gislén in 1922, has the arms 45 to 50 mm. long, the longest of the 15 cirrus segments is about three times as long as broad. The smaller specimens of *parva* have progressively fewer and relatively longer cirrus segments, so that it is likely that one with arms as much as 65 mm. long would have the longest cirrus segments less than three times as long as wide, as they are in *isis*. In 1927 Gislén figured the base of a cirrus of the specimen from ?Korea named *isis* by Mr. Clark in 1909. This appears to have the cirrus segments relatively longer than in the type of *isis* and much more like those of *parva*.

It may be that the position of the first genital pinnule, P_2 in *parva* as opposed to P_4 in *isis*, is more reliable in distinguishing the two species. But Gislén has also described a specimen under the name *Thaumatometra* cf. *tenuis* from 110 meters in Sagami Bay with arm length 40 mm. in which either P_3 or P_4 is the first genital pinnule. The gonads of this specimen were small and he concluded that it was immature and therefore could not be conspecific with the specimen he had named *comaster* in 1922 (i.e. *parva*) or with *isis*. With the present inadequate material of these species no definite conclusion can be reached about this specimen. It is described more fully under the heading of *tenuis*.

THAUMATOMETRA COMASTER A. H. Clark

Thaumatometra comaster A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 128 (listed; *nomen nudum*); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 232 (description; *Albatross* sta. 5032); Crinoids of the Indian Ocean, 1912, p. 246 (synonymy; locality); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (locality; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 256 (references). (Not *T. comaster* GISLÉN, 1922, 1924, and 1927 = *T. parva* A. H. Clark.)

Diagnostic features.—The centrodorsal is much flattened, almost discoidal; the XL to XLV cirri are composed of 13 to 17 segments, of which the longest are three times as long as broad and the last 3 or 4 are not very much longer than broad; P_2 is the first genital pinnule. When the arms are 45 mm. long the cirri are only about 8 mm.

Description.—The centrodorsal is low hemispherical, nearly covered with cirrus sockets which are closely crowded and more or less irregularly arranged.

The cirri are XL–XLV, 13–17 (usually about 15), 8 mm. long, the apical shorter. The first segment is short, the second is about as long as broad, the third is over twice as long as its proximal width, and the fourth, which is the longest, is about 3 times as long as its proximal width; the following segments gradually decrease in length so that the 4 or 5 terminal are about half again as long as wide. The opposing spine is very small, terminally situated, and directed obliquely forward. The terminal claw is about as long as the penultimate segment, rather stout and strongly curved. The earlier cirrus segments have expanded and produced distal ends, this feature dying away on the terminal 5 or 6, which are somewhat compressed laterally.

The distal edges of the radials are even with the rim of the centrodorsal. The IBr_1 are very short, with the lateral edges straight and the distal border concave. The IBr_2 (axillaries) are rhombic, about as long as broad, with the anterior angle somewhat produced and with a rather sharply rounded posterior projection incising the IBr_1.

The 10 arms are about 45 mm. long. The first brachials are short, about twice as long exteriorly as interiorly, with the distal border concave and the inner edges entirely free. The second brachials are larger, irregularly quadrate, with an angular posterior projection incising the first. The first syzygial pair (composed of brachials 3+4) is about as long as broad, slightly longer interiorly than exteriorly. The following 4 or 5 segments are oblong or slightly wedge-shaped, broader than long, those succeeding becoming more obliquely wedge-shaped and rather longer than broad, gradually increasing in length distally.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is broken on all the arms; it seems, however, to have been no longer than P_2, which, like the following pinnules, bears a large gonad.

Locality.—*Albatross* station 5032; in Yezo Strait, north Japan, between Yezo and Kunashir (lat. 44°05′00″ N., long. 145°30′00″ E.); 548–974 meters; temperature 1.61° C. and 2.17° C.; brown or green mud, fine black sand and gravel; September 30, 1906 [A. H. Clark, 1908] (1, U.S.N.M., 22681).

THAUMATOMETRA PLANA (A. H. Clark)

Trichometra plana A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 240 (description; *Investigator* sta. 232).

Thaumatometra plana A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 255 (in key; range), p. 258 (references).

Diagnostic features.—The centrodorsal is much flattened, almost discoidal; the cirri are numerous, LV–LX: P_1 has about 13 segments. The arms were probably between 30 and 35 mm. long in the type. The cirri are unknown.

Description.—The centrodorsal is very low hemispherical, practically thin discoidal with a beveled edge, 2 mm. in diameter. The cirrus sockets are very numerous, from 55 to 60 in number, gradually decreasing in size from the periphery to the center of the centrodorsal. Near the rim of the centrodorsal there are about 4 to a radial area; the sockets about the dorsal pole are scarcely half as large as these. The dorsal pole is small and practically flat. In lateral view the centrodorsal appears thin discoidal with a single row of cirrus sockets, four to each radial area.

The cirri are unknown.

The radials are barely visible beyond the rim of the centrodorsal; their distal angles are slightly separated. The IBr_1 are very short, about six times as broad as long, the sides of adjacent IBr_1 being parallel to each other and slightly separated. The IBr_2 (axillaries) are twice as broad as long, almost triangular, with the distal angle produced, the anterior sides concave, and the lateral angles slightly produced and ending in a fringe of fine spines.

The 10 arms measure 14 mm. from the radials to the eighteenth brachial.

Syzygies occur between brachials 3+4, 9+10, and 14+15, and distally at intervals of 3 muscular articulations.

P_1 is 5.5 mm. long, with 13 segments, exceedingly slender and hairlike. The first segment is twice as broad as long, the second is slightly longer than broad, the third is slightly over twice as long as broad, and the following increase in length so that the distal are excessively elongated with swollen articulations. The pinnule tapers gradually to the fifth segment and is extremely slender from that point onward. P_2 is 3.5 mm. long, with 8 segments, of which the first is broader than long, the second is slightly longer than broad, and the remainder are excessively elongated and slender; it is just perceptibly smaller basally than P_1. P_3 is 3 mm. long, with 8 segments, and resembles P_2. The following pinnules are all broken; but the segments of all of them, except for the first two, are excessively elongated.

Locality.—Laccadive Sea (lat. 7°17′30″ N., long. 76°54′30″ E.); 786 meters; temperature 3.3° C.; gray mud; August 19, 1897 [A. H. Clark, 1912] (1, I.M.).

THAUMATOMETRA, sp. A

[See vol. 1, pt. 2, pl. 57, fig. 1362]

Antedon spec. (*abyssicola* Carp.?) HARTLAUB, Bull. Mus. Comp. Zool., vol. 27, No. 4, 1895, p. 146 (*Albatross* sta. 3381; characters), p. 148, pl. 4, fig. 25.

Bathymetra, sp. DALL, Bull. Mus. Comp. Zool., vol. 43, No. 6, 1908, pp. 317, 318 (diagnosis of *Stilifer* [*Mucronalia*] *bathymetrae*).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 245 (from Hartlaub); Die Crinoïden der Antarktis, 1915, p. 147 (from Hartlaub).—BARTSCH, Proc. U.S. Nat. Mus., vol. 53, 1917, pp. 300, 353 (from Dall), pl. 49, fig. 3 (after Hartlaub).

Characters.—The single specimen from this station lacks the cirri, the arms beyond the first syzygy, and the pinnules beyond a few of the basal segments.

As described by Hartlaub the centrodorsal is conical and bears about 25 cirrus sockets which are relatively large and closely crowded. The radials are entirely exposed, their interradial angles being a little produced between the bases of the IBr_1 so that these are not in lateral contact.

Hartlaub compared it with *Bathymetra abyssicola*, but from his figure it seems to be a partially decalcified example of some species of *Thaumatometra*.

Locality.—*Albatross* station 3381; in the vicinity of Malpelo Island, Bay of Panama (lat. 4°56′00″ N., long. 80°52′30″ W.); 3239 meters; temperature 2.11° C.; green mud; March 6, 1891 [Hartlaub, 1895].

Remarks.—This specimen had attached to it a parasitic gastropod of the genus *Stilifer* belonging, according to Prof. von Martens, to the subgenus *Mucronalia*.

In 1907 I called Dr. W. H. Dall's attention to this gastropod, giving him the name of the crinoid as *Bathymetra*, sp., and in the following year he bestowed the name *Stilifer* (*Mucronalia*) *bathymetrae* upon it.

THAUMATOMETRA, sp. B

Locality.—*Albatross* station 4761; near the Shumagin Islands, Alaska; Point Farewell, Shumagin Islands, bearing N., 49 miles distant (lat. 53°57′30″ N., long. 159°31′00″ W.); 3607 meters; temperature 1.67° C.; blue clay; May 23, 1906 (1, U.S.N.M., 36222).

Remarks.—The specimen consists of the partially decalcified and unidentifiable centrodorsal and arm bases of a species apparently belonging to the genus *Thaumatometra*.

Family PENTAMETROCRINIDAE

Thaumatocrinida Haeckel, Systematische Phylogenie der wirbellosen Thiere (Invertebrata), Theil 2, 1896, pp. 469, 473 (includes only *Thaumatocrinus*).

Thaumatocrinidae Bather, Rep. British Assoc. for 1898, 1899, p. 923; *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, p. 196 (diagnosis; includes only *Thaumatocrinus*).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (includes *Thaumatocrinus;* part of Comatulidae as understood by P. H. Carpenter); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (in key; includes only *Thaumatocrinus;* range), p. 211.

Decametrocrinidae Minckert, Zool. Anz., vol. 28, No. 13, 1905, p. 494 (includes *Decametrocrinus* and *Promachocrinus*).—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (abandoned in favor of Eudiocrinidae); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (must be rejected as it includes *Promachocrinus* a genus of Antedonidae near *Heliometra* and the "utterly different *Decametrocrinus*"); Die Crinoïden der Antarktis, 1915, p. 120 (history and status).

Eudiocrinidae A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (includes *Eudiocrinus* and *Decametrocrinus*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (abandoned for Pentametrocrinidae since *Eudiocrinus* restricted belongs to the Zygometridae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (in key; range), p. 211, p. 212 (in table of range).

Pentametrocrinidae A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 124, p. 135 (includes *Pentametrocrinus*, *Decametrocrinus* and probably *Thaumatocrinus*), p. 136 (listed), p. 149; Proc. U.S. Nat. Mus., vol. 34, 1908, p. 269 (similarity of *Thaumatocrinus* to *Pentametrocrinus* and *Decametrocrinus*), p. 277 (diagnosis; range; included genera *Pentametrocrinus* and *Decametrocrinus*); vol. 35, p. 117 (sequence of articulations); Amer. Nat., vol. 42, No. 503, 1908, pp. 724, 725; Geogr. Journ., vol. 32, No. 6, 1908, p. 606; Proc. Biol. Soc. Washington, vol. 22, 1909, p. 175 (included in Macrophreata); Amer. Nat., vol. 43, 1909, p. 581; Vid. Medd. Nat. Foren. København, 1909, pp. 124, 148; Proc. U.S. Nat. Mus., vol. 36, 1909, pp. 363, 364 (relationship of *Thaumatocrinus* to *Pentametrocrinus* and *Decametrocrinus*); vol. 38, 1910, p. 331; vol. 40, 1911, pp. 6, 9, 649; Crinoids of the Indian Ocean, 1912, p. 6 (in table of E. Indian fauna), pp. 11, 12, 15 (distribution), p. 27 (geographical and bathymetrical ranges), p. 44 (in key), p. 47 (in key), p. 63 (key to the genera), p. 247; Notes Leyden Mus., vol. 34, 1912, p. 151; Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 4; Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, p. 559 (listed), p. 560 (range), pp. 562, 563; Amer. Nat., vol. 49, 1915, p. 525 (listed), p. 526 (asymmetrical genus *Thaumatocrinus*); Die Crinoïden der Antarktis, 1915, pp. 120, 121, p. 148 (references; diagnosis; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 259 (key to the included genera), pp. 265, 266 (comparison with *Atopocrinus*); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, pp. 13, 43, 47 (in key).—Gislén, Zool. Bidrag. Uppsala, vol. 9, 1924, pp. 35, 37, 83, 85, 91 (articulations), p. 213 (short intersyzygial interval), p. 232; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 52.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 16 (in key), p. 23 (diagnosis; occurrence in northwest Atlantic).—Gislén, Arch. Zool., vol. 19, No. 32, 1928, p. 12.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 97, p. 102 (listed), p. 103 (occurs in western Indian Ocean).—Fell, Tuatara, Wellington, New Zealand, vol. 3, No. 2, 1950, p. 81 (in key).—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 57, 58 (depth range).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 95.

Diagnosis.—A family of Macrophreata in which IBr series are absent, the first brachials immediately following the radials, so that the arms are undivided (or perhaps irregularly branched distally); the adult may have 5 or 10 radials and a corresponding number of arms; the first syzygy is between brachials 4+5, which are followed by a few wedge-shaped brachials, those succeeding becoming much more obliquely wedge-shaped or triangular; and the basals are metamorphosed into a rosette.

Geographical range.—From southern Japan southward to New Zealand and New South Wales, and westward to the eastern coast of Africa; Antarctic regions; from Morocco and the Canary Islands northward to the western coast of Ireland and westward to west of Iceland; Lesser Antilles.

Bathymetrical range.—From 254 (?188) to 3290 meters.

Thermal range.—From 0.83° C. to 13.33° C.

Remarks [by A.M.C.].—Since the young of *Thaumatocrinus* have only 5 radials and 5 arms like the adult *Pentametrocrinus*, it appears that one may have arisen from the other by addition or suppression of the supernumary radials in a parallel way to the duplication of radials found in *Promachocrinus* in the Heliometrinae.

Mr. Clark left no discussion of this family as a whole but his remarks on the individual species, notably under the heading of *Thaumatocrinus renovatus*, cover much of the history as well as the interrelationships within the family.

KEY TO THE GENERA OF PENTAMETROCRINIDAE

a^1. Radials and arms 10 (from southwestern Japan southward to the East Indies, thence westward to the Laccadive Islands; Antarctic regions; southwest and west of Iceland; 660–3290 meters). Thaumatocrinus (p. 767)

a^2. Radials and arms 5 (from southern Japan southward to New Zealand and New South Wales, thence westward to eastern Africa; Morocco to western Ireland; Lesser Antilles; 254 [?188]—2115 meters)........Pentametrocrinus (p. 785)

Genus THAUMATOCRINUS P. H. Carpenter*

Promachocrinus (part) P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 385, and following authors.

Thaumatocrinus P. H. Carpenter, Proc. Roy. Soc., vol. 35, No. 225, 1883, pp. 138–140 (*Thaumatocrinus renovatus*); Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, pp. 919–933; Quart. Journ. Micr. Sci., new ser., vol. 24, 1884, pp. 11, 12; *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, p. 370; Narrative, vol. 1, pt. 1, 1885, p. 312.—Wachsmuth and Springer, Proc. Acad. Nat. Sci. Philadelphia, 1885, pp. 227 and following; Revision of the Palaeocrinoidea, 1885, pp. 5 and following.—Perrier, Explorations sous-marins, 1886, p. 276; Nouv. Arch. Mus. Hist. Nat., Paris, ser. 2, vol. 9, 1886, p. 154; Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 106.—Wachsmuth and Springer, Proc. Acad. Nat. Sci. Philadelphia, 1887, p. 27; 1888, pp. 346–348, 359.—P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 66.—W. Marshall, Die Tiefsee und ihr Leben, 1888, p. 239.—Rolleston and Jackson, Forms of animal life, 1888, p. 570.—de Loriol, Paleontologie française, ser. 1, Animaux invertébrés, terrain jurassique, vol. 11, pt. 2, 1889, p. 435.—Neumayr, Die Stämme des Thierreiches, vol. 1, 1889, pp. 435, 443, 448, 457, 483.—Bather, Ann. Mag. Nat. Hist., ser. 6, vol. 5, 1890, p. 331.—Wachsmuth and Springer, Proc. Acad. Nat. Sci. Philadelphia, 1890, pp. 363, 389.—Bather, Ann. Mag. Nat. Hist., ser. 6, vol. 7, 1891, p. 464.—Norman, Ann. Mag. Nat. Hist., ser. 6, vol. 8, No. 44, August 1891, p. 181.—P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 24, 1891, pp. 3, 24.—A. Agassiz,

*See also Addenda (p. 836) under 1962.

Mem. Mus. Comp. Zool., vol. 17, No. 2, 1892, p. 39.—Murray, Geogr. Journ., vol. 3, No. 1, January 1894, p. 22, footnote.—McMurrich, Text-book of invertebrate morphology, 1894, pp. 543 and following.—Bather, Proc. Zool. Soc. London, 1895, pp. 995, 996; Natural science, vol. 6, No. 40, June 1895, p. 419; Geol. Mag., new ser., vol. 6, 1899, pp. 37, 43; Wachsmuth and Springer's Monograph on crinoids, 1899, pp. 37, 43.—Jaekel, Neues Jahrb. Min., 1899, vol. 1, p. 379.—Bather, *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, pp. 125, 135, 196.—Jaekel, Verh. internat. zool. Congr. Berlin, 1901, 1902, pp. 1081, 1082.—Delage and Herouard, Traité de zoologie concrète, vol. 3, 1903, p. 395.—Springer, Journ. Geol., vol. 14, No. 6, 1904, pp. 474, 497.—Minckert, Arch. Naturg., Jahrg. 71, vol. 1, Heft 1, 1905, p. 166.—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575.—A. H. Clark, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 343; Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (arm structure; relation to *Decametrocrinus* and *Pentametrocrinus*), p. 136 (referred to the Pentametrocrinidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (referred to the Thaumatocrinidae), p. 269 (relationships), p. 274 (identity of proximal arm structure with that of *Pentametrocrinus* and *Decametrocrinus*); vol. 35, 1908, pp. 113, 118, 128; fig. 12, p. 118 (arm structure); vol. 36, 1909, pp. 362–365 (compared with *Comatilia*, and with the young of *Comatilia;* probably a young *Pentametrocrinus*).—Oswald, Science Progress, No. 13, July 1909, p. 133.—Kirk, Proc. U.S. Nat. Mus., vol. 41, 1911, pp. 65, 66.—A. H. Clark, Journ. Washington Acad. Sci., vol. 2, No. 13, 1912, pp. 312–314 (a young stage of *Decametrocrinus; Thaumatocrinus renovatus* = *Promachocrinus abyssorum*); Crinoids of the Indian Ocean, 1912, p. 250 (included in *Pentametrocrinus*); Bull. Inst. Océanogr., Monaco, No. 294, 1914, p. 6 (10 rays the result of the coldness of the habitat); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (occurs in both Atlantic and Indo-Pacific; range); Die Crinoïden der Antarktis 1915, p. 149 (synonymy; diagnosis; range), p. 182 (both Atlantic and Indo-Pacific; range); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 13 and following (phylogenetic study); Amer. Nat., vol. 49, 1915, p. 525 (bathymetric range), p. 526 (asymmetrical character of this genus, which is the most specialized in the Pentametrocrinidae), p. 527 (types of asymmetry), p. 542 (more than 5 rays); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 259 (in key; key to the included species).—Bather, Ann. Mag. Nat. Hist., ser. 9, vol. 1, pt. 4, 1918, pp. 298, 299.—A. H. Clark, Journ. Washington Acad. Sci., vol. 9, No. 5, 1919, p. 136 (disk compared with that of *Holopus*); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 14 (asymmetry); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, pp. 13, 43 (range), p. 53 (in key).—Gislén, Zool. Bidrag. Uppsala, vol. 9, 1924, pp. 26, 28, 30, 31, 39, 91, 232 (articulations).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 23 (in key).—Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 6; Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 17.—A. H. Clark, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 98.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56 (depth range).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 95.

Taumathocrinus Perrier, Traité de zoologie, 1893, pp. 794, 795, 858.

Decametrocrinus Minckert, Zool. Anz., vol. 28, No. 13, 1905, p. 494.—A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 127; Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (included with *Promachocrinus* in family Decametrocrinidae; most nearly related to *Eudiocrinus* from which it is a meristic variation; new family Eudiocrinidae proposed to include *Eudiocrinus* and *Decametrocrinus*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (arm structure; relation to *Pentametrocrinus*), p. 136 (referred to Pentametrocrinidae), p. 149 (arm structure); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (referred to Eudiocrinidae), p. 212 (occurs in Japan and in the Crozet and Hawaiian Is.), pp. 215, 216, p. 267 (relation to *Pentametrocrinus*), p. 274 (same), p. 277 (referred to the Pentametrocrinidae), p. 516 (type not designated by author, but here designated as *Promachocrinus abyssorum* P. H. Carpenter, 1888); vol. 35, 1908, pp. 117, 118, 126–128 (arm structure and probable origin); fig. 13, p. 118; vol. 36, 1909, p. 363 (same arm structure as *Thaumatocrinus*; a meristic variation from *Pentametrocrinus*), p. 364 (derived from *Pentametrocrinus* without torsion on account of the 5 interradials).—Vaney, Bull. Mus. Hist. Nat., Paris, No. 3, 1910, p. 160 (history; discussion).—A. H. Clark, *in* Michaelsen and Hartmeyer, Die Fauna Südwest-Australiens, vol. 3, Lief. 13, Crinoidea, 1911, p. 460 (normally 10-rayed); Journ. Washington Acad. Sci., vol. 2, No. 13, 1912, p. 312 (adult of *Thaumatocrinus* type; *T. renovatus* is the young of *Decametrocrinus abyssorum*; significance of plates in former; method of adding new arms); Crinoids of the Indian Ocean, 1912, p. 10 (occurs in Hawaiian Is.), p. 27 (range in detail), p. 63 (in key), p. 247 (original reference; type); Die Crinoïden der Antarktis, 1915, pp. 120, 121 (history and status; closely related to *Pentametrocrinus*).

Pentametrocrinus (part) A. H. CLARK, Mem. Australian Mus., vol. 4, 1911, p. 796; Crinoids of the Indian Ocean, 1912, p. 32.

Thaumatrocrinus KOEHLER, Les échinodermes des mers d'Europe, vol. 1, 1924, p. 58 (editorial error).

Promachrocrinus KOEHLER, Les échinodermes des mers d'Europe, vol. 1, 1924, p. 58 (editorial error).

Diagnosis.—A genus of Pentametrocrinidae in which the adult has 10 radials from each of which arises an undivided arm (possibly irregularly branching distally in one species).

Type species.—*Thaumatocrinus renovatus* P. H. Carpenter, 1883.

Geographical range.—From southwestern Japan southward to the East Indies, thence westward to the Laccadive Islands; Antarctic regions; southwest and west of Iceland.

Bathymetrical range.—From 660 to 3290 meters.

Thermal range.—From 0.83° C. to 5.50° C.

KEY TO THE SPECIES OF THAUMATOCRINUS

[by A.M.C.]

a^1. Gonads in serial form along the pinnules, with an expanded sac corresponding to each pinnule segment, thus appearing moniliform; the arms may be over 300 mm. in length and irregularly branched (off the Maldive and Laccadive Islands, Indian Ocean; 914–1285 meters).
investigatoris (p. 769)

a^2. Gonads undivided, ovoid, concentrated on a few pinnule segments towards the base: arms not known to exceed 250 mm. and unbranched.

b^1. Probably large species growing to a size of 9 mm. diameter of centrodorsal; cirri XXX–C.

c^1. Centrodorsal flattened hemispherical.

d^1. Cirri about C when the centrodorsal is 9 mm. in diameter; proximal part of the arms broad, very rugged, with well developed articular tubercles (Hawaiian Islands; 1393–1828 meters) rugosus (p. 772)

d^2. Cirri about LX when the centrodorsal is 9 mm. in diameter; proximal part of the arms smooth, articular tubercles not very prominent (southeast of the Philippines; 914–1264 meters) naresi (p. 773)

c^2. Centrodorsal low conical; cirri about LXXX when the centrodorsal diameter is 9 mm. (southwestern Japan; 660 meters) borealis (p. 775)

b^2. Size apparently small, not known to exceed 3.5 mm. diameter of centrodorsal; cirri up to XX.

c^1. Southern Ocean; 2425–3290 meters renovatus (p. 776)

c^2. West of Iceland; 823–2075 meters jungerseni (p. 782)

[NOTE BY A.M.C.] Since a reexamination of the specimens of *renovatus* in the British Museum has shown that the third cirrus segments are not necessarily elongated, the use of this character in the key by Mr. Clark to distinguish *renovatus* from *jungerseni* does not hold up. I can see no other significant difference between them but the geographical separation.

THAUMATOCRINUS INVESTIGATORIS, sp. nov. A. H. Clark

FIGURE 48

Decametrocrinus, sp. A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 248, fig. 47,*a*,*b*, p. 249 (description; *Investigator* sta. 124); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 98.

Thaumatocrinus, sp. A. H. CLARK, Die Crinoïden der Antarktis, 1915, p. 150 (same record); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 87, p. 98 (*Mabahiss* sta. 158; description; remarks), p. 102.

Diagnostic features.—The extraordinary beadlike gonads, one sac to each segment of the pinnules and the irregularly branched arms distinguish this species from the rest of the genus.

Characters.—The type specimen consists of a single incomplete arm broken into eight fragments, all but one of which evidently belong in a linear series.

The total length of the specimen is 278 mm., and the basal portion is 4 mm. in diameter. It is probable that at least 50 mm. of the basal part is missing, and 40 mm. of the tip, so that the arm length of the living animal must have been nearly or quite 350 mm. This would give an expanse of 700 mm., and indicate a size approximately the same as that of *Heliometra glacialis* var. *maxima*, the largest known comatulid recent or fossil.

In this specimen the gonads, instead of being ovoid or fusiform bodies as in all other known comatulids, are broken up into a series of small beadlike sacs, approximately one to each of the greatly elongated pinnule segments, which are protected by prominent calcareous plates. This may be due to sexual differentiation, but it seems more probable that its significance is specific and, taken in connection with the very large size, it certainly differentiates this species sharply from all the others in the genus.

This single arm is peculiar in being twice branched. The thirty-fourth brachial from the proximal end as preserved is the hypozygal of a syzygial pair, the epizygal of which has the distal face divided and bearing two brachials, each of which is but slightly smaller than the more normal one would have been. On the left (as viewed dorsally) the first brachial beyond this axillary is short and is united by syzygy to the brachial succeeding. The first brachial on the right is twice as long, obliquely wedge-shaped, with the longer side inward. These two brachials are interiorly united basally for about four-fifths of the length of the left (smaller and shorter) brachial. The twenty-fifth brachial further on bears a well-developed arm as large as the main trunk instead of the usual pinnule; in this supernumerary arm the fourth and fifth brachials are united by syzygy as in primary arms.

When this specimen was placed side by side with the arms of *T. rugosus* from the Hawaiian Islands, no essential differences were found beyond the proportionately greater size and the somewhat different arrangement of the syzygies.

Notes [BY A.M.C.].—In 1937 Mr. Clark described some fragments from John Murray station 158 off the Maldive Islands, which he declared are of the same species as those taken by the *Investigator*. The longest piece, from the outer portion of an arm, is 60 mm. long and 2 mm. broad. It consists of 34 brachials, of which there are 8 syzygial pairs, each separated from the next by 3 or 4 muscular articulations. The brachials are about half again as long as broad with very oblique ends and are rather strongly excavated on the shorter side. The pinnule is attached to the middle of the longer side. Above the pinnule socket the brachial is excavated for the reception of the pinnule when at rest. The pinnules bear along the ventral surface a linear series of small eggs, one to each segment.

Another fragment is 55 mm. long and 2.7 mm. wide at the base. On the eighteenth brachial from the base a short distal portion is regenerated, and on this is a pentagonal axillary bearing two arms, one 12 mm. long with 8 brachials and the other 17 mm. long with 11 brachials. The two first brachials are united interiorly for over half their lengths. Each bears a pinnule on the middle of the outer side. On one

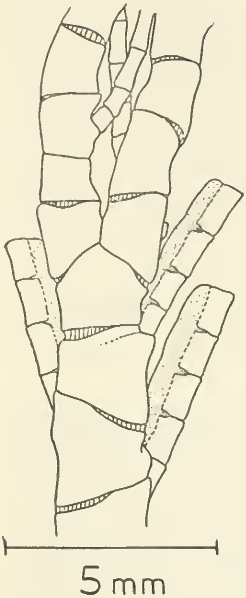

FIGURE 48.—*Thaumatocrinus investigatoris* sp. nov., B.M., 1937. 2.25.29, John Murray station 158, part of arm with axillary.

branch there are syzygies at 2+3 and 6+7, on the other the first syzygy is at 5+6. The pinnules on the main portion of the arm are all moniliform, each bearing ventrally a linear series of eggs; those on the two regenerated arm branches have not as yet developed eggs. The brachials in the main portion of the arm are very obliquely wedge-shaped, almost triangular, somewhat longer than broad, and slightly constricted centrally. The brachials in the two regenerated branches are much longer than broad. The intersyzygial interval is 4 muscular articulations.

The third fragment is a continuation of the left regenerated branch of the preceding one. It is 17 mm. long and consists of 11 brachials.

The individual from which these fragments came was a female. The genital pinnules bear on the ventral side a linear series of entirely closed globular sacs, broadly in contact, and completely enclosed exteriorly by large thin plates, one to each segment, giving the ventral surface of the pinnules a moniliform appearance. The transverse septa between the sacs are very thin. Each sac contains a single large egg.

Localities.—*Investigator* station 124; off the Laccadive Islands (lat. 10°47′45″ N., long. 72°40′20″ E.); 1285 meters; coral bottom; November 21, 1891 [A. H. Clark, 1912] (1 arm, I.M.). Type locality.

John Murray Expedition station 158; off the Maldive Islands (lat. 4°42′30″ N., long. 72°42′30″ E. to 4°36′48″ N., 72°48′54″ E.); 914 meters; April 7, 1934 [A. H. Clark, 1937] (3 fragments, B.M.).

Remarks.—In 1937 Mr. Clark commented that both groups of fragments of this species were taken together with broken specimens of *Crotalometra sentifera.*

He also said that among the known forms of this family, these fragments approach most closely in their structure the species of *Thaumatocrinus*, but the form of the gonads seems to be unique so that the species will probably prove to belong to a different, though related, genus.

[Note by A.M.C.] This part of the typescript was probably written before 1936 and it may be that Mr. Clark had second thoughts about giving a specific name to such broken fragments, since he gave no name to the John Murray material. However, it is obvious that this is a very distinctive form, and so I am leaving it under the name proposed by Mr. Clark in the typescript.

THAUMATOCRINUS RUGOSUS (A. H. Clark)

Decametrocrinus rugosus A. H. Clark, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 213 (in key), p. 215 (description; *Albatross* sta. 4157); vol. 35, 1908, p. 126 (explanation of 9-rayed condition of the type specimen); Crinoids of the Indian Ocean, 1912, p. 248 (range).

Thaumatocrinus rugosus A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 149 (in key), p. 150 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 260 (in key; range).

Diagnostic features.—The size of the unique type specimen is large, the arms being between 200 and 250 mm. in length, and the centrodorsal 9 mm. in diameter at the base. The centrodorsal is large, very much flattened, with a large bare polar area, the second brachial is not appreciably longer than the first, and the proximal portion of the arms is broad and very rugged, with strongly developed articular tubercles.

Description.—The centrodorsal is very low hemispherical, almost thick discoidal. 9 mm. in diameter at the base, with a large bare polar area, the surface of which is studded with shallow pits. The cirrus sockets are closely crowded, arranged roughly in 3 or 4 rows, with about 4 sockets beneath each radial at the periphery of the centrodorsal.

The cirri are about C, but all are broken off at the base. The longest fragment is 15 mm. long and consists of 7 segments, of which the first is very short, the second is about as long as broad, the third is about three times as long as broad, and the remainder are about four times as long as broad. The first two segments are almost circular in cross section, but the third and following become laterally compressed. The segments are oblong in lateral view.

