

**NEW ZEALAND
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH**

BULLETIN 142

The Fauna of the Ross Sea

PART 1

Ophiuroidea

by

H. BARRACLOUGH FELL

New Zealand Oceanographic Institute

Memoir No. 18

1961

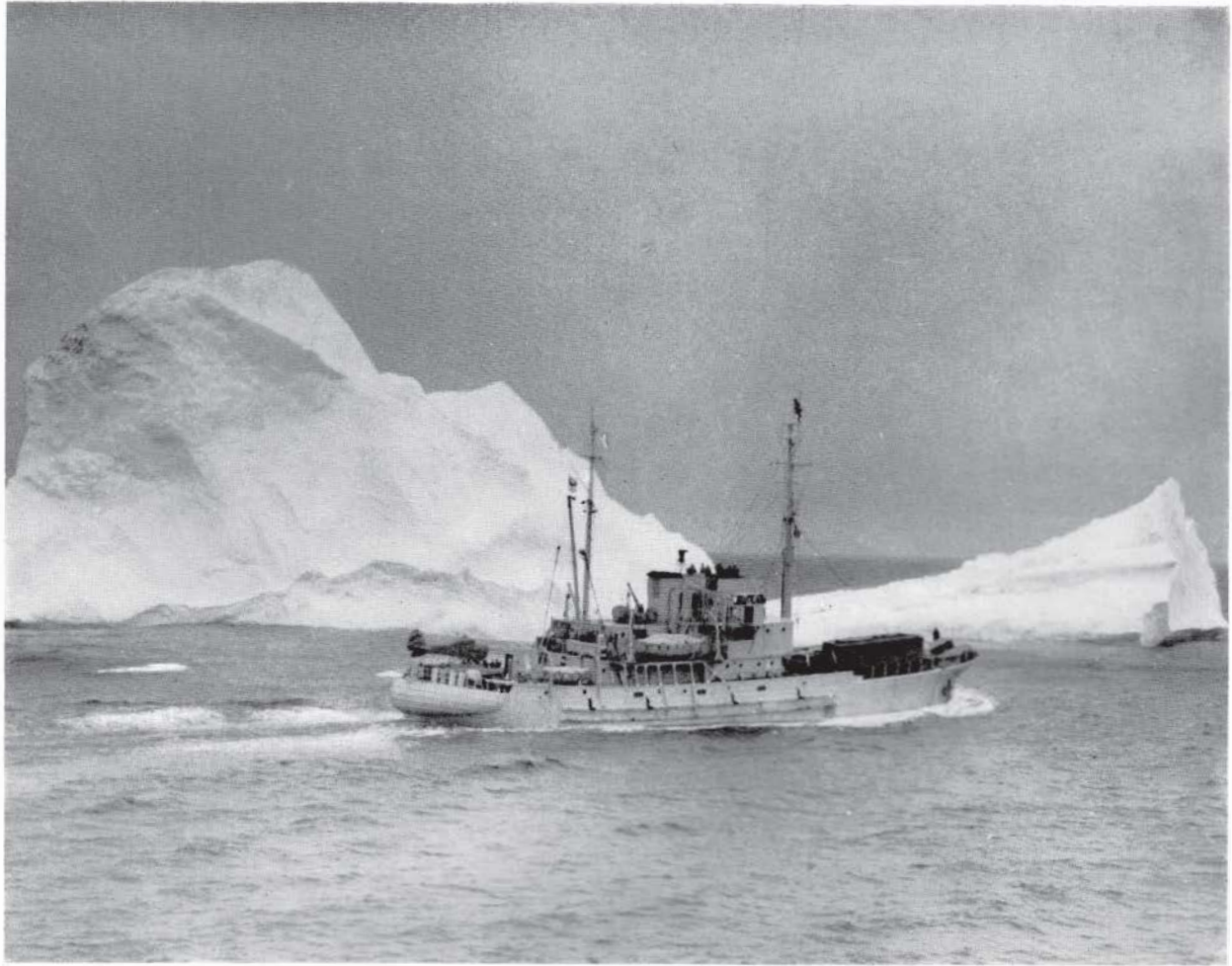


Photo: Tom Lloyd

HMNZS *Endeavour* nearing the pack-ice on the way to McMurdo Sound.

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FOREWORD

Each summer season, since 1956–57, the New Zealand Oceanographic Institute has undertaken one or more research cruises in the Antarctic, initially as part of the International Geophysical Year programmes and their extensions, and latterly as part of the New Zealand Antarctic Research Programme.

The major efforts of the 1958–59 and 1959–60 seasons were devoted to an oceanographic survey of the Ross Sea in which, as well as associated hydrological information, sediment samples, plankton, and fish, substantial collections of benthic animals were obtained.

Each of these expeditions was led by J. S. Bullivant. In 1958–59 he was assisted by D. G. McKnight and A. G. Macfarlane of the Institute staff and N. A. Powell of Antarctic Division, D.S.I.R. John Reseck, jun. (Long Beach State College, California) and Dr R. K. Dell (Dominion Museum, Wellington) were co-workers; and in 1959–60, G. A. Harlen and E. C. French of Antarctic Division, D.S.I.R. assisted.

The cooperation of the New Zealand Naval Board and of the Commanding Officer and ship's company of HMNZS *Endeavour* is gratefully acknowledged. The Antarctic Division has materially assisted the field and laboratory work by the secondment of staff and provision of equipment.

The biological material has been sorted and preserved under the supervision of J. S. Bullivant. The present contribution by Professor Fell includes consideration also of additional material collected by members of the Commonwealth Trans-Antarctic Expedition 1957–58; and by zoologists of Stanford University operating under the United States Antarctic Research Programme. Their cooperation, and particularly the assistance given by Mr John Dearborn, has enabled an effectively wider range of material to be examined. Of particular note in this report are the excellent photographs taken both in the field and in the laboratory, the latter by Mr M. D. King of Victoria University of Wellington.

The preliminary technical editing of the manuscript has been carried out by Dr D. E. Hurley. Mr M. O'Connor (Information Bureau, D.S.I.R.) has been responsible for final editing.

Further results of examinations of these collections will be published as studies of other groups are concluded.

J. W. BRODIE,
Director,
N.Z. Oceanographic Institute.

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Ophiuroidea of the Ross Sea

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Abstract

The material comprised 3,000 specimens from 67 Ross Sea stations between 30 m and 1,375 m. 22 genera are recorded, 11 as new records for the Ross Sea, 3 as new taxa. Of the 33 species, 16 are new records, and 3 new taxa. 17 species enter the Magellanic region, in latitudes corresponding to parts of the New Zealand plateau; the pattern of their distribution implies that the Palmer Archipelago has provided an effective benthal migration route. Save for 1 species (which will probably prove to have a widespread southern distribution), these eurythermal forms are completely absent from New Zealand and Australia. Their absence implies that there can have been no effective benthal migration route between Australasia and Antarctica since late Tertiary times, for if there had been one it would have been used. This argument can also be applied to the earlier Tertiary, when the New Zealand Oligocene and Miocene echinoderm faunas were strongly Indo-Pacific in character. The nature of mid-Tertiary Antarctic echinoderm faunas, though not yet known from direct fossil evidence, can be inferred from the structure of the extant fauna, and known evolution-rates in echinoderms; these data imply that the Antarctic echinoderm fauna had already acquired its present unique generic content by early Tertiary times. Therefore no effective benthal migration can have occurred between Australasia and Antarctica since the Eocene. These conclusions are consistent with the extant generic content of the echinoderm faunas of New Zealand, Australia, Antarctica, and the Magellanic region. Excluding cosmopolitan genera, only 1 ophiuroid genus is common to New Zealand, Antarctica and the Magellanic region, and no genera are shared by New Zealand and Antarctica alone. On the other hand, at least 7 genera are common to Antarctica and the Magellanic region, though found nowhere else in the world; the pattern of their distribution defines the limits of the Antarctic echinoderm fauna, with which the New Zealand fauna has virtually no relationship.

The material was supplemented by underwater photographs of the Ross Sea shelf at depths between 75 and 350 m, (in colour and monochrome). These reveal uneven concentrations of ophiuroids, with estimated local maxima of the order of 10^7 individuals per km² (40,000 per acre). It is inferred that the feeding behaviour of some species involves selective detritus-sampling, but others appear to "fish" for nekton or plankton-fall in characteristic attitudes, which are described. The smaller euryalae are considered to be predators. A significant part of the Antarctic archibenthical biomass comprises ophiuroids.

INTRODUCTION

The Ross Sea occupies a broad embayment of the Antarctic continent almost diametrically opposite the Weddell Sea, of which it is the Pacific counterpart. Its waters support an echinoderm fauna of astonishing richness and variety, distinguished by certain extraordinary genera found in no other part of the globe. The fauna, which apparently extends under the Ross Ice Shelf, is of intrinsic interest as the most southern assemblage of marine animals so far accessible for detailed investigation. It is also of critical importance in zoogeography. Aspects which have been examined in the course of the present study include: (1) faunal relationships between the Ross Sea, Bellingshausen Sea, and Weddell Sea; and (2) whether or not a benthal migration route exists, or formerly existed, between South America, Antarctica, and New Zealand. The data are considered to give clear evidence on these problems.

The report is based mainly upon the collections of Ophiuroidea assembled in the course of two cruises by HMNZS *Endeavour* in connection with Ross Sea surveys carried out by the New Zealand Oceanographic Institute. The general planning of the expeditions was undertaken by the Director of the Institute, Mr J. W. Brodie, and allowed for the biological programme from which the present study is derived, as well as physical, oceanographic and associated investigations. Cruise I, carried out during 1958–59, involved a survey of the Ross Sea between 9 January and 27 January 1959, the work beginning and ending at McMurdo Sound. Mr John S. Bullivant was leader and responsible for photography; D. G. McKnight biology technician; A. G. Macfarlane hydrology technician; and N. A. Powell student assistant. Dr R. K. Dell of the Dominion Museum, Wellington, and Mr J. Reseck of Long Beach State College, California, accompanied the party and gave valuable assistance during the survey. Cruise II, 1959–60, included sea-seismic and oceanographic work carried out during January and February 1960; the oceanographic survey was performed in two stages between 18 January and 17 February 1960. Mr J. S. Bullivant was again leader and responsible for photography and Messrs E. C. French and G. A. Harlen were technical officers.

A valuable collection of echinoderms was assembled by Dr R. W. Balham, the biologist of the Trans-Antarctic (New Zealand) Expedition during 1956–58. These include some 200 specimens

of Ophiuroidea, mostly from shore stations in the south-eastern part of the Ross Sea. Although the original intention was to issue a separate report on the collections of the Trans-Antarctic Expedition, the material of the Expedition provides significant data on the inshore distribution of the same species as are represented in the offshore waters of the Ross Sea, and accordingly the present report combines the results of the two major expeditions. Dr Balham's collections include materials from trawls carried out on HMNZS *Endeavour*, and USS *Glacier*, as well as numerous individual samples obtained from fish-traps lowered through holes in the ice. In this work he was assisted during the summer seasons by Mr Richard E. Barwick. An unusually high proportion of the inshore samples (about half the specimens) comprises juvenile stages which are at present difficult to identify. These have not been included in the present report; there is no reason to believe that they represent species other than those already recognised. A separate list of material taken by the Trans-Antarctic Expedition is given under the section entitled Station Details, and the same distinction is retained throughout the systematic entries under the heading Material Examined. Apart from these, the results are integrated.

Additional material collected by Mr John H. Dearborn has also been included in the report. This was obtained during the course of the Stanford University biological programme in the Ross Sea area, under the leadership of Dr Donald Wohlschlag, with the aid of grants from the United States National Science Foundation.

PREVIOUS WORK

The first collection of ophiuroids from the Ross Sea was obtained by the *Southern Cross* Antarctic Expedition, under the leadership of C. E. Borchgrevink, during the years 1898–1900. The expedition was the first to spend the winter on the mainland, and collections were made at Cape Adare and Franklin Island at depths of 10 and 30 fathoms. Bell (1902) recorded three species:

Ophiosteira antarctica
Ophionotus victoriae
Ophiozona inermis

The first two of these are the types of their genera, and are among the most characteristic Antarctic

echinoderms. The third name is now known to have covered an assemblage of at least two species of *Ophiurolepis* (*O. martensi* and *O. gelida*).

More extensive collections were made by the National Antarctic Expedition of 1901-04, under the leadership of R. F. Scott, the chief vessel being the *Discovery*. Bell (1908) recorded 10 species, including the three which he had previously recorded. Two more species, recorded under the names *Ophiacantha imago* and *Ophiacantha cosmica*, were probably wrongly identified (see p. 34), and cannot be accepted as such. The remaining five new records were:

Ophiura koehleri
Ophiacantha vivipara
Ophioconis antarctica
Amphiura belgicæ
Astrotoma agassizii

The first of these is now known as *Ophioperla koehleri*, and the third is transferred (in the present report, p. 43) to the genus *Toporkovia*. The remaining names stand unchanged.

Four species of ophiuroids were taken by the British National Antarctic Expedition of 1907-09, under the leadership of E. H. Shackleton, the vessel being the *Nimrod*. The party wintered on Ross Island, and all the specimens are from Cape Royds. Koehler (1911) recorded the following species:

Ophioglypha resistens
Ophioglypha flexibilis
Amphiura algida
Ophiacantha disjuncta

Of these, the first is now known to have been *Ophiuroglypha martensi*, and the fourth is *Ophiacantha antarctica*. The second species retains its name, but is now referred to *Ophiura*.

Sten Wallin, who accompanied a whaling expedition to the Ross Sea in 1924, collected seven species which were recorded by Mortensen (1925). Those new to the Ross Sea were:

Ophioparte gigas
Amphiura joubini
Ophiocten megaloplax
Ophiurolepis gelida
Ophiurolepis wallini
Ophiomastus bispinosus

Of these, the second is referred in the present report to *Amphiodia*, and the fifth to *Theodorina*, the others remaining unchanged.

A number of American expeditions were active in the Ross Sea area in subsequent years, but no additions to the ophiuroid fauna were recorded.

Thus, at the outset of the current Ross Sea survey, the known fauna comprised 17 species of Ophiuroidea, referred to 11 genera. The material had been collected under most arduous conditions, mostly from shore stations, and, although complete data are not available, it appears that it aggregated not more than a few hundred specimens. Most of the specimens, which include holotypes, are in the custody of the British Museum.

SCOPE

The scope of the present report is sufficiently indicated by the accompanying map, showing the majority of the 67 stations from which ophiuroids have been obtained. The collections comprise over 3,200 specimens, though the present report is restricted to mature forms only, which number 3,000. The value of the collections is greatly enhanced by the remarkable series of underwater photographs of the floor of the Ross Sea taken by J. S. Bullivant.

ACKNOWLEDGMENTS

In the preparation of the report my colleagues and staff of the New Zealand Oceanographic Institute have kindly given of their time or special knowledge and these are gratefully acknowledged. Mr J. S. Bullivant who has been in general charge of the biological investigations in the Ross Sea has, throughout the project, spared no effort in order to achieve a rich and balanced material. The results of the first season's work were discussed before the second summer expedition, and as a result it was possible to fill some of the gaps in the information provided by the first expedition; in particular, methods of preservation were modified and he obtained a valuable series of deck photographs in colour of the trawl-contents when first brought to the surface. Valuable field notes, including colour data, have been made available to me by Dr R. W. Balham of the Trans-Antarctic Expedition, and by Mr J. S. Bullivant: these are individually acknowledged in the body of the report.

The prime feature of the field work has been the underwater photography for which Bullivant was responsible: it has yielded a series of vivid pictures of outstanding interest and value, both in colour and in black and white. For the opportunity of studying these, in conjunction with the specimens taken from the same stations, I am deeply grateful. The photographs, some portions of which are reproduced here, throw light on old problems and, of course, pose some new ones.* The station data which follow in the next section have been compiled from information provided by Bullivant. I wish to acknowledge the cooperation of the Department of Biological Sciences, Stanford University, whose collections were also entrusted to me, and I would especially thank Mr John H. Dearborn. The map on p. 13 has been prepared by Miss Helen E. Clark from data supplied by J. S. Bullivant and J. H. Dearborn. Much of the initial sorting and curating of the collections has been undertaken by Julian Fell and Alan Simmons. The hydroid and gorgonian visible in plates 1 and 2 were determined as such by Miss P. M. Ralph. To Miss M. Wood, of the Royal Society of New Zealand, I am greatly indebted for assistance in obtaining much of the literature relating to the investigation. Dr G. Beliaev of the Oceanological Institute, Academy of Sciences, Moscow, kindly forwarded North Pacific material for comparison, and re-examined the holotype of *Toporkovia fragilis*.

ATLAS

The photographs which illustrate the systematic section of the report are all due to Mr M. D. King of the Victoria University of Wellington. They represent an almost complete atlas of known Ross Sea ophiuroids. All photographs were made from dry material in order to illustrate diagnostic features not otherwise clearly seen (the descriptions are similarly based on dry material). Due allowance should therefore be made when comparing fresh material with the atlas, and, in every case, the provisional field determination should be checked by study of dried spirit-specimens. Typical examples have been illustrated so far as possible, but where significant changes occur during growth, more than one stage is illustrated. The actual size of each specimen is given beside its identification on the facing page. Unless otherwise stated, the specimens shown on any one plate are all to the same scale.

*Attention is drawn to Bullivant's (1959a) publication of nine photographs of the Ross Sea bottom fauna, three of them in colour. Although ophiuroids are not conspicuous in these, they give an excellent picture of the general bottom ecology.

STATION DETAILS

(1) New Zealand Oceanograph Institute Stations, 1959-60

ABBREVIATIONS

D.C.	Cone dredge.
D.D.	Devonport dredge, a modified naturalist's dredge.
D.N.	Naturalist's dredge.
G.D.	Dietz-LeFonde grab.
G.H.O.	Hayward orange-peel grab.
G.T.H.O.	Two G.H.O. together.
G.T.O.S.	Small orange-peel twin grabs.
G.T.P.	Toothed Petersen grab.
N.S.	Flat circular net.
T.A.S.	Small Agassiz Trawl.
T.P.	Pipe-frame Agassiz trawl.
U.W.C.	Underwater camera.

All depths are uncorrected sonic depths based on a speed of sound in water of 1,500 m/sec.

Sta. A448, 10 Jan 1959, 77° 27'S, 172° 22'E, 1500-2400 h, 752 m, mud, T.A.S., G.T.O.S., bottom temp. -1.8°C, 1 mile from Ross Ice Barrier.

Astrotoma agassizii Lyman 9 small specimens.

Ophiacantha antarctica Koehler 2 specimens.

Ophiosparte gigas Koehler 5 large specimens.

Amphiodia joubini (Koehler) 13 specimens.

Amphiura algida Koehler 7 specimens.

Ophionotus victoriae Bell 11 specimens.

Ophiurolepis martensi (Studer) 1 specimen.

Ophiurolepis gelida (Koehler) 1 specimen.

Ophiurolepis brevirima Mortensen 2 small specimens.

Ophiurolepis tuberosa (Mrtsn) 2 specimens.

Ophiosteira antarctica Bell 8 specimens.

Ophiosteira bullivanti Fell 1 specimen.

Ophiocten megaloplax Koehler 16 specimens (mostly juvenile).

Sta. A449, 11 Jan 1959, 77° 05'S, 177° 12'E, 0630-1240 h, 362 m, mud, T.A.S., G.T.O.S., T.A.S., bottom temp. -1.7°C, Ross Sea.

Astrotoma agassizii Lyman 14 small specimens.

Ophiacantha vivipara Ljungman 3 specimens.

Ophiacantha antarctica Koehler 105 specimens.

Amphiodia joubini (Koehler) 1 specimen.

Toporkovia antarctica (Lyman) 1 large specimen.

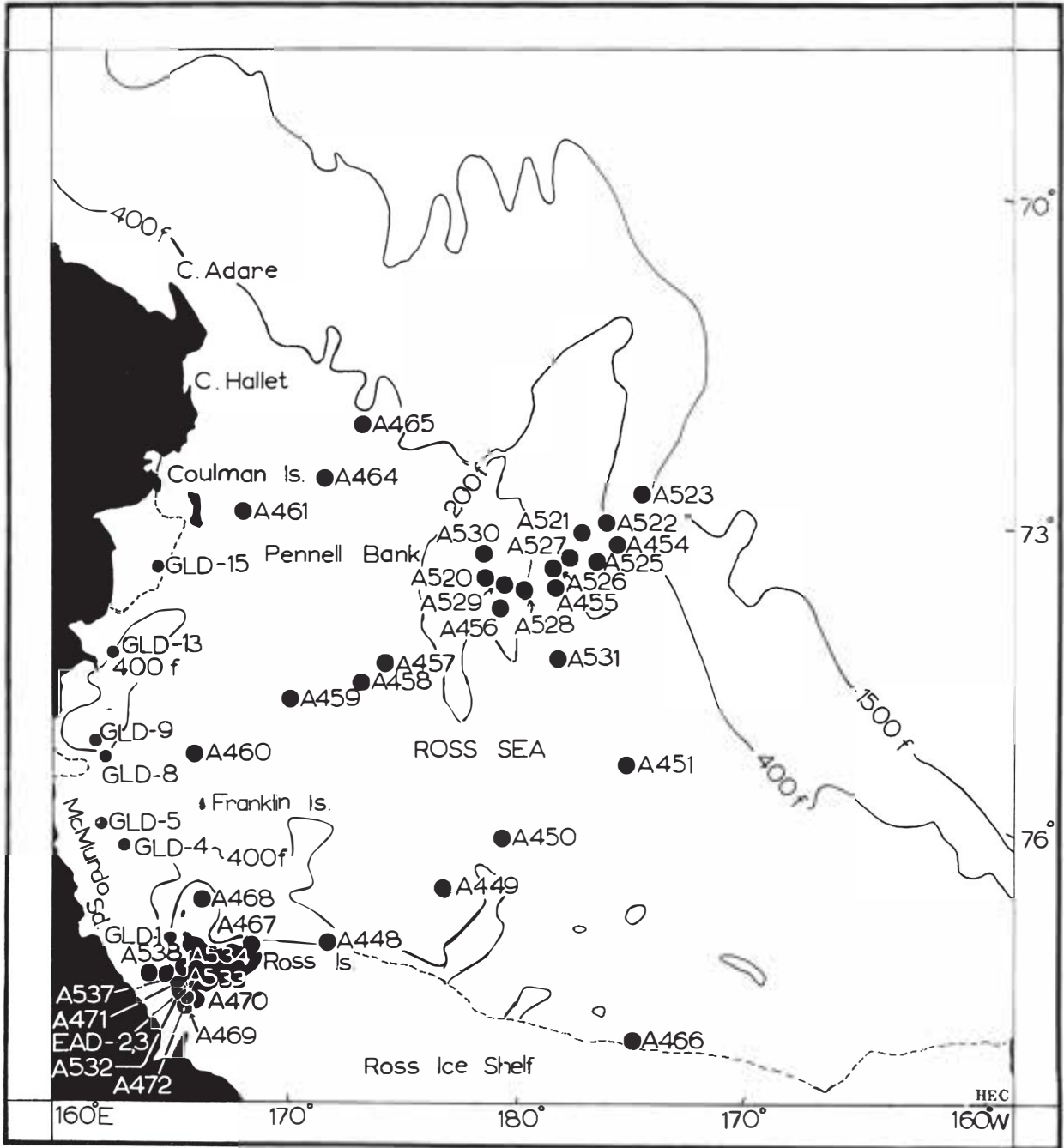


FIG. 1: Ross Sea Oceanographic stations at which Ophiuroidea were obtained.

Ophiuroglypha carinifera (Koehler) 1 disc.
Ophiurolepis gelida (Koehler) 17 specimens.
Ophiurolepis brevissima Mortensen 9 specimens.
Theodorina relegata (Koehler) 1 specimen.

Sta. A450, 11 Jan 1959, 76° 42'S to 76° 36'S, 179° 44'E to 179° 53'E. 1645–2315 h, 472–318 m, muddy sand, G.T.O.S., G.H.O., T.A.S., bottom temp. –1.9°C. Ross Sea.

Astrotoma agassizii Lyman 2 small specimens.
Ophiacantha vivipara Ljungman 1 specimen.
Ophiacantha antarctica Koehler 20 specimens.
Amphiodia joubini (Koehler) 2 specimens.
Ophiuroglypha carinifera (Koehler) 2 specimens.
Ophiurolepis martensi (Studer) 1 specimen.
Ophiurolepis gelida (Koehler) 4 specimens.
Ophiurolepis brevissima Mortensen 5 specimens.
Ophiura flexibilis (Koehler) 2 specimens.
Glaciacantha jason Fell 1 specimen.

Sta. A451, 12 Jan 1959, 76° 00'S, 175° 25'W to 175° 20'W, 523 m, gritty mud, G.T.H.O., T.A.S., G.D., bottom temp. –1.8°C, Ross Sea.

Astrotoma agassizii Lyman 1 specimen.
Ophiacantha antarctica Koehler 1 specimen.
Amphiodia joubini (Koehler) 4 large specimens.

Sta. A454, 14 Jan 1959, 73° 56'S, 176° 30'W, 1900–0040 h, 914–828 m, rocks, bottom temp. 0.0°C, T.A.S., G.H.O., Ross Sea.

Astrochlamys bruneus Koehler 1 specimen.
Amphiura belgicae Koehler 5 specimens.
Toporkovia antarctica (Lyman) 4 juvenile species.
Ophiopyren regularis Koehler 2 specimens.
Ophioceres incipiens Koehler 6 specimens.
Ophiura ambigua (Lyman) 8 specimens.

Sta. A455, 15 Jan 1959, 74° 22'S, 178° 35'W, 0400–0920 h, 322–340 m, stones, muddy sand, bottom temperature –1.0°C, G.T.H.O., G.D., D.N., Ross Sea.

Astrotoma agassizii Lyman 1 specimen.
Ophiacantha vivipara Ljungman 19 specimens.
Ophiacantha pentactis Mortensen 66 specimens.

Ophiacantha antarctica Koehler 30 specimens.
Amphiura belgicae Koehler 5 specimens.
Toporkovia antarctica (Lyman) 5 specimens.
Ophioceres incipiens Koehler 24 specimens.
Ophiuroglypha carinifera (Koehler) 22 specimens.
Ophiurolepis martensi (Studer) 1 specimen.
Ophiurolepis brevissima Mortensen 4 specimens.
Ophiosteira echinulata Koehler 2 specimens.
Ophiura crassa Mortensen 3 specimens.

Sta. A456, 15 Jan 1959, 74° 30'S, 179° 40'W, 1640–2100 h, 238–201 m, stones, gritty mud, bottom temp. –1.3°C, G.T.H.O., T.A.S., Pennell Bank.

Astrotoma agassizii Lyman 14 small specimens.
Ophiacantha antarctica Koehler 118 specimens.
Amphiura belgicae Koehler 6 specimens, one of them large.
Toporkovia antarctica (Lyman) 1 specimen.
Ophioceres incipiens Koehler 25 specimens.
Ophionotus victoriae Bell 2 specimens.
Ophiuroglypha carinifera (Koehler) 9 specimens.
Ophiurolepis gelida (Koehler) 22 specimens.
Ophiurolepis brevissima Mortensen 1 specimen.

Sta. A457, 16 Jan 1959, 75° 02'S, 175° 50'E, 0600–1200 h, 315–42 m, mud, bottom temp. –0.8°C, G.T.H.O., T.P., Ross Sea.

Ophiacantha antarctica Koehler 32 specimens.
Amphiura belgicae Koehler 7 specimens (1 large).
Amphiodia joubini (Koehler) 3 specimens.
Toporkovia antarctica (Lyman) 1 specimen.
Ophioceres incipiens Koehler 13 specimens.
Ophionotus victoriae Bell 3 specimens.
Ophiuroglypha carinifera (Koehler) 3 specimens.
Ophiurolepis gelida (Koehler) 20 specimens.
Ophiurolepis brevissima Mortensen 4 specimens.
Ophiosteira antarctica Bell 2 specimens.
Ophiura flexibilis (Koehler) 3 specimens.

Sta. A458, 16 Jan 1959, 75° 10'S, 174° 00'E, 1545–2000 h, 461–486 m, muddy sand, bottom temp. –1.8°C, G.T.H.O., T.P., G.D., Ross Sea.
Amphiodia joubini (Koehler) 1 specimen.

- Sta. A459**, 16 Jan 1959, 75° 17'S, 172° 20'E, 2350–0620 h, 534–549 m, soft mud, bottom temp. –1.9°C, G.T.H.O., T.P., Ross Sea.
- Astrotoma agassizii* Lyman 2 small specimens.
Ophiacantha antarctica Koehler 12 specimens.
Ophioparte gigas Koehler 8 specimens.
Amphiodia joubini (Koehler) 2 specimens.
Ophionotus victoriae Bell 32 specimens.
Ophiurolepis martensi (Studer) 1 specimen.
Ophiurolepis gelida (Koehler) 14 specimens.
Ophiurolepis brevirima Mortensen 23 specimens.
Ophiosteira antarctica Bell 3 specimens.
Ophiocten megaloplax Koehler 1 specimen.
- Sta. A460**, 17 Jan 1959, 75° 38'S, 168° 32'E, 1430–1915 h, 415–430 m, gritty mud, bottom temp. –1.9°C, G.T.H.O. G.D., T.P., Ross Sea.
- Ophiacantha antarctica* Koehler 7 specimens.
Ophioparte gigas Koehler 1 specimen.
Amphiodia joubini (Koehler) 2 specimens.
Ophionotus victoriae Bell 1 specimen.
Ophiurolepis gelida (Koehler) 1 specimen.
Ophiurolepis brevirima Mortensen 2 specimens.
Theodorina relegata (Koehler) 10 specimens.
- Sta. A461**, 18 Jan 1959, 73° 32'S, 171° 22'E, 1530–2120 h, 578–567 m, sandy mud, bottom temp. –2.0°C, G.T.H.O., T.P., Ross Sea.
- Astrotoma agassizii* Lyman 2 specimens.
Ophiacantha antarctica Koehler 37 specimens.
Ophioparte gigas Koehler 25 large specimens, and fragments.
Amphiodia joubini (Koehler) 3 specimens.
Ophionotus victoriae Bell Arm-fragment.
Ophiurolepis gelida (Koehler) 44 specimens.
Ophiurolepis brevirima Mortensen 5 specimens.
Ophiurolepis tuberosa (Mrtsn.) 14 specimens.
Ophiosteira antarctica Bell 20 specimens.
- Sta. A464**, 22 Jan 1959, 73° 20'S, 174° 00'E, 0030–0800 h, 369–384 m, sand, pebbles, bottom temp. –1.1°C, G.T.H.O., D.N., Ross Sea.
- Astrotoma agassizii* Lyman 1 specimen.
Astrochlamys bruneus Koehler 3 specimens (1 female carrying 2 males).
Astrohamma tuberculatum Koehler 2 specimens.
Ophiacantha vivipara Ljungman 5 specimens.
- Ophiacantha pentactis* Mortensen 17 specimens.
Ophiacantha antarctica Koehler 5 specimens.
Amphiura belgicae Koehler 3 specimens.
Ophioceres incipiens Koehler 19 specimens.
Ophionotus victoriae Bell 1 specimen and fragment.
Ophiuroglypha carinifera (Koehler) 1 specimen.
Ophiomastus bispinosus (Mrtsn.) 3 specimens.
Ophiura ambigua (Lyman) 10 specimens.
- Sta. A465**, 22 Jan 1959, 72° 55'S, 175° 30'E, 1200–1600 h, 399 m, barnacle plates, bottom temp. –0.5°C, G.D., D.C., Ross Sea.
- Astrotoma agassizii* Lyman 6 specimens (fragmentary).
Astrohamma tuberculatum Koehler 1 specimen.
Ophiacantha antarctica Koehler 49 specimens.
Ophioceres incipiens Koehler 2 specimens.
Ophiuroglypha carinifera (Koehler) 1 specimen.
- Sta. A466**, 24 Jan 1959, 78° 26'S, 174° 50'W, 1615–0130 h, 569 m, mud, bottom temp. –1.6°C, G.T.H.O., T.A.S., Ross Sea.
- Ophiacantha antarctica* Koehler 5 specimens.
Ophioparte gigas Koehler 9 specimens.
Ophioduces inanis Koehler 1 specimen.
Amphiodia joubini (Koehler) 1 large specimen.
Ophionotus victoriae Bell 16 specimens and some fragments.
Ophiomastus bispinosus Mrtsn. 2 specimens.
- Sta. A467**, 26 Jan 1959, 77° 25'S, 169° 28'E, 1040–1200 h, 88–183 m, rocks, D.N., off C. Crozier, Ross Island.
- Ophiacantha vivipara* Ljungman 23 specimens.
Ophiacantha antarctica Koehler 18 specimens.
Ophiurolepis martensi (Studer) 52 specimens.
Ophiurolepis gelida (Koehler) 1 specimen.
- Sta. A468**, 26 Jan 1959, 76° 59'S, 167° 36'E, 2115–2245 h, 110 m, T.A.S., U.W.C., Seamount E. of Beaufort I.
- Astrotoma agassizii* Lyman 1 large specimen.
Ophiacantha vivipara Ljungman 3 specimens.

- Ophiacantha antarctica* Koehler 46 specimens.
Ophiurolepis martensi (Studer) 2 specimens.
Ophiurolepis gelida (Koehler) 1 specimen.
Ophiosteira echinulata Koehler 2 specimens.
- Sta. A469**, 29 Jan 1959, 77° 50'S, 166° 33'E, 64 m, gritty mud, spicules, G.T.H.O., U.W.C., off Hut Point, Ross I.
Ophiurolepis martensi (Studer) 9 specimens.
- Sta. A470**, 4 Feb 1959, 77° 50'S, 166° 30'E, 377 m, muddy sand, bottom temp. -2.0°C, G.T.H.O. off Hut Point, Ross I.
Ophiacantha antarctica Koehler 4 specimens.
Ophiurolepis martensi (Studer) 6 specimens.
Ophiurolepis brevissima Mortensen juvenile stages apparently of this species.
Ophiosteira echinulata Koehler 1 specimen.
- Sta. A471**, 6 Feb 1959, 77° 37'S, 166° 20'E, 165-69 m, T.A.S., U.W.C., off C. Evans, Ross I.
Ophiacantha antarctica Koehler 4 specimens.
Ophiurolepis martensi (Studer) 6 specimens.
- Sta. A472**, 7 Feb 1959, 77° 45'S, 166° 20'E, 391 m, U.W.C., McMurdo Sound.
 No specimens were taken at this station, but Bullivant (1959b, fig. 10, p. 495) has published an underwater photograph of the sea-floor, in which can be distinguished the ophiuroid *Ophiurolepis gelida* (Koehler).
- Sta. A516**, 5 Jan 1960, 67° 25'S, 179° 57'W, 0400-0600 h, 457-183 m, rocks, D.N., Scott Island. Remarks: dredge torn, small sample, rocks, animals, seaweed. Colour photograph of trawl-contents.
Ophiacantha pentactis Mortensen 1 specimen.
Ophiacantha antarctica Koehler 24 specimens.
Toporkovia antarctica (Lyman) 1 specimen.
Ophionotus victoriae Bell 1 specimen.
- Sta. A520**, 3 Feb 1960, 74° 20'S, 179° 30'E, 1130-1415 h, 201-205 m, stones and sandy mud, G.H.O., D.N., Pennell Bank. Remarks: 3 grabs samples out of 5. Dredge $\frac{1}{3}$ full abundant Polyzoa.
Ophiacantha antarctica Koehler 18 specimens.
Amphiura belgicae Koehler 6 specimens.
Amphiura algida Koehler 2 specimens.
Ophioceres incipiens Koehler 7 specimens.
Ophionotus victoriae Bell 5 specimens.
Ophiurolepis gelida (Koehler) 22 specimens.
- Sta. A521**, 4 Feb 1960, 73° 54'S, to 73° 52' 36''S, 177° 44'W to 177° 46'W, 0854-1125 h, 582-558 m, stones with mud, G.H.O., G.T.P., D.D., Pennell Bank. Remarks: living and dead solitary corals abundant. Colour photograph of sample on deck.
Astrochlamys bruneus Koehler 4 small specimens.
Ophiacantha antarctica Koehler 3 specimens.
Ophiopyren regularis Koehler 1 specimen.
Ophioceres incipiens Koehler 29 specimens.
Ophiurolepis gelida (Koehler) 1 specimen.
Ophiurolepis martensi (Studer) 1 specimen.
Ophiurolepis brevissima Mortensen 8 specimens.
Ophiura ambigua (Lyman) 4 specimens.
- Sta. 522**, 4 Feb 1960, 73° 48'S, to 73° 50'S, 176° 41'W to 176° 54'W, 1530-2045 h, 1335 m, stones and muddy sand, Pennell Bank. Remarks: D.D. $\frac{3}{4}$ full branchiopods, barnacles, ophiuroids.
Ophiacantha antarctica Koehler 14 specimens.
Euvondrea floretta Fell 5 specimens.
- Sta. A523**, 5 Feb 1960, 73° 34'S to 73° 31'S, 175° 47'W to 175° 34'W, 0030-0830 h, 1375 m, Pennell Bank.
Ophiacantha pentactis Mortensen 14 specimens.
Ophiacantha antarctica Koehler 35 specimens.
Euvondrea floretta Fell 13 specimens.
Ophiura ambigua (Lyman) 9 specimens.
- Sta. A525**, 7 Feb 1960, 74° 09'S to 74° 07'S, 177° 16'W to 177° 09'W, 0800-0855 h, 591-583 m, stones, D.D., Pennell Bank. Remarks: small sample, colour photograph made on deck.
Amphiura belgicae Koehler 1 juvenile specimen.
Toporkovia antarctica (Lyman) 10 specimens.
Ophiopyren regularis Koehler 2 specimens.
Ophioceres incipiens Koehler 1 specimen.
Ophiurolepis gelida (Koehler) 1 specimen.

Sta. A526, 7 Feb 1960, 74° 07'S, 177° 41'W, 1050–1215 h, 461–465 m, Stones, G.H.O., D.D., Pennell Bank. Remarks: D.D., small sample corals, polyzoa, sponges, euphausiids; G.H.O., no sample. Colour photograph of D.D. sample on deck.

Ophiacantha vivipara Ljungman 3 specimens.
Ophiacantha antarctica Koehler 6 specimens.
Amphiura belgicae Koehler 1 specimen.
Ophioceres incipiens Koehler 14 specimens.
Ophiosteira bullivanti Fell 3 specimens, including 6 juveniles.

Sta. A527, 7 Feb 1960, 74° 10'S, 178° 17'W, 1326–1430 h, 358–337 m, stones, G.H.O., D.D., Pennell Bank. Remarks: G.H.O. no sample; D.D. good sample, stylasterine corals and ophiuroids, photographed in colour on deck.

Astrohamma tuberculatum Koehler 3 specimens (one of them black).
Ophiacantha vivipara Ljungman 1 specimen.
Ophiacantha pentactis Mortensen 106 specimens.
Ophiacantha antarctica Koehler 21 specimens.
Amphiura belgicae Koehler 11 specimens.
Ophioceres incipiens Koehler 73 specimens.
Ophiuroglypha carinifera (Koehler) 7 specimens.
Ophiurolepis gelida (Koehler) 5 specimens.
Ophiurolepis brevissima Mortensen 15 specimens.
Ophiosteira echinulata Koehler 3 specimens.
Ophiura ambigua (Lyman) 9 specimens.
Glaciacantha jason Fell 2 specimens.

Sta. A528, 7 Feb 1960, 74° 23'S, 179° 26'W, 1725–1855 h, 274–265 m, patches mud and stones, camera, D.D., Pennell Bank. Remarks: 3 B and W photographs; layer of mud and polyzoa over layer of stones.

Astrotoma agassizii Lyman 1 small specimen.
Ophiacantha vivipara Ljungman 2 specimens.
**Ophiacantha antarctica* Koehler 44 specimens.
**Amphiura belgicae* Koehler 10 specimens.
Toporkovia antarctica (Lyman) 1 specimen.
Ophioceres incipiens Koehler 25 specimens.
Ophiuroglypha carinifera (Koehler) 30 specimens.
**Ophiurolepis gelida* (Koehler) 98 specimens.
Ophiurolepis martensi (Studer) 2 specimens.
Ophiurolepis brevissima Mortensen 15 specimens.
**Ophiacantha pentactis* Mrtsn. [no specimens].

*Visible on seafloor in underwater photographs at this station.

