

SOME CRINOIDS FROM THE INDIAN OCEAN

BY
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By AILSA M. CLARK

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THIS paper deals primarily with a number of crinoids entrusted to the author by the Smithsonian Oceanographic Sorting Center and collected in the course of the International Indian Ocean Year from the research ships 'Anton Bruun' and 'Te Vega'. Some Pacific specimens taken on the latter vessel are dealt with in an appendix. Additional relevant material from the British Museum collections is also discussed, notably some fine specimens from Madagascar sent by Professor A. G. Humes of Boston University. Two new species and two new subspecies are described, of which the holotypes not belonging to the British Museum will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington. Several of the species have rarely been recorded hitherto and the additional material has made possible some studies on variation, mainly expressed in tabular form. The most interesting discovery is an anatomical one, namely the complete perforation of the centrodorsal in adult specimens of *Pterometra pulcherrima* (family Asterometridae) by radially-placed coelomic canals opening on the dorsal (aboral) surface. Similar complete canals have formerly only been recorded in an immature specimen of *Notocrinus virilis* (Notocrinidae) and in some Cretaceous comatulids, though incomplete homologous coelomic pits have been found in other recent Asterometrids. Under the headings of *Heterometra* and *Democrinus* the problem of

size criteria for multiradiate comatulids and stalked crinoids is discussed. The arrangement of genera and species within the families is alphabetical.

Family COMASTERIDAE

Capillaster multiradiatus (Linnaeus)

Asterias multiradiata Linnaeus, 1758 : 663.

Acinometra coccodistoma P. H. Carpenter, 1883 : 747.

Capillaster multiradiata: A. H. Clark, 1909d : 364; 1911b : 8, 13, 16; 1931 : 173-209, pl. 3, fig. 5, pl. 11, fig. 30, pl. 13, fig. 34, pl. 14, figs 35, 36, pl. 81, figs 222, 223.

Capillaster multiradiata var. *coccodistoma*: A. H. Clark, 1911b : 16.

Capillaster coccodistoma: A. H. Clark, 1931 : 212-214.

Capillaster multiradiatus: A. M. Clark, 1967a : 26-27; Clark & Rowe, 1971 : 15.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Islands), 77 metres; 9 specimens.

'Anton Bruun' cruise 1, st. 20, 09°13'N : 97°51'E (SW from Mergui Archipelago, Burma), 58-60 metres; 2 large specimens.

'Anton Bruun' cruise 1, st. 28A, 11°52'N : 92°49'E (Andaman Islands), 66 metres; 4 specimens.

'Anton Bruun' cruise 1, st. 37, 13°28'N : 97°19'E (N of Mergui Archipelago), 64 metres; 6 specimens.

'Anton Bruun' cruise 1, st. 38, 14°07'N : 97°05'E (W of Moskos Islands, Burma), 69-73 metres; 35 specimens.

'Anton Bruun' cruise 1, st. 39A, 14°52'N : 96°39'E (SW of Gulf of Martaban, Burma), 48-64 metres; 1 broken specimen.

'Anton Bruun' cruise 1, st. 43, 15°08'N : 94°04'E (S of Cape Negrais, Burma), 55 metres; 6 specimens.

'Anton Bruun' cruise 1, st. 47B, 19°50'N : 92°55'E (off Akyab, Burma), 22-30 metres; 3 specimens.

'Anton Bruun' cruise 9, st. KA 13, Grand Comoro Island; 1 specimen.

'Anton Bruun' cruise 9, st. KA 14, Mounimeri, Comoro Islands; arms only.

'Anton Bruun' cruise 9, st. RU 272, reef on NW corner of Mounimeri, Comoro Islands; 1 broken specimen.

Prof. A. G. Humes's st. R 741, Ampombilara, Nosy Bé, Madagascar, on millepore, 0.5-1 metre; 6 specimens.

REMARKS. The specimens from Madagascar, the type-locality of *Capillaster coccodistoma*, show that this nominal species was based on immature specimens of *C. multiradiatus* with less than 20 arms and up to only 23 cirrus segments. All six of them have about 30 arms and the maximum number of cirrus segments between 24 and 28 and are not distinguishable from the other mature specimens of *C. multiradiatus* in the collection. The 35 specimens from 'Anton Bruun' station 38 have the arm number ranging from 10 to 39.

The small specimens which have only 10 arms are most easily identified by the

V-shaped ridges on the distal cirrus segments dorsally, the usual distinctive position of the first brachial syzygy at $2 + 3$ being only developed when the arms exceed 10 and some are based on IIBr or subsequent division series.

Comanthus parvicirrus (J. Müller)

Alecto parvicirra J. Müller, 1841 : 185.

Alecto timorensis J. Müller, 1841 : 186.

Comanthus parvicirra: A. H. Clark, 1911b : 8, 17, 19?, 20?; 1931 : 631-684, pl. 29 fig. 88, pl. 65, fig. 184, pl. 73, fig. 200, pl. 78, figs 209, 210, pl. 79, figs 211-214, pl. 80, figs 215-218, pl. 81, fig. 221.

Comanthus timorensis: A. H. Clark, 1931 : 603-631, pl. 64, fig. 181, pl. 75, fig. 204, pl. 76, fig. 205, pl. 77, figs 206, 207.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, $07^{\circ}34'N$: $98^{\circ}00'E$ (between Malaya and the Nicobar Islands), 77 metres; 1 specimen.

'Anton Bruun' cruise 7, st. 372Q, $25^{\circ}57'S$: $33^{\circ}02'E$ (off S Mozambique), 42 metres; 2 specimens.

'Anton Bruun' cruise 8, st. 400C, $20^{\circ}30'S$: $35^{\circ}43'E$ (Ponte da Barra Ralsa, near Beira, Mozambique), 62 metres; 4 specimens.

'Anton Bruun' cruise 9, st. 447, $10^{\circ}00'N$: $51^{\circ}15'E$ (N Somalia), 59-61 metres; 1 specimen.

The specimen from the Bay of Bengal (st. 18A) has about 40 arms and probably all the IIIBr series are of four ossicles. There are about XVI cirri mostly with about 17 segments but not forming a complete ring.

Comanthus wahlbergi (J. Müller)

Alecto wahlbergii J. Müller, 1843 : 131.

Comanthus wahlbergii: A. H. Clark, 1931 : 588-593, pl. 65, fig. 183; Gislén, 1938b : 8-10, fig. 7.

The present collection includes what I believe should be regarded as a distinct subspecies of the South African *Comanthus wahlbergi* restricted to the isolated Walter's Shoal to the south of Madagascar.

It should be pointed out that *Comanthus wahlbergi* does not run down to the genus *Comanthus* in A. H. Clark's monograph (1931 : 83) but to *Comanthoides* on account of the presence of transverse dorsal ridges on the distal cirrus segments, though in smaller specimens these ridges may be so short as to resemble small spines, certainly when viewed in profile. *Comanthoides* A. H. Clark, 1931, is a monotypic genus including only *Comanthus spanoschistum* H. L. Clark from Tasmania and Victoria, Australia, and was referred to the subfamily Capillasterinae by A. H. Clark despite the fact that P_1 only occasionally arises from Br_1 rather than the usual Br_2 on arms based on IIBr (or subsequent) series and the first syzygy is rarely at $2 + 3$ on such arms, the proximal position of both pinnule and syzygy being the primary characters for distinguishing this subfamily. The status and

position of both *Comanthoides spanoschistum* and *Comanthus wahlbergi* need further investigation. They can be distinguished from each other by the very ornate spinose dorsal processes on the bases of the proximal pinnules in the Australian species.

Gislén (1938b) has described two small Comasterids from South Africa (precise locality uncertain but possibly in the vicinity of Durban) as a new species *Comissia serrata*, the specimen more fully described having ten arms while he says the other has 'abnormally eleven arms', the supposed abnormality being presumably because he was referring the species to *Comissia*, which is otherwise known to have only ten arms. In the British Museum there are samples of specimens from off the Tugela River mouth, Natal and from Port Elizabeth, totalling 92 in all, of which only 16% (15 specimens) have more than ten arms, the maximum positive number (owing to breakage) being only 12 arms. The total of 22 IIBr series includes 13 (59%) of four ossicles, 7 (32%) of two ossicles and two abnormal ones with one ossicle. Only two of the 44 arms based on IIBr series have P_1 on Br_1 and these were based on IIBr series of four ossicles not two, contrary to the condition supposed to be characteristic of the Capillasterinae to which A. H. Clark referred *Comissia*. Nevertheless I have no doubt that they are conspecific with *Comissia serrata*, in the eleven-armed paratype of which the single IIBr series is 4(3 + 4) followed by P_1 on Br_2 and the first syzygy is evidently not at 2 + 3. A. H. Clark (1931 : 245) says, 'Taken as a whole *Comissia* is a rather heterogeneous assemblage and some of the species groups within it seem to have little in common with others beyond the possession of only ten arms.' Apart from the small numbers of arms, I can find little difference between these predominantly ten-armed specimens and *Comanthus wahlbergi* and I believe that they should be regarded as conspecific though *serrata* can be retained at the subspecific level and may prove to be restricted geographically to the eastern half of the range of *C. wahlbergi*.

***Comanthus wahlbergi serratus* (Gislén) n. comb.**

Comanthus wahlbergii (part): A. H. Clark, 1931 : 390 (specimens from Algoa Bay).

Comissia serrata Gislén, 1938b : 7-8, figs 3, 4, pl. 1, fig. 1.

MATERIAL. 'Anton Bruun' cruise 7, st. 357B, 29°11'S : 32°02'E (off Natal), c. 68 metres; 1 specimen, in poor condition.

Some descriptive remarks about this subspecies are given under the heading of the new subspecies of *Comanthus wahlbergi* described below; these are based on specimens in the British Museum collections and from Cape Town University Ecological Survey stations in the vicinity of Port Elizabeth.

***Comanthus wahlbergi tenuibrachia* subsp. nov.**

(fig. 1)

MATERIAL. 'Anton Bruun' cruise 7, st. 381A-C, 33°13'S : 43°51-53'E (Walter's Shoal, S from Madagascar), 38-46 metres; c. 215 specimens.

DIAGNOSIS. A subspecies of *Comanthus wahlbergi* (J. Müller) with relatively few arms, less than 15 in 90% of specimens and only ten in nearly 50%, not known to exceed an arm length of about 50 mm; arms moderately slender, maximum arm length : breadth (at the first syzygy) averaging $>30 : 1$; usually six or seven consecutive proximal pinnules with terminal combs.

[DIAGNOSIS OF *C. wahlbergi wahlbergi* FOR COMPARISON. Arm number generally 15–20, or even more, sometimes less; arms markedly tapering, arm length : breadth averaging $<25 : 1$; less than five consecutive pinnules with combs when the arm length is not more than 50 mm.]

DESCRIPTION. The holotype of *C. wahlbergi tenuibrachia* has the centrodorsal completely flat and discoidal, 2.6 mm in diameter. Around the edge there are XVI well developed cirri and two very small rudimentary ones forming an almost continuous though slightly staggered ring except for three narrow gaps in one quadrant. There are up to 18 cirrus segments and the maximum cirrus length is 10.5 mm. The fifth segment is generally the transition one, its distal end (or edge) abruptly shiny like the following segments, the basal ones having a matt texture. The fourth and longest segment measures 0.85 mm in length and 0.40 mm median breadth, a ratio of over $2 : 1$. The distal segments are broader dorso-ventrally so that the median breadth of the fourth from the tip is 0.6 mm. There is a slight transverse dorsal ridge across the distal end of each segment from the seventh one, giving the effect of a small dorsal spine when viewed in profile. This is only a little enlarged on the penultimate segment forming a small opposing spine. The terminal claw is fairly large, curved, acute and hyaline.

The arms are markedly asymmetrical, ranging from 50 mm long on one side to only 25 on the other. They number 13. In the larger ones, the breadth at the first

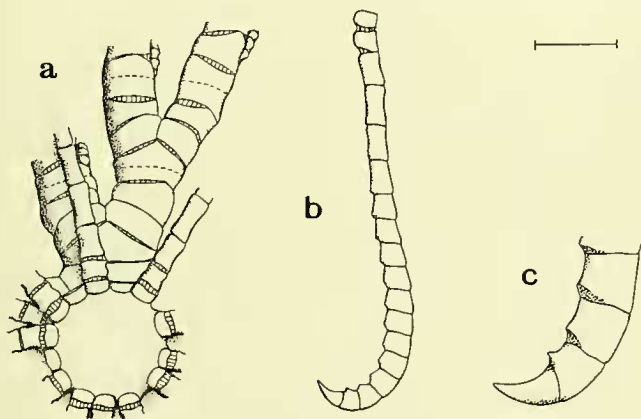


FIG. 1. *Comanthus wahlbergi tenuibrachia* subsp. nov. Holotype. 'Anton Bruun' st. 381B, Walter's Shoal. a. Dorsal view of centrodorsal and proximal part of one post-radial series; b. side view of mature cirrus and c. latero-dorsal view of cirrus tip, enlarged further. [The scale equals 2 mm for a and b but 1 mm for c.]

syzygy on arms based on IBr series is 1.4 mm or after IIBr series 1.3 mm. The length from the proximal edge of the IBr₁ to 3 + 4 (after a IIBr series of four ossicles) is 5.3 mm. All three of the IIBr series have four ossicles. The brachials are flared at their distal ends but the first ten at least have fairly smooth distal edges, though the following ones become spinose.

P_D, the pinnule on the IIBr₂, has 37 segments and measures 9.2 mm; there is a comb of nine teeth from the 29th segment.

P₁ with 26 segments measures 4.8 mm and has a comb of eight teeth. P₂ has about 22 segments. All the pinnules to P₇ have a comb though the more distal ones have only about six teeth.

Where there is no IIBr series, P₁ resembles P_D and so on.

VARIATIONS. The arms of 173 of the more nearly intact specimens were counted, the numbers being as follows:

78	with 10 arms
27	with 11 arms
24	with 12 arms
14	with 13 arms
11	with 14 arms
4	with 15 arms
6	with 16 arms
5	with 17 arms
2	with 18 arms
and 2	with 19 arms.

The mean arm number is 11.7.

In 20 specimens examined closely, out of 28 IIBr series, two consisted of only two ossicles and a third of three with a syzygy at IIBr₂ + 3; all the rest were 4(3 + 4).

The ratio of maximum arm length to the breadth at the first syzygy, after a IBr series only, ranges from 23 to 43 : 1 with a mean of 31 : 1 (i.e. an arm breadth 3.2% of the length), this is in specimens with maximum arm length 25–50 mm. The arm breadth at 3 + 4 on arms arising from IIBr series may be the same as on those from IBr but is usually smaller, up to almost a fifth less.

The cirri number about XII in the smaller specimens increasing to a maximum of XX but in the largest specimens some of the sockets have become obsolete after losing their cirri and the number is most often about XVI. Larger numbers of arms also seem to be correlated with reduction in the cirri, a specimen with 17 arms up to 40 mm long having only XII. The maximum number of cirrus segments increases from 14 to 18 and their length from 6.3 mm to 10.8 mm. The cirrus length varies from 19 to 31% of the maximum arm length and is relatively less in the larger specimens.

AFFINITIES. In comparison with *Comanthus wahlbergi wahlbergi* the most obvious difference is the smaller number of arms. A. H. Clark (1931 : 590) gives the number as 13–21, usually 16–20 for *wahlbergi* from the South African mainland and, apart from the specimens which he mentions from Algoa Bay with only 10–12 arms which

are probably referable to *C. wahlbergi serratus*, the 23 individuals dealt with descriptively average 17.8 arms.

The maximum size is also greater for the subspecies from the mainland, judging from the present sample from Walter's Shoal, the arm length reaching 80 mm rather than only 50 mm. Also the arms are more slender in *C. wahlbergi tenuibrachia*; while a specimen of *C. wahlbergi wahlbergi* from False Bay, South Africa, has arms only 30 mm long at 1.4 mm breadth of 3 + 4 (on arms based on IIBr series), in the Walter's Shoal specimens with the same breadth the maximum arm length is 45-50 mm. Fifteen specimens from the mainland waters have a mean ratio of arm length : breadth 22 : 1, compared with a mean of 33 : 1 in the twelve specimens of *C. wahlbergi tenuibrachia* measured which have IIBr series present to provide a comparable measurement. However, there is some overlap since the range in this ratio in the twelve of *tenuibrachia* is from 25 to 45 : 1, overlapping that of *wahlbergi*, which is 19-29 : 1.

The cirri appear to be relatively shorter in *C. wahlbergi wahlbergi* measuring up to only c. 7 mm in specimens with arm length 30-50 mm, compared with 8-10+ in *C. wahlbergi tenuibrachia*. The transition segment is usually the fifth in the latter but more often the sixth in the mainland specimens.

Finally *C. wahlbergi wahlbergi* may differ in having fewer consecutive proximal pinnules with combs at a comparable size.

As for *Comanthus wahlbergi serratus*, this does resemble *tenuibrachia* in the relatively small number of arms but these are again stouter basally than in the specimens from Walter's Shoal, the ratio of arm length : breadth (after IBr series in this case) ranging from 15-26 : 1 with a mean of 21 : 1 for 26 specimens of *serratus* compared with a range of 23-43 : 1 and a mean of 31 : 1 in the 20 of *tenuibrachia* measured.

The number of cirrus segments may be slightly less in *C. wahlbergi serratus*, usually 13-15 at arm length 25-30 mm compared with 14-16 in *tenuibrachia* at this size. Even the holotype of *serratus* with arm length c. 40 mm was described as having only 13-15 cirrus segments; it has over XX cirri according to Gislén, which may also be a significant difference.

PENTACRINOIDS. Several pentacrinoids were observed attached to the cirri of a number of specimens, as also noted by A. H. Clark in *C. wahlbergi wahlbergi*.

Comaster distinctus (P. H. Carpenter)

Actinometra distincta P. H. Carpenter, 1888 : 295-296, pl. 55, fig 1.

Antedon brevicirra Bell, 1894 : 400.

Comaster parvus A. H. Clark, 1909e : 144; 1912a : 88-89, 315, fig. 3; Gislén, 1927 : 9-10, figs 5, 6.

Comaster distincta : A. H. Clark, 1911a : 533; 1912a : 87-88; 1931 : 448-451, pl. 52, fig. 153.

Comaster brevicirra : A. H. Clark, 1931 : 444-447, pl. 29, figs 84-86.

Comaster sp. ? nov. aff. *distinctus* : A. M. Clark in Humes & Ho, 1970 : 15.

Comaster distinctus and *brevicirrus* : A. M. Clark & Rowe, 1971 : 16.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Islands), 77 metres; 2 specimens.

'Anton Bruun' cruise 9, st. KA 14, Mounimeri, Comoro Islands; one post-radial series and arms [probably of *C. distinctus*].

Prof. A. G. Humes's no. 1298, 13°29'S : 48°06'E (S of Nosy Bé, Madagascar, 47 metres; 7 specimens. B.M. reg. nos 1969.5.13.117-122.

Dr L. Fishelson's nos NS 6317-6320, Gulf of Akaba; 3 specimens and one IIBr series with arms. B.M. 1970.10.8.45 (1 specimen).

REMARKS. The inclusion in *Comaster distinctus* of the fine specimens from Madagascar and the Gulf of Eilat extends both the geographical and the size ranges of the species, which was hitherto unknown either from the western Indian Ocean or to reach an arm length of more than 110 mm.

Some counts and measurements of most of these specimens are given in the following table together with others from the holotypes of *Comaster distinctus* and *brevicirrus* and a specimen in the British Museum collection from the South China Sea, N. of Sarawak (B.M. no. 1964.3.17.15). The arm lengths given are for the longest arms left intact, or almost. Since all possible IIBr series are present in all these specimens, the number of IIBr series of 4 can be found by deducting the number of IIBr 2 series from 10. Except in the seventh specimen listed, the additional III or IVBr series are internal in position.

TABLE I
Numerical data from specimens of *Comaster distinctus*

Specimen	Arms		Cirri			Division Series				
	No.	Length (mm)	No.	Segs.	Length (mm)	IIBrs		IIIIBrs		IVBrs
						2	2	4	2	4
AB st. 18A	30	c. 55	XIX	10	6.8	5	9*	0	0	0
Sarawak	33 (?+)	80	XVIII	13	9.2	0	13	0	0	0
<i>C. brevicirrus</i>										
HOLOTYPE	c. 50	c. 50	XXV	11	6.8	7	12	4	13	0
<i>C. distinctus</i>										
HOLOTYPE	36 (?+)	c. 75	XXX	12	9.0	0	16	0	0	0
Eilat	c. 40	c. 100	XXVIII	12	10.8	0	18	0	1	0
Madagascar	36	150	XX	13	8.7	4	13	2	1	0
"	41	125	XVII	13	8.4	2†	17	0	3	1
"	41	120	XX	13	8.9	4	14	4	3	0
"	c. 40**	140	XVI	13	8.9	2	11+	2	1	0
"	39	150	XV	13	9.7	4††	15	1	2	1
"	41	170	XIX	13	10.3	2	13	3	5	0
"	48	140	XXXVI	14	10.3	2	19	0	9	0

* One IIIBr 3 series also present.

† One IIBr 3 series also present.

** One IBr and one IIBr series broken, probably about 10 arms lost.

†† One IIBr 3 series also present.

The specimen with arms 170 mm long (last but one in the table) has the arm breadth (on arms arising from IIIBr series) measured at Br₂₋₃ (which is a tangential suture unlike Br₁₊₂) measuring 1.6 mm and the length from the proximal edge of the IBr₁

to this same suture is 8.4 mm. The brachials from about Br₁₂ have rugose distal edges but the proximal ossicles are smooth.

The flattened centrodorsal has the dorsal pole 2.1-2.9 mm in diameter, the cirri encroaching unevenly upon it. A mature cirrus measuring 10.3 mm in length has the fourth segment longest, with length : median breadth 1.02 : 0.37 mm (=2.76 : 1). Since the cirri deepen considerably distally, the breadth of the antepenultimate segment (excluding its small dorsal distal projection) measures 0.60 mm. The distal segments each have a short transverse dorsal ridge distally, in profile resembling a small spine. Only the opposing spine on the penultimate segment is narrow.

On an arm preceded by both IIBr 4 and IIIBr 4 series, P₁ (in this case the third pinnule, following the P_D and P_F) has 32 segments and is 9.5 mm long; its comb of seven long teeth starts abruptly and finishes two segments short of the tip. P₂ with about 29 segments measures 6.3 mm and has a comb of nine teeth. Combs are lacking from P₃ and P₅ but present on P₄, P₆ and P₇ and scattered more distal pinnules. P_D has 36 segments and is 11.5 mm long with a comb of nine teeth but an internal P₁ with 32 segments has the last 13 bearing teeth. The genital pinnules are relatively short with stout segments; the gonads are undeveloped. The distal pinnules are much more elongated.

In most of the specimens the joint in the IBr series appears to be usually a pseudosyzygy but in some cases the ends of the radiating ridges characteristic of proper syzygies can be distinguished superficially. The first joint in IIBr series of four ossicles is also rarely syzygial in contrast to that in IIIBr series or the first two brachials.

The key to the species of *Comaster* given in A. H. Clark's monograph (1931) has a dichotomy c (after a²b²) based on more or less than 40 arms, cutting across the present specimens which run down to *C. schoenovi* A. H. Clark, 1918, if one opts for 40+ arms or to *C. brevicirrus* (35-40 arms) or *distinctus* (<35 arms) otherwise. As noted already (A.M.C. & Rowe, 1971 : 16) the number of arms is probably not a valid distinction between *schoenovi*, *brevicirrus* and *distinctus*. Indeed the holotype of *C. brevicirrus* probably had about 50 arms. It came from Macclesfield Bank in the South China Sea, while the holotype of *C. schoenovi* with 60 arms was from the coast of China. The specimen from Singapore figured under the name of *C. schoenovi* by A. H. Clark (1931, pl. 64, fig. 179) appears to have about 45 arms.

In the holotype of *C. brevicirrus* the cirri certainly are shorter and stouter than those of the holotype of *C. distinctus*, having the fourth and longest segment with length : median breadth 0.95 : 0.58 mm (=1.64 : 1) as opposed to 1.00 : 0.53 (=1.89 : 1) but I doubt if this difference is significant. The specimen from Sarawak has cirri of similar proportions to those of the holotype of *C. brevicirrus*. I do not think that the high incidence of IIBr series of only two ossicles (7 out of 10) is significant and I can find no other characters by which to distinguish specifically the holotypes of *C. brevicirrus* and *distinctus*. Accordingly, *C. brevicirrus* is here returned to the synonymy of *C. distinctus*, A. H. Clark having made the same move in 1912 but reversed it in 1931. I think that *C. schoenovi* will also prove to be a synonym of *C. distinctus*, certainly the Singapore specimen is straddled geographically and in arm number by the material of Carpenter's species. *Comaster pulcher* A. H. Clark,

1912, known from only a single specimen from the Kei Islands with 40 arms c. 85 mm long has cirri with as many as 15-17 segments up to 15 mm long and may well be distinct on this account. Unfortunately, immature specimens of the other species such as *C. multifidus*, which completely lack cirri as adults following reduction during growth, also need to have their relationships with *C. distinctus* evaluated. Much better samples, especially from the western tropical Pacific, are needed to allow this to be done.

Comaster gracilis (Hartlaub)

Actinometra gracilis Hartlaub, 1890 : 170, 187; 1891 : 111-112, pl. 5, fig. 55.

Comaster gracilis: A. H. Clark, 1910 : 139; 1912a : 84; 1913 : 12; 1931 : 430-435, pl. 47, figs 143, 144; Gislén, 1934 : 32, 34-35; 1940 : 5; A. M. Clark & Rowe, 1971 : 16.

MATERIAL. 'Te Vega' cruise 2, st. 65, Pulau Hantu, SW of Singapore, reef, intertidal; 1 broken specimen.

'Te Vega' cruise 2, E St John's, Singapore, 'sublittoral'; 2 broken specimens.

'Te Vega' cruise 3, Gan, Maldive Islands, shore; 1 fragmented specimen [with commensal shrimp].

'Te Vega', F. C. Zieshenne's st. 64-11, 4°17'50"N : 73°33'42"E (between Male and Fadiffolu, Maldive Islands), reef, 1-3 feet; 1 broken specimen.

REMARKS. This species has already been collected at Singapore and the Maldive Islands by Svend Gad and Stanley Gardiner respectively. The multiplicity of proximal syzygies renders it very easily broken in preservation and hampers comparison with *Comaster multifidus*, of which it is thought by Gislén to be a synonym. These specimens, including the two from St John's, Singapore, are more slender than the one from that locality which I am referring to *C. multifidus*.

Comaster multifidus (J. Müller)

Alecto multifida J. Müller, 1841 : 188.

Comaster multifida: A. H. Clark, 1911c : 247-248; 1912a : 84-85; 1931 : 413-430, pl. 46, figs 140, 141; Gislén, 1940a : 4-6. [Non *C. multifida*: Gislén, 1919 : 14-19, which is *Comanthus parvicirrus*.]

MATERIAL. 'Te Vega' cruise 2, E St John's, Singapore, 'sublittoral'; 1 specimen.

Comatella maculata (P. H. Carpenter)

Actinometra maculata P. H. Carpenter, 1888 : 307, pl. 5, fig. 1, pl. 55, fig. 2.

Comatella maculata: A. H. Clark, 1910 : 138; 1931 : 112-118, pl. 20, fig. 50.

MATERIAL. 'Te Vega' cruise 3, st. 132, S Nilandu Atoll, Maldive Islands; 1 specimen (somewhat decalcified).

This specimen has 21 arms, the only IIIBr series 2(1 + 2).

Comatella stelligera (P. H. Carpenter)

Actinometra stelligera P. H. Carpenter, 1880 : 198, pl. 12, fig. 26; 1888 : 308-309, pl. 5, fig. 5, pl. 58, figs 1, 2.

Comatella stelligera: A. H. Clark, 1910 : 136; 1911a : 530-531; 1912a : 68, 70; H. L. Clark, 1921 : 13, pl. 2, fig. 2; Gislén, 1922 : 18-21, figs 7-9; A. H. Clark, 1931 : 98-112, pl. 4, figs 6-9; Gislén, 1940a : 3-4.

MATERIAL. 'Anton Bruun' cruise 1, st. 47B, 19°50'N : 92°55'E (off Akyab, Burma), 22-30 metres; 1 specimen.