The ends of the basal rays are occasionally visible as slight tubercles beneath the sutures dividing adjacent radials.

There are 9 radials, the right posterior radius possessing one instead of the normal two. The distal ends of the radials are even with the rim of the centrodorsal; their distal borders are nearly straight, and are not produced interradially.

The 9 arms appear to have been between 200 and 250 mm. long. The first brachials are about twice as broad as long, closely united in the proximal half but widely free beyond, so that a large U-shaped gap separates the distal halves of each two adjacent first brachials. The second brachials are trapezoidal, half again as broad distally as proximally, with the sides concave. The third brachials are nearly twice as broad as long, with the distal and proximal edges equal to the distal edge of the second brachials in length and the lateral edges strongly concave. The first syzygial pair (composed of brachials 4+5) is about as long as its greatest width, with the lateral edges strongly concave. The four following brachials are similar to the second; those succeeding become wedge-shaped, smooth, nearly twice as broad as long, later more obliquely wedge-shaped or practically triangular, about as long as broad, and distally wedge-shaped again and much longer than broad, as much as 4 or 5 times as long as broad in the terminal brachials. The brachials from the second to the ninth inclusive are rather disproportionately large and very strongly tubercular.

Syzygies occur between brachials 4+5, 9+10, and distally at intervals of from 2 to 4 (usually 3 or 4) muscular articulations.

The second brachial bears a pinnule, P_1. The genital pinnules bear short rounded gonads.

Locality.—*Albatross* station 4157; Hawaiian Islands, in the vicinity of Modu Manu, or Bird Island; center of Bird Island bearing S. 77°30′ E., 11.1 miles distant; 1393–1828 meters; temperature 3.33° C.; white mud, Foraminifera, and rocks; August 6, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 22682).

Remarks.—As yet this species is only known from the single much broken 9-rayed specimen described above.

THAUMATOCRINUS NARESI (P. H. Carpenter)

[See vol. 1, pt. 1, fig. 114, p. 181]

Promachocrinus naresii P. H. Carpenter, Proc. Roy. Soc., vol. 28, 1879, p. 385 (*nomen nudum*); Nature, vol. 19, 1879, p. 450 (*nomen nudum*).

Promachocrinus naresi P. H. Carpenter, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 352 (description; *Challenger* sta. 214); pl. 69, figs. 8–10.—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. Clark, Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter, 1888=*Decametrocrinus naresi*); Die Crinoïden der Antarktis, 1915, p. 120 (belongs to the Pentametrocrinidae; =*Thaumatocrinus naresi*).

Decametrocrinus naresi Minckert, Zool. Anz., vol. 28, No. 13, 1905, p. 501.—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 216 (compared with *D. rugosus*); Crinoids of the Indian Ocean, 1912, p. 33 (=*Promachocrinus naresi* P. H. Carpenter, 1888), p. 248 (synonymy; includes *D. borealis* A. H. Clark, 1907; range).

Thaumatocrinus naresi A. H. Clark, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (published references to specimens in B.M.; *Challenger* sta. 214; comparison with *T. borealis*); Die Crinoïden der Antarktis, 1915, p. 150 (in key; range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 260 (in key; range; notes; sta. 122), p. 273 (listed); fig. 14, p. 260.—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 12 (notes).

Diagnostic features.—The centrodorsal is flattened hemispherical, 5.5 and 9 mm. in diameter in the two specimens known, with about XL and LX cirrus sockets respectively; the articular tubercles on the proximal brachials are not very prominent.

Description [by A.M.C.].—The centrodorsal is flattened hemispherical, 9 mm. in diameter at the base, 3.5 mm. in height and the diameter of the dorsal pole between the cirrus sockets is 4 mm. There are LX sockets alternating in position in about three irregular rows around the sides of the centrodorsal.

No cirri remain but a terminal fragment of one with 6 segments and measuring 8 mm. was found in the jar, which presumably comes from this specimen. The terminal claw is short, blunt, and hardly at all inclined dorsally. The penultimate segment is twice as long; it has no opposing spine and even tapers very slightly towards the distal end; it is half again as long as broad. The other segments have similar proportions but are a little wider dorsoventrally and the first three are slightly expanded in the same plane towards their distal ends.

The edges of the radials are visible beyond the edge of the centrodorsal. The first brachials are short, 1.2 mm. long in the dorsal midline. The second ones are 1.9 mm.

long and the width at the joint between them is 2.1 mm. The width at the first syzygy, between brachials 4+5, is 2.7 mm. so the two basal segments are distinctly constricted. The length from the proximal edge of the first brachial to the first syzygy is 6 mm. The only portion of arm remaining attached beyond the first syzygy is broken at the second one, which is at 11+12, though a detached portion, probably from the fifth brachial on, has the next syzygy at 10+11.

The first four brachials are rectangular in shape but after the first syzygy they become more wedge-shaped and the distal ones are triangular, becoming longer than broad. The syzygies are very variable in position. On the middle part of the arms they are usually separated by 4 to 6 muscular articulations but further out the interval may be as many as 12 or 13. There are moderate-sized articular tubercles on alternate sides as far as the second syzygy, after which they are reduced.

The pinnules are all broken. A major part of a proximal one attached to a piece of the disk measures 10 mm. in length and has 18 segments, none of which is longer than broad. A pinnule from the middle of the arm, of which only about half remains, has the slightly flared segments much more elongated, the second one being almost twice as long as wide though the first is still short. The genital pinnules appear to extend quite far out on the arms as two are preserved on a section where the width at a syzygy is only 1.6 mm. They have the first two segments short but the third and those following are about half again as long as broad. The first pinnule arises from the second brachial on the right side in six cases and from the left in the other four.

No estimate can be made of the total length of the arms since none of the fragments remaining is longer than 40 mm.

Notes.—In the specimen taken by the *Siboga* the centrodorsal is 2.5 mm. high and 5.5 mm. in diameter; the very flattened dorsal pole is 2.5 mm. across. Around the sides there are about forty cirrus sockets in three crowded rows, which show a tendency towards arrangement in vertical lines. The cirri are all broken off short. The third segment is about two and a quarter times as long as broad.

The 10 radials are in mutual apposition all around the calyx, being only slightly separated at the distal angles. They are short, projecting beyond the centrodorsal for a distance equal to from a third to a half the length of the first brachials.

The first brachials are approximately oblong, averaging twice as broad as long. The second brachials are similar, of about the same size or slightly shorter. The arm measures 6 mm. from the distal edge of the radials to the distal edge of the fourth brachial (the first syzygy) and the width of the first syzygy is 2.4 mm.

Gislén (1928) gave some brief notes on the type specimen including the fact that there are 23 septa on the syzygial face of the fourth brachial, of which 13 are complete.

Localities.—*Challenger* station 214; off the Meangis Islands (lat. 4°33′ N., long. 127°06′ E.); 914 meters; temperature 5.44° C.; blue mud; February 10, 1875 [P. H. Carpenter, 1879, 1888; A. H. Clark, 1913] (1, B.M.). Type locality.

Siboga station 122; Sangi Islands, northeast of Celebes (lat. 1°58′30″ N., long. 125°00′30″ E.); 1165–1264 meters; bottom, stone; July 17, 1899 [A. H. Clark, 1918] (1, Amsterdam Mus.).

Remarks [by A.M.C.].—The key to the species of *Thaumatocrinus* left by Mr. Clark distinguished *T. naresi* and *rugosus* from the Japanese *borealis* by the appreciably longer second brachials (compared with the first) in *borealis* alone. In measuring the type specimen of *naresi,* I found that the lengths of the first two brachials on each arm are by no means the same but in a quite constant ratio of 1:1.6, the second being distinctly longer on all the arms. Since the type has the centrodorsal 9 mm. in diameter, like the types of both *rugosus* and *borealis*, there is no distinction of size between the three species and only the different numbers of cirrus sockets and the more conical shape of the centrodorsal in *borealis* (though this appears to be but 0.5 mm. higher than that of *naresi*) seem to distinguish them, unless the different development of the articular tubercles is found to be constant in the Hawaiian *rugosus* as opposed to the other two species.

The *Siboga* specimen of *naresi* has the Br_2 no longer than the Br_1 according to Mr. Clark, but in view of the intermediate proportions of the type compared with *borealis* I do not think this is significant.

THAUMATOCRINUS BOREALIS (A. H. Clark)

Decametrocrinus borealis A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 71 (description; *Albatross* sta. 4918); vol. 34, 1908, p. 216 (compared with *D. rugosus*), p. 319 (Japan); Crinoids of the Indian Ocean, 1912, p. 248 (considered as a synonym of *D. naresi*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 66 (a valid species; comparison with *naresi*).

Thaumatocrinus borealis A. H. CLARK, Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 67 (comparison with *T. naresi*); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese type; range and its significance); Die Crinoïden der Antarktis, 1915, p. 149 (in key), p. 150 (range); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 259 (in key; range), p. 260 (specific validity).

Diagnostic features.—The size of the unique type specimen is rather large, the arms being about 125 mm. in length and the centrodorsal 9 mm. broad at the base. The second brachial is twice as long as the first, which is disproportionately small and is excavated by a rounded proximal production of the lower border of the second, and the centrodorsal is low conical bearing about LXXX cirri, there being at the periphery 6 to 8 sockets beneath each radial.

Description.—The centrodorsal is low conical with the sides swollen, 9 mm. broad at the base and 4 mm. high. There is a moderately large bare polar area. The cirrus sockets are closely crowded, arranged in from 2 to 4 rows, with from 6 to 8 beneath each radial about the periphery of the centrodorsal.

The cirri, about LXXX, are all lacking.

The ends of the basal rays, flush with the surface of the centrodorsal, are just visible in alternate interradial angles.

The 10 arms are about 125 mm. long. The first brachials are short and oblong, about 3 times as broad as long, entirely separated from their neighbors. The second brachials are much larger, not quite twice as broad as long, with the proximal edge somewhat produced posteriorly and with the distal edge of the first forming a slight tubercle. The following brachials to about the fifteenth are wedge-shaped, about twice as broad as their median length, those succeeding becoming gradually more obliquely wedge-shaped and then triangular, about as long as broad, distally wedge-shaped again and finally elongate.

Syzygies occur between brachials 4+5, 9+10 or 10+11, and distally at intervals of from 3 to 7 (usually 4 or 5) muscular articulations.

P_1, on the second brachial, is 15 mm. in length, long, slender, evenly tapering and gradually becoming flagellate distally, composed of 45 to 50 segments, of which the basal 5 or 6 are broader than long with the corners cut away, those following are about as broad as long, and the terminal are slightly longer than broad. P_a and P_2 are similar, but only 12 mm. long. The following pinnules are somewhat stouter, with the first two segments very short, the third about as long as broad, and the following becoming progressively elongated, with the distal edges slightly everted and very finely spinous. The succeeding pinnules gradually acquire longer segments; the pinnules in the distal part of the proximal third of the arm have the third and fourth segments twice as long as broad and the following about 3 times as long as broad, becoming even longer distally. The distal pinnules are about 15 mm. long, with about 20 to 25 segments, of which the first 2 are very short, the third is about two and a half times as long as broad, and those succeeding become gradually more elongated. The distal pinnules are slender, and their component segments have everted and finely spinous distal ends.

Locality.—Albatross station 4918; Eastern Sea, about 90 miles west-southwest of Kagoshima Gulf; Gwaja Shima bearing S. 38° E., 34 miles distant (lat. 30°22′00″ N., long. 129°08′39″ E.); 660 meters; gray sand, globigerinae, and broken shells; August 13, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 22652).

Remarks.—After describing this species in 1907 I came to the conclusion that it was in reality the same as Carpenter's *naresi*, and in 1912 relegated it to the synonymy of that species. In 1910 I examined the type of *T. naresi* in the British Museum and found, as stated in 1913, that *T. borealis* is easily distinguished from *T. naresi* by the small size of the first and the large size of the second brachials, the latter being nearly or quite twice as large as the former, whereas in *T. naresi* the first 3 brachials are all of about the same size. [NOTE BY A.M.C.: But see my remarks about *T. naresi.*] *T. borealis* is also more rugged than *T. naresi.*

THAUMATOCRINUS RENOVATUS P. H. Carpenter

FIGURE 49

[See also vol. 1, pt. 1, figs. 115–118 (p. 183), 302 (p. 264), pl. 5, fig. 552; pt. 2, pl. 23, fig. 1141]

Promachocrinus abyssorum P. H. CARPENTER, Proc. Roy. Soc., vol. 28, 1879, p. 385 (*nomen nudum*), Nature, vol. 19, 1879, p. 450 (*nomen nudum*); Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 919, footnote; *Challenger* Reports, Narrative, vol. 1, pt. 1, 1885, p. 311; Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 386; *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 351 (description; *Challenger* stas. 147, 158), pl. 1, figs. 4, 5, pl. 69, figs. 5–7.—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 300.—SHIPLEY, Antarctic manual, 1901, Ch. 18, p. 269.—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576.—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 33 (identity); Die Crinoïden der Antarktis, 1915, p. 120 (belongs to the Pentametrocrinidae; = *Thaumatocrinus renovatus*).—BATHER, Ann. Mag. Nat. Hist., ser. 9, vol. 1, No. 4, 1918, p. 300.

Thaumatocrinus renovatus P. H. CARPENTER, Proc. Roy. Soc., vol. 35, 1883, p. 138 (preliminary notice; *Challenger* sta. 158); Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 919 (detailed description and comparisons; *Challenger* sta. 158), pl. 71; *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, p. 372 (description; *Challenger* sta. 158), pl. 56, figs. 1–5; Narrative, vol. 1, pt. 1, 1885, p. 312, figs. 124, A, B, p. 312 (from preceding).—PERRIER, Explorations sous-marins, 1886, p. 276.—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 66 (description; *Challenger* sta. 158); figs. 1, A, B, p. 67.—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 299 (from Carpenter).—LANG, A text book of comparative anatomy, vol. 2, 1896, p. 310, fig. 256.—BATHER, *in* Lankester, A treatise on zoology, vol. 3, Echinoderma, 1900, p. 196, fig. cxix.—SHIPLEY, Antarctic Manual, 1901, Ch. 18, p. 269.—DELAGE and HEROUARD, Traité de zoologie concrète, vol. 3, 1903, p. 394, fig. 496.—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 36, 1909, p. 362 (compared with young *Comatilia*), p. 363 (arm and pinnule structure identical with that of *Pentametrocrinus* and *Decametrocrinus*); Journ. Washington Acad. Sci., vol. 2, No. 13, 1912, pp. 311–314 (interpretation of structure; young of *Promachocrinus abyssorum*); Crinoids of the Indian Ocean, 1912, p. 32 (=*Pentametrocrinus*, sp.), p. 250 (included in *Pentametrocrinus*), p. 251; Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 67 (published references to specimens in the B.M.; *Challenger* stas. 147, 158; notes); Journ. Washington Acad. Sci., vol. 5, No. 3, 1915, p. 81 (Antarctic; range); Die Crinoïden der Antarktis, 1915, p. 104 (collected by the *Gauss*), p. 106 (collected by the *Challenger*; recorded as *Thaumatocrinus renovotus*+*Promachocrinus abyssorum*), p. 107 (in key to antarctic crinoids), p. 149 (in key to the species of *Thaumatocrinus*), p. 150 (synonymy; *Gauss* records; previous records), p. 170 (a deep water antarctic species; range), p. 171 (systematic and geographical relationships), p. 193 (further discussion), pl. 9, figs. 1, 2; Unstalked crinoids of the *Siboga*-Exped., 1918, p. 259 (in key; range).—BATHER, Ann. Mag. Nat. Hist., ser. 9, vol. 1, No. 4, 1918, p. 299 (interradials).—A. H. CLARK, The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 17 (compared with *T. jungerseni*).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 26 (position of lowest pinnule); Ark. Zool., vol. 19, No. 32, 1928, p. 12 (notes); Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 56 (depth range).

Taumathocrinus renovatus PERRIER, Traité de zoologie, 1893, p. 858.

Decametrocrinus abyssorum MINCKERT, Zool. Anz., vol. 28, No. 13, 1905, p. 501.—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 216 (compared with *rugosus*); Mem. Australian Mus., vol. 4, 1911, p. 796 (locality); Journ. Washington Acad. Sci., vol. 2, No. 13, 1912, pp. 312–314 (adult of *T. renovatus*; growth of the latter); Crinoids of the Indian Ocean, 1912, p. 33 (=*Promachocrinus abyssorum* P. H. Carpenter, 1888), p. 248 (synonymy; localities).

Pentametrocrinus, sp. A. H. CLARK, Mem. Australian Mus., vol. 4, 1911, p. 796; Crinoids of the Indian Ocean, 1912, p. 32.

Promachrocrinus abyssorum KOEHLER, Les échinodermes des mers d'Europe, vol. 1, 1924, p. 58 (depth).

Thaumatrocrinus renovatus KOEHLER, Les échinodermes des mers d'Europe, vol. 1, 1924, p. 58 (depth).

Diagnostic features.—None of the six known specimens exceeds a size of 3.5 mm. diameter of centrodorsal and 4 mm. length of the first 4 brachials; the centrodorsal is low conical with a distinct apex and bears up to XX cirri, of which the basal 2 or 3 segments are short but the rest are probably several times longer than broad; the proximal pinnules are long, with over 15 segments, those of P_1 being not more than twice as long as broad; the segments of the distal pinnules are progressively more elongated.

Description [by A.M.C.].—The specimen from *Challenger* station 158, which is one of the syntypes of *Promachocrinus abyssorum* Carpenter, has the centrodorsal low conical with the dorsal pole coming to a distinct peak. It is 3 mm. in basal diameter and 1.2 mm. high. There are XIV cirrus sockets of which the rims are very prominent except at the distal end. Three segments of the base of one cirrus remain attached. They are all short; even the third is shorter than broad.

The first four brachials together measure 4 mm. in length. The width at the first syzygy at 4+5 is 1.3 mm. The second syzygy is usually at 9+10. The distal intersyzygial interval is from 2 to 5 muscular articulations. The arms are all broken within 25 mm. distance from the calyx. The second brachial has a convex proximal side but is barely longer than the first. It bears the first pinnule, which in 6 cases (5 of which are adjacent) is on the right side and in 4 is on the left. The distal brachials are triangular and become longer than broad.

P_1 has 16+ short segments and measures 5 mm.

P_a with 17 segments may bear a small gonad or P_2 or P_b may be the first genital pinnule.

P_2 has 12+ segments and measures 7 mm. The distal segments are about twice as long as broad. The gonads are very short and thick; they extend for only 3 or 4 segments of the pinnule and end abruptly.

The distal pinnules have progressively more elongated segments, mostly about four times as long as broad and with slightly expanded joints.

The larger specimen from station 147 (fig. 49), which is the syntype of *abyssorum* figured by Carpenter, has the centrodorsal 3.5 mm. in diameter and 1.5 mm. high. The center of the dorsal pole is abruptly raised in a small peak. There are XIX cirrus sockets.

A fragment of cirrus found in the jar has three very long complete segments, each four times as long as broad, with a broken segment at each end. Carpenter figured a detached cirrus of 7 proximal segments with the first two very short; this fragment is presumably its outer half.

The 10 arms are all broken within 30 mm. of the calyx.

The first four brachials measure 4 mm. together and the first syzygy at 4+5 is 1.1 mm. wide. The second brachial is very slightly longer than the first one. It bears the first pinnule on its right side on 8 arms and only twice on the left.

No P_1 is complete.

P_a has 25+ segments, the longest of which are only half again as long as broad; it is 8 mm. long. P_2 has 22+ segments, is 8 mm. long and bears a very small gonad; its longest segments are two to two and a half times as long as broad. All the gonads are much smaller than in the specimen from station 158.

The smaller specimen from station 147 has the centrodorsal 1.6 mm. in diameter and 1.1 mm. high. It is conical in shape. The first four brachials together measure 3.2 mm. The second syzygy is either at brachials 9+10 or 11+12. The pinnules have much longer segments than those of the larger specimens. No gonads are developed.

There are some small differences between the specimen from station 158 (long. 123° E.) and those from station 147 (48° E.), notably the short third cirrus segment of the former (though this is only known from a single cirrus) and the smaller number of segments in the proximal pinnules. It remains to be seen whether these differences are of importance.

Notes.—In the specimen dredged by the *Gauss* in 2450 meters the centrodorsal is 3 mm. in diameter. There are X cirri, and about as many more or less obsolete cirrus

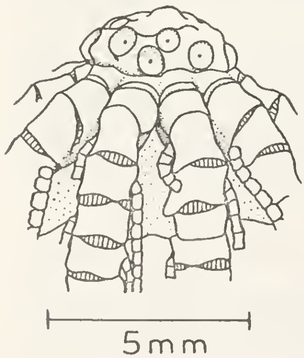

FIGURE 49.—*Thaumatocrinus renovatus* P. H. Carpenter, larger syntype of *Promachocrinus abyssorum*, B.M., 88.11.9.135–6, *Challenger* station 147.

sockets. The proportions of the cirrus segments are the same as shown in Carpenter's figure. The size is similar to that of the specimen figured by Carpenter (pl. 69, fig. 5). The arms measure 20 mm. to the distal end of the nineteenth brachial. The distal intersyzygial interval is usually 3 muscular articulations. On the disk 5 ambulacral grooves leave the mouth, dividing about midway to the arm bases; one of these grooves, the right posterior, divides into 3, while one, the left anterior, is undivided.

The example dredged by the *Gauss* in 2425 meters resembles the preceding. The cirri are XIV. The longest cirrus stump measures 16 mm. to the distal end of the eighth segment. The first segment is about twice as broad as long, the second is about as long as the median width with a strong central constriction, the third is 1.7 mm. in length, and the fourth is 2.8 mm. long; the following gradually decrease in length, the eighth being 2.2 mm. long. The cirri are very slender, resembling the cirri of such species of *Pentametrocrinus* as *P. semperi* or *P. varians*.

Young.—The centrodorsal of the juvenile type specimen of *T. renovatus* is small, flattened hemispherical, with the central canal completely closed so that it must have been for some little time detached from the larval column.

The bases of about VI cirri are attached to the centrodorsal, and there are pits for the reception of 2 or 3 more. In the largest stump which is preserved the first 2 segments are short, but the third reaches a length of 1.5 mm. so that, as remarked by Carpenter, the cirri must have been very like those of the species of *Pentametrocrinus*, which have a succession of very long segments following the short basal ones.

The basals are almost trapezoidal, much broader below than above, and in contact with one another by their truncated lower lateral angles. The middle of the lower edge of each is slightly tubercular.

On the narrow upper or distal edge of the basals rest the interradials, which are oblong and a little higher than broad. Four of these terminate in a free edge at the margin of the disk, where they are in contact with the lowest of the perisomic plates. But that in the posterior interradius bears a rudimentary arm of 4 or 5 segments, the last of which ends freely.

The radials are much larger than the interradials, and are rather strongly convex dorsally. They are united to the first brachials as usual by a muscular articulation.

The brachials are long, slender, and cylindrical; there appears to be a synarthry between the first and second.

One of the 5 arms seems to be broken off at a syzygy between brachials 6+7, while in another there are syzygies between brachials 4+5 and 9+10.

The first pinnule is on the second brachial, on the right side on 3 arms and on the left in the other 2. The pinnules are very delicate, and are composed of long and slender segments.

The central portion of the disk is occupied by 5 relatively large orals which stand up around the peristome. Between these and the margin are 2 or 3 irregular rows of small perisomic plates, some of them extending up onto the lower portion of the long anal tube.

There are no plates along the brachial ambulacra, which lie in the arm grooves close down between the muscles.

There are no traces of sacculi.

The present whereabouts of this specimen are unknown.

Localities.—*Challenger* station 147; between Marion Island and the Crozets (lat. 46° 16′ S., long. 48° 27′ E.); 2925 meters; temperature 1.22° C.; diatom ooze; December 30, 1873 [P. H. Carpenter, 1879, 1883, 1884, 1888; A. H. Clark, 1913, 1915] (2, B.M.).

Gauss; Antarctic regions in the vicinity of Gaussberg; 2425 meters; February 24, 1903 [A. H. Clark, 1915] (1, Berl. M.).

Gauss; vicinity of Gaussberg; 2450 meters; March 1, 1903 [A. H. Clark, 1915] (1, Berl. M.).

Challenger station 158; southwest of Melbourne, Australia (lat. 50° 01′ S., long. 123° 04′ E.); 3290 meters; temperature 0.83° C.; globigerina ooze; March 7, 1874 [P. H. Carpenter, 1879, 1883, 1884, 1888; A. H. Clark, 1913, 1915] (1, B.M.). Type locality, but the surviving specimen is a syntype of *Promachocrinus abyssorum* and not the type of *renovatus*.

Geographical range.—Antarctic and subantarctic regions from Marion Island and the Crozets to south of Australia.

Bathymetrical range.—From 2425 to 3290 meters.

Thermal range.—From 0.83° C. to 1.22° C.

History.—Although the name *Promachocrinus abyssorum* was used twice by Carpenter in 1879, it appeared in both cases as a *nomen nudum*, and the original description of *renovatus*, published in 1884, and based upon the single 5-armed young individual dredged by the *Challenger* at station 158, appeared before *abyssorum* was properly described.

This 5-armed specimen was described at great length and beautifully depicted in two separate publications. Its peculiarities were brought out, and detailed comparisons were made with various other species, especially among the fossils. The anomalous features of this singular specimen, which seemed to separate it sharply from all recent comatulids, and stalked crinoids as well, and to ally it with various of the older fossil species, were the presence of 5 interradials separating the 5 radials, and the occurrence on the anal interradial of a small tapering appendage of 4 or 5 gradually decreasing segments. This appendage seemed to Carpenter to be of the same nature as the so-called proboscis of *Taxocrinus*, *Gnorimocrinus*, *Onychocrinus*, etc. Further extraordinary features were the presence of a complete circlet of basals similar to, but much larger than, the basals of *Atelecrinus*, the presence of 5 large orals, and the occurrence of a pavement of closely set plates between the orals and the radials occupying about a fifth of the total diameter of the disk. But although Carpenter noted that the most striking characters of the young *Thaumatocrinus* show a resemblance to early Paleozoic crinoids, he remarked that it is, nevertheless, a comatulid, and therefore that it is more than probable that this resemblance is not due to any genetic connection between them. He mentioned the similarity of the arms and cirri to those structures in certain species of *Pentametrocrinus*.

Carpenter looked upon the occurrence of 10 radials instead of 5 in the comatulids as a character of prime importance, outweighing any characters to be found in the cirri, arms or pinnules. For the reception of the 10-rayed species he created the genus *Promachocrinus*, in which he included all the species known to him which are now distributed between the genera *Promachocrinus* and *Thaumatocrinus*. Thus it never occurred to him that there could be any connection whatever between his 5-rayed *Thaumatocrinus renovatus* and the 10-rayed *Promachocrinus abyssorum* found at the same station.

While Carpenter recognized certain similarities between the arms and cirri of his *Thaumatocrinus renovatus* and those of the species of *Pentametrocrinus* ("*Eudiocrinus*") with elongated cirri, and also noted the occurrence of orals and of evanescent plates comparable to interradials in the pentacrinoids of *Antedon*, he could not divest himself of the profound impression made upon him by the curious appearance of his specimen, and especially by the process on the anal interradial, and so considered these similarities as purely superficial.

The new genus *Thaumatocrinus* as understood from the characters presented by this young specimen was very widely noticed, and its peculiarities and curious correspondences with various Paleozoic crinoids attracted much attention. It was even made the type of a new family, the Thaumatocrinidae, by Dr. F. A. Bather in 1899.

In my preliminary studies on the comatulids in 1907 I found that the species referable to the genus *Eudiocrinus* as understood by Carpenter which I had at hand (*varians, semperi* and *tuberculatus*) were in all respects, excepting only in the number of radials, closely similar to Carpenter's *Promachocrinus naresi* and *P. abyssorum* as I understood them from analogy with a related form (*borealis*) which I had the year before dredged in Japan. But *Promachocrinus kerguelensis*, the type of the genus *Promachocrinus*, was obviously, excepting for its 10 instead of 5 radials, very closely allied to *Heliometra*. Adopting Minckert's genus *Decametrocrinus* to include *Promachocrinus naresi* and *P. abyssorum*, as well as my new species *borealis*, I created the new family Eudiocrinidae to cover *Eudiocrinus*, as understood on the basis of the three species (*varians, semperi* and *tuberculatus*) at hand, and *Decametrocrinus*, and placed *Promachocrinus* (including *P. kerguelensis* only) in the Antedonidae next to *Heliometra*. This arrangement was published on May 14, 1908, in a preliminary reclassification of the comatulids from which the genus *Thaumatocrinus* was omitted, as, although it did not appear to me to be nearly so anomalous as was commonly supposed, yet I could not satisfactorily place it anywhere.

After this paper was written, I received from Mr. Alan Owston through Mr. Frank Springer a single specimen of a new species of *Eudiocrinus* from Japan which was evidently allied to Semper's *indivisus*, the type of the genus. This specimen showed conclusively that the *Eudiocrinus* of Semper, in spite of its undivided arms, is allied to the genus *Zygometra*, and that *Eudiocrinus indivisus*, *E. granulatus*, and the new species *E. variegatus* have nothing else in common with *E. varians*, *E. atlanticus*, *E. semperi*, *E. japonicus*, and *E. tuberculatus*.

The difference of greatest importance between the *Eudiocrinus indivisus* type and the group of species typified by *E. japonicus* was found to be that in the former a IBr series is present, though the second ossicle is not axillary, while in the latter the arms are morphologically comparable to the arms of other comatulids beyond the last axillary or its equivalent.

The genus *Pentametrocrinus* was created to include those species of Carpenter's genus *Eudiocrinus* in which IBr series are absent (*atlanticus, semperi, varians, japonicus* and *tuberculatus*), and the family Pentametrocrinidae was suggested to cover all the comatulids in which the arms are similarly simple, embraced within the genera *Pentametrocrinus*, *Decametrocrinus* and *Thaumatocrinus*.

Although the paper in which these conclusions were stated was published on April 11, 1908, it was actually written some time after the one published on May 14, 1908.

Having now definitely associated *Thaumatocrinus* with the species of *Pentametrocrinus* and of *Decametrocrinus*, it seemed to me evident that *T. renovatus* was nothing more than the young of some species belonging to one of these two genera, most likely *Pentametrocrinus* because of its 5 arms. So in 1911 and again in 1912 I referred to it as "*Pentametrocrinus*, sp."

Through the kindness of Profs. Ludwig Döderlein and Robert Hartmeyer, I had received a magnificent series of the pentacrinoids of *Promachocrinus kerguelensis* from the dredgings of the *Gauss* in the Antarctic, and from these I learned the hitherto unsuspected fact that this species has at first 5 radials and 5 post-radial series, the other 5 radials first appearing as interradials quite similar to those of *Thaumatocrinus* between the radials already formed.

This discovery explained the true nature of *Thaumatocrinus renovatus*. It is merely a very young specimen of the species described by Carpenter as *Promachocrinus abyssorum* with the interradial radials only partly formed and with the beginnings of an interradial arm on the posterior interradial. In 1912 *Thaumatocrinus* was definitely identified as the young of *Promachocrinus abyssorum*, which, incidentally, had been found at the same station with it.

Since the *Challenger* dredged it in 1873 and 1874, this species has been found but once, by the *Gauss* in 1903. The 2 specimens brought back by the *Gauss* were described in 1915.