Sta. A529, 8 Feb 1960, 74° 20'S, 179° 55'W, 1403–1515 h, 205–216 m, stones, U.W. Camera, D.D., Pennell Bank. Remarks: D.D. sample, polyzoa, ophiuroids and stones; 3-colour photographs of D.D. sample on deck.

Ophiacantha antarctica Koehler 9 specimens.
Amphiura belgicae Koehler 6 specimens.
Ophioceres incipiens Koehler 13 specimens.
**Ophiurolepis gelida* (Koehler) 32 specimens.
Ophiurolepis brevissima Mortensen 2 specimens.

*Visible on seafloor in underwater photographs taken at this station.

Sta. A530, 8 Feb 1960, 74° 03' 30''S to 74° 05'S, 179° 21'E to 179° 19'E, 1818–2000 h, 271–267 m, muddy sand, D.D., Pennell Bank, Remarks: no stones, muddy worm tubes, 2 fish.

Ophiacantha antarctica Koehler 9 specimens.
Amphiodia joubini (Koehler) 1 large specimen.
Ophiurolepis gelida (Koehler) 41 specimens.

Sta. A531 (b), 9 Feb 1960, 75° 02'S, to 75° 12'S, 178° 10'E to 178° 14'E, 1740–1815 h, 348 m, D.D. Remarks: small sample, polyzoa and comatulids.

Astrotoma agassizii Lyman 1 specimen.
**Ophiacantha antarctica* Koehler 6 specimens.
Amphiodia joubini (Koehler) 3 small specimens.
Ophionotus victoriae Bell 2 specimens.

*Underwater photographs taken at Sta. A531 show what appears to be this species, and also comatulids, including *Promachocrinus kerkuensis*, and a small asteroid.

Sta. A532, 10 Feb 1960, 77° 44' 30''S, 166° 20' 5''E, 1045–1200 h, 488 m, muddy sand and volcanic rock fragments, G.H.O., McMurdo Sound. Remarks: 2 grab samples, sponge spicules, gorgonacea, polychaetes.

Ophiacantha antarctica Koehler 4 specimens.
Ophiurolepis gelida (Koehler) 3 specimens.

Sta. A533, 16 Feb 1960, 77° 35'S, 166° 10'E, 1910–1955 h, and 1950–2010 h, 183–84 m, D.D., Cape Barnes. Remarks: masses of sponge, asteroid.

Amphiodia joubini (Koehler) 1 specimen.
Ophiurolepis martensi (Studer) 34 specimens.
Ophiura flexibilis (Koehler) 11 specimens.

Sta. A534, 16 Feb 1960, 77° 36' 42''S to 77° 36'S, 166° 08'E, to 166° 12'E, 2305–2330 h, 380–366 m, D.D., Cape Barnes. Remarks: polyzoa and sponges.

Astrotoma agassizii Lyman 1 large specimen.
Ophiacantha antarctica Koehler 22 specimens.
Amphiura belgicae Koehler 1 juvenile.
Ophiurolepis gelida (Koehler) 36 specimens.
Ophiosteira echinulata Koehler 1 specimen.

Sta. A537, 17 Feb 1960, 77° 30'S, to 77° 34' 48''S, 165° 12'E to 165° 19'E, 0945–1030 h, mud and gravel, D.D., McMurdo Sound. Remarks: Red sponges and *Astrotoma*. Colour photographs of D.D. sample made on deck.

Astrotoma agassizii Lyman 28 large specimens and 6 smaller.
Ophiacantha antarctica Koehler 77 specimens.
Ophiurolepis gelida (Koehler) 24 specimens.

Sta. A538, 17 Feb 1960, McMurdo Sound.

(a) 77° 29' 12''S to 77° 30'S, 164° 39'E to 164° 38'E, 269–256 m, sand and stones (grab sample).

(b) 77° 30'S to 77° 30' 12''S, 164° 38'E to 164° 37'E, 1645–1730 h, 256–260 m, U.W.C.

(c) 77° 30' 36''S to 77° 31' 12''S, 164° 37'E to 164° 38'E, 1740–1800 h, 269–348–256 m, (D.D.): sponge, polyzoa, crustacea. Colour photographs of sample on deck.

**Astrotoma agassizii* Lyman 1 large and 1 small specimen.

Ophiacantha vivipara Ljungman 8 specimens.

**Ophiacantha antarctica* Koehler 40 specimens (many of these parasitized, apparently by a copepod (?*Ophioika* sp.)).

Ophioceres incipiens Koehler 3 specimens.

Ophiurolepis martensi (Studer) 10 specimens.

**Ophiurolepis gelida* (Koehler) 25 specimens.

Ophiosteira antarctica Bell 1 specimen.

Ophiocten megaloplax Koehler 1 specimen (largest).

*Visible on sea-floor in underwater photographs taken at this station.

Hut Point, Ross Island, McMurdo Sound, Jan–Feb 1960, 300 m. specimens from fish-trap.

Astrotoma agassizii Lyman 3 specimens.

Ophiacantha antarctica Koehler 1 specimen.

Ophiurolepis gelida (Koehler) 7 specimens.

(2) Trans-Antarctic (New Zealand) Expedition, 1956–1958

[Abstract of collection data compiled from the expedition log, and from labels accompanying the material obtained by Dr R. W. Balham and Mr R. E. Barwick. The numbers which begin each entry refer to collected material, not to stations, but the entries are arranged so that those referring to substantially the same station are grouped together.]

153. USS Glacier 24 Dec 1956. 74° 44'S, 166° 19'E. 420 m. Coll. R. E. Barwick, from bathythermograph wire.

Astrotoma agassizii Lyman 1 specimen.

158. McMurdo Sound. 5 Jan 1957. Bay Ice-edge, E of Butter Point, coll. R. W. Balham.

Astrotoma agassizii Lyman 1 specimen.

179. McMurdo Sound. Ice-harbour. 28 Jan 1957. On bait and trap used for set-lines.

Ophiacantha antarctica Koehler 1 specimen.

256–328. Cape Armitage, McMurdo Sound. Various dates. All from fish-trap on seabed under bay-ice at 122 m, R. W. Balham.

256. *Ophiacantha antarctica* Koehler 1 specimen.

287. *Ophiacantha antarctica* Koehler 1 specimen.

288. *Ophiurolepis martensi* (Studer) 1 specimen.

325. *Ophiacantha antarctica* Koehler 1 specimen.

326. *Ophiurolepis gelida* (Koehler) 1 specimen.

328. *Ophiacantha antarctica* Koehler 1 specimen.

384–387. McMurdo Sound, 18 miles E of Cape Bernacchi. From crab-trap, 30 min on bottom, to surface. 304 m. U.S. Navy/R. W. Balham.

384. *Ophiurolepis gelida* (Koehler) 2 specimens.

385. *Ophiacantha antarctica* Koehler 3 immature specimens.

387. *Astrotoma agassizii* Lyman 1 specimen.

626. HMNZS Endeavour. Cape Evans, Station A. 27 Jan 1958. Petersen grab from ship. 42–55 m.

Ophiurolepis gelida (Koehler) 2 specimens.

672–691. USS Glacier. Hut Point, McMurdo Sound. 5 Feb 1958. Beam-trawl from ship. 124–165 m.

672. *Ophiacantha vivipara* Ljungman 5 specimens.

672. *Ophiacantha antarctica* Koehler 22 specimens.

672. *Ophiurolepis gelida* (Koehler) 79 mature specimens, plus 44 juveniles probably this sp.

675. *Ophiurolepis gelida* 3 small specimens.

691. *Ophiurolepis martensi* (Studer) 2 specimens.

716. HMNZS Endeavour. Franklin Island. 11 Feb 1958. Beam-trawl towed at dead-slow for 10 min. 73–110 m.

Ophiacantha antarctica Koehler 1 specimen.

Ophiurolepis gelida (Koehler) 1 specimen.

732, 747. HMNZS Endeavour. Cape Roberts, 76° 07'S, 168° 10'E. 12 Feb 1958. Beam-trawl from ship. 188–193 m.

732. *Astrotoma agassizii* Lyman 1 specimen.

732. *Ophiurolepis gelida* (Koehler) 2 specimens

747. *Ophiacantha antarctica* Koehler 59 specimens.

747. *Ophiurolepis martensi* (Studer) 3 specimens.

801. HMNZS Endeavour. Botany Bay, Granite Harbour. 15 Feb 1958. Beam-trawl from ship, R. E. Barwick. 73 m.

Ophiacantha vivipara Ljungman 3 specimens.

817–852. HMNZS Endeavour. Cape Evans, 77° 38'S, 166° 20'E. Beam-trawl from ship, R. E. Barwick. 110 m.

817. *Ophiurolepis martensi* (Studer) 1 specimen.

817. *Ophiurolepis gelida* (Koehler) 37 specimens.

852. *Ophiurolepis gelida* (Koehler) 12 specimens.

Dominion Museum Station, McMurdo Sound. 4–6 Jan. 1959. Fish-trap on ice-edge, R. K. Dell. 440 m.

Astrotoma agassizii 1 specimen.

Ophiacantha antarctica 3 specimens.

In addition to the material listed above, the Trans-Antarctic Expedition obtained ophiuroids in immature stages which could not be precisely determined.

(3) Benthic Invertebrate Program – Stanford University Stations, 1958–60

[Abstract of station data supplied by J. H. Dearborn]

Sta. GLD-1, 11–14 Nov 1958, 77° 42'S, 166° 12'E, McMurdo Sound, off Tent Island, 384 m: bottom, no precise data, probably sponge; time: variable, series of trap-sets for different lengths of time during the period; collectors: H. DeWitt and U.S.S. *Glacier* (AGB-4) Oceanographic Team. Remarks: Nine separate ring trap-sets during four days; GLD-1 station designation refers to U.S.S. *Glacier* – H. DeWitt No. 1.

Ophiacantha antarctica Koehler 1 specimen.

Ophiacantha vivipara Ljungman 1 specimen.

Ophiurolepis gelida (Koehler) 2 specimens.

Ophiosteira echinulata Koehler 1 specimen.

Sta. GLD-4, 27 Nov 1958, 76° 31-8'S, 164° 55'E, Ross Sea, 587 m: bottom, sponge complex, 0615–1700 h; collectors, H. DeWitt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team; remarks, 4 ft Blake trawl used; this station equals U.S.S. *Glacier* Deep Freeze IV Oceanographic Sta. No. GL-5.

Astrotoma agassizii Lyman 7 specimens.

Ophiurolepis gelida (Koehler) 3 specimens.

Ophionotus victoriae Bell 5 specimens.

Sta. GLD-5, 27 Nov 1958, 76° 11-6'S, 164° 46'E, Ross Sea, 695 m: bottom, sponge-gorgonacean complex; 1400–1500 h; collectors, H. DeWitt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team; remarks, triangular dredge; this station equals U.S.S. *Glacier* Deep Freeze IV Oceanographic Sta. No. 6. (GL-6).

Amphiodia joubini (Koehler) 5 specimens.

Ophiurolepis gelida (Koehler) 2 small specimens.

Ophionotus victoriae Bell 4 small specimens.

Sta. GLD-8, 29 Nov 1958, 75° 30'S, 165° 44'E, Ross Sea, off Terra Nova Bay, 631 m; bottom, sponge complex, gorgonaceans, pennatulaceans; 0945-1045 h; collectors, H. DeWitt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team; remarks, 4 ft Blake trawl used; this station equals U.S.S. *Glacier* Deep Freeze IV Oceanographic Sta. No. GL-9.

Amphiodia joubini (Koehler) 1 specimen.

Sta. GLD-9, 29 Nov 1958, 75° 15'S, 165° 55'E, Ross Sea, 808 m, 1500-1545 h; collectors, H. DeWitt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team; remarks, 28 in. diameter ring net, vertical tow, bottom to surface; this station equals U.S.S. *Glacier* Deep Freeze IV Oceanographic Sta. No. GL-10.

Amphiodia joubini (Koehler) 1 specimen.

Sta. GLD-13, 30 Nov 1958, 74° 39'S, 165° 52'E, Ross Sea, off Cape Washington, Terra Nova Bay, 164 m; bottom sponge complex; 2300-2330 h; collectors, H. DeWitt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team. remarks, 4 ft. Blake trawl; this station equals U.S.S. *Glacier* Deep Freeze IV Oceanographic Sta. No. GL-13.

Ophiacantha antarctica Koehler 5 specimens.

Ophiurolepis gelida (Koehler) 16 specimens.

Sta. GLD-15, 1 Dec 1958, 73° 58.5'S, 168° 29'E, Ross Sea, 365 m (?); bottom, gravel and pebbles, some mud; 1930-2000 h; collectors, H. DeWitt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team; remarks, triangular dredge; this station equals U.S.S. *Glacier* Deep Freeze IV Oceanographic Sta. No. GL-16.

Glaciacantha jason Fell holotype.

Ophiacantha antarctica Koehler 13 specimens.

Ophiosparte gigas Koehler 1 specimen.

Amphiodia joubini (Koehler) 1 specimen.

Ophiurolepis gelida (Koehler) 10 specimens.

Theodorina relegata (Koehler) 2 specimens.

Sta. B, in operation 19 Nov 1958 to 5 Jan 1959, McMurdo Sound, Ross Island, north of Hut Point about 1 mile, 115 m; bottom, sponge complex; collector, J. Dearborn, *et. al.*; remarks, variety of gear utilised, seal hole enlarged by hand.

Ophiurolepis gelida (Koehler) 25 Dec 1958 1 specimen.

Sta. CEK, 29 Jan 1960 to 30 Jan 1960, McMurdo Sound, Ross Island, off north shore of Cape Evans, 30 m; bottom, gravel and mud; collectors, J. Dearborn and J. Littlepage; remarks, 3 ft × 4 ft hole cut by hand; traps and bottom samplers utilized.

Amphiura algida Koehler 12 specimens.

Ophiurolepis gelida (Koehler) 6 small specimens.

Sta. X, in operation 24 Dec 1959 to 21 Feb 1960, McMurdo Sound, Ross Island, off Cape Armitage, 135 m; bottom, sponge-shell complex; collector, J. Dearborn, *et. al.*; remarks, hole blasted in ice, variety of gear utilized.

Amphiura algida Koehler 2 specimens.

Ophiurolepis gelida (Koehler) 9 small specimens.

(The ophiuroids were obtained by Petersen Grab, 31 Dec 1959.)

Sta. EAD-2, 19 Feb 1960, start—77° 39.4'S, 166° 16'E, stop—77° 40.8'S, 166° 16.5'E, McMurdo Sound, off Inaccessible Island, 315 m; bottom, sponge complex; 1945-2040 h; collectors, J. Dearborn, J. Littlepage, and U.S.C.G.S. *Eastwind* Oceanographic Team; remarks, 4 ft Blake trawl.

Astrotoma agassizii Lyman 3 small specimens.

Ophiacantha antarctica Koehler 54 specimens.

Ophiacantha vivipara Ljungman 16 specimens.

Ophiuroglypha carinifera (Koehler) 1 specimen.

Ophiosteira echinulata Koehler 1 specimen.

Ophiurolepis gelida (Koehler) 60 specimens.

Sta. EAD-3, 19 Feb 1960, start—77° 42.1'S, 166° 19.5'E, stop—77° 43.1'S, 166° 19.1'E, McMurdo Sound, off Inaccessible Island, 351-432 m; bottom, sponge complex with some rocks; 2149-2300 h; collectors, J. Dearborn, J. Littlepage, and U.S.C.G.S. *Eastwind* Oceanographic Team; remarks, 4 ft Blake trawl.

Astrotoma agassizii Lyman 8 large specimens.

Ophiacantha antarctica Koehler 10 specimens.

Ophiacantha vivipara Ljungman 1 specimen.

Ophiurolepis gelida (Koehler) 44 specimens.

MORPHOLOGY

The morphological features employed in the classification of ophiuroids are relatively few and well-defined. To demonstrate them clearly, it is nearly always necessary to dry a specimen, so that the underlying plates can be seen through the integument. Specimens should preferably be dried out from spirit preservation, rather than from the fresh state; they can be returned to spirit after identification, or preserved in the dried state. The following notes refer more particularly to Antarctic material, though they are of general application

The two surviving groups of ophiuroids are the Euryalina and Ophiurina, here treated as suborders of Ophiurida, the only extant order.

All Antarctic Euryalina so far known belong to the family Gorgonocephalidae. They are easily distinguished from other ophiuroids by the fact that the arms coil in the vertical plane (see plate 10, for representative forms): the other characters of the Gorgonocephalidae are noted in the relevant part of the systematic keys, and the only feature requiring special mention here concerns the shape of the small hooklets carried on the arms. In text fig. 2 is shown an example of such hooklets (or **girdle-hooklets**, as they are usually termed). The pointed, and usually recurved, extremity is termed the **primary tooth**: it is always present. Below it, on one side of the shaft of the girdle-hooklet, there may occur several **secondary teeth**, or only one, or none at all. These characters distinguish the Antarctic (and other) genera, and are mentioned in the keys. All known Antarctic Euryalina have simple (i.e., undivided) arms, but in the Subantarctic region occurs *Gorgonocephalus*, where the arms branch many times.

The other suborder, the Ophiurina, comprises forms in which the arms do not form tight coils in the vertical plane, and the animal is thus able to rest so that the lower surface is in contact with the sea-floor, the arms moving mainly in the horizontal plane. It is conventional to term the upper surface dorsal, the lower surface ventral, but the terms are used only in the analogous sense and imply no homology with parts similarly named in bilaterally symmetrical animals. In the systematic descriptions used throughout this report, the features of the upper or dorsal surface of the disc are given first, then follow those of the ventral surface. The arms are then described, with the dorsal, lateral, and ventral surfaces taken in that order. The dorsal surface of the disc is usually covered by scales or plates, which some-

times carry spines or granules. Near the middle of the disc are often seen six conspicuous plates, termed **primaries**; these comprise a central plate, the **centrodorsal**, which is surrounded by a ring of five **radial plates**. Near the edge of the disc, at the base of each arm, occur five pairs of plates the **radial shields**. The size, shape, and interrelation of these structures serve as taxonomic characters. On the ventral side of the disc the mouth is seen at the centre, surrounded by the five interradially-placed **jaws** and the five radially-placed **arms**. Distad with respect to the jaws lie the so-called **interradial areas**, in which the character of the scaling may be of systematic value. The jaws are margined by **oral papillae** and carry a vertical row of **teeth** at the apex. The oral papillae rest upon **oral plates**; distad to these again lies the single interradially-placed **oral shield**. The shape, size, and mutual interrelationships of these structures are always indicated in taxonomic descriptions. **Genital clefts** are seen at the sides of the arm-bases, opening into the **bursae** of the disc; the clefts may be long or short, bordered by small papillae (forming a so-called **genital-comb**) or devoid of papillae; these details are given in each description.

The arms are covered by discrete plates, the plates repeated in serial repetition from the base of the arm distad, so that the arm appears to be segmented; the segments are here termed **arm-joints**. Each arm-joint is covered dorsally by a **dorsal arm-plate**, laterally by a **lateral arm-plate** on either side, and ventrally by a **ventral arm-plate**. The descriptions always indicate whether these plates are contiguous or not, the shapes of the plates, and whether or not the two members of the lateral pair meet each other above or below. The lateral arm-plates usually carry **spines**, the number and sizes of which are important in specific determinations. On the ventral surface of the arm occur **tentacle-pores** through which the podia can be extruded: a pair of tentacle-pores lies on each arm-joint, and a large pair usually lie just beyond the radial angles of the mouth (the **oral tentacle-pores**). The pores are usually bordered by papillae termed **tentacle-scales**, or there may be a single tentacle-scale, or none: in young specimens the tentacle-scales may be fewer than in the adult, or lacking altogether. Young stages in the development of the arm-joints can be seen in the adult at the extremities of the arms, where new joints are being added.

The foregoing features are of quite general occurrence in ophiuroids, which comprise therefore a remarkably uniform or conservative group of Asterozoa. A few special features of less general occurrence may also be noted here, though they are more fully described in the body of the text. Members of the family Ophiuridae very often carry a row of papillae across the distal margin of the radial shields, the so-called **arm-comb**; it may be continuous with a **genital comb**, extending over the lateral edge of the disc. The radial plate of the primary group may be unusually large, and more or less obscure the radial shields; this is a character of the Antarctic genus *Ophiosteira*. The number of arms is occasionally of significance; thus, *Ophiacantha vivipara* almost always has six arms instead of

five. The genus *Ophioceres* is at once recognisable by the fact that the dorsal arm-plates are subdivided into several conspicuous elements, regularly arranged, on each arm-joint. *Ophionotus* is another Antarctic genus where the dorsal plates are subdivided, but here the central portion of the dorsal plate remains intact, while numerous small fragments of the lateral parts of the plate form a zone on either side. In *Euvondrea* the disc-plates lie in three circlets, with the distal margins curled upwards, like the petals of a flower. Study of the photographic atlas will show that in many cases some character permits ready identification at sight, but the specimen in hand should always be compared with the full description, since it may represent a species not included in the present work.

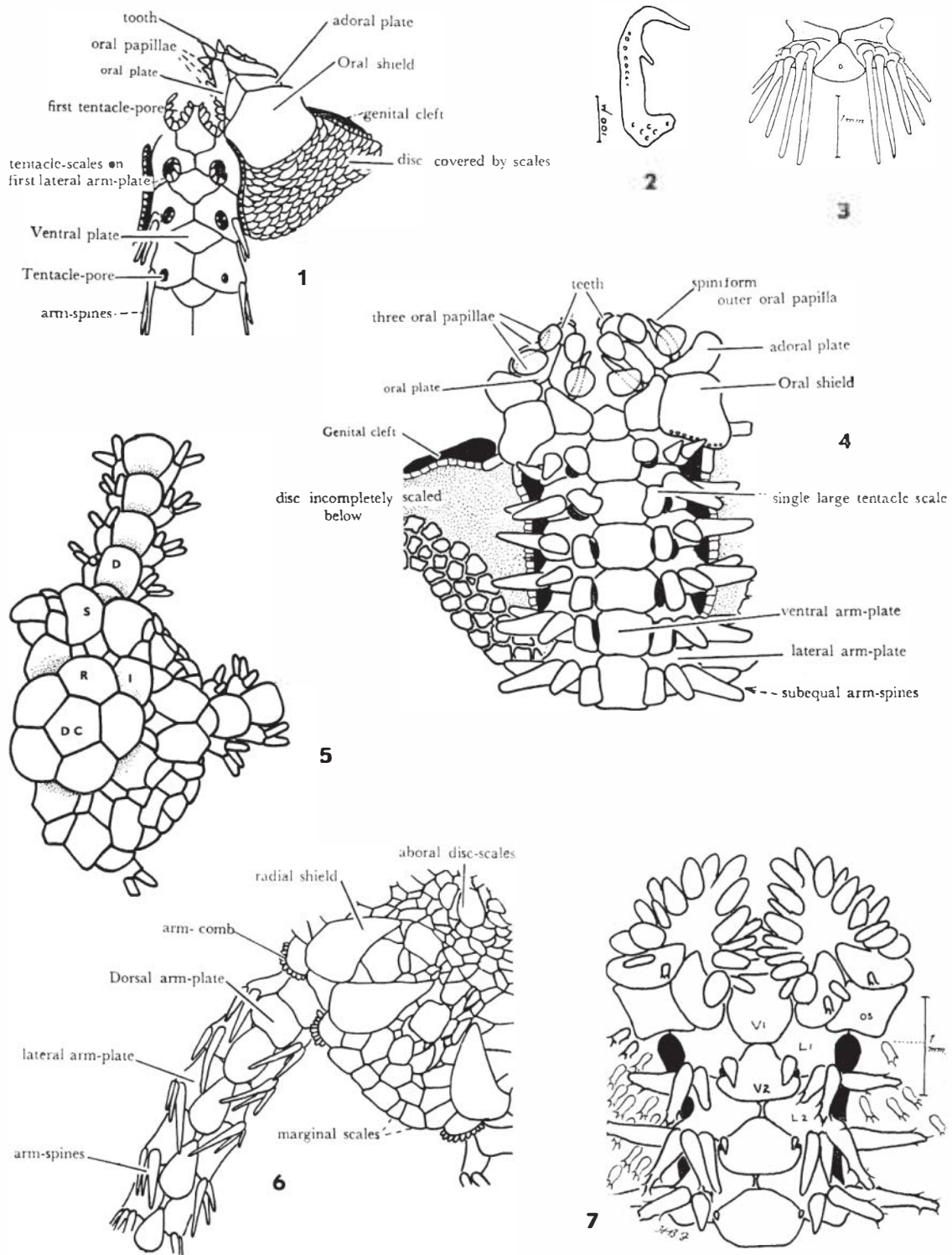


FIG. 2: Morphological features of Ophiuroidea used in taxonomy. 1, *Ophiura* (fam. Ophiuridae), ventral aspect; 2, arm-hooklet of *Astrothorax* (fam. Gorgonocephalidae); 3, dorsal aspect of arm-joint in *Ophiacantha* (fam. Ophiacanthidae); 4, *Ctenamphiura* (fam. Amphiuridae), ventral aspect; 5, *Amphiura* (fam. Amphiuridae), dorsal aspect showing primary plates: DC, centrodorsal; R, radial; I, intercalary plate; S, radial shield; D, dorsal arm-plate; 6, *Ophiura* (fam. Ophiuridae), dorsal aspect; 7, *Ophiacantha* (fam. Ophiacanthidae), ventral aspect: OS, oral shield; V1, V2, first and second ventral arm-plates; L1, L2, first and second lateral arm-plates.

CHECK LIST OF ROSS SEA OPHIUROIDEA

Species new to the Ross Sea are shown in boldface.

- Astrotoma agassizii* Lyman
Astrochlamys bruneus Koehler
Astrohamma tuberculatum (Koehler)
Ophiacantha vivipara Ljungman
Ophiacantha pentactis Mortensen
Ophiacantha antarctica Koehler
Ophiosparte gigas Koehler
Ophiodaces inanis Koehler
Glaciacantha jason Fell
Amphiura belgicae Koehler
Amphiura algida Koehler
Amphiodia joubini (Koehler)
Torporkovia antarctica (Lyman)
Ophiopyren regularis Koehler
Ophionotus victoriae Bell
Ophioperla koehleri (Bell)
Ophiocten megaloplax Koehler
- Ophiura ambigua** (Lyman)
Ophiura flexibilis (Koehler)
Ophiura crassa Mortensen
Ophiomastus bispinosus Mortensen
Ophiuroglypha carinifera (Koehler)
Theodoria relegata (Koehler)
Theodoria wallini (Mortensen)
Ophiurolepis martensi (Studer)
Ophiurolepis gelida (Koehler)
Ophiurolepis brevirima Mortensen
Ophiurolepis tuberosa (Mortensen)
Euvondrea floretta Fell
Ophiosteira antarctica Bell
Ophiosteira echinulata Koehler
Ophiosteira bullivanti Fell
Ophioceres incipiens Koehler

SYSTEMATICS

The systematic section has been keyed throughout to facilitate its use as a faunal handbook, in accordance with general editorial policy which has been adopted for the *Fauna of the Ross Sea*. The keys are, it is believed, in natural sequence. Thus they follow the same taxonomic principles as are used in the extended diagnoses of the taxa. The plan has been followed because it is evident that our present knowledge of the Ross Sea fauna is far from complete, and therefore the use of the artificial keys, though more direct, would impede the recognition of new forms when these are discovered. All keys are to be used in the following way: if the character indicated agrees with the specimen in hand, proceed to the next numbered paragraph, and continue to do so until a determination is reached; if any character does not agree, proceed directly to the contrasted character, indicated by the number of the relevant paragraph which is always given in parentheses. The final check is given by the complete diagnosis and illustration.

Class ASTEROZOA

Subclass OPHIUROIDEA

Asterozoa in which the alimentary organs are essentially confined to a central disc from which the arms are distinctly demarcated and capable of performing the locomotor movements, the tube-feet serving as non-suctorial, sensory tentacles.

Order **OPHIURIDA** Müller & Troschel.
1840

(syn. Myophiuroida Matsumoto, 1915)

Ambulacral groove closed over and purely internal, forming the epineural canal; ambulacral plates fused in pairs to form articulating vertebrae which permit snake-like arm-movements. (The largest order, comprising all living species and all known fossils from the Triassic onwards, as well as one Palaeozoic family, the Aganasteridae.)

KEY TO THE ANTARCTIC SUBORDERS, FAMILIES,
AND SUBFAMILIES

- 1 (2) Disc and arms covered by thick skin which may contain a mosaic of granules but does not overlie a layer of plates or scales. Arm-spines point downwards. Arms roll into vertical coils. Vertebrae articulate by broad, hourglass-shaped surfaces.

(Suborder EURYALINA M. & T. p. 25)

A single Antarctic family, diagnosed as follows; Vertebrae with a ventral furrow, so that the radial canal and nerve are not imbedded in stereom; distal arm-joints long and slender. Hooks on dorsal side of arms; the hooks have no lamina and lack regularly arranged perforations; gonads restricted to disc.

(Family GORGONOCEPHALIDAE Ljungman, 1867, emend. Mortensen, 1933. p. 25)

- 2 (1) Disc and arms covered by scales or plates (sometimes invested by skin or granules). Arm-spines placed laterally on arms. Arms usually move horizontally but in Fam. Hemieuryalidae they roll vertically).
(Suborder OPHIURINA Müller & Troschel, p. 30)
- 3 (4) Paired infradental papillae at the apex of each jaw.
(Family AMPHIURIDAE Ljungman, 1867. p. 38)
- 4 (3) An unpaired infradental papilla at the apex of each jaw.
- 5 (10) Arms inserted laterally into the disc and firmly fused to it.
- 6 (7) Granulation covers over the disc-scales of both upper and lower surfaces, often also covering the jaws.
(Family OPHIODERMATIDAE Ljungman, 1867, p. 43)
- 7 (6) No granulation.
(Family OPHIURIDAE Lyman, 1865. p. 46)
- 8 (9) Second oral tentacle-pore opens more or less entirely outside the oral slits.
(Subfamily OPHIURINAE Lyman, 1865, restr. Matsumoto, 1915. p. 46)
- 9 (8) Second oral tentacle-pore opens entirely within the oral slit.
(Subfamily OPHIOLEPIDINAE Matsumoto, 1915, p. 68)
- 10 (5) Arms inserted ventrally below the disc and partly overlain by the disc, the arms and disc not firmly fused together. Free margins of jaw bear a continuous series of oral papillae. Granules or spinules present on disc. Arms slender, often constricted at the nodes. Mainly abyssal forms.

- 11 (12) Arm-spines numerous, long, conspicuous, erect.
(Family OPHIACANTHIDAE Perrier, 1891, p. 30)

- 12 (11) Arm spines few, small, inconspicuous, adpressed.
(Family OPHIOLEUCIDAE Matsumoto, 1915. p. 45)

Suborder EURYALINA Müller & Troschel, 1840

Family GORGONOCEPHALIDAE

Ljungman, 1867, emend. Mortensen, 1933

KEY TO THE ROSS SEA GENERA

- 1 (4) Disc covered by granulation, sometimes including small spinules or shallow scales, but without coarse projecting spikes or tubercles.
- 2 (3) Granulation of disc more or less covered, and partly obscured, by a soft skin. About two arm-joints included within the disc; genital clefts shorter than 1 arm-joint; ventral arm-plates fragmented: 4 arm-spines.
Astrochlamys Koehler, 1911
- 3 (2) Granulation not invested in skin. Girdle-hooklets without secondary teeth: about 5 arm-spines. — *Astrotoma* Lyman, 1875
- 4 (1) Disc carrying coarse prominent tubercles, but no spikes. Three or four arm-spines. Disc covered above and below by coarse granules and tubercles: arms annulated by double rows of granules, alternating with rows of hooklets which have one feeble secondary tooth.
Astrohamma Döderlein, 1930

Astrotoma Lyman, 1875

Arms five, unbranched, elongate, tapering, with about 4-6 arm-spines, annulated by girdles of hooklets, which lack secondary teeth. Disc covered by granulation above and below, but lacking specialised tubercles or spikes, and not covered by skin. Genital clefts short, peripheral.

Type Species: Astrotoma agassizii Lyman.

The genus, monotypic when established, has been restricted by Matsumoto and Döderlein, who exclude a number of species which were referred to *Astrotoma* until recently. The two New Zealand species originally described under the genus *Astrotoma* are both now referred to the Indo-Pacific genera *Astrothorax* and *Astrothamnus*. Thus *Astrotoma* is once again regarded as monotypic, and restricted to Antarctica and the Magellanic region, as far north as the southern coasts of Chile and Argentina. It is unknown from

any part of the New Zealand submarine plateau, though this region corresponds geographically to the latitudes it occupies in South America. It seems clear that *Astrotoma* is absent from the southern part of the New Zealand plateau only because it has been unable to enter the New Zealand region. Probable reasons for this are discussed elsewhere, p. 73. The two New Zealand species, *Astrothammus benhami* and *Astrothorax waitei*, both of which were formerly placed in the genus *Astrotoma*, and cited as supposed "South American" elements in the New Zealand fauna, are now known to have their closest affinities with North Pacific species such as *Astrothorax misakiensis* and *Astrothammus echinacea* of Japanese waters. Thus, far from giving evidence of a South American affinity of the New Zealand fauna, the two species yield positive evidence to the contrary.

Astrotoma agassizii Lyman, 1875 (pl. 1a, fig. 2; pl. 10, fig. 1, 2, 4; pl. 18, fig. 4: col. pl. 1: col. pl. 2, b)

Astrotoma Agassizii, Lyman, 1875. Ophiuridae and Astrophytidae. Hassler Exped. III. Cat. Mus. Comp. Zool., VIII, p. 24. pl. iv, fig. 52-56; Koehler, 1908. Scott. Nat. Antarct. Exped. Asteries, Ophiures et Echinides, p. 614, pl. xiii, fig. 120; Döderlein, 1911. Japanische und andere Euryalae, p. 100; Kochler, 1922. Austral. Antarct. Exped. Echinod. Ophiuroidea, p. 9, pl. lxxvi, fig. 1-11; Kochler, 1923. Swedish Antarct. Exped. Asteries et Ophiures, p. 102; Fedotov, 1927. Morphologische Studien an Euryalae. Zietschr. Morphol. Ökol. Tiere, XI, pp. 381-4; Döderlein, 1927. Indopacifische Euryalae, p. 87; Döderlein, 1930. Deutsche Tiefsee-Exped. Ophiuriden. II, Euryalae, p. 372, Taf. i, figs. 1, I a; Mortensen, 1936. Disc. Rpts. 12, p. 236, pl. v, fig. 1, 2; pl. vi, fig. 1, 2; Fell, 1960. Zool. Pubns. Vict. Univ. Wgton., 26, p. 9.

Disc: Reaching a diameter of 60 mm, though specimens are usually only ca. 35 mm in diameter; subpentagonal in outline, the more or less deeply indented; upper surface concave towards the centre, strongly ridged by the underlying radial shields; lower surface somewhat convex. The upper surface and the outer part of the lower interradii are densely and uniformly covered by a fine granulation; the granulation becomes coarser in the inner region of the lower surface, especially over the jaws and associated plates, which are completely concealed by granules. The genital clefts are placed near the periphery, about opposite the fifth arm-joint, and do not exceed an arm-joint in length. The genital margins bear conical granules, larger and higher than the surrounding granules.

Arms: Five, stout, tapering, sometimes reaching a length of 400 mm, but usually only 250 mm, the length of the arm not always correlated to the diameter of the disc. The arms become almost cylindrical and very robust in large specimens (pl. 10, fig. 2), where the breadth at the base may reach 12.5 mm, and the height 11 mm; in specimens of size commonly encountered (pl. 10, fig. 1) the dimensions are about half those quoted, and the arm is also relatively narrower, the height of the arm somewhat exceeding the breadth. In the proximal part of the arm the arm-joints are about four times as broad as long. The dorsal and lateral surfaces are densely granulated, the granules forming transverse belts, about 10 rows of granules to a belt, whilst a single transverse row of hooklets demarcates the boundary between adjoining arm-joints. The lateral plates, concealed by the granulation, carry each a transverse row of robust conical arm-spines, each spine about half the length of its arm-joint. The first arm-joint carries no spine; the second carries 2 or 3 somewhat unequal spines; the next 8-10 joints carry each 3 similar spines; thereafter there are 4 or five spines; towards the slender arm-tip the spines become more slender, relatively longer, till they almost equal the arm-joint, and fewer in number. The ventral surface of the arm is more coarsely granulated than the other parts, with 4 or 5 transverse or oblique rows of granules, and furrows between the rows.

Colour in Life: Photographs by J. S. Bullivant (Sta. A537, A538) show the animal when freshly taken from the trawl, with a creamy-white disc and arms, uniformly tinted above and below, and seemingly with a somewhat translucent dermis. Spirit specimens assume a browner colour, sometimes tinged with dull red. The largest specimen (shown in pl. 10, fig. 2) is a darker brown than any of the others, but its appearance in life was not recorded.

Dr R. W. Balham recorded a specimen (No. 158) of the Trans-Antarctic Expedition collection from McMurdo Sound as having a straw-beige colour. A juvenile specimen from the same locality was examined by Dr R. K. Dell of the Dominion Museum; he noted that at this stage the radial shields appear cream, the rest of the disc "navy-blue beneath the surface", the arms light cream.

Type Locality

Lyman's holotype was taken in Magellan Straits, at the Pacific end, in 135 fm. (240 m).

Distribution

Antarctic circumpolar, Magellanic regions, Chile and Argentina; Southern coast of Chile (H. L. Clark, 1915, p. 181); Burdwood Bank, 54° 25'S, 52° 32'W (Koehler, 1909, p. 614); East and West Falkland Is., S. Georgia, off the coast of Argentina, at 48° 31'S, 63° 34'W, and other Magellanic localities (Mortensen, 1936, p. 236); Ross Sea, at Coulman I., and McMurdo Sound (Bell, 1908); Adelie and Wilkes Lands (Koehler, 1922, p. 9). *Bathymetric Range*: 75–750 m.

Material Examined

111 specimens from 24 stations, as follows:

Sta. A448, 1 mile from Ross Ice Barrier, 752 m, 9 small specimens; Sta. A449, Ross Sea, 362 m, 14 small specimens; Sta. A450, 472–318 m, 2 small specimens; Sta. A451, 523 m, 1 specimen; Sta. A455, 322–340 m, 1 specimen; Sta. A456, 238–201 m, 14 small specimens; Sta. A459, 534–549 m, 2 small specimens; Sta. A461, 578–567 m, 2 specimens; Sta. A464, 369–384 m, 1 specimen; Sta. A465, 399 m, 6 fragmentary specimens; Sta. A468, 110 m, 1 large specimen; Sta. A528, 274–265 m, 1 small specimen; Sta. A531(b), 348 m, 1 specimen; Sta. A534, 380–366 m, 1 large specimen; Sta. A538, 369–348–256 m, 1 large and 1 small specimen; Hut Point, Ross Island, fish-trap, 164 fm (300 m), 31 Jan 1960, 1 large and 2 small specimens.

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 153, McMurdo Sound, 420 m, 1 specimen; 158, McMurdo Sound, ice-edge, 1 specimen; 387, McMurdo Sound, 304 m, 1 specimen; 732, Cape Roberts, 188–193 m, 1 specimen; Dominion Museum Station (R. K. Dell), McMurdo Sound, 240 fm (440 m), 1 juvenile specimen.

Stanford University Stations: Sta. EAD-2 315 m, 3 small specimens; Sta. EAD-3, 351–432 m, 8 specimens.

The largest known specimens were taken by the *Discovery* off Cumberland Bay, South Georgia (Mortensen 1936, p. 236–7, pl. V–VI): the disc in these reached 60 mm diameter, but the arms were broken, so that R was indeterminable. The largest specimen from the Ross Sea so far taken is that from Stanford University Sta. EAD-3, McMurdo Sound, off Inaccessible Island; the disc measured 57 mm diameter. The radial shields of this specimen, as seen in pl. 10, fig. 2, form conspicuous ridges beneath the skin, ca 24 mm in

length; similar ridges were noted by Mortensen. As in his material, the arms are broken, but the robust basal portions remain, 12.5 mm thick.