REMARKS. This species has been recorded from the nearby Mergui Archipelago. The present specimen has about 40 arms and up to 27 cirrus segments, the latter bringing it within the range of *Comatella nigra* (P. H. Carpenter, 1888) as given in A. H. Clark's key (1931 : 91-92), though specimens with up to 50 arms have been recorded as *C. stelligera*, contrary to his key but allowed for in the diagnosis. I think it very likely that *nigra* will prove to be not specifically distinguishable; unlike *C. stelligera* it has not been recorded from the Indian Ocean.

Comatula pectinata (Linnaeus)

Asterias pectinata Linnaeus, 1758 : 663.

Comatula pectinata: A. H. Clark, 1910 : 148; 1912a : 80-81; H. L. Clark, 1921 : 14, pl. 1, fig. 3, pl. 3, fig. 2; A. H. Clark, 1931 : 339-360, pl. 20, fig. 49, pl. 33, fig. 100, pl. 34, fig. 101, pl. 35, fig. 102, pl. 36, fig. 103, pl. 37, fig. 104, pl. 38, figs 105-107; H. L. Clark, 1938 : 18-20.

MATERIAL. 'Anton Bruun' cruise 1, st. 38, 14°07'N : 97°05'E (W of the Moskos Islands, Burma), 69-73 metres; 2 specimens.

'Anton Bruun' cruise 1, st. 47B, 19°50'N : 92°55'E (off Akyab, Burma), 22-30 metres; 2 specimens.

RANGE. This predominantly west Pacific species has been recorded from the Straits of Malacca but these are the first positive records from within the Bay of Bengal.

Comissia hartmeyeri A. H. Clark

(fig. 2)

Comissia hartmeyeri A. H. Clark, 1912f : 386-387; 1931 : 267-269, pl. 28, figs 78, 79, pl. 29, figs 80-82.

MATERIAL. 'Anton Brunn' cruise 9, st. HA-39, 27°16'38"N : 33°47'01"E (just S of the Gulf of Suez, Red Sea), 3-5.5 metres; 7 specimens.

Dr Fishelson's no. NS 4477, Ras-Atantur, Sinai Peninsula, Gulf of Akaba, 1 metre, in hole under dead coral; 2 specimens. B.M. reg. no. 1969.5.13.1 and Tel-Aviv University research collection.

The only other record of this small comasterid is that of the type-material, which

was taken at Tor (El Tur) on the Gulf of Suez side of the Sinai Peninsula. It will probably be found to be quite widespread but has escaped attention because of its small size and self-effacing habit.

DESCRIPTION. One of the larger 'Anton Bruun' specimens has arm length c. 30 mm, breadth at the first syzygy 0.7 mm and the length from the proximal edge of the IBr_1 to this syzygy 2.5 mm. There are XV cirri with 12 or 13 segments and length up to 5.8 mm; the fourth and longest segment has length : median breadth 0.8 : 0.25 mm (= 3.2 : 1) and the distal breadth, in the middle of the antepenultimate segment, is 0.4 mm. The second syzygy is at 11 + 12 on eight of the nine remaining arms and at 12 + 13 on the ninth. There are up to seven teeth in the comb on P_1 .

The larger Sinai specimen has arm length 47 mm and the breadth at 3 + 4 1.15 mm. The centrodorsal is c. 2 mm in diameter. There are XX cirri with up to 15 segments and length c. 8 mm; the fifth and longest segment has length : breadth 0.90 : 0.35 mm (= < 3 : 1). The sixth segment is slightly broader, especially at the distal end and the cirrus is distinctly deeper from the seventh segment to the penultimate so that the mean distal breadth is c. 0.55 mm. The last six segments are shorter than their median breadths. There are small median distal dorsal spines or short transverse ridges. The brachials are flared but not markedly spinose, at least in the proximal half of the arm. The pinnule segments are both flared and spinose. There are no dorsal processes at the bases of the proximal pinnules. P_1 with 26 segments has the last six with teeth making the comb; it is c. 9 mm long. P_2 is much smaller with 15 segments, four with teeth; the length is c. 4 mm. P_3 is a genital pinnule. There are eggs on the exterior of some genital pinnules and a pentacrinoid attached to a cirrus of the second Israeli specimen, the same being true of an 'Anton Bruun' specimen and also of the type series.

Both the shore specimens have eleven arms but the 'Anton Bruun' individuals

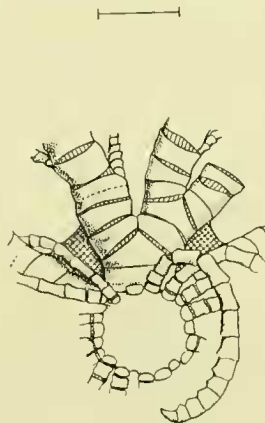


FIG. 2. *Comissia hartmeyeri* A. H. Clark. B.M. reg. no. 1969.5.13.1, SE Sinai peninsula. Arm br 1.15 mm (after IBr series only). Dorsal view of centrodorsal and proximal part of one post-radial series. [The scale equals 2 mm.]

all have ten. The IIBr series, where present, have two ossicles in one specimen and four in the other.

REMARKS. These specimens serve to show that some of the characters used in A. H. Clark's key to the species of *Comissia* (1931 : 246-247), such as the number of cirrus segments and cirri, are correlated with size, *C. hartmeyeri* being supposedly characterized by having not more than 14 cirrus segments, the longest more than three times as long as broad, arms not more than 45 mm long and less than XX cirri, all of which clearly applies only to not fully grown specimens.

Family EUDIOCRINIDAE

EUDIOCRINUS P. H. Carpenter

Eudiocrinus P. H. Carpenter, 1882 : 493; A. H. Clark, 1941 : 145-149. [Type-species *Ophiocrinus indivisus* Semper, 1868.]

A. H. Clark (1941) recognized twelve nominal species of *Eudiocrinus* including a new one, *E. eoa*, rather incompletely described from a single specimen from the Philippine Islands, which seems to me to be close to, if not conspecific with, *E. tenuissima* Gislén, 1940, from the Marshall Islands, the description of which appeared while Clark's monograph was in the press. Most of the numerical characters of these two which were mentioned in the descriptions are given in Table 2 together with comparable data of the other species in the order in which they appear in A. H. Clark's key. The approximate entries for relative length of the longest cirrus segments are estimates from his comparisons of length with either proximal or distal breadth, rather than the usual median breadth. The T.V. (Te Vega) and A.B. ('Anton Bruun') specimens are likely to be deposited in the U.S. National Museum and the Swain Reefs (Great Barrier Reef) specimen of *E. serripinna* in the Australian Museum. Only the holotype of *Antedon granulatus* Bell (a synonym of *E. indivisus*) was hitherto in the British Museum collections, the specimen of *E. gracilis* from the Maldive Islands being in the Cambridge Zoological Museum.

Unfortunately little is known about the range of variation in the species of *Eudiocrinus* and the present collection does little to help rectify this, though it does serve to extend the range of no less than three species into the Bay of Bengal from the Pacific, namely *E. indivisus*, *serripinna* and *venustulus*, if my identifications on the basis of A. H. Clark's key are correct. However, I suspect that not all the nominal species he recognized will prove to be valid.

Eudiocrinus indivisus (Semper)

Ophiocrinus indivisus Semper, 1868 : 68.

Eudiocrinus indivisus: P. H. Carpenter, 1882 : 495; A. H. Clark, 1912a : 102; Gislén, 1922 : 68-69; A. H. Clark, 1941 : 163-169, pl. 11, fig. 42.

Eudiocrinus granulatus Bell, 1894 : 397-398, pl. 23.

MATERIAL. 'Anton Bruun' cruise 1, st. 21, 09°54'N : 97°42'E (SW of Mergui Archipelago), 70 metres; 1 broken specimen.

DESCRIPTION. The arm length is 35 plus possibly about 25 mm; the breadth at $3 + 4$ is 1.4 mm and the length of the first five post-radial ossicles (i.e. to $3 + 4$ since the first two count as IBr_1 and $_2$ by A. H. Clark's terminology) is 3.3 mm. The centrodorsal is 2.6 mm in diameter. There are c. XXII cirri but only one peripheral one of 23 segments is complete; it measures 17 mm, the fifth and longest segment has length : median breadth 1.0 : 0.5 mm and the distal breadth is 0.7 mm.

The arms are smooth, the brachials not flared. Only parts of three remain and two of them do not have a syzygy at $3 + 4$, the brachial syzygies following that between the two IBr ossicles being: $3 + 4$, $9 + 10$; $7 + 8$, $12 + 13$; $15 + 16$, $19 + 20$. In spite of this anomaly in the joints, the last arm has the pinnules on the usual brachials, as on the first arm, no pinnule occurring on Br_3 even though it is not a hypozygal; however, the second arm does have a pinnule on Br_3 .

P_C on the second ossicle, IBr_2 , has 14 segments and is 5.3 mm long. It is prismatic and most markedly flattened horizontally with a lateral flange. P_1 is a similar shape, with 13 segments and is 5.3 mm long. P_a is relatively huge, very stout, smooth and gradually tapering, with 18 segments and length 10.0 mm. P_2 is similar to P_a with 20 segments and is 10.5 mm long; the segments have parallel sides and only the distal ones have a small spine at their distal ends. P_b is variable in size; it may be more slender, with 19 segments and length only 6.8 mm, or almost equal to P_a , while on one arm it is the longest pinnule since P_a is relatively small, only 6.2 mm long.

RANGE. This record extends the known range of *E. indivisus* into the Indian Ocean; it was previously known only from the East Indies, Philippines and South China Sea to the Bonin Islands.

Eudiocrinus minor A. H. Clark

(fig. 3)

Eudiocrinus minor A. H. Clark, 1909b (17 April) : 75-76; 1912a : 102-103, fig. 5.

Eudiocrinus ornatus A. H. Clark, 1909b : 76 (nom. nud.); 1909c (19 June) : 633-635; 1912a : 99-101, fig. 4; 1918 : 70, pl. 17, fig. 29; 1941 : 172-175, pl. 11, fig. 40, pl. 12, fig. 47.

NOMENCLATURE. The dating of A. H. Clark's two papers of 1909 contradicts his treatment of 1918 and 1941, where *E. minor* is referred to the synonymy of *E. ornatus* despite its clear priority and the fact that in 1941 he qualified the entry for *E. ornatus* in the earlier of the two 1909 references as a nomen nudum. I cannot agree with his statement in the text that this earlier paper provided sufficient 'indication' to establish the name since it was not differentiating *E. ornatus* from *E. minor* in any way but likening the two. The relevant passage at the end of the description of *E. minor* reads 'Arms and pinnules as in *E. ornatus*, the overlapping of the brachials and pinnules being moderately marked'. Despite the change away from the usage in A. H. Clark's monograph—the definitive work on this family—I consider that the name *Eudiocrinus minor* is the proper one to use for this species.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, $07^{\circ}34'N$: $98^{\circ}00'E$ (between Malaya and the Nicobar Islands), 77 metres; 1 specimen.

Species	anules			
	P _a		P ₂	
	Segs.	L.	Segs.	L.
<i>junceus</i> A.H.C., 1912	15	11	15	11
<i>philenov</i> A.H.C., 193	15	8	—	—
<i>venustus</i> A.H.C., 1	12	5	similar	
	14	5.3	15	5.5
<i>tenuissima</i> Gis., 194	7	2	similar	
<i>eo</i> A.H.C., 1941	7	2	similar	
<i>serripinna</i> A.H.C., 1	—	—	—	—
	12	5.3	12	5.3
	11	5.3	11	5.0
<i>minor</i> A.H.C., 1909	15	8.5	similar	
	larger		18	12
	10	5.0	11	5.3
	—	—	—	—
<i>indivisus</i> (Semp.), 1	—	—	—	c. 8
	18	10.0	20	10.5
	17	9.0	15	9.0
	10	7.5	11	8
<i>pulchellus</i> Gis., 1922	10	4	12	4
	8	2	—	—
	10	3.5	10	3.2
<i>gracilis</i> A.H.C., 191	10	7	—	—
	11	9	—	—
	16	9	15	8
<i>pinnatus</i> A.H.C., 19	17	11	17	11
	16	12	similar	
<i>loveni</i> Gis., 1922	11	5	11	5
<i>variegatus</i> A.H.C., 1	similar		c. 12	c. 4.5
	12	4	12	4

TABLE 2

Numerical data for the species of *Eudiocrinus* P. H. Carpenter

Species	Specimen	Arms		Cirri			Cirrus L. as % arm length	Pinnules										
		Length	Breadth	No.	Segs.	Length		L : Br longest segment	Pc	P _c		P ₁		P _a		P ₂		
								Segs.	L.	Segs.	L.	Segs.	L.	Segs.	L.	Segs.	L.	
<i>jaunceus</i> A.H.C., 1912b	holotype	90	—	XXV	22	23	say 4.2	26	15	6.5	14	6.5	15	11	15	11		
	T.V. st. 60	c. 30	0.7	XXI	17	10.5	4.5	35	c. 10	3.5	—	—	—	—	—	—	—	
<i>philenor</i> A.H.C., 1932	holotype	c. 40	—	XXV	15	10	4.0	25	11	4	12	4	15	8	—	—		
<i>venustus</i> A.H.C., 1912b	holotype	60	—	XII	16	6.5	say 1.4	11	10	3.0	similar	—	12	5	—	—	similar	
	A.B. st. 21	c. 40	0.9	XX	18	6.3	1.5	16	8	2.2	10	2.9	14	5.3	15	5.5	similar	
<i>tennissima</i> Gis., 1940	holotype	45	0.5	XV	11	c. 4	2.5	9	7	1.5	similar	—	7	2	—	—	similar	
<i>eo</i> A.H.C., 1941	holotype	?	—	XV	12	?	2.5	—	7	1.5	similar	—	7	2	—	—	similar	
<i>serrtipinna</i> A.H.C., 1908	holotype	65	—	XIX	16	10	say 1.2	15	—	—	—	—	—	—	—	—	—	
	Swain Reefs	c. 60	1.4	XXII	17	8	1.4	13	11	3.7	11	3.7	12	5.3	12	5.3	12	5.3
	A.B. st. 18A	40+	1.3	XVI	20	9	1.2	c. 20	10	3.3	10	4.0	11	5.3	11	5.0	11	5.0
<i>minor</i> A.H.C., 1909a	<i>ornatus</i> HT	85	—	XVIII	18	20	say 2.2	24	12	5.5	12	—	15	8.5	—	—	similar	
	Siboga st. 294	c. 50	—	XXI	18	12	say 2.2	24	12	5	15	7.5	larger	—	18	12	—	
	A.B. st. 18A	c. 32	1.1	c. XX	15	9.5	2.7	30	10	3.0	10	3.4	10	5.0	11	5.3	—	
	<i>minor</i> HT	15	—	XII	12	5	2	33	—	—	—	—	—	—	—	—	—	
<i>indivisus</i> (Semp.), 1868	holotype	80	—	XVI	20	9	c. 2	11	—	—	—	—	—	—	—	—	c. 8	
	A.B. st. 21	c. 60	1.4	XXII	23	16.8	2.0	28	14	5.3	13	5.3	18	10.0	20	10.5	—	
	<i>granulatus</i> HT	c. 90	1.7	XXV	21	14.5	1.8	16	13	5.3	13	5.3	17	9.0	15	9.0	—	
	Bock st. 59	—	c. 1.9	XIX	21	15	2	—	10	4	10	4	10	7.5	11	8	—	
<i>pulchellus</i> Gis., 1922	holotype	40	0.8	XIX	15	6.5	c. 2	16	10	2.5	10	3	10	4	12	4	—	
	Bock st. 46	30	—	XVII	14	6.5	c. 3?	15	6	1.5	6	—	8	2	—	—	—	
	Bock st. 45	c. 20	—	XX	12	3	—	22	8	2	8	2	10	3.5	10	3.2	—	
<i>gracilis</i> A.H.C., 1912b	holotype	55	—	X	16	9	say 2.2	16	10	3.5	10	4.5	10	7	—	—	—	
	paratype	—	—	XIII	18	12	—	—	10	4	—	—	11	9	—	—	—	
	S. G. Maldives	100	1.6	c. XX	20	11	1.4	11	14	5	15	5.3	16	9	15	8	—	
<i>pinnatus</i> A.H.C., 1912b	holotype	75	—	XVII	22	11	l < br	15	11	4	12	4.5	17	11	17	11	—	
	Jolo, Kei Is.	—	—	XV	17	—	say 1.2	—	15	6	14	6+	16	12	—	—	similar	
<i>loveni</i> Gis., 1922	holotype	45	1.4	XX	21	10	1.25	22	9	3.5	10	4	11	5	11	5	—	
<i>variegatus</i> A.H.C., 1908	holotype	75	—	XXV	15	9	say 1.3	12	9	4	12	6	similar	—	c. 12	c. 4.5	—	
	Hamburg Mus.	40	—	XVII	15	5	say 1.2	12.5	9	3	9	3	12	4	12	4	—	

DESCRIPTION. The arm length is only 27 plus about 5 mm; the breadth at 3 + 4 is 1.1 mm and the length to this syzygy 2.6 mm. The diameter of the centrodorsal is 2.1 mm, of which the dorsal pole occupies the greater part, being bounded by a staggered row of cirri, mostly only one deep. The cirri number c. XX, have up to 15 segments and are up to 9.5 mm long. The fourth and most attenuated segment has length : median breadth 0.8 : 0.3 mm but is so constricted medially that its distal breadth is 0.5 mm. The antepenultimate segment is also longer than broad with br 0.4 mm.

The brachials are slightly flared at their distal ends so that the profile is uneven but they are not spinose or carinate.

P_c arises on the left side of the IBr_1 and has 9 or sometimes 10 segments, its length being 2.8–3.0 mm; it tapers evenly from a stout base. P_1 with 10 segments is 3.4 mm long. P_a again with 10 segments is larger, 5.0 mm long, the segments being stouter and more flared at their distal ends as well as finely spinose. P_2 with 11 segments is 5.3 mm long.

REMARKS. This specimen agrees fairly well with A. H. Clark's description of the holotype of *E. ornatus*, which is also from the Bay of Bengal but nearer the Andaman Islands, allowing for the much larger size, arm length c. 85 mm. The fewer cirri of the type, only XVIII, probably have little significance and could be attributable

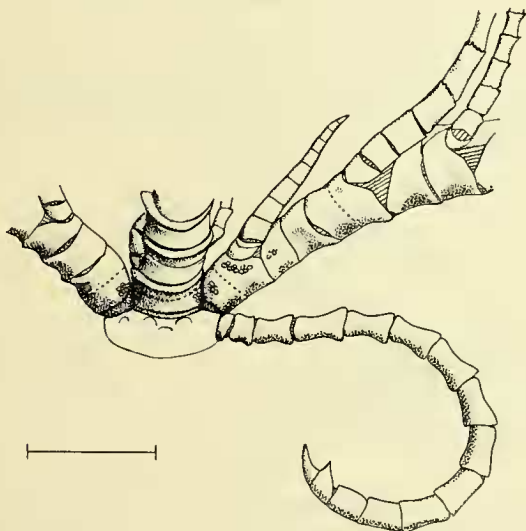


FIG. 3. *Eudiocrinus minor* A. H. Clark. 'Anton Bruun' st. 18A, N Malacca Strait. Arm br 1.1 mm. Side view of calyx with mature cirrus and the bases of three post-radial series, the median one foreshortened, that on the right showing P_c and the bases of P_a and P_b , the centrodorsal drawn only in outline, being obscured by the cirri. [The scale equals 2 mm.]

to A. H. Clark's more conservative estimates of cirrus numbers. The main difference appears to be the smoother brachials in the 'Anton Bruun' specimen (see fig. 3), whereas the holotype has brachials with 'a somewhat concave dorsal surface and very prominent distal ends which are strongly overlapping and give the animal a curiously ornate appearance'. This condition may approximate to that in *E. venustulus* (see fig. 5) from which the holotype of *E. ornatus* differs in having prismatic basal segments to the proximal pinnules and no large dorsal crests. Since *E. venustulus* was also taken at station 18A, the two are sympatric and a study of their variation is desirable. The holotype of *E. minor*, also from the vicinity of the Andaman Islands, is relatively small, the arms only 15 mm long and the XII cirri with up to only 12 segments.

A. H. Clark (1941) notes that *E. philenor* A. H. Clark, 1932, known only from the nearby Mergui Archipelago, is the species most closely related to *E. ornatus*. It seems to differ in having more elongated cirrus segments, up to four times as long as the median width, while P_a and P_2 are relatively longer, the proximal ossicles carinate and their distal edges less produced. In the holotype of *E. philenor* the arm length is 40 mm and P_a is 8 mm long with 15 segments, almost as long as that of the holotype of *E. ornatus* where the arm length is twice as long.

Eudiocrinus serripinna A. H. Clark

(fig. 4)

Eudiocrinus serripinna A. H. Clark, 1908b : 211; 1918 : 71; 1941 : 169-171, pl. 12, fig. 49.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Islands), 77 metres; 1 specimen.

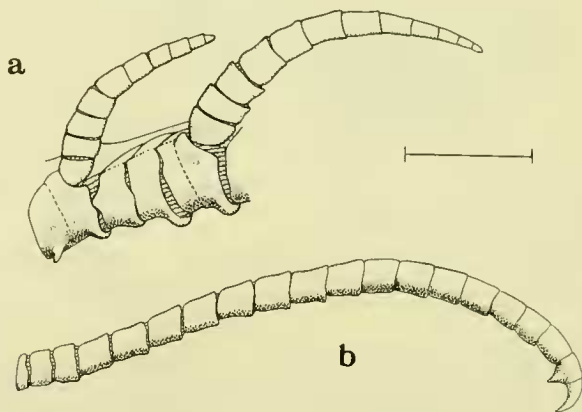


FIG. 4. *Eudiocrinus serripinna* A. H. Clark. 'Anton Bruun' st. 18A, N Malacca Strait. Arm br 1.3 mm. a. side view of base of one post-radial series showing P_c and P_a ; b. mature cirrus. [The scale equals 2 mm.]

DESCRIPTION. The arms are all broken by 16 mm from the calyx but were possibly 40–50 mm, judging from the breadth at 3 + 4, which is 1.3 mm while the length to this syzygy is 2.5 mm. The centrodorsal is 2.0 mm in diameter. There are XVI cirri with up to 20 segments and length up to 9.2 mm; the segments are relatively short, the fifth and longest having length : median breadth 0.55 : 0.45 mm and there is little change in the proportions of the segments distally, the antepenultimate being only fractionally shorter but equally as broad as the fifth.

The proximal post-radial ossicles are markedly flared at their distal ends with median peaks on about the first five (i.e. IB₁ to Br₃ or 4); also the IB₁ and 2 have ventro-lateral flanges.

P_c (on the left) and P₁ are markedly prismatic, both with 10 segments and length respectively 3.3 and 4.0 mm. P_a and P₂ with 11 (or 12) segments are 5.3 and 5.0 mm long but P_b with 10 segments is only 3.4 mm long; it has the segments more flared at their distal ends than the earlier pinnules.

REMARKS. The maximum number of cirrus segments in the Pacific specimens described by A. H. Clark is only 16, corresponding with arm lengths of up to 65 mm, although a specimen from the Great Barrier Reef which I have recently studied (and which provides a further extension of range) has up to 17 cirrus segments at arm length c. 60 mm. However, the cirrus segments are relatively short in *E. serripinna* in comparison with those of the two other species taken at station 18A, *E. minor* and *E. venustulus*, where the ratio of length : median breadth is c. 2 : 1 or more. The proportions of the cirrus segments provide most of the primary dichotomies in A. H. Clark's key to the species of *Eudiocrinus* (1941 : 148–149).

RANGE. This record provides an extension of the known range of *E. serripinna* into the Indian Ocean, previous records being from the Philippines, Kei and Lesser Sunda Islands.*

Eudiocrinus venustulus A. H. Clark

(fig. 5)

Eudiocrinus venustulus A. H. Clark, 1912b : 27–28; 1918 : 68–70, pl. 17, figs 27, 28; 1941 : 160–162, pl. 12, figs 45, 46.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Islands), 77 metres; 2 specimens.

'Anton Bruun' cruise 1, st. 21, 09°54'N : 97°42'E (SW of the Mergui Archipelago), 70 metres; 1 specimen.

DESCRIPTION. All three specimens are similar in size with arm length probably 35–40 mm, the breadth at 3 + 4 c. 1.0 mm and length from IB₁ to 3 + 4 2.3–2.8 mm. One of the specimens from station 18A has its cirri closely curled round the branches of a hydroid and is hard to examine with respect to the centrodorsal and

*Since this paper went to press, I have received from Tel-Aviv University a specimen of *Eudiocrinus serripinna* (no. NS 6094) taken off Taba, near Eilat, Gulf of Akaba, in 25 metres, extending the range farther still.

cirri. The two others have the centrodorsal 1.7 and 2.1 mm in diameter, with the dorsal pole 1.1 and 1.7 mm across respectively, the staggered ring of cirri being doubled for varying extents. In both there are c. XX cirri with up to 16 or 18 more or less constricted segments, the longest cirri up to 6.4 mm long, while the fifth and longest segment has length : median breadth c. 0.5 : 0.3 mm, its flared distal end being 0.45 mm broad; the antepenultimate segment is barely longer than broad, c. 0.40 : 0.35 mm. The distal edges of the radials and the immediately following ossicles are flared and ornamented to some extent with beading or more or less elongated tubercles (see fig. 5a). The distal median projections on the brachials may give the effect of a keel.

P_c is on the left in each case, as usual; it has 8 segments and measures c. 2.3 mm. The first two segments are much enlarged and have very high dorsal crests. P_1 is similar but slightly larger, with 9 or 10 segments and c. 2.8 mm long. P_a is much

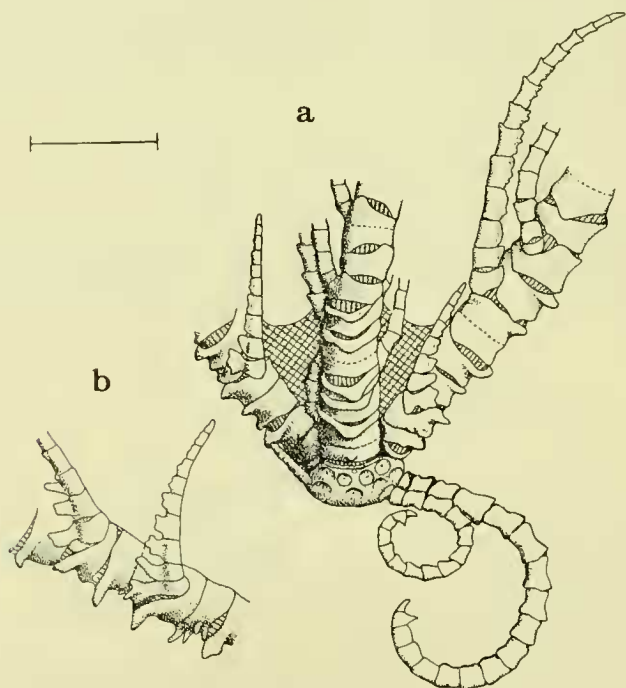


FIG. 5. *Eudiocrinus venustus* A. H. Clark. a. 'Anton Bruun' st. 21, SW Burma. Arm br 0.9 mm. Side view of calyx with mature peripheral and apical cirri and the bases of three post-radial series, the median one foreshortened, that on the left showing P_1 and that on the right P_c , P_a and the base of P_b ; the disc cross-hatched; b. 'Te Vega' st. 60, S China Sea. Arm br 0.8 mm. Side view of part of an arm from IBr_2 to Br_6 showing P_1 and P_2 . [The scale equals 2 mm.]

larger with 11 or 14 segments and is c. 5.3 mm long. The first two segments bear much smaller dorsal crests and the following ones are finely spinose dorsally and at their flared distal ends.

Two of the specimens show signs of double longitudinal brownish stripes along the arms, zigzagging slightly according to the offset of the apices of the plates. In one P_2 has a marked purple stripe.

One of the specimens from station 18A has a large elongated cyst covered by scale-like alternating platelets on the right side of a Br_1 .

RANGE. This material provides an extension of the known range of *E. venustus* into the Indian Ocean, previous records being restricted to the Philippines and Lesser Sunda Islands.

[See also p. 151.]

Family ZYGOMETRIDAE

Zygometra comata A. H. Clark

(fig. 6)

Zygometra comata A. H. Clark, 1911e : 762; 1918 : 61; Gislén, 1936 : 8, fig. 1; A. H. Clark, 1941 : 110-120, pl. 4, figs 13, 14, pl. 5, figs 15-17.