THAUMATOCRINUS JUNGERSENI A. H. Clark

[See vol. 1, pt. 1, fig. 113, p. 181]

Thaumatocrinus jungerseni A. H. Clark, Die Crinoïden der Antarktis, 1915, p. 144 (a north Atlantic species; *nomen nudum*), p. 149 (in key to the species of *Thaumatocrinus;* southwest of Iceland), p. 150 (61°44′ N., 30°29′ W.; 1135 fms.; 3.0° C.); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 259 (in key; range); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 13, fig. 49; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 13 (detailed description; *Ingolf* stas. 18, 97), p. 44 (range); figs. 2–4, p. 14.—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 26, 42, 46, 83 (articulations).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 23 (locality).—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 133 (listed).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 17.

Diagnostic features.—This is a small and slender species, with arms between 90 and 100 mm. in length and the centrodorsal from 2.5 to 3.0 mm. in diameter. The relatively small centrodorsal bears XI–XIII (very rarely more) cirri, which are slender, but not excessively so, with the third segment never more than twice as long as broad and the fourth usually less than 4 times as long as the width of the expanded ends.

Description.—The centrodorsal is small, discoidal, usually rather thin, in the largest individuals from 2.5 to 3.0 mm. in diameter at the base. The cirrus sockets are entirely marginal, and are large and conspicuous. They may be arranged in a fairly regular and uniform marginal row, but they are usually irregular in their disposition, forming a very irregular marginal row. All of them, or very nearly all, are functional. In the middle of the rather broad bare dorsal pole of the centrodorsal there is a rounded or rounded-conical elevation which may be only very slightly developed so that the dorsal pole appears almost flat, or may be so large that the entire dorsal pole rises into a blunt cone; usually, however, it merely forms a prominent central tubercle.

The cirri are IX–XVII (usually XI–XIII, rarely XIV or more), 19–25 (usually 23–25, most commonly 24, in fully developed individuals), from 35 to 48 mm. (averaging about

45 mm. in large specimens) in length. The 17 cirri present give the following number of segments: 19 (1), 20 (3), 21 (3), 22 (2), 23 (1), 24 (5), and 25 (2). The first cirrus segment is about 3 times as broad as long, the second is usually about twice as broad as long, the third varies from as long as broad to twice as long as broad, and the fourth is usually about 4 times as long as the expanded ends; the following segments are greatly elongated. Toward the end of the cirri, the segments gradually become shorter, and in the best-developed cirri they are scarcely more than 3 times as long as broad; but in the terminal 8 to 10 segments the cirri taper with increasing rapidity and, correlatively, the segments rapidly increase in proportionate length. The terminal claw is represented by a minute conical button on the distal end of the excessively elongated penultimate segment. The cirri are few in number, but well developed, large, very long and rather slender, composed of greatly elongated segments; distally they taper, rather abruptly, to a sharp point. The earlier segments have a slight central constriction, the concavity being more marked on the ventral than on the dorsal profile. There is a slight lateral compression in the proximal portion of the cirri which gradually increases and becomes very marked distally. As a whole the cirri of this species exactly resemble those of such species of *Pentametrocrinus* as have these organs greatly elongated, for instance *P. varians* and *P. semperi*.

The 10 radials usually project conspicuously beyond the rim of the centrodorsal. In the best-developed individuals all of the radials are of approximately the same length, but in most of them 5 of the radials are shorter than the other 5, with which they alternate. In some of the best-developed specimens the radials, or at least the shortest of them, project but very slightly beyond the edge of the centrodorsal; in others, not so well developed, the radials may be as long as their proximal width.

The 10 arms are slender, and probably between 90 and 100 mm. in length. The first brachials are more or less trapezoidal, from 2 to 3 times as broad basally as long. The second brachials are irregularly quadrate, always somewhat larger than the first, sometimes, though rarely, twice as large. The third brachials are approximately oblong, about as large as the second. The first syzygial pair (composed of brachials 4+5) is somewhat hour-glass-shaped, about as long in the median line as broad basally, or slightly longer. The succeeding brachials are oblong or slightly wedge-shaped, approximately twice as broad as long. The brachials following the second syzygial pair, which is composed of brachials 9+10, are very obliquely wedge-shaped, longer than broad, distally becoming much elongated, four or more times as long as broad, with swollen articulations. The pinnule sockets are situated in the middle of the sides of the brachials except on the epizygals of syzygial pairs, on which they are in the proximal portion. The dorsal profile of each brachial is straight or slightly concave, and there is no production or overlapping of the distal ends. The arms increase very slightly in diameter from the base outward, this broadening reaching a maximum on the first syzygial pair and on the segments immediately following, from that point tapering almost imperceptibly to the tip.

Syzygies occur between brachials 4+5, 9+10, and distally at intervals of from 1 to 23 (most commonly 4 or 5) muscular articulations.

P_1 (on the second brachial) is from 5 to 7 mm. in length and is composed of 21 to 25 segments. In fully developed individuals all the segments are very short and are broader than long; in dorsal profile both ends of the segments are prominent so that in the pinnule as a whole this profile consists of a series of small and rather deep scallops.

In less developed individuals the first 2 segments are broader than long, the second being slightly longer than the first, the third is about as long as broad, and the remainder are nearly or quite twice as long as broad; the segments are slightly constricted centrally with everted and prominent ends. P_2 is from 5.5 to 7 mm. long with 18 to 25 segments, similar to P_1 but longer and proportionately stouter, with relatively slightly longer segments. In a few cases P_2 bears a gonad. P_3 is 8 mm. long, with 20 to 23 segments, which become as long as broad on the third, twice as long as broad on the fifth, and much elongated distally. There is a large gonad on the third to sixth segments. P_4 is 8 mm. long, similar to P_3 but with a larger gonad and relatively more elongate segments. P_5 resembles P_4, but has more elongate segments. Large well-rounded gonads are borne by P_3, P_4, P_5, and P_6 and the corresponding pinnules on the other side of the arm. These genital pinnules are slightly stouter than the preceding pinnules, especially in the basal portion bearing the gonad. The distal pinnules are extremely slender, with the first segment short and bandlike, more or less crescentic, the second irregularly quadrate, about as long as broad, and the following excessively elongated with somewhat swollen articulations.

In small specimens the segments of P_1, except the basal, are considerably elongated.

The general relationship between the lower pinnules of this species, and indeed of all the species of this genus, are much the same as those between the lower pinnules in *Heliometra glacialis*, though the relative length is reversed.

The disk typically shows 5 large primary groove trunks given off from the mouth; about half way to the arm bases each of these divides into 2, so that the disk presents the same appearance as that of an ordinary 5-rayed and 10-armed endocyclic form. In most of the individuals, however, one or two of the ambulacra run undivided to the arms, while a corresponding number of the others divide into 3 instead of into 2 parts at the arm bases.

Notes.—Many of the specimens show an inequality in the size of the arms, there being one or more considerably smaller than the others. These smaller arms alternate with arms of full size and represent not yet perfected secondary arms derived from the interradials.

Aberrant specimens.—Two of the 40 individuals examined have 9 instead of 10 arms, just as in the only known example of *T. rugosus;* but these are not in any other way different from the remainder.

Another specimen has only 8 arms, the anterior arm of the left anterior ray and the posterior arm of the right anterior ray being represented by interradial plates which are about half as broad as the adjacent radials, swollen and strongly convex, with the distal border (corresponding to the usual articular face) swollen and rounded off, so that they appear like the ends of two large basal rays shoved from their normal position up into the radial circlet.

Young.—A very interesting specimen from *Ingolf* station 97 is without doubt the young of this species. It is in almost every detail identical with the young of *T. renovatus.*

The total length from the tip of the centrodorsal to the middle of the eighteenth brachial is 12 mm.

The centrodorsal is hemispherical with about a dozen cirrus sockets irregularly scattered over the surface.

The interradials have a swollen surface, especially distally, but none of them show any indications of an appendage.

On the arms syzygies occur between brachials 4+5, 10+11, and 14+15.

The pinnule on the third brachial (P_a) has 13 segments, of which the first is twice as broad as long, the second is slightly broader than long, the third is from a third to a half again as long as broad, and the remainder are about three times as long as broad.

The five orals are relatively slightly smaller than in the young of *T. renovatus* described by Carpenter. The perisomic areas are occupied by numerous plates which are largest proximally and in the center of the areas, becoming smaller on the sides and toward the orals. These plates are more or less separated from each other, evidently as a result of a distension of the visceral mass. There is no indication that there ever was any imbrication such as is suggested by Carpenter's figures. The anal tube is conspicuous and cylindrical, and is thickly studded with small plates.

Localities.—*Ingolf* station 18; southwest of Iceland (lat. 61°44′ N., long. 30°29′ W.); 2075 meters; temperature 3.0° C. [A. H. Clark, 1915, 1918, 1921, 1923; Gislén, 1924] (40, U.S.N.M., E. 1089; C.M.). Type locality.

Ingolf station 97; Denmark Strait, between Angmagsalik, Greenland, and northwestern Iceland (lat. 65°28′ N., long. 27°39′ W.); 823 meters; temperature 5.5° C. [A. H. Clark, 1923] (1, C.M.).

Remarks.—This is the only species of the genus known from the Atlantic, and also the only species which has ever been dredged in quantity.

It is not absolutely certain that the young individual from *Ingolf* station 97 belongs to this species, though the probabilities are that it does.

Genus PENTAMETROCRINUS A. H. Clark*

Ophiocrinus (part) P. H. Carpenter, Nature, vol. 15, 1877, p. 198; vol. 19, 1879, p. 450; Proc. Roy. Soc., vol. 28, No. 194, 1879, p. 384; Quart. Journ. Geol. Soc., vol. 36, 1880, p. 41 (subgenus of *Antedon;* all recent material in Carpenter's possession), p. 45 (no basal rays); Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 161; Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 494; Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 919, footnote (preoccupied; name changed to *Eudiocrinus*).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, pp. 34, 271 (history and status of the name).

Eudiocrinus (part) P. H. Carpenter, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 493 (new name for *Ophiocrinus* Semper, 1868 [not *Ophiocrinus* Salter, 1856]); Proc. Roy. Soc., vol. 35, No. 225, 1883, p. 138 (comparison with *Thaumatocrinus*).—Perrier, Compt. Rend. Acad. Sci., vol. 96, No. 11, 1883, p. 725.—P. H. Carpenter, Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 919 (comparison with *Thaumatocrinus*), p. 926 (referred to the Comatulidae); *Challenger* Reports, Narrative, vol. 1, pt. 1, 1885, p. 310.—Perrier, Explorations sous-marins, 1886, p. 275.—P. H. Carpenter, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 385; vol. 28, 1887, p. 308 (homologies with ophiurans); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 73 (general account).—Bather, Proc. London Amateur Sci. Soc., vol. 1, Nos. 1, 2, July 1890, p. 33 (mode of attachment).—Perrier, Traité de Zoologie, 1893, pp. 784, 794, 858.—Bather, Proc. Zool. Soc. London, 1895, p. 995 (comparison of base with that of *Uintacrinus*).—Lang, Text book of comparative anatomy, vol. 2, 1896, p. 313.—Bather, *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, pp. 135, 137, 195.—Delage and Herouard, Traité de Zoologie concrète, vol. 3, 1903, p. 394.—Minckert, Arch. Naturg., Jahrg. 71, Heft 1, 1905, p. 166 (syzygies; regeneration).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575.—A. H. Clark, Proc. U.S. Nat. Mus., vol. 32, 1907, pp. 569, 573; Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, pp. 343, 344; Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134; Proc. U.S. Nat. Mus., vol. 34, 1908, pp. 210, 212, 269, 271, 276.—Vaney, Bull. Mus. Hist. Nat., Paris, No. 3, 1910, pp. 160,

*See also Addenda (p. 836) under 1962.

161 (relation of certain species [as *E. atlanticus*] to *Decametrocrinus* [*Thaumatocrinus*]).—Kirk, Proc. U.S. Nat. Mus., vol. 41, 1911, pp. 65, 66.

Endiocrinus Parkes, Manchester Micr. Soc. Trans. for 1890, 1891, p. 44.—Bather, Rep. British Assoc. for 1898, 1899, p. 923.—Chun, Aus den Tiefen des Weltmeeres, 1900, p. 488.—Hutton, Index faunae Novae-Zealandiae, 1904, p. 291.

Pentametrocrinus A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (diagnosis; type species *Eudiocrinus japonicus* P. H. Carpenter, 1882), p. 136 (assigned to the Pentametrocrinidae); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 267 (relation to *Decametrocrinus* [*Thaumatocrinus*]), p. 269 (observations on the young stages), p. 277 (revised diagnosis; list of species), p. 319 (Japanese species); vol. 35, 1908, pp. 117, 128; fig. 9, p. 117 (arm structure), p. 126 (relation to *Decametrocrinus* [*Thaumatocrinus*]); vol. 36, 1909, p. 363 (arm structure identical with that of *Thaumatocrinus*, which is probably the young of this genus); vol. 38, 1910, p. 331 (includes *Thaumatocrinus*).—Vaney, Bull. Mus. Hist. Nat., Paris, No. 3, 1910, p. 160 (discussion).—A. H. Clark, Amer. Journ. Sci., ser. 4, vol. 32, 1911, p. 129 (characteristic of the Japanese fauna; significance); Crinoids of the Indian Ocean, 1912, p. 11 (occurs both east and west of Ceylon), p. 12 (represented in the Red Sea region; doubtless occurs in the southeast African region), p. 17 (significance of conditions in the genus in southern Japan), p. 27 (range), p. 63 (in key), p. 250 (synonymy; includes *Thaumatocrinus*); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (occurs in both Atlantic and Indo-Pacific; range); Die Crinoïden der Antarktis, 1915, p. 121 (relation to *Decametrocrinus* [*Thaumatocrinus*]), p. 182 (both Atlantic and Indo-Pacific; range).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 90–L, 1915, p. 195 (inorganic constituents of the skeleton); Prof. Paper 102, 1917, pp. 23 and following (same).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 259 (in key), p. 260 (key to the included species); Journ. Washington Acad. Sci., vol. 9, No. 5, 1919, p. 136 (disk compared with that of *Holopus*); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 13 (West Indies and Indo-Pacific), p. 14 (in key); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 33; The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 15, p. 44 (listed), p. 53 (in key).—H. L. Clark, Ann. South African Mus., vol. 13, 1923, p. 227.—Gislén, Zool. Bidrag. Uppsala, vol. 9, 1924, pp. 26, 30, 31, 47, 91 (articulations), p. 212 (pinnule gap).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 23 (in key; diagnosis).—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 109 (5 arms).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 12; Lunds Univ. Årsskr., new ser., Avd. 2, vol. 30, No. 11, 1934, p. 17; Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4; Lunds Univ. Årsskr., new ser., Avd. 2, vol. 34, No. 17, 1939, p. 16.—Cuénot, *in* Grassé, Traité de zoologie, vol. 11, 1948, p. 71.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 56.—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 95.

Eudiocrinus (*Pentametrocrinus*) Koehler and Vaney, Bull. Mus. Hist. Nat., Paris, No. 1, 1910, pp. 26, 31.

Pentamentrocrinus Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 91.

Pentametrocinus Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 69.

Diagnosis.—A genus of Pentametrocrinidae in which there are five radials from each of which arises an individual arm.

Type species.—*Eudiocrinus japonicus* Carpenter, 1882.

Geographical range.—From southwestern Japan southwards to New Zealand and off New South Wales, thence westwards to east Africa and in the Atlantic from the Canary Islands and Morocco, off the west coast of Ireland and the Lesser Antilles.

Bathymetrical range.—From 254 (?188) to 2115 meters.

Thermal range.—From 2.50° C. to 13.33° C.

Remarks [by A.M.C.].—There has been some difference of opinion on the homologies and designations of the pinnules in this genus. Mr. Clark considers the pinnule on the second brachial (only present in *P. varians*) to be P_1 and that on the fifth brachial (the fourth being the hypozygal of the first syzygy) P_2. The pinnule on the other side of the third brachial is then P_a. Gislén in 1924 (p. 26) also called the pinnule of the second brachial of *varians* P_1, but in 1927 (p. 52) and 1934 (p. 17) he writes that in *P. diomediae* P_1 and P_I are lacking and he calls the (first) pinnule on Br_5 P_a not P_2. I have not been able to find the source of Gislén's use of P_1 for the pinnule on Br_2. He used it also for the corresponding pinnule in *Eudiocrinus* (1922, p. 68) in place of Mr. Clark's P_C. *Eudiocrinus* was split off from *Pentametrocrinus* by Mr. Clark in 1908 partly on the belief that in the former the second ossicle of each arm is homologous with the axillaries of the related oligophreate genera, whereas he concluded (also in part 2 of this work, p. 107) that in *Pentametrocrinus*, *Thaumatocrinus* and *Atopocrinus* the first two brachials correspond to those of the free arms of other genera and not to their division series. Gislén evidently did not agree with this.

As explained on p. 801 I have restored the type species, *P. japonicus* Carpenter from the synonymy of *P. semperi*.

KEY TO THE SPECIES OF PENTAMETROCRINUS

a^1. Lowest pinnule on the fifth brachial.

- b^1. Cirri composed of 15–19 segments of which the distal are less elongated than the longer proximal, not especially long and more or less strongly recurved distally; terminal claw long with the slender distal portion recurved.
  - c^1. Cirri very short, their length equal to about one tenth of the arm length, curved for almost their whole length; longest cirrus segments about two and a half times as long as broad; articular tubercles on the arm bases strongly developed (southern Japan; 309–600 meters) **tuberculatus** (p. 787)
  - c^2. Cirri longer, their length equal to one fourth or one fifth of the arm length, straight in the proximal portion and recurved distally; longest cirrus segments about 4 times as long as broad; articular tubercles very slightly, if at all, developed.
    - d^1. Centrodorsal flattened hemispherical to low conical, bearing XX–XXXV cirri which are rather slender and equal more than a quarter of the arm length; perisome with very numerous small plates; the proximal pinnules with about 15 segments (Lesser Antilles; Canary Islands and Morocco northward to the west coast of Ireland; 607–2115 meters). **atlanticus** (p. 790)
    - d^2. Centrodorsal conical, bearing XXX–LX cirri which are stout and equal about one fifth of the arm length; perisome naked; proximal pinnules with over 20 segments (Philippines to southwestern Japan; 278[?188]–522 meters) -------------- **diomedeae** (p. 794)
- b^2. Cirri composed of 25–35 segments all of which beyond the basal ones are much elongated, particularly the distal ones; cirri very long, straight for most of their length, slightly and broadly recurved distally; terminal claw conical and minute.
  - c^1. Cirri over XXX; centrodorsal relatively large (fig. 50,*a*); proximal brachials expanded at the joints (southern Japan to the Lesser Sunda Islands; 254[?195]–1210[?1301] meters). **japonicus** (p. 796)
  - c^2. Cirri under XX; centrodorsal relatively small (fig. 51); proximal brachials with almost straight sides, arms rather smooth (off New South Wales and northern New Zealand; 1279–1736 meters) -- **semperi** (p. 802)

a^2. Lowest pinnule on the second brachial (Maldives to the Lesser Sunda Islands and northward to southern Japan; 457[?378]–2060 meters) -------------------------------- **varians** (p. 804)

PENTAMETROCRINUS TUBERCULATUS (A. H. Clark)*

[See vol. 1, pt. 1, figs. 121 (p. 189), 307 (p. 265); pt. 2, figs. 126 (p. 79), 235 (p. 197)]

Eudiocrinus japonicus (part) P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 501 (Japan; Hilgendorf); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 79, footnote, p. 85, last paragraph (Japan; Hilgendorf).

*See also Addenda (p. 836) under 1962

Eudiocrinus tuberculatus A. H. Clark, Proc. U.S. Nat. Mus., vol. 32, 1907, p. 573 (description; *Albatross* sta. 3661), p. 574 (listed, and type locality given); vol. 34, 1908, p. 271 (history; structure; relationships; assigned to *Pentametrocrinus*); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (arm structure; removed to *Pentametrocrinus*).

Pentametrocrinus tuberculatus A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (listed); Proc. U. S. Nat. Mus., vol. 34, 1908, p. 275, fig. 5 (centrodorsal and base of an arm), p. 277 (listed), p. 319 (Japan); vol. 35, 1908, p. 117; fig. 10, p. 117 (arm structure); vol. 43, 1912, p. 384 (Hilgendorf's specimens identified), p. 408 (description of the preceding); Crinoids of the Indian Ocean, 1912, p. 250 (synonymy; locality); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 261 (in key; range); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 3, fig. 34 (proportions of the cirri).

Diagnostic features.—The lowest pinnule is on the epizygal of the first syzygial pair; the cirri are very short, their length equal to about a tenth that of the arms, rather stout, strongly curved for almost their whole length, composed of 15 to 17 segments, of which the longest are about two and a half times as long as broad, and the distal are shorter; the terminal claw is prominently hooked; and the arm bases are very rugged and tubercular.

Description of the type specimen.—The centrodorsal is conical with the sides gently convex, 5 mm. broad at the base and 4 mm. high. The cirrus sockets are very numerous and closely crowded, arranged approximately in 5 rows, with about 6 sockets beneath each radial at the periphery of the centrodorsal.

The cirri are C–CL, 14–17 (usually 16 or 17), from 15 to 18 mm. in length. The first segment is short, the second is about as long as broad, the third is nearly twice as long as broad, and the fourth to tenth are about two and a half times as long as broad; the following very gradually decrease in length so that the distal ones are about twice as long as broad or even somewhat shorter. The penultimate segment is about as long as broad or slightly longer than broad. The terminal claw is slightly longer than the penultimate segment, stout at the base but becoming slender toward the tip, with the outer half gently recurved. The cirri are of uniform width throughout, the penultimate segment only tapering somewhat. The outer portion of each cirrus becomes gradually compressed. The segments in the proximal half are practically oblong in lateral view, with a scarcely noticeable expansion of the ends, this being much more marked in a dorsal view.

The distal edges of the radials are even with the rim of the centrodorsal.

The 5 arms are probably between 180 and 200 mm. long. The first brachials are short, over four times as broad as long, narrowing rapidly distally, widely separated except at the base, and rising to a strong rounded tubercle with the second brachials in the middle of the distal border. The second brachials are irregularly quadrate with the distal border oblique; the maximum width is rather more than twice the maximum length; the middle of the proximal border rises to a strong tubercle with the adjacent portion of the first brachials, and there is a similar tubercle shared with the third on the dorsolateral portion of the distal border. The following brachials to the tenth are similar; strong articular tubercles are developed on alternate sides of the arm. Beyond the tenth the brachials become triangular and nearly, soon quite, as long as broad, the articular tubercles rapidly diminishing in size. In the distal portion of the arm the brachials gradually become wedge-shaped again and then elongate with the articulations somewhat swollen.

Syzygies occur between brachials 5+6 (on one arm 4+5), 9+10 (on one arm 8+9 and on another 7+8), and distally at intervals of usually 3, sometimes, especially in the earlier portion of the arm, 2, more rarely 4 muscular articulations.

The pinnule on the second brachial, P_1, is absent.

P_2 is 11 mm. long, slender and flagellate, tapering gradually from the base to the tip, and is composed of 35 to 40 segments, of which the first two are short and the remainder are about as long as broad with the corners cut away. The fourth to eighth or ninth segments bear a small rounded gonad.

The following pinnules are stouter basally and the segments beyond the gonad become more and more elongated. Though large on the lower pinnules the gonads come to occupy less and less space as the pinnules gradually increase in length.

P_{10} is 22 mm. long, with 40 to 50 segments, of which the first two are short and very slightly broader than the others, the third is about as long as broad, and the remainder become progressively elongated; after the third to seventh segments, which bear the small gonad, the pinnule gradually becomes exceedingly slender and distally is hairlike with greatly elongated segments which have expanded, and somewhat overlapping distal ends.

After P_5 or P_6 the pinnule segments develop prominent projecting and spinous distal ends.

Notes.—Dr. P. H. Carpenter wrote that when he was at the Berlin Museum, Doctor Hilgendorf showed him some specimens of a species of *Pentametrocrinus* which he had collected in Japan. Carpenter believed that these were probably identical with his *P. japonicus*, but noted that they had fewer cirrus segments, and the articulations of the first 8 brachials were distinctly tubercular, the tubercle between the first two being in the middorsal line, and those between the following lying alternately on either side of the arm. The 3 *Challenger* specimens described by him as *japonicus* showed no traces of these tubercles with the exception of the median one, which was far less marked than in Hilgendorf's specimens.

Thanks to the kindness of Drs. W. Weltner and R. Hartmeyer I was able, while in Berlin in 1910, to reexamine these two specimens. One of these resembles the type specimen from *Albatross* station 3661; the other is smaller, with the articular tubercles less developed. With these specimens are a number of detached cirri. The largest, presumably from the larger individual, are from 18 to 22 mm. in length and are composed of 16 to 17 segments.

At the entrance to Tokyo Bay in 600 meters Dr. Franz Doflein dredged a fine specimen of this species, with arms about 180 mm. long and cirri 20 mm. long, with 15 to 16 segments. The distal pinnules are extremely slender, 23 mm. long with 35 segments. The gonads are enlarged. This example is about the size of the smallest of the 3 from *Albatross* station 3661.

Localities.—*Albatross* station 3661; Gulf of Tokyo, off Uki Shima; 309 meters; temperature 8.89° C.; mud and pebbles; October 13, 1896 [A. H. Clark, 1907, 1908, 1921] (3, U.S.N.M., 22604, 36202). Type locality.

Japan; Hilgendorf [P. H. Carpenter, 1882, 1888; A. H. Clark, 1912] (2, Berl. M., 2831).

Entrance to Tokyo Bay; 600 meters; Dr. Franz Doflein, October 27, 1904 (1, ?Munich Mus.).

Geographical range.—Only known from Tokyo Bay, Japan.

Bathymetrical range.—From 309 to 600 meters.

Thermal range.—One record, 8.89° C.

Remarks.—Of this species, which is much the largest and most robust of the genus, only the 6 specimens above recorded have so far come to light. It is curious that all of these are from Tokyo Bay.

PENTAMETROCRINUS ATLANTICUS (Perrier)

Eudiocrinus atlanticus PERRIER, Compt. Rend. Acad. Sci., vol. 96, No. 11, 1883, p. 725 (description; Gulf of Gascony, 896 m.; *Travailleur*).—P. H. CARPENTER, *Challenger* Reports, Narrative, vol. 1, pt. 1, 1885, p. 310 (discussion).—PERRIER, Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 106 (sacculi); Explorations sous-marins, 1886, p. 275, fig. 195.—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 4, 31, 74, 76–81, 369, 373, 374 (discussion).—PERRIER, Traité de zoologie, 1893, p. 858.—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, Heft 1, 1905, p. 170, footnote (syzygies).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 32, 1907, p. 573 (first reference; type locality); vol. 34, 1908, p. 271 (history); vol. 35, 1908, pp. 113, 114 (arm structure).—KOEHLER, Resultats des Campagnes scientifiques accomplies sur son yacht par Albert 1er, Prince souverain de Monaco, fasc. 34, 1909, p. 271 (*Princesse-Alice* stas. 486, 1894; 578, 1895; 1118, 1901), pl. 32, figs. 15–18.—VANEY, Bull. Mus. Hist. Nat., Paris, No. 3, 1910, p. 160 (relation to *Decametrocrinus* of the species of *Eudiocrinus* typified by this form).

Comatule PARFAIT, Rapport sur la campagne scientifique du *Talisman* en 1883, 1884, p. 45 (32°27 N., 12°15′ E.; 1123 m.; June 17, 1883).—DE FOLIN, Sous les mers, 1887, p. 277 (same record).

Eudiocrinus, sp. KOEHLER, Ann. Univ. Lyon, vol. 26, June 1896, p. 101 (*Caudan* sta. 11; "without doubt *E. atlanticus*").

Pentametrocrinus atlanticus A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 277 (listed); vol. 35, 1908, p. 117 (arm structure); vol. 40, 1911, p. 7 (northwest coast of Africa), p. 7, footnote (also West Indies), p. 9 (indicates a West Indian element in the northwest African fauna), p. 44 (synonymy; localities and range); Bull. Mus. Hist. Nat., Paris, No. 4, 1911, p. 245 (=*Eudiocrinus atlanticus*), p. 259 (*Talisman* sta. 45); Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 4 (*Helga* stations; notes); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 261 (in key; range); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 44 (range).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 26 and following (articulations).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 24 (diagnosis; records); fig. 11, p. 24 (from Perrier).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 12 (notes).

Eudiocrinus (*Pentametrocrinus*) *atlanticus* KOEHLER and VANEY, Bull. Mus. Hist. Nat., Paris, No. 1, 1910, p. 26, p. 31 (localities).

Pentametrocrinus (*Eudiocrinus*) *atlanticus* KOEHLER, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 133 (listed).

Diagnostic features.—Closely resembling *P. diomedeae*, but more slender and less robust with the centrodorsal flattened hemispherical to low conical and bearing XX–XXXV cirri which are slightly longer, reaching a quarter or more of the arm length; the perisome of the disk and arm bases is thickly beset with conspicuous, though very small, calcareous plates; the proximal pinnules have about 15 segments.

Description.—The centrodorsal is small, hemispherical, or flattened hemispherical, with the cirrus sockets arranged in about two marginal rows.

The cirri are XX–XXXV, with 14 to 17 segments and reaching a maximum of 35 mm. in length. The first two segments are very short, a little broader than long, but the segments that follow rapidly become more elongated, the fourth being 3 times as long as broad, and the fifth and sixth 3 or 4 times as long as broad. From this point onward the length of the segments gradually decreases to the penultimate, which is slightly longer than broad. The terminal claw is gently curved. Below the periphery of the centrodorsal the cirri are shorter, with 11 to 12 segments.

The radials are short, and are only partially visible beyond the rim of the centrodorsal.

The 5 arms, which are much elongated and taper very gradually, reach a length of 120 mm. The first brachials are short, very much broader than long, thickened on the edges. The second and third brachials are longer, though still much broader than long; the second is broadened in the distal and the third in the proximal portion. The brachials following the fifth are obliquely wedge-shaped.

Syzygies occur between brachials 4+5 and 9+10, and distally at intervals of from 3 to 7 (usually from 4 to 6) muscular articulations.

The lowest pinnule is on the fifth brachial. The earliest pinnules are subequal and are composed of 14 or 15 segments, of which about 7 of the basal, which correspond to the ovarian region, are more broadened than those following, which are more slender. The following pinnules, beyond the tenth to twelfth, are longer with the third segment elongated and those following still more elongated; these pinnules equal or even exceed 7 brachials in length; the genital region always reaches to about the seventh segment. The ends of the pinnule segments are perceptibly swollen, and even bear 2 or 3 very fine spinules.

The perisome of the disk, which reaches a maximum of about 6 mm. in diameter, and of the interbrachial areas is very thickly set with small regular calcareous plates as described by Carpenter in *P. semperi*.

Sacculi are present in the form of excessively fine granules which are whitish in color and contrast sharply with the more or less dark tissue which surrounds them. They are extremely numerous and crowded on the disk, as well as on the perisome of the earlier brachials, but their number decreases rapidly and they soon become scarce.

Notes.—Of the 3 specimens dredged by the *Princesse-Alice*, the largest, with the disk 6 mm. in diameter, was from station 1118; the most perfect was from station 578 and was somewhat smaller, the disk being about 5 mm. in diameter; an arm fragment measured about 80 mm.; the example from station 486 was very small, the disk measuring only 3 mm. in diameter.

Prof. Koehler compared these specimens directly with Perrier's types at the Paris Museum and found them to be unquestionably of the same species.

In one of the *Talisman* examples recorded by Perrier which still retains a few complete cirri, Koehler counted 16 or 17 cirrus segments; the longest of these cirri did not reach 35 mm. in length. Since some of the arm fragments measured 80 mm., the arms must be more than twice the length of the cirri.