Ecology and Feeding Habits

The general ecology and in particular the mode of feeding of *Astrotoma agassizii* have long remained obscure. The prehensile arms seem to suggest that the animal might inhabit the branches of large antipatharian corals in order to feed on the polyps, like other long-armed Euryalae. Yet no such corals have been reported from the habitat. Particular inquiry as to whether black corals had been taken at the stations where the New Zealand Oceanographic Institute obtained *Astrotoma* did not reveal any suitable species in the collections. Accordingly attention was directed to underwater photographs taken at some of the stations. With the generous cooperation of J. S. Bullivant enlargements were made of all relevant photographs. At Sta. A538, where *Astrotoma* occurred in the trawl-sample, 8 photographs were obtained of the sea-floor at a depth of 260 m. On one of these (serial number 3) I have identified a young specimen of *Astrotoma*. It is resting on the sea-floor, obviously with the oral surface directed upwards, because the long arms are all coiled upwards and inwards (pl. I, fig. A). The observation seems to confirm Mortensen's (1936) suggestion that small pelagic organisms are captured with the long distal extremities of the arms. The attitude of the arms in the specimen photographed on the bottom suggests that they are sweeping the surrounding water, and one arm is seen to be suspended over the disc, as if transferring material to the mouth. A conspicuously different mode of feeding (in detritus) is exhibited by a specimen of *Ophiurolepis gelida* which is visible in the same photograph only a few centimetres away, with one arm thrusting up a little mound of the soft sediment. The other organisms present are mainly tubicolous worms, polyzoa, and other smaller ophiuroids. It may be that at Sta. A538 there is a source of plankton-organisms sufficiently rich to support bottom-forms such as *Astrotoma*, and this may well be in the case wherever *Astrotoma* is present. Mortensen (1936) has already recorded remains of copepods, and probably a hyperiid, from the gut of a large specimen of this ophiuroid.

Astrochlamys Koehler, 1912

Five or ten elongate, unbranched arms. Skin of disc smooth, thin, revealing the underlying plates. Radial shields strongly developed, leaving only a few clear spaces covered by very small plates.

Inter-radial spaces of the ventral surface bearing very small, rounded plates which are not contiguous. Madreporic plate single, very small. Teeth, dental papillae, and oral papillae all similar; teeth numerous and well developed, forming several vertical, irregular rows; oral and dental papillae not numerous. Tentacle-pores, evident from the third pore onwards, large, carrying several spines. Each arm-joint with a crown of highly developed hooklets, evident from the base of the arm outwards. Ventral arm-plates fragmented into 3–5 separate platelets.

Type Species: Astrochlamys bruneus

The genus at present comprises 2 species, both restricted to the Antarctic. Although only the type species is known to occur in the Ross Sea, there is a strong probability that the other will eventually be found, and consequently a key will facilitate identification.

KEY TO KNOWN SPECIES OF *Astrochlamys*

- 1 (2) Arms 5. 10–12 terminal thorns on arm-spine. *bruneus* Koehler
- 2 (1) Arms 10. About 6 terminal thorns on arm-spine. *sol* Mrtsn.
(At present known only from off Clarence Island, W. Antarctica, 342 m, attached to polyzoan. For description and figures, see Mortensen (1936, p. 238–9, fig. 2d, pl. VII, fig. 9).)

***Astrochlamys bruneus* Koehler** (pl. 10, fig. 3, 7, 8; pl. 11, fig. 1, 4, 7; col. pl. 2c)

Astrochlamys bruneus, Koehler 1912. II^c Exped. Antarct. Française, Echinodermes, p. 143, pl. xi, fig. 3, 4, 6, 7, 14, 15; Koehler 1923. Swedish Antarct. Exped. Asteries et Ophiures, p. 103; Döderlein, 1930. Deutsche Tiefsee-Exped. Ophiuriden, II, Euryalae, p. 373, Taf. i, fig. 3–5 (p. 356, fig. 1c; p. 363, fig. 14 I, m.); Mortensen, 1936. Disc. Rpts. 12, p. 237, pl. VII, fig. 8; Fell, 1960. Zool. Pubns. Vict. Univ. Wgton., 26, p. 9.

Disc: Reaching 15 mm in diameter, covered above by extremely thin skin through which the broad, elongate radial shields are visible, nearly reaching the centre of the disc. The interradial spaces extremely reduced, occupied by small rounded plates, sub-equal, their borders in contact, leaving clear spaces between them. Ventral surface of disc with the interradial spaces occupied by similar plates, smaller than those of the dorsal side, and becoming smaller near the jaws. Genital clefts very short, the length not exceeding that of the adjoining arm-joint. Genital plates broad and strong. Oral shields extremely small, irregularly rounded or triangular, a little broader than long,

with a proximal rounded angle. Adoral plates relatively large, elongate, with rounded angles, their median borders almost contiguous. Oral plates small and narrow, separated from the adoral plates medially by a membranous area. Teeth, dental papillae, and oral papillae all similar, conical with a blunt tip. Teeth numerous, arranged in 2 or 3 irregular vertical rows; a few dental papillae, and outside them 2 or 3 oral papillae on either side. All the dental structures are very robust, with a rough surface.

Arms: Quite distinct from the disc, up to ca. 100 mm length. Dorsal arm-plates apparently rudimentary, visible only on the basal arm-joints, where they take the form of small rounded plates. Ventral arm-plates rectangular, transversely elongated, fragmented, not contiguous. First ventral-plate longer than broad, much larger than the following ones. Lateral arm-plates meeting broadly below, each with a transverse crest which continues across the dorsal face of the arm to meet its fellow of the other side, and carrying two rows of hooklets. The hooklets are slender, elongate, and each terminates in a long recurved distal tooth, which forms a right-angle, below it a small accessory tooth; hooklets 0.25–0.28 mm. Tentacular pores of the first joint without papillae; those of the second joint, more elongate than the former, also without papillae. Papillae appear at the pores of the third joint, 2 to each pore. Pores of the fourth joint with 3 papillae to each, and this number continues over the greater part of the arm, thereafter the number of papillae falls to 2 and finally to 1. The papillae are very strong, somewhat elongate, bearing 5 or 6 spinules.

Colour in Life: A specimen visible in a colour photograph made at Sta. A521 by J. S. Bullivant has the upper surface of the disc light grey, the radial shields more or less cream. The arms are pale orange above. The lower surface of the disc and arms is pale orange-brown. In spirit the colour becomes a uniform cream; in dried material the arm-joints are marked by a darker brownish ring at each junction.

Type Locality

The holotype was from Baie Marguerite on the east coast of Bellingshausen Sea, ca. 68°S. 200 m. rock, gravel, sand.

Distribution

West Antarctica (Koehler, 1912; Koehler, 1923); South Georgia (Mortensen, 1936). Ross Sea (present records). *Bathymetric Range*: 120–900 m.



Material Examined

Eight specimens from 3 stations, as follows:

Sta. A454, 914–828 m, 1 specimen; Sta. A464a, 369–384 m, 3 specimens; Sta. A521, 582–558 m, 4 small specimens.

Remarks

The specimens from Sta. A464a comprise a larger female together with two smaller males, both of which were clinging to the dorsal surface of the female. Two of the specimens are shown in pl. 11, fig. 4. Similar evidence of the larger size of the female, and the fact that the dwarf-male is carried on her back, was obtained by Mortensen (1936, p. 238). At Sta. 521 (Pennell Bank) were obtained living and dead solitary corals, and one may suspect that these organisms provide a support on which the prehensile arms of the ophiuroid can coil, whilst the tentacles of the polyp may serve as food.

Astrohamma Döderlein, 1930

Disc covered above and below by conspicuous, coarse spherical tubercles. Arms simple, annulated by double rows of fine granules which alternate with rows of hooklets, each hooklet with a strong terminal tooth and 1 feeble secondary tooth. Arm-spines three or four.

Type Species: *Astrohammus tuberculatus* Koehler, 1923.

The genus, which is monotypic at present, is restricted to Antarctica, and represented in the Ross Sea.

Astrohamma tuberculatum (Koehler) (pl. 10, fig. 5, 6; pl. 11, fig. 2, 5)

Astrohammus tuberculatus, Koehler, 1923, Swedish Antarct. Exped. Asteries et Ophiures, p. 133, fig. 1 a–f.

Astrotoma tuberculatum, Döderlein, 1927. Indopacifische Euryalae, p. 21.

Astrohamma tuberculatum, Döderlein, 1930. Deutsche Tiefsee-Exped. Ophiuriden. II, Euryalae, p. 372, Taf. i. fig. 2 (p. 363, fig. 14n); Mortensen, 1936, Disc. Rpts. 12, p. 239; Fell. 1960, Zool. Pubns. Vict. Univ. Wgton., 26, p. 10.

Disc: Up to 16 mm diameter, thick, subpentagonal, dorsal surface convex and entirely covered by conspicuous rounded, unequal tubercles. Radial shields entirely obscured. Ventral surface carry similar tubercles in the interradii. Jaws covered by much finer tubercles, smaller proximally. Oral papillae either short, thick and

blunt, or elongate, conical and pointed, the 2 types mingled and disposed in 3 irregular rows. Genital clefts small, short, narrow.

Arms: Slender, tapering distally, up to 45 mm long, annulated alternately by double rows of small rounded granules, and by rings of small hooklets, 0.2 mm long, each terminating in a long recurved point, with a feeble secondary tooth about halfway down the shaft. Tentacle pores inconspicuous, rounded; with one very small tentacle-scale, either conical or rounded, on the first pore; on succeeding arm-joints there are three strong, thick, flattened arm-spines, terminating in 1–3 spinules.

Colour in Life: J. S. Bullivant recorded that specimens from Sta. 527 had a purple disc, tinged with pink (no doubt the gonads within) and the arms were cream coloured. Spirit specimens, cream, greyish or (Sta. A527) black.

Type Locality

Graham Land, S.W. of Seymour I., 150 m.

Distribution

Graham Land; Palmer Archipelago; Ross Sea (present record). *Bathymetric Range:* 150–399 m.

Material Examined

Five specimens from 3 stations, as follows:

Sta. A464, 369–384 m, 1 specimen; Sta. A465, 399 m, 1 specimen; Sta. A527, 358–337 m, 3 specimens.

Remarks

At Sta. A527 (Pennell Bank), where 3 of the 5 specimens were obtained, the trawl sample yielded stylasterine corals. As is evident from colour photographs made at the time by J. S. Bullivant, these corals would be large enough to serve as a substrate for *Astrohamma tuberculatum*, and it is more than likely that the ophiuroid clings to the coral with its prehensile arms, whilst browsing on the individual polyps. It may be suggested that the elongate oral papillae are used to gouge the retracted gastrozooids and dactylozooids from their niches. The heavy armature of calcareous tubercles may well serve as an adequate protection against the venomous nematocysts.

The specimen from Sta. A527, recorded above as black, does not seem to differ in other respects from the typical form; it is possible that the dark colour has been exaggerated by preservation, as J. S. Bullivant's field notes do not mention a black ophiuroid from this station. As noted above, for

Astrotoma agassizii, preservation in spirit or formalin does seem to darken adult specimens of some Euryalina.

The specimens from Sta. A464 and A465 both have disc granules which are almost spherical, unlike Koehler's (1923) holotype, where the granules were irregularly wrinkled. The specimens from Sta. A527 seem closer to Koehler's type, and therefore it does not seem necessary to distinguish the Ross Sea form by name. Although known only from west Antarctica and the Ross Sea, the species is probably circumpolar.

Suborder OPHIURINA Müller & Troschel

Family OPHIACANTHIDAE Perrier, 1891

KEY TO THE ROSS SEA GENERA

- 1 (6) Tentacle-pores large and conspicuous.
- 2 (5) Disc completely scaled above and below. Oral papillae of 2 types.
- 3 (4) Plates of disc not surrounded by spinules or granules. Inner oral papillae spiniform, uniform. Outer oral papillae larger, erect, surrounding the oral tentacle-pore. **Ophiodaces** Koehler, 1922
- 4 (3) Plates of disc surrounded by spinules or granules. Inner oral papillae spiniform, in terminal cluster. Lateral and outer oral papillae smaller, rectangular or leaf-like, horizontal, confluent with scales of oral tentacle-pore. **Glaciacantha** Fell, 1961
- 5 (2) Disc covered by a rather thick skin, which contains embedded plates, visible when dried. The soft thick skin of the disc contains rounded small plates which do not imbricate, and small radial shields: internal oral papillae spiniform, external ones flat and spatulate. **Ophiosparte** Koehler, 1922
- 6 (1) Tentacle-pores small and inconspicuous. Disc covered by thin skin bearing granules and stumps or spinules (the underlying scales visible when specimen is dried). Arm-spines hollow. Arms moniliform. **Ophiacantha** M. & T., 1842

Ophiacantha M. & T., 1842

Müller and Troschel. 1842. System der Asteriden. p. 106

Type Species: Asterias bidentata Retzius, 1805.

Disc covered by thin skin-bearing granules or thorny spinules, the underlying scales visible when dried. Radial shields long, narrow, separated. Arm-spines hollow. Tentacle-pores small, inconspicuous.

Ophiacantha is mainly a deep-water genus, and the species consequently tend to be widely distributed, or even cosmopolitan. Of the 7 species known from the New Zealand plateau, all are from deep water, and all save 2 are widely ranging forms. In Antarctic waters, particularly in the Ross Sea, the genus is a conspicuous element, partly because it abounds in numbers of individuals, partly because the species occur at most depths, including shelf stations.

KEY TO THE ROSS SEA SPECIES

- 1 (4) Six arm-spines. Five arms.
- 2 (3) Dorsal arm-plates transversely divided into a proximal and a distal portion. Not viviparous. **antarctica**
- 3 (2) Dorsal arm-plates entire. Viviparous. **imago**
- 4 (1) Eight or more arm-spines.
- 5 (6) Six arms. 11-12 arm-spines. Viviparous. **vivipara**
- 6 (5) Five arms.
- 7 (8) Eight arm-spines, which are translucent. Oral papillae short, conical, none leaf-like. **cosmica**
- 8 (7) Eleven-twelve arm-spines, which are opaque. Oral papillae long, outer papillae leaf-like. **pentactis**

Ophiacantha vivipara Ljungman (pl. 14, fig. 2; pl. 15, fig. 1; col. pl. 2a)

Ophiacantha vivipara, Ljungman, 1870. Om tvänne nya arter Ophiurider. Öfvers. Vet. Akad. Handl., 1870, p. 470; Ludwig, 1899. Ophiuroideen Hamburger Magalh. Sammelreise, p. 13; Koehler, 1912. II^e Exped. Antarct. Française. Echinodermes, p. 138, pl. xi, fig. 1-2, 10; Koehler, 1917. Echinodermes de Kerguelen. Ann. Inst. Oceanogr., VII, 8, p. 71; Mortensen, 1920. On Hermaphroditism in viviparous Ophiurids. Acta Zoologica, I, p. 10; Koehler, 1923. Swedish Antarct. Exped. Asteries et Ophiures, p. 105; G. A. Smith, 1923. Report on the Echinoderms coll. during the voyage of the "Quest". Ann. Mag. Nat. Hist., 9 Ser., XII, p. 368; Koehler, 1927. Austral. Antarct. Exped. Echinod. Ophiuroidea, p. 12; Greig, 1929. Some Echinoderms from the South Shetlands. Bergens Mus. Arbok, 1929, 3, p. 7; Mortensen, 1936. Disc. Rpts. 12, p. 246, pl. VII, fig. 2.

● *phiocoma* (?) *vivipara*, Wyv. Thomson, 1877. The Atlantic, II, p. 241-4, fig. 50.

Ophiacantha vivipara heptactis, Hertz, 1926. Deutsche Südpolar-Exped. Ophiuroiden, p. 36.

Disc: Up to 12 mm diameter: circular, flattened above and below, thickly covered by coarse granules and sometimes also stumpy spinules, radial shields obscured. Ventral interradii carrying smaller granules than those of dorsal side. Oral

shields subtriangular, as broad as long, with broad proximal margin and an acute, but rounded, distal angle. Adoral plates rectangular, transverse, much broader than long. 4–6 oral papillae, the inner ones spiniform and smaller than the outer ones, which latter are often leaf-like and erect. Genital cleft conspicuous, extending to the margin.

Arms: Usually 6 in number (sometimes 7 to 9), reaching ca. 70 mm in length. Dorsal plates transversely lozenge-shaped, only the basal ones contiguous, broader than long, the basal-most carry sometimes granules similar to those of disc, but smaller. Further out on the arm the dorsal plates become fan-shaped, with a proximal acute angle and a convex distal margin. Lateral meeting broadly above over most of the arm, narrowly below over only the distal part of the arm, carrying 11–12 conspicuous, tapering, opaque, hollow spines, the lowest as long as an arm-joint, increasing in length towards the upper ones, which may be three times the length of a joint. Ventral plates rounded pentagonal, with a proximal obtuse angle, and rounded sides and distal margin, contiguous, or almost so, at the base of the arm. One, large, lanceolate, flattened, tentacle-scale, half the length of the arm-joint.

Colour in Life: A colour photograph by J. S. Bullivant of the trawl-sample from Sta. A527 (Pennell Bank) shows a specimen with pale pink arms, and purple-grey disc. Another specimen photographed at Sta. A538 appears to have the lower side of the arms and disc a translucent off-white, the upper sides of the arms similar. Koehler (1912) has already recorded specimens from west Antarctica with “le disque gris, les bras blancs”. In spirit the specimens are greyish or whitish.

Type Locality

Presumed to be Falkland Islands; Ljungman's original material somehow became confused with specimens of some other animal from “Altatum urbem Mexicanum”. Lütken, E. A. Smith and Bell (1908, p. 13) have rejected the supposed Mexican locality.

Distribution

Widely distributed on all Antarctic coasts, in the Subantarctic region (but not the so-called “Subantarctic Islands of New Zealand”), Heard, Kerguelen, Burdwood Bank, off the coast of Argentina at 37°S (*Challenger*); C. Wadsworth, S. Victoria Land (Bell, 1908). The absence of the species from the New Zealand plateau, although present on the South American shelf and slope

at comparable latitudes, is significant evidence with zoogeographical implications; see p. 71 for discussion. *Bathymetric Range:* 17–1,097 m.

Material Examined

Ninety-eight specimens from 15 stations, as follows:

Sta. A449, 362 m, 3 specimens; Sta. A450, 472–318 m, 1 specimen; Sta. A455, 322–340 m, 19 specimens; Sta. A464, 369–384 m, 5 specimens; Sta. A467, 88–183 m, 23 specimens; Sta. A469, 64 m, 3 specimens; Sta. A526, 461–465 m, 7 specimens; Sta. A527, 358–337 m, 1 specimen; Sta. A528, 274–265 m, 2 specimens; Sta. A538, 269–348–256 m, 8 specimens.

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 672, Hut Point, McMurdo Sound, 124–165 m, 5 specimens; 801, Botany Bay, Granite Harbour, 73 m, 3 specimens.

Stanford University Stations: Sta. GLD-1, 384 m, 1 specimen; Sta. EAD-2, 315 m, 16 specimens; Sta. EAD-3, 351–432 m, 1 specimen.

Remarks

As Mortensen (1936) records, *O. vivipara* does not appear to reach the size of *O. pentactis*. Typical adult forms are shown together for comparison on pl. 14, where dimensions are quoted. I agree with Madsen (1955) that *O. pentactis* is better treated as a distinct species, rather than as a variety of *vivipara* (as Mortensen, 1936, proposed). The lack of correspondence between the station lists at which these two species occur is quite striking in the present report, and suggests that in general the species are not sympatric, *O. pentactis* being essentially an Antarctic form.

No recognisable evidence of *O. vivipara* has been found in any of the underwater photographs from the Ross Sea.

***Ophiacantha pentactis* Mortensen (pl. 14, fig. 1; pl. 15, fig. 2)**

Ophiacantha vivipara var. *pentactis* Mortensen, 1936, Disc. Rpts., 12, p. 253, pl. 7, fig. 3, 4.

O. vivipara Koehler, 1912, Deuxieme Exped. Antarct. Franç. Echinodermes, pl. XL, fig. 1.

O. pentactis, Madsen, 1955, Sci. Res. Norweg. Antarct. Exped., 37, p. 4.

Disc: Reaching a diameter of 20 mm, rounded, usually densely covered by stumpy granules and rather coarse, blunt spines, mingled together,

sometimes in irregular clumps, with more naked patches. Oral shield triangular, broader than long, with a distal obtuse angle. Otherwise similar to *O. vivipara* (above).

Arms: Reaching a length of 110 mm, and thus much longer and more robust than in *O. vivipara*, but otherwise resembling that species, save for the conspicuous difference that there are 5 arms.

Colour in Life: Field notes and colour photographs made by J. S. Bullivant indicate that the disc is usually pale-grey or blue-grey above, the ventral side similar; the arms, including the long spines, white above and white below (Sta. A516 and A527). Colour in spirit, pure white.

Type Locality

Not precisely stated, but original material was all from West Antarctica (Clarence I.: Palmer Archipelago; Bismarck Strait). 90–350 m.

Distribution

West Antarctica and Ross Sea, therefore probably circumpolar Antarctic. Largest specimens apparently occur at the most southern stations. *Bathymetric Range:* 90–1,400 m.

Material Examined

204 specimens from 5 stations, as follows:

Sta. A455, 322–340 m, 66 specimens; Sta. A464, 369–384 m, 17 specimens; Sta. A516, 457–183 m, 1 specimen; Sta. A523, 1,375 m, 14 specimens; Sta. A527, 358–337 m, 106 specimens.

Remarks

As noted under the preceding species, *O. vivipara* and *O. pentactis* differ markedly in size, and do not appear to be sympatric, or to only a minor extent: thus, for example, at Sta. A527, where 106 specimens of *O. pentactis* were obtained, only 1 specimen of *O. vivipara* was found; and at Sta. A467 where 23 specimens of *O. vivipara* were taken, there were no specimens of *O. pentactis*.

Two specimens of *Ophiacantha pentactis* have been recognised on one of three photographs taken by J. S. Bullivant of the sea-floor at Sta. A528, Pennell Bank, at 274–264 m. They are seen to be resting on a dense colony of polyzoa, and the accompanying fauna includes *Amphiura belgicae*, *Ophiurolepis gelida*, and a species of *Sterechinus*. The occurrence at this station is noteworthy, as no specimen is present in the trawl-sample from the same station, whereas the other species

mentioned are well represented. The attitude of the arms in the larger of the specimens photographed is reminiscent of that adopted by Antarctic feather-stars in the feeding position, and suggests that the food may be small nekton entangled in the mesh of the long arm-spines, together with particles of the general plankton-shower.

***Ophiacantha antarctica* Koehler** (pl. 3, fig. 1: pl. 14, fig. 7; pl. 15, fig. 6; col. pl. 2b–d)

Ophiacantha antarctica Koehler, 1900. Bull. Acad. Belg. p. 819; Koehler, 1901, Voy. S.Y. Belgica. Echin. et Ophiur., p. 34, pl. IV; Koehler, 1912. 2me Exped. Antarct. Franç., Echinodermes, p. 137; Grieg, 1929. Bergens Mus. Arbok, p. 8.

NON: *Ophiacantha antarctica sensu* Mortensen, 1936 [= *Toporkovia antarctica* (Lyman)].

Ophiodiplax disjuncta Koehler, 1911. Brit. Antarct. Exp. 1907–09, Aster., Ophiur. & Echin., p. 48, pl. VI, fig. 9–11, VII, fig. 13; Koehler, 1912. 2me Exp. Antarct. Franç., Echinodermes, p. 142; Koehler, 1922. Austral. Antarct. Exp., Echin. Ophiur., p. 15, pl. 78, fig. 4–5, 9–12; Koehler, 1923. Swed. Antarct. Exp., Aster. & Ophiur., p. 105; G. A. Smith, 1923. Echinodermes of the Quest. Ann. Mag. Nat. Hist., 9 ser., 12, p. 369; Mortensen, 1925. Arkiv f. Zoologi, 17A (31), p. 2; Hertz, 1926. Deutsche Südpolar-Exped., Ophiur., p. 38, pl. VII, fig. 5.

Ophiacantha disjuncta Mortensen, 1936. Disc. Rpts., 12, p. 252.

[Note on synonymy: Hertz (1926) synonymised the genus *Ophiodiplax* (erected in 1911 specially for the species *disjuncta* by Koehler) with the genus *Ophiacantha* M & T. Subsequently Mortensen (1936) demonstrated that *Ophiodiplax disjuncta* is the same species as Koehler had himself described 11 years earlier (1900) as *Ophiacantha antarctica*. However, Mortensen considered that Lyman's (1882) species *Ophiocoelis antarctica* should also be referred to *Ophiacantha*. The name *antarctica* was therefore preoccupied by *Ophiacantha antarctica* (Lyman), and not available to the species of *Ophiacantha* to which Koehler had applied it in 1900; consequently the synonym *disjuncta* was considered by Mortensen to be the oldest valid specific name. The species appears, accordingly, in the Discovery Reports as *Ophiacantha disjuncta* (Koehler).

This situation can no longer be maintained, however. On page 43 of the present volume evidence is presented to show that *Ophiocoelis antarctica* Lyman cannot be referred to *Ophiacantha*. It is, in fact, a species of the genus *Toporkovia* Djakonov and, like *Ophiocoelis*, is better placed in the family Ophiidermatidae. Accordingly, the name *antarctica* Koehler, 1900 remains available for *disjuncta*, 1911, and must take priority. The correct name of the species is therefore *Ophiacantha antarctica* Koehler, 1900.]

Disc: Up to 12 mm diameter; subpentagonal or pentagonal, the sides more or less indented interradially. Dorsal surface covered by densely arranged spinules, either slender and cylindrical, with several divergent terminal points, or thick and conical with terminal points, the two types occurring together, or alternatively one or other occur-

ring exclusively. Radial shields indistinct, but usually indicated by a conspicuous pair of radial ridges in each radius. Ventral surface covered with similar spinules, somewhat smaller, continuing to the oral shields. Genital clefts conspicuous, bordered by fine plates, extending to the margin. Oral shields large, rectangular with rounded angles, broader than long. Adoral plates broad, but not large enough as to separate the oral shield from the first lateral plate. Oral papillae conical, about a dozen on either side, sometimes in several rows and crowded, sometimes in single series.

Arms: Reaching a length of ca. 60 mm, slender, more or less moniliform, especially distally. First dorsal arm-plates more or less obscured by spinules or granules of the same type as on the disc. Further out the plates carry only a distal row of small granules, or none at all. Dorsal arm-plates fanshaped with a broad distal border, and a narrow proximal portion; usually a transverse fissure divides the plate into a smaller proximal part and a larger distal one. Lateral plates prominent at their distal margin, which carries 6 slender, thorny spines, whose length generally exceeds that of the arm-joint. Ventral plates at the arm base broader than long, triangular, with an obtuse proximal angle and a strongly convex distal margin; distally they become longer than broad, with an acute proximal angle; all are widely separated. Tentacle scale single, short, narrow, spiniform.

Colour in Life: Variable, but most specimens have a bluish-grey disc and orange arms. In spirit, the disc greyish-fawn, arms lighter grey or whitish. Dr R. W. Balham records a specimen (No. 287) from the Trans-Antarctic Expedition in which the disc was light grey above, the radial shields straw-coloured, the ambitus salmon-pink, the arms above and below straw-coloured; a second specimen (No. 256) was similar, but the radial shields were not distinguished, and the arms were flesh-pink.

Type Locality

West Antarctica, 70°–71°S, 83°W, 100–600 m.

Distribution

Circumpolar on Antarctic coasts and in the Antarctic Ocean south of the polar circle. 90–1,400 m.

Material Examined

1,003 specimens from 53 stations, as follows:
Sta. A448, 752 m, 2 specimens; Sta. A449, 362 m, 105 specimens; Sta. A450, 472–318 m, 20 specimens; Sta. A451, 523 m, 1 specimen; Sta. A455, 322–340 m, 30 specimens; Sta. A456, 238–201 m, 118 specimens; Sta. 457, 315–342 m, 32 specimens; Sta. A459, 534–549 m, 12 specimens; Sta. A460, 415–430 m, 7 specimens; Sta. A461, 578–567 m, 37 specimens; Sta. A464, 369–384 m, 5 specimens; Sta. A465, 399 m, 48 specimens; Sta. A466, 569 m, 5 specimens; Sta. A467, 88–183 m, 18 specimens; Sta. A468, 110 m, 46 specimens; Sta. A470, 377 m, 4 specimens; Sta. A471, 165–69 m, 4 specimens; Sta. A516, 457–183 m, 24 specimens; Sta. A519, 479 m, 4 specimens; Sta. A520, 201–205 m, 18 specimens; Sta. A521, 582–558 m, 3 specimens; Sta. A522, 1,335 m, 14 specimens; Sta. A523, 1,375 m, 35 specimens; Sta. A526, 461–465 m, 6 specimens; Sta. A527, 358–337 m, 21 specimens; Sta. A528, 274–265 m, 44 specimens; Sta. A529, 205–216 m, 9 specimens; Sta. A530, 271–267 m, 9 specimens; Sta. A531 (b), 348 m, 6 specimens; Sta. A532, 488 m, 4 specimens; Sta. A534, 380–366 m, 22 specimens; Sta. A537, 574–543 m, 77 specimens; Sta. A538, 269–256 m, 40 specimens; Hut Point, Fish-trap, 13/Feb. 1960, 300 m, 1 specimen.

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 179, McMurdo Sound, 1 specimen; 256, Cape Armitage, 122 m, 2 specimens; 325, Cape Armitage, 122 m, 1 specimen; 328, Cape Armitage, 122 m, 1 specimen; 385, McMurdo Sound, 304 m, 3 immature specimens; 672, Hut Point, McMurdo Sound, 124–165 m, 22 specimens; 716, Franklin Island, 73–110 m, 1 specimen; 747, Cape Roberts, 188–193 m, 59 specimens; Dominion Museum Station (R. K. Dell), McMurdo Sound, 440 m, 3 specimens.

Stanford University Stations: Sta. GLD-1, 384 m, 1 specimen; Sta. GLD-13, 165 m, 5 specimens; Sta. GLD-15, 366 m, 13 specimens; Sta. EAD-2, 315 m, 54 specimens; Sta. EAD-3, 351–432 m, 10 specimens.

Remarks

Ophiacantha antarctica, as is evident from the foregoing station list, is now to be recognised as by far the most abundant Ross Sea ophiuroid. Indeed, it is the most abundant and widely distributed echinoderm in the Ross Sea, and must play an important part in the general sea-floor biological balance. To judge by sea-floor photo-

graphs, up to one-third of the total biomass comprises ophiuroids (in areas where shelled animals are not abundant), and of this proportion, the greater part would be made up of individuals of *Ophiacantha antarctica*.

{The following species have been recorded on one occasion from the Ross Sea, but the record is unconfirmed, and probably rests upon mistaken identifications of *Ophiacantha pentactis* and *O. antarctica*.}

***Ophiacantha cosmica* Lyman**

This species has not been taken by the expeditions upon which the present report is based, and its record from the Ross Sea is due solely to Bell (1908, p. 14). He recorded it from off Coulman Island, in 100 fm (183 m), and off the Barrier, in 300 fm (549 m). He implied that his specimens were unusually large, and one strongly suspects that he really had *Ophiacantha pentactis*. The species has been included in the key above, and should be recognisable if it is really present.

***Ophiacantha imago* Lyman**

Also recorded by Bell (1908, p. 13). Bell states "I hope I am right in referring to this species from Winter quarters, 30 fm; Hut Point . . . 100 fm; but, in sooth, some of the *Challenger* types of ophiuroids are hardly mature". No other details are given as to the characters of Bell's specimens, and, like the foregoing record, it must be treated with considerable suspicion. Nonetheless on the statement of Bell, the species is included in the key, which should facilitate its recognition if present. It seems very probable that Bell really had *Ophiacantha antarctica*.

Ophioparte Koehler, 1922

All plates of the disc and arms covered by an integument which leaves exposed only the arm-spines and the oral papillae. No tentacle-scale, but the tentacle-pore is largely covered by the arm-spines. Arms thick, and strong, carrying short, spatulate, arm-spines on the ventral surface, each spine with a denticulate distal margin. Genital clefts elongate, extending to the dorsal margin of the ambitus.

The genus comprises the single species *Ophioparte gigas*, the type of the genus as originally described (by monotypy). Restricted to the Antarctic.

***Ophioparte gigas* Koehler, 1922 (pl. 14, fig. 4; pl. 15, fig. 3)**

Koehler, 1922. Australasian Antarct. Exped., 1911-14, Sci. Rpts. Ser. C, 8 (2), p. 21, pl. 77; Mortensen, 1925. Arkiv f. Zool. 17a (31), p. 2.

Disc: Reaching about 50 mm diameter, subpentagonal, thick dorsal surface somewhat convex, covered by soft, thick integument which conceals the underlying plates. In dried specimens the disc-

plates become visible, and comprise small central primary plates surrounded by rounded, somewhat imbricated, thin scales. Radial shields relatively small, triangular, with rounded contours and a proximal angle, a little longer than broad, the members of each pair separated by 1 or 2 rows of scales which are continuous with the dorsal plates of the arms. On the ventral surface the plates imbricate, and are similar to those above. Genital clefts elongate, extending from the oral shields to the dorsal margin. Oral shields large, a little broader than long, triangular with rounded proximal angle and a convex distal border. Adoral plates triangular, elongate, separating the oral shield from the first lateral arm-plate. Oral plates divergent, twice as long as broad. Numerous oral papillae, the internal ones small and short; the external ones flattened, spatulate, larger than the internal ones. All the oral plates and shields are concealed by skin, but become visible in dried material.

Arms: Reaching ca 100 mm in length, robust, broader than high, breadth at base ca 12 mm. Basal dorsal arm-plates short, narrow; beyond these they are larger and broader, at first quadrangular with a proximal border smaller than the distal border; further out the proximal border shortens, and the whole plate becomes no broader than long; dorsal plates contiguous throughout. Lateral plates meeting neither above nor below, save on distal joints, where they meet narrowly below; carrying 5 spatulate arm-spines on the distal ventral margin. Ventral plates quadrangular, with a narrow proximal margin and a broader distal margin, contiguous (save on the outermost joints), about as broad as long on proximal joints; on outer joints they become triangular with a proximal angle, and longer than broad. No tentacle-scale. Tentacle-pore large, tentacle conspicuous, large, tapering distally.

Colour in Life: Pink; in spirit, greyish-white.

Type Locality

Not precisely indicated, but Koehler's original material was from off Wilkes Land, in 60-110 fm (110-200 m).

Distribution

Known only from Wilkes Land and (the present records) from Ross Sea. *Bathymetric Range*: 110-750 m.

Material Examined

Forty-nine specimens from 6 stations, as follows:

Sta. A448, 1 mile off Ross Ice Barrier, 752 m, 5 large specimens; Sta. A459, Ross Sea, 534–549 m, 8 specimens; Sta. A460, Ross Sea, 415–430 m, 1 specimen; Sta. A461, Ross Sea, 578–567 m, 25 large specimens and fragments; Sta. A466, Ross Sea, 569 m, 9 specimens.

Stanford University Station: Sta. GLD-15, Ross Sea, 365 m, 1 specimen.

Ecology

The species is evidently an indicator of soft-bottom, as every record on the list given above is from mud. Koehler (1922) did not indicate the substrate from which his three type specimens were taken; and Mortensen (1925) gave mixed bottom-data for his one specimen from Discovery Inlet.

The species is one of the more conspicuous Ross Sea ophiuroids, being exceeded in size only by *Astrotoma agassizii*. As, however, it is apparently restricted in distribution (like *Astrotoma agassizii*) it is absent from most stations, and has not been recognised in any of the underwater photographs of the sea-floor which I have examined. At those stations where it was present in the trawl-sample, no underwater photographs were taken. The large disc relative to the arms should make the species easy to recognise in photographs. The highly-developed conical tube-feet and spatulate arm-spines are consistent with its habitat, and one may infer that it uses these structures as paddles or stilts in making its way on soft substrate; the large disc and flattened arms are also characters consistent with the habitat.

Ophioduces Koehler, 1922

Disc covered by thin imbricating scales, without granules or spinules, covered by a thin translucent integument. Radial shields large, naked. Oral papillae of two types, numerous; inner papillae conical, in a regular series; outer papillae larger, placed on the adoral plate, bordering the oral tentacle pore. Tentacle-pores large, each with a single tentacle-scale. Dorsal plates, large, contiguous. Arm-spines small.

Type Species: Ophioduces inanis (by monotypy)

The genus is restricted to Antarctica, where its known range comprises only the coast of Wilkes Land and (the present record) the Ross Sea. In

a recent synopsis of the genera of Ophiuroidea (Fell, 1960, p. 15) the genus *Ophioduces* was inadvertently listed as a synonym of *Ophiodictys* (both genera proposed by Koehler in 1922); this is, of course, incorrect as the two genera are entirely different. I would take this early opportunity of amending the reference, and indicate that the type species of *Ophiodictys* is *O. uncinatus* Koehler, 1922a, from Macassar Strait in 900 fm. *Ophioduces* should be inserted as paragraph 14a in the synopsis, as follows:

14 (15) Radial shields evident.

14a (14b) Oral papillae of 2 types; the inner ones spiniform, uniform; the outer 2 or 3 larger, erect, surrounding the oral tentacle-pore. **Ophioduces** Koehler, 1922
**inanis* Koehler, 1922a Antarctica, 120 fm.

14b (14a) Not so. **Amphipsila** Verrill, 1899
**maculata* Verrill, 1899. Caribbean, 200 fm.

Ophioduces inanis Koehler (pl. 6, fig. 1, 4)

Ophioduces inanis Koehler, 1922. Australas. Antarct. Exped. 1911–14. Sci. Rpts. C 8 (2) p. 24, pl. 78.

Ophioduces inutilis Koehler, 1922. *ibid.* p. 89 (lapsus calami).

Disc: Reaching a diameter of ca 11 mm, rounded, slightly excavate in the interradii; the dorsal surface covered by thin, translucent, imbricating subequal plates which are covered over by a thin translucent integument. Radial shields oval, naked, longer than broad, the members of a pair broadly separated, somewhat divergent. Plates of ventral surface similar to those above, but weakly granulated. Genital clefts large, elongate, bordered by genital plates. Oral shield large, with an obtuse proximal angle, rounded sides and convex distal border, a little broader than long. Adoral plates large, elongate, narrow, the external margin deeply excavated by the oral tentacle-pore, contiguous within, expanded without, separating the oral shield from the first lateral plate. About 5 inner oral papillae, conical, short, with a blunt tip, their height increasing from the distal part of the jaw towards the angle of the jaw; outer oral papillae, surrounding the oral tentacle-pore, erect, larger than the inner papillae.

Arms: Reaching about 25 mm in length; at the base of the arm dorsal plates are short and broadly rectangular; at about 6 arm-joints beyond the disc the plates are square, with rounded angles; further out the plates become hexagonal, and remain contiguous throughout. Lateral plates

bearing 5 spines at the base of the arms, the longest spine equal to the arm-joint, uppermost; the shortest half as long, lowest: ventral plates with a narrow proximal border and a broad proximal margin, fan-shaped, contiguous at the base of the arm. Tentacle-scale lacking from the basal pores, conical on succeeding pores, becoming more spiniform distally.

Colour in Life: Unknown; in spirit, whitish.

Type Locality

66° 8'S, 94° 17'E, 120 fm (220 m), off Wilkes Land, East Antarctica.

Distribution

Off Wilkes Land, and (present record) Ross Sea. *Bathymetric Range:* 220–570 m.

Material Examined

One specimen, from Sta. A466, 569 m, mud. The single specimen is illustrated on pl. 6.

Remarks

The structure of the mouth-parts suggests a close relationship between *Ophioduces* and *Ophiosparte*: in young specimens of *Ophiosparte* the skin of the disc is thinner, and the plates within can more easily be seen; the spines however differ markedly in the two genera. One is tempted to speculate on whether *Ophioduces* might only be a very early juvenile stage of *Ophiosparte*. At present there is no evidence in the way of specimens of intermediate size between young *Ophiosparte* and *Ophioduces*. As against this suggestion is the fact that all three known specimens of *Ophioduces* are markedly similar to one another, and dissimilar from *Ophiosparte*, at least from *Ophiosparte gigas*. Should these two genera eventually be found to represent two species of a single genus which changes with age, the name *Ophiosparte* will have priority. At present it is necessary to retain the classification based on Koehler's excellent descriptions.

Glaciacantha Fell, 1961

Disc covered above by a mosaic of plates, among which the six primaries are conspicuous, and the radial shields with smaller plates intercalated. Disc plates above and below bordered by palisades of spinules or granules or both. Two to four flattened, oval, leaf-like tentacle-scales at the

base of the arm, a single tentacle-scale beyond. Inner oral papillae elongate, spiniform; outer oral papillae flattened, leaf-like, confluent with similar papillae surrounding the oral tentacle-pore.