MATERIAL. 'Anton Bruun' cruise 1, st. 37, $13^{\circ}28'N$: $97^{\circ}19'E$ (N of Mergui Archipelago, Burma), 64 metres; 4 small broken specimens.

'Anton Bruun' cruise 1, st. 38, $14^{\circ}07'N$: $97^{\circ}05'E$ (W of the Moskos Islands, Burma), 69-73 metres; 2 specimens.

DESCRIPTION. The two specimens from station 38 have respectively 14 arms, 45 plus c. 10 mm long and 12 (?13) arms c. 45 mm long. Br at 3 + 4 on arms based on a $IIBr_4$ series is 1.0 mm in both and on arms based on IBr series c. 1.15 (including the lateral flanges in each case). The length from the proximal edge of the IBr to 3 + 4 including a $IIBr_4$ series is 4.7 and 4.2 mm respectively. The cirri number c. XXII and XVI, with up to 24 or 25 segments, the maximum length 12.1 and 11.0 mm, while the sixth and longest segment has length : median breadth 0.7 : 0.6 mm and the segments from the sixth (sometimes the fifth) have attenuated, sharp, erect dorsal spines. Two of the four $IIBr$ series in the 14-armed specimen are of 2 ossicles, the others are all 4. The division series and basal brachials have distinct,

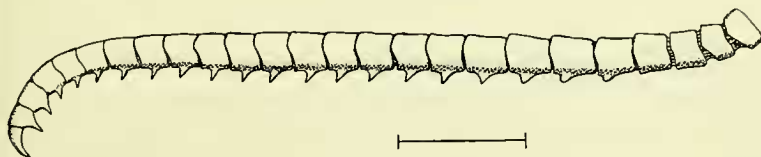


FIG. 6. *Zygometra comata* A. H. Clark. 'Anton Bruun' st. 38. Arm br 1.0 mm (after $IIBr_4$ series). Mature cirrus. [The scale equals 2 mm.]

continuous, straight-edged lateral flanges. The two specimens have P_1 to P_3 on arms based on IBr series with the following segment numbers and lengths:

P_1 24, 7.4 mm; P_2 29, 9.2 mm and P_3 15, 4.0 mm
26, 6.8 mm; 25, 7.9 mm and 17, 4.7 mm

The second specimen has a P_D (on IIBr₂) 25, 7.1 mm followed by P_1 27, 9.2 mm and P_2 25, 7.9 mm, the second pinnule, whatever its designation, being the largest in each case. The basal pinnules have high crests, are angular in cross section and taper to flagellate tips. One specimen has a relatively massive sausage-shaped cyst, probably caused by a myzostome, superimposed on a P_1 , consisting of irregular platelets and with an opening at the dorsal end.

REMARKS. These relatively small specimens have about the minimum number of arms and cirrus segments given by A. H. Clark for *Z. comata*; indeed one of the specimens from station 37 may not have had more than ten arms. Consequently they could run down to *Z. punctata* from the Aru Islands and northern Australia in A. H. Clark's key to the species of *Zygometra* (1941: 82). However, they differ from a specimen of *Z. punctata* of similar arm length from the Great Barrier Reef in the smoother, more rounded ossicles and the more slender cirri with sharper hyaline dorsal spines. In this specimen of *Z. punctata* none of the cirrus segments are appreciably longer than broad.

LECTOTYPE. The naming of this species has pursued a very ramshackle course. *Antedon comata* was a nomen nudum published by von Graff in 1887 when describing myzostome parasites from some crinoids collected in the Mergui Archipelago and given this provisional manuscript name by P. H. Carpenter who abandoned it before his crinoid report was published. In 1911 (e, p. 762) the first valid mention by A. H. Clark of the name *Zygometra comata* was in the form of a footnote to *Z. elegans* pointing out that *Z. fluctuans* (Carpenter) is a synonym of *Z. elegans* (Bell), necessitating another name for the Singapore and Mergui Archipelago specimens of *Zygometra* which he had previously mentioned under one or other of these names. The synonymy given in A. H. Clark's monograph (1941, p. 111) shows that in 1911 there were four sources of material which he considered as belonging to the species, namely:

- (1) the Mergui Archipelago, Anderson collection, referred to *Antedon elegans* Bell by P. H. Carpenter, 1888 and 1889;
- (2) the Philippines, Semper collection, referred to *A. elegans* by Carpenter, 1889;
- (3) the Philippines, collected by the 'Albatross' at stations 5137, 5138 and 5358, referred to *Zygometra elegans* by himself in 1908(b) and to *Z. comata* (as a nomen nudum) in 1911(a); finally
- (4) Singapore, Gad collection, referred to *Z. fluctuans* by himself in 1909 (*Vidensk. Medd.*, actually published in 1910).

In the 1911 footnote A. H. Clark refers to his own description of Singapore material to establish the species *Z. comata* and notes that it also occurs in the Philippine Islands.

There are thus three localities—the Mergui Archipelago, Singapore and the Philippines—for the type-series of the species as defined in article 72(b) of the Code

of Nomenclature, although, if the type-locality is to be narrowed down by selection of a lectotype, material from Singapore is probably to be preferred, following the wording of A. H. Clark's footnote. Also the Mergui specimens have the lowest priority for selection, not having been studied by A. H. Clark himself. Correspondence with Dr Madsen of the Copenhagen museum and Dr Pawson and Miss M. Downey of the U.S. National Museum reveals that in neither institution is there material labelled as type or types of *Zygometra comata*. The specimen from Singapore shown in plate 4 figure 13 of A. H. Clark's monograph (1941) appears to answer the description given in 1910, having about 19 arms. Unfortunately this specimen cannot be traced in either museum. However, the fine specimen from 'Albatross' station 5138 shown in plate 5 figs 15-17 is recognisable in the U.S. National Museum collection, catalogue number 35137. One post-radial series has been detached, so clearly the specimen was particularly examined by A. H. Clark and it also has the virtue of having over 20 arms, thereby showing well the 2, 1, 1, 2 arrangement of arm branching said by him to be characteristic of the species in contrast to *Z. elegans*—a feature less obvious in the specimens from Singapore which evidently tend to have few arms in comparison with those from the Philippine area. Accordingly I propose that this specimen be regarded as the lectotype of *Zygometra comata*.

Family MARIAMETRIDAE

Mariametridae A. H. Clark, 1911f : 649; 1941 : 391-396.

Except for *Mariametra* itself with its spinose ossicles and the monotypic *Pelometra* (known from only a single specimen) with peculiar glassy keels on the genital pinnules, the taxa included by A. H. Clark in this family are very poorly defined in view of the degree of variation found in most of the characters used by Mr Clark to try and distinguish between them. That he himself had considerable reservations about them is obvious from some of his remarks: for instance (on *Oxymetra*) 'as herein understood (it) includes three closely related species that may eventually prove to be simply more or less distinct forms of the same species'; (on four of the nominal species of *Stephanometra*) 'there is really no hard and fast line of division between these forms'; (on two of the three nominal species of *Liparometra*) these 'are very closely related and may eventually prove to be different forms of the same species, or possibly even identical'; (on the two nominal species of *Lamprometra*) 'It is quite possible that *L. klunzingeri* is simply the western form of *L. palmata*'; (on the nominal species of *Dichrometra*) 'these seven species are all very much alike, and the differences between them are slight'. At the generic level Gislén (1922 : 76) comments 'It seems to me to be rather unfortunate within this family to base the characteristics of genus on the relation between the length of P_1 , P_2 and P_3 , as has been done in the genera *Liparometra*, *Lamprometra* and *Dichrometra*, which are surely very closely related to each other'. I fully agree with Gislén and think that *Liparometra* and *Lamprometra* will prove to be better referred to the synonymy of *Dichrometra* with *Stephanometra* probably included as well since it seems to me to

intergrade with *Lamprometra palmata*. I have often found difficulty in deciding whether to refer specimens to *S. indica indica* (sensu A. H. Clark, 1941) or to *Lamprometra*. A. H. Clark's dogmatic diagnosis of *Stephanometra* (1941 : 407) with 'one or more of the oral pinnules enlarged, greatly stiffened, sharp pointed, and spinelike' clearly needs qualification after reading in his key to *S. indica indica* (p. 409) that P_2 is 'somewhat less enlarged (than in *S. indica protectus*) and stiffened, usually more or less strongly recurved (i.e. bending towards the arm tip), distally becoming very slender and delicate, though not flagellate, composed of 15-20 segments of which the fourth and fifth are not noticeably different from the rest'. For comparison his description of *Lamprometra palmata palmata* (p. 481) reads ' P_2 is the longest and stoutest pinnule on the arm and is usually much longer and stouter than either P_1 or P_3 . . . It is more or less strongly stiffened, though tapering to a delicate and flagellate tip. It is usually more or less, and often strongly, recurved towards the arm tip, but it may be straight and almost spinelike . . . It is composed of 16-40 (most commonly 25-30) segments'. Apart from the segment number, the difference seems to depend on the interpretation of 'flagellate', for which figure 10 g and e provide a comparison. The first is of an external P_2 of the specimen of *S. indica* from Rodriguez (which is in fact the holotype), described by A. H. Clark (1913 : 29) as slender distally but not flagellate; while the second is from the specimen from Muhlos, Maldives, described (also under the name *S. indica* at the same time) as 'enlarged and stiff but distally flagellate'. During Jeffery Bell's lifetime it was not politic to relabel specimens he had otherwise identified and, on a subsequent visit, A. H. Clark re-named and labelled this same Muhlos specimen as *Lamprometra palmata*, recording it as such in 1929 (p. 641) without reference to his earlier treatment of it. In his monograph the record appears twice over; on p. 453 it is referred to *Stephanometra indica protectus* and on p. 502 to *Lamprometra palmata palmata*.

If the shape of P_2 cannot always be relied upon to distinguish between *Stephanometra* and *Lamprometra* then what about the shape of the division series? A. H. Clark (1941 : 407) specifies that those of *Stephanometra* are 'well separated, and the component ossicles bear rounded ventro-lateral extensions' as opposed to *Lamprometra* (p. 473) where they are 'usually in very close lateral contact with more or less broadly and sharply flattened sides, more rarely just in contact with the sides slightly or not at all flattened'. I would say that in *Lamprometra* too the division series are not always very close together and the sides may have ventro-lateral flanges, though these are usually blunter than in *Stephanometra* and normally have a continuous straight edge, whereas in *Stephanometra* the flange of each ossicle tends to be rounded off at the ends so as to give a scalloped outline when viewed dorsally (compare figures 9f and 10f). When the disc has been lost in preservation, the prominence of the ventro-lateral flanges may be emphasized.

Unfortunately there are specimens such as three taken by the 'Te Vega' at East St John's, Singapore (fig. 10b), in which the division series are slightly scalloped at the edges but the very large P_2 has more than 25 segments and its tip is slender and could be described as flagellate. One of the three from Singapore has less disparity between P_2 and the other basal pinnules than in the two other specimens

and this inclines me to identify all three as *Lamprometra palmata*. [However, it should be noted that a fourth specimen from St John's, though taken by a different collector (J. Kelts) and separately preserved, is undoubtedly referable to *Stephanometra indica protecta* (sensu A. H. Clark) having markedly scalloped, though blunt, flanges on the division series and P_2 perfectly straight, stiff throughout and with only twelve segments.] Four rather similar specimens from the sudanese Red Sea in the British Museum collections (fig. 9e and f) add a further problem, however; they have P_2 relatively huge, especially on arms based on IBr series, inclined inwards over the disc and stiff for the proximal two-thirds but slender and slightly flexible distally and again with more than 25 (26-32) segments; also the division series are slightly scalloped, their ventro-lateral flanges being fairly well developed but the edges of these not perfectly straight. In one of the four, P_3 is almost as stout and as long as P_2 but in the rest it is markedly smaller. These specimens are also remarkable for having distinct keels on the proximal pinnules along the edge facing the arm tip, as in *Lamprometra palmata gyges*, as opposed to *L. klunzingeri*, according to A. H. Clark. Despite this, the relatively large size of P_2 and the form of the division series, it seems impossible to me to identify these specimens as anything other than *L. klunzingeri*, if that is to be recognized as distinct from *L. palmata*, the fauna of the Red Sea being so restricted. In A. H. Clark's key, *L. klunzingeri* is supposedly distinguished from *L. palmata palmata* by having P_2 neither markedly stouter than the other proximal pinnules, nor with the proximal segments of the early pinnules more than very slightly carinate. This single sample simultaneously negates the validity of both these distinctions.

Unfortunately the British Museum collections have only a poor representation of the species of *Liparometra* and *Dichrometra*, which should certainly be included in any detailed revision of the relationships within the family Mariametridae, so it seems better to defer such a revision to another occasion.

A new species of *Dichrometra* is described below, being necessitated by the unusual arrangement of the division series, not by any difference in the proximal pinnules.

Dichrometra afra A. H. Clark

(fig. 7)

Dichrometra flagellata var. *afra* A. H. Clark, 1912g : 23-24.

Dichrometra afra A. H. Clark, 1913 : 31; 1941 : 558-562, pl. 58, figs 269, 270.

Liparometra multicroca H. L. Clark, 1923 : 232-233, pl. 8, fig. 2.

Liparometra sp. A. M. Clark in Humes & Ho, 1970 : 7, 11.

MATERIAL. 'Anton Bruun' cruise 8, st. 400C, 20°30'S : 35°43'E (off Beira, Mozambique), 62 metres; 2 specimens.

Prof. A. G. Humes' no. 1082, off Pte Lokobe, Nosy Bé, Madagascar, 15 metres; 1 specimen. B.M. reg. no. 1969.5.13.114.

Prof. Humes' no. 125I, c. 13°29'S : 48°10'E (near Nosy Bé), 23-27 metres, M/V 'Vauban'; 1 specimen. 1969.5.13.115.

Prof. Humes' no. 1336, W. of Ambatoloaka, Nosy Bé, 35 metres; 1 specimen. 1969.5.13.116.

DESCRIPTION. Some numerical details of the specimens are given in Table 3.

The diameter of the centrodorsal is 3.8 mm in the smaller specimen from st. 400C and 4.5 mm in the specimen from Ambatoloaka. The dorsal spines on the cirri begin as a raised keel, sometimes interrupted slightly in the middle of its length giving the dorsal profile a double peak, or else the projection is 'roman-nosed', the high bridge diminishing on the distal segments.

The first IIIBr, or IVBr series when present, to appear are external in position, the corresponding internal (or adradial) series only appearing subsequently. All the division series are of two ossicles and have slightly rugose lateral projections which form a continuous straight-edged lateral flange each side of the post-radial series. The dorsal surface of the division series and arm bases is smooth and there are low rounded synarthrial tubercles just distinguishable.

The relative proportions of the proximal pinnules are very variable, possibly to some extent correlated with the maturity of the individual arms. P_3 is either similar to P_2 or slightly longer and stouter, sometimes distinctly so, or conversely it may be shorter. The first six or seven segments are not appreciably longer than broad but the rest are somewhat elongated though probably all not more than twice as long as broad. Specimen no. 1969.5.13.114 has only immature external arms based on IIIBr series with intact proximal pinnules and here P_3 is distinctly smaller than P_2 ; this is also true on an external arm based on a IIBr series.

REMARKS. Owing to the similarity between P_2 and P_3 , which contradicts A. H. Clark's diagnosis of *Dichrometra*, I made the same mistake with this species as H. L. Clark (1923) in my preliminary determination of Professor Humes' specimens

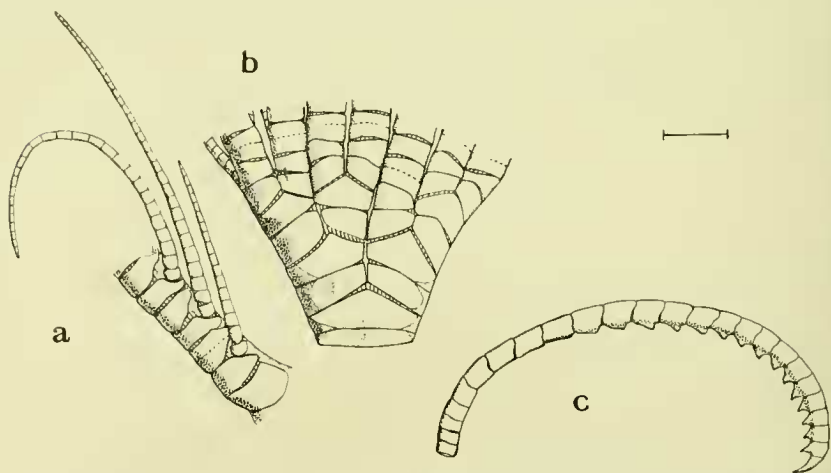


FIG. 7. *Dichrometra afra* A. H. Clark. B.M. reg. no. 1969.5.13.116, Nosy Bé, Madagascar. Arm br 1.3 mm (after IIIBr series). a. side view of first eight brachials showing P_1 to P_3 of an external arm; b. dorsal view of one post-radial series; c. mature cirrus. [The scale equals 2 mm.]

as referable to *Liparometra*. Further study indicates that his two specimens which I formerly labelled '*Dichrometra* sp. ?*afra*' should be referred to a distinct species, described below, leaving the present specimens instead attributable to *D. afra*. This is in spite of A. H. Clark's statement in his key (1941 : 538, d¹) that P₂ and P₃ are 'composed of segments most of which are not longer than broad'. Although these segments of these pinnules are relatively short, this is an exaggeration, at least for the specimens I have seen, those from Madagascar approximating to the type-locality. As for the relative lengths of these pinnules, in the holotype of *D. afra* P₃ is only 5% longer than P₂ and in the holotype of *Liparometra multicirra*, which A. H. Clark reckons is a synonym of *D. afra*, P₃ is similar to or smaller than P₂. P₃ is also smaller in the two specimens from 'Anton Bruun' st. 400C which, like the holotype of *L. multicirra* (from off northern Natal) came from the vicinity of the African mainland rather than from Madagascar. It is interesting that all three of these show cirri of relatively large size and more segments than the specimens from Madagascar but much more material is needed to clarify the range of variation in these characters.

In comparison with the specimens from Madagascar which I have called *Lamprometra klunzingeri*, the main differences are that *D. afra* has better developed dorsal spines on the distal cirrus segments and P₂ and P₃ not markedly dissimilar whereas in *L. klunzingeri* P₃ is much smaller. It seems to me that these characters are hardly of generic weight, especially in view of the considerable variation in the relative proportions of the proximal pinnules throughout this family. A detailed assessment of the affinity of the type-species of *Dichrometra*, *Lamprometra* and *Liparometra* is needed on the basis of large samples. Certainly if *Dichrometra afra* is to be retained in that genus then the species of *Liparometra* should also be referred to *Dichrometra*, which is the oldest of the three generic names.

COMMENSALS. The copepods *Pseudanthessius major* and *minor* were found associated with the specimens from Madagascar, as also with the following species of *Dichrometra* and *Lamprometra klunzingeri* as well as the himerometrin *Heterometra africana*.

*Dichrometra austini** sp. nov.

(fig. 8)

Dichrometra sp. ?*afra* A. M. Clark in Humes & Ho, 1970 : 7, 11, 13. [Non *D. afra* A. H. Clark.]

MATERIAL. Prof. A. G. Humes's no. 802, Ambariobé, near Nosy Bé, Madagascar, 6-8 metres; 1 fragmented specimen. B.M. reg. no. 1969.5.13.112.

Prof. Humes's no. 876, Ambariotelo, near Nosy Bé, 2 metres; the holotype. B.M. 1969.5.13.113.

DIAGNOSIS. A species of *Dichrometra* in which the IIIBr series develop first internally on the post-radial series, not externally, the ossicles of the division series have individual ventro-lateral rounded processes not forming a continuous lateral

*Named after Austin H. Clark.

flange and the distal cirrus segments are simply carinate dorsally, without spines. In comparison with the sympatric *D. afra* also P_3 is notably stouter relative to P_2 .

DESCRIPTION. Some numerical details of the holotype and paratype are given in Table 3.

The centrodorsal is 5.3 mm in diameter and c. 1.8 mm high with the slightly concave dorsal pole 2.6–2.9 mm in diameter. The irregularly-placed cirri are two or three deep around the sides. The seventh cirrus segment is approximately the longest, measuring 1.2 mm in length while length : median breadth is 1.2 : 1. After about the tenth segment a low median dorsal keel begins to develop, at first straight but becoming convex in profile on the shorter distal segments. The opposing spine and terminal claw are relatively small in comparison with those of *D. afra*.

The length from the proximal edge of the $I\text{Br}_1$ to the syzygy at Br_{3+4} , including I, II and IIIBr division series, is 8.4 mm. All the division series are of two ossicles. Synarthrial tubercles are barely appreciable but laterally the axillaries have abruptly projecting short rounded flanges externally and the IIIBr_1 and Br_1 have similar ventro-lateral projections for most of their lengths but rounded off at the ends so that the resultant flange is discontinuous. Internally the pairs of ossicles following each axillary are contiguous for two-thirds of their lengths and then diverge abruptly so that the arms are separated from each other basally, unlike those of *D. afra* which are closely contiguous. All five of the IIIBr series present are internal in

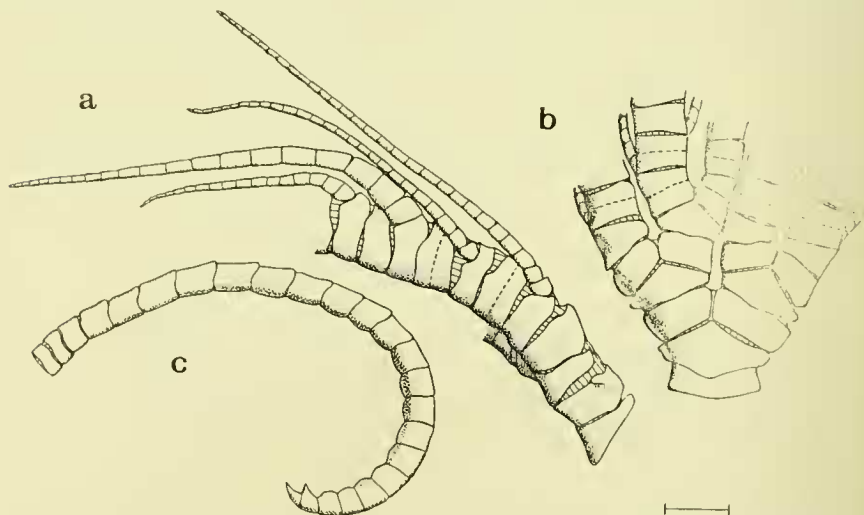


FIG. 8. *Dichrometra austini* sp. nov. Holotype. B.M. reg. no. 1969.5.13.113, Nosy Bè, Madagascar. Arm br 1.7 mm (after IIIBr series). a. side view of proximal part of a post-radial series from IBr_2 to Br_{10} (including a IIIBr series) showing P_1 to P_4 ; b. dorsal view of proximal part of one post-radial series; c. mature cirrus. [The scale equals 2 mm.]

Numerical values except where marked

Specimen	P ₃		P ₄	
	Segs.	Length	Segs.	Length
<i>Dichrometra afra</i>				
Holotype	24	10	—	—
1969.5.13.115	34	17.4	20	7.6
	—	—	21	8.7
1969.5.13.116	29	11.3	17	11.0
1969.5.13.114	—	—	—	—
'Liparometra multicir	= or < P ₂		= P ₁	
'A.B.' st. 400C	c. 20*	c. 11	smaller	
'A.B.' st. 400C	? = P ₁ +		—	—
<i>Dichrometra austini</i>				
Holotype	21†	13.7	16†	7.4
Paratype	c. 17	c. 14	—	—
	c. 20†	c. 13.5	15†	5.5
<i>Dichrometra ciliata</i>				
Syntypes	31	18.5	12	11.5
'A.B.' st. 22A	22	12.1	19	8.2
<i>Lamprometra klunzingeri</i>				
1969.5.13.83	15	4.5	14	3.4
	—	—	14	3.2
1969.5.13.82	14	3.4	11	2.9

* Pinnules from arm

† Pinnules from arm

** Quadriradiate specimen

TABLE 3

Numerical data from some specimens of *Dichrometra* and *Lamprometra*, that from the arms taken from arms based on III Br series except where marked

Specimen	Arms		Br at 3 + 4	Cirri					Pinnules							
	No.	Length		No.	Segs.	Length	1st seg. with 'spine'	I : br longest seg.	P ₁		P ₂		P ₃		P ₄	
								Segs.	Length	Segs.	Length	Segs.	Length	Segs.	Length	
<i>Dichrometra afra</i>																
Holotype	29	c. 85	—	XX	29	18	9, 10	1 > br	25	8	25	9.5	24	10	—	—
1969.5.13.115	c. 27	100	1.5	c. XXXV	28	23	9	1.5 : 1	—	—	34	15.8	34	17.4	20	7.6
									21	7.4	26	9.7	—	—	21	8.7
1969.5.13.116	c. 36	c. 85	1.3	XLV	25	18	9	1.5	18	6.1	33	10.5	29	11.3	17	11.0
1969.5.13.114	c. 25-30	c. 55	0.9	c. XXVII	24	12.5	9, 10	1.5	—	—	—	—	—	—	—	—
'Liparometra multicirra'	c. 50	c. 85	—	XLIII	36	—	10, 11	l = br(+)	21	10	26	13	= or < P ₂		= P ₁	
'A.B.' st. 400C	c. 45-50	c. 70	1.2	c. XL	42	32	13	1.05	21*	9.0	24*	14.2	c. 20*	c. 11	smaller	
'A.B.' st. 400C	41	c. 45	1.1	XXXVI	31	22	11	1.3	15	5.8	19	9.5	? = P ₁ +		—	—
<i>Dichrometra austini</i>																
Holotype	25	130	1.7	c. XL	25	23	—	1.2	30†	13.7	26†	12.1	21†	13.7	16†	7.4
Paratype	22+	c. 100	1.5	XLIV	26	24	—	1.4	24	10.8	c. 20	c. 14.5	c. 17	c. 14	—	—
									c. 24†	—	23†	12.6	c. 20†	c. 13.5	15†	5.5
<i>Dichrometra ciliata</i>																
Syntypes	34-42	110-120	—	XXXVII	29-35	30	10-13	—	29	11.5	34	17	31	18.5	12	11.5
'A.B.' st. 22A	c. 40	c. 110	1.4	c. XXX	39	c. 35	11, 12	1.3	25	8.2	27	10.3	22	12.1	19	8.2
<i>Lamprometra hlunzingeri</i>																
1969.5.13.83	29	c. 70	1.2	c. XXXV	25	14	10	1.4	27	6.8	28	11.0	15	4.5	14	3.4
									25	6.8	24	9.0	—	—	14	3.2
1969.5.13.82	31**	c. 60	1.1	XXXVII	23	13.5	10	1.2	22	6.8	25	9.5	14	3.4	11	2.9

* Pinnules from arm based on IVBr series.

† Pinnules from arm based on IIBr series.

** Quadriradiate specimen with only four IBr series.

position, two of them occurring on the same post-radial series, which is symmetrical.

The first two pinnules are slender with basal breadth c. 0.7 mm, or P_2 may be slightly broader; P_3 is markedly stouter, the first segment c. 1.0 mm broad, but the total length is not appreciably greater than that of the previous pinnules, in fact P_2 may be the longest. However, P_4 is much shorter. On the inner side, P_b is nearly always markedly stouter than P_c , while on internal arms P_2 is more often than not the stoutest.

The disc has been lost.

The whole animal is notably smooth in all its ossicles.

The paratype consists of a centrodorsal with two incomplete post-radial division series, one of which has both internal and external IIIBr series one side; the arms are all detached from their bases. A separate post-radial series with four arms attached has two internal IIIBr series but none external. The centrodorsal is 4.7 mm in diameter and the dorsal pole about 2.4 mm. There were XLIV cirri but no intact ones remain attached. Five loose cirri have 24 segments and another has 26; the development of keels on the distal segments is just like that in the holotype.

P_1 on the single external arm on the detached post-radial series has 18+ segments; it is curled round between two arms but is probably only about two-thirds the length of P_2 which is much stouter with 23 segments, very attenuated distally and with basal breadth 0.85 mm compared with P_3 , the basal breadth of which is 0.70 mm. The segment numbers and lengths of these pinnules are the second series given in Table 3. One other detached arm which may also have been external in position (it has a division series still attached) has P_3 distinctly stouter basally than P_2 while three other loose arms have P_2 and P_3 similar in size. However, eleven more loose arms have P_2 markedly the largest pinnule; in one, P_2 with c. 20 segments is c. 15.5 mm long with basal breadth 0.95 mm, corresponding with a P_3 having only 13 segments, measuring 5.8 mm, with basal breadth 0.70 mm. Possibly all such arms were internal in position.