Koehler noted that the figure of this species given by Perrier in 1886 (republished in a second edition of the same work in 1891) does not give a correct idea of the relative proportions of the arms and cirri.

In the specimen from *Princesse-Alice* station 486, Prof. Koehler found the arrangement of the syzygies to be as follows: First arm, between brachials 4+5, 9+10, 14+15; second arm, between brachials 4+5, 9+10, 15+16, 18+19, 22+23, 27+28, 31+32; third arm, between brachials 4+5, 9+10, 16+17, 19+20, 23+24, 27+28; fourth arm, between brachials 4+5, 9+10, 15+16; fifth arm, between brachials 4+5, 9+10, 14+15, 18+19.

In the specimen from *Princesse-Alice* station 578, the second syzygy is between brachials 9+10 on 3 arms and between brachials 11+12 on one; the fifth arm is broken off near the base.

The specimen from *Princesse-Alice* station 1118 shows some anomalies which, as suggested by Prof. Koehler, are doubtless the result of the regeneration of the left anterior, right posterior and left posterior arms. On the normal arms (anterior and right anterior) the first syzygy is between brachials 4+5, the second is between brachials 9+10, and the third is at the distal end of brachial 14, the arms being broken off here. On the left anterior arm the first syzygy is between brachials 4+5 and the second between brachials 6+7; the next is between brachials 8+9; the arm has been broken off between brachials 9 and 10, and has regenerated. In this regenerated portion syzygies occur between brachials 14+15 and 18+19, and the arm is lost at the distal syzygial face of brachial 24. On the left posterior arm regeneration has taken place at the syzygial distal face of brachial 4; the second syzygy is between brachials 8+9 and the arm is lost at the distal syzygial face of brachial 12.

[Notes by A.M.C.] Gislén (1928) noted that the specimen in the British Museum from *Helga* station S.R. 489, has the centrodorsal low conical. The radials are hidden and the disk extends to brachial 5. I agree that the centrodorsal is low conical. It is 2.7 mm. in diameter and 1.5 mm. high. There are XXXIV cirrus sockets in three irregular rows around the sides and the dorsal pole is covered with papillae. No complete cirrus remains attached but a peripheral one with 10 segments left measures 19 mm. The first two segments are shorter than wide; the third is about two and a half times as long as its median width; the fourth is nearly four times as long as wide and the longest segments are five times as long as wide. The apical cirri are narrower and with relatively longer segments. A detached outer portion of a nonperipheral cirrus measuring 9 mm. with 10 segments, has the tapering penultimate segment three times as long as wide. The terminal claw tapers abruptly near its base and its slightly curved outer half is attenuate and sharp.

The first syzygy at brachials 4+5 measures 1.8 mm. in width and the brachials to the second syzygy at 9+10 total 8.5 mm. in length. The first brachial is very short.

The first few pinnules, which bear gonads, have the first two segments short but the third is half again as long as broad and the following ones become a little longer. Their joints are slightly expanded and spinous.

Localities.—Blake station 205; off Martinique, French West Indies (lat. 14°25′15″ N., long. 60°56′35″ W.); 607 meters; temperature 7.50° C.; fine sand and broken shells; February 10, 1879 [A. H. Clark, 1911, as "West Indies"] (1, M.C.Z.).

Princesse-Alice station 1118; off Lanzarote, Canary Islands (lat. 29°06′30″ N., long. 13°02′45″ W.); 1098 meters; sandy mud; July 12, 1901 [Koehler, 1909].

Talisman station 45; between the Canary Islands and Mogador, Morocco (lat. 30°01′ N., long. 11°46′ W.); 2115 meters; gray mud and broken shells; June 24, 1883 [A. H. Clark, 1911] (2, P.M.).

Talisman station 36; northwest of Mogador, Morocco (lat. 32°27′ N., long. 9°55′ W.); 1123 meters; temperature 11° C.; red mud; June 17, 1883 [Parfait, 1884, de Folin, 1887; Koehler and Vaney, 1910] (fragments, P.M.).

Princesse-Alice station 578; Azores (lat. 38°26′00″ N., long. 26°30′45″ W.); 1165 meters; July 14, 1895 [Koehler, 1909].

Princesse-Alice station 486; off northwestern Spain (lat. 43°53′30″ or 43°52′00″ N., long. 9°02′15″ or 9°05′45″ W.); 1674 meters; fine sand and foraminifera; August 21, 1894 [Koehler, 1909].

Travailleur station 42; Bay of Biscay (lat. 44°01′20″ N., long. 7°04′45″ W.); 896 meters; mud and coral; August 16, 1881 [Perrier, 1883, 1886, 1893; P. H. Carpenter, 1885, 1888; Koehler and Vaney, 1910] (fragments, P.M.). Type locality.

Travailleur station 39*b*; off northwestern Spain (lat. 44°05′45″ N., long. 9°32′30″ W.); 1037 meters; black sand and coral; August 15, 1881 [Koehler and Vaney, 1910] (2, P.M.).

Caudan station 11; Bay of Biscay (lat. 44°36′ N., long. 4°25′ W.); 650 meters [Koehler, 1896].

Thor station 74; southwest of Ireland (lat. 49°23′ N., long. 12°13′ W.); 1220 meters; June 9, 1906 (1, C.M.).

Helga station S.R. 506; off the western coast of Ireland (lat. 50°34′ N., long. 11°19′ W.); 1209–1229 meters; September 12, 1907 [A. H. Clark, 1913] (2, U.S.N.M., 36282; Dublin M.).

Helga station S.R. 331; off the western coast of Ireland (lat. 51°12′ N., long. 11° 55′ W.); 1116–1243 meters; May 9, 1906 [A. H. Clark, 1913] (1, Dublin M.).

Helga station S.R. 489; off the western coast of Ireland (lat. 51°35′ N., long. 11°55′ W.); 1317 meters; September 3, 1907 [A. H. Clark, 1913; Gislén, 1928] (1, B. M.).

Geographical range.—Lesser Antilles; from the Canary Islands and the coast of Morocco northward to the western coast of Ireland.

Bathymetrical range.—From 607 to 2115 meters; the average of 13 records is 1180 meters.

Thermal range.—Two records, 7.50° C. and 11.0° C.

History.—This species was briefly described by M. Edmond Perrier in 1883 from 15 specimens which had been dredged by the *Travailleur* in the Bay of Biscay in the summer of 1881. The record was notable not only in indicating for the first time the presence of this genus in the Atlantic, but also because of the relatively large number of individuals secured, there being at the time only 10 others, representing 3 species, in existence, 2 in Berlin and 8 in London. In 1886 Prof. Perrier included a figure of this new form in a popular work on submarine exploration, which was reprinted in 1891. Unfortunately this figure is quite inaccurate and especially gives a very erroneous idea of the relative proportions of the arms and cirri.

In 1896 Prof. Rene Koehler recorded from the dredgings of the *Caudan*, also in the Bay of Biscay, a single mutilated specimen of some species of *Pentametrocrinus* which he said was without doubt *P. atlanticus*.

In 1909 Prof. Koehler published a very detailed account of this species, which he redescribed and accurately figured for the first time, based upon 3 specimens which had been obtained by the Prince of Monaco's yacht *Princesse-Alice*, as well as upon a reexamination of all those previously secured by the *Travailleur* and the *Caudan*. In the following year, in association with Prof. C. Vaney, he listed the localities at which it had been secured by the *Travailleur* and the *Talisman* in 1881 and 1883.

While in Paris in 1910 I examined all of the specimens preserved in the museum there, and a few weeks later, during a visit to Lyon, Professor Koehler was so kind as to show me all his material.

At the Museum of Comparative Zoology in the summer of 1907 Dr. W. McM. Woodworth, in looking over some marine worms from *Blake* station 205, discovered a much mutilated example of a species of *Pentametrocrinus*, which he showed to me. Presumably the species represented is *P. atlanticus*, though the condition of the specimen is such that accurate identification is not possible. This individual was taken in 1879, and was therefore the first actually dredged. Having this capture in mind, I added "West Indies" to the distribution of the "Eudiocrinidae" (Pentametrocrinidae) given in a paper published in 1908 (Proc. U.S. Nat. Mus., vol. 34, p. 210), and also added "West Indies" to the known habitat of *P. atlanticus* in 1911.

In 1913 I recorded this species from 3 of the *Helga* stations off the western coast of Ireland.

In 1928 Gislén reexamined one of the *Helga* specimens in the British Museum and published a brief note on it.

PENTAMETROCRINUS DIOMEDEAE A. H. Clark

[See vol. 1, pt. 1, fig. 130, p. 187]

Eudiocrinus japonicus (part) A. H. Clark, Proc. U.S. Nat. Mus., vol. 32, 1907, p. 571 (*Albatross* sta. 4934).

Pentametrocrinus japonicus (part) A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135.

Pentametrocrinus diomedeae A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 319 (Japan; listed; *nomen nudum*); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 234 (*Albatross* sta. 4934; also 5173); Crinoids of the Indian Ocean, 1912, p. 250 (synonymy; localities); Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (Malayan type; range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 261 (in key; range; notes; sta. 95), p. 272 (listed); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 14, fig. 50.—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 26, 39, 41, 42, 44, 46, 83 (articulations), p. 283 (length of the ambulacral groove); fig. 11, p. 45 (arm base); fig. 90, p. 81; fig. 116, p. 93; figs. 189–191, p. 98; Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 3 (stas. 7, 24), p. 52 (stations; notes), p. 68 (listed); figs. 45–46, p. 44; Ark. Zool., vol. 19, No. 32, 1928, p. 12; Lunds Univ. Årsskr., new ser., Avd. 2, vol. 30, No. 11, 1934, p. 17.

Pentametrocinus diomedioe Gislén, Vid. Medd. Nat. Foren. København, vol. 83, 1927, p. 69.

Diagnostic features.—The lowest pinnule is on the epizygal of the first syzygial pair, Br_5; the centrodorsal is conical, bearing XXX–LX cirri which in length equal about a fifth the length of the arms and which are moderately stout, strongly recurved in the outer portion, composed of 15 to 19 segments, of which the longest is about 4 times as long as broad and the distal are shorter; the terminal claw is prominently hooked; and the arm bases are rather robust, though not rugged, the articular tubercles being obsolete; the proximal pinnules have over 20 segments.

Description.—The centrodorsal is conical with the sides gently convex, 4 mm. broad at the base and 3 mm. high. The cirrus sockets are closely crowded, arranged roughly in two or three, with sometimes a partial fourth, rows; about the periphery of the centrodorsal there are usually four sockets beneath each radial.

The cirri are XL–LX, 14–17 (usually 15–17), from 15 to 20 mm. long. The first segment is short, the second is about as long as broad, the third is about twice as long as broad, the fourth is about three times as long as broad, and the fifth to seventh are about four times as long as broad; the following segments gradually decrease in length so that the antepenultimate is about twice as long as broad and the penultimate about as long as broad. The cirri do not taper distally, but the penultimate segment is less broad than that preceding it. The terminal claw is considerably longer than the penultimate segment, stout basally, tapering distally, comparatively straight in the basal half but curved strongly downward at the tip. The cirri are moderately compressed; their component segments are practically oblong in lateral view, the distal ventral ends of the basal ones being only very slightly prominent.

The 5 arms are about 100 mm. long, and resemble those of *P. semperi*. The proximal portion of the arms shows a moderate development of articular tubercles.

Notes.—The preceding description was drawn up from the type specimen dredged by the *Albatross* off southwestern Japan at station 4934.

Of the five specimens from the Philippines collected by the *Siboga* at station 95 the best preserved has the cirri 27 mm. long with 17 to 19 (usually 18) segments. It agrees well with a somewhat smaller individual from the same region taken by the *Albatross* at station 5173, which has the cirri 22 mm. long, with 14 to 16 segments, of the same general proportions. The difference in size probably accounts for the difference in the length of the cirri and in the number of segments. Three of the other four specimens taken by the *Siboga* are smaller; one of them has the cirri 15 mm. long with 14 to 15 segments.

[NOTES BY A.M.C.] Gislén (1927) has given notes on two specimens taken by Dr. Mortensen, one from off Kiu-Shiu and the other from the Sagami Sea. The former is young with XXX cirri, 6 to 10.5 mm. long with 12 to 15 segments. The longest segments are up to four and a half times as long as wide and the penultimate is a little longer than wide, without an opposing spine. The five arms are 60 mm. long and the proximal brachials are 1.0 mm. wide. The distal intersyzygial interval is four muscular articulations. P_I and P_1 (P_1 and P_a according to our reckoning, see p. 786) are lacking and the first pinnule is on Br_5 to the right in four cases out of five. This P_a (i.e. P_2) Gislén says has about 25 segments and is 5.5 mm. long. P_2 (P_b) on brachial 6 is 5.7 mm. long, with 25 segments, of which the distal ones are flattened, and most of them are short, the longest segments being half again as long as their median widths. P_3 (P_c) also has 25 segments; it is 6.7 mm. long. P_c (P_4) has 23 segments, 7 mm. long. The distal pinnules have 14 segments, 6.5 mm. long, all but the first two segments being very slender, five times as long as wide and slightly thickened and spiny at the ends. The disk is large, extending to brachial six or seven; it is naked or with minute granules in the skin.

The specimen from the Sagami Sea has about L cirri, with 11 to 18 segments and 5.5 to 16 mm. long. The longest segment is three times as long as broad. The five arms are 90 mm. long and smooth. The distal intersyzygial interval is four to six muscular articulations. P_a (i.e. P_2) is to the right on the fifth brachial in each case and has 21 segments, 6.7 mm. long. The third segment is squarish, the fourth is half again as long as broad. P_b (P_3) is broken and has a small gonad. P_c (P_4) has 26 segments and is 12 mm. long. The distal pinnules have over 22 segments, about 15.5 mm. long, with the fourth segment three times as long as broad and the distal segments six to eight times as long as broad. The disk is somewhat incised, 7 to 11 mm. in diameter, while the anal cone is 3.5 mm. high.

Two loose arms from another specimen measure about 115 mm. in length.

Of the five *Siboga* specimens from station 95, the best has the arm width at the first syzygy about 2.3 mm. and the length from the first brachial to 9+10 is 11.0 mm.; however, the second syzygy is very variable in position: of the four arms remaining beyond the first syzygy one has the second at 7+8, another at 9+10, the third at 10+11, and the fourth at 11+12. There is at least one cirrus with 19 segments; the penultimate is slightly longer than broad and the terminal claw is a little curved. Another specimen has the width at the first syzygy 1.8 mm., the length to 9+10 is 9 mm., and the centrodorsal is 2.5 mm. high. A third has the arm width 1.4 mm. and the first 9 brachials together measure 8.0 mm. The fourth has the centrodorsal broken, the arm width is 2.1 mm. and the length to 9+10 is 9.5 mm. The second syzygy is in this position on all four remaining arms. P_b, P_c, and P_3 are all more or less complete with over 20 segments.

Localities.—*Albatross* station 5173; in the vicinity of Jolo (Sulu); Jolo light bearing N. 82° E., 6.75 miles distant (lat. 6°02′55″ N., long. 120°53′00″ E.); 340 meters; shells and coral; March 5, 1908 [A. H. Clark, 1908] (1, U.S.N.M., 35929).

Siboga station 95; Jolo (Sulu) archipelago (lat. 5°43′30″ N., long. 119°40′00″ E.); 522 meters; stony bottom; June 26, 1899 [A. H. Clark, 1918] (5, Amsterdam Mus.).

Albatross station 4934; Eastern Sea, off Kagoshima Gulf; Sata Misaki light bearing N. 77°30′ E., 7 miles distant (lat. 30°58′30″ N., long. 130°32′00″ E.); 188–278 meters; temperature 13.33° C.; bottom rocky; August 16, 1906 [A. H. Clark, 1907, 1908, 1921] (13, U.S.N.M., 22699, 35930). Type locality.

Dr. Mortensen's Japanese station 7; off Kiu-Shiu, Japan (lat. 32°17′ N., long. 128°11′ E.); 200 meters; sand; May 14, 1914 [Gislén, 1927] (1, C.M.).

Dr. Mortensen's Japanese station 24; Sagami Sea; 914 meters; June 26, 1914 [Gislén, 1927] (1, C.M.).

Dr. Mortensen's Pacific Expedition; 7 miles S. of Olutanga, Mindanao; c. 548 meters; hard bottom; March 8, 1914 (1, C.M.).

Danish Expedition to the Kei Is. station 49; 245 meters; sand; May 3, 1922 (1, C.M.).

Geographical range.—From the Jolo (Sulu) archipelago, Kei Islands and Philippines, northward to southern Japan.

Bathymetrical range.—From 200 (?188) to 914 meters.

Thermal range.—One record, 13.33° C.

Remarks.—In my first account of the species of *Pentametrocrinus* collected by the *Albatross* off southern Japan in 1906, published in 1907, I confused this form with *P. japonicus* with which it agrees in pinnulation in contrast to the other common Japanese species *P. varians.* But this error was almost immediately discovered, and *P. diomedeae* was described in 1908, a Philippine station being added to the original Japanese locality. The *Siboga* had already met with this form in the Philippines in 1899 and the specimens collected were described in 1918.

PENTAMETROCRINUS JAPONICUS (P. H. Carpenter)

FIGURE 50

[See also vol. 1, pt. 1, figs. 67 (not 66 as given in the legend (p. 93), 299 (p. 264), 404 (p. 311), 513 (p. 373; pt. 2, figs. 114, 115 (p. 67)]

Eudiocrinus japonicus P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 495 (in key), p. 499 (description; *Challenger* sta. 235); *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 47, 109, 127, 339, 378 (notes).—PERRIER, Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 106 (sacculi).—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 84 (description; *Challenger* sta. 235); pl. 7, figs. 1, 2.—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, Heft 1, 1905, p. 171 (syzygies).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. CLARK, Proc. U.S. Nat.

Mus., vol. 32, 1907, p. 571 (*Albatross* stas. 4900, 4903, 4916, 4919, [4934], 4958, 4975, 4976, 4980, 5079, 5082, 5083), p. 572 (discussion of range and comparison with that of *varians*), p. 573 (comparison with *tuberculatus*), p. 574 (listed, and original reference and type locality given); vol. 34, 1908, p. 271 (history; structure; relationships; assigned to *Pentametrocrinus*); vol. 35, 1908, pp. 113, 114 (arm structure); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (arm structure; assigned to *Pentametrocrinus*); Proc. U.S. Nat. Mus., vol. 43, 1912, p. 384 (specimens in Berlin Mus. mentioned by Carpenter = *P. tuberculatus*); Crinoids of the Indian Ocean, 1912, p. 33 (identity).

Pentametrocrinus japonicus A. H. Clark, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 274, figs. 1, 2 (articular faces of the radials), p. 277 (listed), p. 319 (Japan); vol. 35, 1908, p. 117 (arm structure); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 234 (compared with *P. diomedeae*); Crinoids of the Indian Ocean, 1912, p. 33 (identity), p. 251 (synonymy; localities); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 67 (published references to specimens in the B.M.; *Challenger* sta. 235).—F. W. Clarke and Wheeler, U.S. Geol. Surv. Prof. Paper 90–D, 1914, pp. 33 and following (inorganic constituents of the skeleton).—A. H. Clark, Journ. Washington Acad. Sci., vol. 5, No. 6, 1915, p. 215 (southern Japanese type; range and its significance).—F. W. Clarke and Wheeler, U.S. Geol. Survey Prof. Paper 102, 1917, pp. 20 and following (inorganic constituents); No. 124, 1922, p. 17 (same).—A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 261 (in key; range; notes; stas. 38, 74), pp. 271, 272 (listed); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 1, figs. 6–8 (radials and centrodorsal).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 26 (pinnulation); Ark. Zool., vol. 19, No. 32, 1928, p. 12 (notes).—Vinogradov, Mem. Sears Found. Mar. Res., vol. 2, 1953, p. 256 (inorganic constituents).

Pentametrocrinus semperi (not of Carpenter), A. H. Clark, Unstalked crinoids of the *Siboga*-Exped., 1918, p. 262.

Diagnostic features.—The lowest pinnule is on the epizygal of the first syzygy, Br_5; the relatively long cirri, equal to about a third of the arm length, have the first three segments short but most are about four times as long as broad and are hardly at all expanded at the joints, particularly in the outer half of the cirrus which is fairly straight; the centrodorsal is relatively large, with XXX–LXIII cirri in at least 3 irregular rows around the sides; the proximal brachials are conspicuously swollen at the joints and somewhat constricted in the middle and at the syzygies; the disk is plated.

Description.—The centrodorsal is from nearly hemispherical to rounded conical; the cirrus sockets, which have strong articular rims about the central canal, are closely crowded and arranged in 3 or 4 sometimes irregular rows with about 4 sockets beneath each radial at the periphery of the centrodorsal. The bare dorsal pole is somewhat roughened and in very large individuals may be slightly concave. Small papillae may occupy the obsolete apical cirrus sockets.

The cirri are XXX–LXIII, 25–35 (usually about 27), in the largest specimens 54 mm. long, but more commonly about 35 mm. in length, slender, delicate, and rather strongly compressed laterally. The first two segments are short, about twice as broad as long, the third is usually longer than broad, often twice as long as broad, rarely about as long as broad or broader than long, and the fourth is slightly shorter than the fifth, which is nearly or quite four times as long as broad and in large examples reaches a length of over 2 mm. The following segments are similar as far as the tenth, after which the length very gradually decreases so that the distal segments are about two and a half times as long as broad. The terminal segments gradually taper so that the cirri end in a sharp point; while maintaining the same absolute length, these segments increase in relative length, becoming very slender. The terminal claw is conical and minute.

The 5 arms reach a length of 125 mm. in the largest specimens. Their structure is the same as that of the arms of *P. varians*, but they are generally stouter and more robust than in that species.

Syzygies occur between brachials 4+5, 9+10 or 10+11 and distally at intervals of from 2 to 6 (usually 4 or 5) muscular articulations.

P_1 and P_a are absent. The remaining pinnules resemble those of *P. varians*.

[NOTES BY A.M.C.] The syntypes of *japonicus* in the British Museum have the centrodorsal relatively large. In one (fig. 50, *a*), it is distinctly conical and is 3.7 mm. in basal diameter and 3.0 mm. high. In the other, the shape is more hemispherical and the diameter is 3.8 mm. but the height only 2.4 mm. The sides of the centrodorsal are covered with about three irregular rows of cirrus sockets, numbering XL in one specimen and XXXV in the other. The peripheral sockets particularly have the rims very prominent, projecting out from the surface. According to Carpenter the cirri were tapering and more than 35 mm. long with 27 segments. Only a fragment of one now remains.

The proximal brachials are considerably expanded at the joints, except for the syzygies, which are constricted so that the first one is only 1.8 mm. wide, i.e., the same width as in the types of *P. semperi* where the brachials are straight-sided and appear much less robust. The second syzygy is either at brachials 9+10 or 10+11; in the former case the first nine brachials together measure 10.0 mm. in both specimens. The lowest pinnules appear to be fairly equal, with about 20 stout segments, of which the proximal ones are short. The following pinnules develop relatively longer and more slender segments.

The disk appears to be naked. The brachial ambulacra have a few supporting rods and fenestrated plates. There are no sacculi.

Some numerical details of these and certain other specimens are included in table 18 (p. 802).

In a relatively small specimen from *Albatross* station 4900 (fig. 50, *c*), P_2 and P_3 are similar, with 25 to 30 segments, of which the longest proximal ones are about two and a half times as long as broad but the distal ones are relatively shorter, not longer than broad. The cirri differ from those of larger specimens in having the penultimate segment shorter than the preceding one and the terminal claw curved and acute.

Of the *Siboga* specimens, the one from station 38 has three or four of the basal cirrus segments not longer than broad and the longest segments are about three and a half times as long as broad. The specimen from station 74 has an incomplete cirrus of 34 segments, probably two or three more when complete. The suture of the first syzygy is distinctly diagonal and the fourth brachial in each case has a lateral projection.

Notes.—Of the 80 specimens collected by the *Albatross* off Southern Japan in 1906 the largest (with the arms 125 mm. and the cirri 54 mm. in length) were from station 4958, where *P. varians* was not found; but examples from station 5083 were nearly as large (with the arms 100 mm. and the longest cirri 42 mm. long) and were here associated with the largest individuals collected of the other species. Medium-sized specimens were dredged at stations 4903, 4916, 4919, 4975, 4976, 4980, 5079, and 5082, and small ones only at station 4900.

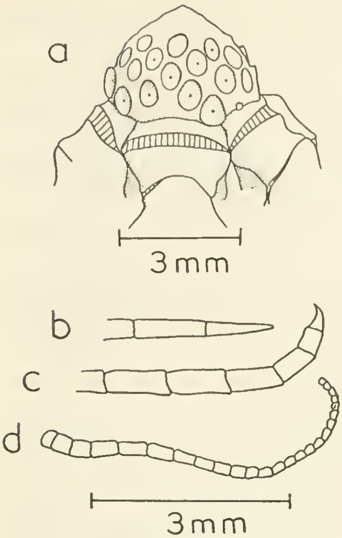

FIGURE 50.—*Pentametrocrinus japonicus* (P. H. Carpenter): *a*, Syntype; *b*, U.S.N.M., 35924, *Albatross* station 4900, tip of large cirrus; *c*, tip of peripheral cirrus of small specimen, arm width at first syzygy 0.8 mm.; *d*, P_2.

Pentametrocrinus japonicus can be distinguished at a glance from *P. varians*, with which it is frequently associated, by its more robust and massive appearance. In color the two are practically identical.

Abnormal specimen.—In one of the arms of one of the 2 examples dredged by the *Siboga* at station 211 the first brachial is repeated as a small ossicle about half the size of the normal first brachial and of about half its width, which is inserted between the normal first brachial and the second brachial. The articulation between the normal and the supernumerary first brachials and that between the latter and the second are both synarthries.

Parasitism [by A.M.C.].—The small specimens from *Albatross* station 4900 (U.S. N.M., 35924) are all infected by gall-producing parasites which appear to have induced a marked hypertrophy of the infected arms. These arms are both longer and thicker than the arms which do not bear the galls.

Localities.—*Albatross* station 5661; Flores Sea; Cape Lassa bearing N. 21° E., 12.5 miles distant (lat. 5°49′40″ S., long. 120°24′30″ E.); 329 meters; temperature 10.28° C.; hard bottom; December 20, 1909 (1, U.S.N.M., 36006).

Siboga station 38; Sunda Sea, north of Sumbava (lat. 7°35′24″ S., long. 117°28′36″ E.); 521 meters; coral; April 1, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 74; off Macassar, southwestern Celebes (lat. 5°03′30″ S., long. 119°00′00″ E.); 450 meters; globigerina ooze ("obviously a thin layer"); June 8, 1899 [A. H. Clark, 1918] (1, Amsterdam M.).

Siboga station 211; off Saleyer, south of western Celebes (lat. 5°40′42″ S., long. 120°45′30″ E.); 1158 meters; coarse gray mud with more fluid superficial layer; September 19, 1899 [A. H. Clark, 1918] (2, U.S.N.M., E. 480; Amsterdam M.).

Albatross station 5601; Gulf of Tomini, Celebes; Limbe Island (NE) bearing N. 20.7 miles distant (lat. 1°13′10″ N., long. 125°17′05″ E.); 1398 meters; sand, globigerinae and pteropods; November 13, 1909 (1, U.S.N.M., 36035).

Dr. Th. Mortensen's Pacific Expedition; 3 miles southwest of Tucuran, Mindanao; c. 550 meters; March 10, 1914 (1, C.M.).

Albatross station 4903; Eastern Sea, southwest of the Goto Is.; Ose Saki light bearing N. 22° E., 6 miles distant (lat. 32°31′10″ N., long. 128°33′20″ E.); 195–256 meters; gray sand and broken shells; August 10, 1906 [A. H. Clark, 1907] (2, U.S.N.M.).

Albatross station 4900; Eastern Sea, southwest of the Goto Is. (lat. 32°28′50″ N., long. 128°34′40″ E.); 254 meters; temperature 11.61° C.; gray sand and broken shells; August 10, 1906 [A. H. Clark, 1907] (4, U.S.N.M., 35924).

Albatross station 4916; Eastern Sea, about 90 miles west-southwest of Kagoshima Gulf; Gwaja Shima bearing S. 37° E., 37.5 miles distant (lat. 30°25′00″ N., long. 129°06′40″ E.); 660 meters; temperature 5.95° C.; gray sand, globigerinae, and broken shells; August 13, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 35921).

Albatross station 4919; Eastern Sea, about 90 miles west-southwest of Kagoshima Gulf; Kusakaki Jima bearing N. 18° E., 17.6 miles distant (lat. 30°34′00″ N., long. 129°19′30″ E.); 804 meters; temperature 5.44° C.; globigerina ooze; August 13, 1906 [A. H. Clark, 1907] (2, U.S.N.M., 35920).

Albatross station 4958; southwest of Kobe, Japan; Mizimoko Shima light bearing N. 26° W., 29.3 miles distant (lat. 32°36′20″ N., long. 132°24′30″ E.); 740 meters; temperature 4.50° C.; green and brown mud, fine gray sand, and foraminifera; August 23, 1906 [A. H. Clark, 1907] (11, U.S.N.M., 35922).

Albatross station 4976; between Kobe and Yokohama; Shio Misaki light bearing N. 59° E., 6.4 miles distant (lat. 33°22′50″ N., long. 135°38′30″ E.); 994–996 meters; temperature 3.72° C.; brown mud and small stones; August 31, 1906 [A. H. Clark, 1907] (3, U.S.N.M., 35918).

Albatross station 4975; between Kobe and Yokohama; Shio Misaki light bearing N. 49° E., 7 miles distant (lat. 33°21′30″ N., long. 135°38′50″ E.); 996–1301 meters; temperature 3.05° C.; brown mud, pebbles, and foraminifera; August 31, 1906 [A. H. Clark, 1907] (2, U.S.N.M., 35919).

Albatross station 4980; near Tokyo Bay (lat. 34°09′00″ N., long. 137°55′00″ E.); 927 meters; temperature 3.89° C.; brown mud, fine sand and foraminifera; September 1, 1906 [A. H. Clark, 1907] (25, U.S.N.M., 35915, 36188, 36175, 36234).

Albatross station 5083; near Suruga Gulf; Omai Saki light bearing N. 23°30′ E., 34.5 miles distant (lat. 34°04′20″ N., long. 137°57′30″ E.); 1141 meters; temperature

3.39° C.; fine gray sand and globigerinae; October 20, 1906 [A. H. Clark, 1907] (15, U.S.N.M., 35916).

Albatross station 5082; near Suruga Gulf; Omai Saki light bearing N. 22° E., 33 miles distant (lat. 34°05′00″ N., long. 137° 59′00″E.); 1210 meters; temperature 3.17° C.; green mud, fine sand and globigerinae; October 20, 1906 [A. H. Clark, 1907] (2, U.S.N.M., 35923).

Albatross station 5079; near Suruga Gulf; Omai Saki light bearing N. 29° E., 24 miles distant (lat. 34°15′00″ N., long. 138°00′00″ E.); 868–923 meters; temperature 3.95° C.; pebbles; October 19, 1906 [A. H. Clark, 1907] (2, U.S.N.M., 35917).

Challenger station 235; south of Japan (lat. 34°07′ N., long. 138°00′ E.); 1033 meters; temperature 3.39° C.; green mud; June 4, 1875 [P. H. Carpenter, 1882, 1888; A. H. Clark, 1913] (2, B.M.). Type locality.

Geographical range.—From the Lesser Sunda Islands northward to southern Japan, as far eastward as Tokyo Bay.