Type Species: Glaciacantha jason

The genus falls close to *Ophiomedea* Koehler, differing in having the oral papillae differentiated in the opposite sense (they are leaf-like within, spiniform without, in *Ophiomedea*) and in having the disc-plates bordered by palisades of spinules. The trivial name of the type species is intended to draw attention to the relationship with *Ophiomedea*. The genus, which was originally found in a Ross Sea sample taken by the U.S.S. *Glacier*, is named for this vessel.

Glaciacantha is at present known only from the Ross Sea.

Glaciacantha jason Fell (pl. 7, fig. 1, 2; text-fig. 3)

Fell, 1961. Trans. Roy. Soc. N.Z., 88 (4), p. 839, fig. 4–6.

Disc: Reaching a diameter of ca 9 mm (holotype): subpentagonal, flattened, covered above by the six primary plates, the radial shields and the intercalated plates, of which an interradial row and a shorter radial row (intercalated between the radial shields proximally) are most conspicuous. All disc-plates bordered by spinules, or spiniform granules, which form palisades around the naked plates. Radial shields oval, divergent, contiguous distally. Genital clefts elongate, conspicuous, extending from the oral shield to the margin. Ventral surface covered by a few large imbricating rounded scales in the interradia. Oral shields very large, conspicuous, subtriangular, with an acute proximal angle, and an extremely convex distal margin. Adoral plates narrow, attenuated without by the large oral tentacle-pore, narrowly separating the oral shield from the first lateral plate. Oral plates large, broadly contiguous within, the distal margin excavate by the oral tentacle-pore. A terminal cluster of teeth and tooth-papillae, the cluster forming several vertical rows in adult specimens, a single vertical row in younger stages. Inner oral papillae conical, 4–6 in number, becoming squarish towards the outer end of the jaw, where they merge with the leaf-like tentacle-scales of the large oral tentacle-pore. Oral tentacle-pore bordered by about 10 leaf-like scales, extremely conspicuous.

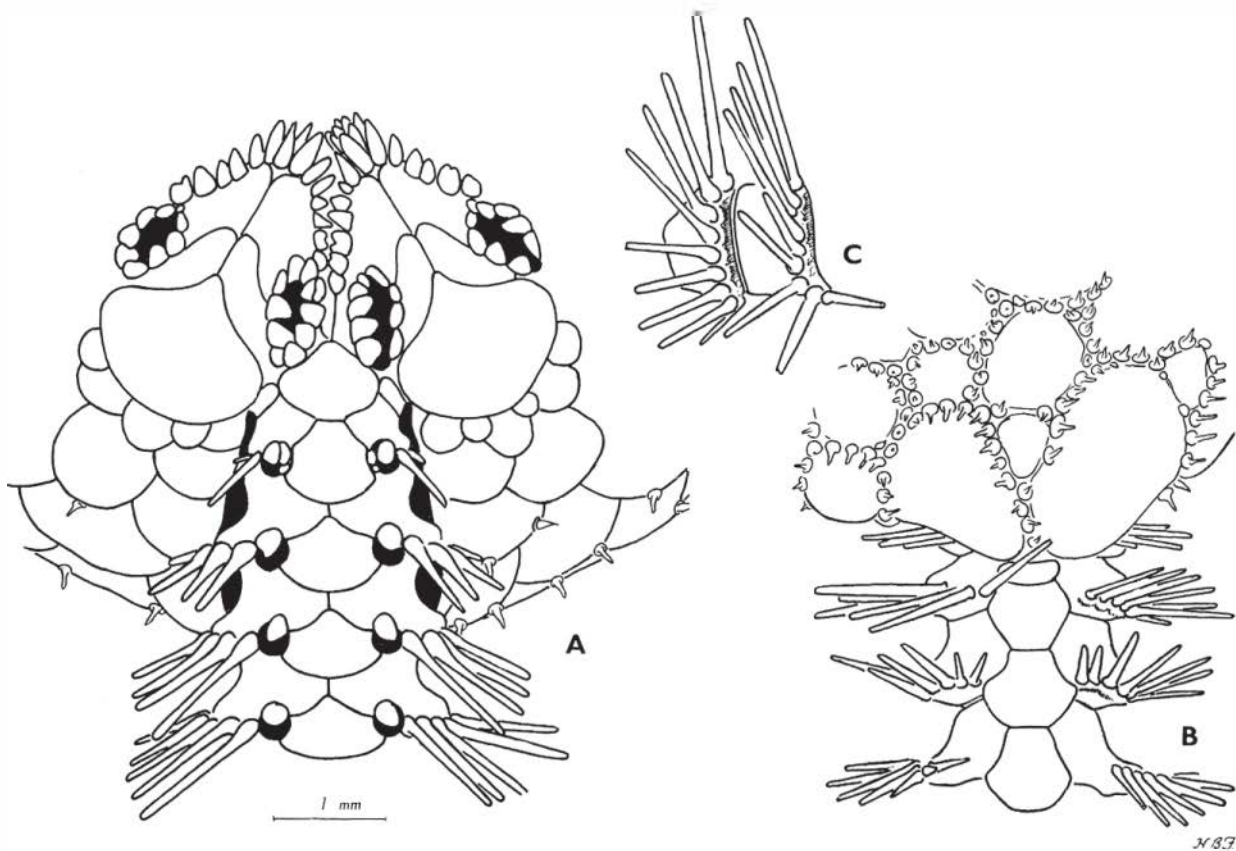


FIG. 3. *Glaciacantha jason*, holotype from Sta. GLD-15. A, ventral aspect; B, dorsal aspect; C, lateral aspect of basal arm-joints. All to scale shown.

Arms: Reaching a length of ca 35 mm from the centre of the disc (holotype). Dorsal arm-plates cup-shaped, i.e., pentagonal in outline, with a narrow proximal border, a very broad convex distal margin, and divergent lateral margins which are concave; the basal plate however is broadly rectangular, differing from all the others. All the dorsal arm-plates are contiguous. Lateral arm-plates large, meeting narrowly below, but not above, with a prominent distal margin which carries 8–10 spines at the base of the arm. The spines are arranged in a fan, the uppermost spine ca 1.5 arm-joints in length, then the spines decrease gradually to the lowermost, which is ca 1 joint in length. At the tenth arm-joint there are still 9 or 10 arm-spines but they are here all sub-equal, ca 1 arm-joint in length. Near the arm-tip, where the arms are markedly moniliform and the ophiacanthid facies is conspicuous, the arm-spines are only one-third as long as the arm-joint, sub-equal, ca 8 in number. Ventral plates vary in shape. The proximal one is subtriangular with an obtuse proximal angle, broader than long,

narrowly contiguous with the second plate. The second plate is pentagonal with a short proximal border and a broad convex distal margin, about as broad as long. The third and succeeding ventral plates are broader than long, becoming rapidly very much broader than long, not contiguous, with an obtuse proximal angle and a convex, broad distal margin. Tentacle-pores large, conspicuous, the basal pore with 2–4 tentacle scales, leaf-like, of varied sizes. Thereafter there is a single broad, flat, leaf-like tentacle-scale covering most of the pore.

Colour in Life: Unknown; colour in spirit, white.

Type Locality

Stanford University Station GLD-15 (equals U.S.S. *Glacier Deep Freeze IV* Oceanographic Station GL-16), Ross Sea, 1 Dec 1958, 75° 58.5'S, 168° 29'E, 365 m, coll. H. De Witt, J. Dearborn, U.S.S. *Glacier* Oceanographic Team. The holotype is the property of the Stanford University.

but will ultimately be deposited in the United States National Museum. R ca. 35 mm, r 4.5 mm.

Distribution

Ross Sea. *Bathymetric Range*: 337–365 m.

Material Examined

Four specimens from 3 localities, as follows:
Sta. A450, 472–318 m, 1 specimen; Sta. A527, 358–337 m, 2 specimens.

Stanford University Station: GLD–15, 365 m, holotype.

Remarks

Two of the specimens show more granuliform spinules in the margins of the disc-plates than is the case in the holotype, but the difference is considered to be possibly no more than individual variation: a richer material will be necessary before a clear idea can be formed of the range of variation, as it is possible that *Glaciacantha*, like *Ophiacantha*, may prove to embrace forms which differ individually in the disc-clothing.

Family AMPHIURIDAE Ljungman, 1867

KEY TO THE ROSS SEA GENERA

- 1 (2) Oral papillae, not forming a continuous row along the side of the jaw, but instead there is a gap between the infra-dental papillae and the outer papillae: the mouth angle is therefore permanently gaping: an additional papilla occurs dorsal to the infradental papilla. **Amphiura** Forbes, 1942
- 2 (1) Three or 4 oral papillae, the outermost carried on the oral plate: no papillae on the adoral shield, and no additional papilla just dorsal to the infradental one. **Amphiodia** Verrill, 1899

Amphiura Forbes, 1842

(restr. Verrill, 1900)

Disc covered by fine, imbricating scales. Radial shields divergent. Adoral plates separating the oral shield from the first lateral plate. A proximal and a distal oral papilla separated by an interval, in which occurs at a higher level a smaller intermediate papilla.

Type species: *Amphiura chiajei* Forbes.

KEY TO THE ROSS SEA SPECIES

- 1 (2) Small forms, disc not exceeding 5 mm diameter, 1 large flat, elongate tentacle-scale. **algida** Koehler
- 2 (1) Large forms, disc exceeding 5 mm diameter, 2 elongate tentacle-scales on most arm-joints, save the first one or two. **belgicae** Koehler

Amphiura belgicae Koehler (pl. 2d, fig. 2; pl. 16, fig. 4; pl. 17, fig. 3)

Amphiura belgicae Koehler, 1900. Bull. Acad. Belg., p. 819; Koehler, 1901. Res. Voy. S.Y. *Belgica*, Ech. et Oph., p. 27, pl. 7; Bell, 1908. Nat. Antarct. Exped., 1901–4, Nat. Hist. 4, Echin., p. 14.; Greig, 1929. Bergens Mus. Arbok, 3, p. 6; Mortensen, 1936. Disc Rpts., 12, p. 279.

Amphiura Mortenseni Koehler, 1909. Trans. Roy. Soc. Edin., p. 604, pl. 14, fig. 121–2; Koehler, 1912. 2me Exped. Antarct. Franç., Echin., p. 134, pl. 12, fig. 2; Koehler, 1922. Australas. Antarct. Exped., Sci. Rpts., Ser. C, 8 (2), p. 31, pl. 80, fig. 5–8; Koehler, 1923. Swed. Antarct. Exped., Aster. et Oph., p. 112; Greig, 1929. Sci. Res. Norweg. Antarct. Exped., 2, p. 11.

Amphiura alternans Koehler, 1923. Swed. Antarct. Exped., Aster, et Oph., p. 107, pl. 15, fig. 1–4.

Amphiura Eugeniae Mortenseni Hertz, 1926. Deutsche Südpolar-Exped., Ophiur., p. 29.

Amphiura Eugeniae gracilis Hertz, 1926. *ibid.*, p. 30.

Disc: Subpentagonal, slightly indented in the interradii, flattened above, reaching ca 9 mm in diameter: covered above by conspicuous flattened scales, somewhat larger near the centre. Radial shields piriform, divergent proximad, separated by several scales, extending about one-third of the distance from the edge to the centre. Uniformly scaled below. Genital clefts conspicuous, elongate, extending from the oral shield to the ambitus. Oral shield small, subtriangular or spade-shaped, with an acute proximal angle, and a distal lobe on the distal margin. Adoral plates triangular, broader without than within, almost contiguous within, and the members of adjacent pairs almost contiguous on the radial mid-line. Oral plates united along the mid-interradius. Inner oral papilla leaf-shaped, square or triangular, flattened. Outer oral papilla carried on the adoral plate, leaf-like, or spiniform. Intermediate oral papilla inconspicuous, at a higher level than the other two.

Arms: Relatively robust, tapering only at the distal extremity, uniformly broad over most of the length, which reaches ca 40 mm. Dorsal arm-plates broadly elliptical, contiguous, sometimes with a weakened median line, where fracture of the plate tends to occur. Lateral plates not contiguous

above or below, carrying 4, erect, robust, tapering, cylindrical opaque arm-spines, which are subequal and usually have a blunt extremity. As seen from above the arm-spines stand at right angles to the arm-axis, and their length equals the width of the arm at the point at which they are located. (Note: this yields a diagnostic character in the interpretation of underwater photographs.) Ventral plates quadrangular with rounded angles, as broad as long, or a little longer than broad, contiguous throughout. Tentacle-pore large. Usually 2 elongate tentacle-scales, but occasional pores are seen with only 1, flattened, leaf-like scale, especially near the base of the arm.

Colour in Life: Probably deep brick-red; in spirit, fawn or white.

Type Locality

West Antarctica, in 55–168 fm (100–300 m).

Distribution

Antarctic circumpolar and Magellanic, as far north as 52°S, and including the Falklands, South Orkneys, South Georgia, Palmer Archipelago, Graham Land, Wilkes Land, and the Ross Sea as far south as the Barrier Ice. *Bathymetric Range:* 15–900 m.

Material Examined

Sixty-two specimens from 12 stations, as follows:

Sta. A454, 914–828 m, 5 specimens; Sta. A455, 322–340 m, 5 specimens; Sta. A456, 238–201 m, 6 specimens; Sta. A457, 315–342 m, 7 specimens; Sta. A464, 369–384 m, 3 specimens; Sta. A520, 201–205 m, 6 specimens; Sta. A525, 591–583 m, 1 juvenile; Sta. A526, 461–465 m, 1 specimen; Sta. A527, 358–337 m, 11 specimens; Sta. A528, 274–265 m, 10 specimens; Sta. A529, 205–216 m, 6 specimens; Sta. A534, 380–366 m, 1 juvenile.

Remarks

The variety of names under which the species is recorded in the literature cited above is due to the inconstancy of the characters of the oral papillae and, particularly, of the tentacle-scales, which may vary in shape and number, a feature unusual in *Amphiura*, as Mortensen (1936, p. 281) has pointed out. Similar variation is seen also in *Amphiodia joubini*. This latter is the only other large amphiuroid present in the Ross Sea

collections, and the characters of the arm-spines enable the two to be distinguished readily.

Ecology

Unlike many amphiuroids of comparable form and size (e.g., *A. rosea* and *A. norae* of New Zealand) this species does not seem to be a mud-dwelling form. At most of the stations at which it has been taken, the bottom includes stones or, if mud is present, it is overlain by polyzoan assemblages. A dense assemblage of *Amphiura belgicae* has been identified on enlargements of part of a black and white photograph taken at Sta. A528, Pennell Bank, in 274–264 m. About 10 individuals are clearly visible over an area less than 1 metre square, resting on the upper surface of the polyzoan masses, mostly with the arms spread out horizontally. This is in sharp contrast to the cryptic habits of similar amphiuroids on shallow-water bottom in the photic zone, and is no doubt attributable to the fact that a cryptozoic habit is adopted by amphiuroids only when they are illuminated. Indeed, the comment might be made of ophiuroids in general. A second photograph at the same station also shows *Amphiura belgicae* lying with the arms outspread on polyzoans. This suggests that the species may feed upon the zooids of the polyzoans; an alternative suggestion might be that both the amphiuroids and the polyzoans are dependent upon the plankton-shower. Both could be true simultaneously. Associated species of ophiuroids seen in the photographs include *Ophiurolepis gelida* (in some cases heavily infected by *Iophon radiatus*) and a species believed to be *Ophiacantha pentactis*. All these seem to be crawling over the polyzoan masses, as if seeking food there. Both *Amphiura belgicae* and *Ophiurolepis gelida* are conspicuous in the trawl-samples taken at the same station. Although the enlargements suffer from the grain in the negative, the erect robust, and evidently blunt, spines serve to confirm the identification of *Amphiura belgicae* (the radial shields can be faintly distinguished in one specimen). The species is evidently more selective as to environment than *Ophiurolepis gelida* which, as indicated elsewhere (p. 59) occurs in many photographs on both soft and hard bottom, with no sign of amphiuroids.

Amphiura belgicae was first recorded from the Ross Sea by Bell (1908, p. 14), from Cape Wadsworth in 8–15 fm, and off the Barrier Ice in 300 fm.

Amphiura algida Koehler (pl. 16, fig. 2; pl. 17, fig. 2; pl. 18, fig. 2)

Koehler, 1911, Brit. Antarct. Exp. 1907-9, 2 (4), p. 46, pl. VII; Koehler, 1922, Austral. Antarct. Exp. 1911-14, 8 (2), p. 30, pl. 81.

Disc: Reaching 4.5 mm diameter, rounded or subpentagonal, No primary plates visible; dorsal surface coarsely scaled with plates of dissimilar sizes, largest proximally. Radial shields divergent proximally, separated by a row of small scales, reaching only a quarter-radius from periphery. Ventral surface covered by scales smaller than those of dorsal side. Oral shield triangular with a convex distal border, as long as broad, or longer than broad. Adoral plates triangular, emarginated within and scarcely contiguous. Inner oral papilla thick and rounded, outer papilla also thick, obtuse, prominent, a small middle papilla between them, conical, acute. Genital clefts narrow.

Arms: Reaching 12-16 mm in length. Dorsal plates fan-shaped, with a proximal rounded angle, a little broader than long, all contiguous. Lateral plates carrying 4, erect, subequal, conical, tapering spines, equal in length to the arm-joint. Ventral plates rectangular, a little longer than broad, narrowly contiguous. One large, flat tentacle-scale, longer than broad.

Colour in Life: Unknown. Spirit specimens creamy white.

Type Locality

Cape Royds, Ross Island, 10-80 fm (19-146 m).

Distribution

Ross Sea, Adelie Land, 20-750 m.

Material Examined

Twenty-one specimens from 4 stations, as follows:

Sta. A448, off Ross Ice Barrier, 752 m, 7 specimens; Sta. 520, Pennell Bank, 201-205 m, 2 specimens.

Stanford University Stations: Sta. CEK, 30 m, 12 specimens; Sta. X, 135 m, 2 specimens.

Remarks

The species, which is inconspicuous, has not been recognised in any of the underwater photographs. It is apparently rare

Some of the Ross Sea specimens show the intermediate oral papilla enlarged, triangular in shape and at the same level as the inner and outer papillae, thus giving the species the facies of *Amphiodia*. On the other hand some specimens present the facies of *Amphiura*, having only a small, inwardly displaced intermediate oral papilla, as in Koehler's type material. The outer oral papilla is leaf like in most specimens examined, and sometimes reduplicated, though not on all jaws in the same specimen. The single elongate tentacle-scale and 4 erect subequal arm-spines yield distinctive and relatively invariable features. *Amphiura algida* differs from the other known Ross Sea amphiuroids in having only 1 tentacle-scale, which is large and conspicuous. From *A. angularis* Lyman (which ranges the subantarctic seas) it is less easily distinguishable, but the tentacle scale is rounded, and the outer oral papillae is conical in *A. angularis*. Hertz (1926) has suggested that *A. algida* may be only a form of *A. angularis*, but the Ross Sea material, as indicated above, differs consistently in having the elongate tentacle-scale, and most specimens have leaf-like outer oral papillae quite unlike those of *A. angularis*. Another conspicuous difference is seen in the arm-spines, already 5 or 6 in number in *A. angularis*, when the disc does not exceed 3 mm diameter. For discussion of *A. angularis* in Australasia, see Fell (1958, p. 26, and 1960, p. 68).

Summarising, it may be concluded that *A. algida* is strictly an Antarctic form, and is distinct from *A. angularis* which is circumpolar in the temperate and subantarctic latitudes.

***Amphiodia* Verrill, 1899**

Disc scaled above and below. Radial shields divergent. No specially modified marginal scales. Three or 4 subequal oral papillae, carried at the same level on the jaw.

Type Species: *Amphiura pulchella* Lyman, 1869.

A single Ross Sea species.

***Amphiodia joubini* (Koehler) n.comb.** (pl. 16, fig. 3; pl. 17, fig. 4; text-fig. 4)

Amphiura joubini Koehler, 1912. 2e Exped. Antarct. Franç. Echinod., p. 132, pl. 11, fig. 9, 13; Mortensen, 1925, Ark. f. Zoologi, 17a, 31, p. 2; Greig, 1929, Bergens Mus. Arbok, 3, p. 7; Mortensen, 1936, Disc. Rpts., 12, p. 277, fig. 16, 17.

Amphiodia destinata Koehler, 1922. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (2), p. 32, pl. 79; Fell, 1958. Zoo. Pubns. Viet. Univ. Wellington, 24, p. 27.

Disc: Reaching a diameter of ca 12 mm, rounded, indented in the interradii. Primary plates more or less distinct. Dorsal surface finely scaled, the scales near the ambitus, and below the ambitus finely spinulose along their free margins. Radial shields small, narrow, about 5 times as long as broad, divergent proximad, separated by several rows of small scales proximad, by only 1 scale distad; the area between the shield forming thus an isocetes triangle with an acute distal apex, twice as high as the base is broad. Ventral surface finely scaled, becoming naked in the vicinity of the oral shield. Genital clefts extending nearly to the margin, but partly obscured by the arm-spines. Oral shield small, subtriangular or more or less lozenge-shaped, the distal border convex or obtusely angled, the proximal angle almost a right-angle, the shield a little broader than long. Inner oral papilla short, thick, rounded or square with rounded angles. Outer oral papilla robust, conical, spiniform, acutely pointed, erect, carried on the adoral plate. Intermediate oral papilla of variable size and character, but when fully developed it stands on the same level as the other papillae, and is spiniform, a little smaller than the other two; when incompletely developed it is spiniform, and lies at a higher level within the mouth, as in *Amphiura*.

Arms: Reaching about 100 mm in length, elongate, slender, tapering gradually from about half-way out to the tip, very flexible (see pl. 16, fig. 3). Dorsal arm-plates pentagonal or transversely oval, much broader than long, contiguous. Lateral arm-plates meeting neither above nor below, carrying 5 to 7 erect, tapering, conical arm-spines; the lowest arm-spine has a straight extremity and is shorter than those immediately above it. The second, third, and sometimes fourth spines from the lowest have a hyaline tip, recurved proximad near the base of the arm, sometimes recurved distad near the middle part of the arm. Ventral arm-plates square with rounded angles, or pentagonal, contiguous. Tentacle-scales 2, small, rounded.

Colour in Life: Disc deep brick-red, arms lighter red. In spirit, whitish or greyish fawn.

Type Locality

West Antarctica, Marguerite Bay, 200 m.

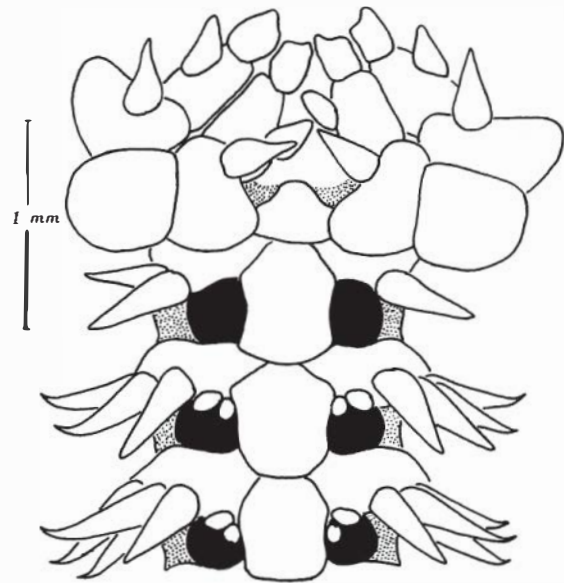


FIG. 4: *Amphiodia joubini*, details of ventral aspect in a specimen from Sta. A451, representative of the forms where the middle oral papilla is well-developed, and corresponding to *A. destinata* Koehler. Compare with pl. 17, fig. 4, which illustrates the form with only the inner and outer papillae well developed.

Distribution

Circumpolar Antarctic and Subantarctic and (in deep water) New Zealand. Probably present in other southern regions not yet fully investigated. **Bathymetric Range:** 80–1,100 m; but in the New Zealand area it has been taken only at depths below 200 fm (360–750 m, in Cook Strait and Bay of Plenty).

Material Examined

Thirty-seven specimens from 12 stations, as follows:

Sta. A448, 752 m, 13 specimens; Sta. A449, 362 m, 1 specimen; Sta. A450, 472–318 m, 2 specimens; Sta. A451, 523 m, 4 large specimens; Sta. A457, 315–342 m, 3 specimens; Sta. A458, 461–486 m, 1 specimen; Sta. A459, 534–549 m, 2 specimens; Sta. A460, 415–430 m, 2 specimens; Sta. A461, 578–567 m, 3 specimens; Sta. A466, 569 m, 1 large specimen; Sta. A530, 271–267 m, 1 specimen; Sta. A531 b, 348 m, 3 small specimens; Sta. A533, 183–84 m, 1 specimen.

Remarks

It is now quite clear that Koehler described this species under at least two names, as *Amphiura joubini* and as *Amphiodia destinata*. The conflict

in generic placing is explained by the great variability of the oral papillae, mentioned in the description above, which is based on the range of material now available. Since most specimens, especially the larger ones, show a relatively large and low-placed intermediate papilla, the genus *Amphiodia* appears more applicable, but it is obvious that *Amphiura* and *Amphiodia* cannot always be sharply demarcated, and it is a matter of personal opinion as to whether *Amphiodia* should be maintained as a valid genus. *Amphiura* is a large genus, and therefore it seems a practical convenience to maintain the divisions proposed by Verrill, even though this Antarctic species is intermediate. The differences between Koehler's description of his *Joubini* and that of *destinata* are trivial, and concern the precise shape of the oral shields, and the arm-plates; also *destinata* had only 5 arm-spines in his type. Fell's (1958) material from New Zealand, reported under the name of *Amphiodia destinata*, had 6 or 7 arm-spines, and variation is seen in the Ross Sea material now on hand. As regards the intermediate oral papilla in *destinata*, Koehler (1922) himself commented: "Dans les deux grands exemplaires ces trois papilles sont presque égales, la deuxième restant cependant un peu plus petite que les deux autres". Koehler also stated that the second lowest arm-spine carried a recurved point, implying that the others did not. Fell (1958) has already pointed out that Koehler's photograph (pl. 79, fig. 8) appears to show more than one recurved spine on basal segments, as was the case with the New Zealand material. The Ross Sea material now available shows that this is in fact the normal condition, the second, third, and fourth lowest spines being commonly modified in this way. Thus there can be no doubt that the species in New Zealand waters is identical with the Ross Sea species, and, further, the Ross Sea species is identical with the earlier described *joubini*. The name of the New Zealand record is to be amended accordingly. Unfortunately this is not necessarily the end of the nomenclatural confusion. Mortensen (1936, p. 279) has already given reasons for suspecting that *Amphiura joubini* may be identical with Koehler's *Amphiura polita*, also from the *Belgica* expedition. *A. polita* was defined as having thorny arm-spines; but Mortensen, who examined the types at Brussels, states that not all specimens of *polita* show this character. It is impossible at present to state whether two species were included under *polita*, or whether all the forms under consideration belong to one extremely variable taxon. If the latter proves to be the case, the name *polita* will take priority.

Ecology

All the above records are from soft bottom – either mud, gritty mud, or muddy sand – save only that at two of the stations the nature of the bottom was not recorded. Koehler recorded the holotype of *joubini* from mixed bottom sampling (rock, gravel, sand); the bottom from which the holotype of *destinata* was taken is not stated by Koehler, and Mortensen (1936) did not give bottom data. It is evident that the species, unlike *Amphiura belgicae*, is an indicator of soft bottom. At only 1 station were *A. belgicae* and *A. joubini* taken together – Sta. A457 – where the bottom was recorded as "mud"; there are grounds, then, for believing that the sample from this station is of mixed derivation, and that the trawl sample included a fraction from hard or temporary hard bottom.

Distribution

The species is notable as being the only ophiuroid known to be shared by the faunas of New Zealand and Antarctica. It is significant that the New Zealand records do not include specimens from the shelf. It is probable that the species is in reality of wide southern distribution in deep, cold water, and that it comes up on to the continental shelf only in the Subantarctic and Antarctic regions. The deepest known occurrence, at 1,080 m, off the S. Shetland Islands (L. 61°S) is consistent with this view, as is also the shallowest record, 84 m, off C. Barnes (L. 77° 35'S). The species is to be expected in deep water off the coasts of Chile and Argentina, though it has not yet been reported from these areas. It may similarly be expected from southern Australian waters, though not from the shelf.

The ophiuroid is probably a common species in the off-shore deep water of New Zealand, because it has been taken in no less than 3 samples of the relatively few deep hauls so far obtained – and from localities 300 miles apart, on the north and south coasts of the North Island. It is particularly interesting that the northern localities, in the Bay of Plenty, yield also echinoderms with Indonesian affinities, such as *Anthenoides granulosis*, taken at 270 fm (490 m) at Dom. Mus., Sta. B.S.209, where *Amphiodia joubini* was taken. This record particularly suggests that *Amphiodia joubini* is not to be regarded as an Antarctic species, but rather as a cold-water, eurybathic form. In the Antarctic, where all water-zones are cold, it has colonised the shelf. In the south temperate region, where the surface waters are at a

higher temperature, it is presumably unable to occupy the shelf. Mortensen (1936) has already shown that the species is not viviparous: this does not necessarily mean that it has a free-swimming larva, however, because an oviparous ophiuroid with direct development is known (Kirk, 1916). Since cold water seems to be necessary for *A. joubini* in the adult stage, it may be assumed to be necessary also in the young stage. But young stages of ophiuroids with indirect development seem always to be surface-inhabiting forms, which sink to the sea-floor after metamorphosis. It would not be unreasonable, then, to infer that *A. joubini* has a direct development, and that the eggs are shed on the bottom and undergo their development there. It should be feasible to investigate a topic of this kind if a low temperature aquarium were available.

Family OPHIODERMATIDAE

Ljungman, 1867

This family is represented in Australia and New Zealand by species of *Pectinura*, a genus with a widespread Indo-Pacific distribution. *Pectinura* extends throughout the New Zealand plateau, including therefore the Auckland and Campbell Islands. It is completely lacking from the Antarctic where, most unexpectedly, the genus *Toporkovia* proves to be the southernmost representative of the family.

Toporkovia Djakonov, 1954

Arm-spines erect, not adpressed to the arm. Oral shields naked, but all other plates of the disc and jaw covered by granules. Arm-plates concentrically striated. One large tentacle-scale.

Type Species: Toporkovia fragilis Djakonov.

The type species, until now the only known species, was taken in 414 m from "east of Etorofu Island, Kurile arc, a single specimen in damaged condition" (Djakonov, 1954, p. 132).

It is therefore very remarkable that a second species of the genus is now to be recorded from the Antarctic, thus making *Toporkovia* a bipolar genus, with representatives in the extreme north and extreme south of the Pacific Ocean. *Toporkovia* is closely related to the genera *Ophiurodon* and *Ophiuroconis*, both of which differ from *Toporkovia* in having the oral shields covered by granules. *Ophiurodon* is represented in Indonesia, whilst *Ophiuroconis* has a Japanese

representative. A more remotely related genus is *Ophiocoelis*, where not only are the oral shields completely covered by granules, but also the arm-spines are not of the erect, free type seen in the other genera mentioned. These relationships may be significant, for it is conceivable that *Toporkovia* could be a diphyletic genus, in which species with naked oral shields have arisen independently from stock such as *Ophiurodon* or *Ophiuroconis*, whose species occupy intermediate seas between the two geographical extremes occupied by *Toporkovia*. *Toporkovia*, with one species off the Kuriles, and the other Antarctic and Magellanic, is a more remarkable example of bipolarity in a genus than the pycnogonid genus *Rhynchothorax*, cited by Hedgpeth (1947, p. 40), where the northern member comes at least as far south as the Mediterranean. It would be unwise to speculate further on the meaning of bipolarity in the present case, at least until more is known of the distribution of *Toporkovia* at the northern end of its range.

Toporkovia antarctica (Lyman) n. comb. (pl. 16, fig. 1; pl. 17, fig. 1; pl. 18, fig. 1; text-fig. 5)

Ophiocoelis antarctica Lyman, 1882. Challenger Rpts., Ophiuroidea, p. 107, pl. 23, fig. 1-3; Hertz, 1926. Deutsche Südpolar-Exped. Oph., p. 40. Bell, 1908. Nat. Antarct. Exped. 1901-04, Nat. Hist. 4 Zool., Echin., p. 14.

Ophiacantha polaris Koehler, 1901, Res. S.Y. Belgica, Echin. et Oph., p. 32; Koehler, 1912, 2e Exped. Antarct. Franç., Echinod., p. 317.

Ophiacantha antarctica Mortensen, 1936. Disc. Rpts., 12, p. 254.

NON: *Ophiacantha antarctica* Koehler, 1900. Bull. Acad. Belg., p. 819.

Disc: Reaching a diameter of 13 mm, circular, granulated as for the generic diagnosis, 5-6 grains to the mm. Oral shields conspicuous, broadly triangular, with an obtuse proximal angle and a nearly straight distal border; other jaw-plates concealed. Oral papillae differentiated, the inner ones slender and pointed, the outer ones broader, flattened, rectangular. Genital clefts of moderate size, extending from the distal edge of the oral shield to the ambitus.

Arms: Reaching a length of 60 mm, robust, about 2 mm broad at the base (omitting the spines), tapering more abruptly near the tip. Dorsal arm-plates broadly fan-shaped, contiguous, with a proximal obtuse angle and a distal convex margin, thick, somewhat arched, carrying a fine microscopic tuberculation. Lateral arm-plates

meeting below, carrying 7 long, smooth, cylindrical, tapering arm-spines, of which the upper 2 are as long as 3 arm-joints, the others shorter. Ventral plates pentagonal, broader than long, with an obtuse proximal angle, a weakly curved distal edge, and re-entrant lateral margins, 1 elongate, broad tentacle-scale. The lateral and ventral plates are distinctly sculptured by concentric undulating ridges and grooves which reflect the light.

Colour in Life: Upper surface of disc and arms pale mauve; interradiad adoral areas mauve, remainder of lower surface of disc and arms paler (colour photograph by J. S. Bullivant, Sta. A525); pink arms and grey-pink disc (field notes, J. S. Bullivant, Sta. A516). Colour in spirit, white.

Type Locality

52°S, 71°E, off Marion and Prince Edward Islands, 150 fm (270 m).

Distribution

Indian Ocean sector of Antarctic Ocean, Ross Sea; probably circumpolar Subantarctic and Antarctic. *Bathymetric Range:* 180–900 m.

Material Examined

Twenty-four specimens from 8 stations, as follows:

Sta. A449, 362 m, 1 specimen; Sta. A454, 914–828 m, 4 small specimens; Sta. A455, 322–340 m, 5 specimens; Sta. A456, 238–201 m, 1 specimen; Sta. A457, 315–342 m, 1 specimen; Sta. A516, 457–183 m, 1 specimen; Sta. A525, 591–583 m, 10 specimens; Sta. A528, 274–265 m, 1 specimen.

Remarks

Bell (1908, p. 14) recorded the species from Winter Quarters (South Victoria Land) under Lyman's name *Ophioconis antarctica*; beyond the statement that the specimens were larger than Lyman's types, he gave no details, but the record may be accepted as such, in view of the confirmation given by the data presented here.

Most of the Ross Sea localities register rocks or stones, with or without mud, so that the species seems to frequent mixed bottom.

Toporkovia antarctica is apparently very similar to the type species, *Toporkovia fragilis* Djakonov, and it is even possible that the two species may be identical (in which case Lyman's specific name

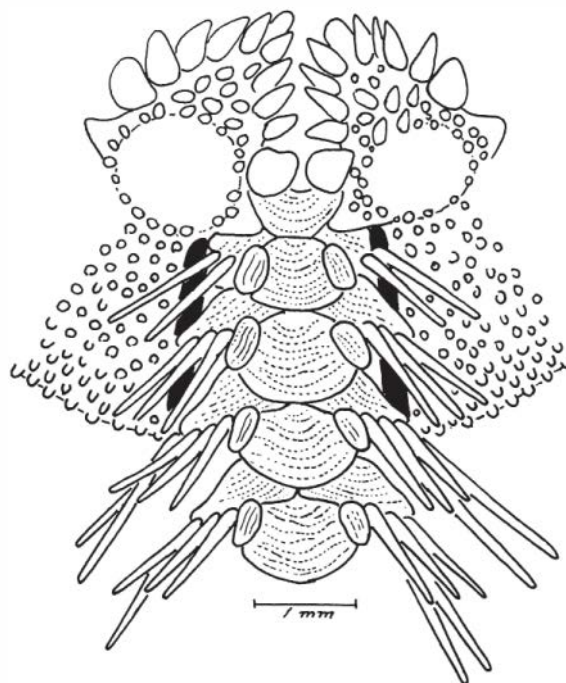


FIG. 5: *Toporkovia antarctica* from Sta. A455, ventral aspect showing diagnostic characters.

will take priority), though it should be referred to *Toporkovia* which was well defined by Djakonov. The differences between the two species may be seen by comparing the figures of *antarctica* given here, with Djakonov's illustration (1954, p. 131, fig. 47). Djakonov shows only 2 suboral papillae on the ventral surface of the jaw in *fragilis*, and there are only 4 oral papillae, all of them blunt. In *antarctica* (pl. 18, fig. 1) the suboral papillae are more numerous (though variable in number) and the oral papillae number 5–6, of attenuated spini-form type with sharp terminations. Djakonov's unique specimen was, as he records (1954, p. 132) "small, in damaged condition, 4 mm, disc diameter". The specimen of *antarctica* illustrated in pl. 18 is 10 mm in disc diameter, and thus some of the differences may be due to age. If the two species should ultimately prove to be indistinguishable, the bipolarity of the united taxon will be the more extraordinary.*

**Postscript:* These results have been discussed with Russian colleagues whilst the present report has been in the press. Dr G. M. Beliaev of Moscow informs me that he has now examined new material of *Toporkovia fragilis*, and concludes that the species may well be identical with *T. antarctica*, representing merely a subspecies. Dr Z. Maranova of Leningrad also informs me that she believes that *T. fragilis* is identical with *Ophioconis papillata* H. L. Clark, of the NE Pacific. It would thus appear that the correct name for all these forms is *Toporkovia antarctica*. The new data will be published in joint papers by Fell, Beliaev and Ivanov in the *Zoologicheskii Zhurnal*.

Family OPHIOLEUCIDAE Matsumoto,
1915

A single Ross Sea genus

Ophiopyren Lyman, 1878

Disc pentagonal, flattened, convex above and covered by granulation, naked and somewhat concave below. Arms extremely slender, 2 tentacle scales throughout.

Type Species: Ophiopyren longispinus Lyman, 1878.

The genus comprises delicate, deep-sea forms of widespread distribution. A single Ross Sea species.

In my synoptic keys of ophiuroidea (Fell, 1960, p. 20) the genus *Ophioperla* was also included in the Ophioleucidae, and if this course is followed, would represent a second Antarctic genus of the family. Although I still lack material of *Ophioperla*, the specimens of *Ophiopyren regularis* discussed in the present report differ so markedly in general facies from *Ophioperla* that I no longer consider that *Ophioperla* can be treated as at all closely related. Instead, I now accept Mortensen's treatment of *Ophioperla* as a genus of Ophiuridae (= Ophiolepididae auct.). *Ophioperla* is therefore discussed under that family, see p. 48.

Ophiopyren regularis Koehler (pl. 6, fig. 2, 3)

Ophiopyren regulare Koehler, 1900. Bull. Acad. Belg., p. 819; Koehler, 1901. Res. Voy. S.Y. Belgica, Echin. et Oph., p. 26, pl. 8, fig. 52-4.

Ophiopyren regularis Koehler, 1922. Australas. Antarct. Exped. 1911-14, Ser. C. 8 (2), p. 36, pl. 86, fig. 1-2; Mortensen, 1936. Disc. Rpts., 12, p. 345, fig. 53.