The colour of the paratype in life is given as brownish with alternating dark reddish brown and cream bands on the arms.

AFFINITIES. The development of IIIBr series internally rather than externally in both specimens sets this species aside from all the other members of the Mariametridae and possibly could justify a generic separation, though A. H. Clark (1941 : 439) mentions a specimen of *Stephanometra indica*, also from Madagascar, with internal not external IIIBr series. In Gislén's analysis of the arm ramification of the recent comatulids (1934 : 25) *D. austini* would fall into section 41, characteristic only of the thalassometrid *Stylometra spinifera* and some species of the charitometrid genus *Crinometra*, whereas most of the mariametrids (but also two thalassometrids and some representatives of other families) fall into sections 42 and 43 with IIIBrs external or both external and internal.

In comparison with *Dichrometra afra* and *Lamprometra klunzingeri*, *D. austini* may also differ in the simply carinate distal cirrus segments without any sort of spines and the individual rounded ventro-lateral processes on the division series coupled with the separated arm bases. In fact the processes on the division series

resemble those of *Stephanometra* but that genus is distinguished by the erect, stiffened form of P_2 and sometimes also P_3 .

COMMENSALS. The copepods *Pseudanthessius major* and *minor* were both associated with this species as well as with *D. afra*, *Lamprometra klunzingeri* and *Heterometra africana*.

Dichrometra ciliata A. H. Clark

Dichrometra ciliata A. H. Clark, 1912a : 319-320; 1932 : 558; 1941 : 565-566, pl. 57, figs 263, 264, pl. 58, figs 265-268.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, $07^{\circ}34'N$: $98^{\circ}00'E$ (between Malaya and the Nicobar Islands), 77 metres; 1 small specimen.

'Anton Bruun' cruise 1, st. 22A, $10^{\circ}37'N$: $97^{\circ}34'E$ (SW of the Mergui Archipelago, Burma), 75-80 metres; 1 specimen.

'Anton Bruun' cruise 1, st. 36A, $13^{\circ}00'N$: $97^{\circ}41'E$ (off Cape Tavoy, S Burma), 68 metres; 1 small specimen.

REMARKS. Details of the specimen from station 22A are given in Table 3 facing p. 100. The two smaller specimens both have an arm length of c. 35 mm, which probably accounts for the fact that P_3 is similar to or, more often, smaller than P_2 . There are up to 21 cirrus segments, with fairly large nose-like dorsal spines from about the eighth one. The large specimen has the pinnules very variable; in series other than the one included in the table, P_1 has 23, 26 or 27 segments, in the last case the length being 0.5 mm and a P_4 has 24 segments and is 11.8 mm long.

Lamprometra klunzingeri (Hartlaub)

(fig. 9)

Antedon klunzingeri Hartlaub, 1890 : 175; 1891 : 46-47, pl. 2, figs 22, 25.

Lamprometra klunzingeri: A. H. Clark, 1909b : 144; 1929 : 641; 1937 : 89; 1941 : 527-536, pl. 55, fig. 256; Tortonese, 1953 : 26-27, pl. 1, fig. 1; A. M. Clark, 1967a : 28-29; A. M. Clark in Humes & Ho, 1970 : 6, 11.

MATERIAL. 'Anton Bruun' cruise 8, st. 412D (RU 180), $12^{\circ}46'S$: $47^{\circ}45'E$ (NW of Madagascar), 44 metres; 1 specimen, poorly preserved.

Prof. A. G. Humes's no. 690, Pte Ambarionaomby, Nosy Komba, near Nosy Bé, Madagascar, 1 metre; 1 specimen. B.M. reg. no. 1969.5.13.82.

Prof. Humes's no. 1372, opposite Antsiabe, Nosy Komba, 13 metres; 1 specimen. 1969.5.13.83.

DESCRIPTION. Humes's no. 690 is unusual in being quadriradiate, each of three rays having as many as eight arms, including one external IVBr series, while the fourth has seven. All three specimens are rather slender and the arms and division series are not closely flattened against each other basally, though many other specimens of *Lamprometra* do also show this condition, contrary to A. H. Clark's diagnosis. The lateral spacing is of course particularly noticeable in the quadriradiate

specimen, though the division series fan out sharply to take up the space. In comparison with the other *Mariametrinae* from Madagascar now under study, the dorsal spines of the distal cirrus segments are low and blunt, smaller than those of *Dichrometra afra* but more asymmetrical in profile than the low keels of *D. austini*. However, the cirri of *Lamprometra palmata* are very variable and this may well be true also in *L. klunzingeri*.

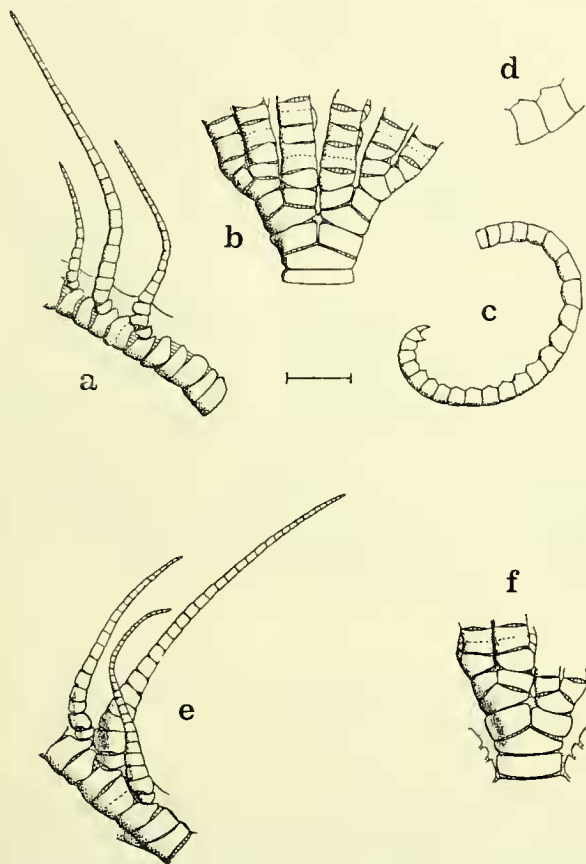


FIG. 9. *Lamprometra klunzingeri* (Hartlaub). a-d. B.M. reg. no. 1969.5.13.83, Nosy Komba, Madagascar. Arm br 1.0 mm. a. side view of proximal part of one post-radial series from IIBr₁ to Br₇ showing P₁ to P₃; b. dorsal view of proximal part of one post-radial series; c. mature cirrus with d. segments 19 and 20 enlarged; e and f. B.M. reg. no. 1951.5.7.17 (pt.), Sudanese Red Sea. Arm br 1.15 mm (after IBr series) or 1.05 mm (after IIBr series). (Specimen with P₂ especially large.) e. side view of proximal part of one post-radial series from IBr₂ to Br₇ showing P₁ to P₃; f. dorsal view of proximal part of one post-radial series, the IIBr₂ and following ossicles on the right regenerating. [The scale equals 2 mm for a-c, e and f but 1 mm for d.]

AFFINITIES. As noted in the discussion of the family Mariametridae, *Lamprometra palmata* and *klunzingeri* are poorly distinguished from one another. A. H. Clark (1941) gives a key to no less than sixteen named forms of *L. palmata* (including the subspecies *gyges*), most of them supposedly distinguished only by rather small variations in the shape and size of the proximal pinnules. Also, apart from the geographical isolation of *L. klunzingeri* around the Arabian peninsula, he could only distinguish it from *L. palmata* by P_2 being neither keeled basally nor markedly stouter than P_1 and P_3 , neither of which characters is completely reliable, as already noted. In an analysis of the geographical distribution of Indo-West Pacific echinoderms from shallow water (down to c. 20 m), of nearly 1000 species of the other four major groups, more than 5% extend throughout the area, from the Red Sea and SW Indian Ocean to the South Pacific and Hawaiian Islands but not a single one of the 138 nominal species of crinoids represented has such a wide distribution. I think this is a false picture and may be attributed to undue weighting of certain characters by A. H. Clark resulting in fragmentation of a number of species, including *Lamprometra palmata*, to the synonymy of which *L. klunzingeri* should probably be referred.

RANGE. These records extend the known range of *Lamprometra* to the southwest Indian Ocean, although *L. klunzingeri* was provisionally recorded from Zanzibar by A. H. Clark (1929) on the basis of a small specimen in the British Museum collections. This specimen has $2I + 2$ or 3 arms c. 40 mm long and its cirri agree with those of *L. klunzingeri*. Most of the pinnules are broken but P_3 appears to have been distinctly smaller than P_2 so that it agrees best with this species. The same may well be true of the broken specimen from Dar-es-Salaam in the Berlin Museum recorded by A. H. Clark in 1912 without realizing that the locality was outside the Red Sea. The Zanzibar specimen has an unusual anomaly in that one P_2 is triple, three pinnules arising from the same brachial.

Lamprometra palmata palmata (J. Müller)

(fig. 10a-e)

Alecto palmata J. Müller, 1841 : 185.

Lamprometra palmata : A. H. Clark, 1929 : 641 ; 1932 : 557-558, pl. 19, fig. 9; Gislén, 1940a : 10; A. H. Clark, 1941 : 474-517, pl. 53, figs 243-246, pl. 54, figs 248-252, pl. 55, fig. 257.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, $07^{\circ}34'N$: $98^{\circ}00'E$ (between Malaya and the Nicobar Islands), 77 metres; 1 specimen.

'Anton Bruun' cruise 1, st. 47B, $19^{\circ}50'N$: $92^{\circ}55'E$ (off Akyab, Burma), 22-30 metres; 6 specimens.

'Te Vega' cruise 2, $01^{\circ}14'N$: $103^{\circ}51'E$ (East St John's, Singapore), 'sublittoral'; 3 specimens.

The specimen figured and the other two from Singapore have the division series widely separated laterally and not much flattened. Also the very large P_2 is usually

inclined proximally over the disc and stiffened in the basal part, though flagellate distally and with about 30 segments, affiliating them with *Lamprometra* rather than *Stephanometra* with its straight tapering P_2 .

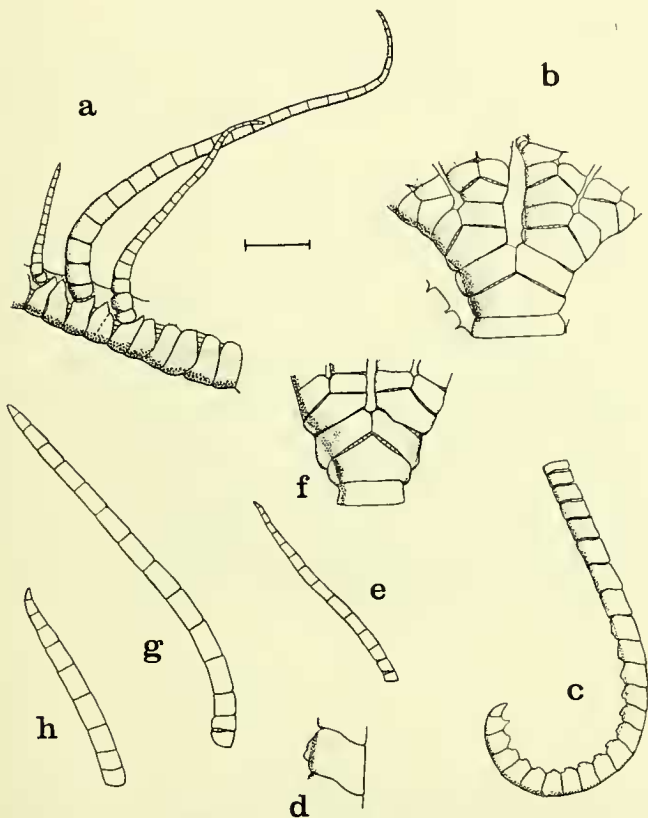


FIG. 10. a-e. *Lamprometra palmata palmata* (J. Müller). a-d. 'Te Vega' cruise 2, E St John's, Singapore. Arm br 1.4 mm (after IIBr series). a. side view of proximal part of one post-radial series from IIBr₁ to Br₇ (including a IIBr series) showing P₁ to P₃; b. dorsal view of proximal part of one post-radial series; c. mature cirrus with d. segment 13 enlarged; e. B.M. reg. no. 1902.3.13.46, Muhlos, Maldive Is. Arm br 1.15 mm (after IBr series). P₂ from arm based on IBr series; f-h. *Stephanometra indica* (Smith); f. 'Te Vega' cruise 2, E St John's, Singapore. Arm br 1.25 mm (after IIBr series), dorsal view of proximal part of one post-radial series; g. holotype, B.M. reg. no. 76.5.5.24, Rodriguez. Arm br 1.4 mm (after either IIBr or IIBr series), external P₂ from arm based on IIBr series. (Internal P₂s may be slightly larger with up to 17 segments, as described by Smith.) h. 'Anton Bruun' st. 412D, NW Madagascar. Arm br 1.25 mm (after IIBr series), P₂ from arm based on IIBr series. [The scale equals 2 mm for a-c and e-h but 1 mm for d.]

Mariametra vicaria (Bell)

Antedon vicaria Bell, 1894 : 400.

Mariametra vicaria: A. H. Clark, 1912a : 142-143; 1941 : 573-579.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Islands), 77 metres; 1 specimen.

'Anton Bruun' cruise 1, st. 22A, 10°37'N : 97°34'E (SW of the Mergui Archipelago, Burma), 75-80 metres; 14 specimens.

DESCRIPTION. Numerical details of seven specimens are given in Table 4. The maximum arm length and number of cirrus segments exceed the 65 and 36 given by A. H. Clark.

The centrodorsal is low but convex, though the dorsal pole is more or less flat. I think the shape of the whole ossicle is better described as flattened hemispherical rather than discoidal. The longest cirrus segments, about the seventh, have length : median breadth 1.35-1.65 : 1 and are distinctly constricted medially and flared distally. Dorsal spines develop from about the thirteenth segment; those on the short distal segments are sharp.

III Br series are usually, but not exclusively, external. The ossicles of the division series and brachials are all abruptly flared with spinose distal edges, even at the syzygies; also the purple mid-line along each arm is raised above the rest of the surface, whereas in the holotype the profile is relatively smoother and the mid-line flush, though other specimens described by A. H. Clark also have everted, more or less spinose or rugose, ossicles. The division series are wall-sided and their lateral parts are particularly spinose but this lessens dorsally. A rugose or spinose texture extends on to the centrodorsal around the cirrus sockets.

The pinnules are rather variable in relative proportions, as usual in this family. P₁ may have as many as 20 segments.

TABLE 4

Numerical data from specimens of *Mariametra vicaria*, the arm breadth taken from arms based on II Br series and the pinnule data from similar arms except where marked *, which measurements are from arms based on III Brs

Arms			Cirri			Pinnules					
No.	Length	Br at	No.	Segs.	Length	P ₁		P ₂		P ₃	
		3 + 4				Segs.	L.	Segs.	L.	Segs.	L.
26	c. 60	1.0	XXIV	41	21	18*	5.8	23*	7.6	c. 23*	11.6+
c. 28	c. 55	1.1	XXV	40	20	16	5.0	16+	7.0+	21	11.8
21	c. 60	1.2	XX	39	21	18	4.5	19	8.2	21	10.5
27	c. 65	1.1	XXII	43	22	17	5.5	16	6.8	17	10.0
25	—	1.2	XIX	43	22	—	—	—	—	—	—
c. 26	70	1.2	XXVI	42	22	17	5.8	18	8.2	19	10.5
23	80-90	1.2	XX	44	23	13*	3.2	13*	3.7	c. 22*	13.7

Stephanometra indica (Smith)

(fig. 10f-h)

Comatula indica Smith, 1876 : 406; 1879 : 564, pl. 51, figs 3, 3b [not 3a].*Stephanometra indica* : A. H. Clark, 1911b : 26; 1913 : 29; 1937 : 88-89; A. M. Clark in Humes & Ho, 1970 : 6, 12.*Stephanometra indica indica* : A. H. Clark, 1941 : 436-443, pl. 51, figs 233, 234.*Stephanometra indica protectus* : A. H. Clark, 1941 : 443-459, pl. 49, fig. 222, pl. 50, figs 225-230, pl. 51, figs 231, 232.

MATERIAL. 'Anton Bruun' cruise 8, st. 412D, 12°46'S : 47°45'E (NW of Madagascar), 44 metres; 1 specimen.

'Anton Bruun' cruise 9, st. RU 296, 12°30'S : 45°16'E (inner side of Bandeli Reef, Mayolta Islands, Comoro Islands), c. 1 metre; arms detached.

'Te Vega' cruise 2, 1°14'N : 103°51'E (E St John's, Singapore), 'sublittoral', rock and coral; 1 specimen.

'Te Vega' st. FZ 64-20, 06°55'28"N : 73°11'55"E (N end Filadu Island, Tiladummati Atoll, Maldive Islands), 0-1 metre; 1 specimen.

Prof. A. G. Humes's no. 932, E of Pte Ambarionaomby, Nosy Komba, near Nosy Bé, Madagascar, 6 metres; 1 specimen. B.M. reg. no. 1969.5.13.18.

Prof. Humes's no. 1139, Antsiabe, S shore of Nosy Komba, 2 metres; 1 specimen. 1969.5.13.19.

Prof. Humes's no. 1303, pass between Nosy Komba and Nosy Bé, 17 metres, on sponge; 1 specimen. 1969.5.13.111.

Prof. Humes's no. 1371, opposite Antsiabe, 13 metres; 1 specimen. 1969.5.13.110.

Dr J. D. Taylor, S of East Channel, Aldabra Island; 1 specimen. 1969.5.1.124.

Mr W. Humphreys, off Settlement, Aldabra, night; 1 specimen. 1971.3.2.2.

DESCRIPTION. The specimen from 'Anton Bruun' station 412D has P_2 particularly stout (fig. 10h) with only 10 segments of which the fourth, fifth and sixth are especially large and the last four segments taper rather abruptly in the only intact external P_2 (which is slightly bent at the penultimate segment in preservation but was probably quite straight in life). This form of P_2 is very like that supposed to be characteristic of *S. indica protectus* (Lütken in P. H. Carpenter), according to A. H. Clark (1941 : 409), which subspecies ranges westwards only to the Maldive Islands. In the holotype of *S. indica* from Rodriguez, an intact external P_2 (fig. 10g) with 15 segments is rather more elongated but still quite stout and with the last three segments tapering fairly abruptly and hardly 'slender and delicate' as given in A. H. Clark's key to *S. indica indica* (as opposed to *protectus*). On account of these specimens I am inclined to doubt whether it is worthwhile retaining the subspecies *protectus* (or *protecta* if its gender is matched with that of *Stephanometra*), which in any case was very ill-founded nomenclatorially. It dates from a quote by P. H. Carpenter (1879 : 19) of a passage from an MS of Lütken's noting that the oral pinnules in *Antedon* are 'only slightly differentiated from the others, or are transformed into strong rigid spines, forming a protective covering over the disc [*A. protectus*, mihi]'. This statement might equally well apply to a species such as *Himerometra martensi* and is completely inadequate on its own to identify the

species concerned. Also subsequent examinations of specimens from Tonga distributed by the Godeffroy Museum and the basis of Lütken's *Antedon protectus*, have shown that some of them at least, like the one in the British Museum collections, are referable to *Lamprometra palmata* and not to *Stephanometra* at all. However, in 1881 (p. 192) P. H. Carpenter noted that his new species *Antedon* (now *Stephanometra*) *spicata* 'is closely allied to the Fijian *Antedon protecta* Lütken MS which has nearly 50 cirri, smoother arm joints, and a relatively smaller pinnule on the fifth brachial', and this does serve to narrow down the identity of the species, though the quote of 1879 may be considered as supplying sufficient indication to establish the name from that date. If the Malagasy and some other western Indian Ocean specimens can be referred to *S. indica protecta* then the geographical range of that subspecies becomes co-extensive with the range of *S. indica indica* and I think the rank should be even less than subspecific.

Of the present specimens, the two collected by the 'Te Vega' may both be referred to *protecta* but the remaining specimens have P₂ more gradually tapering, quite straight and usually erect but sometimes appressed to the arm and inclined distally, though probably only in preservation; it has 15-17 segments.

The colour of specimen RU 296 in life was black and yellow.

COMMENSALS. The copepods *Pseudanthessius angularis* and *major* were associated with Professor Humes's specimens from Madagascar; the latter was also found on *Lamprometra klunzingeri*, *Dichrometra afra* and *austini*, as well as *Heterometra africana* and *Cenometra emendatrix* but the former only on *D. austini*.

Stephanometra spicata (P. H. Carpenter)

Antedon spicata P. H. Carpenter, 1881 : 190-192; 1889 : 310-311, pl. 27, figs 3-5.

Stephanometra spicata: A. H. Clark, 1911d : 183; Gislén, 1936 : 11-12; A. H. Clark, 1941 : 424-436, pl. 49, figs 223, 224.

MATERIAL. 'Te Vega' cruise 2, st. 65, Pulau Hantu, SW of Singapore, intertidal; 4 specimens.

Family HIMEROMETRIDAE

Amphimetra mollerii (A. H. Clark)

Himerometra mollerii A. H. Clark, 1908a : 222.

Amphimetra mollerii: A. H. Clark, 1910 : 156; Gislén, 1936 : 10; A. H. Clark, 1941 : 349-358, pl. 38, figs 169-171.

MATERIAL. 'Anton Bruun' cruise 1, st. 20, 09°13'N : 97°51'E (SW from Mergui Archipelago, Burma), 58-60 metres; 7 specimens.

DESCRIPTION. These specimens have been referred to *Amphimetra mollerii* since they are certainly conspecific with another in the British Museum collections from NW of Penang which was determined as *A. mollerii* by A. H. Clark himself. Also this is the only member of the genus which has been recorded from within the

TABLE 5

Numerical data from specimens of *Amphimetra mollevi*, the last being derived from A. H. Clark's description of the holotype from the 'Indian Ocean'. The specimen marked * is B.M. no. 1923.8.28.4, from NW of Penang. The cirrus measurements are in micrometer scale units, of which 19 = 1 mm. The distal cirrus breadth measurements include the height of the dorsal spine, which is 6 units or 0.3 mm in the fifth specimen listed.

Arms		Cirri				Pinnules											
Length	Br at	No.	Segs.	L.	L : br 8th seg.	L : br 10th from tip	1st seg. with spine	P ₁			P ₂			P ₃			
								Segs.	L.	Segs.	L.	Segs.	L.	Segs.	L.		
35 + c. 10	1.1	XVIII	29	13	11 : 14 = 1 : 1.3	8 : 15.5 = 1 : 1.9	9	15	4.7	15	5.8	15	5.8	c. 10	c. 4.0		
22 + c. 15	1.2	XV	28	15	12.5 : 18	9 : 18.5	8	15	6.0	13	5.2	13	5.2	13	4.2		
40 + c. 20	1.6	XX	—	—	13.5 : 22	11 : 24	(7)	20	7.1	15	7.1	12	5.2	12	5.2		
40 + c. 20	1.8	XX	32	23	14 : 25	13 : 28	8	15	5.8	16	7.6	14	4.7	14	4.7		
60 + c. 25	2.2	XXII	35	28	16 : 32	15 : 32	10	20	9.0	16	10.3	16	9.2	16	9.2		
70 + c. 25	2.5	XXIV	35	30	18 : 39	15 : 35	11	19	9.0	17	10.5	15	9.5	15	9.5		
* 35 + +	3.0	XXII	36	30	18 : 28	9 : 18.5	11	23	11.0	22	13.2	22	11.6	22	11.6		
50 + +	3.2	XXVI	43	40	18 : 33	14 : 31	13	23	9.5	c. 22	c. 12.7	20	11.8	20	11.8		
115	—	XVI	37	20	c. 2		6	18	10	15	15	sim.	11	11	11		

Bay of Bengal, though *A. tessellata discoidea* and *A. ensifera* are known from Singapore. However, there are some respects in which they do not agree with A. H. Clark's key to the species of *Amphimetra* (1941: 346-347). Firstly *A. molleri* comes within the section having 'very flexible and more or less evenly curved cirri with the distal segments very slightly longer than the proximal ones', whereas the present specimens appear to have the cirri somewhat stiffer proximally than distally and the distal segments are usually slightly *shorter* than the proximal ones (see Table 5). The primary dichotomy in the key also depends on the stoutness of the cirri, which can be seen from the table to increase with size. The early position of the first cirral spine on the sixth segment in the holotype does not seem significant either since not only does A. H. Clark record other specimens with the first spine on about the eleventh segment but also the specimen from NW of Penang has the first spine absent from up to 14 segments, though its usual position is at about the tenth or eleventh. In general I think it unwise to put much faith in the precise form of the cirri as providing characters of specific weight in this genus and I think that some of the nominal species recognized by A. H. Clark will prove to be untenable. This is particularly true of *A. spectabilis* A. H. Clark, 1918, which is based on two large Philippine specimens with 45-51 cirrus segments, these being exceptionally broad with spines only from about the sixteenth, as would be expected in very large specimens of *A. molleri*.

HETEROMETRA A. H. Clark

Heterometra A. H. Clark, 1909d: 11; 1941: 225-235; A. M. Clark & Rowe, 1971: 21. [Type-species *Antedon quinduplicava* P. H. Carpenter, 1888.]

A. H. Clark made three attempts to draw up a satisfactory key to the 26 nominal species of this genus which he recognized, using mainly the following characters:

- Cirri*:
1. Number of segments.*
 2. Length: breadth of the proximal and/or distal segments.*
 3. Development of spines or tubercles on distal segments.
 4. Abruptness of appearance of spines or tubercles.
 5. Degree of taper.†
- Division series*:
1. Occurrence of III Br series of four ossicles.
 2. Ruggedness or convexity of surface.
- Arms*:
1. Number.†
 2. Relative length of brachials.*
 3. Obliqueness of articulations beyond the base.
 4. Smoothness of profile.
- Pinnules*:
1. Number of segments.*
 2. Stoutness.
 3. Development of basal keel facing the arm tip.†

4. Development of distal processes on the segments or prismatic form.†
5. Size of P_2 relative to P_3 .*
6. Size of P_1 relative to P_2 and P_3 .*

Some of these characters (marked *) are certainly modified during growth and others (shown by †) exhibit some degree of variation in specimens of similar size. It should help to clarify the interrelationships if data could be related more precisely to size. However, in a genus such as this where the multibrachiate condition prevails (i.e. the number of arms normally exceeds ten), can the arm length alone be used as the criterion of size still or should a further factor for the arm number be included? Table 6 shows numerical data derived from some specimens of *Heterometra* from the western part of the Indian Ocean including 14 specimens from Madagascar, which I am referring to *H. madagascarensis*. These 14 are arranged in the mean sequence derived from averaging the size sequences suggested by all but the last of the 17 columns, assuming that, apart from increases in the proportions and segment numbers, the relative breadth of the cirrus segments increases and the position of the first dorsal spine shifts distalwards in the later-developed cirri. These 14 specimens indicate that, in *H. madagascarensis* at least, the longest cirrus segments are at first longer than broad but become distinctly broader than long in more mature specimens. Also the length of P_2 relative to P_3 changes from larger to smaller.

It is significant that the specimen with the fewest but longest arms comes last in the average sequence. Since augmentation in arm number occurs by autotomy and regeneration of two arms in place of one, all but two of the arms in this eleven-armed individual are the original ones and have been able to develop uninterruptedly, whereas the 22-armed specimen has no original arms and the regeneration involved may well have served to retard the growth of the cirri, which are not disproportionately large although they do have more numerous segments. In this genus at least it therefore seems that arm number could be disregarded in size estimates.