Bathymetrical range.—From 254 to 1210 meters; the average of 17 records is 872 meters.

Thermal range.—From 3.95° C. to 11.61° C., but all but two of the records are below 6° C. The average of the 12 records is 5.20° C.; the average of all the records except the two highest is 4.04° C.

Remarks.—Carpenter remarked that it was with some hesitation that he separated *japonicus* from *semperi*; but *japonicus* is altogether larger and more massive than *semperi*, with a larger and more distinctly conical centrodorsal and more numerous cirri. The first brachials have larger muscle plates for articulation with the radials, and are more trapezoidal in outline. As the second brachials are relatively longer than those of *semperi* and at the same time more trapezoidal in form, the base of each arm is considerably constricted at the junction of its first two brachials. He noted that the general proportions of the remaining brachials and of the pinnules appeared to be much the same in the two types, excepting that in the smaller *semperi* the segments of the lower pinnules are rather longer in proportion to their width than in *japonicus*.

In his key to the species of the genus "*Eudiocrinus*" Carpenter separated these two species on the basis of the plated disk and nearly oblong first brachials of *semperi* as contrasted with the naked disk and trapezoidal first brachials of *japonicus*.

In some individuals the plating of the disk is far more conspicuous than in others. For instance, it is very noticeable in the rather large specimen from *Albatross* station 5661, which has a conical centrodorsal and is in every other way a typical *japonicus*. But on close examination I find a plating quite resembling that described for *semperi* in some of the specimens of *japonicus* dredged by the *Albatross* off southern Japan.

[Note by A.M.C.] Mr. Clark concluded from this that *japonicus* and *semperi* are synonymous. However, having examined the type specimens of both species and found that those of *semperi* have only about 15 cirrus sockets as opposed to 35 and 40 in *japonicus*, where the centrodorsal itself is much larger though the lengths of the proximal brachials are the same, I cannot agree that they represent the same species. I am therefore restoring *japonicus* as a valid species. On biogeographical grounds also the identity of the two is unlikely.

TABLE 18.—*Comparison of measurements of some specimens of* Pentametrocrinus japonicus *and the syntypes of* P. semperi

	Centrodorsal		Number of cirrus sockets	Breadth of arms at 4+5 (mm.)	Length of Brs 1–9 (mm.)
	Diam. (mm.)	Height (mm.)			
japonicus, syntype	3. 7	3. 0	XL	1. 8	10. 0
japonicus, syntype	3. 8	2. 4	XXXV	1. 8	10. 0
U.S.N.M. 35922	5. 0	4. 0	LII	2. 5	13. 0
U.S.N.M. 35922	4. 5	3. 6	XLV	2. 2	12. 0
U.S.N.M. 35922	4. 5	3. 4	LXIII	2. 0	11. 0
U.S.N.M. 35922	4. 0	3. 0	XLV	1. 9	11. 0
U.S.N.M. 35922	3. 2	2. 5	XL	1. 6	10. 0
U.S.N.M. 35922	3. 5	2. 4	XL	1. 7	9. 5
U.S.N.M. 35922	3. 1	2. 2	XXXIII	1. 5	8. 5
U.S.N.M. 35922	3. 2	2. 1	XXXVII	1. 6	9. 0
U.S.N.M. 35924	2. 6	2. 1	XL	1. 1	6. 0
U.S.N.M. 35924	1. 8	1. 2	c. XXX	0. 8	6. 0
U.S.N.M. 35924	1. 8	1. 4	XXXV	0. 8	5. 5
U.S.N.M. 35924	1. 5	1. 0	c. XXX	0. 7	5. 0
Siboga sta. 38	3. 7	2. 6	XXXVII	2. 0	9. 5
Siboga sta. 74	3. 6	2. 4	XXXII	2. 3	9. 0
Siboga sta. 211	2. 6	2. 2	c. XXX	1. 4	–
semperi, syntype	2. 7	1. 8	XVI	1. 8	10. 0
semperi, syntype	2. 2	1. 5	XV	1. 4	9. 0

PENTAMETROCRINUS SEMPERI (P. H. Carpenter)

FIGURE 51

[See also vol. 1, pt. 1, fig. 512 (p. 373); pt. 2, pl. 4, figs. 1006, 1007, pl. 6, fig. 1016, pl. 12, fig. 1033, pl. 25, fig. 1158]

Eudiocrinus semperi P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 495 (in key), p. 497 (description; *Challenger* stas. 164, 169); Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 919 (comparison with *Thaumatocrinus renovatus*); *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 36, 47, 127 (notes).—PERRIER, Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 106 (sacculi).—P. H. CARPENTER, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 387 (*Challenger* stas. 164, 169; no sacculi); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 82 (description; *Challenger* stas. 164, 169), pl. 3, fig. 7, pl. 6, figs. 1–3.—WHITELEGGE, Journ. Roy. Soc. New South Wales, vol. 23, 1890, p. 197 (after Carpenter).—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, Heft 1, 1905, pp. 170 and following (syzygies).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 32, 1907, p. 574 (original reference and type locality [selected as *Challenger* sta. 164]); vol. 34, 1908, p. 271 (history; structure; relationships; assigned to *Pentametrocrinus*); vol. 35, 1908, pp. 113, 114 (arm structure); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (arm structure; removed to *Pentametrocrinus*); Crinoids of the Indian Ocean, 1912, p. 33 (of P. H. Carpenter=*Pentametrocrinus semperi*).

Ophiocrinus semperi P. H. CARPENTER, Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 919, footnote (name changed to *Eudiocrinus semperi*, *Ophiocrinus* being preoccupied).

Antedon (*Ophiocrinus*) *semperi* P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pl. 3, fig. 7.

Endiocrinus semperi HUTTON, Index faunae Novae Zelandiae, 1904, p. 291.

Pentametrocrinus semperi A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 277 (listed); vol. 35, 1908, p. 117 (arm structure); Mem. Australian Mus., vol. 4, 1911, p. 796 (*Challenger* locality off Port Jackson); Crinoids of the Indian Ocean, 1912, p. 33 (identity), p. 251 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 67 (published references to specimens in the B.M.; *Challenger* sta. 169; plating on the disk described).—GISLÉN, Zool. Bidrag. Uppsala, vol. 9, 1924, p. 26 (pinnulation); Ark. Zool., vol. 19, No. 32, 1928, p. 12 (notes).—FELL, New Zealand Science Congress, 1947, p. 209 (listed).

Pentametrocrinus semperei FELL, Tuatara, Wellington, New Zealand, vol. 3, No. 2, 1950, p. 81 (in key), text-fig. 6 (calyx and arm bases).

Diagnostic features.—The lowest pinnule is on the epizygal of the first syzygial pair; the relatively long cirri, about 30 mm. when the arms are probably about 80 mm. long, have the first three segments short but the majority about four times as long as broad and very little expanded at the joints, particularly in the outer half of the cirrus, which is hardly curved; the centrodorsal is relatively small, with only about XV cirri and an irregular dorsal pole; the proximal brachials have only inconspicuous articular tubercles and are not markedly swollen at the joints.

Description of the syntype from *Challenger* station 169 [by A.M.C.].—The centrodorsal is rounded conical; 2.7 mm. in basal diameter and 1.8 mm. high. There are XVI well-defined cirrus sockets irregularly placed around the sides, and the dorsal pole is rough and rather pitted.

Three basal segments of one cirrus remain attached. All are short, the third is about as long as broad.

There are some detached cirri which may belong either to this specimen or to the syntype from station 164, since the tubes in which they are kept were not stoppered. The largest of these was probably a peripheral cirrus. It has lost at least 4 segments from the base and probably 2 or 3 from the tip but the 17 remaining segments are 29 mm. long. All are about four times as long as broad. A less robust cirrus with only the tip lost has 21 segments and measures 28 mm. The third segment from the base is slightly longer than broad, the fourth is two and a half times as long as broad, the fifth is four times as long as broad. This proportion continues to the last remaining segment. The first nine segments have slightly expanded joints but those following have straight sides. After the first 15 mm. the cirrus tapers evenly. No terminal portion remains. Carpenter gave the number of segments as 26 and the length 30 mm.

The proximal brachials to the second syzygy have almost parallel proximal and distal sides but further out the brachials become relatively longer and more triangular. The articular tubercles are low and inconspicuous and the brachials are not much expanded at the joints. The first syzygy is at brachials 4+5 and is 1.8 mm. wide. The second syzygy is variable, on the 5 arms it is twice at brachials 9+10, twice at 10+11, and once at 8+9. The length from the proximal edge of the first brachial to the second syzygy at 9+10 is 10.0 mm. The longest remaining arm is 50 mm. When complete it may have been double this as the tapering is slight. The intersyzygial interval is 2 to 6 brachials.

The first pinnule arises on the right side of the fifth brachial in 3 out of 5 cases. The longest remaining one has 15+ segments, probably about 18, and is 7 mm. long. The first three segments are short, the fourth and fifth are half again as long as broad and the rest are up to two and a quarter times as long as broad. The pinnule on the sixth brachial has 17 segments similar in proportions to those of the first one. The segments are only a little expanded at the joints.

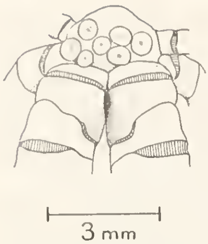

FIGURE 51.—*Pentametrocrinus semperi* (P. H. Carpenter), syntype, *Challenger* station 164.

The genital pinnules arise from about the ninth brachial on. They have about 20 segments and measure about 11 mm. The gonad is short and extends from the fourth to the seventh segments. The outer segments are about three times as long as broad.

The disk and arm bases are rather closely plated.

The syntype from station 164, pronounced the type locality by Mr. Clark, has the centrodorsal 2.5 mm. wide and 1.6 mm. high. There are XV cirrus sockets and the dorsal pole is also pitted and irregular; Carpenter gives the number of sockets as 20 to 30, but some of these are definitely obsolete. All the pinnules are broken. The specimen is very similar in all respects to the one just described.

Localities.—*Challenger* station 164; off Port Jackson, New South Wales (lat. 34°08′ S., long. 152°00′ E.); 1736 meters; temperature 2.50° C.; green mud; June 12, 1874 [P. H. Carpenter, 1882, 1887, 1888] (1, B.M.). Type locality.

Challenger station 169; northeast of New Zealand (lat. 37°34′ S., long. 179°22′ E.); 1279 meters; temperature 4.44° C.; blue mud; July 10, 1874 [P. H. Carpenter, 1882, 1887, 1888; A. H. Clark, 1913] (1, B.M.).

Remarks [by A.M.C.].—As explained under the heading of *P. japonicus*, I do not think this Australasian form is conspecific with the Japanese one, although there are many similarities.

PENTAMETROCRINUS VARIANS (P. H. Carpenter)*

[See vol. 1, pt. 1, figs. 119(p. 185), 308(p. 267); pt. 2, figs. 286(p. 215), 758(p. 353), 802(p. 378)]

Eudiocrinus varians P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 495 (in key), p. 496 (description; *Challenger* sta. 205); Proc. Roy. Soc. Edinburgh, vol. 12, 1884, p. 367 (comparison of the cirri with those of *Antedon hystrix* [*Poliometra prolixa*]); Trans. Linn. Soc. (Zool.), ser. 2, vol. 2, 1886, p. 475 (dimorphism of the cirri); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 81 (description; *Challenger* sta. 205), pl. 7, figs. 3–7).—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 299 (from Carpenter).—MINCKERT, Arch. Naturg., Jahrg. 71, 1905, vol. 1, Heft 1, p. 189 (syzygies).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1576 (listed).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 32, 1907, p. 569 (*Albatross* stas. 4906, 4911, 4912, 4915, 4916, 4919, 4920, 4975, 5082, 5083), p. 570 (discussion of range), p. 572 (comparison of range with that of *P. japonicus*), p. 574 (original reference and type locality); vol. 34, 1908, p. 271 (history; structure; relationships; assigned to *Pentametrocrinus*); vol. 35, 1908, p. 113 (arm structure); Proc. Biol. Soc. Washington, vol. 21, 1908, p. 134 (arm structure; removed to *Pentametrocrinus*); Crinoids of the Indian Ocean, 1912, p. 33 (=*Pentametrocrinus varians*).

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* See also Addenda (p. 836) under 1962.

Eudiocrinus, sp. WOOD-MASON and ALCOCK, Ann. Mag. Nat. Hist., ser. 6, vol. 8, No. 48, December 1891, p. 443 (muddy bottoms in the Andaman Sea; 922 fms.).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 285 (previous reference is to *Pentametrocrinus*, sp.).

Pentametrocrinus varians A. H. CLARK, Proc. Biol. Soc. Washington, vol. 21, 1908, p. 135 (listed); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 277 (listed), p. 319 (Japan); vol. 35, 1908, p. 117 (arm structure); Smithsonian Misc. Coll., vol. 52, pt. 2, 1908, p. 234 (compared with *P. diomedeae*); Rec. Indian Mus., vol. 7, pt. 3, No. 26, 1912, p. 271 (*Investigator* sta. 114); Crinoids of the Indian Ocean, 1912, p. 33 (=*Eudiocrinus varians*, P. H. Carpenter), p. 251 (synonymy; *Investigator* stas. 315, 331; descriptions and comparisons; other records); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 67 (published references to specimens in the B.M.; *Challenger* sta. 205); Journ. Washington Acad. Sci., vol. 5, 1915, No. 6, p. 215 (range and its significance); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 260 (in key; range), p. 262 (references; notes; stas. 45, 48, 314), pp. 271, 276 (listed); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, pl. 2, fig. 24 (ambulacral deposits), pl. 3, fig. 35 (proportions of the cirri).—H. L. CLARK, Ann. South African Mus., vol. 13, 1923, p. 227, p. 229 (in key), p. 235 (station; range) [? this species].—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, p. 26 (pinnulation); Ark. Zool., vol. 19, No. 32, 1928, p. 12 (notes); Lunds Univ. Årsskr., new ser., vol. 30, No. 11, 1934, p. 17.—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 87 (listed), p. 97 (station; notes; range), pp. 102, 104, 105.—GISLÉN, Kungl. Svenska Vet.-Akad. Handl., ser. 3, vol. 17, No. 2, 1938, p. 4; Lunds Univ. Årsskr., new ser., Avd. 2, vol. 34, No. 17, 1939, p. 16.

Diagnostic features.—The lowest pinnule is on the second brachial. In general appearance this species closely resembles *japonicus*, from which it is readily distinguished by the occurrence of a pinnule on the second brachial as well as by its somewhat more slender build.

Description.—The centrodorsal is low hemispherical, with a large bare polar area which usually shows marginal pittings representing obsolete cirrus sockets. The cirrus sockets are arranged roughly in two rows; about the periphery of the centrodorsal there are three beneath each radial.

The cirri are XV–XXX (usually about XX), from 30 to 50 mm. long, composed of 18 to 22 (usually 20 to 22) segments. The first two segments are about twice as broad as long, the third is about twice as long as its proximal width, or rather longer, and is centrally constricted, the fourth is between three and four times as long as broad (commonly about 2 mm. long), and the fifth is proportionately and absolutely longer (up to 3 mm. in the largest examples). The following segments as far as the tenth are similar to the fifth, those succeeding gradually becoming shorter. The terminal 7 or 8 segments form a tapering point to the cirri, the last two being very slender; these segments thus become proportionately, though not absolutely, longer. The terminal claw is straight and tapers to a sharp point; it is not quite so long as the penultimate segment which, owing to its slenderness, is six or eight times as long as broad. The third segment of each cirrus is noticeably constricted centrally, and the following increase slightly in diameter from the center toward each end, this feature becoming obsolete after the middle of the cirrus. In their distal halves the cirri are somewhat flattened laterally, and in lateral view the segments have almost straight sides.

Sometimes there are a few cirri near the dorsal pole which are only about half the length of the cirri described, and in which all the component segments are short.

The disk is either naked, or bears a few plates on and about the anal tube. The sacculi are small and few in number.

The distal borders of the radials are usually even with the edge of the centrodorsal, or project slightly beyond it. The anterolateral angles of the radials are separated by a notch.

The 5 arms are from 80 to 110 mm. long. The first brachials are oblong, about twice as broad as long, or even shorter, with the anterolateral corners produced inwardly in the form of a rounded process. The second brachials are similar, but usually slightly longer. There is a more or less pronounced synarthrial tubercle on the articulation between the first and second brachials. The second brachial bears a pinnule on one side and an anterolateral projection similiar to that of the first brachial on the other. The third brachial is oblong, about twice as broad as long. The first syzygial pair (composed of brachials 4+5) has the hypozygal (fourth brachial) wedge-shaped and the epizygal (fifth brachial) oblong, the two together usually being in width rather more than the lesser and less than the longer side; in some individuals the width slightly exceeds the longer side. The following brachials to the eleventh are wedge-shaped, broader than long, those succeeding becoming obliquely wedge-shaped and nearly, or quite, as long as broad, later less obliquely wedge-shaped again and proportionately longer, and terminally moderately wedge-shaped or almost oblong, about twice as long as broad, with the articulations prominent. The arms are smooth, the brachials not overlapping.

Syzygies occur between brachials 4+5, 9+10 to 11+12 (usually 10+11), 13+14 to 16+17 (usually 15+16), and distally at intervals of from 2 to 8 (usually 3 to 5) muscular articulations.

P_1 is short, weak, and slender, in a medium-sized individual 6.5 mm. long, with 25 segments, all of which are short, the proximal three or four not so long as broad and the following gradually becoming slightly longer than broad. The segments in the basal third have their corners cut away; this feature gradually disappears in those following, which become cylindrical. P_2 is slender, 9 mm. long, composed of 25 segments, of which the first two are very short, the third is about as long as broad, and those following very gradually become elongated, distally reaching a length of about twice the width. There is sometimes a gonad on the fourth to sixth segments. P_3 is 10 mm. long, rather stouter than P_2, composed of 24 segments, of which the first two are very short and those following gradually become elongated, reaching a length of about twice the width distally. The corners of the 3 or 4 lowest segments are cut away, and from the fourth or fifth onward the segments have rather prominent articulations. There is a large rounded gonad on the fourth to eighth segments. The following pinnules increase in length, P_5 being 11 mm. long and P_6 12 mm. long; the latter is composed of 25 segments which resemble those of P_3 except that those beyond the gonad are more slender and more elongated (three or four times as long as broad) with more expanded articulations. P_5 is intermediate between P_3 and P_6, though more like the latter. The following pinnules, while remaining of about the same length, come to have more elongated segments, and the gonad gradually decreases in size; with the decrease in size of the gonad the pinnule comes to have a uniform taper, losing the sudden diminution in diameter at the outer extremity of the gonad. P_{10} is 11 mm. long, with 22 segments, of which the first is short and crescentic, the second is about as long as broad and slightly trapezoidal, and the remainder rapidly become elongated with enlarged articulations, and exceedingly long and slender distally. The gonad is small, occupying only the fourth to sixth segments. The gonads persist to about P_{13}. None of the distal pinnules are preserved entire; they resemble P_{10}, but except for the first two the segments are somewhat more elongate, and the articulations rather more expanded.

[NOTES BY A.M.C.] In one of the two syntypes in the British Museum the flattened hemispherical centrodorsal is 4.3 mm. in diameter and 2.0 mm. high. There were XXX cirri. Only stumps of these remain. The third segment may be only a little longer than broad or twice as long as broad. The second syzygy on the arms is either at brachials 10+11 or 11+12. In the first case the length of the first 10 brachials is 14.0 mm. The width at 4+5 is 2.1 mm. P_1 in each case is on the right side of the arm. All are broken but 10 segments of one measure 5 mm. The segments are all short, but those of P_2 after the fourth are a little longer than broad and in P_3 again the relative length of the outer segments increases. The fourth and fifth (sometimes also the third or sixth) segments of the proximal pinnules have a distinct dorsal crest, not shown in Carpenter's figure. This ends abruptly in each case, the following segment being much narrower in side view. P_2 has 25 segments and measures 11 mm. in length.

The other syntype has the centrodorsal 3.3 mm. by 2.2 mm., there being a slight apex in the middle of the dorsal pole. There are XXVIII cirrus sockets or stumps. The second syzygy is twice at 9+10, twice at 10+11, and once at 11+12 when the first is at 5+6. The first 10 segments when it is at 10+11 together measure 12.5 mm. The pinnule segments are more elongate than in the larger type. P_2 again has 25 segments and is 11 mm. long. Its outer part is attenuate. The proximal crest is again well developed. The longest detached portion of cirrus is about half of one and measures 22 mm. The joints are slightly expanded unlike those of *P. japonicus* and the segments are about four times as long as wide.

A specimen from *Siboga* station 314 has the longest remaining arm measuring 65 mm.; when complete it was probably about 90 mm. The longest remaining cirrus is broken at the twenty-first segment; at least three segments appear to have been lost. The length is 26 mm., most of the segments being very elongated.

The width of the arm at the first syzygy is 1.3 mm. The second syzygy is four times 9+10, when the first nine brachials together measure 8.0 mm. in length, and once at 10+11 when the length of the 10 segments is 8.5 mm.

P_1 arises twice on the right side of the second brachial and three times on the left side. P_2 may bear a small gonad. P_3 is larger than P_2 and with longer segments. None of these pinnules remains entire.

Notes.—In 1910 I [A.H.C.] examined the type specimens in London and found that they resemble the larger individuals which I had previously seen from Japan and from the Indian Ocean.

Of the 238 specimens from southern Japan examined, the largest, with the arms 106 mm. and the cirri 50 mm. in length, were from *Albatross* station 5083. Stations 4912, 4916, 4919, 4920, 4975, and 5082 yielded medium-sized specimens, while all of those from stations 4906, 4911, and 4915 were small.

The specimen from *Investigator* station 114 mentioned by Messrs. Wood-Mason and Alcock and subsequently studied by myself was small and much broken.

A very fine specimen dredged by the *Investigator* at station 315 resembles in the minutest details specimens dredged by the *Albatross* off southern Japan, with which it was compared directly. The arms are between 100 and 110 mm. in length, and the cirri are 30 mm. long, with 21 segments. Its size, therefore, is about the same as that of the largest Japanese examples. An individual of the same size as, and similar to, the preceding was dredged by the *Investigator* at station 331.

Of the specimens collected by the *Siboga* the two from station 45 are of medium size; the more nearly perfect one has the cirri 22 mm. long with 19 segments; the two from station 48 are much broken; the larger individual from station 314 has the arms about 120 mm. long, and the swollen ovaries appear to contain ripe eggs; the smaller has the arms about 90 mm. long.

In this species there is considerable variation in regard to the extension of the first brachial beyond the rim of the centrodorsal. In most individuals the first brachials are fairly conspicuous, but in one or two they do not show at all so that the first pinnule is borne on the lowest visible brachial. The arms and cirri are long and slender and the centrodorsal comparatively small, giving the species a remarkably attenuated appearance.

The specimen collected by the John Murray Expedition in the Maldive area has the lower brachials rather strongly constricted centrally with prominent ends. This feature also occurs in some specimens from southern Japan, though it is not so marked. [Note by A.M.C.] This specimen appears to have double syzygies on two of the three remaining arms consisting of brachials 4+5+6. On the third arm they are 4+5 and 7+8. There are XX cirri, of which the longest segments are six times as long as wide. P_a has 23 segments. No distinct crests are developed on the proximal segments of the basal pinnules.

Localities.—Investigator station 114; Andaman Sea (lat. 13°21′ N., long. 93°27′ E.); 1685 meters; temperature 5.1° C.; blue mud; September 13, 1890 [Wood-Mason and Alcock, 1891; A. H. Clark, 1912] (1, I.M.).

Investigator station 331; Andaman Sea (lat. 11°46′30″ N., long. 93°16′00″ E.); 1040 meters; temperature 4.4° C.; March 26, 1904 [A. H. Clark, 1912] (1, U.S.N.M., 35940).

Investigator station 315; south of the Andaman Islands (lat. 10°06′ N., long. 92°29′ E.); 1289 meters; temperature 6.7° C.; green mud; April 12, 1903 [A. H. Clark, 1912] (1, I.M.).

John Murray Expedition station 135; Maldive area (lat. 4°37′32″ N., long. 72°35′36″ E., to 4°29′18″ N., 72°23′54″ E.); 2727 meters; at 2375 meters, temperature 2.31° C., salinity 34.64‰; yellow ooze over gray globigerina ooze; February 18, 1934 [A. H. Clark, 1936] (1, B.M.).

Siboga station 314; Sunda Sea, north of Sumbava (lat. 7°36′00″ S., long. 117°30′48″ E.); 694 meters; fine sandy mud; February 17, 1900 [A. H. Clark, 1918] (2, U.S.N.M., E. 444; Amsterdam M.).

Siboga station 45; Sunda Sea, north of Sumbava (lat. 7°24′00″ S., long. 118°15′12″ E.); 794 meters; fine gray mud with some radiolarians and diatoms; March 6, 1899 [A. H. Clark, 1918] (2, U.S.N.M., E. 445; Amsterdam M.).

Siboga station 48; Sunda Sea, north of Sumbava (lat. 8°04′42″ S., long. 118°44′18″ E.); 2060 meters; fine gray mud, partially green; March 13, 1899 [A. H. Clark, 1918] (2, Amsterdam M.).

Challenger station 205; Philippine Islands, off Luzon (lat. 16°42′ N., long. 119°22′ E.); 1919 meters; temperature 2.78° C.; blue mud; November 13, 1874 [P. H. Carpenter, 1882, 1884, 1886, 1888; Walther, 1894; Minckert, 1905; A. H. Clark, 1913] (2, B.M.). Type locality.

Albatross station 4916; Eastern Sea, about 90 miles west-southwest of Kagoshima Gulf; Gwaja Shima bearing S. 37° E., 37.5 miles distant (lat. 30°25′00″ N., long.

129°06′40″ E.); 660 meters; temperature 5.95° C.; gray sand, globigerinae, and broken shells; August 13, 1906 [A. H. Clark, 1907] (3, U.S.N.M., 35937).

Albatross station 4911; Eastern Sea, southwest of the Koshika Islands; Tsurikake Saki light bearing S. 88° E., 18 miles distant (lat. 31°38′30″ N., long. 129°19′00″ E.); 715 meters; temperature 5.50° C.; gray globigerina ooze; August 12, 1906 [A. H. Clark, 1907] (4, U.S.N.M., 35939).

Albatross station 4919; Eastern Sea, about 90 miles west-southwest of Kagoshima Gulf; Kusakaki Jima bearing N. 18° E., 17.6 miles distant (lat. 30°34′00″ N., long. 129°19′30″ E.); 804 meters; temperature 5.44° C.; globigerina ooze; August 13, 1906 [A. H. Clark, 1907] (104, U.S.N.M., 35934).

Albatross station 4912; Eastern Sea, southwest of the Koshika Islands; Tsurikake Saki light bearing S. 84° E., 17.5 miles distant (lat. 31°39′40″ N., long. 129°20′00″ E.); 715 meters; temperature 5.50° C.; gray globigerina ooze; August 12, 1906 [A. H. Clark, 1907] (13, U.S.N.M., 35936).

Albatross station 4906; Eastern Sea, southwest of the Kodhika Islands; Tsurikake Saki light bearing S. 85° E., 17.2 miles distant (lat. 31°39′00″ N., long. 129°20′30″ E.); 674–742 meters; temperature 6.33° C.; August 11, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 35941).

Albatross station 4920; Eastern Sea, about 90 miles west-southwest of Kagoshima Gulf; Kusakaki Jima bearing N. 10° E., 17.5 miles distant (lat. 30°34′00″ N., long. 129°22′00″ E.); 804 meters; temperature 4.44° C.; globigerina ooze; August 13, 1906 [A. H. Clark, 1907] (5, U.S.N.M., 35942).

Albatross station 4915; Eastern Sea, southwest of the Koshika Islands; Tsurikake Saki light bearing N. 62° E., 14.8 miles distant (lat. 31°31′00″ N., long. 129°25′30″ E.); 780 meters; temperature 5.50° C.; gray globigerina ooze and broken shells; August 12, 1906 [A. H. Clark, 1907] (1, U.S.N.M., 35943).

Albatross station 4975; between Kobe and Yokohama; Shio Misaki light bearing N. 49° E., 7 miles distant (lat. 33°21′30″ N., long. 135°38′50″ E.); 996–1301 meters; temperature 3.05° C.; brown mud, pebbles and foraminifera; August 31, 1906 [A. H. Clark, 1907] (9, U.S.N.M., 35938).

Albatross station 3721; Sagami Bay; Oi Gawa bearing N. 49° W., 2.8 miles distant; 378–457 meters; gray mud; May 12, 1900 (1, U.S.N.M., 35944).

Albatross station 5083; near Suruga Gulf; Omai Saki light bearing N. 23°30′ E., 34.5 miles distant (lat. 34°04′20″ N., long. 137°57′30″ E.); 1141 meters; temperature 3.39° C.; fine gray sand and globigerinae; October 20, 1906 [A. H. Clark, 1907] (28, U.S.N.M., 35935).

Albatross station 5082; near Suruga Gulf; Omai Saki light bearing N. 22° E., 33 miles distant (lat. 34°05′00″ N., long. 137°59′00″ E.); 1210 meters; temperature 3.17° C.; green mud, fine sand, and globigerinae; October 20, 1906 [A. H. Clark, 1907] (70, U.S.N.M., 35933).

[*Pieter Faure* No. 17351; Cape Point, South Africa, N. 86° E., 43 miles; 1646–1830 meters; gray mud [H. L. Clark, 1923] (1, ? S. Afr. M.) (identity needs confirmation).]

Geographical range.—From the vicinity of the Andaman and Maldive Islands to the Lesser Sunda Islands, and northward to southern Japan, as far east as Suruga Gulf. The record of H. L. Clark from South Africa needs confirmation.

Bathymetrical range.—From 457 (?378) to 2727 meters; the average of 18 records is 988 meters.

Thermal range.—From 2.31° C. to 6.7° C.; the average of 15 records is 4.6° C.

Remarks.—Off southern Japan the *Albatross* dredged *Pentametrocrinus tuberculatus* alone at station 3661 in 309 meters with a bottom temperature of 8.89° C. This is evidently a shallow water form as it has been twice taken without elaborate dredging equipment.

Pentametrocrinus diomedeae alone was taken at station 4934 in from 188 to 279 meters with a temperature of 13.33° C.

Pentametrocrinus japonicus alone was dredged at stations 4900, 4903, 4958, 4976, 4980, and 5079, in from 254 (?195) to 996 meters with temperatures from 3.72° C. to 11.61° C.

Pentametrocrinus varians only was dredged at stations 3721, 4906, 4911, 4912, 4915, and 4920 in from 714 (?378) to 804 meters with temperatures from 5.44° C. to 6.33° C.

Pentametrocrinus varians in company with *P. japonicus* was dredged at stations 4916, 4919, 4975, 5082, and 5083 in 660 to 1301 meters with temperatures from 3.05° C. to 5.95° C.

Pentametrocrinus japonicus and *P. varians* thus appear to occupy about the same habitat so far as temperature and depth are concerned, although it is worthy of note that *P. japonicus* was found at stations with lesser depths and higher temperatures than *P. varians*. Wherever *P. japonicus* and *P. varians* were found together the examples of each were always of practically the same size; when *P. varians* was large and robust, *P. japonicus* was also large and robust and when *P. varians* was small *P. japonicus* was also small, suggesting that the same factors influenced the growth of each in the same degree.

Pentametrocrinus japonicus can be distinguished at a glance from *P. varians* by its more robust and massive appearance. In color the two species are practically the same.

At some places off the Japanese coast these comatulids were extraordinarily abundant, coming up in hundreds in the net or on the tangles. It was only possible to preserve a very small proportion of those collected.