Disc: Circular, reaching a diameter of ca 10 mm, lightly arched above, flat or concave below, the ambitus very distinctly demarcated below by the interradial arcs of disc-plates. The plates of the upper side form a mosaic, among which the radial shields are the most conspicuous. The plates of the upper surface carry peripheral zones of small, spherical, uniform granules, the greater part of each plate remaining naked. The granules become taller and cylindrical towards the ambitus, where they abruptly cease, so that the ventral side is quite naked. Radial shields oval, contiguous distad, divergent proximad, where they are separated by a single conspicuous radial plate, and the granules which border the margins of the plates concerned. Interradial areas below very large, covered by uniform, imbricating, naked scales. Genital clefts very conspicuous, elongate, but not reaching the ambitus. Oral shield

extremely small, lozenge-shaped, as broad as wide, with distal and proximal right angles, or with a proximal right angle and a distal convex border. Adoral plates narrow, rectangular, meeting within, and separating the oral shield from the first lateral plate. Oral plates large, triangular, meeting broadly within, carrying conspicuous lanceolate teeth, and about 10 oral papillae of rectangular shape, crowded, becoming smaller distad. The jaw-angle is very wide, especially distad, where it is confluent with a deep radial groove excavated upon the proximo-ventral surface of the first ventral plate. A short genital comb of a few granules along the proximal end of the adradial margin of the genital cleft.

Arms: Tapering rapidly from the base, ca 20 mm long, extremely delicate slender, sharply demarcated from the disc and seeming to lie in radial, ventral excavations of the disc; the ventral surface of the arm being thus at the same level as the ventral interradial surface, enabling the whole ventral surface to be applied to the substrate, and raised as a suctorial disc. Dorsal plates rectangular or trapezoidal, with straight transverse proximal and distal margins, strongly arched, broadly contiguous throughout. Lateral plates meeting neither above nor below, carrying 2 dissimilar arm-spines at the ventro-distal angle: the upper spine conical, minute, the lower flattened, lanceolate or triangular, almost as long as the arm-joint. Ventral arm-plates transversely with parallel distal and proximal curved margins, the distal convex, the proximal concave, the lateral margins excavate, to contain the large tentacle-pore; broadly contiguous, a little broader than long. 2-3 leaf-like tentacle scales on the basal pores, a single leaf-shaped conspicuous scale carried on the radial margin of succeeding pores.

Colour in Life: Disc brilliant, deep saturated crimson above, the arms cross-banded with pink (colour photograph, Sta. A525): "disc blood-red-orange dorsally, and white ventrally, with red patches on the arms" (field-notes, J. S. Bullivant). Colour in spirit, uniform off-white, or fawn or (one specimen) uniform light brown. The brilliant colours combined with the very fragile arms disproportionately slender in relation to the disc, are characters which enable immediate recognition of this species in the field.

Type Locality

West Antarctica, 70°-71°S, 80° 50'W, in 460 m.

Distribution

Probably circumpolar Antarctic; the actual known localities are West Antarctica (Bellingshausen Sea), off Wilkes Land, and (the present record) Ross Sea. Mortensen's (1936) record from South Georgia may not be this species. *Bathymetric Range*: 10–900 m.

Material Examined

Five specimens from 3 stations, as follows:

Sta. A454, 914–828 m, 2 specimens; Sta. A521, 582–558 m, 1 specimen; Sta. A525, 591–593 m, 2 specimens.

Remarks

Mortensen (1936, p. 346) illustrates a specimen from South Georgia which differs from Koehler's material in having the upper surface of the disc densely granulated, with only parts of the radial shields naked; it further differs from Koehler's material in having a transverse row of granules on each of the proximal six dorsal plates, the granules lying proximad on each plate. These features were observed on the single specimen of *Ophiopyren* taken by the *Discovery*. The colour notes for the specimen do not entirely agree with those given here for the Ross Sea material. The specimen described by Mortensen may be only a variant, but in view of the fact that the Ross Sea material agrees perfectly with Koehler's material, there is now a distinct possibility that Mortensen's form represents a separate species. It is perhaps significant that all Koehler's material, like mine, came from Antarctic localities, whereas Mortensen's single specimen is from the Magellanic region. Until the matter is more fully investigated, it is advisable to delete the Magellanic region from the distribution records of *Ophiopyren regularis*, and to treat the South Georgia record as a potentially distinct species. The photographic illustrations of the Ross Sea form given in the present memoir (pl. 6) may assist in future study of the Magellanic form, when more specimens become available.

Ecology

The Ross Sea stations at which *O. regularis* was taken each registered rocks, stones, or stones and mud. These data are not inconsistent with Mortensen's (1936) suggestion that the structure of the disc in *Ophiopyren* is such as to serve as a suction organ, the animal being supposed to adhere to a hard surface. Possibly the raised disc may serve to provide an external filter-chamber surrounding the mouth, the chamber supplied by

currents set up by the extremely large tentacles, lashing in the direction of the base of the arm, and directing the water into the groove within which the base of the arm is lodged. At all events, the extraordinary fragility and "brachiole-like" character of the arms, combined with the relatively large and probably concave disc, implies some feeding mechanism of the kind visualised. Perhaps the arms themselves serve as tentacles sweeping to the right and left, and driving the "sweepings" towards the ambitus, whence they can be sucked into the disc-chamber.

Family OPHIURIDAE Lyman, 1865
(Syn. Ophiolepididae auctt.)

Subfamily OPHIURINAE Lyman, 1865
(Syn. Ophiomastinae Matsu., 1915)

KEY TO THE ROSS SEA GENERA

- 1 (18) Disc covered above by naked plates or scales.
Ophiionotus Bell, 1902
- 2 (3) Each dorsal arm-plate fragmented into a central plate, with several lateral mosaic platelets on either side.
Ophiionotus Bell, 1902
- 3 (2) Dorsal arm-plates not fragmented.
- 4 (5) Disc covered above by a central rosette of primary plates, surrounded by three circlets of petal-like, flattened plates, which curve upwards at their distal extremities. Dorsal arm-plates bearing each a tall conical tubercle.
Euvondrea Fell, 1961
- 5 (4) No so.
- 6 (13) Tentacle pores restricted to a few basal arm-joints.
- 7 (10) Disc higher than arms. Arm-spines minute.
- 8 (9) Tentacle-pores conspicuous on 3 basal joints. Jaws excavate on midline.
Theodorina n.g.
- 9 (8) Only 1 tentacle-pore. Jaws not excavate on mid-line.
Ophiurolepis Matsumoto, 1915
- 10 (7) Disc not conspicuously higher than arms, though covered by tumid plates. Arm-spines not minute.
- 11 (12) A large keel-like plate at the base of the arm, more or less obscuring the radial shields; arms compressed, triangular in sections, because the dorsal plates stand high and keel-like, giving a serrated outline to the arm: 5 or more similar arm-spines.
Ophiosteira Bell, 1902

- 12 (11) Three arm-spines, whereof the middle one becomes transformed into a hyaline up-turned hooklet on distal arm-joints.
Ophiuroglypha Hertz, 1926
- 13 (6) Tentacle-pores occurring over most of the arm, though the proximal pores are much larger than the distal ones.
- 14 (15) Disc high, arms not broader than high: primary plates large and conspicuous. No arm-comb. Tentacle-scales present. Centrodorsal plate large, pentagonal or rounded. One to 3 tentacle-scales on basal pores, 1 or none beyond the arm-base: adoral shields well-developed; oral papillae more or less fused together. **Ophiomastus** Lyman, 1878
- 15 (12) Disc low and flat. Arms broader than high.
- 16 (17) Primary plates more or less conspicuous, edge of disc not emarginated at the arm-base: basal dorsal arm-plates well developed, each one sometimes carrying a transverse row of spinules: arm-comb usually continuous across arm-base. **Ophiocten** Lütken, 1855
- 17 (16) Primary plates inconspicuous: no transverse spinules on dorsal arm-plates: tentacle-scales papilliform, on both outer and inner edges of pores, more numerous on basal arm-joints. Arm-comb usually present, but not continuous across arm-base: edge of disc emarginated at arm-base, and the notch so formed is occupied by several rudimentary dorsal arm-plates.
Ophiura Lamarck, 1801
- 18 (1) Fine granulation covers upper surface of disc and may extend on to part of lower surface.
- 19 (20) Radial shields short, oval, widely separated by numerous small platelets and by granulation. No arm-comb.
Ophiogona Studer, 1876
- 20 (19) Radial shields obscured by granulation. Arm-comb present.
Ophioperla Koehler, 1912

Ophionotus Bell, 1902

Disc low, flattened, covered above by a mosaic of small scales imbedded in integument. No arm-comb. Dorsal plates of arm fragmented into a series of median plates, one on each arm-joint, with numerous irregular platelets on either side.

Type Species: Ophionotus victoriae Bell.

The genus contains two known species. One of them, *Ophionotus hexactis* (E. A. Smith) is circumpolar Subantarctic and Magellanic, but seems to be absent from any part of Antarctica; it is readily distinguishable by its hexamerous

symmetry and viviparous habit. The other species, *Ophionotus victoriae* ranges the Antarctic, with the type locality Cape Adare in the Ross Sea; its pentamerous symmetry, and larger size at once differentiate it. Mortensen (1936, p. 312) notes that both species occur together at South Georgia, whereas otherwise the 2 species are allopatric. South Georgia (in 54°S latitude) lies on the overlap region between the Subantarctic and Antarctic zones, with the Palmer Archipelago providing a shallow-water bridge from the continental margin of Antarctica. Therefore the sympatric occurrence in South Georgia is not surprising; but neither is it likely to be typical, and it seems improbable that *Ophionotus hexactis* occurs in the Ross Sea. No member of this extreme southern genus is known from the Auckland, Campbell, or Antipodes Islands, nor indeed from any part of the New Zealand plateau. On the other hand, *Ophionotus hexactis* is a conspicuous member of the littoral fauna of Heard Island and Kerguelen Island. The significance of these facts, in conjunction with other features of southern ophiuroid faunas, is discussed separately on p. 71.

Ophionotus victoriae Bell (pl. 14, fig. 5; pl. 15, fig. 7; pl. 18, fig. 5; col. pl. 2d)

Ophionotus victoriae Bell, 1902. Rpt. Nat. Hist. Coll. *Southern Cross*. Echin., p. 219, pl. 28; Koehler, 1906. Exped. Antarct. Franç. 1903-5, Echin., p. 29; Bell, 1908. Nat. Antarct. Exped. 1901-4, 4, Zool. Echin., p. 13; Koehler, 1912. 2me Exped. Antarct. Franç., Echin., p. 114, pl. 10, fig. 2-4, 12-13; pl. 11, fig. 8; Koehler, 1922. Australas. Antarct. Exped. Ser. C, 8 (2), p. 51. Koehler, 1923. Swed. Antarct. Exped. Aster & Oph., p. 124; Hertz, 1926. Deutsche Südpolar-Exped., Oph., p. 16; Hertz, 1927. Deutsche Tiefsee-Exped. Oph., p. 67; Grieg, 1929. Sci. Res. Norweg. Antarct. Exped. 1927-29, 11, 9; Mortensen, 1936. Disc. Rpts., 12, p. 311.

Disc: Large, flat, circular with well defined vertical ambitus, reaching a diameter of ca 40 mm. Dorsal surface covered by small platelets imbedded in a thick integument, with no sign in the adult of primary plates nor of radial shields. The inter-radial areas of the ventral side are similarly covered, but the scales are larger, and imbricate weakly, with no integument lying between the platelets. Genital clefts large, elongate, reaching from the oral shield to the ambitus, with a conspicuous vertical interradiar margin, the ventral edge of which carries a long series of uniformly small, flattened rounded or triangular scales, forming a delicate comb. Oral shield spade-shaped, with a proximal oblique or right angle.

bounded by straight proximal sides, and a distal semicircular border; between the proximal and distal margins, on the adradial border of each side, is a distinct lobe; the shield is about two-thirds as broad as long, and has a delicate fabric, almost translucent at the edges. The jaws are narrow with conspicuous radial jaw-angles which are permanently gaping, and serve for the accommodation of the very large oral tentacles. Both adoral and oral plates are long and narrow, meeting within, and having parallel sides. The oral papillae are differentiated, and form a continuous, though not uniform, series. The outermost 5 papillae are block-like, rectangular, contiguous; then follow about 4 pointed conical papillae, smaller than the foregoing, barely contiguous; then follow the terminal cluster of dental papillae, resembling the teeth, lanceolate or conical, flattened, about twice as long as broad as the other papillae. The outer papillae often stand in an erect attitude, as if thrust ventrad by the oral tentacle.

Arms: Short, robust, depressed, flattened above and below, tapering rapidly from the base distad, reaching a length of ca 90 mm. Dorsal arm-plates in adult stage comprising a medioradial series of contiguous, small pentagonal or fan-shaped platelets, about one-sixth of the arm-width; outside these lie numerous crescentic, imbricating scales of much smaller size, irregularly arranged. In the immature form the dorsal plates are simple, transversely rectangular, broadly contiguous, and the successive stages in fragmentation of the outer margins can be followed in older individuals. Lateral plates broad, meeting narrowly below, carrying on the distal edge 4 conspicuous, erect, flattened, elongate, tapering spines; the uppermost spine is most developed, and reaches (in the adult stage) for one and a half joints; the second is as long as a joint, the third and lowest is shorter. Ventral plates broad and short, about 6 times as broad as long, with a straight or weakly convex distal margin, and a small proximal medial acute angle; the plates are sometimes irregularly fragmented in the adult. Tentacle-scales flattened, leaf-like, large, usually on basal joints, though 3 or more may occur in very large individuals, a single scale on joints beyond the twelfth.

Colour in Life: Variable - brown, red-brown, brick-red, brownish-violet with darker patches, brownish-grey; a specimen visible in a colour photograph by J. S. Bullivant at St. A516 shows a grey disc with radial fawn streaks, arms pinkish-fawn, with narrow transverse bars of creamy-white at successively closer intervals distad, the spines pinkish-fawn. In spirit, mottled light grey.

Type Locality

Cape Adare is mentioned first by Bell, but he also had material from Franklin Island: 10–27 fm (18–49 m).

Distribution

Antarctic and South Georgia.

Bathymetric Range: Eurybathic, 5–750 m.

Material Examined

Seventy-two specimens from 10 stations, as follows:

Sta. A448, 752 m, 11 large specimens; Sta. A459, 534–549 m, 31 specimens; Sta. A460, 415–430 m, 1 specimen; Sta. A461, 578–567 m, arm-fragment; Sta. A464, 369–384 m, 1 specimen and fragment; Sta. A466, 569 m, 16 specimens and fragments.

Young specimens in which fragmentation of the dorsal arm-plates had not occurred, or was still restricted to basal joints, were obtained from the following stations: Sta. A456, 238–201 m, 2 specimens; Sta. A457, 315–342 m, Sta. A459, 534–549 m, 1 specimen; Sta. A464, 369–384 m, 1 specimen; Sta. A466, 569 m, arm-fragments; Sta. A520, 201–205 m, 5 specimens; Sta. A531b, 348 m, 2 specimens.

Remarks

The description given above is based on large specimens from Sta. A448, Bell (1902, p. 219) indicated that the type material had arms up to 12 cm in length, though the largest disc he had measured 30 mm diameter. There seems to be some error here, and the dimensions given in my description above are those observed in the material studied.

Ophioperla Koehler, 1912

Basal tentacle-pores with 6 scales, dwindling to 3 or 4 scales on distal pores. Disc and radial shields covered by fine granulation. Arm-comb present.

Type Species: *Ophiura koehleri* Bell.

A single Antarctic species.

Ophioperla koehleri (Bell)

Ophiura Koehleri Bell, 1908. Nat. Antarct. Exped. 1901-4. Echinoderma, p. 11.

Ophioperla ludwigi Koehler, 1912. Zeit. wiss. Zool. ci. p. 259. Koehler, 1912. 2me. Exped. Antarct. Franç., Echin., p. 126, pl. 10, fig. 1, 5-7; Koehler, 1922. Australas. Antarct. Exped., Sci. Rpts., Ser. C, 8 (2), p. 51; Koehler, 1923. Swed. Antarct. Exped., Ast. & Oph., p. 127.

Ophioperla koehleri Mrtsn., 1936. Disc. Rpts., 12, p. 310.

Disc: Pentagonal, reaching a diameter of ca 35 mm, thick, flat above, the margins rounded; uniformly covered with rounded granules. Radial shields obscured by granulation. Arm-comb present, comprising elongate but blunt spines. Ventral surface of disc covered by rounded, naked plates, some of the plates carrying a few granules like those of upper surface. In young specimens the scales of both the upper and lower surfaces of the disc may be visible, and the radial shields are then seen to be short and broad, widely divergent, scarcely contiguous distally. Oral shields of medium size, pentagonal, with an obtuse proximal angle, a convex distal margin and concave sides. Adoral plates elongate, 4 times longer than broad, with parallel sides, separating the oral shield from the first lateral arm-plate. Oral plates broader and shorter than adoral plates. Oral papillae small, not extending along the whole free edge of the oral plate, conical and delicate, their size increasing proximad; the teeth resemble the contiguous papillae. Genital cleft conspicuous, extending from the middle part of the oral shield (which is excavate) to the ambitus.

Arms: Robust, tapering, reaching a length of ca 55 mm. Dorsal arm-plates broadly rectangular, broadly contiguous. The lateral plates carry on the upper distal margin 3 similar, long flattened lanceolate spines. Ventral plates broadly fan-shaped, with an acute proximal angle and a convex distal margin. Tentacle-scales 6 at base of arm, 3 or 4 on distal pores.

Colour in Life: Disc and arms orange to brick-red above; disc pink below, the arms salmon below. Colour in spirit, off-white.

Type Locality

North of Victoria Land, 67° 21'S, 155° 21'E, in 254 fm (460 m).

Distribution

Circumpolar Antarctic and Magellanic, as far north as 54°S (South Georgia). The type locality

of *Ophioperla ludwigi* is Port Lockroy, West Antarctica, 64° 49'S, 65° 49'W, at 70 m, on grey clay and stones. Under the latter name Koehler (1922) also recorded the species from off Wilkes Land (64°-65°S, 96°-97°E). Although the two types of *O. koehleri* were taken near the north coast of Victoria Land, the species has not yet been found in the Ross Sea itself. **Bathymetric Range:** 70-720 m.

Bell's (1908, p. 11) description is grossly misleading, and it was not until Mortensen (1936, p. 311) examined the holotype in the British Museum that it was realised that "*Ophiura koehleri*" was in fact the same species as Koehler (1912, p. 259) had independently described as *Ophioperla ludwigi*. Thus it has come about that the type species of *Ophioperla* Koehler is *O. koehleri*.

Material Examined

None. The species is almost certainly present in the Ross Sea, and since it is by no means a rare species in other parts of Antarctica, its absence from the present collections is hard to explain.

Ophiecten Lütken, 1855

Disc low, flat, the primary plates conspicuous, the edge of the disc not emarginated at the arm-base; arm-comb usually continuing across the base of the arm. Arms broader than high, the tentacle-pores continuing to the distal joints, though larger on the proximal joints. Dorsal arm-plates often carrying a transverse row of spinules.

Type Species: *Ophiura sericea* Forbes.

The single Ross Sea species is characterised by the very large centrodorsal plate, which is circular, translucent, with a weakly developed central thickening.

Ophiecten megaloplax Koehler (pl. 8, fig. 4, 6)

Koehler, 1900. Bull. Acad. Belg., p. 819; Koehler, 1901. Res. Voy. S.Y. *Belgica*, Echin. et Oph., p. 22, pl. 6, fig. 38-39; Koehler, 1922. Australas. Antarct. Exped. 1911-14, Sci. Res., Ser. C, 8 (2), p. 82, pl. 84, fig. 15, 16; Mortensen, 1925. Archiv. Zool., 17a, 31, p. 2.

Disc: Reaching a diameter of ca 8 mm, rounded, flattened above and below. The dorsal surface is covered by plates of assorted sizes, of which the largest is the centrodorsal, occupying

the central one-third of the disc; it is surrounded by imbricating plates of varying size, between which are numerous much smaller platelets. The radial shields are more or less elliptical, a little longer than broad, reaching barely one-quarter of the distance from the ambitus to the centre, divergent proximad, separated by several rows of small scales, and having their margins more or less encroached upon by the surrounding platelets. The arm-comb, of short blunt spinelets, extends across the base of the arm, carried by the shields and by the single intervening distal platelet between the shields. Genital clefts elongate, conspicuous, extending from the distal margin of the oral shield to the ambitus, the genital plates without a comb. Ventral surface occupied largely by the conspicuous oral shields and smaller scales which imbricate. Oral shields large, pentagonal, either a little broader than long or a little longer than broad, with an obtuse proximal angle, the lateral and distal margins rounded. Adoral plates small, variable in size and shape, narrow, bar-like. Oral plates large, rectangular; both adoral plates and oral plates are broadly contiguous on the radial midline. The innermost oral papilla is lanceolate, and resembles the tooth. The outer papillae, 3 or 4 in number, are low, rectangular, and become successively wider towards the distal angle of the jaws.

Arms: Slender, tapering, reaching a length of ca 30 mm. Dorsal arm-plates rectangular, a little broader than long at the base of the arm, becoming square at about the fifth joint, and beyond this they become successively longer than broad, broadly contiguous throughout. Lateral arm-plates meeting broadly below on all segments, carrying on the distal margin 3 erect, elongate, slender, tapering arm-spines, of which the uppermost equals 3 joints in length, the second equals the joint, and the lowest is shorter than an arm-joint. Ventral plates transversely fan-shaped on basal joints, becoming half-moon-shaped at about the tenth joint, having the convex side distad; widely separated, about twice as broad as long. Tentacle-pores large on the basal joints, becoming smaller distad; guarded by one leaf-shaped scale, except on basal joints, where 2 of 3 scales occur.

Colour in Life: Violet, the arms annulated rose and white (Koehler, 1912); in spirit, whitish, with darker greyish markings.

Type Locality

West Antarctica, Bellingshausen Sea, 70° 50'S, 94° 42'W, in 350 m.

Distribution

Probably circumpolar Antarctic, not Magellanic. The recorded localities are: Marguerite Bay, Palmer Peninsula; of Wilkes Land; off Adelie Land; and Ross Sea. *Bathymetric Range:* 200–750 m.

Material Examined

Eighteen specimens from 3 stations, as follows:

Sta. A448, 752 m, 16 specimens (mostly juvenile, with no arm-comb developed); Sta. A459, 534–549 m, 1 specimen; Sta. A538, 269–256 m, 1 large specimen.

Ecology

All but one of the Ross Sea specimens are from mud-bottom; the single exception, from Sta. A538, is from a mixed trawl, and could well have been derived from a mud fraction. The species may therefore be regarded as a soft-bottom indicator.

Ophiura Lamarck, 1801

Disc low, emarginated at the arm-base, the notch so-formed occupied by several rudimentary dorsal arm-plates. Arm-comb usually present, but not continuous across the arm-base. Primary plates inconspicuous. Tentacle-pores well developed throughout the arm, but better developed at the base, where they carry numerous scales.

Type Species: *Asterius ophiura* Linnaeus.

The genus has been successively restricted during the last century and a half. As originally conceived, it included all ophiuroids with unbranched arms.

KEY TO THE ROSS SEA SPECIES

- 1 (2) Ventral arm-plates all longer than broad, the arms consequently freely flexible. Arm-spines 4, equally spaced. **flexibilis** Koehler, 1911
- 2 (1) Ventral arm-plates not longer than broad in the basal region of the arm.
- 3 (4) Arm-spines 4, 3 of them placed together low down on the lateral plate, the other placed alone at a higher level. First 7–9 tentacle-pores very conspicuous. — **ambigua** Lyman, 1878
- 4 (3) Arm-spines 5, equally spaced. Only the first tentacle-pore is conspicuous. — **crassa** Mortensen, 1936

Ophiura ambigua (Lyman) (pl. 14, fig. 3, 6; pl. 15, fig. 4, 5; pl. 18, fig. 3; col. pl. 2c)

Ophioglypha ambigua Lyman, 1878. Bull. Mus. Comp. Zool., 5 (7), p. 79; Lyman, 1882. Challenger Rpts., Zool., 5 (1), p. 54, pl. 8, fig. 4, 5.

Ophiura ambigua Koehler, 1912. 2me. Exped. Antarct. Franç., Echin., p. 109.

Disc: Pentagonal-rounded, with a flattened upper surface, and well defined ambitus, reaching ca 16 mm diameter, covered above by thick, somewhat angular, small plates forming a mosaic, among which the primaries can be discerned with difficulty. Radial shields triangular with rounded angles, longer than broad, widely separated by 1 large and 2–3 small scales. Papillae of arm-comb short, squarish, close-set. Ventral interradii covered by a mosaic of plates. Genital clefts elongate narrow, extending from the middle of the oral shield to the ambitus, the interradii margin bordered by uniform, close-set squarish papillae. Oral shield pentagonal as broad as long, with an oblique proximal angle, and a distal margin which is either convex, concave, or straight; an occasional shield may be triangular, in which case it is broader than long, and the sides and distal border form a continuous convex margin. Adoral plates about 3 times longer than broad, meeting within. Oral papillae 5, short, blunt, similar, and confluent with scales of the oral tentacle-pore.

Arms: Robust, broader than high, tapering regularly from base to tip, ca. 45 mm in length. Dorsal arm-plates broader than long, broadly contiguous. Lateral plates meeting neither above nor below, carrying 4 arm-spines, which are very short and blunt, scale-like, similar to the papillae of the arm-comb, placed so that 3 lie together low down on the plate, beside the tentacle-scales, and the fourth lies alone a short distance above the middle of the lateral plate. The spines are adpressed to the arm, and stand on the distal margin of the lateral plate. Ventral plate broadly triangular, with a proximal obtuse angle, and a slightly convex, wide distal border, contiguous on the first 6 or so joints, broader than long. Beyond the middle of the arm the ventral plates become fanshaped and are separated by the laterals. Tentacle-pores conspicuous on the first 7–9 joints, with numerous scales on both margins.

Colour in Life: Disc purplish-pink above, pinkish-white below; arms pale pink above, white below (J. S. Bullivant, field notes and colour photograph, Sta. A527; a colour photograph from Sta. A521 shows a specimen which has the disc

and arms fawn-coloured above; colour in spirit, creamy-white, or greyish-white).

Type Locality

Royal Sound, Kerguelen Island, 25–28 fm (46–51 m).

Distribution

Kerguelen and Ross Sea (present record).
Bathymetric Range: 40–900 m.

Material Examined

Forty specimens from 5 stations, as follows:

Sta. A454, 914–828 m, 8 specimens; Sta. A464, 369–384 m, 10 specimens; Sta. A521, 582–558 m, 4 specimens; Sta. A523, 1,375 m, 9 specimens; Sta. A527, 358–337 m, 9 specimens.

Remarks

There appears to be no doubt as to the identity of most of these specimens with Lyman's species from Kerguelen, where it was taken in shallow water. The occurrence of the species in the Ross Sea is of considerable interest, and raises the question as to whether the species is circumpolar in both Subantarctic and Antarctic waters; this might seem unlikely since it has not been recorded from the numerous samples that have been taken in west Antarctica. However, I am not entirely convinced that *ambigua* and *rouchei* Koehler are two different species. *Ophiura rouchei*, a smaller species, has only the first two tentacle-pores enlarged, and the ventral plates fall off in size beyond the second joint; also there are 3 arm-spines. Now, at Sta. A454 and Sta. A464 occur specimens which come rather close to *O. rouchei*, having 3 arm-spines instead of 4, and the ventral arm-plates and pores are very near to the condition in *rouchei*. Yet at these same stations occur other, larger specimens which are undoubtedly *Ophiura ambigua*, and much exceed the recorded size-range from *O. rouchei*. At each of these two stations occur other forms which are intermediate in size between the largest recorded *rouchei* and the smaller examples of *ambigua*. I therefore place all these specimens in the one species, for which the valid name is *ambigua*. Koehler himself (1912, p. 109) drew attention to the evident relationship between the two species, but apparently neither he nor Mortensen (1936) found interconnecting forms. Mortensen recorded sexually mature viviparous specimens of *rouchei* in which the disc measured only 7 mm across. The facts given above do not lead to a definite

conclusion. An explanation invoking only embryological principles, without calling upon hybridisation, would be that *ambigua* passes through a stage resembling *rouchei* (which is highly probable in the light of known facts of ophiuroid development), and therefore the supposed *rouchei* forms in the Ross Sea are merely immature *ambigua*. An alternative view could be that *O. ambigua* and *O. rouchei* are species which are normally allopatric, though interfertile: in the Ross Sea their distribution areas overlap and, when sympatric, interfertility gives rise to hybrid forms. It is by no means necessary to invoke such a hypothesis, though it should not be dismissed on that score alone: one may reflect that Lyman's species is not inaptly named, though the original grounds for the name do not seem to be on record.

Ecology

Ophiura ambigua seems to prefer a varied bottom, where stones or other objects are present together with softer substrate. The stations noted above registered rock, sand with pebbles, stones in mud, and stylasterine corals, polyzoa, etc., with stones. The wide disc and flattened arms suggest a selective detritus-feeding habit on soft mud or sand.

Ophiura flexibilis (Koehler) (pl. 7, fig. 3, 6)

Koehler, 1911, *Brit. Antarctic. Exp. 1907-9*, 2 (4), p. 44, pl. V. Koehler, 1922, *Austral. Antarct. Exp. 1911-14*, 8 (2), p. 52.

Disc: Reaching 8 mm diameter, rounded or sub-pentagonal, dorsal surface convex, ventral surface flat. Dorsal surface covered by a few well defined plates among which the primaries can be distinguished. Radial shields small, divergent, triangular, separated by 2-3 scales, the proximal largest. Inconspicuous arm-comb of small rectangular papillae. Ventral surface covered by a few, large scales. Oral shields large, pentagonal. Adoral plates small, narrow. Three rectangular oral papillae. Genital cleft large, conspicuous, with small quadrangular papillae on the interradiar margin.

Arms: Up to 28 mm long. Dorsal plates large, those at the base of the arm being contiguous and broader than long, becoming distad triangular with a distal convex border, longer than broad, not contiguous. Lateral plates carrying each 4 short, conical spines, placed at equal distances

along the distal margin. Ventral plates longer than broad, pentagonal, not contiguous beyond the third arm-joint. On the proximal joints there are 3 tentacle-scales on either margin of the tentacle-pore, the number decreasing distad, so that there is only a single tentacle-scale (carried on the proximal margin) on pores beyond the sixth arm-joint.

Colour in Life: Unknown. Spirit specimens white.

Type Locality

Cape Royds, Ross Island.

Distribution

Ross Sea, off Adelie Land, off Wilkes Land (all known localities south of 60°S). 80-470 m.

Material Examined

Sixteen specimens from 3 stations, as follows:

Sta. A450, 472-318 m, Ross Sea, 2 specimens;
Sta. A457, 315-342 m, Ross Sea, 3 specimens;
Sta. A533, 84-183 m, Cape Barnes, 11 specimens.

The largest specimen, R 28 mm, r 4 mm, approximates in size that of Koehler's largest type (R 25 mm, r 4 mm), and is considerably larger than specimens from off Wilkes and Adelie, taken by Mawson.

Ophiura crassa Mortensen (pl. 11, fig. 3, 6)

Ophiura flexibilis var *crassa* Mortensen, 1936. *Disc. Rpts.*, 12, p. 333, fig. 46.

Disc: Pentagonal reaching a diameter of ca 8 mm, covered by numerous imbricating plates of varying size, among which the primaries and radial shields can be distinguished only by their slightly greater size. Ventral surface covered by larger imbricating plates, of which the oral shields are most conspicuous. Oral shield pentagonal, with an obtuse proximal angle, and straight or lightly curved sides and distal margin. Adoral plates with parallel sides, meeting within. Oral plates triangular, longer than broad, meeting broadly within. About 6 subequal square oral papillae. Genital cleft elongate, conspicuous, reaching from the middle of the oral shield to the ambitus, bordered interradially by a comb of small, uniform square papillae.

Arms: Cylindrical, not flattened reaching about 25 mm in length. Dorsal arm-plates lozenge-

shaped, as broad as long near the base of the arm, contiguous only at the base of the arm. Lateral plates meeting narrowly below, save on the basal joints, carrying 5 equally spaced arm-spines, which are conical, tapering, half the length of the joint. Ventral plates pentagonal, as broad as long, with a proximal acute angle, and a convex distal margin, the proximal 4 or 5 plates contiguous. Tentacle-pore of first joint conspicuous with 3 or 4 scales; successive pores smaller with 2 or 1 scale.

Colour in Life: Not known; in spirit, creamy white.

Type Locality

Clarence Island (South Shetlands), 61°S, 54°W, 342 m.

Distribution

Clarence I., and Ross Sea., probably circum-polar.

Material Examined

Three specimens from Sta. A455, 322–340 m.

Mortensen's original material comprised the single holotype, and the arm-spines were stated to number 4, "quite exceptionally there may be five". In the specimens examined 5, not 4, is the usual number, though at a short distance from the arm-base the number falls to 4. The material differs markedly and consistently from *flexibilis*, and accordingly the taxon is better regarded as a distinct species.

Ophiogona Studer, 1876

This genus is unknown from the Ross Sea, but as the type species *O. laevigata* Studer, 1876 occurs at Kerguelen, and a closely related species *O. doderleini* (Koehler, 1901) was taken in west Antarctica by the *Belgica*, it is not improbable that a representative occurs in the Ross Sea. The genus is completely diagnosed in the key to the family *Ophiuridae*, on p. 46, and should therefore be readily recognisable if it is found. As Mortensen (1936, p. 309) suggests that *doderleini* may well be a synonym of *laevigata*, and has given detailed illustrations of both forms, reference should be made to his account for details, if required: see *Discovery Report*, 12, p. 308, 1936.

Ophiomastus Lyman, 1878

Disc high, mainly covered by the large, conspicuous, contiguous primary plates, which form a rosette. Arms not broader than high, tentacle-

pores occurring over most of the arm; 1 to 3 scales on basal pores, 1 or none beyond the arm-base. Adoral shields well developed. Oral papillae more or less fused together.

Type Species: *Ophiomastus tegulitius* Lyman.

The genus is widely distributed in deep water.

Ophiomastus bispinosus Mortensen (pl. 19, fig. 1–4)

Mortensen, 1925. *Arkiv. f. Zool.*, 17a, 31, p. 6.

Disc: Hemispherical above, flattened below, reaching a diameter of ca 3 mm; carrying a conspicuous dorsal rosette, which is surrounded by the small radial shields, a column of 2 plates in each radius, and a column of 2 in each interradius. The ventral surface is covered by a few large plates, 2 on each interradius with a smaller one on either side. Oral shield triangular, of medium size, with an obtuse proximal angle and a convex distal border. Adoral shields lozenge-shaped about twice as long as broad. Four oral papillae, the outermost broadly rectangular, the inner 2 square and smaller. Genital cleft shorter than one arm-joint, without papillae. No arm-comb.

Arms: Cylindrical, ca 10 mm long. Dorsal plates contiguous only at the base of the arm, where they are ovoidal; beyond they are elongate lozenge-shaped, not contiguous; each carries a high medioradial crest, triangular in profile. Lateral plates meeting broadly below, carrying 2 very small, adpressed spines. Ventral plates transversely fan-shaped, with an oblique proximal angle and a convex distal margin, all widely separated throughout the arm. Adoral pores conspicuous, with 2–3 papillae on each side. Second pore with only one scale, the third, smaller with no scale. Fourth, fifth, and sixth pores distinct, without papillae. An occasional scale is seen on the succeeding pores, sometimes to the end of the arm.

Colour in Life: Unknown; in spirit, white.

Type Locality

Discovery Inlet, Ross Sea, 560 m.

Distribution

Ross Sea.

Material Examined

Five specimens from 2 localities, as follows:

Sta. A464a, 369–384 m, 3 specimens; Sta. A466, 569 m, 2 specimens.

Remarks

Two species of *Ophiomastus* have been recorded from the New Zealand plateau, but neither appears to be closely related to this Antarctic form; see Fell (1952, p. 30–32, fig. 23–27; and 1958, p. 31–32, pl. 4, fig. B, C, D).

Ecology

The stations suggest that the species is an indicator of soft-bottom, sand, or mud.

Ophiuroglypha Hertz, 1926

Disc low, flattened above, covered by naked scales and plates whereof the primary plates and radial shields are recognisable. Arm-comb present. Tentacle-pores restricted to the base of the arm, the oral pore with numerous scales. Three arm-spines placed low on the lateral plate, the middle spine becoming transformed into an up-turned hooklet on distal arm-joints.

Type Species: Ophioglypha lymani Ljungman.

A single Ross Sea species.

Ophiuroglypha carinifera (Koehler) (pl. 9, fig. 1)

Ophioglypha carinifera Koehler, 1901. Res. Voy. S.Y. Belgica. Echin. et Oph. p. 14, pl. 1, fig. 3–7.
Ophiosteira senouqui Koehler, 1912. 2me Exped. Antarct. Franç. Echin., p. 110, pl. 10, fig. 8–11; Koehler, 1922. Australas. Antarct. Exped. 1911–14. Sci. Rpts., Ser. C, 8 (2), p. 46, pl. 87, fig. 1–5; Hertz, 1926. Deutsche Südpolar-Exped. Oph., p. 24, pl. 5, fig. 1–3, 7; Mortensen, 1936. Disc. Rpts., 12, p. 314.

Disc: Rounded pentagonal, reaching a diameter of ca 20 mm, covered by naked, tumid plates of varying sizes, and separated by grooves. The primary plates are always conspicuous, though rather small and widely separated by smaller platelets, the centrodorsal circular in outline and more or less tumid, the oval or rounded radials a little smaller than the centrodorsal. The radial shields are the largest plates, triangular, with a proximal angle, convex outer sides and straight or concave inner sides, contiguous distally, separated by 1, 2, or more plates in a radial series, the latter plates more or less tumid, sometimes forming a low crest between the radial shields. The ventral

interradius is covered by small angular plates in mosaic, with grooves between them. All the plates so far mentioned are occasionally liable to develop a roughened granular appearance of variable coarseness, but usually they are smooth. The oral shields are large and conspicuous, smooth, not tumid, but very robust: pentagonal, with a proximal obtuse angle and straight sides and distal margin, the corners rounded, as broad as long. Adoral shields are small, narrow, with parallel sides. The oral plates are larger than the adoral plates and together form a V-shaped jaw. Oral papillae apparently 10 to each border, but the outer 5 are in reality the scales of the oral tentacle-pore, with which the oral papillae are continuous: the papillae are conical and pointed within, blunter, and larger without, and none of them is so large as the teeth. Genital cleft elongate, narrow, extending from the middle of the oral shield to the edge of the disc, the interradiial margin bordered by very fine papillae.

Arms: Triangular in section, with a dorsal acute-angled crest, about 65 mm long. Dorsal plates strongly carinate, as broad as long and as high as broad, contiguous for the full breadth. Lateral plates high, carrying 3 small blunt, peg-like, contiguous arm-spines on the lower distal edge, the spines one-third as long as the joint, and closely adpressed to it; distally the middle spine tends to become transformed into a hooklet, the distal part of the spine itself becoming hyaline and up-turned abruptly. Ventral arm-plates broadly fan-shaped, contiguous on the first 6–8 joints, with a proximal acute angle and a rounded distal margin, all broader than long. Basal tentacle-pores large; from the oral pore outwards they carry respectively, on the interradiial border, 5, 5, 5, 4, 3, 2, 2, and thereafter 1, tentacle-scales.

Colour in Life: Bright red, save for the disc-plates, which are white. In spirit, uniformly cream or white.

Type Locality

West Antarctica.

Distribution

Circumpolar Antarctic. Absent from Magellanic region, where the species is apparently replaced by *Ophiuroglypha lymani*. *Bathymetric Range:* 90–470 m.

Material Examined

Seventy-eight specimens from 10 stations, as follows:

Sta. A449, 362 m, 1 disc; Sta. A450, 472–318 m, 2 specimens; Sta. A455, 322–340 m, 22 specimens;

Sta. A456, 238–201 m, 9 specimens; Sta. A457, 315–342 m, 3 specimens; Sta. A464, 369–384 m, 1 specimen; Sta. A465, 399 m, 2 specimens; Sta. A520, 201–205 m, 1 specimen; Sta. A527, 358–337 m, 7 specimens; Sta. A528, 274–265 m, 30 specimens.

Remarks

Mortensen (1936, p. 314) has drawn attention to the similarity of the two species listed in the synonymy above, and indicated that only trivial differences in granulation distinguish them. This I would confirm, and add that material from Sta. A455, for example, includes a wide range of forms, from those with completely naked plates (the majority), those with lightly developed granules on a few of the plates (especially the centrodorsal and the margins of the radial shields), to those with rather coarse but widely spaced granules covering all the plates on the upper side of the disc. At the same time, but in no way correlated with this variation, is another pattern of variation in which the radial shields and the plates between them show a tendency to become tumid and even elevated; also the other plates vary from rounded forms to angular or even imbricating forms, some tumid, some almost flat. In the light of this random variation, in which granulation factors show no coordination with other factors, it seems clear that Mortensen is correct in inferring that *senouqui* and *carinifera* are identical, the latter name having priority; the holotypes of both were from west Antarctica.