Because of the discussions on interrelationships, the species of *Heterometra* dealt with here are not treated in alphabetical order but geographically, those from the western Indian Ocean, including *H. delagoae* and *H. madagascarensis*, first. These two species need to be compared with *H. africana*, recorded from the East African mainland and from Karachi, and *H. savignii* from the Red Sea, Persian Gulf and Gulf of Oman. Some measurements and counts from five specimens from Karachi determined as *H. africana* by A. H. Clark are given in Table 6 together with others from the few specimens available from East Africa. The Karachi specimens do not show any significant differences from the others in the characters tabulated, agreeing even in having P_3 consistently smaller than P_2 , unlike *H. madagascarensis*. The shape of the basal pinnules varies somewhat in these Karachi specimens, in some of them being very smooth, as in *Heterometra savignii*, with no trace of a secondary dorsal ridge in addition to the usual keel facing the arm tip, while in other specimens a dorsal ridge is quite distinct, as in most, but not all, of the specimens of *H. madagascarensis*. The segments of the proximal pinnules also have similar proportions

to those of *H. africana* from East Africa, in contrast to the corresponding pinnules of *H. savignii*, where the segments, especially of P_D and P_1 , are much more attenuated. Other differences from *H. savignii* include the flanged approximating division series of *H. africana*, those of *H. savignii* being more or less rounded laterally and widely separated, also *H. savignii* has distinctly more elongated cirrus segments, the longest ones with length : median breadth usually c. 1.5 : 1. The geographical limits between *H. africana* and *H. savignii* remain to be determined. A. H. Clark in 1912 recorded as *H. savignii* not only the specimens from Karachi but also some from the Straits of Ormuz (Hormuz) between the Persian Gulf and the Gulf of Oman, both of which he subsequently (1941) referred to *H. africana*. The Ormuz material had the longest cirrus segments 'from slightly longer than broad to slightly broader than long' and the division series 'in lateral contact with sharply flattened sides, which are produced . . .', both features agreeing with *H. africana*. However, Gislén (1940b) records as *H. savignyi** fourteen specimens from within the Persian Gulf, noting that these have 'rather long cirrus joints—though not as long as those which I have seen from the Red Sea—narrow arm bases and almost smooth proximal pinnules'.

A. H. Clark (1911b) also described briefly two further nominal species of *Heterometra* from East Africa in the vicinity of Zanzibar, each from a single specimen. These are *H. joubini* and *H. gravieri*.

The holotype of *Heterometra joubini* has 20 arms about 80 mm long and XXII cirri with as many as 39–43 segments and measuring c. 30 mm, even the longest cirrus segments are distinctly broader than long and the dorsal spines are blunt. This last character together with the large number of cirrus segments may serve to distinguish the species.

The holotype of *H. gravieri* has 19 arms also c. 80 mm long and XXVIII cirri with 36–39 segments but cirrus length only c. 21 mm; the cirri are also more slender than those of *H. joubini*, the longest segments distinctly longer than broad. P_3 is slightly smaller than P_2 , as it is also in *H. joubini*.

Several further species have been recorded (mostly by A. H. Clark) from the Maldive Islands and the west coast of India. These are *Heterometra flora* (A. H. Clark), *H. compta* A. H. Clark, *H. producta* (A. H. Clark) and *H. reynaudi* (J. Müller), though the two last I have explained (1966) are doubtful records. In addition *Heterometra ater* (A. H. Clark) (better as *atra*) from the Red Sea is not well known and needs to be included in any comparative survey with the other nominal species.

Heterometra delagoae Gislén

Heterometra africana var. *delagoae* Gislén, 1938b : 10–12, figs 8–11, pl. 1, fig. 3.

Heterometra delagoae : A. H. Clark, 1941 : 334–335.

MATERIAL. 'Anton Brunn' cruise 8, st. 403A, 19°09'S : 36°20'E (NE of Beira, Mozambique), 27–30 metres; 7 specimens.

* His spelling.

DESCRIPTION. Numerical data for three of the more nearly intact specimens is given in Table 6. Another arm of the first specimen detailed has P_1 to P_3 with only three-quarters as many segments and also only three-quarters the length (except for P_3 which is barely half as long) of the corresponding pinnules in the table, though the preceding P_D is similar. It is likely that this arm is chronologically younger than the first one though its length is about equal.

The number of arms is probably about thirty in all the specimens, which agrees with the type material. Also in contrast to *H. madagascarensis* the number of cirri is consistently greater, averaging c. XXX in comparison with XXI in the fourteen specimens from Madagascar seen. However, the specimen of *H. africana* from Wasin, Kenya, has likewise c. XXX cirri by my reckoning (including fractions for the immature ones according to size, whereas A. H. Clark's estimate of only XX ignores all but the fully-grown cirri). In relation to arm length there may also be a small difference in *H. delagoae* in the stoutness of the cirrus segments, the longest of which are 1.3-1.6 times as broad as long at an arm length of c. 80 mm, the median breadth of these segments being 1.1 mm, proportions only matched in the specimen of *H. madagascarensis* with arms 150 mm long, the specimens with arm length c. 80 mm having the cirrus breadth only c. 0.8 mm. However, further material may show that this difference is not consistent.

Heterometra madagascarensis (A. H. Clark)

(fig. 11)

Craspedometra madagascarensis A. H. Clark, 1911b : 23.

Heterometra madagascarensis: A. H. Clark, 1918 : 78; 1941 : 295-297, pl. 29, figs 120-122.

Heterometra africana: A. M. Clark in Humes & Ho, 1970 : 5, 11. [Non *H. africana* (A. H. Clark, 1911)]

MATERIAL. Professor A. G. Humes's nos. 1166, 1188, 1255, 1273, 1300, 1304, 1312, 1313, 1350-1352, 1361-1363, Madagascar: off Pte. Lokobe, Nosy Bé, 17 metres; near Ambatoloaka, Nosy Bé, 29 and 34 metres; N of Nosy Varona, near Nosy Bé, 18 metres and SW of Nosy Bé, 25 metres; 14 specimens, B.M. reg. nos. 1969.5.13.5-17 & 96.

I formerly identified these specimens for Professor Humes as *Heterometra africana* since they failed to run down to *H. madagascarensis* in A. H. Clark's key (1941 : 230-232) because that species is included there in section d², p. 231, with relatively small blunt spines on the cirri developing gradually, and then in section g², p. 232, which has cirrus segments longer than broad. These specimens show some variation in the development of the cirrus spines, which are quite large and pointed in some specimens and develop to their full size over only two or three segments. They are particularly prominent in the specimen with arm length 120 mm (see Table 6) which gives the data shown in Table 7 in comparison with the specimen from Wasin, Kenya, in the British Museum collections, identified as *H. africana* by A. H. Clark, which had arm length c. 100 mm.

TABLE 7

Comparison of spine development on the cirri of
Heterometra madagascarensis and *H. africana*

	Madagascar	Kenya
A. Cirrus length (mm)	25	18
B. Height of opposing spine	0.35	0.25
C. Remaining breadth of penultimate segment	1.00	0.70
D. Maximum cirrus breadth at fourth segment	1.30	0.95
A : B	72 : 1	72 : 1
A : C	25 : 1	26 : 1
A : D	19 : 1	19 : 1

The development of the opposing spine is directly proportional to that of the other dorsal spines on the distal segments and is clearly indistinguishable in these two specimens.

As for the relative length of the cirrus segments, A. H. Clark's key and diagnosis to *H. madagascarensis* are directly contradicted by his description of the holotype which gives the longest cirrus segments as 'from only slightly broader than long to

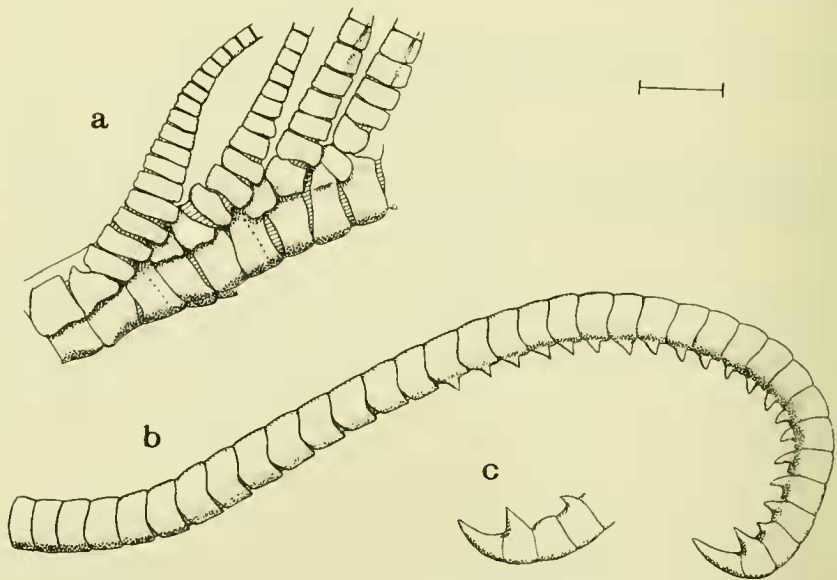


FIG. 11. *Heterometra madagascarensis* (A. H. Clark). B.M. reg. no. 1969.5.13.7, Nosy Bé, Madagascar. Arm br 2.1 mm (after IIBr series). a, side view of proximal part of one post-radial series from IIBr₁ to Br₇ showing P_D and P₁ to P₃; b, mature cirrus and c, tip of another cirrus without a spine on the antepenultimate segment. [The scale equals 2 mm.]

Species and locality	P ₂		P ₃		Lengths P ₃ : P ₂
	L.	Segs.	L.		
<i>H. africana</i>					
Zanzibar	7.4*	20*	8.9*		—
"	12.6	—	? similar		—
Wasin	—	24	12.6		—
Karachi	8.9	19	6.3		0.71 : 1
"	14.5	23	9.7		0.67
"	9.2	21	7.1		0.78
"	13.4	28	12.1		0.96
"	13.4	27	12.9		0.96
<i>H. delagoae</i>					
Mozambique	16.8	28	14.5		0.86
"	13.7	26	13.1		0.98
"	—	—	—		—
<i>H. madagascare</i>					
Madagascar	—	—	—		—
"	8.1	21	7.9		0.98
"	8.4	—	larger		—
"	—	23	8.7		—
"	10.8	c. 22	c. 10.5		c. 1.0
"	9.5	21	11.6		1.23
"	10.8	22	10.8		1.00
"	11.0	—	smaller		—
"	—	23	10.5		—
"	—	26	12.9		—
"	10.5	26	15.0		1.43
"	12.1	c. 27	14.2		1.18
"	15.3	—	larger		—
"	14.2	33	19.5		1.38

TABLE 6

Numerical data from some specimens of *Heterometra africana*, *H. delagoae* and *H. madagascarensis*, that from the arms taken from arms based on IIBr series except where marked *

Species and locality	Arms			Cirri					Pinnules								
	Length	No.	Br at 3 + 4	No.	Segs	Length	Br : L longest segment	First seg. with spine	Segs.	P _D L.	Segs.	P ₁ L.	Segs.	P ₂ L.	Segs.	P ₃ L.	Lengths P ₃ : P ₂
<i>H. africana</i>																	
Zanzibar	c. 55	10	1.5*	XX	29	18	1.0 : 1	10	—	—	22*	4.2*	20*	7.4*	20*	8.9*	—
"	65	19	1.6	XVIII	33	22	1.0	10, 11	30	7.9	31	10.5	23	12.6	—	? similar	—
Wasin	c. 100	23	1.6	XXX	28	18	1.0	10, 11	32	8.9	32	10.0	—	—	24	12.6	—
Karachi	c. 75	18	1.7	XX	32 (36)	17	1.2	9, 10	20	5.8	23	8.4	24	8.9	19	6.3	0.71 : 1
"	c. 75	19 (?20)	1.7	XVIII	35	18	1.3	10-12	c. 29	c. 8.5	c. 28	c. 13.5	c. 29	c. 14.5	23	9.7	0.67
"	70	20	1.8	XXI	32	24	1.25	10 (11)	27	6.3	24	6.6	21	9.2	21	7.1	0.78
"	c. 95	17	1.9	XXVI	34	24	1.1	13	28	8.1	32	10.0	30	13.4	28	12.1	0.96
"	110	16 (?19)	1.8	XXIV	36	24	1.1	12, 13	26	7.4	29	8.9	27	13.4	27	12.9	0.96
<i>H. delagoae</i>																	
Mozambique	c. 75	30	1.5	XXVIII	35	c. 22	1.4	14	34	12.1	33	12.6	33	16.8	28	14.5	0.86
"	c. 75	30+	1.5	XXXI	31+	—	1.3	12	27	9.5	25	9.5	31	13.7	26	13.1	0.98
"	c. 85	c. 30	1.5	XXVIII	35	23	1.6	13	—	—	—	—	—	—	—	—	—
<i>H. madagascarensis</i>																	
Madagascar	55	11	1.3*	XVIII	25	14	0.9	8, 9	—	—	—	—	—	—	—	—	—
"	70	12	1.2	XX	29	19	0.85	(9) 10	28	6.8	—	—	24	8.1	21	7.9	0.98
"	65	16 (?17)	1.3	XVI	31	17	1.0	9-11	20	5.2	23	6.3	c. 23	8.4	—	larger	—
"	80	13 (?14)	1.4	XVIII	29	19	1.0	8 (9)	25	6.3	—	—	—	23	8.7	—	—
"	80	11 (?13)	1.6	XXIII	30	22	1.0	11	26	7.4	22	8.1	26	10.8	c. 22	c. 10.5	c. 1.0
"	100	13	1.8	XVIII	32	20	1.1	—	24	6.8	25	7.1	24	9.5	21	11.6	1.23
"	90	15	1.8	XX	32	22	1.1	12, 13	30	8.4	29	9.5	27	10.8	22	10.8	1.00
"	85	16	1.3	XXII	32	23	1.25	12, 13	24	7.4	c. 27	c. 9.2	28	11.0	—	smaller	—
"	100	16 (?17)	2.0	XXIV	31	c. 19	1.05	10, 11	29	8.4	32	13.7	c. 27	—	23	10.5	—
"	95	20	1.9	XX	32	19	1.15	(12) 13	34	9.0	28	8.7	—	26	12.9	—	—
"	110	22	1.8	XX	36	23	1.1	10-12	32	7.6	31	8.9	29	10.5	26	15.0	1.43
"	100	16	2.0	XXIII	34	21+	1.2	(9) 10	33	10.5	31	10.8	32	12.1	c. 27	14.2	1.18
"	120	14	2.1	XXII	34	c. 26	1.05	13	36	10.5	39	12.6	35	15.3	—	larger	—
"	150	11	2.0	XXVIII	35	c. 27	1.4	14	40	12.6	36	12.1	30	14.2	33	19.5	1.38

one-third again as broad as long', that is *not* longer than broad, which is in agreement with all but the smallest of Humes's specimens from Madagascar. There is thus no significant difference between *H. madagascarensis* and *H. africana* in the proportions of the cirrus segments.

However, when it comes to pinnule shape there is a very appreciable difference between the Wasin specimen of *H. africana* and the malagasy specimens. One of the latter with arms c. 90 mm long was used for comparison, yielding the data in Table 8.

TABLE 8

Comparison of the breadth of the first two pinnules in
Heterometra madagascarensis and *H. africana*

	Madagascar	Kenya
P _D Length (mm)	8.4	8.9
Segment number	30	32
Breadth at 20th segment	0.15	0.35
P ₁ Length	9.5	10.0
Segment number	29	32
Breadth at 20th segment	0.20	0.35
Breadth at 10th segment	0.35	0.75
Breadth at 3rd segment	c. 0.9	c. 0.9

In the malagasy specimen there are very conspicuous basal crests on the edge of the proximal pinnules facing the arm tip but the pinnules become rapidly attenuated and their distal halves are much more flagellate than those of the specimen from Kenya, which is unfortunately the only well-developed example of *H. africana* available from the vicinity of the type-locality (the Zanzibar area).

Other characters used by A. H. Clark to distinguish between these two geographically approximating species are the supposedly more tapering cirri of *H. madagascarensis* and the longer, more wedge-shaped brachials. Table 7 shows that there may not be any appreciable difference in the degree of taper of the cirri, while comparative counts of brachials over lengths of 20 mm in the proximal and distal halves of the Kenya specimen of *H. africana* and one of *H. madagascarensis* of comparable size show fewer but longer brachials in the former! [The numbers are 32 : 38 proximally, counting from the 20th brachial, and 43 : 50 distally.] However, there happen to be more syzygies in this Madagascar specimen, syzygial brachials being naturally shorter. I cannot distinguish any appreciable difference in the obliqueness of the articulations between the brachials.

Apart from the difference in shape of the basal pinnules between the two species, it seems likely that there is also a difference in their proportions, at least as far as this can be judged from the available material. Unfortunately the few East African specimens of *H. africana* in the British Museum collections are small, apart from the Wasin specimen which has no P₂ left intact. However, five specimens from Karachi, which were identified as *H. africana* by A. H. Clark, consistently have P₃ smaller than P₂, though in the larger ones with arm length c. 100 mm these two pinnules

are almost equal. The holotype of *H. africana* has P_3 similar to or smaller than P_2 . As can be seen from Table 6, in *H. madagascarensis* P_3 and P_2 are approximately equal until the arm length exceeds 80–90 mm when P_3 becomes distinctly larger. Much more material is needed to establish whether these proportions and growth changes are consistent.

Heterometra madagascarensis was previously known only from the three type specimens in the U.S. National Museum, the precise locality of which in Madagascar was not known. The present material extends the range of arm number from 13–18 up to 11–22 and the number of cirri to a maximum of XXVIII (though A. H. Clark underestimates cirrus number in comparison to me by counting only the fully mature ones). The number of cirrus segments and the length of the cirri do not exceed his maximum but inevitably there is a bigger range in the proximal pinnules owing to the greater range of size of the specimens.

A notable feature is that a few specimens have no trace of a dorsal spine on the antepenultimate segment of some cirri, there being a distinct gap in the series (fig. 11c). The shape of the dorsal spine varies from blunt to sharp and is often roman-nosed with a subsidiary proximal peak. The specimen with 14 arms has one IIIBr series present. Another with 22 arms has several irregularities in the division series, one of the seven IIBr series having only two ossicles instead of the usual four, while there is another IIBr series of five ossicles (with a syzygy still at 3 + 4) followed by a IIIBr series of only a single (axillary) ossicle; two other IIIBr series have the usual two ossicles. On arms based on IBr series, P_4 is about equal to P_3 in length though with a few less segments; otherwise P_4 is distinctly smaller than the preceding pinnule.

Heterometra sp. ? *H. bengalensis* (Hartlaub)

Antedon bengalensis Hartlaub, 1890 : 182; 1891 : 19–21, pl. 1, fig. 2, pl. 2, fig. 16.

Heterometra bengalensis : A. H. Clark, 1941 : 321–325, pl. 30, figs 127–130.

MATERIAL. 'Anton Bruun' cruise 1, st. 22A, 10°37'N : 97°34'E (SW of Mergui Archipelago, Burma), 75–80 metres; 1 specimen.

DESCRIPTION. The arm length is 90 + 10–20 mm; the breadth at the first syzygy on arms based on IIBr₄ series is 1.75 mm and the length from the proximal edge of the IBr₇ to this syzygy is 6.3 mm. There are 19 arms and two IIIBr series each of two ossicles. The cirri numbered XXV–XXX (the exact number being uncertain since a piece is broken off the centrodorsal). All are broken off short but a detached cirrus caught between the arms has 33 segments and measures 27 mm in length. It is mature and could be a peripheral cirrus. The fifth and longest segment has length : breadth 1.2 : 0.85 mm. The dorsal spines appear abruptly on the eighth segment; all are rather blunt. The distal end of the cirrus is not tapered, the sixth segment from the tip (measured since the fifth has the spine broken) is 1.05 mm broad including the spine, or 0.85 mm without the spine.

The division series are smooth, straight-sided and the proximal brachials are all more or less wedge-shaped.

P_D has 17+ segments and is 5.8+ mm long. P_1 is similar but larger. Both of them have a thin high crest on segments 2 to 6. P_2 is much larger, 15.25 mm long, with 29 or 30 segments; very stout basally and with a lower crest on segments 2 to 5, then becoming prismatic and attenuated distally. P_3 is slightly smaller, 13.2 mm long and more attenuated; it has 26 segments. In another series from an arm also based on a IIBr₄ series, P_3 is the largest pinnule although it is regenerated from the tenth segment and broken at the 23rd, at least five segments having been lost; the length is 14.75+ mm and the first ten segments measure 7.1 mm, whereas the first ten segments of P_2 are only 6.4 mm long.

AFFINITIES. This specimen agrees with *Heterometra bengalensis* in most characters except that the proximal brachials are more or less wedge-shaped and do not have strongly produced ends; also the number of cirrus segments exceeds 30. On this account it runs down, in A. H. Clark's first key, to *H. compta* A. H. Clark (known from SW of India between Goa and Cochin) except that P_3 is not markedly smaller than P_1 or P_2 . The British Museum collections include only two specimens named *H. bengalensis*. These are from Singapore and were determined in 1929 by A. H. Clark as *H. aspera*, which he treated as a synonym of *H. bengalensis* in 1941. These two specimens are badly broken. They agree with *H. bengalensis* in having relatively few arms (c. 12) and the profile irregular but most of their brachials are distinctly wedge-shaped rather than discoidal and I think they may be conspecific with *H. singularis*, also known from Malacca Strait.

Heterometra flora (A. H. Clark)

Amphimetra flora A. H. Clark, 1913 : 23.

Heterometra flora: A. H. Clark, 1918 : 77; 1941 : 333; A. M. Clark, 1966 : 604-606.

MATERIAL. 'Anton Bruun' cruise 1, st. 28A, 11°52'N : 92°49'E (Andaman Islands), 66 metres; 1 specimen.

DESCRIPTION. The arm length is 55 + c. 50 mm; the breadth at the first syzygy on arms based on IIBr₄ series is 2.25 mm and the length from the proximal edge of the IBr₁ to this syzygy is 7.1 mm. There are 13, possibly 14 arms and two of the three IIBr series are unusual in having only two ossicles. The centrodorsal has a concave dorsal pole. The cirri are XXIV; all are broken though one peripheral may lack only 2-4 segments beyond the 26 that are left. All the segments are shorter than broad. There are dorsal spines from about the ninth segment and the more proximal ones are doubled or abruptly truncated.

Few of the brachials are particularly wedge-shaped but most are more or less discoidal and flared.

The only external post-radial series with IIBr₄ has the pinnules increasing in stoutness to P_4 , which is forked abnormally from the third segment. P_D with 20 segments is huge basally with a high crest on the first and second segments but is rapidly attenuated distally; it is 7.4 mm long. P_1 is possibly regenerating; it has 18 segments, is similar in shape to P_D but measures only 6.3 mm. P_2 with 21 segments

ments is 8.7 mm long and P₃ with 18 segments is 8.4 mm long. P₄, if normal, would probably have been the longest pinnule as well as the stoutest basally, since P₅ is also very stout and equal in length to P₃. An arm based on a IBr series has P₄ the stoutest pinnule basally.

Except for the truncated or doubled cirrus spines, this specimen agrees with the type material of *H. flora*.

RANGE. This record extends the known range of the species from the Maldiv Islands into the Bay of Bengal.

Heterometra reynaudi (J. Müller)

Comatula (Alecto) reynaudi J. Müller, 1846 : 178.

Heterometra reynaudii: A. H. Clark, 1911c : 251; 1912a : 121-124, fig. 9.

Heterometra reynaudi: A. H. Clark, 1941 : 302-311, pl. 32, figs 137-143.

MATERIAL. 'Anton Bruun' cruise 1, st. 47B, 19°50'N : 92°55'E (off Akyab, Burma), 22-30 metres; 8 specimens.

DESCRIPTION. The largest specimen has arm length 50 + c. 50 mm; the breadth at the first syzygy on arms based on IIBr₄ series is 1.7 mm and the length from the proximal edge of the IBr₁ to this syzygy is 5.5 mm. There are c. 22 arms. The cirrus number can be expressed as XXVIII, based on XXI mature cirri and X more or less immature ones. The longest are 26 mm with up to 40 segments, none of which are longer than broad. The dorsal spines start between the fourteenth and seventeenth segments, usually at the fifteenth; they are not particularly sharp. Two series of P_D, P₁, P₂ and P₃ are as follows:

24, 6.3 mm; 33, c. 10 mm; 35, 15 mm; 33, 18 mm

26, 6.0 mm; 34, c. 14 mm; 34, 20 mm; 30, 16 mm

REMARKS. A. H. Clark's first key (1941 : 230-232) contradicts his text where *Heterometra reynaudi* is concerned, since he includes it in h¹ (bottom of p. 231) with 'P₃ as large as, or larger than, P₂', whereas his diagnosis states that P₂ is the largest pinnule. It is clear from his description that in this instance length was his size criterion but, as the measurements above show, either P₂ or P₃ may be the longest pinnule and this character is not reliable.

Heterometra singularis A. H. Clark

Heterometra singularis A. H. Clark, 1909c : 638-639; 1912a : 128-130, fig. 11; 1941 : 290-293 pl. 36, figs 161-163.

?*Heterometra pulchra* A. H. Clark, 1912a : 317-318; 1941 : 287-289, pl. 36, figs 164, 165.

MATERIAL. 'Anton Bruun' cruise 1, st. 21, 09°54'N : 97°42'E (SW of the Mergui Archipelago, Burma), 70 metres; 4 specimens.

'Anton Bruun' cruise 1, st. 22A, 10°37'N : 97°34'E (SW of the Mergui Archipelago), 75-80 metres; 2 specimens.

'Anton Bruun' cruise 1, st. 38, 14°07'N : 97°05'E (W of the Moskos Islands, Burma), 69-73 metres; 1 specimen (? *H. singularis*).

Cable ship 'Patrol', 05°38'45'N : 99°39'40"E (off Penang, Malaya), 55 metres; 2 specimens, B.M. reg. no. 1929.7.16.6.

DESCRIPTION. The most nearly intact specimen from 'Anton Bruun' st. 21 has the arm length 80 + 10-20 mm, 19 or possibly 20 arms, the breadth at the first syzygy following a IIBr₄ series 1.7 mm and the length to this syzygy 5.5 mm. The cirri number c. XXIII and have up to 50 segments, the maximum length being c. 38 mm. The twelfth and longest segment has length : breadth 1.1 : 1.0 mm. The maximum breadth is 1.1 mm at about the fifth segment and the cirri taper distally so that the fifth segment from the tip is only 0.6 mm excluding the dorsal spine or 0.75 mm including the spine. The spines are pointed, though relatively small and distally-directed, starting gradually between the 24th and 30th segments.

The division series are flanged laterally with straight edges; they approximate closely laterally. Only one IIIBr series is present; it consists of two ossicles.

In one pinnule series, P_D has 29 segments and is 7.6 mm long; segments two to five have a very high thin crest beyond which the pinnule becomes very attenuated. P₁ with 20 segments measures 7.9 mm; its crest is slightly more extended and the distal segments are relatively longer than those of P_D. P₂ with c. 22 segments measures 11.0 mm; its first eight segments together measure 5.0 mm, the crest is borne by segments two to four. P₃ is regenerating distally, with 19+ segments, the first eight of which are original and measure 4.5 mm so the length was probably little less than that of P₂. P₂ was probably the largest pinnule in most cases but the external ones are mostly broken or on regenerating arms.

A slightly smaller specimen from this station is badly broken. It has arms c. 95 mm long and 1.5 mm broad at the first syzygy. The centrodorsal is 4.75 mm in diameter and the dorsal pole c. 3.2 mm. Again the longest cirrus segments are slightly longer than broad and the cirri taper distally.

The larger of the two specimens from station 22A had arm length only c. 50 mm and 12 arms with breadth at the first syzygy 1.2 mm. There are up to 31 cirrus segments, the sixth and longest with length : breadth 0.9 : 0.5 mm; the dorsal spines start between the twelfth and fourteenth segments; they are fairly large and sharp but on some cirri are truncated abruptly or double-peaked. Although taken at the same station as the specimen doubtfully referred to *H. bengalensis*, these two are marked off by the much more distal appearance of the cirrus spines at about segment thirteen rather than eight.

The specimen from station 38, which is only provisionally referred to *H. singularis*, has arm length 35 + 20-30 mm and only ten arms with breadth at the first syzygy 1.2 mm. There are c. XX cirri with up to 30 segments and length up to c. 20 mm. The fifth and longest segment has length : breadth 0.90 : 0.65 mm and the dorsal spines begin at the eighth or ninth segment of the mature cirri but not until about the twelfth in the immature ones. The spines are large and sharp. P₁ with 15 segments is 3.7 mm long. P₂ and P₃ with 18 segments are 6.6 mm long.