[Note by A.M.C.] This species has been recorded a number of times by Mr. Clark from various stations in the Indo-West Pacific. In 1923 Dr. H. L. Clark gave the name *varians* to a specimen taken off South Africa after comparing it with others from Japan. He does not mention the occurrence of the proximal pinnules. I think this specimen is more likely to be *P. atlanticus* since a number of species occurring in the northeast Atlantic are also found at the Cape, although sometimes the southern forms have been distinguished as subspecies.

PENTAMETROCRINUS, sp.

Endiocrinus, sp. Chun, Aus den Tiefen des Weltmeeres, 1900, p. 488.

Pentametrocrinus, sp. A. H. Clark, Proc. U.S. Nat. Mus., vol. 40, 1911, pp. 5, 49 (same record); Crinoids of the Indian Ocean, 1912, p. 288 (same record); John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, pp. 102, 104 (listed).

Remarks.—Professor Chun records the capture by the *Valdivia* of a sulphur-yellow species of *Pentametrocrinus*, determined as a new species by Prof. Ludwig Döderlein, off the coast of Somaliland, northeastern Africa, in 1289 meters.

Family ATELECRINIDAE

Atelecrinidae BATHER, Rep. British Assoc. for 1898, 1899, p. 923 (listed among families of the Grade Pinnata of Order 2, Flexibilia of Sub-Class Dicyclica); *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, p. 195 (diagnosis; includes only *Atelecrinus*).—A. H. CLARK, Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 344 (includes *Atelecrinus*; part of Comatulidae as understood by P. H. Carpenter); Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (in key; includes only *Atelecrinus;* range), p. 211 (represented in Hawaiian Is.), p. 212 (range); vol. 35, 1908, p. 119 (arm structure), p. 126 (arm structure compared with that of *Isocrinus narcsianus*); fig. 18; vol. 36, 1909, p. 362 (pinnulation compared with that of *Comatilia*); Proc. Biol. Soc. Washington, vol. 22, 1909, p. 175 (referred to Comatulida Macrophreata); Proc. U.S. Nat. Mus., vol. 40, 1911, p. 649 (Macrophreata); Crinoids of the Indian Ocean, 1912, p. 6 (distribution of included genera and species), p. 8 (bathymetrical distribution), p. 9 (absent from Australia), p. 14 (characteristic of the Intermediate fauna), p. 27 (details of distribution; 552–809 fms. in the East Indian Region), pp. 44, 48 (in keys), p. 63 (includes only *Atelecrinus*), p. 251; Notes Leyden Mus., vol. 34, 1912, p. 150 (*Atopocrinus*, gen. nov.).—SPRINGER and CLARK, *in* Zittel-Eastman's Paleontology, 1913, p. 236 (assigned to Macrophreata).—A. H. CLARK, Bull. Inst. Océanogr. Monaco, No. 294, 1914, pp. 7, 8 (temperature relations); Journ. Washington Acad. Sci., vol. 4, No. 19, 1914, pp. 559–563 (correlation of geographical and bathymetrical ranges); No. 20, p. 582 (relation to temperature of habitat); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (occurs in both Atlantic and Indo-Pacific regions); Journ. Washington Acad. Sci., vol. 5, No. 4, 1915, pp. 126–134 (bathymetrical range; phylogenetic and paleontological significance); Die Crinoïden der Antarktis, 1915, p. 192 (species are characteristic of the Intermediate fauna); Amer. Journ. Sci., vol. 40, 1915, p. 68 (discussion of depth range); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 9 and following (phylogenetic study); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (1 specimen collected by the *Albatross* in the East Indies), p. 262 (key to the included genera); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 12 (represented in West Indies); Smithsonian Misc. Coll., vol. 72, No. 7, 1921, p. 2; The Danish *Ingolf*-Exped., vol. 4, No. 5, 1923, p. 44 (Atlantic species), p. 48 (in key).—GISLÉN, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 35, 83, 85, 91 (articulations of the brachials), p. 101, p. 166 (relations with fossil *Jaekelometra*), p. 213 (short intersyzygial interval), p. 223 (proximal pinnule gap in adults), pp. 231, 232, 239 (relations).—MORTENSEN, Handbook of the echinoderms of the British Isles, 1927, p. 16 (in key), p. 22 (diagnosis).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 12.—TORTONESE, Natura, Milano, vol. 24, 1933, p. 163.—GISLÉN, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.—EKMAN, Zoogeographica, vol. 2, No. 3, 1934, pp. 328, 343; Tiergeographie des Meeres, 1935, pp. 66, 360.—A. H. CLARK, John Murray Exped. 1933–34, Sci. Reports, vol. 4, No. 4, 1937, p. 103 (absent from western part of the Indian Ocean).—H. L. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 13.—GISLÉN, Lunds Univ. Årsskr., new ser., Avd. 2, vol. 40, No. 8, 1944, p. 54, footnote 1; Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, pp. 55, 57, 58 (depth range); Internat. Zool. Congress, 1953, Publ. Un. Int. Sci. Biol., series B, No. 16, 1954, p. 38.—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 95 (deep water).
Atelecrinoiden HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, p. 485 (justified as a family).

Diagnosis [by A.M.C.].—A family of Macrophreata, in which IBr series are usually present, giving rise to 10 arms, but may be absent, leaving 5 arms (*Atopocrinus*); the centrodorsal is high conical, with the cirrus sockets in 10 (sometimes 15) vertical columns, each socket flanked, except in *Sibogacrinus*, by prominent elevations which sometimes form a horseshoe-shaped ridge round it; the proximal brachials are triangular rather than oblong in shape; except in *Atopocrinus*, pinnules are absent from the first 12 or more brachials.

Geographical range.—Known from the East Indian area to Fiji and the Hawaiian Islands and from Brazil to Florida and the northeast Atlantic.

Bathymetrical range.—Known from 532 (?384) to 1633 meters.

Thermal range.—Known from 3.89° to 8.61° C.

Remarks [by A.M.C.].—Mr. Clark left no diagnosis or discussion of this family since his *Siboga* report revealed the existence of the genus *Atopocrinus* and of the new species *Atelecrinus anomalus*, for which he has here created the new genus *Sibogacrinus*. The characters of these two genera necessitate considerable qualification of the diagnosis previously given for *Atelecrinus* alone. Of the three main characters which formerly marked off the Atelecrinidae from other comatulids, the visibility of the basals in the adult and the absence of proximal pinnules are not shared by *Atopocrinus* and the elevations round the cirrus sockets are absent in *Sibogacrinus*, which on the other hand does have the basals prominent, even more so than in *Atelecrinus*. Unfortunately, the unique holotype of *Sibogacrinus anomalus* has lost the arms from the first syzygy, so that the occurrence of its pinnules is unknown.

With the inclusion of *Atopocrinus* in the family, the Atelecrinidae shows an interesting parallel to the Pentametrocrinidae with the difference that its 10-armed genera, *Atelecrinus* and *Sibogacrinus*, have division series but in *Thaumatocrinus* of the other family the duplication is from the radials.

In *Atelecrinus* and probably also in *Sibogacrinus* there appears to have been a neotenous tendency with regard to the nondevelopment of the proximal pinnules, which normally appear in the ontogeny of most comatulids after the distal pinnules have been formed.

I am not entirely convinced that *Atopocrinus* is so closely related to *Atelecrinus* as Mr. Clark suggests. Since he has separated the 5-armed oligophreate genus *Eudiocrinus* with no division series as a family distinct from the Zygometridae, where such series are present, I am inclined to think that the parallel distinction of *Atopocrinus* from the rest of the Atelecrinidae is warranted. However, I agree that *Atopocrinus* seems to be more closely related to the Atelecrinidae than to any other comatulids. The characters provided by the centrodorsal particularly are undeniably similar.

KEY TO THE GENERA OF ATELECRINIDAE

*a*¹. Five undivided arms; no IBr series; first syzygy between brachials 4+5; no basals (Moluccas; 1633 meters) .... Atopocrinus (p. 812)

*a*². Ten arms; IBr series present; first syzygy between brachials 3+4; basals present.

- *b*¹. Basals small, forming low triangles in the interradial angles the attenuated lateral angles of which may or may not come into contact beneath the radials; cirrus sockets flanked on either side by a high elevation triangular in profile, the two elevations on either side of a socket sometimes joined about the proximal (ventral) border of the socket by a low rim, forming with this a horseshoe-shaped ventrolateral rim highest at the two ends; cirri very delicate and slender, very gently curved, composed of more than 20 segments of which the distalmost are about twice as long as broad; terminal claw minute and conical (Hawaiian Islands to Fiji and the Moluccas; Brazil to Florida; western coast of Ireland; 532 [?384]–1256 [?1479] meters) .... Atelecrinus (p. 817)
- *b*². Basals very large, the height equal to more than half the width, and broadly in contact laterally; surface of the centrodorsal smooth, with no elevations flanking the cirrus sockets; cirri recurved, with not more than 20 segments of which those in the outer third are much shorter than the proximal, and but little longer than broad; terminal claw long, stout, and recurved (Moluccas; 1633 meters) .... Sibogacrinus (p. 832)

Genus ATOPOCRINUS A. H. Clark

Atopocrinus A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 150 (diagnosis; type species *A. sibogae*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery by the *Siboga*), p. 262 (in key).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 26 and following (discussion); Ark.

Zool., vol. 19, No. 32, 1928, p. 12 (? *Pentametrocrinus varians* referable to it); Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 17; Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (depth range).—HYMAN, The invertebrates, vol. 4, Echinodermata, 1955, p. 95 (five arms).

Diagnosis.—A genus of Atelecrinidae in which the arms are 5 in number, without IBr series, and the first syzygy is between brachials 4+5; there are no basals, and all the pinnules are present.

Type species.—*Atopocrinus sibogae* A. H. Clark, 1912.

Geographical range.—Only known from the Moluccas.

Bathymetrical range.—Only known from 1633 meters.

Remarks.—In inquiring into the relationships of this curious genus, one naturally first turns to the family Pentametrocrinidae, in which no division series are present, and the first syzygy is between brachials 4+5 instead of between brachials 3+4, as is the general rule among the comatulids, while the genus *Pentametrocrinus* also has but 5 arms.

But in the Pentametrocrinidae, (1) the disk is large and stellate and extends far out upon the arms, being nearly or quite black in color; (2) the cirrus sockets are closely crowded and irregularly arranged on a rounded conical or hemispherical centrodorsal; (3) the individual cirrus sockets have no fulcral ridges nor produced margins [NOTE BY A.M.C.: After drawing the centrodorsals of three species of Pentametrocrinidae (figs. 49–51), I cannot agree entirely about this point. The rims of the cirrus sockets seemed to me to be particularly prominent in all three and in *Thaumatocrinus renovatus* the height of the rim reaches a maximum on each side of the socket but a minimum at the distal end, thus forming a parallel with the horseshoe-shaped fulcral ridges found in *Atelecrinus*, though in a straight comparison (see figs. 52 and 53), the ridges are far more noticeable in the latter genus]; (4) the radials are almost or quite concealed by the centrodorsal; (5) the lower brachials are more or less oblong, the triangular form not becoming pronounced until after the third or fourth; and (6) the second segment of the lowest pinnules is very short. Clearly, therefore, *Atopocrinus* cannot belong to the Pentametrocrinidae.

Atopocrinus suggests the genus *Zenometra* in certain ways; the arms are stout and robust, and the conical centrodorsal is divided into 10 sharply delimited areas, each with a regular column of cirrus sockets. But in *Zenometra*, (1) the disk is broader and the ambulacral grooves run direct from its surface to the ventral surface of the arms; (2) the earlier brachials and the first syzygial pair are oblong; and (3) the cirrus sockets have no fulcral ridges.

In (1) the details of the arrangement of the cirri on the centrodorsal, (2) the details of the structure of the cirrus sockets, (3) the structure of the disk, (4) the triangular brachials at the base of the arms, and especially (5) the triangular first syzygial pair, *Atopocrinus* agrees with *Atelecrinus* and differs from all other comatulids.

Atopocrinus differs from *Atelecrinus* in (1) having no basals, (2) having only 5 arms, (3) lacking IBr series, and (4) having all the pinnules present.

But the basals are always much reduced in *Atelecrinus* compared with *Sibogacrinus*, especially in *A. wyvilli* in which species they are scarcely visible externally. This suggests that the variation in the size of the basals in genera obviously closely related is so great that their presence or absence cannot be a valid major character in the diagnosis of the family Atelecrinidae.

In both the Atelecrinidae and Pentametrocrinidae the arms are anomalous in having lost features of fundamental phylogenetical significance common to all other comatulids. The normal comatulid arm possesses IBr series, and extending from the first to about the third syzygy there is a series of more or less oblong brachials which are succeeded by nearly or quite triangular brachials. The IBr series represent a pair of plates, one on either side of the original intersegmental boundary, which have come to lie tandem instead of side by side on either side. The series of oblong brachials as far as the third syzygy, represents the brachials of the pentacrinoid arm, with about 14 brachials developed and no pinnules. This pentacrinoid arm is not a real comatulid arm, but represents merely a jointed appendage, more of the nature of a pinnule which, however, at this point more or less abruptly changes its character and develops into an arm.

Since the arms of the Atelecrinidae have lost one of the two most important phylogenetic features of comatulid arms and since those of the Pentametrocrinidae have lost the other feature, the arms in these two families are strictly comparable in being on the same phylogenetic plane, which is in advance of that of the arms in any of the other families. Since the arms in these two families are on a strictly comparable plane, it is not surprising that the type peculiar to one should reappear in the other.

The arms of *Atopocrinus*, it should be noticed, combine the loss of the IBr series otherwise peculiar to the Pentametrocrinidae with the loss of the earlier oblong brachials characteristic of the Atelecrinidae. They are, therefore, the most highly specialized arms to be found among the comatulids.

In the families Comasteridae, Colobometridae, Antedonidae (Zenometrinae and Perometrinae), and Pentametrocrinidae, species (or genera) with deficient and also with complete pinnulation occur. In nearly all cases the species with deficient pinnulation have the arm bases so closely crowded as to prevent the proper functioning of the earlier pinnules, which are therefore lost. There is, therefore, nothing remarkable in the reappearance of all the pinnules in a genus of Atelecrinidae in which the arm bases are not crowded as they are in *Atelecrinus* itself.

Since the differences between *Atopocrinus* and *Atelecrinus* are of relatively small importance, while the differences between *Atopocrinus* and all the other comatulid genera are fundamental, there appears to be sufficient justification for placing *Atopocrinus* in the Atelecrinidae.

ATOPOCRINUS SIBOGAE A. H. Clark

[See vol. 1, pt. 1, fig. 227, p. 245]

Atopocrinus sibogae A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 151 (description; *Siboga* sta. 177); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 263 (detailed description; sta. 177), p. 274 (listed); fig. 15, p. 263; pl. 26, fig. 95.—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, p. 26 (new information regarding the pinnulation), p. 83 (articulations).

Description.—The centrodorsal is elongate conical, 5.5 mm. broad at the base and 7 mm. long, with the tip slightly blunted and the sides straight. Five strong interradial ridges, each about as broad as the adjacent columns of cirrus sockets, divide the surface of the centrodorsal into 5 radial areas, each of which is bisected by a narrow median ridge which, except at the base, is as high as the interradial ridges.

The distal (dorsal) border of each cirrus socket is produced outward, forming a strong ridge across the proximal border of the one next below it. Thus each cirrus socket occupies an approximately oblong rather deep pit, bounded proximally and distally by these ridges just described and laterally by the longitudinal interradial and radial ridges. There are 13 or 14 cirrus sockets in the two columns in each radial area, making about 68 in all. The youngest cirrus sockets, on the proximal margin of the centrodorsal, project above the general surface of the latter, appearing like the first segment of a cirrus. Each cirrus socket bears on either side of the minute central canal, which is slightly below the center, a strong rounded fulcral ridge; this, like the produced distal border of the cirrus sockets, gradually decreases in height proximally, but much more rapidly decreases in height distally. These transverse fulcral ridges are on either side produced outward to a point which is somewhat higher than the general surface of the interradial and radial ridges between the columns of cirrus sockets, so that in profile these ridges appear very strongly serrate, the radial rather more so than the interradial, the teeth of the serrations being convex proximally and concave distally. In a lateral view of the centrodorsal these projections appear as alternating bracketlike processes proximally arising gradually but distally terminating abruptly in a straight horizontal border. On the interradial ridges these projections are separated by a median free bare area about equal to their own lateral height, but on the radial ridges they occur almost in a straight line.

The cirri are lacking.

Deep subradial clefts are present between the radials and the centrodorsal, as in *Zenometra* and in *Psathyrometra;* in height these are equal to half the dorsoventral width of the topmost fully developed cirrus sockets.

High and narrow basal rays, of which the outer ends are broadly pentagonal and convex, cap the proximal ends of the interradial ridges and extend inward under the radial pentagon, forming the sides and the blind inner wall of the subradial clefts.

The radials are about twice as broad as high in the median line, but recumbent, so that in a direct lateral view they appear about 4 times as broad as high. They are thus much shorter than the radials in *Atelecrinus.*

The 5 arms are very stout, and probably also very long. All are broken off near the base, the longest stump measuring 19 mm. from the subradial cleft to the distal border of the tenth brachial (i.e. the third syzygy). The first brachial is slightly over twice as broad as its lateral length and is basally just in apposition with its neighbors; the lateral edges are approximately perpendicular to the proximal border; there is a deep notch in the distal outer angle. The second brachial is very irregularly quadrate, the longer side longer than the sides of the first, the shorter about the width of the pinnule which it bears, and somewhat produced ventrally. There is a strong but evenly rounded synarthrial tubercle at the junction of the first and second brachials, the body of the animal at the synarthrial tubercles being 11 mm. in diameter. The third brachial is approximately triangular, not quite so long as broad, with strongly concave sides. The first syzygial pair (composed of brachials 4+5) is approximately triangular, and about as long as broad; both the epizygal and the hypozygal are triangular, the latter being slightly longer than the former. The following brachials are similar to the third, gradually becoming slightly longer in proportion to their width, while their shorter sides become slightly longer. None of the arms are preserved beyond the tenth brachial. The width of the arms at the base of the first brachial is 4 mm., at the first syzygy 3.5 mm., and at the third syzygy 3.5 mm.

Sygyzies occur on the various arms as follows: Left posterior, between brachials 4+5, 7+8, and 10+11; left anterior, between brachials 4+5, 7+8, and 10+11; anterior, between brachials 4+5 and 7+8; right anterior, between brachials 4+5, 7+8, and 10+11; right posterior, between brachials 3+4, 6+7, and 9+10. The length from the proximal edge of the first brachial to the syzygy at 7+8 is 12.0 mm.

The sculpture of the syzygial faces in this species is unique. Laterally and dorsally the central canal is bounded by a high ridge of moderate width; from this ridge there extends to the dorsal margin of the joint face in the dorsoventral line another ridge which at first is about as broad as the ridge from which it springs, but on the outer side gradually broadens to a slight degree. Two similar ridges extend outward, one from either end of the laterodorsal ridge about the central canal, making with the median ridge an angle of about 45°, or about a right angle with each other. Just beyond these lateral ridges, entirely unconnected with the ridge about the central canal, separated from the lateral ridges by a ligament space about the same shape and size as the two lateral ridges, are two more ridges, slightly broader than the others; each has a very narrow fan-shaped space beyond it. Beyond these two ligament spaces, the distal borders of which are approximately at right angles to the dorsoventral axis of the joint face, are two large obsolete muscular fossae which are about as high as the distance between their proximal borders and the dorsal edge of the joint face. These are rounded triangular in shape; inwardly each rises somewhat, forming two parallel, very inconspicuous, low and well-rounded ridges, which are interiorly separated by a shallow rounded groove. This groove becomes more accentuated just beyond the central canal, where it separates the inner ends of the inner pair of ridges. The inner ends of the ligament spaces just beyond these ridges are bounded by the ridges bordering interiorly the muscular fossae. There is a deep intermuscular notch the sides of which make an angle of from 60° to 90° with each other. The ridges on the syzygial faces are high, and consequently the ligament fibers are long, appearing in dorsal view almost or quite as long as those of the neighboring dorsal ligaments.

All of the pinnules are present. P_1, which arises from the right side of the second brachial on 4 arms, is about 16 mm. in length; the first segment is slightly trapezoidal, and, as viewed from the side, about half again as long as broad; the second is between two and a half and three times as long as broad, 2.3 mm. in length. The following segments are similar, but proportionately somewhat longer. The pinnule is moderately stout, like the proximal pinnules of the large species of *Psathyrometra*, and is somewhat compressed laterally. The first segment increases somewhat in width distally, the second decreases slightly, and the third also decreases slightly, more especially in the proximal half; from that point onward the pinnule tapers very gradually.

P_2 is 15 mm. long, with 10 segments, and resembles P_1; the fourth segment, which is the longest, is about three and a half to four times as long as broad, and the fifth is about the same; but the sixth and following are only about twice as long as broad, or slightly less.

Only the bases of the following pinnules are preserved; they appear to become gradually shorter and more slender, the second segment decreasing rapidly in length and progressively decreasing more and more rapidly in distal width, on the pinnule of the ninth brachial being not quite so long as its proximal width and slightly trapezoidal, so that the following segments must have been very slender.

The surface of the disk is more or less mutilated and concealed. The disk resembles that of *Atelecrinus*, and is comparatively small and compact, its ventral surface reaching the height of the base of the ninth brachial. The ventral surface of the disk is in the form of a high rounded dome, beginning to curve inward at about the fifth brachial; from this point the ambulacra, which reach the arms at about the ninth brachial, are supported upon high narrow bridges as in *Gephyrocrinus*, *Thalassocrinus* and *Ptilocrinus*. Up to the level of the general surface of the disk, the pinnules are connected with it by webs or thin sheets of perisome, resembling the thicker sheets which support the brachial ambulacra in their passage to the arms. A strip of thickened perisome extends downward interradially to the union of the first brachials, just above which it bears a cluster of about a dozen rounded calcareous plates. Just above the union of the first brachials are deep oval pits, whether blind or not cannot be determined without dissection; similar, but somewhat larger pits occur just beyond the distal angles of each first brachial, on either side of each syzygy, and at the base of each pinnule.

Locality.—*Siboga* station 177; north of Ceram (lat. 2°24′30″ S., long. 129°-38′30″ E.); 1633 meters (during the haul the depth diminished to 1300 meters); dead coral and stones, covered with manganese; September 1, 1899 [A. H. Clark, 1912, 1918; Gislén, 1924] (1, Amsterdam Mus.).

Remarks [BY A.M.C.].—In 1928 Gislén tentatively put forward the suggestion that *Pentametrocrinus varians* might belong to the genus *Atopocrinus* since both have pinnules on the proximal brachials unlike the other species of *Pentametrocrinus*. However, as he pointed out, there are no visible basals in *P. varians* and the centrodorsal and cirrus sockets are quite different. Also the proximal brachials of *varians* are oblong rather than triangular and the segments of the proximal pinnules are very much shorter, besides being modified into a crest near the base of each pinnule. Though *varians* does stand apart from the other species of *Pentametrocrinus*, there is no doubt in my mind that it is much more nearly related to them than to *Atopocrinus*.

Genus ATELECRINUS P. H. Carpenter

Antedon (part) POURTALÈS, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 356; vol. 5, No. 9, 1878, p. 214.

Atelecrinus P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 152 (met with at *Blake* stas. 150, 151, 222), p. 161 (sacculi present), p. 166 (characters; 2 species mentioned, *cubensis* [*Antedon cubensis* Pourtalès, part] and *balanoides*); Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 488; Rep. British Assoc. for 1881, 1882, p. 672; Proc. Roy. Soc., vol. 35, 1883, No. 225, p. 139 (comparison with *Thaumatocrinus*).—PERRIER, Compt. Rend. Acad. Sci., vol. 96, No. 11, 1883, p. 725.—P. H. CARPENTER, Phil. Trans. Roy. Soc. for 1883, pt. 3, 1884, p. 920 (basals compared with those of *Thaumatocrinus*), p. 926 (referred to the Comatulidae).—LOCKINGTON, Standard natural history, vol. 1, 1884, p. 142.—P. H. CARPENTER, *Challenger* Reports, Narrative, vol. 1, pt. 1, 1885, p. 311.—PERRIER, Mémoire sur l'organisation et le developpement de la comatule de la Méditerranée, 1886, p. 106 (sacculi).—P. H. CARPENTER, Quart. Journ. Micr. Sci., new ser., vol. 27, 1887, p. 385 (sacculi present); *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 68 (detailed discussion).—A. AGASSIZ, Bull. Mus. Comp. Zool., vol. 15 (reprinted as "Three Cruises of the *Blake*," vol. 2), 1888, p. 124.—ROLLESTON and JACKSON, Forms of animal life, 1888, p. 570.—DE LORIOL, Paleontologie française, ser. 1, Animaux invertébrés, terrain jurassique, vol. 11, pt. 2, 1889, p. 434.—BATHER, Ann. Mag. Nat. Hist., ser. 6, vol. 7, 1891, p. 464 (listed).—P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 24, 1891, p. 59 (comparison of calyx with that of an immature *Poliometra prolixa*).—NORMAN, Ann. Mag. Nat. Hist., ser. 6, vol. 8, 1891, No. 44, p. 181.—A. AGASSIZ, Mem. Mus. Comp. Zool., vol. 17, No. 2, 1892, p. 27 (pinnulation).—PERRIER, Traité de Zoologie, 1893, p. 858.—LANG, A text book of Comparative Anatomy, vol. 2, 1896, p. 313.—BATHER, Royal natural history, vol. 6, 1896, p. 300; Rep. British

Assoc. for 1898, 1899, p. 923; *in* Lankester, A treatise on zoology, pt. 3, Echinoderma, 1900, pp. 137, 195.—Delage and Herouard, Traité de Zoologie concrète, vol. 3, 1903, p. 394.—Minckert, Arch. Nat., Jahrg. 71, 1905, vol. 1, Heft 1, p. 166 (syzygies; regeneration).—A. H. Clark, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 130 (comparison of proximal structure with that of *Antedon* [*Neometra*] *multicolor*); Smithsonian Misc. Coll., vol. 50, pt. 3, 1907, p. 343 (included by P. H. Carpenter in the family Comatulidae).—Hamann, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575.—A. H. Clark, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 210 (referred to Atelecrinidae), p. 212 (occurs in the West Indies and Hawaii), pp. 436, 501; vol. 35, 1908, p. 119, fig. 18, p. 119 (arm structure); Amer. Nat., vol. 42, No. 503, 1908, p. 724 (color); vol. 43, 1909, p. 580 (pinnulation).—Proc. U.S. Nat. Mus., vol. 36, 1909, p. 362 (pinnulation compared with that of *Comatilia*); vol. 38, 1910, p. 118 (basals retained).—Kirk, Proc. U.S. Nat. Mus., vol. 41, 1911, p. 66 (belongs to Type 1 of free crinoids).—Hartlaub, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 386 (history), p 480 (detailed account).—A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 151 (compared with *Atopocrinus*); Crinoids of the Indian Ocean, 1912, p. 10 (occurs in the Hawaiian Is.; absent from Japan), p. 27 (range), p. 63 (only genus in the family), p. 252 (original reference; type species); Internat. Rev. gesamt. Hydrobiol. und Hydrogr., vol. 6, 1914, pp. 6 and following (occurs in both Atlantic and Indo-Pacific; range and its significance); Die Crinoïden der Antarktis, 1915, p. 182 (same); Smithsonian Misc. Coll., vol. 65, No. 10, 1915, pp. 11 and following (phylogenetical study); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (discovery of a new type [*Sibogacrinus*] by the *Siboga*), p. 262 (in key), p. 266 (key to the included species); Univ. Iowa Studies in Nat. Hist., vol. 9, No. 5, 1921, p. 13 (West Indies and Indo-Pacific), p. 16 (in key); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 44 (range, and included Atlantic species).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 44, 47, 55, 61 (obliquity of brachial articulations), p. 131, p. 212 (pinnule gap retained).—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 22 (diagnosis).—Gislén, Kungl. Fysiogr. Sällsk. Handl., new ser., vol. 45, No. 11, 1934, p. 18.—Cuénot *in* Grassé, Traité de zoologie, vol. 11, 1948, pp. 39, 71.—Gislén, Rep. Swedish Deep Sea Exped., vol. 2, Zool., No. 4, 1951, p. 55 (depth range).—Hyman, The invertebrates, vol. 4, Echinodermata, 1955, p. 53 (basals may be visible), text-fig. 23 A and B, p. 95.

Diagnosis.—A genus of Atelecrinidae in which the arms are 10 in number, IBr series with the IBr_2 axillary being present; the first syzygy is between brachials 3+4; there are no pinnules before the seventeenth (more rarely the thirteenth) brachials; basals are present, visible as low triangles in the interradial angles of the calyx, sometimes, especially in small individuals, in contact by their attenuated lateral angles beneath the radials; the cirrus sockets are flanked on either side by a high elevation triangular in profile, the 2 elevations on either side of a socket being sometimes, especially in small specimens, joined by a rim about the proximal (ventral) border of the socket forming with this a horseshoe-shaped ventrolateral rim highest at its two ends; the cirri are long, very gently curved, slender and delicate, usually lost in capture, composed of more than 20 segments, of which the earlier are much elongated and the terminal 2 or 3 are about twice as long as broad; the terminal claw is conical and minute.

Type species.—*Atelecrinus balanoides* P. H. Carpenter, 1881.

Geographical range.—From the Hawaiian Islands to Fiji and the Moluccas; from Brazil northward to Florida; western coast of Ireland.

Bathymetrical range.—From 532 [?384] to 1256 [?1479] meters.

Thermal range.—From 3.89° C. to 8.61° C.

KEY TO THE SPECIES OF ATELECRINUS

a^1. Centrodorsal with 15 columns of cirrus sockets (Hawaiian Islands; 1009–1479 meters). conifer (p. 819)

a^2. Centrodorsal with 10 columns of cirrus sockets.

b^1. Columns of cirrus sockets segregated into 5 pairs by relatively broad naked interradial areas;

sockets of the two columns in each radial area quite distinct from one another; interradial ridges on the proximal portion of the centrodorsal, if present, low, rounded and short (Fiji to Borneo and the Moluccas; 724 [?384]—795 [?1115] meters)..............wyvilli (p. 820)

b^2. The 10 columns of cirrus sockets closely crowded, not segregated into 5 pairs; projections flanking the cirrus sockets more or less dovetailed with those of adjacent columns; interradial ridges on the proximal portion of the centrodorsal usually high and sharp.

c^1. Centrodorsal usually much longer than its basal width with the sides more nearly parallel towards the base than further out (Brazil to Florida; 532–1256 meters).
balanoides (p. 823)

c^2. Centrodorsal very slightly longer than its basal width, sharply conical (west coast of Ireland; 698–900 meters)..helgae (p. 831)

ATELECRINUS CONIFER A. H. Clark

[See vol. 1, pt. 1, figs. 14(p. 65), 223(p. 243), 405(p. 311)]

Atelecrinus conifer A. H. CLARK, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 213 (in key), p. 214 (description; *Albatross* sta. 3887); Crinoids of the Indian Ocean, 1912, p. 27 (much the largest species of the genus), p. 252 (synonymy; locality).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 485 (history and habitat).—A. H. CLARK, Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 5 (compared with *A. helgae*); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 266 (in key; range).—GISLÉN, Ann. Mag. Nat. Hist., ser. 9, vol. 16, No. 91, 1925, p. 12.

Diagnostic features.—The 15 columns of cirrus sockets, 3 in each radial division of the centrodorsal, easily distinguish this species from all others in the genus.