Ecology

The bottom data for the stations listed above show some dissimilarity, but almost all the stations include mud or muddy sand or gritty mud as a constituent; five of the stations show this as the only constituent. It is therefore likely that the species is an indicator of soft-bottom. Whether the carinate arm-structure or the minute arm-hooklets serve any function is difficult to say. The hooklets here are often very poorly developed, sometimes only on 4 or 5 segments, and are very small. Even so, they seem to engage upon objects, as I have noted that on some arm-joints the middle spine has apparently been torn off, while the other two remain intact.

Theodorina genus novum

Disc convex or hemispherical above, distinctly higher than the arms, covered by naked plates among which the primaries are conspicuous. Arm-comb rudimentary. Oral shield not conspicuous,

often fragmented. Jaws deeply excavate along the interradius. Tentacle-pores restricted to first 3 joints; first pore (oral tentacle-pore) very large, conspicuous, with 5 to 10 scales; second and third also conspicuous, but successively smaller, and with successively fewer scales.

Type Species: Amphiophiura relegata Koehler.

The genus is restricted to the Antarctic and Magellanic region. From *Ophiurolepis*, the most closely related genus, it differs in having the jaws deeply excavate (solid in *Ophiurolepis*), in having 3 conspicuous tentacle-pores with numerous scales (a single pore only in *Ophiurolepis*), and in having the oral shield relatively smaller and often fragmented. From *Ophiopyrgus*, *Theodorina* differs in having only 3 tentacle-pores (numerous pores in *Ophiopyrgus*), and *Theodorina* lacks the enlarged primary plates of *Ophiopyrgus*. The only other genus to which *Theodorina* may be supposed to have any close affinity is *Amphiophiura*. However, *Amphiophiura* has tentacle-pores over most of the arm (though the basal ones are larger), a distinct arm-comb is developed, the arms have blunt tips, and a large, conspicuous oral shield is the predominant plate on the ventral interradius. Mortensen (1936, p. 324) clearly recognised the need for a new genus to accommodate both *Amphiophiura relegata* and *Ophiurolepis wallini*, and pointed to the 3 large tentacle-pores as a distinguishing feature. He also cited the "total absence of papillae at the base of the arms", though, as can be seen from the diagnosis above, I do not think this is entirely true, for rudimentary papillae can be seen on the genital plates of *relegata*, whilst Mortensen (1925, p. 4) has himself clearly drawn rudimentary papillae at the base of the arm of his species *wallini*. Mortensen also noted the depressed interradiial midline of the jaw in *wallini*, as also in *Ophioglyphu partita* Koehler (1908). That Mortensen refrained from diagnosing and naming the genus he thus delineated was due, as he explains, to his lack of time for undertaking a fuller study of the implications upon *Homalophiura*. Although I have not any opportunity for performing this task either, it is perfectly clear that *Homalophiura* H. L. Clark is based on forms with a low disc, inconspicuous tentacle-pores (save for the oral pore which, however, is not large), with a well developed arm-comb and relatively broad arms: the type species, which shows all these features is *Ophioglyphu inornata* Lyman. Thus, it is quite impossible to refer the 3 species under discussion to any of the existing genera, and to attempt to do so would make the diagnoses

of the genera chaotic. A new genus is required, and clearly its main diagnostic features will be those which Mortensen had already noted in 1936. *Theodoria* is so named to commemorate Theodor Mortensen.

At least three species can be referred to the genus immediately. These throw some additional light upon the characters of the genus, and accordingly a key to the species will be useful though only two of the species are so far known from the Ross Sea.

KEY TO THE SPECIES OF THEODORIA

- 1 (2) Ventral disc-plates separated by depressed sutures which lie in grooves. Oral shields entire. Genital clefts elongate, extending over 2 arm-joints, with well developed genital plates. Dorsal arm-plates entire. Ross Sea and Antarctic generally. — *relegata* Koehler, 1922
- 2 (1) No depressed sutures on the ventral surface. Oral shields often fragmented. Genital clefts short, not passing the first arm-joint.
- 3 (4) Dorsal arm-plates subdivided into 2 or more parts on most joints. Inner oral papilla broad, short, subrectangular. West Antarctica. — *partita* Koehler, 1908
- 4 (3) Dorsal arm-plates entire. Inner oral papilla spiniform. Ross Sea, West Antarctica, South Georgia. — *wallini* Mortensen, 1925

It is possible that *Ophioglypha frigida* Koehler may also fall within the bounds of *Theodoria* but I have insufficient information on the species.

Theodoria relegata (Koehler) (pl. 7, fig. 4, 5)

Amphiophiura relegata Koehler, 1922. Australas. Antarct. Exped. 1911-14, Sci. Rpts., Ser. C, 8 (2), p. 57, pl. 88, fig. 1-7; Mortensen, 1936. Disc. Rpts., 12, p. 324.

Disc: Pentagonal or rounded pentagonal, reaching a diameter of 10 mm, convex above; covered dorsally by naked plates among which the primaries are usually conspicuous; and the radial shields, which are a little larger than the primaries, oval, a little longer than broad, divergent proximad, separated by a row of small scales, the breadth of which at the distal end of the shields, is less than the arm-breadth. All the larger disc-plates are separated by a mosaic of smaller plates, tending to lie in single or double rows. Ventral surface covered by relatively few plates, of which the oral shield and an adjoining distal interradial plate are the most conspicuous; the plates have peripheral excavate zones, which adjoin the

sutures between them, so that the suture lines lie in grooves, the grooves forming an interconnecting mesh. Oral shield rounded pentagonal with an obtuse proximal angle, weakly concave sides and a convex distal border. Adoral plates crescentic, concave without, convex within, the inner margin excavate. Oral plates bar-like, meeting proximad, but separated by excavate margins along the inter-radius. Oral papillae 3, the outermost broadest, all flattened and low. Genital cleft elongate, extending from the adoral plate to the edge of the disc, with conspicuous outer margins, which carry a few irregular papillae distad, these continuing part of the way towards the radial shields as a rudimentary arm-comb.

Arms: Slender, cylindrical, ca 25 mm in length (fragile, and broken on all material examined). Dorsal plates elongate ovoid, not contiguous, save for the first 2 plates. Lateral plates meeting narrowly above, broadly below, with 3 or 4 widely spaced minute, conical spines carried on the distal margin, adpressed to the arm. Ventral arm-plates triangular at the arm-base, pentagonal beyond, with an acute proximal angle. The basal triangular plates have a convex distal margin, but when the plates assume the pentagonal form, the distal and lateral margins are nearly straight. Three conspicuous tentacle-pores, the first with 8-10 scales; the second smaller, with 4-7 scales; the third with 2 scales on the interradial margin.

Colour in Life: Unknown; in spirit, white above, yellowish or cream below.

Type Locality

Off Enderby Land, 65° 42'S, 92° 10'E, in 60 fm (110 m).

Distribution

Indian Ocean sector of Antarctica, and Ross Sea (present record). *Bathymetric Range:* 110-430 m.

Material Examined

Thirteen specimens from 3 stations, as follows: Sta. A449, 362 m, 1 specimen; Sta. A460, 415-430 m, 10 specimens.

Stanford University Station: GLD-15, 365 m, 2 specimens.

Remarks

Although Koehler's illustration of the species is indistinct, the characteristic appearance of the ventral aspect, as a result of the depressed sutures,

is hardly mistakeable. I give herewith a detailed figure of the ventral aspect, from which it can immediately be seen that *relegata*, though related to *wallini*, differs consistently from it. Mortensen (1925) has already given a corresponding figure for *wallini*, and the same writer (1936, p. 324) regretted the lack of a clear figure of *relegata*. A feature which is visible in Koehler's illustrations (1922, pl. 88, fig. 2 and 5) is the curved form of the genital clefts, convex on the interradiial side, and the perceptible enlargement of the arm-joints which carry the second and third ventral plate; this feature is clearly shown in my material, and if constant, may serve as another distinction from *wallini*.

Theodorina wallini (Mortensen) n. comb.

Ophiurolepis Wallini Mortensen, 1925. Arkiv. f. Zool., 17a, 31, p. 3, fig. 2; Mortensen, 1936. Disc. Rpts., 12 p. 324.

Disc: Pentagonal, convex above, reaching a diameter of ca 7 mm, covered with naked plates, among which the 6 primaries are very conspicuous, and somewhat less conspicuous are the ovoid radial shields; all these plates are separated by single or double rows of smaller plates, the radial shields separated by an interval equal to that of the arm-width, occupied by a mosaic of plates. Ventral surface covered by relatively few plates. Genital clefts narrow, short, not reaching beyond the first arm-joint. Oral shields rounded squarish, generally split longitudinally into 2 or 3 pieces. Adoral shields short, not joining within, where instead the jaw is excavate. Oral plates with central region excavate. Oral papillae ca 4, the outer ones broad, flat, the inner ones spiniform, conical.

Arms: Rather slender, reaching a length of ca 3 times the disc diameter. Dorsal arm-plates contiguous on first 3-4 joints, where they are square with rounded angles, or ovoid; beyond, they become lozenge-shaped, longer than broad, and separated by increasing intervals. Lateral plates meeting broadly below, carrying 4 short arm-spines. Ventral plates fan-shaped with a proximal oblique angle and a convex distal margin, not contiguous; the proximal angle sometimes is divided off as a separate platelet. Tentacle-pores conspicuous, 3; the inner (oral) pore large, with 5 or 6 scales; the second smaller, with 3-4 scales; the third smallest with 1 or 2 scales on the interradiial side only.

Colour in Life: Unknown; in spirit, white.

Type Locality

35°N of Discovery Inlet, Ross Sea, 640 m.

Distribution

Ross Sea, West Antarctica, South Georgia.
Bathymetric Range: 130-640 m.

Material Examined

None.

Remarks

As Mortensen (1936) observes, the species is very closely related to *relegata*, but apparently distinct. The differences have been concisely expressed in the key to the species given above. Should the differences ultimately be found to fall within the range of variation of either form, the name *relegata* will take priority over *wallini*; but on our present information the two species differ more than Mortensen apparently realised. Although I have not seen a specimen of *wallini*, I would judge from Mortensen's excellent drawing that there can be no sign of depressed sutures in the species, and this should enable it to be distinguished very easily from *relegata*, where the whole ventral aspect is dominated by the pattern of grooves between the plates.

Ophiurolepis Matsumoto

(Restr. Koehler, 1922; Fell, 1961)

Disc covered by naked plates, among which there are larger plates surrounded by belts of smaller ones. Genital clefts bordered by genital plates carrying rudimentary granules or papillae continuous with a rudimentary arm-comb. Arms higher than broad, the tentacle-pores minute, restricted to a few basal arm-joints. Arm-spines minute, 2, similar to tentacle-scales, which are also 2 in number.

Type Species: *Ophiurolepis carinata* Studer

As defined above, the genus is now still further restricted by the exclusion of those species with large pores at the base of the arm (here referred to *Theodorina*). The genus is highly characteristic of the southern regions, and reaches its highest development in the Antarctic. It is completely unknown from the New Zealand plateau (as from Australasia as a whole), whereas it is well represented in the Magellanic region. At least 4 species occur in the Ross Sea.

KEY TO THE ROSS SEA SPECIES

- 1 (4) Disc-plates smooth, not thickened at the edges or in the centre. *Iophon* never present.
- 2 (3) Primary plates similar to other large intercalary plates. Oral shield large. Dorsal arm-plates contiguous. — ***martensi***
- 3 (2) Primary plates and radial shields, together with 1 large plate in each interradius, form a regular pattern, whilst much smaller plates are wedged between them. Oral shield often fragmented. Dorsal arm-plates not contiguous, sometimes fragmented. — ***tuberosa***
- 4 (1) Disc-plates thickened unevenly. Dorsal arm-plates carinate, so that the arm is triangular in section. *Iophon* may occur.
- 5 (6) Disc-plates, ventral arm-plates, and sometimes other plates, show concentric growth-rings. Disc-plates thickened so as to have either a central eminence or arc-shaped ridge. *Iophon* usually forming a dense infestation on the disc and arm-bases. Genital cleft elongate. — ***gelida***
- 6 (5) Disc-plates conspicuously massive, thickened at their margins, so that the central parts of the plates appear excavate. *Iophon*, if present, is inconspicuous and does not conceal disc-plates. Genital clefts shorter than an arm-joint. — ***brevirima***

Ophiurolepis gelida (Koehler) (pl. 1b, fig. 1; pl. 2c, fig. 4; pl. 12, fig. 1, 3–5; col. pl. 1; col. pl. 2, a, b)

Ophioglypha gelida Koehler, 1900. Bull. Acad. Belg., p. 819; Koehler, 1901. Res. Voy. S.Y. *Belgicae*, Ech. et Oph., p. 17, pl. 1, fig. 6–8; Koehler, 1912. 2me. Exped. Antarct. Franç., Echin., p. 102, pl. 9, fig. 4–10, 13–15.

Ophiozona inermis Bell, 1908. Nat. Antarct. Exped. 1901–4, Nat. Hist. Zool., p. 12, (partim – some *O. martensi* also included).

Homalophiura gelida H. L. Clark, 1915. Cat. Rec. Ophiurans, Mem. Mus. Comp. Zool., 25 (4), p. 326.

Ophiurolepis gelida Koehler, 1922. Australas. Antarct. Exped., Sci. Rpts., Ser. C, 8 (2), p. 79, pl. 86, fig. 11–15; pl. 89, fig. 1–14; pl. 90, fig. 1–6; Koehler, 1923. Swed. Antarct. Exped., Aster. et Oph., p. 130; Mortensen, 1925. Arkiv f. Zool., 17A, 31, p. 2; Hertz, 1926. Deutsche Südpolar-Exped. Ophiur., p. 20; Hertz, 1927. Deutsche Tiefsee-Exped., Oph., p. 94; Mortensen, 1936. Disc. Rpts., p. 318, fig. 36; Madsen, 1955. Sci. Res. Norweg. Antarct. Exped. 1927–28 et seq., 37, p. 6.

Disc: Pentagonal or rounded pentagonal, usually flattened above and below (rarely tumid hemispherical above), not bounded by obliquely sloping sides, reaching a diameter of ca 20 mm. Primary plates circular, similar, scarcely or not at all contiguous, more or less separated by smaller

intercalary scales and granules, which may equal the size of the primaries. Radial shields flattened, almond-shaped with a proximal rounded acute angle, contiguous, or nearly so distad, a wedge of several rows of scales in the interradiation space between adjoining shields, only a few scales in single series between the members of a radial pair. All these plates are somewhat thickened, especially some distance in from the margins of the plates, or at their centres, so that arcs or raised calcite are produced, or a central excrescence: extremely conspicuous concentric growth-lines are nearly always visible, as also on the plates of the lower surface. In most specimens it is necessary to remove the adhering *Iophon* in order to see the plates, and these are often found to be eroded by the sponge. Interradiation areas below somewhat depressed, the depression on the interradiation mid-line often extending to include the oral shield, which may thus appear a little concave; the depression does not involve the jaw itself (unlike *Fasmeria*): the areas are covered by 6–10 scales of which the large genital plates are usually the most conspicuous, though the oral shield itself is sometimes enlarged. Oral shield oval or pentagonal rounded, either broader than long or longer than broad, the proximal angle accordingly either obtuse or acute. Adoral plates lanceolate, 3 times longer than broad, meeting broadly within, unless an intercalary plate intervenes. Oral plates small, narrow, meeting narrowly within. Oral papillae 6–7, uniform, squarish, contiguous, similar to the terminal tooth. Genital cleft variable in length, usually as long as 2 or 3 arm-joints, conspicuous, bounded interradiationally by a robust genital plate bearing a single, irregular series of flattened papillae; on some specimens the cleft is shorter than 2 arm-joints, and may lack papillae, but such specimens are rare.

Arms: Long, tapering, very robust although not very thick, usually entire, reaching a length of ca 50 mm. Dorsal plates lozenge-shaped or hexagonal in dorsal aspect, more or less broadly contiguous over most of the arm, elevated into a keel, especially near the distal border. Lateral plates not usually meeting below on proximal arm-joints (though this occurs on specimens with smaller ventral plates), meeting broadly below in the distal part of the arm. Arm-spines 4, of which 3 are carried on the lower part of the plate, though not always in immediate proximity to one another, whilst the remaining spine stands alone near the upper margin; the lowest 2 spines correspond to tentacle-scales. Ventral plates transversely triangular, with proximally an obtuse inner angle.

or (distad on arm) an acute inner angle; in all cases the distal margin is convex. All the ventral plates are broader than long. The ventral plates often show concentric growth-rings; they are sometimes thickened, so as to stand above the level of the laterals, as in *O. brevissima*. They are usually contiguous near the base of the arm, but not always so. Tentacle-pores visible only on the first joint.

Colour in Life: Orange-brown or yellowish-brown, but if *Iophon* is present, as it usually is, the disc and arm-bases are obscured by the darker brown of the sponge. Colour in spirit, cream or light brown, never white or black.

Type Locality

Bellingshausen Sea, West Antarctica (70°–71°S, 82°–90°W, 100–600 m).

Distribution

Magellanic Region (South Sandwich Islands, and southwards from 57°S, into the Palmer Archipelago), Graham Land, Adelie, Ross Sea; hence circumpolar Antarctic, but not circumpolar subantarctic. *Bathymetric Range:* 40–750 m.

Material Examined

695 specimens from 36 stations, as follows:
Sta. A450, 238–201 m, 4 specimens; Sta. A456, 238–201 m, 22 specimens; Sta. A457, 315–342 m, 20 specimens; Sta. A459, 534–549 m, 14 specimens; Sta. A460, 415–430 m, 1 specimen; Sta. A461, 578–567 m, 44 specimens; Sta. A467, 88–183 m, 1 specimen; Sta. A468, 110 m, 1 specimen; Sta. A519, 479 m, 13 specimens; Sta. A520, 201–205 m, 22 specimens; Sta. A521, 582–558 m, 1 specimen; Sta. A525, 591–583 m, 1 specimen; Sta. A527, 358–337 m, 5 specimens; Sta. A528, 274–265 m, 98 specimens; Sta. 529, 205–216 m, 32 specimens; Sta. A530, 271–267 m, 41 specimens; Sta. A532, 488 m, 3 specimens; Sta. A534, 380–366 m, 36 specimens; Sta. A537, 574–543 m, 24 specimens; Sta. A538, 256–269 m, 25 specimens; Fish-traps, Hut Point, Ross Island, 7 specimens at various dates, all from 164 fm (300 m).

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 79, McMurdo Sound, 174 m, 3 specimens; 326, Cape Armitage, 122 m, 1 specimen; 384, McMurdo Sound, 304 m, 2 specimens; 626, Cape Evans, 42–55 m, 2 specimens; 672, Hut Point, McMurdo Sound, 124–165 m, 79 mature specimens (plus 44 juvenile forms probably belonging to this species, though not included in

the total of 695 specimens listed above); 675, Hut Point, McMurdo Sound, 124–165 m, 3 specimens; 716, Franklin Island, 73–110 m, 1 specimen; 732, Cape Roberts, 188–193 m, 2 specimens; 817, Cape Evans, 110 m, 37 specimens.

Stanford University Stations: Sta. GLD–1, 384 m, 2 specimens; Sta. GLD–4, 587 m, 2 specimens; Sta. GLD–5, 695 m, 2 small specimens; Sta. GLD–13, 165 m, 16 specimens; Sta. GLD–15, 366 m, 10 specimens; Sta. EAD–2, 315 m, 60 specimens; Sta. EAD–3, 351–432 m, 44 specimens. A few juvenile *Ophiurolepis* sp. indet. (probably *gelida*) were also taken from stations on the ice-shelf in McMurdo Sound (Sta. B, CEK, X).

Ecology

The species, as well known, is susceptible to attack by *Iophon radiatus* Topsent, a parasitic or epizoid sponge. The incidence of infection is very high, nearly all specimens showing some degree of infestation, from quite early stages of development. The infestation is generally very extensive, and, as can be seen in the typical case illustrated on pl. 12, fig. 3, the whole disc and the basal parts of the arms are involved. In most specimens the lower side of the disc is also affected, and there may be isolated patches on the arms further out. As explained in the discussion under *Ophiurolepis brevissima*, the difference in the degree of infestation found in the two host species is so pronounced as to make identification on sight very easy; further, any specimen seen in an underwater photograph to be carrying *Iophon* can be confidently determined as *Ophiurolepis gelida*. A fine example of an underwater photograph obtained by J. S. Bullivant is shown on pl. 1, fig. B. Here it is immediately apparent that the species is the present one. Extrapolation from such a clear image as this one, towards the more indistinct images in other photographs, permits, with practice, identification of many other individuals. Not all are seen to be parasitised, and confusion with other species of *Ophiurolepis* could occur in such cases. In a photograph of the surface of the sea-floor at Pennell Bank, taken at Sta. A528, at 274–264 m, several individuals of *Ophiurolepis* sp. can be seen creeping over the polyzoan colonies, in company with *Amphiura belgicae* and *Ophiacantha pentactis*. At least one of the specimens is seen to be heavily infected by *Iophon* (pl. 2, fig. C), and probably most of the specimens of *Ophiurolepis* in the field do belong to this species, the infection being perhaps too light to be visible. On pl. 1, fig. A, is shown a specimen of *Ophiurolepis*, almost certainly *O. gelida*, practising

selective detritus feeding, the leading arm thrusting up a little mound of mud, while the other 4 arms lever the disc forward. Specimens in similar attitudes, or with the disc partly buried, can be seen in many of the photographs examined. In no case have specimens been observed in attitudes suggesting the "fishing" which some of the other species appear to practise.

Variation

Koehler (1912, p. 104-5) noted the variation in the length of the genital cleft which "peut être assez courte sur certains individus, tandis qu'ailleurs elle s'étend jusqu'à la peripherie du disque". The same variation is seen in the material examined, though it is evident that the short cleft is decidedly exceptional. Also the thickness of the ventral arm-plates varies much, and the size of these plates: in many specimens they are not contiguous, and are separated by grooves. Mortensen (1936) believed that the latter character is not found in *gelida*, and that it is typical of *brevirima*. This is not a reliable difference between the species. More characteristic are the differences in the mode and degree of thickening of the disc-plates, the liability to *Iophon* infestation, and the manner in which the infestation occurs.

Bell, (1908, p. 12) included *Ophiurolepis martensi* in his *Ophiozona inermis*—as can be inferred from the photograph of *Homalophiura* (*Ophiozona*) *inermis* published by H. L. Clark (1915, pl. 20, fig. 3, 4). However, this was not the only species involved, for Bell (1908, p. 12) states "In some specimens the dorsal plates of the disc are deeply incised; this appears to be due to a want of sufficient calcareous matter, but as *others are infested by a sponge*, it is possible that this is the cause". The passage here italicised shows that *Ophiurolepis gelida* must also have been included.

Ophiurolepis brevirima Mortensen (pl. 12, fig. 2: pl. 13, fig. 3, 6)

Ophiurolepis brevirima Mortensen, 1936. Disc. Rpts., 12, p. 319, pl. 8, fig. 8-13.

Disc: Pentagonal or rounded pentagonal, with a flattened or sometimes depressed central region above, bounded by obliquely sloping sides (in which the radial shields lie), flattened below, reaching a diameter of ca 20 mm. Primary plates circular, similar, contiguous, occupying the centre of the disc. Radial shields almond-shaped with a proximal acute, rounded angle, almost contiguous distad, separated by a wedge of several scales.

Intercalary plates, mostly rather large, occupy the rest of the upper surface. All the plates are thickened, especially round their margins, the extreme thickening of the margins of some plates resulting in a central excavate region: concentric arcs or growth lines sometimes seen, but not conspicuous. Interradial areas below covered mainly by the oral shields and one other similar interradial plate, with smaller plates wedged around them. Oral shield subcircular, as broad as long. Adoral plate rectangular or lozenge-shaped, a little longer than broad. Oral plates triangular. Both adoral and oral plates meet broadly within, forming a robust jaw, in which an intercalary plate is often seen. Oral papillae 4 or 5, rectangular, low, broader without than proximally, the inner ones similar to the low, squarish terminal tooth. Genital cleft short, usually very narrow, not exceeding the arm-joint in length, bounded interradially by a few granules which become more numerous beyond the distal end of the cleft. A thin membrane invests the jaw region in many specimens, obscuring the outlines of the plates.

Arms: Long, slender, tapering, but none the less robust on account of the thickness of the plates, and so usually entire: reaching a length of ca 50 mm. Dorsal plates lozenge-shaped in dorsal aspect, contiguous throughout the proximal half of the arm, rising each in a rounded tuberosity nearer the distal margin of the plate; the plates near the base of the arm in older specimens are hexagonal, broadly contiguous; in all cases the plates are as broad as long in the proximal part of the arm, becoming broader than long in the distal half, where they are no longer contiguous. Lateral plates meeting more or less broadly below, save on the first few arm-joints, where occasionally the ventral plates are contiguous and separate the laterals. Arm-spines 4, 3 of them carried together on the lower part of the plate, the other placed alone about midway up the side of the plate: 2 of the lowermost spines correspond to tentacle-scales. Ventral plates transversely triangular or lozenge-shaped, not contiguous save occasionally on basal joints (as noted above), about two-thirds as long as broad on basal joints, becoming distad as broad as long: they are thickened, and thus stand out from the medioradial parts of the lateral plates which intervene, and seem to be separated by transverse depressions, occupied by the laterals. Tentacle-pores minute, visible only on the first joint.

Colour in Life: Rich deep orange-brown, paler below. Colour in spirit, usually blackish or

greyish, sometimes brown or cream; J. S. Bullivant (personal communication) did not note any black specimens in the trawl-samples on deck, so that it appears that the darkening has occurred in preservation. The dark colour is so characteristic in spirit material that it is possible in most cases to identify the species immediately by that character alone.

Type Locality

Off Cape Bowles, Clarence Island, 342 m: hereby nominated, the first locality of the three listed by Mortensen, 1936).

Distribution

Magellanic Region (Clarence Island, South Shetlands); and Ross Sea (present records).
Bathymetric Range: 200–750 m.

Material Examined

Ninety-one specimens from 11 stations, as follows:

Sta. A448, 752 m, 2 small specimens, apparently typical, also 4 specimens from sample (No. 5) intermediate between *gelida* and *brevirima*, possibly hybrids; Sta. A456, 238–201 m, 1 specimen apparently intermediate between typical *gelida* and *brevirima*, possibly a hybrid; Sta. A449, 362 m, 9 typical specimens; (all material from remaining stations is typical *brevirima*)—Sta. A450, 472–318 m, 5 specimens; Sta. A455, 322–340 m, 4 specimens; Sta. A456, 238–201 m, 1 specimen; Sta. A457, 315–342 m, 4 specimens; Sta. A459, 534–549 m, 23 specimens; Sta. A461, 578–567 m, 5 specimens; Sta. A470, 377 m, various early developmental stages; Sta. A519, 479 m, 1 small specimen; Sta. A521, 582–558 m, 8 specimens; Sta. A527, 358–337 m, 15 specimens; Sta. A528, 274–265 m, 15 specimens; Sta. A529, 205–216 m, 2 specimens.

Remarks

The five specimens from Stations A448 and A456, noted above as apparently intermediate between *gelida* and *brevirima*, show a relatively low disc, smaller primary plates, and more numerous intercalary plates, and have a lighter coloration, than is seen in typical *brevirima*. All show a more robust, thicker plate-structure than is usual in *gelida*, and none are infested by the parasitic sponge *Iophon radiatus*. The facies of the material from the two stations suggests that it represents hybrid forms between the two, otherwise quite distinct, species *gelida* and *brevirima*. Both

of the presumed parent species are represented at the two stations where the intermediate forms occurred.

Ecology

Ophiurolepis brevirima has not been recognised in underwater photographs examined, even though it was taken in the trawl sample from Sta. 528, at which 3 underwater photographs were obtained. Mortensen (1936) draws attention to the fact that this species, as well as *O. gelida*, is liable to attack by the sponge *Iophon radiatus*. However, there is a considerable difference in the degree to which it is infested. Mortensen's own illustrations (1936, pl. 8, fig. 8–13) do not reveal infestation, which evidently was slight. In the much more extensive material now available, most specimens prove to be free from *Iophon*, and of the few that carry it, none have any more than very small patches barely visible to the naked eye; in no case is there luxuriant growth such as occurs on the disc and arms of *gelida* (see for example pl. 12, fig. 3, of the present work). Another difference is that in *gelida* almost the whole population is infected by *Iophon*, from quite early stages onwards. Consequently, there does not appear to be any serious likelihood of mistaking the identity of specimens of *Ophiurolepis* which can be seen to be carrying *Iophon* in underwater photographs; whenever *Iophon* is recognisable in the indistinct images in sea-floor photographs it has been treated throughout the present investigation as giving sufficient evidence for the identification of its host as *Ophiurolepis gelida*.

Ophiurolepis martensi (Studer) (pl. 13, fig. 2, 5)

Ophioglypha Martensi, Studer, 1885. Jahrb. wiss. Anst. Hamburg, 2, p. 131.

Ophioglypha resistens, Koehler, 1911. British Antarctic Exped. 1907–9, 2, Biology (IV), p. 42.

Amphiophiura martensi, H. L. Clark, 1915. Cat. Recent Ophiurans. p. 315.

Amphiophiura resistens, H. L. Clark, 1915. *ibid.* p. 315.

Ophiurolepis resistens, Koehler, 1922. Australian Antarctic Exped., Ser. C, 8 (2), p. 74; Koehler, 1923. Swedish Antarctic Exped., Further Zool. Res., 1 (1), p. 130; Hertz, 1926. Deutsche Südpolar-Exped. Ophiuroiden, p. 19; Grieg, 1929. Bergens Mus. Arbok, 1929, 3, p. 6; Grieg, 1929. Sci. Res. Norwegian Antarctic Exped., 2, p. 8.

Ophiurolepis Martensi. Mortensen, 1936. Discovery Rpts., 12, p. 321.

Disc: Rounded or subpentagonal reaching 15 mm diameter; covered above by rounded plates or larger and smaller sizes. The larger plates com-

prise the 6 primaries and the radial shields, these being separated by belts of smaller plates, such that a wedge of 2 or 3 smaller plates separate the radial shields, and an interradiial belt lies between the shields of adjacent radii. Radial shields not extending more than a quarter of the distance from the ambitus to the centre: their distal margins bearing small, rounded papillae: central part of each shield somewhat depressed, but not patterned with concentric ridges. The ventral surface of the disc carries a broad plate on the inter-radial margin, with several smaller plates bordering it, of which the most conspicuous are 2 triangular wedge-shaped plates which separate it from the large oral shield. Genital clefts narrow, elongate, extending to the ambitus, the genital plates carrying on their free margin a row of small papillae. Radial shields large, conspicuous, subpentagonal, usually somewhat longer than broad, with an acute angle within. Adoral plates, elongate, narrow, their borders parallel. Oral plates similar, but smaller. Four oral papillae, rectangular, sub-equal; a small terminal tooth.

Arms: Tapering but robust, reaching a length of 30 mm. Dorsal plates fan-shaped, with a broad, convex distal margin, about as broad as long at the base of the arm, tumid, robust, all broadly contiguous. Lateral plates meeting below, save on the basal joints below the disc, each bearing 3 very small spines which are widely spaced along the distal margin, adpressed. Ventral plates triangular with an obtuse angle within and a broad, distal convex base: only the proximal 2 or 3 are contiguous.

Colour in Life: Spirit specimens, which are invariably white or off-white, give no indication of the colour in life, which has now been determined by Dr R. W. Balham, and proves to be highly distinctive within the genus. Detailed sketches made by Balham from his specimen (No. 288) from Cape Armitage show that on the aboral surface of the disc, the primaries, and some of the other large plates are light green, those near the ambitus somewhat darker green, whilst the intervening platelets are medium orange. On the adoral side the disc is straw-coloured, tinged with green. The arms are light orange above, pale straw-colour below. It is possible, he points out, that the observed colours may have faded slightly before he recorded them, as the specimen had been immersed in fresh-water while being thawed from the trap. The new data will facilitate recognising the species in underwater photographs, since the other species of the genus have an entirely different coloration.

Type Locality

South Georgia: Koehler's type for *resistens* was Cape Royds, Ross Sea, 10–20 fm (18–36 m).

Distribution

Ross Sea, Adelie Land, South Georgia, Marion I., Falkland Is. Probably circumpolar. Unknown from Macquarie I., or the Campbell Plateau.

Bathymetric Range: Littoral and archibenthal. 17–752 m.

Ecology

The species is tolerant of a wide range of environmental conditions, occurring on mud, muddy sand, sand, and rocks.

Material Examined

Eighty-six specimens from 12 stations, as follows:

Sta. A467, 83–183 m, 1 specimen; Sta. A448, 752 m, 1 specimen; Sta. A450, 472–318 m, 1 specimen; Sta. A455, 322–340 m, 1 specimen; Sta. A459, 534–549 m, 1 specimen; Sta. A467, 83–183 m, 52 specimens; Sta. A468, 110 m, 2 specimens; Sta. A469, 64 m, 9 specimens; Sta. A470, 377 m, 6 specimens; Sta. A471, 165–169 m, 6 specimens; Sta. A533, 183–84 m, 34 specimens; Sta. A538, 269–256 m, 10 specimens.

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 288, Cape Armitage, 122 m, 1 specimen; 691, Hut Point, McMurdo Sound, 124–165 m, 2 specimens (1 of them immature); 747, Cape Roberts, 188–193 m, 5 specimens (3 of them immature); 817, Cape Evans, 110 m, 1 specimen.

Stanford University Station: GLD-13, 165 m, 1 specimen.

Ophiurolepis tuberosa (Mortensen) (pl. 13, fig. 1, 4)

Homalophiura inornata var. *tuberosa* Mortensen, 1936. Disc. Rpts., 12, p. 329, fig. 43.

Ophiurolepis tuberosa Madsen, 1955. Res. Norweg. Antarct. Exped. 1927–28 et seq., 37, p. 6.

Disc: Pentagonal with straight sides, flattened above and below, reaching a diameter of ca 9 mm. In half-grown specimens the primary plates and radial shields almost cover the disc and are still contiguous even when the disc diameter reaches

4 mm. During later development the intercalary plates, of smaller size, arise between the pre-existing plates and separate them. In the adult, the centrodorsal is conspicuous, circular, ringed by the 5, transversely oval radials, with small rounded intercalaries wedged between the inter-radial angles of the primaries. The radial shields are ovoid, separated radially by a few rounded intercalary scales; in the interradius lies a large rounded plate, contiguous with the adjoining radial shield of either side. Small intercalary plates occupy all the interspaces between the larger plates. Oral shields (if entire) large, pentagonal, as broad as long, with a proximal obtuse angle, covering about half of the interradiation area below; often, however, the oral shield is fragmented into several irregular pieces, which may become so displaced as to obscure the original character of the plate from which they arose. The oral shield is never very conspicuous, despite its size, as the borders of the plate, like those of the neighbouring plates, are indicated only by narrow suture lines. Thus the whole ventral surface appears more or less continuous. Adoral plates strap-shaped, narrow, with more or less parallel sides, meeting broadly within, scarcely separating the oral shield from the first lateral plate. Oral plates forming a triangle, meeting broadly within. Oral papillae ca 5, small, low, rectangular, contiguous (almost soldered together in some specimens). The jaw-angle is so extremely attenuated that the oral papillae of adjacent jaws are contiguous. The intercalary plate of the jaw is variously developed, and like the fragmentation of the oral shield, the degree of development varies from one interradius to the other in the same individual. Genital cleft very narrow, not longer than the basal arm-joint, bordered interradially by a discontinuous series of small granular structures representing papillae, the granules more numerous at the distal extremity of the cleft.

Arms: Slender, cylindrical, reaching a length of ca 20 or possibly 25 mm (broken in all specimens studied). Dorsal arm-plates small, lozenge-shaped, markedly thickened, with a tubercle or wart-like excrescence on the distal portion, contiguous only on the first few joints of the adult, more or less widely separated on other joints. Lateral plates meeting broadly below on every joint, including the first (adoral) joint, carrying two widely separated minute nodules representing arm-spines. Ventral plates lozenge-shaped, twice as broad as long, widely separated. Two tentacle-scales similar to the arm-spines. Tentacle-pore invisible beyond the second arm-joint.

Colour in Life: Unknown; in spirit, creamy white, the tumid plates of the upper surface of the disc somewhat deeper cream.

Type Locality

Bransfield Strait, South Shetlands, 200 m (hereby nominated, as being the locality from which Mortensen (1936) obtained his best-characterised specimen).

Distribution

Magellanic region (S. Shetlands, Zavodovski Island and Elephant Island) and Ross Sea (present records). *Bathymetric Range:* 278–587 m.

Material Examined

Nineteen specimens from 4 stations, as follows:
Sta. A448, 752 m, 2 specimens; Sta. A460, 415–430 m, 2 specimens; Sta. A461, 578–567 m, 14 specimens.

Stanford University Station: GLD-4, 587 m, 1 specimen.

Remarks

In some specimens the dorsal arm-plates are seen to be subdivided on certain of the arm-joints, forming 2 or 3 pieces which still retain the overall outline of the plate which became fragmented. The distal part of the dorsal plate is not always so thickened as in Mortensen's type, the tuberosity condition being apparently more pronounced in the younger stages than in the fully grown forms. Some of the upper disc-plates similarly become subdivided, as also the mouth-shields. The granulated area at the outer extremity of the genital cleft usually is well developed.

Euvondrea Fell, 1961

Disc covered by imbricating, naked scales which resemble petals, since the distal margins are up-turned; centrodorsal and primary radials in the form of a 5-petalled Tudor rose, surrounded by 3 circlets of petal-like plates, the outer circlet comprising the broad radial shields, together with a single strap-shaped plate in each interradius: the plates of the outer circlet project well beyond the margin of the disc, which appears thus to bear a floret on its upper surface, interradiation areas below covered each by 4 parallel, imbricating, strap-like plates, inclined obliquely outwards and

upwards, each extending from the oral shield to the margin; genital clefts very narrow, extending from the oral shield to the margin; oral shield subcircular, concave, patterned with a series of concentric circular grooves; jaw small, deeply sunken, bearing thick oral papillae which are confluent with the scales of the vestigial oral tentacle-pore; no arm-comb; upper arm-plates tumid, contiguous, each bearing a conspicuous, erect, conical tubercle; arm-spines minute; no tentacle-pores; no distal arm-hooklets.

Type Species: Euvondrea floretta.

The structure of the disc distinguishes *Euvondrea* from all other known genera; the obliquely inclined adoral plates and dorsally displaced oral plates give an unusual appearance to the jaws, because the oral papillae remain at the same level as the oral shield; in this character *Euvondrea* recalls *Theodoria*, where the jaws are excavate. The structure of the arm, and the presence of concentric growth rings on the oral shield are both indicative of a relationship with *Ophiurolepis*. Young stages illustrate the relationship even more clearly, and point to an affinity with a species such as *Ophiurolepis brevirima*. The genus, at present monotypic, is known only from abyssal stations in the Ross Sea.

***Euvondrea floretta* Fell (pl. 4, fig. 1–4; text-fig. 6)**

Euvondrea floretta Fell, 1961. Trans. Roy. Soc. N.Z., 88 (4), p. 839–841, fig. 2, 3.

Disc: Circular, reaching ca 9 mm diameter, concave above, with upturned narrow margins, which slope obliquely inwards, below, towards the oral shields. Oral shields subcircular, inclined outwards and upwards at ca 45 degrees, a little longer than broad, with a proximal oblique angle. Adoral plate polygonal with 2 triangular facets, one in the same plane as the oral shield, the other inclined at right-angles to it, so as to make an angle of 45 degrees with the (horizontal) oral plates meeting narrowly within. Oral plates triangular, meeting broadly within, and lying dorsad to the rest of the jaw. Oral papillae 3–4, rectangular, block-like, low, elongate, contiguous, placed ventrad to the lateral margin of the oral plate. The terminal unpaired papilla (tooth) is taller than the adjacent oral papilla and triangular, thick, and block-like.