REMARKS. In spite of the slightly shorter P₃ relative to P₂, which links it with

Heterometra singularis, the first specimen described above, which is the only mature reasonably intact one, agrees much more closely with A. H. Clark's description of the type-material of *H. pulchra* from Cape Negrals, Burma (arms 85+ mm long), than with that of *H. singularis* from the southern part of the Malacca Strait (arm length only c. 40 mm), especially in the distal position of the earliest cirrus spines beyond the twentieth segment, whereas the holotype of *H. singularis* has spines as far proximally as the seventh cirrus segment. The size difference is not enough to account for this since a small specimen also from 'Anton Bruun' station 21 with arms only c. 40 mm has two mature peripheral cirri with respectively 31 segments and spines from the fourteenth, or 27 segments with spines from the eleventh. The specimens from NW of Penang which A. H. Clark (1929) referred to *H. singularis* are all large (arm length 90 mm or more) and have cirrus spines starting from about the fifteenth segment or beyond on the larger cirri though more proximally on the apical ones. [A. H. Clark said that there are six of these specimens collected by the C.S. 'Patrol' in the British Museum collections which is true but only four of them, no. 1923.8.28.1-2, were labelled as *Heterometra singularis* by him, the other two, 1929.7.16.6, with locality 5°38'45"N : 99°39'40"E (which is also NW of Penang) were simply labelled as 'Crinoids' until 1950 but must have been the balance of the sample studied by Mr Clark. On both of these specimens, on mature arms following IIBr series, P₃ is distinctly larger than P₂, a characteristic of *H. pulchra* according to him, although on arms based on IBr series it is smaller in at least one case, as he describes for *H. singularis*.] These specimens from off Penang are clearly conspecific with the specimens described above (with the possible exception of the one from station 38) and accordingly I am referring the 'Anton Bruun' material to *H. singularis* although I am not certain whether they are also conspecific with the holotype. If this provision does hold good then *H. pulchra* should be referred to the synonymy of *H. singularis* but this cannot be checked until a good series of specimens, preferably from the Malacca Strait, can be examined.

Himerometra sol A. H. Clark

Antedon palmata: Bell, 1902 : 224. [Non *Alecto palmata* Müller, 1841.]

Himerometra sol A. H. Clark, 1912a : 115-116; 1941 : 188-189.

MATERIAL. 'Te Vega', F. C. Ziesenhenné's st. 64-20, small island at end of reef W of N end Filadu I., Tiladummati Atoll, Maldives Is., under loose coral boulders; 1 specimen.

DESCRIPTION. The arms are reflected dorsally and difficult to count all round but three radii together have 29 arms so the total is probably c. 50. Their length is c. 120 mm. The cirri have 24-33 segments, which develop a median dorsal convexity, becoming a small blunt tubercle on the segments of the outer third of each cirrus. All the segments are broader than long. One cirrus with 27 segments is c. 30 mm long. The IIBr series are normally of four ossicles externally and two internally. There are low synarthrial tubercles. The only P_D (pinnule on IIBr₂) and P_F (on

IIIBr₂) which are visible for their whole length both have the tip regenerated; they have respectively 31 segments measuring c. 22 mm and 29 segments measuring c. 21 mm. The P₁ of two different series have 23 or 25 segments and are c. 16 and 15 mm long; P₂ is much smaller.

This is only the second record of *Himerometra sol*. The holotype and paratype were also from the Maldive Islands.

Family COLOBOMETRIDAE

Cenometra emendatrix madagascarensis subsp. nov.

(fig. 12)

Cenometra emendatrix: A. M. Clark in Humes & Ho, 1970 : 5.

MATERIAL. Prof. A. G. Humes's no. 1360, Banc de Dzamandzar, Nosy Bé, Madagascar, 20 metres; 12 specimens including nos. 1, 2 and 12 in Table 9. B.M. reg. no. 1969.5.13.84-90.

Humes's no. 947, NW coast of Nosy Ovy, Radama Islands, E Madagascar, 10 metres; the holotype and another specimen, nos. 10 and 8 in Table 9. B.M. 1969.5.13.93.

Humes's no. 702, S of Tany Kely, near Nosy Bé, 20 metres; 6 specimens, nos. 3, 4, 6, 7, 9 and 11 in Table 9. B.M. 1969.5.13.91, 92, 106-107.

Prof. J. Stock's no. MD 25, same locality, on 'sea-whip', c. 14 metres; 1 specimen, no. 5 in Table 9. Amsterdam Museum.

Since identifying these specimens from Madagascar for Professors Stock and Humes simply as *Cenometra emendatrix*, a detailed comparison with material from Mauritius, the type-locality, and the Seychelles, has revealed consistent differences not only in the number of arms and cirri but also in the proximal pinnules of specimens with comparable arm length, sufficient to justify the recognition of a distinct subspecies from Madagascar in my opinion.

DESCRIPTION. The holotype has the centrodorsal 5.0-5.8 mm in diameter and 1.3 to 1.7 mm in height. The dorsal pole is irregular in outline due to variable encroachment of the cirrus sockets, which are two or three deep around the sides, so that the diameter of the naked part ranges from 1.1 to 2.6 mm; it is slightly sunken in the middle.

The cirri number XXXIII with up to 46 segments and length up to 30 mm. All the segments are broader than long, the longer ones (around the tenth) with length : median breadth c. 0.8 : 1.2 mm = 0.67 : 1. The dorsal 'spines' begin between the tenth and twelfth segments.

The division series are widely separated laterally and have abrupt ventro-lateral flanges, though these are not quite continuous longitudinally, being cut off just short of the proximal and distal edges of each ossicle. There are slight synarthrial convexities. The arms are flat-sided without flanges. There are 28 (possibly 30) arms, the longest remaining one 120 plus probably about 5 mm in length and the breadth at 3 + 4 after either IIBr or IIIBr series is 1.6 mm.

On one arm P_1 with 26 segments is 8.4 mm long; it is slender with most segments distinctly longer than broad and br at the fifth segment 0.5 mm. P_2 is much stouter, as usual in the genus, with most segments broader than long; there are c. 25 segments and the length is 14.2 mm, br at the fifth is 0.75 mm and there are distal spinose projections starting at about the fourth segment, while the second to fourth segments bear a slight longitudinal, more or less rounded, crest on the side facing the arm tip, whereas on the following pinnules the third to fifth (sometimes also the second) segments have better developed squarer and sharper axe-like keels. P_3 is much smaller than P_2 , with 17 segments and is 6.0–6.5 mm long.

VARIATIONS. Some of the numerical variations are indicated in Table 9, the entries in which are arranged in a size sequence derived from the product of arm length, breadth and number for the specimens from Madagascar (nos. 1–21) and separately for *Cenometra emendatrix emendatrix* from Mauritius and the Seychelles (nos. 22–28). In some cases, pinnules from two different arms were counted to give some idea of the variation within a single individual.

AFFINITIES. Of the specimens from Madagascar, excepting the two smallest which do have less than 20 arms, the other 19 have the arm number ranging from 24 to 32 (possibly more), with a mean of 30 compared with a maximum number of 22 and a mean of 17 in the specimens from Mauritius and the Seychelles. The

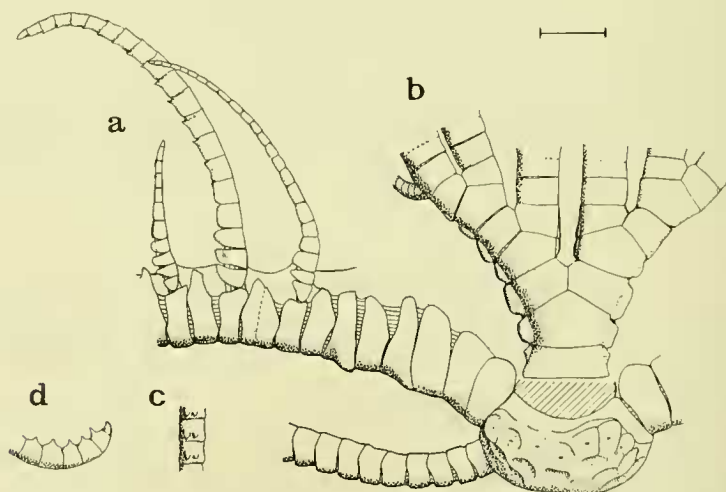


FIG. 12. *Cenometra emendatrix madagascarensis* subsp. nov. Holotype and paratype. B.M. reg. no. 1969.5.13.93. E Madagascar. Arm br 1.6 mm (after either IIBr or IIIBr series) and 1.5 mm. a. paratype, side view of calyx with cirrus base and proximal part of one post-radial series to Br_7 showing P_1 to P_3 ; b. holotype, dorsal view of proximal part of one post-radial series; c. dorsal view of segments from middle of cirrus showing paired spines and d. cirrus tip. [The scale equals 2 mm.]

increase in arm number during growth is most often by multiple augmentation (Gislén, 1923 : 14), the synarthry between the first two brachials on arms following IBr series being very easily broken, the subsequent regeneration resulting in simultaneous development not just of an axillary IIBr₂ and a pair of arms but of another division series (a IIIBr) in place of the external arm followed by a simple pair, resulting in three arms in place of one rather than the more usual two. This tendency for rapid augmentation in arm number is more marked in the Malagasy specimens where most post-radial series are symmetrical with six arms, the two median ones based on IIBr axillaries while the external four are paired on IIBr series. In the Mascarene and Seychellois specimens the average number of arms derived from each radial is four, the asymmetrical arm on one side being based on the IBr series having survived after loss and replacement of its opposite number.

As can be seen from the table, apart from the greater arm number, the number of cirri is also much greater in the specimens from Madagascar even though the centro-dorsal is similar in size, its diameter being most often about 5.0-5.5 mm in the specimens from both areas. However, the composition and length of the cirri themselves may not be significantly different, though unfortunately those of the syntypes of *C. emendatrix emendatrix* are unknown.

In a direct comparison of individual specimens, if the product of arm length, breadth and number is used as the criterion of size then specimen no. 3 of *C. emendatrix madagascarensis* in the table is most closely comparable with no. 27 of *C. e. emendatrix*. The cirri are similar in segments number and length in these two but there are nearly twice as many of them in the Malagasy specimen. Also the lengths of P₁ and P₃ at least are significantly greater, while P₁ also has more segments. These differences still hold good if specimens with individual arms of similar proportions are compared, for instance nos. 4 and 5 against 24, all with arms c. 90 mm long and 1.4 mm proximal br. The syntypes of *C. e. emendatrix* are rather variable with regard to the shapes of P₁ and P₂; one has quite a stout P₁ with br at the fifth segment 0.6 mm compared with 0.8 mm br at the fifth segment of P₂, which has particularly short segments in this specimen, most of them distinctly shorter than broad. Another syntype has a much slimmer P₁ with more prominent crests on segments two to five. With regard to these crests, in my opinion none of the three larger syntypes of *C. e. emendatrix* has the carination of P₂ really 'high and conspicuous' (see A.M.C. & Rowe, 1971, fig. 7a, p. 18) as given as characteristic of the species in A. H. Clark's key to *Cenometra* (1947 : 27), even if it was so in Möbius' specimen from Mauritius. Clark's key leans heavily on the development of basal crests on the various proximal pinnules for distinguishing the species of *Cenometra* and I would not be surprised if the poorly-described *C. herdmani* A. H. Clark, 1909, from Ceylon and southern India, with crests only on P₁ and P₃, does not prove to be conspecific with *C. emendatrix*. *C. cornuta* A. H. Clark, 1911, from Australia has relatively shorter cirrus segments, P₂ much shorter, P₁ somewhat stouter and the division series less widely separated, though again with distinct ventro-lateral flanges, judging from a direct comparison of the holotype with the present material. The small number of cirri, only XIV, given by A. H. Clark for the type of *C. cornuta* might be thought to provide a further distinction but I estimate that there are (or

TABLE 9

Numerical data from specimens of *Cenomethra emendatrix madagascarensis* subsp. nov. (nos 1-21) and *C. emendatrix emendatrix* (22-28); nos. 25, 26 and 28 are syntypes

No.	Arms			Cirri			Pinnules						
	No.	Length	Br at 3 + 4	No.	Segs.	Length	P ₁	P ₂	P ₃	Segs.	L.	Segs.	L.
1	18	—	1·0	XIV	31	16	—	—	—	—	—	—	—
2	16	—	1·2	XVII	—	—	24	6·8	23	11·3	14	4·2	4·2
3	32	c. 90	1·3	XL	38	21	26	8·9	23	11·0	16	6·3	6·3
4	29 (?30)	c. 90	1·4	XXVII	39	25	24	9·5	23	12·1	17	5·3	5·3
5	30	c. 90	1·4	XXV+	41	20	25	9·5	23	13·2	16	6·3	6·3
6	32	60+ +	1·4	XXX	49	32	20	8·7	26	13·9	15	5·5	5·5
7	c. 30	90	1·5	XXIX	43	30	25	10·0	25	14·7	17	6·3	6·3
8	28 (?29)	40+ +	1·5	XL	42	27	23	8·4	25	14·7	18	6·6	6·6
9	29 (?30)	40+ +	1·6	XXVII	41	24	25	10·8	27	15·8	14	5·5	5·5
10	28 (?30)	c. 125	1·6	XXXIII	46	30	26	8·4	25	14·2	17	6·3	6·3
11	12 + (?33)	c. 100	1·5	XXXV	51	35	27	10·3	34	15·8	18	6·8	6·8
12	31 (?32)	120	1·6	XXXII	45	25	30	11·0	—	—	17	6·3	6·3
13-21	Arm no. 24-32 (?37) in nine more or less broken specimens												
Range	24-32 (?37)	90-125	1·3-1·6	XXVII-XL	38-51	21-35	24-30	8·4-11·0	23-34	10·5-15·8	14-21	5·3-8·4	5·3-8·4
Mean	30			XXXII			25	9·6	25	13·6	17	6·4	6·4
22	12	c. 70	1·3	XVI	34	17	13	4·7	17	8·2	12	2·9	2·9
23	13 (?16)	80	1·3	XV	—	—	16	5·3	18	7·9	13	4·0	4·0
24	14	90	1·4	XX	41	c. 27	18	5·8	—	—	13	4·2	4·2
25	19	c. 75	1·5	XXIII	—	—	20	8·7	20	11·6	13	4·0	4·0
26	21	c. 70	1·6	XIX	—	—	20	6·8	18	9·5	14	5·8	5·8
27	22	c. 115	1·4	XXII	36	c. 22	20	6·6	20	6·6	14	5·0	5·0
28	14 (?16)	90	1·6	XVIII	—	—	(17)	6·6	20	13·1	14	4·7	4·7
Range	18-22	70-125	1·3-1·6	XV-XXIII	34-41	17-27	13-20	4·7-8·7	17-22	7·9-13·1	12-14	2·9-5·8	2·9-5·8
Mean	17			XIX			18	6·3	19	10·1	13	4·2	4·2

were) XV mature cirri and an additional six immature ones, giving a total of, say, XVIII, which lessens the discrepancy. I have no material of the oldest known species, *C. bella* (Hartlaub, 1890), recorded from the South Pacific islands to Burma, only the largest specimens of which are said to have any sign of pinnule crests.

Colobometra discolor A. H. Clark

Colobometra discolor A. H. Clark, 1909c : 640-641; 1912a : 166-168, fig. 25; 1947 : 128-132, pl. 15, figs 72-75, pl. 16, figs 76-79.

MATERIAL. 'Anton Bruun' cruise I, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Is.), 77 metres; 17 specimens.

DESCRIPTION. Measurements and counts were made on four specimens. These have:

arm length	c. 80 mm	c. 90 mm	c. 85 mm	c. 65 mm
breadth at 3 + 4	1·7 mm	1·6 mm	1·6 mm	1·5 mm
length to 3 + 4	4·0 mm	4·1 mm	4·0 mm	3·4 mm
cirrus number*	XVIII + vi	XX + iv	XXII + iii	XVIII + iv
cirrus segments	47-49	40-42	40-42	35-39
cirrus length	25-30 mm	c. 28 mm	c. 23 mm	22-23 mm
P ₁ segs and length	18, 7·6 mm	17, 7·1 mm	16, 5·5 mm	18, c. 5 mm
P ₂ segs and length	19, 11-12 mm	17, 13·4 mm	17, 10·5 mm	14, 8·7 mm
P ₃ segs and length	15, 8·7 mm	17, 12·6 mm	17, 10·0 mm	15, 7·6 mm

The cirrus segments are flared distally, the dorsal spines stout; the longest segments (about the eighth) have length : median breadth c. 1·0 : 0·7 mm in the first specimen. The dorsal pole of the centrodorsal is 2·0-2·6 mm in diameter. P₁ is relatively smooth and tapering; P₂ is much stouter with elongated, distally-flared and spinose segments; P₃ is similar to P₂ but shorter.

The maximum number of cirrus segments given by A. H. Clark is 48 (though up to only 40 are mentioned in his diagnosis); otherwise these specimens fall within the ranges he gives for the various characters.

Cotylometra gracilicirra (A. H. Clark)

(fig. 13)

Oligometra gracilicirra A. H. Clark, 1908b : 221-222; 1912a : 168, 323, fig. 26.

Cotylometra gracilicirra : A. H. Clark, 1918 : 128, pl. 28, fig. 110.

Cotylometra gracilicirra gracilicirra : A. H. Clark, 1947 : 49-51, pl. 8, figs 38-40, pl. 9, figs 41, 42.

MATERIAL. 'Anton Bruun' cruise I, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Is.), 77 metres; 2 specimens.

*Roman capitals signify the number of more or less mature cirri and small roman numerals of immature cirri. The numbers of segments and cirrus length refer only to mature peripheral cirri.

DESCRIPTION. The larger specimen has arms $40 + c. 5$ mm long and the breadth at the first syzygy, $3 + 4$, is 1.2 mm. The very thick discoidal centrodorsal is 1.1 mm high and 2.4 mm in maximum diameter; the diameter of the flat but markedly spinose dorsal pole is 1.7 mm. The cirri number XII; the three remaining have 33, 33 and 35 segments; the last measures 12.0 mm in length. The longest cirrus segment, about the eighth, has length : median breadth 0.55 : 0.60 mm with maximum breadth 0.65 mm including the dorsal projection. This projection takes the form of a single distally directed spine from about the twelfth segment measuring up to c. 0.1 mm in height but on several segments preceding the twelfth there is an additional slightly smaller spine each side making a transverse row of three. P_1 has 10 or 11 segments and measures c. 2.6 mm. P_2 with 12 segments is c. 4.0 mm long and P_3 with 10 segments 3.4 mm long. P_2 and the following pinnules have markedly spinose and flared distal ends to the segments after the basal two and are distinctly prismatic in their distal halves. P_a is absent throughout and P_1 on one arm.

The smaller specimen has arms c. 35 mm long; the breadth at the first syzygy is 1.05 mm. There are 30 segments in two mature cirri counted. The dorsal spines are sharper and more prolonged than in the other specimen (see fig. 13c) and are usually single from the tenth segment, being preceded on several segments by a transverse ridge of three spines.

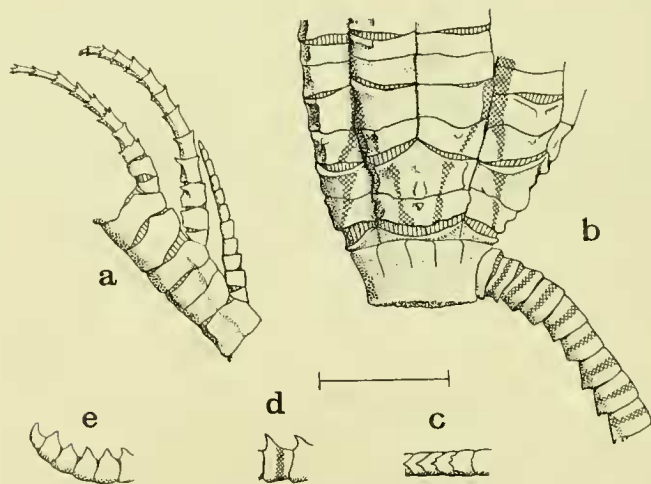


FIG. 13. *Cotylometra gracilicirra* (A. H. Clark). 'Anton Bruun' st. 18A, N Malacca Strait. Arm br 1.2 mm (after IIBr series). a. side view of proximal part of an external arm from Br₂ to Br₇ showing P_1 to P_3 ; side view of calyx, bases of post-radial series and a cirrus; c. dorsal view of cirrus segments 8-11 of smaller specimen showing transition from small multiple spines to single large one; d. side view of segment 12 and e. of cirrus tip. (The colour pattern is indicated by cross-hatching.) [The scale equals 2 mm.]

REMARKS. In spite of its original inclusion in *Oligometra* by A. H. Clark, *Cotylometra gracilicirra* does not fit very well into the family Colobometridae on account of its laterally compressed cirri with even the proximal segments lacking the characteristic flattened dorsal surface with paired tubercles or spines. Although there is a transverse ridge on a few segments, this is highest in the middle. However, the frequent absence of P_a allies it with some members of the Colobometridae, while the prismatic, spinose pinnules mark it off from the subfamily Perometrinae of the Antedoninae—which also shows a tendency for reduction of P_a .

As can be seen from figure 13b, the larger of the two 'Anton Bruun' specimens has a distinct keel on each division series and a median tubercle on the first brachial of each arm. A. H. Clark distinguished four specimens from east of Borneo showing this condition, together with marginal tubercles on the division series and first two brachials, as *Cotylometra gracilicirra* variety (later subspecies) *ornata* but such modifications in ornamentation are often variable and the present specimens suggest that the carinate condition may occur throughout the range of the species. I think that further material will probably show little justification for maintaining the subspecies.

Cyllometra manca (P. H. Carpenter)

Antedon manca P. H. Carpenter, 1888 : 226–227, pl. 44, figs 2, 3.

Cyllometra manca: A. H. Clark, 1907 : 357; Gislén, 1922 : 80–81, figs 66, 67; A. H. Clark, 1947 : 137–169, pl. 17, fig. 86, pl. 18, fig. 87, pl. 19, figs 91–96, pl. 20, figs 99, 100, pl. 21, fig. 101, pl. 22, figs 102–108; Utinomi & Kogo, 1965 : 276–277, fig. 8.

MATERIAL. 'Anton Bruun' cruise 1, st. 21, 09°54'N : 97°42'E (SW of Mergui Archipelago), 70 metres; 1 specimen.

'Anton Bruun' cruise 1, st. 22A, 10°37'N : 97°34'E (SW of Mergui Archipelago), 75–80 metres; 9 specimens.

'Anton Bruun' cruise 8, st. 420A, 02°42'N : 40°53'E (off Kenya–Somalia border), 140 metres; 1 specimen.

'Anton Bruun' cruise 9, st. 437, 09°25'N : 50°54'E (off N Somalia), 85–95 metres; 1½ specimens.

'Anton Bruun' cruise 9, st. 442, 09°33'N : 50°59'E (off N Somalia), 70–80 metres; 6 specimens.

'Anton Bruun' cruise 9, st. 444, 09°36'N : 51°01'E (off N Somalia), 78–82 metres; 5 specimens.

'Anton Bruun' cruise 9, st. 447, 10°00'N : 51°15'E (off N Somalia), 59–61 metres; 1 specimen.

DESCRIPTION. Of the fourteen specimens from off Somalia, all but three have more than ten arms, the maximum number (in one of the smallest specimens) being 17. The largest specimen from st. 442, arm length c. 90 mm, breadth at the first syzygy (after IBr series) 1.25 mm, contrasts with the rest not only in having the purple colour much more widespread but also in having most of the cirri with the maximum dorsal height predominantly median rather than in the form of paired

tubercles and P_3 almost as stout as P_2 . On the mature cirri the last ten or more segments before the penultimate have a crescentic dorsal elevation with a more or less sharp apex, though proximally there is sometimes more of a transverse ridge with one or more tubercles each side of the median projection. This form of the cirri resembles that in the larger specimens from Japan described under the name of *Cyllometra alboburpurea* by Gislén (1922), regarded by A. H. Clark (1947) as a synonym of *C. manca*, together with *C. disciformis* (P. H. Carpenter), *C. anomala* A. H. Clark, *C. soluta* A. H. Clark and *C. pulchella* Gislén. If A. H. Clark is right then *C. manca* is an extremely variable species, especially with regard to the cirri. Detailed correlation of the variable characters relating them to absolute size is needed before a proper assessment of the specific limits in *Cyllometra* can be arrived at. Unfortunately the genus is poorly represented in the British Museum collections.

The large specimen from station 442 has 14 arms. Its centrodorsal is 3.7 mm in maximum diameter with the dorsal pole 3.0 mm across. The division series are smooth, widely separated laterally, as usual in *Cyllometra*, especially in contrast with *Cotylometra*, without synarthrial tubercles, though the arm bases are slightly carinate. P_1 is very slender with 16 extremely elongated segments and length 7.9 mm. No P_2 is complete or unregenerated; likewise P_3 though both these pinnules appear similarly stout and their segments are flared at their distal ends with a rugose dorsal tuft. The cirri, described above, have up to 31 segments and the longest measure c. 16 mm.

The largest of the other specimens from this station have arm length c. 60 mm and mostly have small paired dorsal spines on the cirri giving way to a single spine for the last five or so segments before the penultimate.

RANGE. The records from off Somalia represent an extension of the known range of this species, the previous westernmost locality known being the entrance to the Persian Gulf. [See also p. 152.]

Decametra mylitta A. H. Clark

Decametra mylitta A. H. Clark, 1912d : 36; 1918 : 118-120; 1947 : 188-191, pl. 22, fig. 110, pl. 23, figs 116, 117, pl. 24, fig. 118.

MATERIAL. 'Anton Bruun' cruise 1, st. 28A, 11°52'N : 92°49'E (Andaman Is.), 66 metres; 1 specimen (?*D. mylitta*).

'Anton Bruun' cruise 1, st. 47B, 19°50'N : 92°55'E (off Akyab, Burma), 22-30 metres; 2 specimens, one badly broken.

DESCRIPTION. The more nearly intact specimen from st. 47B has arms up to 65 mm long, breadth at the first syzygy (3 + 4) 1.4 mm and length from the proximal edge of the 1Br₁ to this syzygy 3.3 mm. The maximum and dorsal pole diameters of the centrodorsal are 3.3 and c. 2.0 mm. There are XXII cirri with up to 25 segments and length up to 11.5 mm; the longer segments about the ninth have

length : breadth 0.55 : 0.80 mm and the antepenultimate 0.45 : 0.65 mm. There are small paired tubercles from about the ninth segment, fusing into a single slightly larger one about four segments before the penultimate. The division series have synarthral tubercles of moderate size, also the first two brachials. There are no lateral flanges though the adjacent division series are less widely spaced than in *Cyllometra*. P_1 , P_2 and P_3 have 15, 16 and 15 segments and measure 5.0, 7.6 and 5.5 mm in length, P_2 being stoutest; it develops a small spinose tuft dorsally at the distal end of the fourth segment with slightly larger tufts shifting to the edge facing the arm tip on the following segments; otherwise the pinnules are fairly smooth. P_a is only found on two arms. There are small pink spots on many brachials and one each side of many pinnule segments.

The specimen from station 28A is only provisionally referred to this species since it has P_a present, as in *Oligometra*; however, this is often rather variable. The arms are c. 75 mm long. The stout cirri have 20 or 21 short segments, mostly with transverse ridges though a few have paired tubercles. The first three pinnules have 16, 17 and 13 segments and measure 5.5, 9.0 and 5.3 mm; they are nearly cylindrical and smooth distally. There are five acorn barnacles, *Octolasmis orthogonia* (Darwin) (named by Dr K. McKenzie), on the cirri.

RANGE. This is now extended into the Bay of Bengal, Singapore being the previous westernmost record.

Oligometra serripinna (P. H. Carpenter)

Antedon serripinna P. H. Carpenter, 1881 : 182.

Oligometra serripinna: A. H. Clark, 1910 : 179-180; 1912a : 169-174, 323-324, fig. 28; 1947 : 216-217 (varieties and subspp. treated separately).

MATERIAL. 'Anton Bruun' cruise 1, st. 22A, 10°37'N : 97°34'E (SW of Mergui Archipelago), 75-80 metres; 2 specimens.

'Anton Bruun' cruise 1, st. 37, 13°28'N : 97°19'E (N of Mergui Archipelago), 64 metres; 1 specimen.

'Anton Bruun' cruise 1, st. 47A, 20°16'N : 92°32'E (NW of Akyab, Burma), 13-15 metres; 5 specimens.

'Anton Bruun' cruise 1, st. 47B, 19°50'N : 92°55'E (off Akyab, Burma), 22-30 metres; 8 specimens.

'Anton Bruun' cruise 8, st. 400C, 20°30'S : 35°43'E (off Beira, Mozambique), 62 metres; 4 specimens.

Prof. A. G. Humes's no. 948, NW coast of Nosy Ory, Radama Is., Madagascar, 10 metres; 3 specimens. B.M. reg. no. 1969.5.13.94.

Mr W. Humphreys, Passe du Bois, Aldabra; 1 specimen. 1971.3.3.1.