Description.—The centrodorsal is long-conical with the sides in profile only slightly convex, 5 mm. broad at the base and 6 mm. high; the proximal portion is marked with slight interradial ridges. The cirrus sockets are arranged in 15 columns, 3 in each radial area. They are rather prominent and are furnished on each side with a longitudinally elongate rounded triangular elevation which terminates rather abruptly distally. There is no special elevation of the proximal or distal borders.

The cirri are all broken. The longest stump, which measures 35 mm. in length, consists of 19 segments, of which the first two are short, the third is about half again as long as broad, and the remainder are about 3 times as long as broad. The cirri are strongly compressed laterally. The distal ends of the segments are not prominent on the ventral profile as in *A. balanoides.*

The basals are very short, everywhere in close contact with the centrodorsal, forming a uniform narrow band all around the calyx. The external ends of the basals in each radial area lie in a plane, or are very gently concave and the interradial angles are well rounded so that, viewed dorsally, the basal ring is seen to form a pentagon with well-rounded angles and straight or very slightly incurved sides.

The radials are somewhat over twice as broad as long, closely united laterally, with the dorsal surface almost flat and the distal edge almost straight, though bending upward rather sharply in the interradial angles.

The IBr_1 are not quite so long as broad, with their lateral edges parallel; the distal border is slightly incised; the whole dorsal surface gradually rises to form a slight tubercle in the middle of the distal border with the middle of the posterior border of the IBr_2. The IBr_2 (axillaries) are about as long as broad, with the distal angle somewhat sharper than the proximal which incises the IBr_1 and the lateral edges strongly oblique.

The longest remaining arm stump is broken off at the distal end of the twelfth brachial. The length from the tip of the centrodorsal to the distal end of the twelfth brachial is 25 mm. The first brachial is longer exteriorly than interiorly, with the distal border slightly incised; the inner sides of adjacent first brachials just meet over the distal angle of the axillaries, from that point diverging rapidly so as to leave a considerable gap between them. The second brachials are irregularly quadrate, with the distal border strongly oblique, and the posterior with a sharp angular projection incising the first. The first syzygial pair (composed of brachials 3+4) is very obliquely wedge-shaped, over twice as long interiorly as exteriorly. The following brachials are very obliquely wedge-shaped, not quite so long as broad.

Syzygies occur between brachials 3+4, 6+7, 9+10, and 12+13.

The only known specimen has no pinnules on the few remaining brachials.

A striking feature of this species is the conspicuous diamond-shaped aperture in each interradius between the IBr series resulting from the strongly oblique lateral edges of the axillaries and the wide divergence of the inner sides of the first brachials.

Locality.—*Albatross* station 3887; north coast of Molokai, Hawaiian Islands; Mokuhooniki Islet bearing S. 15° W., 8.8 miles distant; 1009–1479 meters; temperature 4.17° C.; globigerina mud; April 17, 1902 [A. H. Clark, 1908] (1, U.S.N.M., 22685).

ATELECRINUS WYVILLI P. H. Carpenter

FIGURE 52

See also vol. 1, pt. 1, figs. 123 (p. 192), 125 (p. 193); pt. 2, pl. 26, fig. 1164]

Atelecrinus wyvilli P. H. CARPENTER, Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 492 (description; *Challenger* sta. 174).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 13 (syzygies).

Atelecrinus wyvillii P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 72 (description; *Challenger* sta. 174C.), pl. 6, figs. 4, 5.—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 299 (after Carpenter).—A. H. CLARK, Crinoids of the Indian Ocean, 1912, p. 32 (identity), p. 252 (synonymy; locality); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 68 (published references to specimens in B.M.; *Challenger* sta. 174C); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 267 (in key; range).

Atelecrinus wyvillei HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575 (listed).—A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 153 (compared with *A. sulcatus*).

Atelecrinus sulcatus A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 152 (description; *Siboga* sta. 85); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 267 (in key; range; detailed description; sta. 85), p. 268 (*Albatross* sta. 5619), p. 272 (listed); fig. 16, p. 267; pl. 26, fig. 94.

Diagnostic features.—The 10 columns of cirrus sockets are segregated into 5 pairs of columns, one pair in each radial area. These pairs of columns of cirrus sockets are separated from their neighbors by relatively broad naked interradial spaces or shallow grooves. The sockets of the 2 columns in each radial area are quite distinct from each other. There are low, short interradial ridges on the proximal (basal) portion of the centrodorsal, with well-rounded summits.

Description of the type specimen [modified by A.M.C.].—The centrodorsal is conical, 3 mm. broad at the base and 4 mm. high. The cirrus sockets are arranged in 10 columns of 4, rarely 5, each, two in each radial area. The 2 columns in each radial area are well separated from those in the adjoining radial areas by intervening spaces, and do not reach the dorsal pole. The adjacent rows of sockets tend to alternate in level. The proximal (basal) portion of the centrodorsal is uniformly smooth, without any interradial ridges; but the edge is marked by 5 slight incisions situated interradially. A pair of prominent, conical, almost vertically directed tubercles borders each cirrus socket laterally, and similar ones cover the apex of the centrodorsal.

The cirri are unknown.

The narrowly visible basals are nearly uniform in height throughout their whole width, but are slightly arched in form. The apex of each arch is interradial, and the very small interval between it and the notched edge of the centrodorsal below is occupied only by perisome. Hence, the basal ring is really only in contact with the centrodorsal at its 5 lowest points, that is, at the interbasal sutures, immediately beneath the middle of the radials.

The radials are barely half as long as the IBr_1 though twice as long as the basals; they have exceedingly high muscle plates projecting inward.

The IBr_1 are about as long as broad, with the distal border incised to receive the backward projection from the IBr_2 (axillaries). The sides of the IBr_1 are slightly flanged and the adjacent ones are nearly in apposition; except at the distal end where they converge abruptly, the sides are parallel. The proximal half of the axillary is narrower than the main part of the IBr_1 but widens abruptly in the middle of its length to define a distinct pore between adjacent division series. A similar but smaller pore is formed between the first two pairs of brachials.

There are 10 smooth, cylindrical arms, all broken at or before the third syzygy (9+10).

The first brachials are well separated laterally, and have their inner sides much shorter than the outer; the distal border is incised to receive the strong backward projection from the quadrate second brachials. The following brachials have markedly unequal sides.

Syzygies usually occur between brachials 3+4, 6+7, and probably 9+10 but are often irregular in position. The length from the proximal edge of the IBr_1 to the second syzygy at brachials 6+7 is 8 to 8.5 mm. The width at brachials 3+4 is 1.7 mm.

No pinnule-bearing brachials remain.

The disk is almost naked, 4 mm. in diameter. The mouth is somewhat excentric and is surrounded by a large peristome, immediately behind which is the anal tube. The brachial ambulacra lie close down upon and between the muscle bundles.

FIGURE 52.—*Atelecrinus wyvilli* P. H. Carpenter, holotype.

Description of the type specimen of Atelecrinus sulcatus.—The centrodorsal is sharply conical, 3 mm. broad at the base and 4 mm. high. The cirrus sockets are arranged in 10 columns of 4, more rarely 5, each, the 2 columns of each radial area close together, the pairs of columns in each radial area separated from those in the adjacent radial areas by shallow furrows which proximally are in width nearly equal to the width of the neighboring cirrus sockets, but become gradually narrower distally. The interradial separation of the columns of cirrus sockets is always somewhat greater than the midradial separation. Each cirrus socket is bordered proximally and laterally by a horseshoe-shaped rim which proximally scarcely rises above the general surface of the centrodorsal, but on either side stands out as a high ridge so that in lateral view the profile of the centrodorsal appears strongly serrate, the longer side of the teeth being gently convex and roughly parallel with the dorsoventral axis, the shorter slightly concave and at right angles to this axis. The ridges on either side of the cirrus sockets gradually increase in thickness distally, but terminate rather abruptly just after attaining their maximum height and thickness so that the border of the cirrus sockets distal to them is not raised above the general surface of the centrodorsal. The basal outline of the centrodorsal as viewed dorsally is pentagonal, each side of the pentagon being slightly and evenly concave. Five well-marked rounded interradial ridges are present which slowly decrease in height and disappear at about the distal border of the first cirrus sockets. These ridges mark the angles of the pentagon when the centrodorsal is viewed dorsally. Their height is scarcely more than sufficient to modify the normally circular base of the centrodorsal to a pentagon.

The basals form a very narrow band of almost uniform height between the radials and the centrodorsal, though they are slightly higher in the angles of the calyx where their exterior surface is raised to form a proximal continuation of the interradial ridges on the centrodorsal.

The radials are relatively long, distally not quite twice as broad as the median length. The profile of the dorsal surface is straight. The proximal edge is somewhat shorter than the distal.

The IBr_1 are regularly oblong, about a third again as broad as long, entirely free basally. There is almost no incision of the distal border but the distal lateral angles are slightly cut away. The IBr_2 (axillaries) are broadly pentagonal, slightly broader than long. Their lateral edges slope slightly inward and downward so as to form, with the truncated distal corners of the IBr_1, prominent water pores. Similar water pores occur between the first and second brachials above the distal angles of the axillaries.

The 10 smooth, straight-sided arms resemble those of the type of *wyvilli* itself.

Syzygies usually occur between brachials 3+4, 6+7, and 10+11 (or 9+10 on two arms), and distally at intervals of 3 or 4 muscular articulations. The width at 3+4 is 1.9 mm., the length from IBr_1 to 6+7 is 9.5 mm. and to 10+11 is 13.5 mm.

The lowest pinnule, on two arms, is on the sixteenth brachial. The pinnules are small and weak, long jointed and strongly flattened.

The visceral mass is high and narrow, and the ambulacral grooves reach the arms along the summits of perisomic bridges as in *Gephyrocrinus* and in *Thalassocrinus.* The mouth is central. The disk is unplated.

Notes.—A specimen dredged by the *Albatross* at station 5619, near the locality (station 85) where the type of *A. sulcatus* was taken by the *Siboga,* appears to belong to this species. Compared with the type of *A. sulcatus* the centrodorsal is seen to be somewhat more sharply pointed. There are the same interradial furrows. The proximal interradial ridges, though prominent, are more rounded. The basals are visible only in the interradial angles of the calyx, taking the form of low triangles with excessively produced lateral apices which fail to meet the similarly produced apices of those on either side. The radials are considerably shorter than those of the type of *A. sulcatus*, and, when the specimen is viewed laterally, their dorsal profiles make considerably more than, instead of less than, a right angle with each other. The elements of the IBr series are proportionately shorter than those of the type of *A. sulcatus*, and the brachials also are relatively slightly shorter. This gives the animal a more robust and compact appearance.

Localities.—Siboga station 85; Makassar Strait, between Borneo and Celebes (lat. 0°36′30″ S., long. 119°29′30″ E.); 724 meters; fine gray mud; June 17, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam Mus.).

Albatross station 5619; west of Halmahera (Gilolo); Mareh Island (S.) bearing S. 78° E., 7 miles distant (lat. 0°35′00″ N., long. 127°14′40″ E.); 795 meters; fine gray sand and mud; November 27, 1909 [A. H. Clark, 1918] (1, U.S.N.M., 36220).

Challenger station 174C; near Kandavu, Fiji (lat. [about] 19°06′ S., long. [about] 178°18′ E.); 411, 1115, or 384 meters; temperature (at 1115 meters) 3.89° C.; August 3, 1874 [P. H. Carpenter, 1882, 1888; A. H. Clark, 1913] (1, B.M.). Type locality.

Geographical range.—From Fiji to the Moluccas and Borneo.

Bathymetrical range.—From 724 (?384) to 795 (?1115) meters.

Thermal range.—One record, 3.89° C.

Remarks.—Atelecrinus wyvilli was originally described by Carpenter in 1882 and was redescribed and figured in 1888. The species was based on a single mutilated individual dredged by the *Challenger* at station 174C, which specimen I examined at the British Museum in 1910.

In 1912 I described as a new species *Atelecrinus sulcatus* from *Siboga* station 85. This was assumed to differ from *A. wyvilli* in having the centrodorsal, basals, and radials everywhere in intimate contact, there being no perisomic lacunae as in *A. wyvilli*, in having the centrodorsal more sharply conical in form with interradial ridges proximally passing into interradial furrows between the columns of cirrus sockets, in the greater height of the lateral ridges bordering the cirrus sockets, and in the absence of notches on the proximal border.

The existence of perisomic lacunae between the basals and the centrodorsal in the interradial angles in the type specimen of *Atelecrinus wyvilli* I believe to have been due to a partial decalcification before it came into Carpenter's hands. As the other differences shown are all of minor importance there can be no doubt that *Atelecrinus sulcatus* and *A. wyvilli* are conspecific.

ATELECRINUS BALANOIDES P. H. Carpenter

FIGURE 53

[See also vol. 1, pt. 1, figs. 124(p. 193), 218(p. 243), 300(p. 264), 406(p. 311), 430(p. 321), pl. 8 figs. 573–575; pt. 2, pl. 26, fig. 1163]

Antedon cubensis POURTALÈS, Bull. Mus. Comp. Zool., vol. 1, No. 11, 1869, p. 356 (in part; coast of Cuba, 450 fms. [specimen described = *Trichometra cubensis*]); vol. 5, No. 9, 1879, p. 214 (*Blake* sta. 43, 339 fms.).

Atelecrinus cubensis P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 166 (off Cojima, Cuba, 450 fms.; *Antedon cubensis* Pourtalès, in part; characters), p. 168 (comparison with *A. balanoides*); pl. 1, fig. 7; Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 491 (detailed description; 1 specimen, off Cojima, 450 fms.); *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, p. 379 (locality).—LOCKINGTON, Standard natural history, vol. 1, 1884, p. 144 (from Carpenter).—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, pp. 69–73 (comparisons with other species), pp. 369, 374 (locality).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 155 (name not tenable; *pourtalesi* proposed as a substitute).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575 (listed).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 281 (listed), p. 386 (history), p. 484 (comparison of type specimen with *balanoides*), pl. 14, figs. 3, 8, 9.

Atelecrinus balanoides P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 166 (*Blake* sta. 43, 339 fms.; *Challenger*, near Pernambuco, 350 fms.; *Blake* stas. 150, 151, 222, 260, 291–375 fms.; characters), p. 167 (basals and centrodorsal), p. 168 (comparison with *A. cubensis*), pl. 1, figs. 1–6; Journ. Linn. Soc. (Zool.), vol. 16, 1882, p. 489 (detailed description; *Challenger* sta. 122; other localities as before); *Challenger* Reports, Zoology, vol. 11, pt. 32, 1884, pp. 376, 380.—LOCKINGTON, Standard natural history, vol. 1, 1884, p. 144 (from Carpenter).—P. H. CARPENTER, *Challenger* Reports, Zoology, vol. 26, pt. 60, 1888, p. 70 (detailed description; *Challenger* sta. 122), p. 374 (distribution), pl. 6, figs. 6, 7.—WALTHER, Einleitung in die Geologie als historische Wiss., 1894, p. 299 (after Carpenter).—BATHER, *in* Lankester, A treatise on zoology, vol. 3, Echinoderma, 1900, p. 196, fig. CXVIII.—MINCKERT, Arch. Naturg., Jahrg. 71, vol. 1, 1905, Heft 1, p. 172 (syzygies; pinnulation).—A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 130 (comparison of proximal structure with that of *Antedon* [*Neometra*] *multicolor*), p. 155 (history).—HAMANN, Bronn's Klassen und Ordnungen des Tier-Reichs, vol. 2, Abt. 3, 1907, p. 1575 (listed).—A. H. CLARK, Notes Leyden Mus., vol. 34, 1912, p. 151 (disk compared with that of *Atopocrinus sibogae*).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 281 (in *Blake* collection), p. 386 (history), pp. 481–485 (*Blake* stas. 43, 150, 151, 222, 260 [specimens examined from 150, 151, 260]; detailed account), p. 482, fig. 15, a–d, p. 483, fig. 16, a, b; pl. 14, figs. 1, 2, 4, 6, 7.—A. H. CLARK, Fisheries, Ireland, Sci. Invest., pt. 4, 1913, p. 5 (compared with *A. helgae*); Smithsonian Misc. Coll., vol. 61, No. 15, 1913, p. 68 (published references to specimens in the B.M.; *Challenger* sta. 122); Unstalked crinoids of the *Siboga*-Exped., 1918, p. 267 (in key; range; synonymy); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 44 (range).—GISLÉN, Ark. Zool., vol. 19, No. 32, 1928, p. 12 (brachial articulation).—H. L. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 13 (*Atlantis* sta. 2990), p. 14 (comparison with *pourtalesi*).—A. H. CLARK, Bull. U.S. Fish. Comm., vol. 55, 1954, p. 374 (listed).

Atelecrinus, sp. P. H. CARPENTER, Bull. Mus. Comp. Zool., vol. 9, No. 4, 1881, p. 152 (*Blake* stas. 150, 151, 222).—A. AGASSIZ, Bull. Mus. Comp. Zool., vol. 15 (reprinted as "Three Cruises of the *Blake*," vol. 2), 1888, fig. 416, p. 124.

Atelecrinus pourtalesi A. H. CLARK, Proc. U.S. Nat. Mus., vol. 33, 1907, p. 155 (new name for *Atelecrinus cubensis* P. H. Carpenter, not *Antedon cubensis* Pourtalès).—HARTLAUB, Mem. Mus. Comp. Zool., vol. 27, No. 4, 1912, p. 484 (history of the name).—H. L. CLARK, Mem. Soc. Cubana Hist. Nat., vol. 15, No. 1, 1941, p. 13 (*Atlantis* sta. 3341; distinct from *balanoides*).

Diagnostic features.—Since the 10 columns of cirrus sockets are not noticeably marked off into radial pairs by interradial spaces and since the columns alternate in level on the centrodorsal, the projections flanking the cirrus sockets of any two adjacent columns tend to be crowded into a single, more or less zigzag, row; in shape the centrodorsal has straight sides near the base and then tapers evenly to the fairly sharp apex; it is distinctly higher than its basal diameter, and the interradial ridges on the basal portion are usually high and sharp; finally the IBr_1 have no approximating lateral flanges.

Description.—The centrodorsal is conical but with the sides almost parallel near the base, reaching 3.5 mm. in width at the base and 5 mm. in height, though usually somewhat smaller. It bears 10 columns of cirrus sockets of from 4 to 6 each, 2 columns to each radial area, the pairs of columns in each radial area being separated from each other proximally by more or less marked interradial ridges. In the young, each cirrus socket is bordered by a strongly developed ventrolateral horseshoe-shaped ridge rather higher at its two ends than elsewhere, the two ends being somewhat projecting. In older animals this ridge decreases in height proximally (ventrally), where it finally becomes obsolete, with the result that the cirrus sockets are merely flanked on each side by a prominent lateral tubercle longitudinally elongated and triangular in side view. These tubercles give the appearance of interrupted longitudinal ridges bordering each column of cirrus sockets. Though well separated in the young, the cirrus sockets later gradually become larger with the result that in the largest examples they are closely crowded. As the sockets of one column alternate in position with the sockets in the columns on either side, the lateral tubercular prominences of neighboring columns finally come to lie in a straight line and the cirrus sockets are separated all around the centrodorsal by prominent serrate ridges, their proximal and distal borders not being marked by prominences or ridges of any kind.

The cirri are very rarely recovered. A cirrus which appears to lack but a single distal segment measures 30 mm. in length and is composed of 28 segments (Carpenter records about 35 in a cirrus, presumablyfrom a *Blake* specimen since the *Challenger* specimen had none), of which the first four are very short and the following are four or five times as long as their proximal widths, gradually becoming shorter distally with the result that the last two are scarcely twice as long as broad. The segments all have prominent ventral ends which more or less overlap, this feature being most pronounced in the distal half but becoming less marked again terminally. Excepting for the proximal segments, the cirri are very strongly compressed laterally. The dorsoventral height of the segments increases somewhat in the outer half, gradually decreasing again in the terminal portion with the result that the last 6 segments taper rapidly to a point. According to Carpenter, the terminal claw is very small. In a specimen which was taken by the *Atlantis* off Cuba and which H. L. Clark attributed to *Atelecrinus pourtalesi*, the bases of some cirri were left intact as far as the sixth segment. Dr. Clark

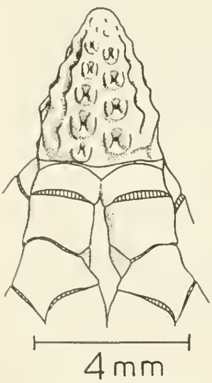

FIGURE 53.—*Atelecrinus balanoides* P. H. Carpenter, paratype, B.M., 88.11.9.1, *Challenger* station 122.

does not state how far up on the centrodorsal these cirri are placed. Their second segment is already twice as long as wide and the sixth is five times as long as its median width, being somewhat expanded at the ends. This specimen has the centrodorsal "rather more than 3 mm." in height and "less than 3 mm." in basal diameter. The six cirrus segments together measure up to 9 mm. in length.

The disk may bear a few minute calcareous granules on its ventral surface and also on its sides between the post-radial series; in other specimens it is nearly or quite naked. The mouth is somewhat excentric and is surrounded by a large peristome. Near the mouth is the anal tube, which also is slightly excentric in position.

The basal ring is a very thin circlet of plates. Exteriorly the basals are visible as very low triangles; interradially they are somewhat elevated and may form prominent tubercles upon the interradial ridges of the centrodorsal. In the young the basals are relatively larger, externally forming a broad ring of nearly uniform height (0.5 mm.) all around the calyx, and rising only very slightly in the interradial angles where, however, they project outward somewhat. With advancing age the radial portion of the basals becomes more and more narrow until finally it is visible only as a narrow line connecting the interradial triangles, which, with the decrease in the height of the radial portion of the basals, become more marked.

The radials are short and dorsally nearly flat in the fully grown, but longer, often half as long as broad, in the young.

The IBr_1 are about twice as broad as long in the larger individuals, with the distal border but little incised. The sides are straight. In smaller specimens they are about as long as broad and often have the distal border considerably incised. The IBr_2 (axillaries) are pentagonal in the larger specimens and sometimes as much as twice as long as the IBr_1 with little, if any, backward projection; but in the smaller specimens they are more and more rhombic, about as long as broad, with a strong proximal projection The distal sides are concave and the distal angle is truncated at the tip.

The 10 arms are seldom preserved much beyond the first few syzygies. The first brachials are wedge-shaped, interiorly separated at the base by the truncated distal angle of the axillary. The second brachials are quadrate, with the distal border very oblique. The synarthrial articulations between the elements of the IBr series and the first two brachials rise to a low more or less pronounced tubercle. The first syzygial pair (composed of brachials 3+4) is very obliquely wedge-shaped with the inner side much longer than the outer. The following brachials have very oblique ends and markedly unequal sides; they are at first slightly broader than long, but after about the seventeenth they become longer than broad, and in the middle of the arm much longer than broad. The distal part of the arm is unknown. In cross section the division series and proximal brachials are more or less cylindrical but their sides may be somewhat flattened.

Syzygies occur between brachials 3+4 and then at intervals of from 2 to 7 (usually from 2 to 4) muscular articulations.

The lowest pinnule is almost always on the seventeenth brachial (the twelfth brachial of Carpenter), exceptionally as early as the thirteenth brachial (the tenth brachial of Carpenter). It is about 3.5 mm. long and is composed of about 12 segments, of which the first is short, the second is somewhat longer than broad, and those following become progressively elongated. The pinnules immediately succeeding appear to be similar, but the first segment is shorter and more crescentic, and the second is trapezoidal. According to Carpenter, the pinnules after the lowest increase in size, decreasing again toward the arm tips. The lower segments of the middle and later pinnules bear irregular spinous processes on their dorsal edges.

Notes.—Hartlaub remarked that Carpenter's figure of *Atelecrinus balanoides* (1881, fig. 1) gave a too diagrammatic representation of the centrodorsal. The horseshoe-shaped rims about the cirrus sockets are scarcely so well marked, while the distal ends of these rims stand up in a much sharper and more spinelike manner than is shown. The sides of the centrodorsal, which appear as almost smooth, are in reality markedly uneven and more as they appear in Carpenter's figure of *Atelecrinus cubensis* (1881, fig. 7). The cirrus sockets have a strong central excavation bounded by a prominent horseshoe-shaped rim, and this is outwardly bordered by a narrow oblique surface which is covered by the base of the cirrus. On Carpenter's figure 1 the bases of the cirri appear to be surrounded by the horseshoe-shaped rims, which in reality is not the case. The basal cirrus segment is very broad in comparison with the 3 short following segments and is not circular in section but laterally compressed and oval. The basals are only visible interradially, and in this respect Carpenter's figure is incorrect. In no case can there be found radially any separation between the radials and the centrodorsal, all traces of an original separation having entirely disappeared. In the specimen from *Blake* station 260 also, which is only half as large, the basals are not nearly so widely visible as in Carpenter's figure 3, being at the most only perceptible as a very narrow line. There is always a sharp division between the centrodorsal and the lowest calyx plates. The radials are markedly longer than is shown by Carpenter.

This last statement also holds for the smallest of the specimens examined by Hartlaub (from station 151) which is about half as large as that from Grenada (station 260). In it the basals have about the relations shown by Carpenter.

The surface of the centrodorsal in the specimen from Grenada is somewhat less spiny than it is in the others.

Gislén (1928) has given some details of the occurrence and form of the syzygies. Proximally they occur at intervals of usually two muscular articulations, that is between brachials 3+4, 6+7, 9+10, and 12+13, and distally at intervals of four or five muscular articulations. The syzygies themselves are without muscular fossae; there are 11 to 12 syzygial septa in the dorsal half of the ossicles, which are rather distinct and 7 to 8 of them are complete. There is a large deep excavation around the lumen. In the other articulations the muscular fossae are very high. There is no reversion of the proximal brachials and the distal brachials are long and slender, over twice as long as broad.

The *Challenger* specimen of *balanoides* (fig. 53) has the centrodorsal 4.1 mm. in vertical height and 3.2 mm. in basal diameter. Even at this size the basals still form a complete, though very narrow, ring separating the centrodorsal from the radials. The short suture between adjacent basals is very hard to see.

Localities.—*Albatross* station 2415; off Fernandina, northern Florida (lat. 30°44′00″ N., long. 79°26′00″ W.); 804 meters; temperature 7.56° C.; coral, coarse sand, shells, and foraminifera; April 1, 1885 (1, U.S.N.M., 34956).

Blake station 43; south of the Dry Tortugas, Florida (lat. 24°08′00″ N., long. 82°51′00″ W.); 620 meters; temperature 7.22° C.; 1877–78 [Pourtalès, 1879; P. H. Carpenter, 1881, 1882, 1888] (1, M.C.Z., 233).

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Fish Hawk station 7285; south of Key West, Florida (lat. 24°15′00″ N., long. 81°47′30″ W.); 620 meters; temperature 8.61° C.; bottom density 1.0252; sand; February 19, 1902 (1, U.S.N.M., 34820).

Albatross station 2117; eastern Caribbean, near Aves rock (lat. 15°24′40″ N., long. 63°31′30″ W.); 1248 meters; temperature 4.28° C.; yellow mud and fine sand; January 27, 1884 (1, U.S.N.M., 16893).

Blake station 150; Lesser Antilles, between St. Kitts and Nevis (lat. 17°11′22″ N., long. 62°46′00″ W.); 683 meters; temperature 7.22° C.; fine sand and black specks; January 15, 1879 [P. H. Carpenter, 1881, 1882; Hartlaub, 1912] (1, M.C.Z., 43).

Blake station 151; off Nevis (lat. 17°08′21″ N., long. 62°42′00″ W.); 651 meters; January 15, 1879 [P. H. Carpenter, 1881, 1882; Hartlaub, 1912] (1, M.C.Z., 230).

Albatross station 2751; southwest of Nevis (lat. 16°54′00″ N., long. 63°12′00″ W.); 1256 meters; temperature 4.44° C.; blue globigerina ooze; November 28, 1887 (1, M.C.Z., 231).

Blake station 222; off St. Lucia (lat. 13°58′37″ N., long. 61°04′45″ W.); 771 meters; temperature 5.83° C.; sand and ooze; February 16, 1879 [P. H. Carpenter, 1881, 1882] (1, M.C.Z., 229).

Blake station 260; off Grenada (lat. 12°03′30″ N., long. 61°47′10″ W.); 532 meters; temperature 8.33° C.; sand and ooze; February 28, 1879 [P. H. Carpenter, 1881, 1882; Hartlaub, 1912].

Albatross station 2756; off Ceara, Brazil (lat. 3°22′00″ S., long. 37°49′00′ W.); 762 meters; temperature 4.72° C.; gray sticky specks; December 14, 1887 (1, M.C.Z., 232).

Challenger station 122; off Barra Grande, near Pernambuco, Brazil (lat. 9°05′ S., long. 34°50′ W.); 640 meters; red mud; September 10, 1873 [P. H. Carpenter, 1881, 1882, 1888; A. H. Clark, 1913] (1, B.M.).

Atlantis station 2990; off Puerto Sagua la Grande, Nicholas Channel, Santa Clara Province, Cuba; 713 meters [H. L. Clark, 1941] (5).

Atlantis station 3341; off the south coast of Santa Clara Province, Cuba, in the Golfo Cazones; 566–777 meters [H. L. Clark, 1941] (1, ?M.C.Z.).

Bibb station 139P; off Cojima, near Havana, Cuba; 823 meters; March 4, 1869 [Pourtalès, 1869; P. H. Carpenter, 1881, 1882, 1888; Hartlaub, 1912] (specimen lost).

Geographical range.—From Pernambuco, Brazil, northward to northern Florida.

Bathymetrical range.—From 532 to 1256 meters; the average of 14 records is 771 meters.

Thermal range.—From 4.28° C. to 8.61° C.; the average of 9 records in 6.46° C.

Type locality [by A.M.C.].—There is some doubt about the exact type locality of this species, whether it is *Blake* station 150 or 151. Carpenter based the species on specimens from five *Blake* stations and one *Challenger* station but said that the best one (1881, pl. 1, fig. 1) was from *Blake* station 151. Hartlaub in 1912 gave photographs of this specimen (pl. 14, figs. 1 and 2 (pt.) which he captioned as the "Original-Exemplar") and of the two others which were all that reached him from *Blake* stations 150 and 260 (the latter also designated "Original-Exemplar"). The specimen from station 151 appears to be the only one with stumps of cirri remaining attached to the centrodorsal, and so must be the specimen which H. L. Clark called the holotype in 1941, comparing it with an *Atelecrinus* taken by the *Atlantis*. Unfortunately, Dr. Elisabeth Deichmann of the Museum of Comparative Zoology (to whom I am indebted for the information) tells me that the specimen from *Blake* station 150 is designated as the type of *balanoides*. It has the centrodorsal 4 mm. in height and 3 mm. in basal diameter, though the maximum diameter is a little greater. Fortunately, both stations are close together in the vicinity of Nevis in the Leeward Islands at 667($\pm$16) meters, which will suffice for the type locality, but if a holotype is designated, despite the labeling, it should be the one figured by Carpenter from *Blake* station 151.

History.—The first specimen of this species to be obtained was dredged in 1869 by the *Bibb* at station 139P off Cuba. Two small comatulids were taken which Count Pourtalès later in the same year described under the name of *Antedon cubensis*. His description, however, applied only to the larger specimen, which is the type of what is now called *Trichometra cubensis*, and he made no reference to the characters of the smaller and more mutilated individual.

Ten years later, in 1879, Pourtalès recorded this species again under the name of *Antedon cubensis* from *Blake* station 43. He remarked that the two damaged specimens lacking cirri and arms differed somewhat from his type specimen, but possibly the differences were due to age. He then described one of these specimens in considerable detail and remarked that a smaller equally mutilated specimen had previously been dredged by himself at *Bibb* station 139P.