Arms: Robust, reaching a length of ca 20 mm, markedly moniliform, although the structure is still robust even in the nodes, tapering evenly towards the arm-tip, with the widest part of the arm at the fourth or fifth arm-joint; the arms are remarkable in being inserted under the overhanging edge of the disc, instead of laterally into the disc, as usual for the *Ophiuridae*. Dorsal arm-plates twice as high as long, rising to form coarse, blunt tubercles (so that the arm has the appearance of a vertebral column with the neural spines represented by the dorsal tubercles); the dorsal plates are contiguous proximally, but not so on the distal part of the arm. Lateral arm-plates broadly contiguous below on all arm-joints, each bearing 4 short conical arm-spines, set on the distal margin of the internodal crest, one placed alone, high on the crest, the other 3 together lower down. Ventral arm-plates twice as broad as long, widely separated on every joint, with a proximal oblique angle and a distal convex or nearly straight base; greatly thickened, with concentric growth-lines and intervening grooves occupied by the lateral plates. Oral pore vestigial. No tentacle-pores.

Colour in Life: Unknown; in spirit, reddish-brown above, fawn below.

Type Locality

North-east of Pennell Bank, Ross Sea (Sta. A523), 1,375 m.

Distribution

Known only from Ross Sea; 1,335–1,375 m.

Material Examined

Eighteen specimens (not all adult) from 2 stations, as follows:

Sta. A523 (Sample 6), 1,375 m, 13 specimens, including holotype; Sta. A522 (Sample 12), 1,335 m, 5 specimens.

Young Stages

When the disc is about 2.5 mm in diameter, it is covered almost entirely by the 6 primary plates. These are more rounded than in the adult, but the radials are already curled upwards like the 5 petals of a Tudor Rose. The remainder of the disc has at this stage assumed the characteristic form of the adult, though the radial shields are small and not petal-like. It resembles the corresponding stage of *Ophiurolepis brevirima* more than the adults of the two species do. The tentacle pores are lacking from the young *Euvondrea*, a fact which

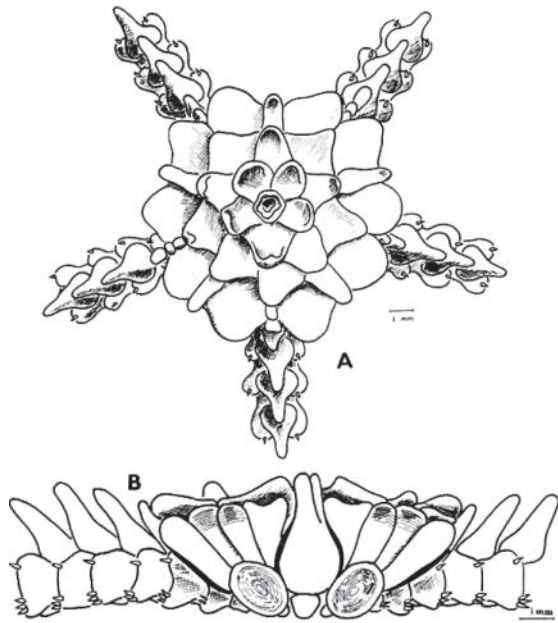


FIG. 6: *Euvondrea floretta*, holotype from Sta. A523, in dorsal aspect (A), and lateral radial aspect (B), each to the scale shown.

suggests that *Theodoria*, *Ophiurolepis*, and *Euvondrea* represent evolutionary stages in a sequence in which there has been a successive reduction in the pores, the basal pore being the last one to disappear.

Ecology

Insufficient data is available as yet to indicate the habitat, beyond the fact that both samples were taken in deep water on the margin of the abyssal basin to the north-east of the Ross Sea proper.

Euvondrea floretta exhibits the same extraordinary tendency to develop skeletal excrescences as is seen in another Antarctic genus, *Ophiosteira*. Both genera occur in the Ross Sea: where *Ophiosteira* seems to have its highest development. Analogous specialisations are not known from Arctic ophiuroidea, and it is therefore obscure why excessive skeletal development should characterise ophiuroids of the Antarctic. One may recall in this connection that whereas viviparity and/or direct development characterise Antarctic ophiuroids, the reverse is true of Arctic species.

All known specimens of *Euvondrea* were obtained by HMNZS *Endeavour* from which the generic name is derived by anagram.

Ophiosteira Bell, 1902

Disc hemispherical above, flattened below. Radial shields more or less concealed by the 5 enlarged keel-like radial primaries. Arms compressed, triangular in section, the dorsal plates standing erect and keel-like, giving a serrated outline to the arm. Three or more arm-spines.

Type Species: Ophiosteira antarctica Bell.

The genus is restricted to Antarctic continental seas, and is therefore absent from the Magellanic Region. It is well represented in the Ross Sea. The Magellanic representative of *Ophiosteira* is apparently *Ophiomages* Koehler, 1923. Mortensen (1936) synonymised the two genera, and Fell (1960, p. 31) accepted this suggestion. However, study of the rich *Ophiosteira* material obtained in the Ross Sea makes it probable that Mortensen's conception of *Ophiosteira* was based on hybrid forms showing extreme variation. Such variation is not observed in any of the material obtained from the present Ross Sea stations, and therefore I think that the species which Mortensen considered synonymous are really quite distinct. Similarly, I can no longer regard *Ophiomages* as a synonym of *Ophiosteira*, and accept Koehler's (1923) conception of the two genera.

KEY TO THE ROSS SEA SPECIES

- 1 (2) Disc covered almost entirely by the six primary plates. **bullivanti**
- 2 (1) Disc covered by the centrodorsal and intercalary plates, the radials standing erect between the radial shields.
- 3 (4) One coarse club-like spine stands on each of the larger intercalary plates. Radial shields bean-shaped, erect. Arm-spines and tentacle scales similar, conical. **echinulata**
- 4 (3) Intercalary plates without spines. Radial shields resemble thin, vertical fins. Arm-spines conical, acuminate; tentacle-scales square, flat. **antarctica**

Ophiosteira antarctica Bell (pl. 8, fig. 2. 3)

Ophiosteira antarctica Bell, 1902. Rpt. Voy. *Southern Cross*. Nat. Hist., p. 218, pl. 26, 27; Bell, 1908. Nat. Antarct. Exped., 1901-4, Nat. Hist., Zool., p. 12, pl. 5, fig. 2; Mortensen, 1936. Disc. Rpts., 12, p. 316 (partim).

Disc: Pentagonal in outline, with steep lateral margins, high hemispherical upper surface, flattened below, reaching a diameter of ca 15 mm. Centrodorsal conspicuous, carrying a central prominence. Primary radials separated from the

centrodorsal by small intercalary scales, elongate and high, very narrow, extending from almost the centre of the disc to the arm-bases, as high narrow flanges; ca 6 times as long as broad, nearly as high as long. Radial shields ovoid, contiguous along the midradius with the primary radial plate, which partly conceals them. Intercalary plates small, partly imbricating, without spines or other excrescences, forming a smooth continuous surface between the primary plates. Interradial areas below covered almost completely by the oral shields. Oral shield triangular, broader than long, with an inner angle which is almost a right angle, and a convex distal margin. Adoral plates strap-shaped, narrow, meeting broadly within, separating the oral shield without from the first lateral plate. Oral plates elongate triangular, meeting broadly within. Oral papillae ca 7, uniformly, squarish, of uniform size throughout, all contiguous, smaller than the terminal papilla (or tooth), confluent with and resembling the scales of the oral tentacle pore. Genital cleft narrow, inconspicuous, as long as the first lateral plate, bounded interradially by the oral shield.

Arms: Robust at the base, tapering rapidly to a slender extremity, reaching ca 40 mm in length. Dorsal plates elongate, extremely narrow and confined to the central radial midline, ca 4 times as long as the widest part, rising as flat, erect keels, rectangular in outline on basal plates, somewhat high than long. They remain contiguous to the distal end of the arm, but are there much lower, though still higher than broad. Lateral plates high, flattened below, meeting more or less broadly below except on the first 3 joints, where the ventral plates intervene; carrying a comb of short, acuminate spines on the lower part of the lateral side of the lateral plate, the spines sharply distinguished in shape and size from the tentacle-scales, which adjoin them below. Arm-spines 7–9, short, not exceeding one-quarter of the length of the lateral plate, the upper 3–4 even shorter. Tentacle-scales numerous, flattened, square, contiguous, adjoining the arm-spines in a continuous sequence with them, but entirely dissimilar from them. The oral tentacle-pore is bounded on both margins by scales, those on the interradiial border indistinguishable from the oral papillae (and have been counted with the latter in the foregoing description), those of the radial border numbering 3, similar in form and arrangement to the oral papillae. The succeeding pore carries 5–7 similar scales on the interradiial margin, 4–6 on the radial margin; the third pore, and fourth pore, each carry ca 4 flat, square scales on either margin.

Beyond this point the scales become successively fewer, with the terminal points carrying only 1 tentacle-scale on the proximal margin, none on the distal margin. On most joints the acuminate arm-spine immediately adjoining the outer tentacle-scale is ca 3 times as long as the scale. Ventral plates lozenge-shaped, all broader than long, contiguous only on the first 3 or 4 joints, very distantly placed on the distal joints, where they may be separated by an interval 2 or 3 times their own length.

Colour in Life: Unknown, but probably similar to *O. echinulata* (see p. 67). In spirit, pure white, sometimes porcellanous.

Type Locality

Cape Adare.

Distribution

Ross Sea only. *Bathymetric Range:* 25–750 m.

Material Examined

Thirty-four specimens from 5 stations, as follows:

Sta. A448, 752 m, 8 specimens; Sta. A457, 315–342 m, 2 specimens; Sta. A459, 534–549 m, 3 specimens; Sta. A461, 578–567 m, 20 specimens; Sta. A538, 269–256 m, 1 specimen.

Ecology

All the above records are from mud bottom, or sandy mud, save the last, where the sample was evidently mixed. The species may therefore be presumed to be a soft-bottom indicator.

At none of the above stations were any specimens of *O. echinulata* taken, so it seems that the two species are usually allopatric. No intermediate forms of the type mentioned by Mortensen (1936) were taken, so that it appears that the material in the British Museum (examined by Mortensen) must include, or comprise, hybrid forms between *antarctica* and *echinulata*. The British Museum material was originally collected by the *Southern Cross* at Cape Adare, and further specimens were contributed by Scott's *Discovery I* party (Bell, 1908) at Ross Island and Coulman Island. Mortensen (1936) does not indicate which of these specimens he examined. But in any case it is clear that the name *antarctica* is to be applied to the species described above.

Ophiosteira echinulata Koehler (pl. 5, fig. 1-3; pl. 8, fig. 5)

Ophiosteira echinulata Koehler, 1922. Australas. Antarct. Exped. 1911-14. Sci. Rpts., C, 8 (2), p. 38, pl. 82, fig. 5-10, pl. 83, fig. 1-7; Mortensen, 1936. Disc. Rpts., 12, p. 315-6.

Ophiosteira antarctica Mortensen, 1936. Disc. Rpts., 12, p. 316.

NON: *Ophiosteira antarctica* Bell, 1902.

Disc: Subpentagonal, reaching a diameter of ca 15 mm, flattened below, low hemispherical above, with almost vertical lateral margins; centrodorsal large, conspicuous, rounded or subpentagonal, naked. Radial primaries conspicuous, elevated into a high, ovoid crest, longer than broad, higher than broad, with a somewhat open, spongy texture, separated from the centrodorsal by intercalary plates, overlying and partly concealing the smaller radial shields. Radial shields ovoid, almost contiguous in the radial midline, which is placed higher than the interradiial margins. Intercalary plates of varying size, all smaller than the primary plates and radial shields, each carrying one, conspicuous, club-shaped spine with a spherical termination. Interradiial areas below almost completely covered by the oral shield. Oral shield pentagonal with an acute proximal angle, the sides and distal margin rounded and somewhat expanded. Adoral plates strapshaped, narrow, meeting broadly within, separating the oral shield without from the lateral plate. Oral plates large, subtriangular, meeting broadly within. Oral papillae 4-5, conspicuous, separate, contiguous, larger and triangular proximad; small, squarish, on the distal part of the jaw. Jaw-angles narrow, not gaping. Genital cleft very short and rounded, lying beside the first lateral plate, bounded interradiially by the oral shield.

Arms: Robust at the base, but tapering rapidly to a slender extremity, reaching ca 40 mm in length. Dorsal plates very short and narrow, restricted to the middle of the arm, contiguous only on the basal few segments, but rising conspicuously to form tall, blunt prominences, about 3 times as high as broad. Lateral plates tall, squarish, with a comb of short spines, carried on the lower half of the plate; proximad the laterals are separated below by the ventral plates, but distad on the arm they meet at first narrowly, and further out broadly, in the midline below. Arm-spines ca 9, all short, not exceeding one-third of the length of the joint, the uppermost even shorter. One or 2 large, blunt tentacle-scales on the radial border of the proximal tentacle-pores (the outer border bounded by homologous scales, which how-

ever are not distinguishable from the arm-spines, and have been counted with the latter in the description above). Ventral plates lozenge-shaped; as broad as long and contiguous on basal joints; longer than broad and separated on distal joints.

Colour in Life: Disc deep purplish-brown, with conspicuous white radial keels on the primary plates (i.e., a white vertical keel at each arm-base); arms pure white; foregoing data from a specimen visible in a colour photograph by J. S. Bullivant of the trawl sample at Sta. A527. Colour in spirit, white.

Type Locality

Adelie Land, 45-50 fm (82-91 m).

Distribution

Adelie Land; Ross Sea; apparently absent from West Antarctica. **Bathymetric Range:** 80-730 m.

Material Examined

Eleven specimens from 7 stations, as follows:

Sta. A455, 322-340 m, 2 specimens; Sta. A468, 110 m, 2 specimens; Sta. A470, 377 m, 1 specimen; Sta. A527, 358-337 m, 3 specimens; Sta. A534, 380-366 m, 1 specimen.

Stanford University Stations: GLD-1, 384 m, 1 specimen; EAD-2, 315 m, 1 specimen.

Ecology

Probably similar to that of *O. antarctica*, although the two species seem to be allopatric.

See *O. antarctica* (above, p. 65) for remarks on the systematic status of *antarctica* and *echinulata*.

Ophiosteira bullivanti Fell (pl. 5, fig. 4, 5; pl. 8, fig. 1; text-fig. 7)

Ophiosteira bullivanti Fell, 1961. Trans. Roy. Soc. N.Z., 88 (4) p. 840-841, fig. 1.

Disc: High, hemispherical, reaching a diameter of ca 4 mm, covered mainly by the 6 primary plates, of which the radial plates almost cover and obscure the radial shields; each radial plate broadly contiguous with the large, pentagonal centrodorsal, and separated from the adjoining radials by only 1 small interradiial platelet on either side; the primaries are extremely high and tumid, and collectively resemble a small starfish resting on the disc; oral shield small, pentagonal, with an acute angle proximad; ca 4 flat, rounded

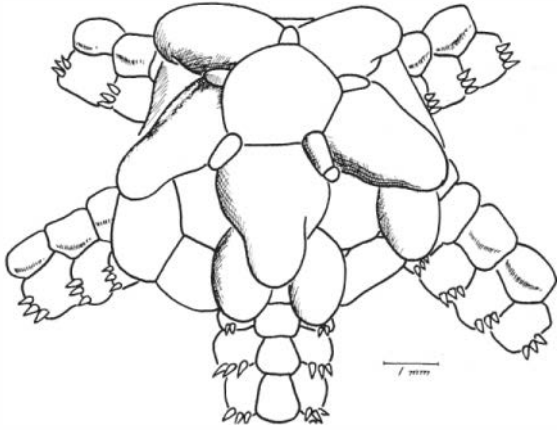


FIG. 7: *Ophiosteira bullivanti*, holotype from Sta. A526, in oblique latero-dorsal aspect.

oral papillae, confluent with the tentacle-scales of the oral tentacle-pores. Genital clefts conspicuous, extending to the margin, with papillae on the inter-radial border.

Arms: Reaching a length of ca 12 mm; upper arm-plates broadly contiguous, each with a high median crest (which becomes more like a tubercle on distal plates); lateral plates broadly contiguous below, each bearing 3 small conical arm-spines on the lower distal margin; lower arm-plates lozenge-shaped, small, widely separated; 2 scales on either side of oral tentacle-pore; succeeding pore with 3-4 scales on the proximal margin, and 2-3 on the distal margin; distally the number of scales progressively less, till none remain.

Colour in Life: Unknown; in spirit, dull grey.

Type Locality

Off Pennell Bank, Ross Sea, 461-465 m.

Distribution

Known only from Ross Sea. *Bathymetric Range:* 460-835 m.

Material Examined

Five specimens from 3 stations, as follows: Sta. A448, 752 m, 1 specimen; Sta. A526, 461-465 m, 3 specimens, including holotype, and two juveniles.

Stanford University Station: GLD-16, off Coulman Island, 835 m, 1 specimen.

Remarks

The species presents some similarity to *Ophiosteira rotundata* Koehler, and as the differences seemed attributable to immaturity, the species was at first referred to *rotundata*. However, material was subsequently obtained from two other stations, and on each occasion represented by a form of the same size and appearance as the one selected as the holotype; the genital clefts were found to be fully developed, and in no case were the specimens associated with *rotundata*. It is therefore considered to be a distinct species, differing from all other known species of *Ophiosteira* in the relatively massive, tumid primary plates and the relatively small body size.

Subfamily OPHIOLEPIDINAE Matsumoto, 1915

KEY TO THE ROSS SEA GENERA

- 1 (2) Dorsal arm-plates profoundly modified by extensive fragmentation and intercalation of small mosaic platelets; subdivided into 2 lateral halves which are more or less widely separated at the base of the arm by a mosaic; but distally they lie close together, and 1 or 2 median plates intervene, or alternate, with them. Genital clefts not extending beyond the first arm-joint.

Ophioceres Koehler, 1922

- 2 (1) Dorsal arm-plates quite distinct, but accompanied by a few supplementary plates. Tentacle-pores well developed throughout arm. Disc covered by irregular plates, not distinctly umbricating; usually small granules at or near the margins of the plates: radial shields small but distinct: primaries not distinct: one dorsal supplementary plate on each arm-joint, or on some arm-joints only.

Ophiobella Mortensen, 1936

Ophioceres Koehler, 1922

Disc scaled above and below, radial shields small and inconspicuous. Dorsal arm-plates profoundly modified by extensive fragmentation and those covering the disc; distad the lateral halves which are more or less widely separated at the base of the arm by a mosaic of plates similar to those covering the disc; distad the lateral halves lie close together, or are contiguous on the mediocradial line, and 1 or 2 medial plates are wedged between them, or alternate with them. Genital clefts short, not extending beyond the first arm-joint. Tentacle-pores large, extending throughout the arm, covered by a large rounded scale.

Type Species: Ophioceres incipiens Koehler.

The genus is a southern one with 3 known species. The type species *incipiens* ranges the Antarctic and Magellanic region, as far north as South Georgia, but is entirely unknown from the New Zealand submarine plateau, whereas 2 other species occupy New Zealand and are unknown from Antarctica or the Magellanic region. The genus thus seems to be an ancient one which has speciated within the limits imposed by geographical factors. Although I think it unlikely that the species will be found to overlap, it will perhaps be desirable to give a key in case the New Zealand forms should later prove to range further southward than at present believed.

KEY TO THE KNOWN SPECIES OF *Ophioceres*

- 1 (2) Arm-spines 2, closely adpressed to lateral-plates, inconspicuous, barely half the length of the arm-joint. Antarctic and Magellanic. ***incipiens*** Koehler, 1922
- 2 (1) Arm-spines conspicuous, not adpressed to arm but more or less erect; New Zealand submarine plateau.
- 3 (4) Armspines 2, nearly as long as the joint. Genital cleft reaching the second joint. No specially modified marginal scales on disc. North and South Islands of New Zealand. ***huttoni*** (Farquhar, 1899)
- 4 (3) Arm-spines 4. Genital cleft reaching only to first joint. Marginal scales demarcate edge of disc. Auckland Islands. ***marginata*** Fell, 1953

Ophioceres incipiens Koehler (pl. 1A, fig. 3; pl. 2A, fig. 1; pl. 3, fig. 2; pl. 9, fig. 2 (2))

Ophioceres incipiens Koehler, 1922. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (2), p. 48, pl. 84, fig. 1–6, 13, 14; Koehler, 1923. Swed. South Polar Exped., Aster. et Oph., p. 121; G. A. Smith, 1923. Ann. Mag. Nat. Hist., Ser. 9, 12, p. 370; Hertz, 1926. Deutsche Südpolar-Exped. Ophiur., p. 25; Mortensen, 1936. Disc. Rpts., 12, p. 307, pl. 7, fig. 7.

Disc: Pentagonal, thick, often convex above with rounded margins, reaching a diameter of ca 12 mm. The dorsal surface is covered by thick plates of dissimilar sizes and shapes, irregularly polygonal or rounded, separated by deep furrows. The plates become smaller near the ambitus. The primary plates are often distinct, larger than the other plates, separated from one another by smaller platelets. Radial shields small, oval, or rounded, widely separated from each other by several series of platelets which occupy an area as broad as the arm. Ventral interradii scaled by

thick plates which tend to imbricate. Genital clefts short, conspicuous, not extending beyond the first arm-joint. Oral shields small, with a proximal obtuse angle, and a convex distal margin, which may carry a lobe; if a lobe is present, the shield is longer than broad; if not, broader than long. Adoral plates small and narrow with parallel sides. Oral plates small, 1w. Oral papillae 5; the outermost slender and pointed, the next one broad and rectangular, the third, fourth, and fifth are similar but become successively narrower towards the apex. The teeth are broad and blunt.

Arms: Robust, cylindrical, flexible in the lateral and ventral directions, often somewhat unequal in length, reaching about 35 mm. At the arm-base there is an irregular mosaic of platelets covering the upper and lateral surface of the joints. Further out the arrangement of the dorsal and lateral plates is in accordance with the generic diagnosis. Two short papilliform arm-spines are carried on the lateral plate. Ventral plates large, pentagonal, somewhat broader than long, with a rounded proximal angle and a convex broad distal margin; contiguous at the base of the arm; distad they are separated, and become longer than broad. Tentacle-pore large, covered by a very large round tentacle-scale.

Colour in Life: Blue-grey disc, arms cream (colour photograph, Sta. A526); bluish disc, arms pinkish-yellow (colour photographs, Sta. A516); purple disc, arms white (field notes, Sta. A526); all data from J. S. Bullivant.

Type Locality

Koehler's types were from off Adelie and Wilkes Land; of the three localities listed, the first is hereby selected as type locality, 60° 32'S, 141° 39'E, off Adelie Land, 157 fm (280 m).

Distribution

Magellanic Region and Antarctic coasts, circumpolar. **Bathymetric Range:** 110–590 m.

Material Examined

251 specimens from 14 stations, as follows:
Sta. A454, 914–828 m, 6 specimens; Sta. A455, 322–340 m, 24 specimens; Sta. A456, 238–201 m, 25 specimens; Sta. A457, 315–342 m, 13 specimens; Sta. A464, 369–384 m, 19 specimens; Sta. A465, 399 m, 2 specimens; Sta. A520, 201–205 m, 7 specimens; Sta. A521, 582–558 m, 29 specimens; Sta. A525, 591–583 m, 1 specimen; Sta. A526, 461–465 m, 14 specimens; Sta. A527, 358–337 m,

73 specimens; Sta. A528, 274–265 m, 25 specimens; Sta. A529, 205–216 m, 13 specimens; Sta. A538, 269–256 m, 3 specimens.

Meristic Variation

Tetramerous and hexamerous variants were noted in material from Sta. A527 and A528; at both stations the species was well represented, and the incidence of such variation is rather high in these samples, ca 3%. Mortensen (1936, p. 307) also noted meristic anomalous development, which is apparently, therefore, not infrequent in the species.

Ecology

A detailed study of underwater photographs from stations at which the species was taken in the trawl revealed two criteria by which *Ophioceres incipiens* may be recognised in such photographs, and these in turn led to another finding which not only aids identification, but also throws an interesting light on the habits of the species, and probable structural modifications correlated with feeding habits.

The following are the steps in the study of the photographic material. A black-and-white enlargement of underwater photograph serial No. 5, taken at Sta. A538 (McMurdo Sound, 256–260 m), showed, among other ophiuroids, a number of specimens of a medium-sized species with unusually flexible arms. They were evidently gliding through polyzoan masses, with the arms coiling to a limited extent ventrad. The arms appeared white, while the disc was a greyish tint in the print. The size agreed with *Ophioceres incipiens*, and a further examination of preserved material showed that in many individuals the arms were in fact preserved in similar positions. It was apparent from study of specimens under low powers of the microscope that the unusual flexibility of the arms is largely due to the generic character, namely the fragmentation of the dorsal arm-plates which, though still remaining robust form a flexible sheath in conjunction with the small lateral plates, allowing the movement that had been observed. Further examination of the original colour transparency showed that the greyish disc of the black-and-white print was distinctly bluish in the original. Thus the provisional identification appears to be confirmed. But in the same photograph, other specimens of the same species are seen in the unusual attitude shown in pl. 36, and specimens of what is evidently the same species can be seen in the same position in other photo-

graphs. The indications are that the species is able to climb the tubes of tubicolous worms and the stems of colonial hydroids and similar substrates, and to grasp the substrate with 2 of the arms in a “scissors-hold”, whilst the remaining 3 arms are held out in the surrounding water. It appears that such individuals are in effect “fishing” for small nekton or plankton particles. Study of the photographs under considerable enlargement suggests that the tentacles are extended from the pores. The species has unusually large, lid-like tentacle-scales, and it seems highly probable that these are trap-door devices for permitting the withdrawal or extrusion of the tentacles, which are apparently capable of considerable extension. It is probably significant that a specimen identifiable as the same species is to be seen in an underwater photograph (pl. 1A) taken at Sta. A538: it is evidently “fishing” in the manner inferred, and has ascended an erect sponge only a few centimetres away from the specimen of *Astrotoma agassizii*, already described as “fishing” in a different attitude in the account given earlier on p. 68.

Convinced that the foregoing inferences are substantially correct, surprising though they may seem, I would note that such photographs as these have not been available for detailed study before, and therefore our previous ignorance of behaviour of this kind among ophiuroids is accounted for. A fuller investigation of the ecology of the seafloor in the area studied will be possible when the systematic reports on other groups become available, and further inquiry into the topic is therefore better postponed for the present.

Ophiolebella Mortensen, 1936

Mortensen, Th. 1936. Disc. Rpts., 12, p. 305.

Type Species: Ophiolebes biscutifer E. A. Smith, 1923.

The genus *Ophiolebella* is known only from the southern part of the Magellanic Region, especially South Georgia. In the zoogeographic chapter of this work reasons are given for including South Georgia in the Antarctic faunal region, and therefore it seems possible that the genus may occur in the Ross Sea. As *Ophiolebella* is fully characterised in the key to the *Ophiolepidinae* (p. 68), and comprises only the type species, the key will permit ready identification should a specimen be obtained. For illustrations and description, see Mortensen (1936).

ECOLOGY AND ZOOGEOGRAPHY

Special ecological features related to the habitat have been discussed already under the individual species in the systematic part of this work, and are therefore excluded from the present chapter. Before considering the zoogeographic implications of the Ross Sea ophiuroid fauna it is desirable to examine the possible influence on distribution of (a) thermal tolerance and (b) bathymetric tolerance. As these two ecological factors are directly related to the zoogeography of the species concerned, it has been considered preferable to combine the inquiry under a single head.

Thermal Tolerance

Study of the existing literature shows that at least 19 of the 33 known Ross Sea ophiuroid species enter the Subantarctic or south temperate zones. A concise summary of the relevant data has been prepared in the form of a distribution chart for the Magellanic region where, largely owing to the *Discovery II* Investigations, a fairly comprehensive series of records is available. The plots given in the chart (text-fig. 8) indicate the known ranges of individual species. As most of the relevant *Discovery II* stations were in or near 200 m, the approximate 200 m isotherms are sketched in; they are taken from Sverdrup, Johnson, and Fleming (1942, Chart IV). An indication is also given of the general sea-floor contours. The inferred thermal tolerances (which are conservative, since full distribution data are obviously lacking) are shown in diagrammatic form at the lower left.

It is immediately obvious that five species are strongly eurythermal, tolerating bottom temperatures of between minus 2°C and plus 5°C. In addition, it should be noted that at least one other species is eurythermal, namely *Toporkovia antarctica*, which occurs at Marion Island in the south Indian Ocean at 48°S latitude, though its distribution in the Magellanic region remains unknown. About six other species show a moderate tolerance of between minus 2°C and plus 1.5°C.

With this information we are now in a better position to assess the potential distribution of Antarctic ophiuroids in non-Antarctic areas.

Although detailed thermometric data is not yet available for the 200 m line around the coasts and islets of the southern part of the New Zealand submarine plateau, Sverdrup, Johnson, and Fleming (1942) give a general chart sufficient for the present purpose. From these data it is now evident that *Ophiacantha vivipara* would tolerate the deeper parts of the New Zealand shelf off Otago, and would also tolerate the shelves of the Antipodes, Bounty, Campbell, and Auckland Islands. At the islands mentioned we could also expect to find the conspicuous euryalid *Astrotoma agassizii* as well as *Amphiura belgicae*, *Ophiuroglypha carinifera*, *Ophiurolepis martensi*, and *Toporkovia antarctica*.

In point of fact, not one of these species has ever been recorded from any one of these localities, although collections of ophiuroidea have been made by 11 expeditions to the southern islands, and numerous investigators on the mainland coasts. It cannot be argued that the said species were not collected because trawls were not made at 200 m, for the ophiuroids which were in fact collected are known to have bathymetric ranges similar to those of the Antarctic species under discussion. The species and genera present prove to be of Indo-Pacific affinity, though occupying a southern area which might seem more suited to forms of Antarctic or Subantarctic origin.

We are therefore led to inquire why the eurythermal Antarctic species have failed to enter the southern part of the New Zealand submarine plateau in the same way that they have occupied the shelf-waters of Chile, Patagonia, Falkland Islands, Burdwood Bank, and other localities in the Magellanic region.

Bathymetric tolerance

In the course of a general discussion on post-Mesozoic migration of Australasian echinoderm faunas, Fell (1953) concluded that the recent echinoderm faunas of the Auckland, Campbell, Snares, and Antipodes Islands of the so-called Subantarctic region do not possess a Subantarctic echinoderm fauna, but have drawn their component genera and species from the New Zealand mainland fauna. These islands all have relatively

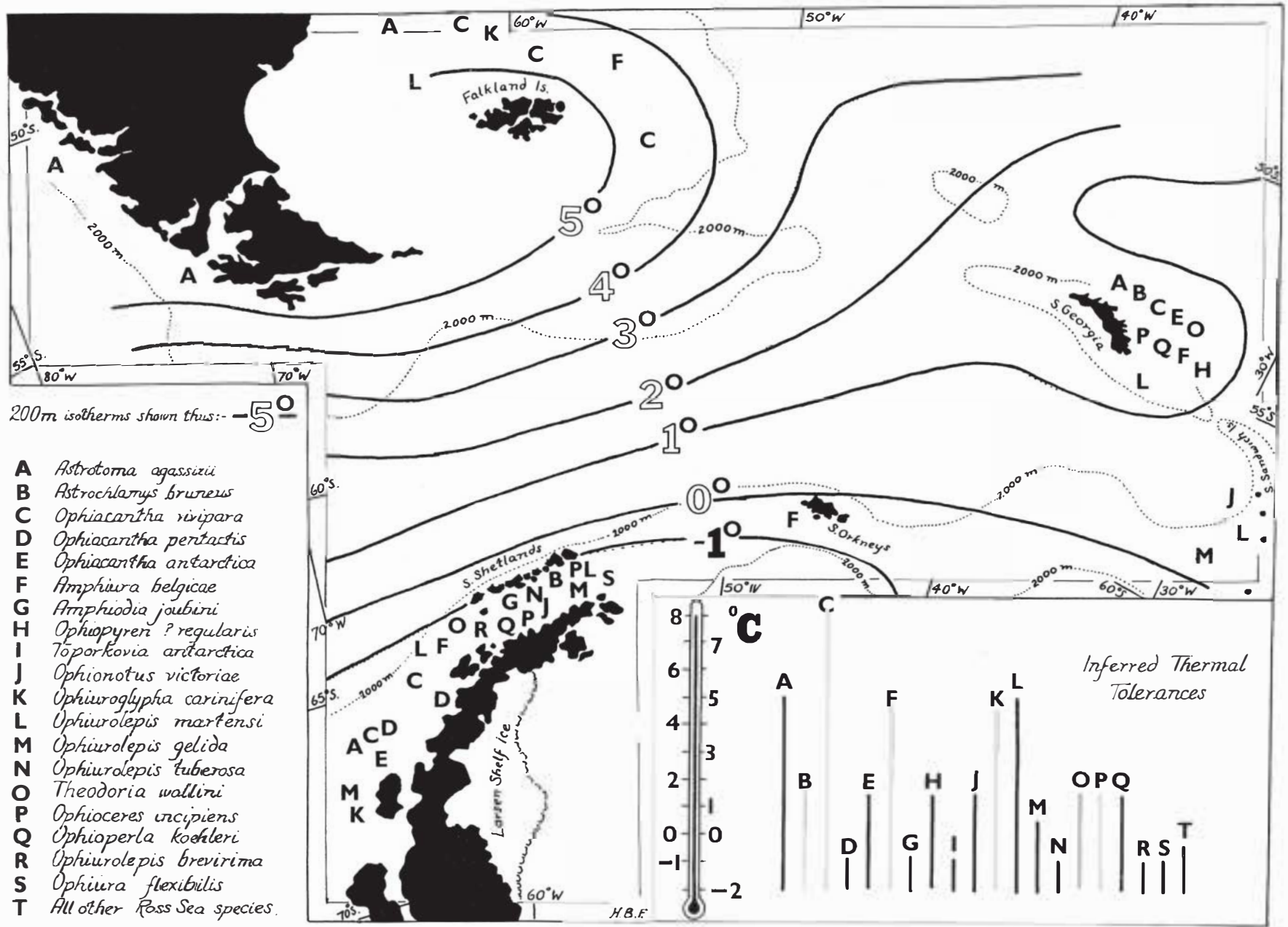


FIG. 8: Thermal tolerances of Ross Sea Ophiuroidea which enter the Magellanic region. See text for fuller explanation.

shallow-water links with New Zealand. The echinoderm fauna of the nearby Macquarie Island, which stands in deep water, is essentially Subantarctic in character; it shares only one echinoid (*Pseudechinus novaezelandiae*) with New Zealand, a species with a pelagic larva. Fell concluded that shallow-water routes have been of greater importance to the dispersal of echinoderms than relatively narrow deep-water gaps, unless a favourable current or surface drift traverses the gap.

Available charts of the sea-floor topography between New Zealand and Antarctica reveal no shallow-water route between the two regions. In the Magellanic region, in contrast, a submerged arc links the Palmer Archipelago with South Georgia, by way of the South Orkney Islands, and the Scotia Arc (South Shetland Islands ridge); from South Georgia it is no great distance to the banks which lie about the Falkland Islands, and link up with the South American shelf.

Thus all the evidence points to the parallel which exists between the two cases, namely, the Subantarctic region of South America has relatively shallow-water links with Antarctica, and shares a large part of its echinoderm fauna with Antarctica; and the southern islands of New Zealand have relatively shallow-water links with New Zealand (and hence Australasia) and share their echinoderm fauna with New Zealand. Thus, the reason for the presence of *Astrotoma* in South America and Antarctica is probably that it is a eurythermal species, and a migration route is open, or was open, for its transfer. The absence of *Astrotoma* from the suitable thermal conditions of southern New Zealand shelf-waters is presumably due to the absence of a shallow-water route, or former shallow-water route between Antarctica and New Zealand. The replacement of *Astrotoma* in New Zealand and Australian shelf-waters by Indo-Pacific euryalids such as *Astrothorax* and *Astrothammus* is doubtless because a shallow-water route exists or formerly existed between Indonesia and Australasia. All the inferred shallow-water migration paths are matched by relatively shallow ridges on the existing sea-floors. A more extended discussion of circumpolar species in Subantarctic and south temperate seas would not be strictly relevant in the present context, but nothing has arisen in the present investigation to contradict the views expressed on the topic by Fell (1953), when examining the distribution of the few genera of echinoderms which are known to be shared by South America and New Zealand.

GENERAL ZOOGEOGRAPHY

It remains, then, only to outline the distinctive features of the Antarctic ophiuroid fauna, to contrast it with that of the adjoining areas, and to attempt to relate the Ross Sea ophiuroid fauna with that of other Antarctic seas.

Reference to the Magellanic fauna (text-fig. 8) shows that a rather pronounced thermal hiatus exists between South Georgia and the Falkland Islands, and there is a corresponding hiatus between the proportion of Antarctic species of ophiuroids present in the two areas. This appears to give a convenient line of demarcation between the Antarctic fauna in the strict sense and a peripheral fauna. Accordingly, one may define an Antarctic benthal faunal region on the basis of Ophiuroidea (and no doubt the other Echinodermata will give consistent results), which includes all shallow-water benthal faunas colder than about 2°C. This area (text-fig. 9) comprises Antarctica, the Palmer Archipelago, and all islands of the Scotia Arc up to and including South Georgia. The ophiuroid fauna is distinguished by the relatively stenothermal genera named on the diagram, i.e., *Astrohamma*, *Astrochlamys*, *Glaciacantha*, *Ophiosparte*, *Ophioduces*, *Fuvondrea*, *Ophioperla*, and *Theodorina*. Certain species of cosmopolitan genera appear also to be confined to the region, for example, *Amphiura algida* and *Ophiacantha pentactis*; others need not be listed here. The area outlined, occupied by these endemic forms, corresponds well with Ekman's (1935) proposals, and differs completely from Hart's (1942) scheme. However, there is no real disagreement in the results, because Hart based his findings on plankton organisms, whereas Ekman and Fell have considered benthal forms. Since echinoderms have planktonic larvae, it might be asked why their distribution pattern appears to conform to sea-floor factors which would affect only the adult stage. Part of the answer to this problem may lie in the fact, already noted by Mortensen (1936), that viviparity and direct development are extraordinarily widespread in Antarctic echinoderms, especially ophiuroids. Another relevant factor is the shortness of the planktonic stage in those echinoderms which possess it; this would limit the span of ocean that could be covered. As Fell (1953) suggested, epiplanktonic distribution of adults may well be more significant than transportation of true planktonic larval stages; since Antarctic echinoderms have little, if any, opportunity of epiplanktonic distribution, unlike Subantarctic echinoderms, their distribution could well tend to follow a strictly benthal pattern.

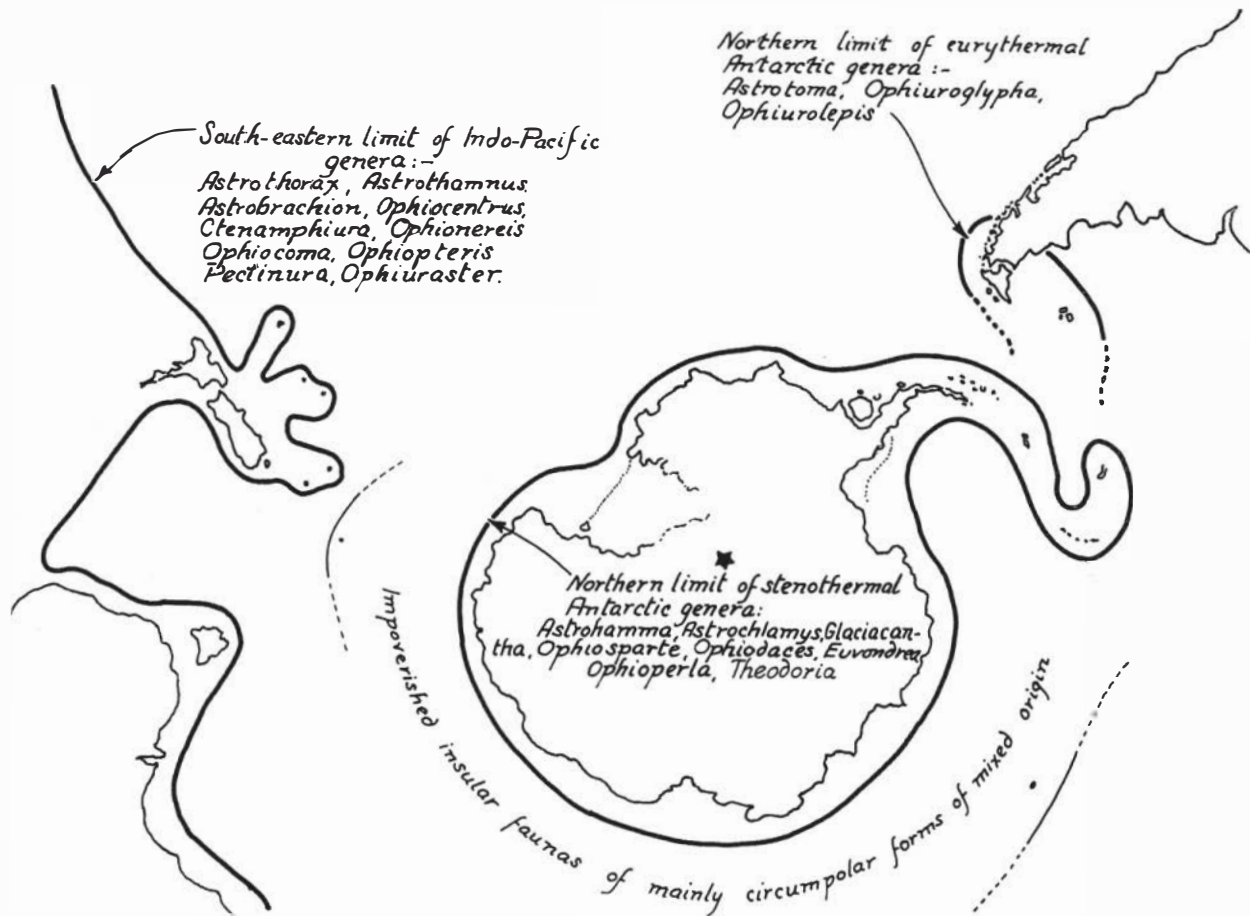


FIG. 9: General zoogeography of the Ophiuroidea of Antarctica and the South Pacific.