All these specimens run down to the subspecies *O. serripinna serripinna* in A. H. Clark's key (1947 : 216-217) except for the one from off Mozambique which has very ornate processes on the proximal pinnules and could be referred to the variety

electrae and the one from Aldabra, which conversely has the earlier pinnules hardly serrate in profile and could be called variety *occidentalis*.

Several immature specimens of Colobometrids cannot be determined with any certainty without more knowledge of the growth changes and variation within this family:

Colobometrid sp. A

MATERIAL. 'Anton Bruun' cruise 7, st. 371D, 24°46'S : 35°20'E (SE of Inhambane, Mozambique), 165 metres; 2 specimens.

One has 11 arms 20 + 5-10 mm long, breadth at the first syzygy 0.55 mm and c. XV cirri with 16 segments, c. 5 mm long. P_2 is the largest pinnule on some arms and there is no P_a . The other specimen has ten arms c. 25 mm long, breadth 0.50 mm and c. XII cirri with 16 segments, c. 4.5 mm long.

Both have relatively narrow division series and may be referable to *Cyllometra manca* but, despite the extension westwards to Somalia in the known range of that species in this paper, without more mature specimens from further south off the East African coast I hesitate to refer them to *C. manca*.

Colobometrid sp. B

MATERIAL. 'Anton Bruun' cruise 8, st. 393A, 29°32'S : 31°17'E (NE of Durban, Natal), 50-53 metres; 1 specimen.

The ten arms were c. 33 mm long; the breadth at the first syzygy is 0.65 mm. The short cirri have up to 13 segments and measure only 3.8 mm. The proportions of the proximal pinnules are difficult to determine but P_1 may be larger than P_2 which has c. 10 segments. P_a is absent. The division series and first brachial of each arm have ventro-lateral flanges, unlike *Cyllometra*.

Colobometrid sp. C

MATERIAL. 'Anton Bruun' cruise 1, st. 21, 09°54'N : 97°42'E (SW of Mergui Archipelago), 70 metres; 1 specimen.

The ten arms were c. 38 mm long; the breadth at the first syzygy is 0.90 mm. The centrodorsal is finely papillose; the cirri are all lost. P_1 , P_2 and P_3 have 12, 14 and 11 segments and are 3.0, c. 4.2 and 2.8 mm long, P_2 being the stoutest. There is no P_a .

Colobometrid sp. D

MATERIAL. 'Anton Bruun' cruise 1, st. 21, 09°54'N : 97°42'E (SW of Mergui Archipelago), 70 metres; 7 specimens.

The ten arms are 20-30 mm long; one specimen has the breadth at the first

syzygy 0.35 mm. There are only c. 12 cirrus segments which are very short with fine sharp spines. The division series and brachials are all flared at the edges so that the profile of the arms is very serrate. The pinnules have long fine spines at the distal ends of the segments. P_2 is absent.

Possibly these may be referred to *Decametra*.

Family TROPIOMETRIDAE

Tropiometra carinata carinata (Lamarck)

Comatula carinata Lamarck, 1816 : 534.

Tropiometra carinata : A. H. Clark, 1911b : 34-35; Humes & Ho, 1970 : 1.

Tropiometra carinata carinata : A. H. Clark, 1947 : 291-337, pl. 35, figs 183, 184, pl. 36, figs 187, 188.

MATERIAL. 'Anton Bruun' cruise 8, st. 420A, 02°42'S : 40°53'E (off Kenya-Somalia border), 140 metres; c. 50 specimens.

'Anton Bruun' cruise 9, st. KA-13, reef on W shore, Grand Comoro I., 5-15 metres; 3 specimens.

'Anton Bruun' cruise 9, st. 447, 10°00'N : 51°15'E (off N Somalia), 59-61 metres; 2 specimens.

'Anton Bruun' cruise 9, st. RU 295, 13°30'S : 45°16'E (outer and inner sides, Bandeli Reef, Mayotta I., Comoro Is.), c. 1 metre; 5 specimens.

J. Rudloe's st. 29, Ambatoaka Beach, Nosy Bé, Madagascar; 1 specimen.

J. Rudloe's st. 30, Ambarionaombi Point, Nosy Bé; 1 specimen.

Professor A. G. Humes, Nosy Bé area (various stations, see Humes & Ho, 1970); 104 specimens.

Tropiometra magnifica A. H. Clark

Tropiometra magnifica A. H. Clark, 1937 : 90-91, pl. 1, fig. 1; 1947 : 266-268, pl. 33, figs 170-173.

MATERIAL. 'Anton Bruun' cruise 8, st. 420A, 02°42'S : 40°53'E (off Kenya-Somalia border), 140 metres; 5 specimens.

DESCRIPTION. This fine species was previously only known from the holotype taken in the Gulf of Aden by the John Murray Expedition.

Unfortunately all the arms of these specimens are somewhat broken; the longest, detached from its calyx, is 210+ mm. It is noticeable that the centrodorsal in this species is much higher relatively than in any of the numerous examples of *Tropiometra carinata* studied, in which it is quite flat with only a single peripheral row of cirri. There are purple stripes or spots along the arms and markings on the cirri, but not as bold as in the holotype.

The last specimen in the table has peripheral cirri with 43 or 44 segments measuring 4.0-4.5 mm. Its dorsal pole is distinctly convex. P_2 and P_3 have 26 and 27

segments and measure c. 21 and c. 22 mm. [Owing to the relatively large size these measurements are all taken with the naked eye, the need for precision being countered by variation.]

The holotype of *Tropiometra magnifica* with arm length 265 mm (A. H. Clark's estimate) has the breadth at the first syzygy only 3.7 mm so the 'Anton Bruun' specimens are all even larger.

RANGE. This record provides a small extension of range southwards from the Gulf of Aden.

TABLE 10

Numerical data from the four least broken specimens of *Tropiometra magnifica*, only 5, 3, 6 and 9 arms remain respectively

Diam.	Centrodorsal		Arm br. at 3 + 4	Cirrus no.	Segs.	P ₁		2nd syzygy at 9 + 10
	Ht.	D. pole				L.		
15	5.5	10.0	5.5	XXXIV	32*	c. 25		4/5
14	4.5	8.5	5.5	XXIX	37	c. 30		2/3
14	5.5	10.0	5.0-5.5	XXVI	35	c. 28		6/6
12	5.0	c. 7	4.5-5.0	XXXIV	39	c. 32		8/9

*Possibly regenerated from the seventh segment after which the segments are abruptly shorter though not narrower.

Family CALOMETRIDAE

Neometra spinosissima (A. H. Clark)

Calometra spinosissima A. H. Clark, 1909b : 79-80.

Neometra spinosissima: A. H. Clark, 1912a : 181-183, fig. 30; 1947 : 364-366, pl. 39, fig. 203.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Is.), 77 metres; 2 specimens.

DESCRIPTION. The larger specimen has 17 arms on four radii, the fifth IBr series being broken; there were probably 21 arms. All the division series are of two ossicles and are very constricted laterally. The breadth at the first syzygy (3 + 4) after a IIBr series is 1.3 mm and the length from the proximal edge of the IBr₁ to this syzygy is 7.5 mm. The complete arm length was probably just over 100 mm. The cirri are XV + iii, the longest intact one with 47 segments and c. 30 mm in length (all are considerably incurled in the distal part). The longest cirrus segments have length : breadth c. 1.0 : 1.0 mm. Dorsal spines 'roman-nosed' in profile start from about the twelfth segment. P₁ has 36 segments and measures 11.0 mm in length. No P₂ or P₃ remains intact; they are progressively stouter than P₁ and their first 14 segments measure respectively 11.3 and 14.0 mm. P₄ is similar to P₃ except that the first two segments are less extravagantly enlarged.

The smaller specimen probably had c. 20 arms and XV cirri with c. 46 segments.

These specimens conform well with the holotype and only known specimen.

RANGE. This record provides a small extension of range southwards from the Andaman Islands.

Family ASTEROMETRIDAE

Asterometridae Gislén, 1924 : 231; A. H. Clark, 1947 : 415-416.

A. H. Clark (1947) distinguishes two genera in this family, having split off *Pterometra* from *Asterometra* in 1909. In his key (1947 : 416), *Pterometra* is characterized by having 20-30 arms, cirri with the longer proximal segments more or less constricted medially and usually with a *ventral* projection at their distal ends, as well as pinnules of the proximal third of the arms not shorter than the distal but with many segments medially constricted and distally flared and spinose. *Asterometra* is said to have only 10-16 arms, the longer cirrus segments not constricted or produced ventrally and proximal pinnules shorter than the distal ones with only their distalmost segments at all modified. The main specific characters used in his keys include the length of the cirri relative to the arms, the development and extent of keels on the division series and the relative breadth of the proximal part of the animal. He also notes that the colour is pale in *Asterometra* but more or less brown or reddish in *Pterometra*.

The large sample of c. 70 asterometrids taken at 'Anton Bruun' station 18A (between Malaya and the Nicobar Islands) shows a range in arm number from 11 to 20, though with a mean of c. 19 if the smaller specimens are excluded (approximating perhaps more to *Pterometra*), the longer cirrus segments not notably constricted and, except in nine specimens, lacking any trace of ventral processes (which agrees more with *Asterometra*, as do the form and proportions of the pinnules, only the distalmost segments of the proximal ones being at all flared and spinose, though the darkish colour of many specimens again allies them with *Pterometra*). Then the length of the cirri relative to the arms ranges from 0.69 to 1.17 : 1 and the division series vary from having sharp median keels to being perfectly smooth, while it seems to me that the relative breadth of the proximal part of the animal depends too much on the attitude of the arms in preservation to be of use as a distinguishing character.

Further study of A. H. Clark's keys shows that two of the five species of *Pterometra* are, in fact, not supposed to have ventral cirral spines, in contradiction to the generic key, these two being *P. magnifica* and *P. pulcherrima*. However, A. H. Clark has referred to the latter species a specimen from the Gulf of Martaban (Burma) in which prominent ventral spines *are* present on the cirri. This record is the only one for the whole family from the Indian Ocean and, since A. H. Clark has referred mature specimens with as few as 12 arms to *P. pulcherrima* despite his generic diagnosis, I am referring the 'Anton Bruun' specimens to this species. However, I am very doubtful whether it is worth retaining *Pterometra* as a distinct genus. Unfortunately the family is poorly represented in the British Museum collections and I cannot at present try and ascertain the extent of variation in any of the other species.

Some additional descriptive notes on the holotype of *Asterometra longicirra* are given in the Appendix on p. 152.

Pterometra pulcherrima (A. H. Clark)

(fig. 14)

Ptilometra pulcherrima A. H. Clark, 1909f : 400-402.

Asterometra pulcherrima : A. H. Clark, 1912a : 193.

Pterometra pulcherrima : A. H. Clark, 1918 : 145, pl. 9, pl. 28, fig. 104; 1947 : 427-432, pl. 43, figs 218, 219.

MATERIAL. 'Anton Bruun' cruise 1, st. 18A, 07°34'N : 98°00'E (between Malaya and the Nicobar Is.), 77 metres; c. 70 specimens.

REMARKS. Fortunately in this family the arms are strong and end abruptly after tapering sharply, to such an extent that with the naked eye they look almost as if they are regenerating after breakage. It is therefore possible to relate their length to other measurements and counts with a fair degree of precision, though in the calculations for the data given in Table 11 the arm lengths were taken to the nearest 5 mm, allowing a little for variation of the individual arms. It is notable that the sample consists mainly of specimens showing a small size range, arm length 55-70 mm, only two specimens having arms less than 40 mm long.

About one specimen in eight was found to have even the longest segments of the peripheral cirri barely longer than broad and with a prominent ventral spine projecting from the distal end of each, as in the 'Investigator' specimen also from the Bay of Bengal, described by A. H. Clark. Also none of the specimens with such cirri have any development of a keel on the division series. However, this latter character is not restricted to the specimens with ventral cirrus spines and the range in the relative length of the longest cirrus segments overlaps that in the bulk of the material. The number of cirrus segments is no greater in the specimens with ventral cirrus spines and consequently the length of their cirri tends to be less, relative to the arm length, than in the main part of the sample. (It should be noted though that unfortunately the peripheral cirri are more often broken than the arms, so that estimates of their length and segment number may be too low, not being based on the largest ones.) Although there is some correlation between the form of the cirri and the lack of modification of the division series in these specimens, I do not think it is sufficient to justify a nomenclatorial difference, though the specimens concerned are segregated in Table 11. Also separated off from the bulk of the sample are seven specimens which are relatively small in mass, having either unusually few arms (e.g. 12, though with an arm length of c. 65 mm) or unusually short arms (only 40 mm long in one specimen, though numbering as many as 19).

In addition the table includes for comparison some summarized data from Gislén (1922 : 111) on *Asterometra anthus* (A. H. Clark) from the Bonin Islands, S. of Japan, this being the only other good sample of any member of the family for which details

Numerical data from s

	No.	Br st (1)	Pinnules				
			P ₁		P ₂		L.P ₂ : L.P ₁
			Segs.	L. (mm)	Segs.	L. (mm)	
<i>erometra pulcherrima</i>							
all specimens:							
Range	11-19	81	9-15	4.0-4.7	10-13	5.0-5.8	1.22-1.36
Mean and number	14 (6)	7)	11	4.3 (5)	11	5.5 (6)	1.28 (5)
in sample:							
Range	16-20	76	12-15	4.2-6.3	12-16	5.2-9.0	1.05-1.55
Mean and number	19 (47)	17)	13	5.3 (41)	14	6.9 (43)	1.29 (40)
S.D.	1.02		0.88	0.50	1.08	0.69	0.14
specimens with short cirrals:							
Range	20-21	27	10-17	4.2-6.8	10-17	5.3-10.0	1.15-1.69
Mean and number	20 (9)	9)	13	5.6 (18)†	13	7.4 (18)†	1.33 (18)†
type material (from A.H.C.,							
1947)	20		—	—	—	—	—
Holotype	20		16	8	19	12.5	1.56
investigator' st. 387							
(from A.H.C.)	20		15	7	15	10	1.43
<i>erometra anthus</i>							
larger specimens							
(from Gislén, 1922):							
Range	10-16		8-14	4-7	9-14	5.0-9.5	1.00-1.39
Mean and number	11 (32)		11.4	5.6 (24)	11.6	6.7 (25)	1.18 (24)
<i>erometra longicirra</i>							
Holotype	10		11	6.3	12	8.4	1.34

This value is probably slightly low since some true figure may be c. 1.0 : 1.

Several pinnules were measured from each s

This maximum must be an error if the hol

TABLE II

Numerical data from specimens of *Pterometra pulcherrima*, also *Asterometra anthus* and the holotype of *A. longicirra* for comparison.
The cirrus counts include consolidated fractions for immature ones

	Arms			Centrodorsal			Cirri				Pinnules						
	No.	L. (mm)	Breadth at 3 + 4 (mm)	Length to 3 + 4 (mm)	Ht. (mm)	Diam. : Ht. (: 1)	Cirrus L. : Arm L.	No.	Segs.	L. (mm)	L. of longest seg. (mm)	L. : Br longest seg. (: 1)	P ₁		P ₂		
													Segs.	L. (mm)	Segs.	L. (mm)	L.P ₂ : L.P ₁
<i>Pterometra pulcherrima</i>																	
Small specimens:																	
Range	11-19	33-65	0.8-1.2	4.7-6.2	1.6-3.2	1.05-1.40	0.69-1.14	XIV-XX	58-93	35-61	0.85-1.15	1.31-1.81	9-15	4.0-4.7	10-13	5.0-5.8	1.22-1.36
Mean and number	14 (6)	47.5 (7)	1.04 (7)	5.4 (7)	2.4 (7)	1.32 (7)	0.95 (6)	XVII (7)	70 (6)	43 (6)	1.00 (7)	1.46 (7)	11	4.3 (5)	11	5.5 (6)	1.28 (5)
Main sample:																	
Range	16-20	55-70	1.2-1.5	5.5-7.4	2.4-4.5	0.87-1.88	0.69-1.17	XV-XXV	70-100	40-70	0.90-1.30	1.06-1.76	12-15	4.2-6.3	12-16	5.2-9.0	1.05-1.55
Mean and number	19 (47)	64 (47)	1.3 (47)	6.3 (47)	3.2 (47)	1.33 (47)	0.91* (38)	XX (47)	84 (40)	57 (40)	1.13 (47)	1.35 (47)	13	5.3 (41)	14	6.9 (43)	1.29 (40)
S.D.	1.02	5.30	0.07	0.39	0.50	0.20	0.11	2.30	7.35	6.33	0.09	0.16	0.88	0.50	1.08	0.69	0.14
Specimens with short cirrals:																	
Range	20-21	55-70	1.2-1.3	5.3-6.3	2.4-2.9	1.38-1.73	0.64-0.84	XV-XXIV	68-87	40-50	0.95-1.05	1.00-1.27	10-17	4.2-6.8	10-17	5.3-10.0	1.15-1.69
Mean and number	20 (9)	61 (7)	1.3 (9)	5.9 (9)	2.7 (9)	1.54 (9)	0.72 (5)	XX (9)	79 (8)	44 (8)	1.00 (9)	1.08 (9)	13	5.6 (18)†	13	7.4 (18)†	1.33 (18)†
Type material (from A.H.C., 1947)	20	70-120	—	—	—	—	0.75-1+	XII-XXV**	80-120	78-128	—	—	—	—	—	—	—
Holotype	20	100	—	—	5	1.2	c. 0.8	XXXV	80-85	75-80	—	c. 1.4	16	8	19	12.5	1.56
'Investigator' st. 387 (from A.H.C.)	20	70	—	—	—	c. 2	c. 0.7	XXV	72-88	46-54	—	c. 1.3	15	7	15	10	1.43
<i>Asterometra anthus</i>																	
Larger specimens (from Gislén, 1922):																	
Range	10-16	55-105	—	—	—	—	0.50-0.88	XV-XXIII	64-100	35-73	—	—	8-14	4-7	9-14	5.0-9.5	1.00-1.39
Mean and number	11 (32)	80 (30)	—	—	—	—	0.73 (31)	XIX (32)	75 (31)	54 (31)	—	—	11.4	5.6 (24)	11.6	6.7 (25)	1.18 (24)
<i>Asterometra longicirra</i>																	
Holotype	10	80-95	2.3	8.2	3.7	1.29	c. 1.0	XVIII	85	90	1.5	1.28	11	6.3	12	8.4	1.34

* This value is probably slightly low since some specimens may have had the longest cirri all broken; the true figure may be c. 1.0 : 1.

† Several pinnules were measured from each specimen, accounting for the extra number.

** This maximum must be an error if the holotype really does have as many as XXXV.

have been published. As a result of his observations Gislén synonymized with *A. anthus* two other nominal species of *Asterometra* described by A. H. Clark.

Since so many of the specimens have one or more complete arms, it was possible to make some measurements of length for correlation with the numbers of brachials. Some variation was found in the length of individual arms in the same specimen, to a maximum of c. 10 mm in the largest, so that, even though the maximum length given in the table is 70 mm, some individual arms c. 75 mm long occur but balanced by others in the same specimen less than the mean value used in the figures. Gislén also found (1922) that it is not practicable to estimate arm length within about 5 mm. The number of brachials is closely correlated with the arm length so that in a single specimen with six complete arms these range in length from 65 to 75 mm and their brachial counts from 110 to 130. A relatively small specimen with arms c. 35 mm long has only 74 brachials on two arms counted.

Apart from the variable features mentioned above and in the discussion of the family, the centrodorsal shows a considerable range of shape from higher than its maximum breadth in a few cases to almost twice as broad as high, the dorsal pole being either dome-shaped or, more often, with five radial convexities of varying degrees of prominence. (A. H. Clark's description of these as *interradial* in his Burmese specimen I think must be a mistake; in the main description of *P. pulcherrima* he notes they are radial.) As shown in fig. 14 there are openings in the calcified part of the centrodorsal, if not in the overlying body wall, on the apices of these convexities, or in similar positions when the dorsal pole is simply domed. These

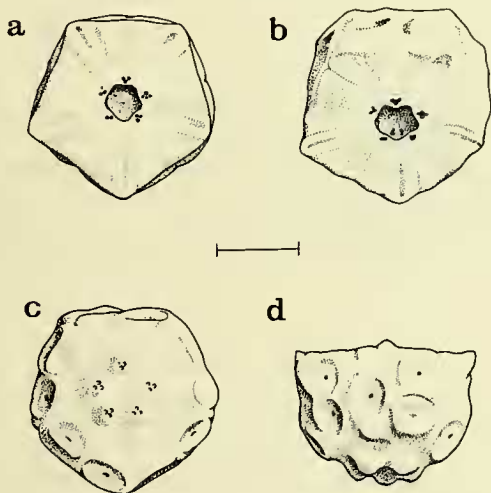


FIG. 14. *Pterometra pulcherrima* (A. H. Clark). 'Anton Bruun' st. 18A, N Malacca Strait. Centrodorsal 4.3 mm in diameter in a. ventral, b. oblique ventral, c. dorsal and d. side views, showing radial canals. [The scale equals 2 mm.]

are the aboral ends of vertical radial canals which perforate the entire centrodorsal outside the chambered organ and are subdivided by partial vertical septa, so that the canal in each radius branches and anastomoses irregularly into up to four separate passages with considerably more surface area than a single canal. However, preliminary sectioning indicates that these canals do not open to the exterior on the dorsal pole. In comparison, the radial pits described and figured by Gislén (1924, figs 287 and 288, p. 209, also fig. 293, p. 217) in *Notocrinus virilis* Mortensen, *Pterometra trichopoda* (A. H. Clark) and *Asterometra anthus* (A. H. Clark) are not only blind, stopping short by a third or less of the total height of the centrodorsal, but also single.

The discovery of complete radial canals perforating the centrodorsal in a recent comatulid supports the presence of similar ones in fossil species such as some of those of *Glenotremites*, *Loriolometra* and *Semiometra* figured by Gislén (1924) and Rasmussen (1961), the existence of which was dismissed by A. H. Clark (1915 : 229). It is also likely that complete canals through the centrodorsal exist, at least in some stage in the ontogeny, in other species of the Asterometridae. All the other species of *Pterometra* described by A. H. Clark usually have five radial convexities (tubercles in his terminology) on the dorsal pole and though in *Asterometra macropoda* he describes such tubercles as interradiar, his figure 190 (1915 : 235) shows them as radial. Although in the fossil species with aboral openings in the skeleton of the centrodorsal these are sunk into stellate hollows, in recent species it could be that they are correlated with convexities instead.

Unfortunately the absence of any really small specimens in the present sample prevents an ontogenetic study of this feature. Mortensen (1918 : 2) notes a fine pore in the centre of the apex of the dorsal pole of his smaller ('half-grown') specimen of *Notocrinus virilis*, surrounded by five radially-placed, possibly blind, pits, the latter having disappeared in the fully-grown specimen. This suggests that if radial perforations exist at any stage then this is likely to be younger rather than older. A fully-grown specimen of *N. virilis* in the British Museum collection decalcified and sectioned shows radial canals penetrating about two-thirds of the height of the centrodorsal. Without either dissolving the skin from the centrodorsal or decalcifying and sectioning it, it is impossible to be certain as to the presence of complete canals but they are present in all four of the 'Anton Braun' specimens so prepared, of both large and medium size, and external examination suggests that at least several more, if not the whole sample, also have them.

Familt THALASSOMETRIDAE

Cosmiometra gardineri A. H. Clark

Cosmiometra gardineri A. H. Clark, 1911b : 38; 1950 : 63-64.

MATERIAL. Stanley Gardiner; Saya da Malha Bank (between the Seychelles and the Mascarene Islands), c. 250 metres; the holotype. B.M. reg. no. 1907.7.1.135. 'Anton Bruun' cruise 9, st. 463, 11°24'N : 51°35'E (near Cape Gardafui, Somalia), 75-175 metres; 4 specimens.

DESCRIPTION. The holotype was only cursorily described by A. H. Clark in the form of a comparison with *Cosmiometra woodmasoni*. Some numerical details of it are given at the head of Table 12.

All its division series are of two ossicles. The centrodorsal is low and flattened with height : diameter 3.0 : 5.0 mm; it is somewhat tubercular around the base. There are XIX mature and iii immature cirri; all the mature peripheral ones are broken by the twenty-eighth segment, the data in the table being based on an immature cirrus. The transition segment, usually the ninth, measures 2.4 : 1.0 mm in one mature cirrus and 2.0 : 1.0 in another. The division series bear a smooth, slightly rounded, median keel and are squared off laterally, adjacent ones being fairly well appressed. The IB_{r1} are rather irregular. The 20 arms are carinate throughout, finely spinose in the distal half, each brachial having a truncated median distal keel.

TABLE 12

Numerical data from the holotype and four other specimens of
Cosmiometra gaudinevi

Arms		Cirri			Pinnules			
L. (mm)	Br at 3 + 4 (mm)	No.	Segs.	L. (mm)	P ₁ Segs.	L. (mm)	P ₂ Segs.	L. (mm)
140	2.0	c. XX	(c. 33)	c. 33	14	10.5	11	6.3
c. 80	1.5	XVIII	40	34	—	—	—	—
c. 70	1.5	c. XVI	—	—	17	8.7	11	5.3
—	1.5	XIV	c. 37	c. 27	19	9.0	—	—
c. 75	1.4	XII	—	—	17	8.4	14	6.6

The proximal pinnules are laterally compressed. The longest segments of P₁ have length : breadth 1.3 : 1. P₂ is stout basally, tapering in the distal half. The pinnules after P₇ have slightly broader median segments, prismatic in cross section. The distal pinnules are longer, P₃₇ with 19 segments being 10.5 mm long.

The 'Anton Bruun' specimens are more broken than the holotype but probably also had about 20 arms. The centrodorsal is rounded conical in the second specimen tabulated, with height : breadth 2.9 : 4.0 mm, fairly high rounded hemispherical in the next two with height : breadth c. 3.6 : 4.3 mm and the dorsal pole smooth, but low rounded conical in the last one. In the third specimen tabulated there is a slight raised ridge midradially in two radial areas but the other three have a median cirrus arising in this position. On the cirri the transition segment is usually the sixth or seventh but in one with 40 segments it is the eighth; this cirrus has dorsal spines starting from the ninth segment, in shape like the truncated lip of a jug, though as the segments shorten distally the lip becomes narrower and sharper. The division series and arms are much as in the type, laterally appressed basally and with distinctly acute keels except on the IB_r series where they are slightly blunted.

REMARKS. This species does not run down easily to *Cosmiometra* in A. H. Clark's key to the genera of Thalassometridae (1950 : 5) since the carination of the division series is fairly well-marked, contrary to the diagnosis of the genus, leading one to *Stenometra*.

RANGE. The new record extends the known range northwards into the Arabian Sea.

Crotalometra sp. ?*C. sentifera* A. H. Clark

Crotalometra sentifera A. H. Clark, 1909e : 147 (?); 1937 : 92; 1950 : 91-92, pl. 32, figs 100-103.

Thalassometra sentifera : A. H. Clark, 1912a : 201-203, fig. 37.

Crotalometra sp. ?*sentifera* : A. M. Clark, 1967b : 158-161.

MATERIAL. Eastern and Associated Cable Co., C.S. 'Electra', January, 1911 [assuming this date is that of capture, then the locality must be the Red Sea or, more likely, the Gulf of Aden]; 1 specimen. B.M. reg. no. 1911.7.29.2.

DESCRIPTION. Some numerical details are given in Table 13. The centro-dorsal is conical with large apical papillae. The cirri are arranged in ten paired columns of two to four in each, the pairs of columns contiguous adapically but separated peripherally by a triangular, slightly sunken, space in each radius. There are XXV mature and v-x immature cirri. The sixth cirrus segment is usually the transition one except on two of the peripheral cirri where it is the seventh and one apical one where it is the fifth. The first five segments of the mature peripheral cirri are shorter than broad; there are dorsal spines from about the fifteenth segment and these are small, sharp and distally-directed at first, even the distal ones being highest at the distal end with the profile slightly convex proximal to the apex of each spine, like an aquiline beak.

The IBr series and first two ossicles following (IIBr₁ and ₂ or Br₁ and ₂) have an angular median keel; also the proximal and distal edges of these ossicles are flared into frills, though these are only finely spinose. There is a coarse median tubercle on each radial. The brachials are rounded and, although the profiles of the arms become somewhat serrated in the distal half, the median angular projection on each brachial is neither very sharp nor markedly spinose. The joint between brachials one and two is usually fine and non-muscular, though more like a pseudosyzygy than a true syzygy, a broken one showing almost flush joint faces with some slight tubercles and a bare suggestion of the peripheral radiating ridges characteristic of a syzygy.