In 1881 in his preliminary report on the comatulids collected by the *Blake* and other American ships, Carpenter recognized the fact that the two specimens from *Blake* station 43 and the smaller and more mutilated one from *Bibb* station 139P were very similar to one another and entirely different from the type specimen of *Antedon cubensis*. He mentioned other examples of the same nature as these three from *Challenger* station 122 and *Blake* stations 150, 151, 222, and 260.

The peculiarities of these crinoids were discussed by Carpenter at considerable length, and he conferred upon them the new generic name *Atelecrinus*. The original specimen from *Bibb* station 139P was so different from those obtained later that he regarded it as a distinct species which he called, using Pourtalés' name, *cubensis;* the others he considered as representatives of a new species which he called *balanoides*. He gave figures of the single specimen of *Atelecrinus cubensis* from *Bibb* station 139P and of the best specimen of *A. balanoides* obtained, which was from *Blake* station 151, as well as of parts of another specimen which he dissected.

In 1882 Carpenter published a formal diagnosis of the new genus *Atelecrinus* (selecting as the type species *A. balanoides*) as well as descriptions of the three known species, *balanoides*, *cubensis*, and *wyvilli*, the latter, from *Challenger* station 174, being here mentioned for the first time.

In the *Challenger* report on the stalked crinoids (1884) Carpenter discussed the peculiarities of the genus *Atelecrinus* at considerable length. He mentioned *A. cubensis* from the original locality off Cojima and *A. balanoides* from *Challenger* station 122 and *Blake* station 43.

In the *Challenger* report on the comatulids (1888) Carpenter recapitulated the history of this genus and its species. He redescribed the genus in great detail and redescribed and figured *A. balanoides*, which he gave as from *Challenger* station 122 and as "also obtained by the U.S. Coast Survey steamer *Blake* at five stations in the Caribbean Sea between 291 and 422 fathoms [532 and 771 meters]." *Atelecrinus cubensis* was included in the key to the species of the genus, but was not formally described.

He noted that there were known at that time 11 different individuals of representatives of this genus, 1 each of *A. cubensis* and *A. wyvilli*, and 9 of *A. balanoides*.

After Carpenter's death the *Blake* material was turned over to Dr. Clemens Hartlaub, and a preliminary study of it was made under his supervision by Dr. Wilhelm Minckert. In 1905 the latter published some notes on the occurrence of the syzygies and on the pinnulation of *Atelecrinus balanoides* resulting from his study of these specimens.

Carpenter used the name (*Atelecrinus*) *cubensis* for the species represented by the single specimen dredged at *Bibb* station 139P, crediting it to Pourtalès.

[Note by A.M.C.] In the belief that the specific name *cubensis* was invalidated by its prior use as *Antedon cubensis* by Pourtalès, Mr. Clark in 1907 renamed the species represented by the smaller *Bibb* specimen as *Atelecrinus pourtalesi*. It seems to me that this was unnecessary if Carpenter is considered as the authority for *Atelecrinus cubensis*, as indeed he was, though he himself still credited the name to Pourtalès in 1882. Hartlaub (1912) has also pointed this out. However, as long as *cubensis* and *balanoides* are regarded as synonymous, the problem does not arise.

History [continued, by A.H.C.].—In 1912 Hartlaub published a detailed account of the *Blake* collections. Of the eight *Blake* specimens of *A. balanoides* mentioned by Carpenter, he had before him only three, one each from stations 150, 151, and 260. He quoted Carpenter extensively and redescribed the species on the basis of the available material, giving photographic reproductions of all three specimens as well as of the type specimen of *Atelecrinus cubensis*. He also quoted from a letter of mine written in December 1909 in which I had said that "*Atelecrinus cubensis* is nothing but an immature specimen of *A. balanoides*." [Apparently Hartlaub remained unconvinced of this since he captioned the photographs of the type specimen of *cubensis* under that name, besides crediting it to Carpenter rather than Pourtalès.—A.M.C.] In 1910 I examined the specimen of *A. balanoides* from *Challenger* station 122 at the British Museum, mentioning the fact in 1913. In 1918 I included *A. balanoides* in a key to all the species of *Atelecrinus* then known, naming *cubensis* and *pourtalesi* as synonyms, and in 1923 gave its range, based on unpublished as well as published data.

Remarks [by A.M.C.].—The only recent record of *balanoides* is that of H. L. Clark in 1941 from the collections of the *Atlantis* off Cuba. The five specimens from station 2990, he said, are fairly typical and the smaller ones probably had arms about 75 mm. long. The largest has the calyx 7 mm. in diameter. He also recorded under the name *pourtalesi* a specimen from station 3341, which revives the question as to whether or not there are two species of *Atelecrinus* in the West Indian area. The photographs given by Hartlaub of the lost type specimen of *cubensis* show that the ornamentation of the centrodorsal was very marked, more so than is suggested by Carpenter's drawings. Dr. H. L. Clark commented on a similar elaboration in the *Atlantis* specimen. The articulations of the brachials in *cubensis* also appear to be much more expanded than those of *balanoides*.

Carpenter considered that the main differences between the two lie in the uniform width of the visible part of the basals and in the more prominent proximal projections of the axillaries and second brachials (i.e., synarthrial tubercles) in *cubensis*. The large size of the basals is possibly attributable to the smaller size of the holotype of *cubensis*, and the development of synarthrial tubercles is somewhat variable in other comatulid species. However, Hartlaub added a further difference in that the first two brachials of each arm of *cubensis* are wall-sided, while they are not so in *balanoides*. He also emphasized the greater elaboration of the prominences on the centrodorsal in *cubensis*. H. L. Clark unfortunately made no comment on the shape of the proximal brachials of his specimen, but as it did retain the bases of some cirri, unlike the holotype of *cubensis*, he was able to contrast these with the stumps remaining on the *Blake* holotype of *balanoides*, which was presumably from station 151. Carpenter's description and figures (and more particularly those of Hartlaub) of this specimen show that there are three or four short segments at the base of the cirri followed by much more elongated segments. H. L. Clark describes the cirri of the *Atlantis* specimen as having only the first segment short, the second being already twice as long as broad and the following ones progressively longer. He comments that they are much more slender and cylindrical than in *balanoides*, where they are apparently rather flattened laterally, at least at the base. If the enlargements given in Hartlaub's captions to his plate 14 are accurate, the height of the centrodorsal in the holotype of *balanoides* is about 4 mm. and only a little larger than that of the *Atlantis* specimen. Such a small difference in size would not be sufficient to account for the more slender cirri of the *Atlantis* specimen, and I am inclined to believe that it is H. L. Clark who is correct in thinking that two distinct species of *Atelecrinus* do occur in the West Indian area. However, with no material at hand but the single *Challenger* specimen of *balanoides*, which lacks the cirri, I can come to no conclusion about this problem. The differences in the ornamentation of the centrodorsal, in the shape of the proximal brachials, and particularly in the cirri, may well prove to provide valid distinctions, but until more material is available, I am leaving *cubensis* (*pourtalesi*) in the synonymy of *balanoides*, where Mr. A. H. Clark placed it.

ATELECRINUS HELGAE A. H. Clark

Atelecrinus helgae A. H. Clark, Fisheries, Ireland, Sci. Invest., 1913, pt. 4, p. 4 (description; *Helga* sta. CXX; comparisons).—Unstalked crinoids of the *Siboga*-Exped., 1918, p. 267 (in key; range); The Danish *Ingolf*-Exped., vol. 4, No. 5, Crinoidea, 1923, p. 44 (range [including that of an unrecorded specimen]).—Gislén, Zool. Bidrag Uppsala, vol. 9, 1924, pp. 43, 47, 53 (obliquity of articulations), p. 83 (additional data); fig. 12, p. 45; figs 25, 26, p. 50; fig. 91, p. 81; fig. 117, p. 93.—Mortensen, Handbook of the echinoderms of the British Isles, 1927, p. 22 (diagnosis; localities); fig. 10, p. 23.—Koehler, Les échinodermes des mers d'Europe, vol. 2, 1927, p. 133 (listed).—Gislén, Ark. Zool., vol. 19, No. 32, 1928, p. 13.

Diagnostic features.—This species very closely resembles *A. balanoides*, from which it seems to differ only in being smaller and in having the centrodorsal sharply conical and only very slightly longer than the basal width.

Description.—The centrodorsal is sharply conical, 2.5 mm. in diameter at the base and 3 mm. long interradially, measured along its side [probably about 2.75 mm. in vertical height—A.M.C.]. The cirrus sockets are arranged in 2 regular very closely crowded columns in each radial area, 3 or 4 to a column. On either side of each cirrus socket is a subtriangular thickening, the swollen fulcral ridge, which is produced outward and slightly downward (distally) so that the centrodorsal has a strongly serrate profile. In the midradial line these processes form a zigzag line running down the center of the radial area. In the interradial lines they lie on either side of a very narrow slitlike furrow. In the basal portion of the centrodorsal there are 5 prominent interradial ridges which run from the produced center of each basal downward, becoming narrower, sharper and lower, disappearing between the proximal cirrus sockets.

The cirri are XXXV, all lacking.

The basals are very short, with the interradial portion swollen and rising to the height of the ridge on the proximal portion of the centrodorsal, and the radial portions reduced to a narrow line separating the radial from the centrodorsal.

The radials are short, 4 or 5 times as broad as long in the median line.

The IBr_1 are approximately oblong, nearly twice as broad as long in the median line; the median portion of the distal edge is slightly incised. The IBr_2 (axillaries) are nearly rhombic, about as broad as long, with the anterior angle slightly produced. The proximal portion of the lateral edge may be produced into a rather prominent tubercle corresponding to a slight thickening of the anterolateral angle of the IBr_1, or both the lateral edge of the IBr_1 and that of the axillary may be cut away so that they form an obtuse angle with each other as in *A. conifer*.

None of the 10 arms are preserved beyond the ninth brachial (the hypozygal of the third syzygial pair). The brachials resemble those of *A. balanoides*, but are proportionately slightly shorter.

The length of the type specimen from the tip of the centrodorsal to the third syzygy is 13 mm.

Notes [by A.M.C].—In 1924 Gislén gave some details and figures of the brachial articulations of this species, presumably from a study of the *Thor* specimen, and in 1927 Mortensen published a figure of the calyx and arm bases, again probably of this specimen. It appears from this that the cirrus sockets are not in very regular columns. He did not give the size of the centrodorsal but the specimen is presumably larger than the type since the basals are only visible as small interradial triangles. Even in the type with the centrodorsal about 2.5 mm. high the radial parts of the basals are "reduced to a narrow line separating the radial from the centrodorsal." In *A. balanoides* from the West Indies the basals seem to be a little more prominent since the holotype from *Blake* station 151, with the centrodorsal probably about 4 mm. high, still has the basals forming a continuous band around the calyx. However, there must be considerable variation in this since the *Challenger* specimen of *balanoides*, which also has the centrodorsal 4 mm. high, has the basals barely visible radially.

Localities.—*Helga* station CXX; northwest of Galway Bay, western Ireland (lat. 53°58′ N., long. 12°24′ W.); 698 meters; August 24, 1901 [A. H. Clark, 1912, 1918, 1923] (1, U.S.N.M., 35779). Type locality.

Thor; southwest of the Faroe Islands (lat. 61°15′ N., long. 9°35′ W.); 900 meters; May 22, 1904 [A. H. Clark, 1923; Gislén, 1924; Mortensen, 1927] (1, C.M.).

SIBOGACRINUS, gen. nov., A. H. Clark

Atelecrinus (part) A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 153; Unstalked crinoids of the *Siboga*-Exped., 1918, pp. viii, 266, 269.

Diagnosis.—A genus of Atelecrinidae in which the arms are 10 in number, IBr series being present with the IBr_2 axillary, and the first syzygy is between brachials 3+4. The basals are very large, their height equal to more than half their width, and are broadly in contact laterally. The surface of the centrodorsal is smooth, with no elevations flanking the cirrus sockets. The cirri are recurved, with not more than 20 segments, of which those in the outer third are much shorter than the proximal, and but little longer than broad. The terminal claw is long, stout, and recurved.

Type species.—*Atelecrinus anomalus* A. H. Clark, 1912.

Geographical range.—Only known from the Moluccas.

Bathymetrical range.—Only known from 1633 meters.

SIBOGACRINUS ANOMALUS (A. H. Clark)

[See vol. 1, pt. 1, fig. 414, p. 319]

Atelecrinus anomalus A. H. Clark, Notes Leyden Mus., vol. 34, 1912, p. 153 (description; *Siboga* sta. 177); Unstalked crinoids of the *Siboga*-Exped., 1918, p. viii (a new type [of *Atelecrinus*] discovered by the *Siboga*), p. 266 (in key; range), p. 269 (detailed description; sta. 177); fig. 17, p. 269, p. 274 (listed), pl. 26, fig. 96.—Gislén, Zool. Bidrag. Uppsala, vol. 9, 1924, p. 166 (comparison with fossil *Jaekelometra*); Ark. Zool., vol. 19, No. 32, 1928, p. 11.

Description.—The centrodorsal is very long, about 1.8 mm. broad at the base and 3 mm. long in the radial line, cylindrical in the proximal third, from that point onward conical, the transition from the cylindrical to the conical portion being rather abrupt. The cirrus sockets are moderate in size, and are arranged in 10 evenly spaced columns, 3, rarely 2 or 4, to a column. Each socket is separated from its neighbors in the same column by about the same distance that the columns are apart. The surface of the centrodorsal is smooth and undifferentiated. The cirrus sockets are simple excavations, without the raised borders found in the species of *Atelecrinus*. In each cirrus socket, just proximal to the middle, a half conical ridge extends in from either side; these ridges are triangular in outline, the apex of the triangle abutting on the central canal. The ligament areas ventral to these ridges are rounded proximally, the sides converging in a sharp angle at the central canal; their area is approximately equal to that of the ridges. The ligament areas lying dorsally from (or distal to) these ridges are shallower, occupying about half the area of the cirrus socket or rather more. The interradial portions of the centrodorsal just below the basals are slightly raised above the general surface so that a section of the centrodorsal through the base (or proximal third) is rounded pentagonal. The cirrus sockets occur almost exclusively on the conical distal two-thirds of the centrodorsal.

The cirri are XXX, 19–20, about 13 mm. long. The first two segments are about twice as broad as long, the third is slightly broader than long, or about as long as broad, the fourth is twice as long as the diameter of its ends, the fifth is nearly or quite 3 times as long as the width of its ends, and the sixth is slightly shorter. The following segments decrease gradually in length so that the fourteenth and following are only slightly longer than broad; the fourth to seventh are moderately constricted centrally, but this central constriction disappears in the next 2 or 3 succeeding, when the cirri become strongly compressed laterally. The opposing spine is terminal, small, and blunt. The terminal claw is slightly longer than the penultimate segment, rather stout, evenly tapering, and rather strongly curved.

The basals are very large and conspicuous, broadly 7-sided, in contact laterally for a distance equal to about half the greatest (median) length. The proximal edge of the basals bordering the swollen interradial portion of the centrodorsal is slightly concave. The two adjacent proximal edges are of about the same length, but straight. The anterior angle of the basals is broadly obtuse and is of the same degree as the midradial angle made by the proximal edges of adjacent basals over the proximal edge of the centrodorsal. The sides of the basal ring are parallel, with the result that the basal ring continues the column made by the columnar basal third of the centrodorsal.

The radials are slightly broader than long, in lateral contact throughout their entire length; their interradial angles are somewhat produced. Proximally the radials are slightly rounded dorsally, becoming more strongly rounded distally, especially at the sides, with the result that at the distal portion of the interradial areas there is a well-marked interradial furrow.

The IBr_1 are proximally about as broad as the lateral length, and distally slightly broader, though not quite twice as broad as the median length. The lateral length is half again as great as the median length, due to incision by a posterior process from the axillary. The lateral edges are straight, diverging somewhat, and entirely free. The IBr_2 (axillaries) are rhombic, the lateral angles slightly truncated and continuing the direction of the lateral edges of the IBr_1; the anterior angle and the posterior process incising the IBr_1 are about equally produced, and are similar. All four edges are slightly concave.

All 10 arms are broken off at the syzygy between brachials 3+4; the length from the tip of the centrodorsal to the distal face of the third brachial is 9 mm. The first brachial is wedge-shaped, with the proximal and distal edges slightly concave, and is about as broad as the external (greater) length. The internal length is not much more than half the external length. The internal edges are entirely free. The second brachial is larger than the first, irregularly quadrate in form. The third is nearly twice as long interiorly as exteriorly, and about as broad as the exterior length. [Presumably there was no pinnule on the second brachial since none was mentioned.—A.M.C.]

Locality.—Siboga station 177; north of Ceram (lat. 2°24′30″ S., long. 129°38′30″ E.); 1633 meters (during the haul the depth diminished to 1300 meters); dead coral and stones, covered with manganese; September 1, 1899 [A. H. Clark, 1912, 1918] (1, Amsterdam Mus.).

Remarks [by A.M.C.].—The type specimen was seen by me in Amsterdam in November 1957. Unfortunately, it was found to be less complete than when it was first described, the basals and radials together being detached from the centrodorsal and only a single IBr_1 remaining attached to them, though a second was loose in the jar; the cirri and arm ossicles to the first syzygy were missing.

ADDENDA

SCATTER DIAGRAM (See page 619)

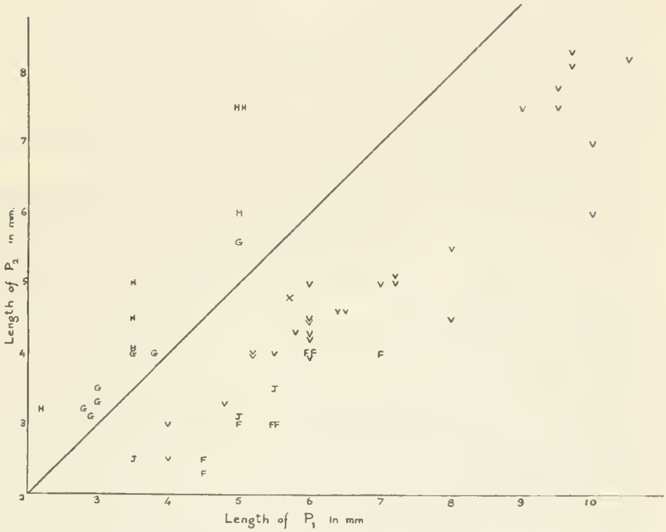

DIAGRAM SHOWING RELATIVE PROPORTIONS of the first two pinnules in some of the species of *Isometra: hordea* (H), *graminea* (G), *vivipara* (V), *johanni* (J), and *flavescens* (F). The specimen of *?vivipara* from Bransfield Strait is represented by X. The diagonal indicates where the two pinnules would be equal in length. (See p. 619.)

Since this monograph was set in type, the following additional references dealing with crinoid species coming within the scope of this final part of volume 1 of the monograph have come to light. The arrangement is chronological.

1956. DIRECTION 42. Internat. Comm. Zool. Nom.
Antedon, p. 161 (name usually treated as feminine, which gender is recommended to the Commission).

1957. DIRECTION 73. Internat. Comm. Zool. Nom.
Antedon, p. 209 (placed on Official List of Generic Names).
Antedon bifida, p. 200 (original combination *Asterias bifida*, a senior synonym of *Antedon gorgonia* and placed on Official List of Specific Names).

1958. Cherbonnier, G. Faune marine des Pyrénées-Orientales, fasc. 2. Echinodermes.

Antedon mediterranea, p. 9 (ecology; parasites; recorded from: Banyuls; Port Vendres, 65–85 meters; Collioure, 60–70 meters; Madeloch, N. of Port Vendres; Cape Oullestreil, 15 meters; Cape Abeille, 18–20 meters; Cape Creus, 20–30 and 130 meters; *President Thèodor Tissier* station 412, 150–200 meters; Balearic Islands, 39°24′N., 2°43′E., 35 meters).

Leptometra phalangium, p. 7 (listed); p. 10 (recorded from Banyuls and *President Théodor Tissier* station 412).

1959. Djakonov, A. M., Baranova, Z. I., and Saveljeva, T. S. List of the marine fauna of the waters of southern Sakhalin and the southern Kurile Islands. Invest. Far-East Seas U.S.S.R., vol. 6 [in russian].

Heliometra glacialis maxima, p. 238 (recorded from S. Sakhalin and the Kurile Islands).

1959. Tortonese, E. Campagne de la *Calypso:* Golfe de Gênes (1957). Echinodermes. Ann. Inst. Océanogr., vol. 37, fasc. 4, No. 2.

Antedon mediterranea, p. 290 (recorded from *Calypso* stations 1262 and 1269 in the Gulf of Genoa: between Portofino and San Fruttuoso, 20–40 meters; and St. Lucia Bank, 154–170 meters—2 specimens).

Leptometra phalangium, p. 290 (recorded from *Calypso* stations 1269 and 1272 in the Gulf of Genoa: St. Lucia Bank, 154–170 meters and 160–180 meters—numerous specimens).

1960. Zavodnik, D. Echinodermata der insel Krk. Acta Adriat., vol. 9, No. 2.

Antedon adriatica (as *A. mediterranea*), p. 8 (recorded from the Isle of Krk, N. Yugoslavia).

1962. Clark, A. M. Starfishes and their relations. British Museum (Nat. Hist.).

Antedon bifida, p. 15, fig. 5d (oral disk), p. 24, p. 70, pl. xi, figs. e,f, p. 72, p. 73, fig. 23a (proportions), p. 79 (size), p. 80, p. 81 (feeding), p. 101, fig. 27b (myzostomes), p. 102.

Other species and genera mentioned: *Phrixometra nutrix* (p. 28); *Isometra* (pl. xi, fig. c, pentacrinoid); *Promachocrinus* (pp. 69, 72, 79); *P. kerguelensis* (p. 75, fig. 24f); *Heliometra glacialis* (p. 79, size and color, p. 92, fig. 26a, regeneration); *Florometra* (p. 79); *Leptometra celtica* (pp. 72, 73, 79, color); *Thaumatocrinus* (p. 72); *Pentametrocrinus* (p. 74); *P. tuberculatus* (p. 75, fig. 24e); *P. varians* (p. 73, fig. 23b, proportions).

1962. Nicholls, D. Echinoderms. Hutchinson University Library.

Antedon, p. 15, fig. 1a, pp. 22, 26, 108, fig. 15b (tube foot), p. 110 (feeding).

Notocrinus p. 25.

Isometra p. 25.

1962. Baranova, Z. I. Echinoderms of the Kurile Islands. Invest. Far-East Seas U.S.S.R., vol. 8 [in Russian].

Heliometra glacialis maxima, p. 351 (listed from Kurile Islands).

Psathyrometra fragilis (as *Antedon fragilis*), p. 351 (listed), p. 358.

Florometra asperrima (as *Antedon rathbuni*), p. 351 (listed), p. 358.

1963. Fell, H. B. The evolution of the Echinoderms. Ann. Rep. Smithsonian Institution for 1962.
Promachocrinus p. 485, fig. 16A, B (pentacrinoid).
Eumorphometra, p. 485, fig. 16 D, E (pentacrinoid).

1963. Fell, H. B. The phylogeny of sea-stars. Philos. Trans. Roy. Soc., ser. B, vol. 246.
Promachocrinus, pp. 417, 422.
P. kerguelensis, p. 418, fig. 15, *1*, *4* (pentacrinoid).
Eumorphometra, pp. 417, 422.
E. aurora, p. 418, fig. 15, *3*, *6* (pentacrinoid).

1963. Cherbonnier, G. Echinodermes des côtes du Cameroun récoltés par A. Crosnier en Décembre 1962–Janvier 1963. Bull. Mus. Hist. Nat., vol. 35.
Antedon sp., p. 181 (recorded from Cameroons, dredge 10, 3°58′ N., 11°15′14″ E., 70 meters; 3°55′05″ N., 11°12′15″ E., 60–70 meters).

1963 Tortonese, E. Note sistematiche e coroliche su alcuni echinodermi del Mediterraneo. Ann. Mus. Civ. Stor. Nat. Genova, vol. 73.
Leptometra celtica, p. 282 (recorded from *President Th. Tissier* station L. 391, Morocco, SW. of Alidade Bank, 440–510 meters; station M. 37, Tunisia, NE. of Galita Island, 427–445 meters).

1963. Marr, J. W. S. Unstalked crinoids of the Antarctic Continental Shelf: notes on their natural history and distribution. Philos. Trans. Roy. Soc., ser. B, vol. 246, pp. 327–379.
This work is based mainly on previously published reports on antarctic comatulids, detailing the geographical and bathymetrical distribution of the following 22 species; distribution maps are included for species indicated with an asterisk (*).
*Notocrinus mortenseni**, *N. virilis**, *Promachocrinus kerguelensis**, *Florometra mawsoni**, *F. goughi*, *Anthometra adriani**, *Solanometra antarctica*, *Isometra vivipara**, *I. flavescens*, *I. graminea**, *I. hordea*, *Phrixometra nutrix*, *P. longipinna* var. *antarctica*, *P. rayneri*, *Hathrometra exigua* [here referred to *Phrixometra*], *Eumorphometra aurora*, *E. concinna*, *E. fraseri*, *E. hirsuta*, *E. marri*, *Kempometra grisea* and *Anisometra frigida*.

1963. Riedl, R. Fauna und flora der Adria.
Antedon mediterranea [*adriatica*], pp. 448–449, pl. clix.

1964. Arnaud, P. Echinodermes littoraux de Terre Adélie. Expéditions Polaires Françaises, Missions Paul-Emile Victor, No. 258.
Promachocrinus kerguelensis, p. 23 (listed), p. 39 (recorded from Archipelago of Point Geology, between Claude Bernard and Lamarck Islands, Adélie Land; distribution), pp. 42, 43, and 45 (in tables).
Florometra mawsoni, p. 23 (listed), p. 40 (recorded from Archipelago of Point Geology, W. of Astrolabe Glacier, Adélie Land; distribution).

1965. Gamulin-Brida, H. Contribution aux recherches sur la bionomie benthique de la baie de Porto Paone (Naples, Italie). Pubbl. Staz. Zool. Naples, vol. 34.
Antedon mediterranea, p. 493 (associated community).

1965. Guille, A. Observations faites en soucoupe plongeante à la limite inférieure d'un fond à *Ophiothrix quinquemaculata* D. Ch. au large de la côte du Roussillon. Rapp. Comm. Int. Explor. Sci. Mer Medit., vol. 18.

Antedon mediterranea, p. 116 (recorded from off Canet Plage, SW. France).

1965. Reyss, D., and Soyer, J. Etude de deux vallées sous-marines de la mer Catalane. Rapp. Comm. Int. Explor. Sci. Mer Medit., vol. 18.

Leptometra phalangium, p. 77 (density ca. 30/sq. m.; recorded from Banyuls area), pp. 78, 79, 80, 81.

1965. Tortonese, E. Echinodermata. Fauna d'Italia.

Antedon, p. 27 (key to Mediterranean species; *A. moroccana* as synonym of *A. bifida*).

Antedon mediterranea, p. 27 (in key), p. 29 (*A. adriatica* considered to be a synonym; localities; description; distribution and biology), figs. 6A–C, 7, 8.

Leptometra, p. 33 (key to Mediterranean species including *L. celtica*).

L. phalangium, p. 33 (recorded from various localities; brief description, distribution, and biology), figs. 6D, 9.

1965. Utinomi, H., and Kogo, I. On some comatulids from the coastal sea of Kii peninsula. Publ. Seto Mar. Biol. Lab., vol. 13.

Deals with 19 Japanese species, 4 of which come within the scope of this final part, namely:

Compsometra serrata [here referred to *Antedon*], p. 281 (color, distribution; recorded from N. coast of Seto-zaki, Shirahama, southern Japan).

Eumetra aphrodite, p. 282 (color, distribution; recorded from Hikimoto, southern Japan), fig. 12. [The excellent figure shows a calyx and arm bases in side view, also a cirrus with 20 segments and P_1, P_2, and P_3 with 7, 10 or 11, and 24 segments respectively, compared with counts of 16–18 (cirrus), 11 or 12, 15 and 19 for the specimen described in this monograph and 12–17 (cirrus), 12 or 13, 14–16, and 18 or 19 for the one described by Gislén (1927).]

Perometra diomedeae, p. 283 (color; distribution; recorded from off Minabe, Kii peninsula, southern Japan, 100+ meters), fig. 13. [The figure shows a cirrus with as many as 84 relatively short segments at a total length of 30 mm. (if the scale is correct), whereas 35–55 segments occur in the specimens described here, their relative lengths being considerably greater. However no sign of any P_1 appears on the several arm bases also figured by Utinomi and Kogo, so it is possible that they have a distinct species, in spite of the similarity in the elaborate synarthrial tubercles.]

Erythrometra rubra, p. 284 (color, distribution, recorded from off Minabe, southern Japan, 100+ meters), fig. 14. [The figure shows a side view of the calyx and arm bases, part of P_1, and a cirrus with 29 segments, the last agreeing with the count of 30 given here.]

This paper also gives details and excellent figures of most of the following Oligophreate species, those marked with an asterisk (*) also illustrated by color photographs: *Comanthina schlegeli** (described in detail), *Comantheria intermedia, C. imbricata, Comanthus* (*Cenolia*) *japonica**, *Comanthus* (*Comanthus*) *parvicirra** (described in detail), *Catoptometra magnifica, Liparometra grandis, Lamprometra palmata palmata** (described in detail), *Iconometra japonica, Cyllometra manca, Decametra parva, Tropiometra afra macrodiscus, Pectinometra flavopurpurea, Calometra callista*, and *Stenometra diadema*.

1965. TOMMASI, L. R. Lista dos crinóides recentes do Brasil. Contr. avuls. Inst. Oceanogr. Univ. S. Paulo, ser. Oceanogr., Biol. no. 9, pp. 1–33.

Atelecrinus balanoides, p. 10, figs. 23, 24.

This paper also gives records of some other recent crinoids beyond the scope of this part of the monograph, namely: *Nemaster rubiginosa*, *Neocomatella pulchella*, *Comactinia echinoptera*, *Tropiometra carinata carinata*, *Diplocrinus maclearanus*, and *Rhizocrinus lofotensis*.

1966. CLARK, A. M. Some crinoids from New Zealand waters. New Zealand Journ. Sci., vol. 9.

Helenametra, new genus (subfamily Perometrinae), p. 691, type *H. perplexa*, new species, p. 692, figs. 2, 3 (N.Z. Oceanographic Institute, sta. C. 758, near North Cape, New Zealand, 203 meters).

Erythrometra rostrata, new species, p. 696, figs. 4, 5 (same station).

Argyrometra mortenseni, p. 700, figs. 6, 7 (sta. C. 749, NW. of North Island, New Zealand, 210 meters; sta. C. 798, Bay of Plenty, New Zealand, 205 meters).

?*Thaumatometra alternata*, p. 702 (sta. C. 758).

Zenometrin sp., p. 703 (sta. C. 365, W. of North Island, 441 meters).

Florometra sp., p. 704 (sta. A. 738, Antipodes Islands, 58 meters). This is *Florometra austini*, new species.

1966. CLARK, A. M. Port Phillip Survey, 1957–1963. Echinodermata. Mem. Nat. Mus. Victoria No. 27.

Antedonid sp., p. 301, fig. 1.

Euantedon paucicirra, p. 303 (Port Phillip).

Antedon, p. 305, comparison between *A. loveni* and *A. incommoda*.

A. loveni and *A. incommoda*, p. 304 (table), p. 306 (Port Phillip).

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