The first pinnule, P_D, is massive basally, prismatic and markedly tapering beyond the base; two studied have 18 and 21 segments but both measure 10.3 mm in length. P₁ with 17 segments is 7.9 mm long and P₂ with 11 is 5.5 mm and much more slender throughout.

There is an acorn barnacle on one cirrus and, as in one of the Deutsche Tiefsee-Expedition specimens, a parasitic gall on the disc.

REMARKS. In 1967 I described under the name of '*Crotalometra* sp. ?*sentifera*', two specimens from the Deutsche Tiefsee-Expedition taken off Kenya, commenting

that they are conspecific with the two John Murray Expedition specimens from the Maldive Islands if not with the little-known and badly-broken syntypes from the Laccadive Islands. The same is true of the 'Electra' specimen since there is clearly considerable variation in the shape and ornamentation of the centrodorsal, cirrals, division series and brachials, as well as in the number of cirri and the nature of the joint between the first two brachials. The two Kenyan specimens differ markedly in the number of cirri and the two Maldive ones in the shape of the centrodorsal and the development of papillae.

[It should be noted that there are two errors in my 1967 paper with regard to this species: p. 160, paragraph 5, line 4, should read 'on the IIBr₂' (not IIBr₃) for the position of P_D and paragraph 6, line 1, should have 'The arm breadth at the syzygy between brachials 3 + 4 is', etc.]

RANGE. If my surmise as to locality is correct, this record extends the known range of the species (whether or not it can be called *C. sentifera*) northwards into the Gulf of Aden.

TABLE 13

Numerical data from two John Murray Expedition specimens, one from the Deutsche Tiefsee-Expedition (in the Munich Museum) and the 'Electra' specimen of *Crotalometra* sp. ?*C. sentifera*

No.	Arms			Centrodorsal		Cirri			L : Br trans. seg. (: 1)	
	L. (mm)	Br at 3 + 4 (mm)	L. to 3 + 4 (mm)	Ht. (mm)	Diam. : Ht. (: 1)	No.	Segs.	L. (mm)		Trans. seg.
18 (? + 1)	—	1.6	10.5	3.7	1.35	XIX	57	c. 45	8	2.2
15 (? + 5)	—	1.7	10.5	3.7	1.15	XVII	65	c. 47	9 (8)	2.1
19	c. 130	1.6	8.5	5.25	1.32	XXXV	72	55	7	1.9
18	c. 130	1.8	10.0	4.2	1.05	XXX	71	60	6	1.6

Family ANTEDONIDAE

Subfamily ANTEDONINAE

Andrometra sp. ?*A. psyche* (A. H. Clark)

(fig. 15)

Antedon psyche A. H. Clark, 1908c : 241, pl. 1, figs 2, 3.*Andrometra psyche* : A. H. Clark, 1918 : 210; A. H. & A. M. Clark, 1967 : 81-84, fig. 5.*Andrometra aequipinna* Gislén, 1922 : 129-131, figs 114-116, pl. 2, fig. 11.

MATERIAL. 'Anton Bruun' cruise 9, st. 445, 09°41'N : 51°03'E (off N Somalia), 60-70 metres; 1 specimen.

'Anton Bruun' cruise 9, st. 447, 10°00'N : 51°15'E, 59-61 metres; 1 specimen.

DESCRIPTION. The specimen from station 447 is reasonably complete. The arm length is up to 57 mm; the breadth 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.

The shape of the centrodorsal is obscured by the cirri but it is probably low conical since the irregular papillose dorsal pole is only c. 0.5 mm in diameter while the peripheral diameter is 1.8 mm; the height is c. 0.8 mm. There are c. XXXV cirri, the stout peripheral ones with 14–16 fairly short segments and c. 7 mm long. On one cirrus the fourth segment from the base has median breadth 0.42 mm while the fourth segment from the tip is 0.55 mm broad, the distal enlargement being only moderate. The apical cirri have c. 11 segments and measure c. 3 mm in length.

The division series are well separated laterally, the IBr_1 having converging sides so that the lateral angles of the rhombic axillaries project well beyond them. The proximal angle of the axillary is very obtuse and only slightly elevated in an indistinct synarthrial tubercle. The two first brachials of each pair of arms are in contact beyond the distal angle of the axillary.

P_1 , P_2 and P_3 have respectively 8 (or 9), 10 and 9 segments and lengths c. 6.3, 7.9 and 5.0 mm. Their segments are elongated after the first one (or two) and mainly cylindrical and smooth but becoming slightly flared and spinose at their distal ends.

The second specimen has nine of the arms broken at the first syzygy and the tenth at the second. Its cirri have up to 14 segments and are incurved over the centrodorsal so as to obscure its shape again. P_1 , P_2 and P_3 have 8, 11 and 10 segments and are 4.2, 6.2 and 4.3 mm long in the one series remaining.

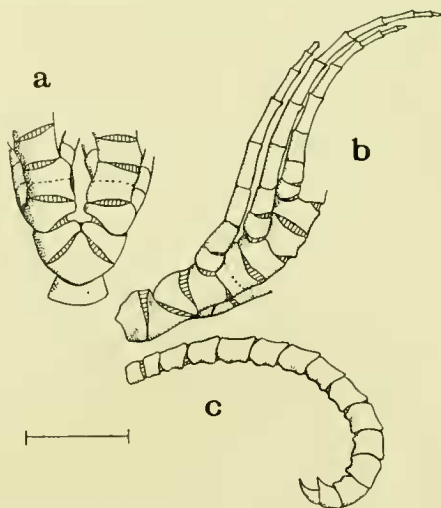


FIG. 15. *Andrometra* sp. ?*A. psyche* (A. H. Clark). 'Anton Bruun' st. 447, off Somalia. Arm br 1.0 mm. a. dorsal and b. side views of proximal part of one post-radial series, the arm in b. to Br_7 showing P_1 to P_3 ; c. mature peripheral cirrus. [The scale equals 2 mm.]

AFFINITIES. These specimens agree well with *Andrometra psyche* from southern Japan except that specimens of *A. psyche* with arm length c. 60 mm have up to 18 cirrus segments, the division series approximate to each other laterally, the IB₁ having parallel sides, and the pinnules are relatively smaller, P₁, for instance, being not more than 4 mm long. The geographically closer *Andrometra indica* (A. H. Clark) from the Andaman Islands differs much more in having the conical centro-dorsal bathymetrin-like, its height equal to its diameter, while the cirrus sockets number as many as LXX (the cirri themselves being unknown). *Antedon arabica* (A. H. Clark) from southern Arabia has heavier cirri with up to only 12 segments and its proximal pinnules are very different, P₁ with c. 20 short segments being much longer than P₂.

Antedon parviflora (A. H. Clark)

Compsometra parviflora A. H. Clark, 1912c : 133; Gislén, 1922 : 124-126, figs 109-113.
Antedon parviflora: A. H. & A. M. Clark, 1967 : 147-151, fig. 9b, c.

MATERIAL. 'Te Vega', F. C. Ziesenhenné's st. 64-19, 05°58'N : 73°79'E, lagoon off Kendikolu I., Miladummadulu Atoll, Maldive Is., 44-46 metres; 1 specimen.

DESCRIPTION. The arms are all broken at the first syzygy except one which remains to the second. The breadth at the first syzygy is 0.5 mm. The centro-dorsal is low hemispherical, 1.2 mm in diameter with c. XXV cirrus sockets; the central part has obsolete sockets and the surface is irregular. Only four cirri remain attached, none of which are mature or peripheral. The two larger ones have ten medially constricted segments flared at the joints and measure 2.8 mm in length. The fifth and longest segment is 0.4 mm long with length : median breadth 2.7 : 1. An apical cirrus has eight segments.

The axillaries are hexagonal with short projecting lateral flanges.

P₁ appears relatively huge; it has 9 or 10 + 1(?) segments and was probably c. 4.2 mm long when complete. The first two segments are short but the next is very stout, long and flared distally. P₂ with 5 + 1 (or 2) segments is c. 1.6 mm long. P₃, the first genital pinnule, had 5 + 1 (or 2) segments and is also c. 1.6 mm long.

RANGE. The Maldive Islands is the only locality in the Indian Ocean from which this species has been recorded. It was taken at Suvadiva Atoll by the 'Snellius' Expedition.*

Dorometra mauritiana (A. H. Clark)

Iridometra mauritiana A. H. Clark, 1911b : 40-42.
Dorometra mauritiana: A. H. & A. M. Clark, 1967 : 69-71.

MATERIAL. 'Anton Bruun', Tulear, Madagascar, offshore reef; 1 specimen.

*Since this paper went to press, I have received from Tel-Aviv University two specimens of *Antedon parviflora* (nos NS 4444 and 4446) taken at Dahab, Gulf of Akaba, in 7 and 25 metres, extending the range farther still.

DESCRIPTION. The arm length was probably c. 37 mm; the breadth at the first syzygy, 3 + 4, is 0.8 mm and the length from the proximal edge of the IBR_1 to this syzygy is 1.8 mm; the length to the second syzygy at 9 + 10 is 4.5 mm. The centrodorsal is 1.8 mm in diameter, almost completely covered with cirrus sockets; it has no distinct dorsal pole. All but one of the cirri have been lost, this one is from the second row from the periphery and has 11 segments, the length being 5.0 mm. The fourth and longest segment is flared at the ends, especially the distal end, and has length : median breadth 3 : 1, the length being 0.6 mm; the antepenultimate segment is 0.4 mm long with length : breadth 1.5 : 1.

P_1 and P_2 are straight and tapering. P_1 with 11 segments is 3.4–3.7 mm long; P_2 with 10 segments is c. 2.7 mm long and P_3 with 17 segments is c. 7.5 mm long; it is the first genital pinnule. The following pinnules are smaller than P_3 but have stouter gonads.

Dorometra nana (Hartlaub)

Antedon nana Hartlaub, 1890 : 170–171; 1891 : 89–90, pl. 5, figs 57, 58.

Dorometra nana: A. H. Clark, 1918 : 216; Gislén, 1922 : 133–135, figs 123, 124; 1940 : 15, pl. 2, figs 9–11; A. H. & A. M. Clark, 1967 : 71–75, fig. 3d.

MATERIAL. 'Te Vega', F. C. Ziesenhenné's st. 64–19, 05°58'N : 73°79'E, lagoon off Kendikoh I., Miladummadulu Atoll, Maldives Is., 44–46 metres; 2 specimens.

DESCRIPTION. Both specimens are badly broken. The larger one has the arm breadth at the first syzygy, 3 + 4, 0.7 mm; the length from the proximal edge of the IBR_1 to the second syzygy at 9 + 10 is c. 4.0 mm for the single, recurved, arm left beyond the first syzygy. The low rounded hemispherical centrodorsal is 1.6 mm in diameter. The cirri have all become detached and could belong to either specimen; the larger ones have 12–14 segments and measure c. 7 mm in length; the fifth and longest segment is 0.75 mm long with length : median breadth 2.8 : 1; only the first two segments are not longer than broad. There are c. XXV cirrus sockets. P_1 , P_2 and P_3 have segment counts and lengths of: 7, 2.1 mm; 7, 2.6 mm and 9 + c. 2, c. 7 mm.

The smaller specimen has P_3 with 12 segments, 3.4 mm long; the last few segments are very attenuated.

The larger specimen retains some pink colour in spirit but the smaller is banded with brown and off-white.

REMARKS. In 1967 (in Clark & Clark, 1967) I referred to *Dorometra mauritiana* five specimens from Male Atoll, also in the Maldives Islands, which A. H. Clark had originally identified as *D. nana*, since these five have as many as 21–25 segments in P_3 , the maximum recorded in *D. nana* being 16. The male specimens have the arm breadth at the first syzygy c. 1.1 mm and the smaller number of segments in the pinnules of Capt. Ziesenhenné's specimens might be attributable to their smaller size. However, the holotype of *D. mauritiana* and the 'Anton Bruun' specimen from Madagascar also have P_3 c. 7 mm long, like the larger of the present two, but with 17–20 segments. Accordingly it seems better to refer these two to *D. nana*.

RANGE. With this record, the range of the species is once again extended westwards to the Maldive Islands.

Subfamily **BATHYMETRINAE**

Fariometra liobrachia sp. nov.

(fig. 16)

MATERIAL. 'Anton Bruun' cruise 9, st. 423, 06°52'S : 39°54'E (off Tanzania), 200 metres; the holotype and ten paratypes.

DIAGNOSIS. A species of *Fariometra* in which the brachials are smooth, the two first brachials of each pair of arms are inwardly contiguous, the division series have parallel sides, the cirri have c. 20–25 segments, the longest segments four or five times as long as the median breadth, P₁ is much longer than P₂ or P₃, and P₄ is usually the first genital pinnule.

DESCRIPTION. Some numerical details of the holotype and paratypes are given in Table 14.

In the holotype the centrodorsal is rounded conical, two-thirds of its height being covered with crowded, irregularly-placed cirrus sockets, giving a honeycomb effect. The adapical obsolete sockets are occupied by rounded papillae but these stop short of the apex. Peripherally there are about five sockets opposite each radial.

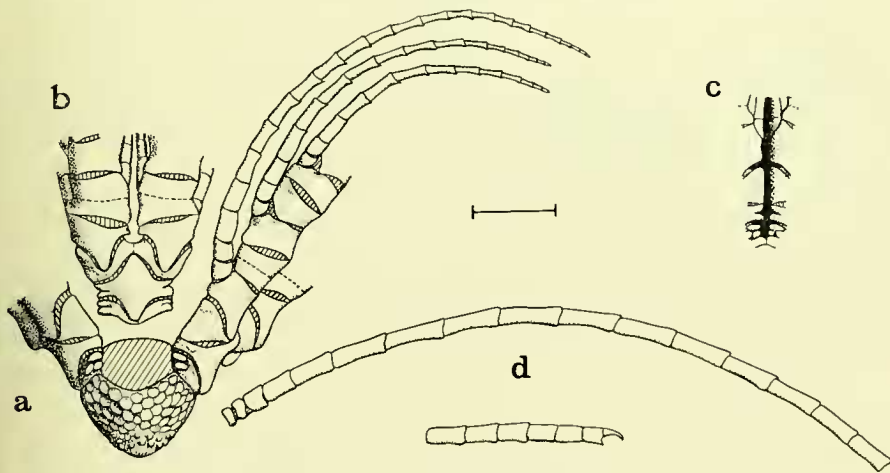


FIG. 16. *Fariometra liobrachia* sp. nov. Holotype. 'Anton Bruun' st. 423, off Tanzania. Arm br 1.35 mm. a. side view of calyx and proximal parts of two post-radial series, that on the right to Br₇ showing P₁ to P₃; b. dorsal view of proximal part of one post-radial series; c. dorsal view, interradially, showing flattened faces of two adjoining post-radial series with notches corresponding to the synarthrial joints between IBr₁ and 2 and Br₁ and 2; d. mature cirrus (probably not peripheral), drawn in two parts. [The scale equals 2 mm.]

TABLE 14
 Numerical data from the ten paratypes and the holotype (last) of *Favionetra tiobrachia* sp. nov.
 Numbers in brackets signify non-peripheral cirri

L. (mm)	Arms		Centrodorsal			Cirri		Pinnules								
	Br at (mm)	L. to (mm)	D. (mm)	D. : Ht. (: 1)	No. (approx.)	Segs.	L. (mm)	P ₁ Segs.	L. (mm)	P ₂ Segs.	L. (mm)	P ₃ Segs.	L. (mm)	L. (mm)	L. (mm)	
40 + c. 10	1.2	6.4	2.25	1.4	LXV	—	—	20	10.8	13	7.1	13	5.8	1.2	—	—
50 + c. 10	1.2	6.8	2.25	1.4	LXV	21	14.2	21	12.5	13	7.25	10	5.4	1.35	—	—
	1.2	6.7	2.3	1.4	LXX	(23)	17)	19	10.8	15	6.8	13	6.5	1.05	—	—
—	1.2	—	2.75	1.6	LXXV	—	—	18	10.8	—	—	—	—	—	—	—
—	1.25	6.8	2.5	1.4	LXXV	—	—	21	11.7	12	6.7	11	5.5	1.2	—	—
—	1.25	—	2.5	1.6	LXV	24	17.0	23	12.5	—	—	—	—	—	—	—
35 + c. 15	1.25	6.9	2.7	1.3	LXXV	—	—	19	10.0	c. 15	c. 8	15	6.7	1.2	—	—
—	1.35	c. 6.3	2.9	1.3	LXXV	—	—	18	10.0	15	8.6	—	—	—	—	—
—	1.4	7.5	2.9	1.6	LXXX	—	—	—	—	—	—	—	—	—	—	—
—	1.35	7.6	2.7	1.3	LXXX	(22)	14.6)	18	11.25	11	6.25	15	7.7	0.8	—	—
c. 60	1.35	7.9	2.6	1.4	LXXV	(21)	17.4)	23	13.2	17	9.2	13	7.0	1.3	—	—

There are no peripheral cirri left, the largest intact cirrus from among the middle ones has 21 segments and measures 17.4 mm in length. [A detached cirrus of 22 segments 17.6 mm long has the first two segments short, the third as long as broad, the seventh and longest 1.3 mm long with length : median breadth 4.8 : 1, the more distal segments only gradually becoming shorter so that the antepenultimate still has length : median breadth 1.75 : 1.]

The radials are almost completely occluded by the centrodorsal. The axillary has a conspicuous proximally-directed median angle so that the IBr_1 is deeply concave distally. Similarly the second brachial has a pronounced proximal angle at the synarthry. However, these synarthrial tubercles are not very high in profile. Laterally the proximal and distal edges of the IBr_1 are thickened and raised forming two or three coarse raised knobs. The proximal joints are markedly notched laterally, which is especially evident between the bases of each pair of arms where the space is T-shaped since the two first brachials, though short inwardly, are fully contiguous with each other distal to the angle of the axillary but then have a free tangential face leading to the constricted joint with the second brachial (see fig. 16b). The axillaries have length : maximum breadth 1.9 : 1.7 mm. The arms are quite smooth. The distal intersyzygial interval is three muscular joints.

Most of the segments of P_1 are elongated and in side view have almost parallel sides, though they become slightly flared at the joints with a few fine spinelets dorsally. P_2 and P_3 are progressively more tapering than P_1 . P_4 is the first genital pinnule; it has 13 segments and is 5.8 mm long.

VARIATIONS. There is some variation in the relative height of the centrodorsal so that the diameter : maximum (interradial) height ranges from 1.3 : 1 to 1.6 : 1. The apex is more angular in some specimens. Owing to their irregular arrangement and crowding the number of cirrus sockets is difficult to estimate accurately but there are well over fifty in all the specimens. The radials are more evident in some of the specimens than in the holotype, especially laterally where they may have a convexity forming a cluster with the elevations on the IBr_1 , while the proximal lateral corner of the axillary can also be thickened and raised. There are small differences in the relative lengths of the proximal pinnules; although P_2 is normally distinctly longer than P_3 , in one specimen the reverse is true. The pinnules on different arms of the same specimen may vary slightly; for instance, an apparently mature P_1 in the tenth specimen in the table has only 15 segments and measures 9.6 mm compared with 18 segments and 11.25 mm in the one cited.

AFFINITIES. Of the other species of *Fariometra* recorded from the Indian Ocean, this new species differs from *F. sokotrae* John in the relatively lower centrodorsal, that of *F. sokotrae* being nearly as high as broad, the more numerous cirri, about five rather than three opposite each radial round the periphery, the smooth brachials and the position of the first genital pinnule, which is P_2 in the species from Sokotra. *Fariometra sewelli* A. H. Clark, from the Maldive area, has a centrodorsal of similar lowish conical shape but its cirrus segments are relatively shorter, the division series and arms are finely spinose and again P_2 is the first genital pinnule. The closest morphologically is probably the specimen from Deutsche Tiefsee-Expedition

station 265 off Somalia which I named '*Fariometra* sp. A' in 1967 (b : 163); this is very similar in size to the holotype of *F. liobrachia* and has P_5 , sometimes P_4 , the first genital pinnule but the centrodorsal is higher, the cirrus segments are probably more numerous and the division series and brachials are finely spinose.

Family PENTAMETROCRINIDAE

Pentametrocrinus varians (P. H. Carpenter)

Eudiocrinus varians P. H. Carpenter, 1882 : 496-497; 1888 : 81-82, pl. 7, figs 3-7.

Pentametrocrinus varians : A. H. Clark, 1912a : 251; 1937 : 97; A. H. & A. M. Clark, 1967 : 804-810.

MATERIAL. 'Anton Bruun' cruise 7, st. 369F, $24^{\circ}04'S$: $36^{\circ}15'E$ - $24^{\circ}07'S$: $36^{\circ}11'E$ (off Mozambique), 1630-1600 metres; 2 specimens.

DESCRIPTION. Both specimens are very badly broken and one of them is very small with no more than eight brachials of any arm left. There is a synarthry between the first two brachials so, in spite of the pinnule on the second one, this is a *Pentametrocrinus* not a *Eudiocrinus*. *P. varians* is the only known species of the genus in which P_1 is developed. Unfortunately all the pinnules are broken at their bases. The brachials are alternately flared and constricted.

The larger specimen has the centrodorsal 3.2 mm in diameter. The cirri probably numbered c. XII but there are about six other, probably obsolete, sockets. All the cirri are broken but two with more than four segments have the first three markedly shorter than broad, the fourth with length 1.6 mm and length : median breadth 1.9 : 1 and the sixth with length : median breadth 2.7 : 0.7 = 3.9 : 1, though its flared distal end is 1.0 mm broad. A loose incomplete cirrus of 16 segments has lost about five segments proximally and one or two distally; it shows considerable taper.

The longest piece of arm remaining is broken at the twentieth brachial and measures 23 mm. The breadth at the first syzygy (4 + 5) is 2.4 mm and the length from the first brachial to the second syzygy when this is at 10 + 11 is 11.3 mm (in one case the second syzygy is at 11 + 12).

The smaller specimen has the centrodorsal rounded conical and the radials are comparatively long, whereas in the larger one they are almost completely occluded by the centrodorsal.

Family BATHYCRINIDAE

Democrinus chuni (Döderlein)

(fig. 17)

Rhizocrinus sp. Döderlein in Chun, 1900 : fig. on p. 488.

Rhizocrinus chuni Döderlein, 1907 : 14-15, pl. 1, fig. 5, pl. 6, fig. 6.

Rhizocrinus (Bythocrinus) chuni : Döderlein, 1912 : 14-16, figs 3a, 5, 6, pl. 3, figs 1-7, pl. 5, figs 2, 4, pl. 7, figs 1-5, pl. 8, figs 1-10.

Rhizocrinus (Bythocrinus) braueri Döderlein, 1912 : 16-18, figs 3b, 7, pl. 4, figs 1-6, pl. 5, fig. 3, pl. 6, figs 1-6.

Democrinus chuni : Gislén, 1938a : 26-27; 1938b : 21-22, pl. 2, fig. 8.

MATERIAL. 'Anton Bruun' cruise 7, st. 369F, 24°04'S : 36°15'E-24°07'S : 36°11'E (off Mozambique), 1630-1600 metres; 4 specimens.

'Anton Bruun' cruise 7, st. 389E, 30°09'S : 31°37'E (off Durban), 930 metres; 41 specimens.

'Anton Bruun' cruise 7, st. 389G, 29°57'S : 31°31'E (SE of Durban), 700 metres; 9 specimens.

'Anton Bruun' cruise 8, st. 407A, 18°24'S : 42°11'E (Mozambique Channel), 2125 metres; 1 specimen.

REMARKS. This is the only stalked crinoid taken by the 'Anton Bruun'. Unfortunately, as usual in this family, the arms are badly broken in the great majority of specimens and in fact only three have any brachials left beyond the first one.

Although Döderlein has given some idea of the variation in the material taken by the Deutsche Tiefsee-Expedition and Gislén (1927) has discussed growth changes in *D. japonicus*, it seems worth while to include here some numerical data to try and show variations and growth changes by relating some of the proportions to others. In Table 15 the individual specimens have been grouped into three lots using the mean size sequence derived from the sequences obtained by: (1) the length \times maximum breadth of the calyx (basals and radials together), which is an unreliable criterion of size on its own owing to differences in *shape*, (2) the diameter of the top of the stalk, (3) the maximum length of an unspecialized columnal (omitting the sporadic double columnals sometimes found) and (4) the length of the ten proximal-most columnals. Using the mean sequence from all these, inevitably there is some overlapping in the individual measurements such as calyx length, which could alternatively be used itself alone as criterion of size, or any of the above four measurements. However, I think a more accurate estimate is obtained by taking the four into consideration.

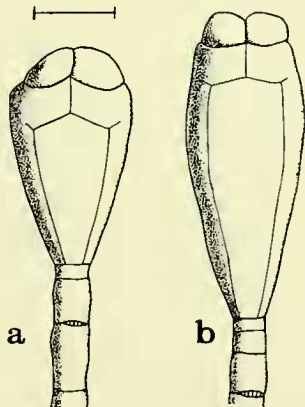


FIG. 17. *Democrinus chuni* (Döderlein). 'Anton Bruun' st. 389E, off Natal. Two specimens (arms lacking beyond the first brachial and only the proximal-most part of the stalk drawn) to show the two basic shapes of calyx, A and B, corresponding to a. and b. [The scale equals 2 mm.]

TABLE 15

Summarized numerical data from 52 specimens of *Demarcinus chani* taken by the 'Anton Bruun', divided into three successive size groups (see text) followed by the totals. The excessive numbers in brackets are for abnormal specimens or ones possibly misplaced in the size estimates

	Range	No.	Mean	Range	No.	Mean	Range	No.	Mean	Total range	No.	Mean	S.D.
Calyx length (mm)	1.5-2.8	17	2.3	2.1-3.7 (4.8, 6.3)	17	3.2	3.8-8.5	17	5.6	1.5-8.5	—	—	—
Calyx max. breadth (mm)	1.0-1.5	17	1.3	1.3-1.9	17	1.5	1.5-2.5	18	1.9	1.0-2.5	—	—	—
Basals max. length (mm)	1.0-2.4	17	1.7	1.6-3.4 (4.3, 6.0)	17	2.7	3.5-7.9	17	5.1	1.0-7.9	—	—	—
Radials length (mm)	0.4-0.6	17	0.5	0.4-0.8	17	0.5	0.3-0.7	18	0.5	0.3-0.8	52	0.5	0.11
Top of stalk diameter (mm)	0.3-0.5	16	0.4	0.4-0.6	17	0.5	0.6-1.2	18	0.8	0.3-1.2	—	—	—
Basals length as % of calyx length	71-87	17	78	73-93	17	83	87-94 (85)	17	91	71-94	51	84	7.4
Calyx breadth as % of calyx length	43-75	17	60	29-68	17	51	23-44 (55)	17	35	23-75	51	49	13.8
Calyx shape: A, AB or B	10 : 2 : 5	—	—	4 : 2 : 11	—	—	0 : 6 : 12	—	—	14 : 10 : 28	—	—	—
Stalk length (mm)	19-29	9	24	28-35 (50)	4	32	50-82 (95+)	6	70	19-82 (95+)	—	—	—
Columnals no.	26-36	9	29	31-35 (39+)	4	34	37-53 (60+)	6	47	26-53 (60+)	—	—	—
Columnals no. to first 'cirrus'	24-30 (33)	14	27	25-35	13	30	26-50	11	40	24-50	—	—	—
First ten columnals length (mm)	4.7-7.6	16	6.3	6.8-10.0	17	7.8	8.8-14.5	18	11.1	4.7-14.5	—	—	—
Longer columnals individual length (mm)	0.8-1.0 (0.7)	16	0.9	0.9-1.3	17	1.1	1.2-2.6	18	1.6	0.8-2.6 (0.7)	—	—	—
Longer columnals length : median breadth (: 1)	2.1-4.0	16	2.9	1.9-3.4	17	2.6	1.6-2.7	18	2.0	1.6-4.0	—	—	—
First ten columnals length as % of stalk length	22-31	9	27	21-27	4	23	15-19	6	16	15-31	19	23	5.4
Br ₁ length (mm)	0.4-1.1	17	0.8	0.4-1.4	16	0.7	0.5-0.8	15	0.6	0.4-1.4	48	0.7	0.25
Br ₁ length : median breadth (: 1)	0.7-1.7	17	1.2	0.6-1.7	16	1.1	0.6-0.9	15	0.8	0.6-1.7	48	1.0	0.3