The Magellanic region contains an ophiuroid fauna of predominantly Southern American type, mingled with those few species of Antarctic ophiuroids which, as already shown, are eurythermal; the genera involved in the latter category are *Astrotoma*, *Ophiuroglypha*, *Ophiurolepis*, and probably also *Toporkovia*; also certain species of cosmopolitan genera, thus *Amphiura belgicae* is common to Southern Argentine waters and Antarctica, though found nowhere else.

The New Zealand region is part of the general Indo-Pacific area, and marks the south-eastern limit of such genera as *Astrothorax*, *Astrothamnus*, *Astrobrachion*, *Ophiocentrus*, *Ctenamphiura*, *Ophionereis*, *Ophiocoma*, *Ophiopteris*, *Pectinura*, and *Ophiuraster*. The New Zealand species are mostly endemic (63 out of a total of 84 known species), but many of these endemic species are so closely related to Australian species as to indicate their common origin: and of the

non-endemic species, a majority are shared also with Australia, Indonesia, or Fiji. Only one genus, *Ophioceres*, is shared by New Zealand and Antarctica, and not present also in Australia. The case is parallel to that of *Pseudechinus* among echinoids, and *Asterodon* among asteroids, already discussed by Fell (1953). In these genera we find a single species in the Magellanic region, and odd species in various southern islets, one species at each point; on the other hand, we find clusters of species in New Zealand, and evidence (in the case of *Pseudechinus*) of a long Tertiary occupation of the New Zealand region. Fell concludes that New Zealand has served as a donor area to other southern regions, to which occasional "escapes" have immigrated from the home area in Australasia, where more extensive speciation indicates their prolonged occupation. *Ophioceres* is shared not only by Antarctica and New Zealand, but also by the Magellanic region. In New Zealand there are two species (both having conspicuous arm-

spines) whereas there is only one species known from the whole Antarctic and Magellanic areas: it differs from the New Zealand form in having inconspicuous arm-spines. It is here tentatively suggested that New Zealand may have been the original home of *Ophioceres*, and that at some time an immigrant sample (epiplanktonic perhaps) reached the Magellanic region, via the west-wind drift, and thence spread along the shallow-water route into the Palmer Archipelago and Antarctica as a whole. Considering the vast time-spans available and the slow evolution rates of echinoderms, the chances against such an occurrence do not appear at all prohibitive.

Supposed Antarctic Connexions of New Zealand

The tenor of the discussion above is entirely opposed to any connexion between New Zealand and Antarctica, by land-bridge or any other means. If such a land-bridge or shallow-water route existed in Tertiary times, it is inconceivable that shelf-inhabiting echinoderms could have failed to use it. The fossil record of the echinoderms in the New Zealand Tertiary is entirely consistent with Indo-Pacific connections (Fell, 1953, 1954). The genera mentioned above as characteristic of Antarctica differ most markedly from any found elsewhere in the world. Nothing parallels *Ophiosteira* in the Arctic, or anywhere else. Fossil asterozoans of the early Tertiary, or even the Cretaceous, quite closely resemble living species of the same genera. It is reasonable to infer that the peculiar Antarctic genera are the result of a long Tertiary evolution in relative isolation. Cidaridae, a group of living fossils of Palaeozoic origin, have been extremely slow in their evolution rates; yet in Antarctica we find a whole sub-family, the Ctenocidarinae, characteristic of the

fauna, and distinguishing it sharply from other cidarid faunas. Thus the facts of echinoderm distribution, only a few examples of which have been cited here, point to the isolation of Antarctic echinoderm faunas over a long period, and in particular the absence of any benthal migration route to New Zealand or Australia.

Ross Sea Ophiuroid Fauna Considered as Such

In the present report the genera *Euwondrea* and *Glaciacantha* are established for species known only from the Ross Sea. Until much wider sampling has been carried out, there are no grounds for supposing that they are restricted to the Ross Sea, or serve as indicators of a Ross Sea fauna. It is true that the genus *Ophiosteira* (in the strict sense, excluding *Ophiuroglypha carinifera*) is apparently very highly developed in the Ross Sea, and absent from the Bellingshausen Sea (where *Ophiomages* may replace it). This might be used as evidence of a Ross Sea fauna. However, *Ophiosteira* is represented in Wilkes Land and Adelie Land, a fact which suggests that sampling of the southern parts of the Bellingshausen and Weddell Seas may well reveal *Ophiosteira* populations matching those in the southern part of the Ross Sea. A discussion at greater length cannot conveniently be carried out until the other groups of echinoderms of the Ross Sea have been examined in detail. It is inferred, in the meantime, that the Ross Sea ophiuroid fauna closely resembles that recorded from West Antarctica, sharing at least half of its species with that area; whether any significant number of species is restricted to the Ross Sea is indeterminate at present and it is clear that extensive sampling is required from other Antarctic coasts.

REFERENCES

As full synonymies are given under each species, purely systematic material is omitted from the following bibliography unless it has been cited in the course of the general discussion.

- BELIAEV, G. M. and IVANOV, B. G. 1961: K voprosy o bipolyarnosti ophiuri roda *Toporkovia* Djakonov. *Zoolog. Zhurn.*, 6 (in press).
- BELL, T. J. 1902: Reports on the Natural History Collections of the Voyage of the *Southern Cross*. *Echinoderms*, pp. 214–220.
- 1908: National Antarctic Expedition 1901–04. *Nat. Hist. W., Zool. Echinoderms*, 1–15.
- BULLIVANT, J. S. 1959: An oceanographic survey of the Ross Sea. *Nature, Lond.* 184:422–3.
- 1959a: Photographs of the bottom fauna in the Ross Sea. *N.Z. J. Sci.* 2 (4):485–597. (Includes 3 colour-plates and 6 monochrome sea-floor photographs at stations mentioned in the present report.)
- CLARK, H. L. 1915: Catalogue of Recent ophiurans. *Mem. Mus. Comp. Zool. Harv.* 25.
- DJAKONOV, A. M. 1954: Ophiuri Morei CCCP. M.-L. *Izd-vo Akad. Nauk CCCP.* (In Russian.)
- EKMAN, S. 1935: Tiergeographie des Meeres (Leipzig).
- FELL, H. B. 1953: The origin and migrations of Australasian echinoderm faunas since the Mesozoic. *Trans. roy. Soc. N.Z.* 81 (2):245–55.
- 1954: Tertiary and Recent Echinoidea of New Zealand: Cidaridae. *N.Z. geol. Surv. pal. Bull.* 23.
- 1958: Deep-sea echinoderms of New Zealand. *Zool. Pubns. Vict. Univ. Wgton.* 24.
- 1960: Synoptic keys to the genera of Ophiuroidea. *ibid.* 26.
- 1961: New genera and species of Ophiuroidea from Antarctica. *Trans. roy. Soc. N.Z.* 88 (4):839–41.
- 1961: Bipolyarnii rod Ophiuroidea—*Toporkovia* Djakonov. *Zoolog. Zhurn.*, 6 (in press).
- HART, T. 1942: *Rhizosolenia curvata* Zacharias, an indicator species in the Southern Ocean. *Discovery Rpts.* 16:413–46.
- HEDGPETH, J. W. 1947: On the evolutionary significance of the Pycnogonida. *Smithson. Misc. Coll.* 106 (18):
- HERTZ, M. 1927: Deutsche Südpolar-Expedition. Die Ophiuroiden.
- KIRK, H. B. 1916: Much abbreviated development of a sand-star. *Trans. N.Z. Inst.* 48:
- KOEHLER, R. 1901: Resultats du Voyage S.Y. *Belgica* 1887–89. Echinides et Ophiures. (Anvers).
- 1906: Expedition Antarctique Francaise 1903–05. Echinodermes.
- 1909: Asteries, Ophiures et Echinides de l'Expedition Antarctique Nationale Ecossaie. *Trans. roy. Soc. Edin.* 46:529–649.
- 1911: British Antarctic Expedition 1907–09. *Rpts.*, 2 *Biology* (4), Asteries, Ophiures et Echinides.
- 1912: Deuxieme Expedition Antarctique Francaise. Echinodermes.
- 1922: Australasian Antarctic Expedition 1911–14. *Sci. Rpts. Ser. C*, 8 (2). Ophiurcs.
- 1923: Swedish Antarctic Expedition 1901–03. *Further Results*, 1. Asteries et Ophiures.
- MAJSEN, F. J. 1955: Echinoderms. *Sci. Res. Norweg. Antarct. Exped.* 37.
- MORTENSEN, TH. 1925: On a small collection of echinoderms from the Antarctic Sea. *Ark. f. Zool.* 17a (31): 1–12.
- 1936: Echinoidea and Ophiuroidea. *Discovery Rpts.* 12.
- SVERDRUP, H. U.; JOHNSON, M. W.; FLEMING, R. H. 1942: *The Oceans.* (New York).

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COLOUR PLATE 1

Sta. A537, McMurdo Sound, 574-543 m. Representative echinoderms from the trawl sample, photographed on deck.

Upper left, *Sterechinus neumayeri* (Meissner), aboral aspect.

Upper right, *Promachocrinus kerguelensis* P. H. Carpenter.

Middle, *Acodontaster conspicuus* (Koehler), the specimen having one arm bifurcate distally; below, and partly overlying it, is a specimen of *Cuenotaster* sp.

Lower left, *Sterechinus neumayeri* (Meissner), adoral aspect.

Lower middle, *Astrotoma agassizii* Lyman, aboral aspect.

Lower right, two specimens of *Ophiacantha antarctica* Koehler, and (between them) *Ophiurolepis gelida* (Koehler).

The scale-divisions each measure 1 cm.



Photo: J. S. Bullivant

COLOUR PLATE I

6 Inset

COLOUR PLATE 2

a. Sta. A538. McMurdo Sound, 348–256 m, part of trawl sample photographed on deck.

Upper left, a group of *Ophiurolepis gelida* (Koehler), some carrying the parasitic sponge *Iophon radiatus* Topsent. To the extreme left of the group is a specimen of *Ophiacantha vivipara* Ljungman. Other echinoderms in the field include the asteroid *Porania antarctica* E. A. Smith, beside the brachiopod, and two unidentified holothurians. Scale-divisions each measure 1 cm.

b. Sta. A538, another portion of the same trawl sample.

Below, the large cream-coloured ophiuroid is *Astrotoma agassizii* Lyman, in adoral aspect, with a smaller specimen of the same species in aboral aspect immediately above, to the left. Above these again are two specimens of *Ophiacantha antarctica* Koehler, resting upon the colonial coelenterate. Above, lying on the dark stone, is another specimen of *Ophiacantha antarctica* Koehler, here represented by the more typical form with a dark grey disc and light coloured arms. The dark ophiuroid to the right of the stone is *Ophiurolepis gelida* (Koehler). Scale-divisions each measure 1 cm.

c. Sta. A521. Pennell Bank, 582–558 m, part of trawl sample photographed on deck.

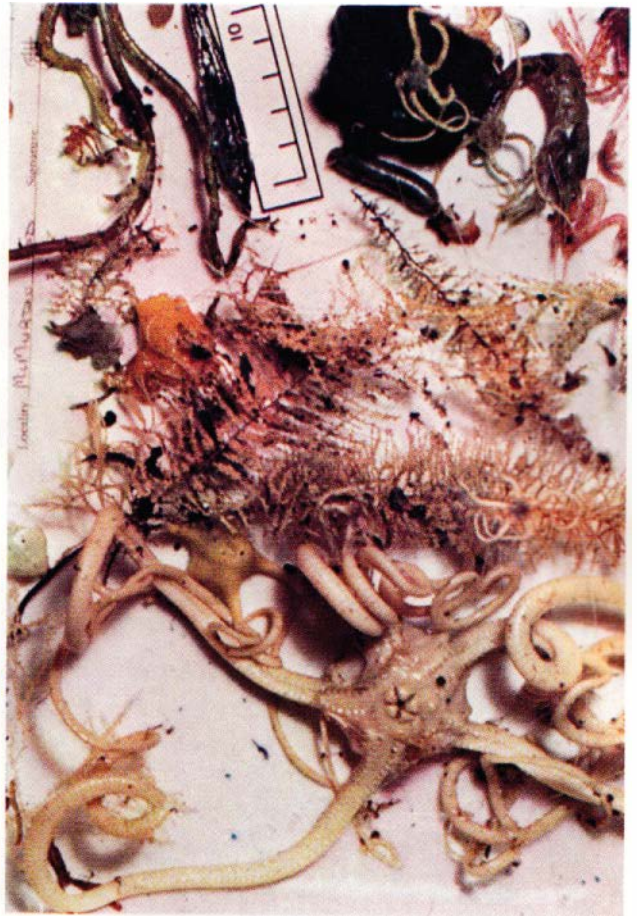
Upper left, a large echinoid *Ctenocidaris perrieri* Koehler. At the extremity of the long radiole, and also just above the radiole, are two specimens of *Ophiacantha antarctica* Koehler, here represented by a form with a deep red disc. On the right of the field are two immature specimens of an echinoid, *Sterechinus* sp., and to their left and partly overlying the centimetre-scale, is a specimen of *Astrochlamys bruneus* Koehler, with coiled arm-tips. Another specimen of *A. bruneus* overlies the long radiole of the cidarid. The smaller ophiuroids, with bluish discs and whitish arms are all *Ophioceres incipiens* Koehler. Below these, to the lower left of centre are two small ophiuroids with greyish-brown discs and pale arms, apparently *Ophiacantha antarctica* Koehler. The ophiuroid to the extreme lower left, with coiled arms has not been identified with certainty, but probably represents another of the specimens of *Astrochlamys bruneus* taken at this station, and here seen in adoral aspect. The remaining three large ophiuroids, all with pentagonal discs and short broken arms, are *Ophiura ambigua* Lyman. Scale-divisions each measure 1 cm.

d. Sta. A516, Scott Island, 457–183 m.

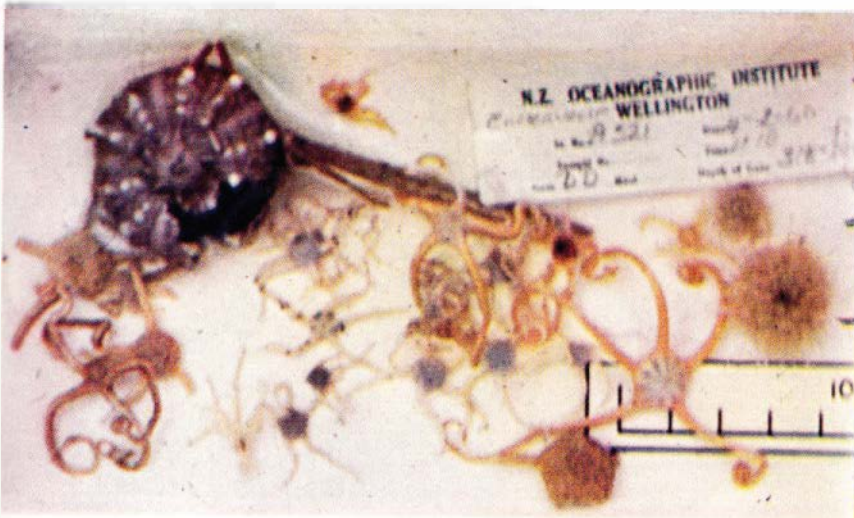
The large ophiuroid is *Ophionotus victoriae* Bell, seen in aboral aspect. Other small ophiuroids are *Ophiacantha antarctica* Koehler. Scale approximately the same as in fig. b.



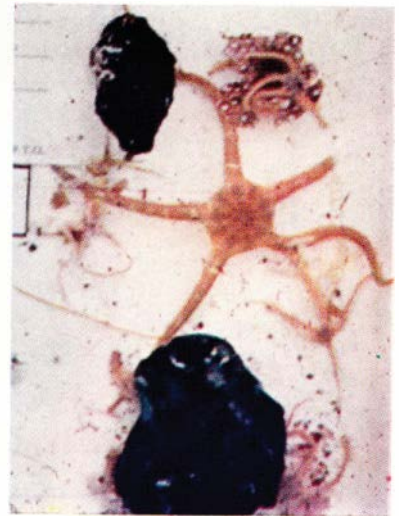
a



b



c



d

Photos: J. S. Bullivant

COLOUR PLATE 2

PLATE 1

Underwater photographs illustrating general ecology of Antarctic Ophiuroidea

A. Sta. A538, McMurdo Sound, depth 260 m. Monochrome enlargement of portion of a colour transparency. The area visible is approximately 40 cm across. Three contrasted types of feeding behaviour are evident.

1. **Ophiurolepis** sp. (probably **gelida**) showing selective detritus feeding; the leading arm is thrust into the soft substrate and has raised a small mound above it, the mouth directed downwards.

2. A euryalid, identified as **Astrotoma agassizii**, lies on the bottom with the prehensile arms coiled over the up-turned oral surface and apparently sweeping the surrounding water for small nekton or plankton-fall.

3. **Ophioceres incipiens** clinging to an erect sponge, apparently "fishing" the adjacent water.

4. A nudibranch.

5. Unidentified ophiuroid.

B. Sta. A518, Beaufort Island, 75 m. Enlargement of portion of original monochrome photograph. The area visible is approximately 40 cm across.

1. **Ophiurolepis gelida**, an adult specimen heavily parasitised by the sponge *Iophon radiatus*, is moving over the sea-floor by using two pairs of arms as "oars". The tips of the arms are raised whilst the fifth arm is apparently trailing. The whole disc and the proximal halves of the arms carry sponge.

6. A gorgonid.

7. An asteroid.

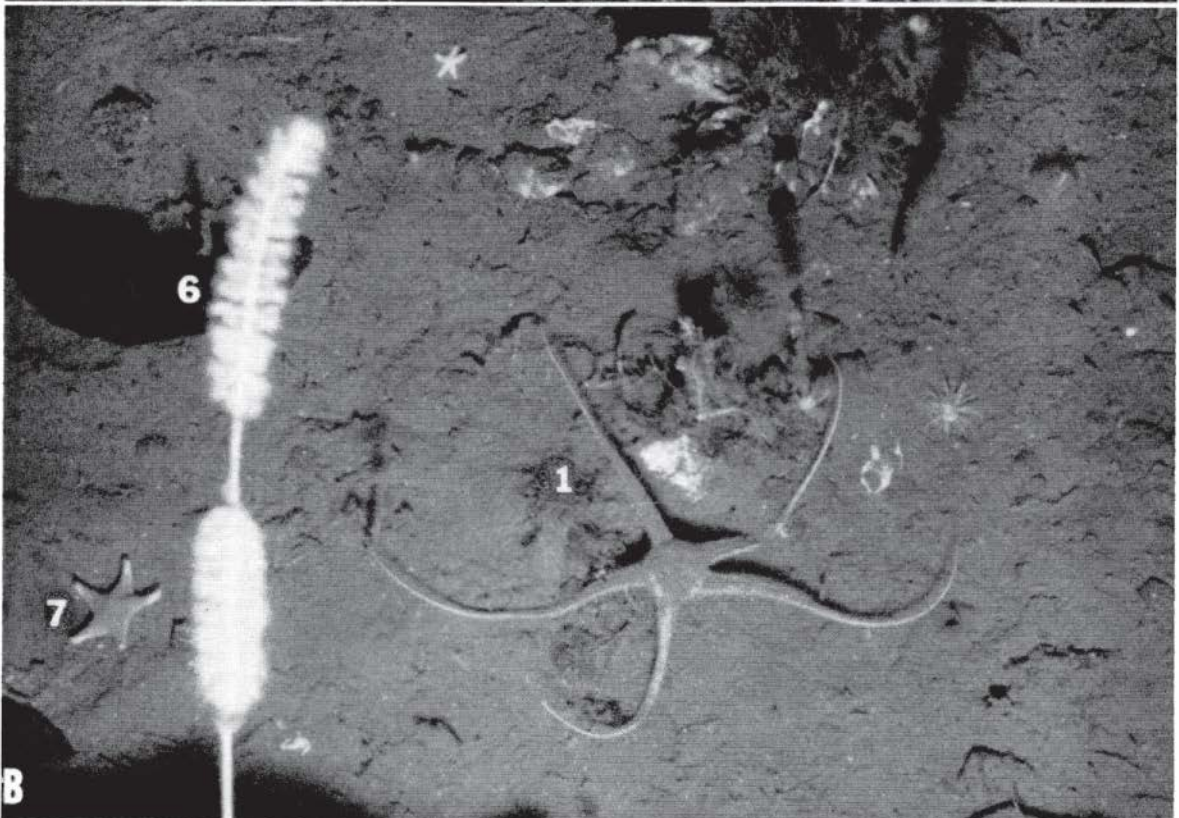
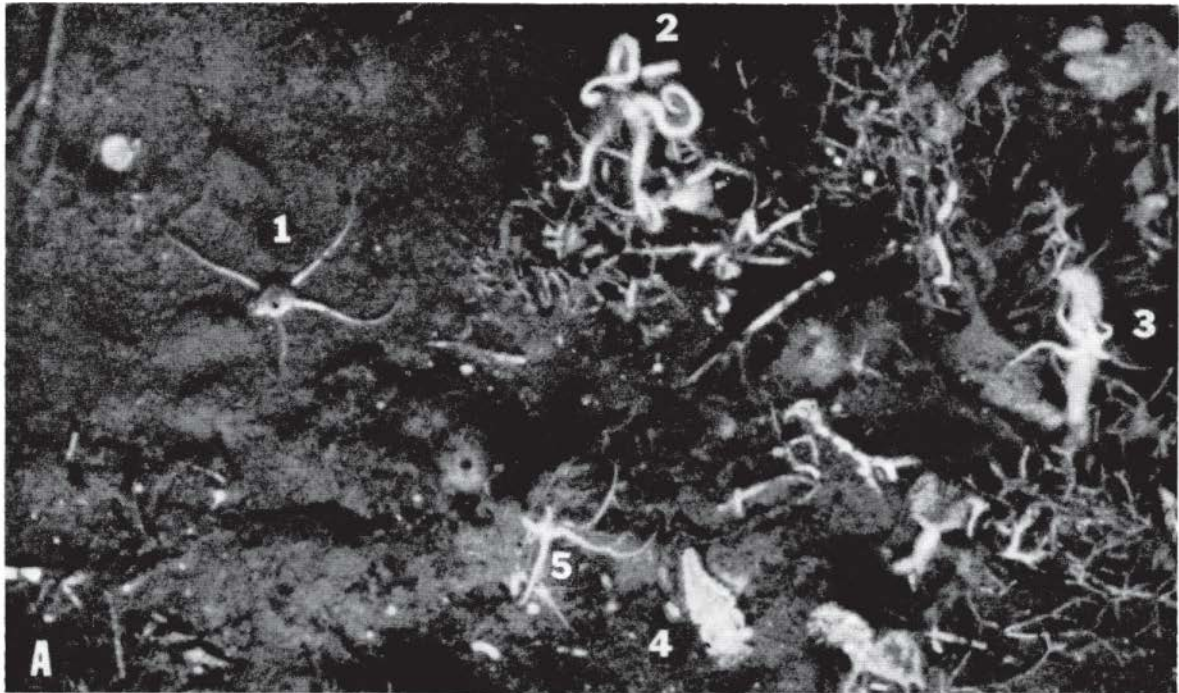


Photo: J. S. Bullivant

PLATE 1

PLATE 2

Underwater photographs illustrating general ecology of Antarctic Ophiuroidea

a. Sta. A538, McMurdo Sound, depth 260 m. Monochrome enlargement of portion of a colour transparency (serial No. A538/4). The area visible is approximately 40 cm across.

1. **Ophioceres incipiens**, apparently "fishing" with three arms while the other two arms have a scissors grip on the stem of the colonial hydroid it has ascended. Compare the euryalid-like spiral twisting of the right upper arm with pl. 9, fig. 2.

5. Terminal branches of the hydroid.

7. Erect sponge behind the hydroid.

b. Inset, for comparison, and on the same scale, the individual of **Ophioceres incipiens** seen in pl. 1, fig. A.

c. Sta. A528, Pennell Bank, depth 274–264 m. Enlargement of portion of original monochrome photograph. The area visible is approximately 15 cm across the lower margin. Ophiuroids are seen creeping across an association of polyzoa.

3. **Ophiurolepis** sp. (either **martensi** or juvenile **gelida**).

4. **Ophiurolepis gelida**, identifiable by its heavy infestation of *Iophon radiatus*.

d. Sta. A528, Pennell Bank, depth 274–264 m. Enlargement to same scale as fig. c of another portion of the same monochrome photograph. Area visible approximately 25 cm across lower margin.

2. **Amphiura belgicae**.

3. **Ophiurolepis** sp. (either **martensi** or **gelida**).

6. Tentacles of a dendrochirote holothurian.

Other ophiuroids visible in the photographs have not been identified, but **Ophiacantha pentactis** has been recognised on another part of the negative not clear enough for reproduction.

Figures c and d are of interest in showing that amphiuroids below the photic zone are not cryptozoic, even though abundant shelter is available.



Photo: J. S. Bullivant

PLATE 2

PLATE 3

a, c. Two portions reproduced in monochrome of an original colour transparency (serial No. A538/5) showing the maximum density of ophiuroid populations observed on the Ross Sea floor, at Sta. A538, McMurdo Sound, depth 260 m. The area shown in (a) is approximately 40 cm across the lower margin. The area shown in (c) is enlarged to same scale, but lies further into the background, so that it would measure approximately 60 cm across the lower margin. Fig. b, inset, is a small portion of the same photograph, lying in the middle distance. The identifications are as follow:

1. **Ophiacantha antarctica** (Lyman). The specimen at the lower right is creeping across a large sponge (3), and shows in the original photograph the dark disc and light arms of this species.

2. **Ophioceres incipiens** in characteristic euryalid-like attitudes. Most are creeping over polyzoa, but the inset photograph (b) shows one which is "fishing" from the tube of a polychaete which it has ascended.

4. **Ophiurolepis** sp. feeding in detritus.

In the complete photograph taken at this station (A538/5) at least 22 individual ophiuroids are seen on an area approximately 75 cm across the foreground and 1 m deep, indicating that population densities in excess of $10^2/\text{km}^2$ can occur locally. The commonest species at this station appears to be *Ophioceres incipiens*, identifiable in the original colour film by its blue-grey disc and semi-prehensile arms of lighter shade.

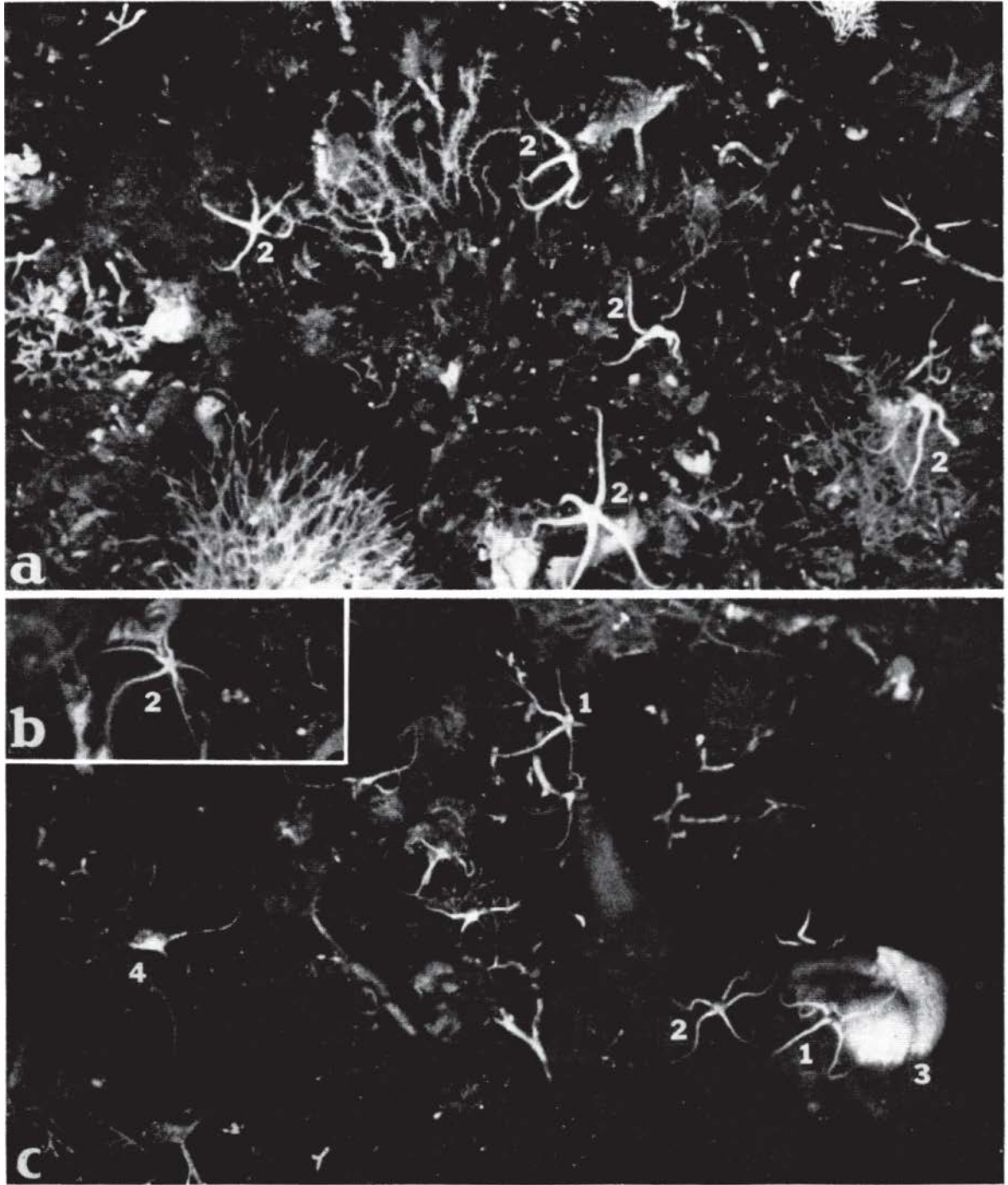


Photo: J. S. Bullivant

PLATE 3

PLATE 4

***Euvondrea floretta* Fell** (page 64)

1. Holotype, aboral aspect. Sta. A523, disc 9 mm diam.
2. Holotype, adoral aspect.
- 3, 4. Juvenile paratypes. Sta. A523. 3. in aboral aspect, disc 3·8 mm diam; 4. in adoral aspect disc 4 mm diam.

All specimens are uniformly enlarged.

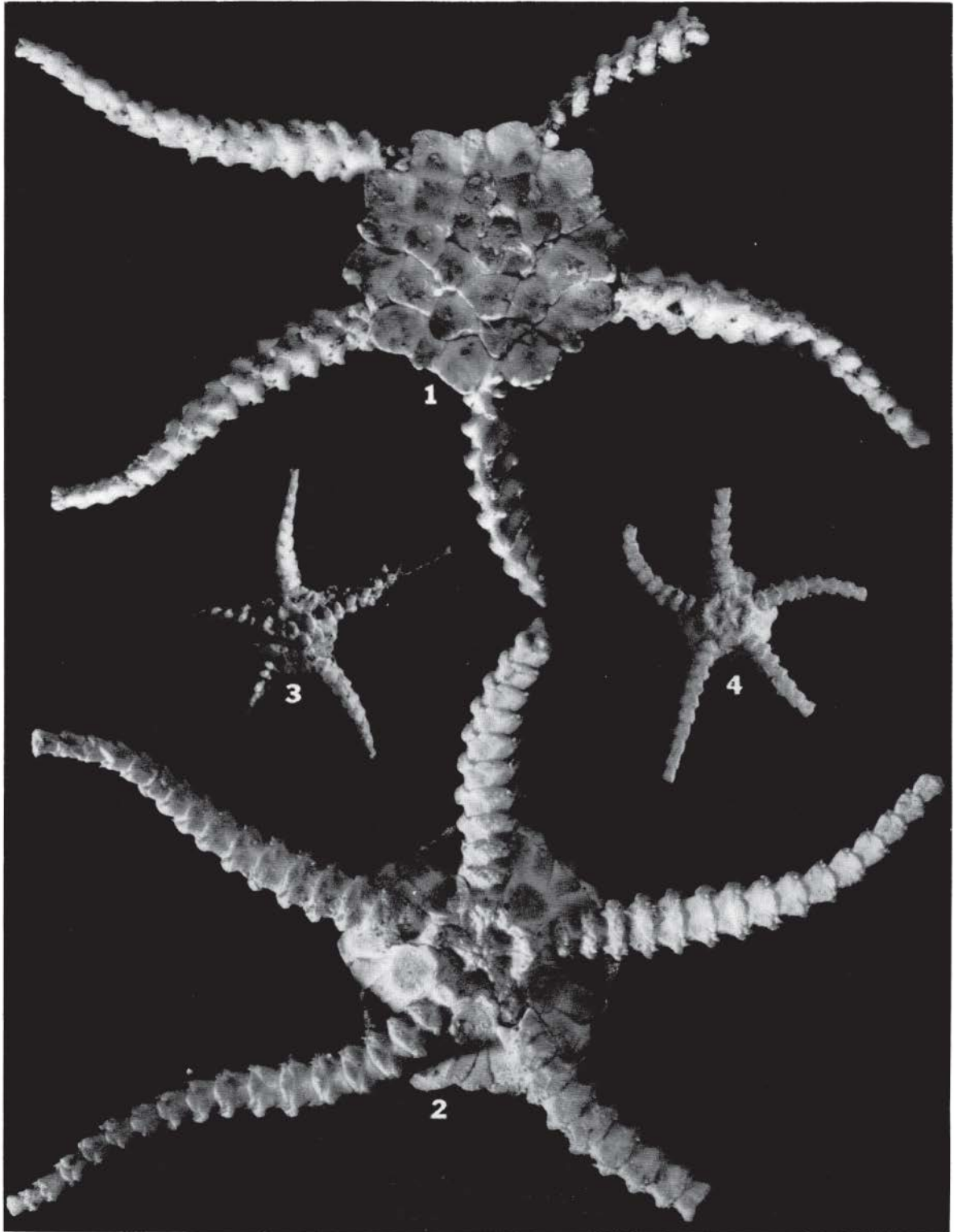


Photo: M. D. King

PLATE 4

PLATE 5

Ophiosteira echinulata Koehler (page 67)

- 1, aboral and 2, adoral aspects of specimen from Sta. A468, measuring 4.1 mm across the disc, for comparison with *Ophiosteira bullivanti* of same size.
- 3, aboral aspect of young individual showing early development of intercalary plates between radials and centrodorsal.

Ophiosteira bullivanti Fell (page 67)

- 4, aboral and 5, adoral aspects of holotype from Sta. A526, measuring 4.1 mm across the disc.

All specimens on this plate are uniformly enlarged.

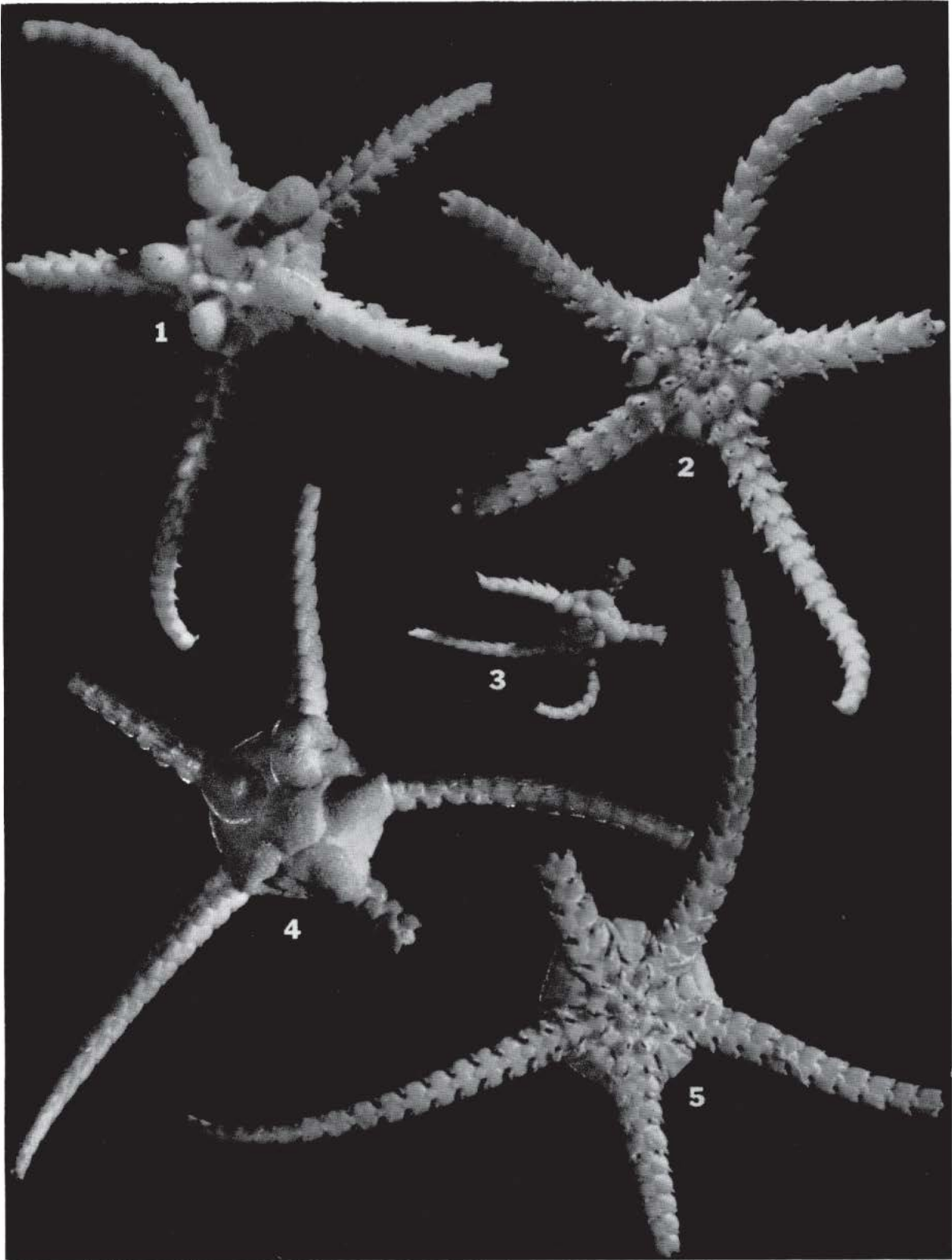


Photo: M. D. King

PLATE 5

8*

PLATE 6

Ophiodaces inanis Koehler (page 35)

1, adoral and 4, aboral aspects of specimen from Sta. A466, measuring 6.5 mm across the disc.

Ophiopyren regularis Koehler (page 45)

2, adoral and 3, aboral aspects of specimen from Sta. A525, measuring 10 mm across the disc.

All specimens on this plate are uniformly enlarged.

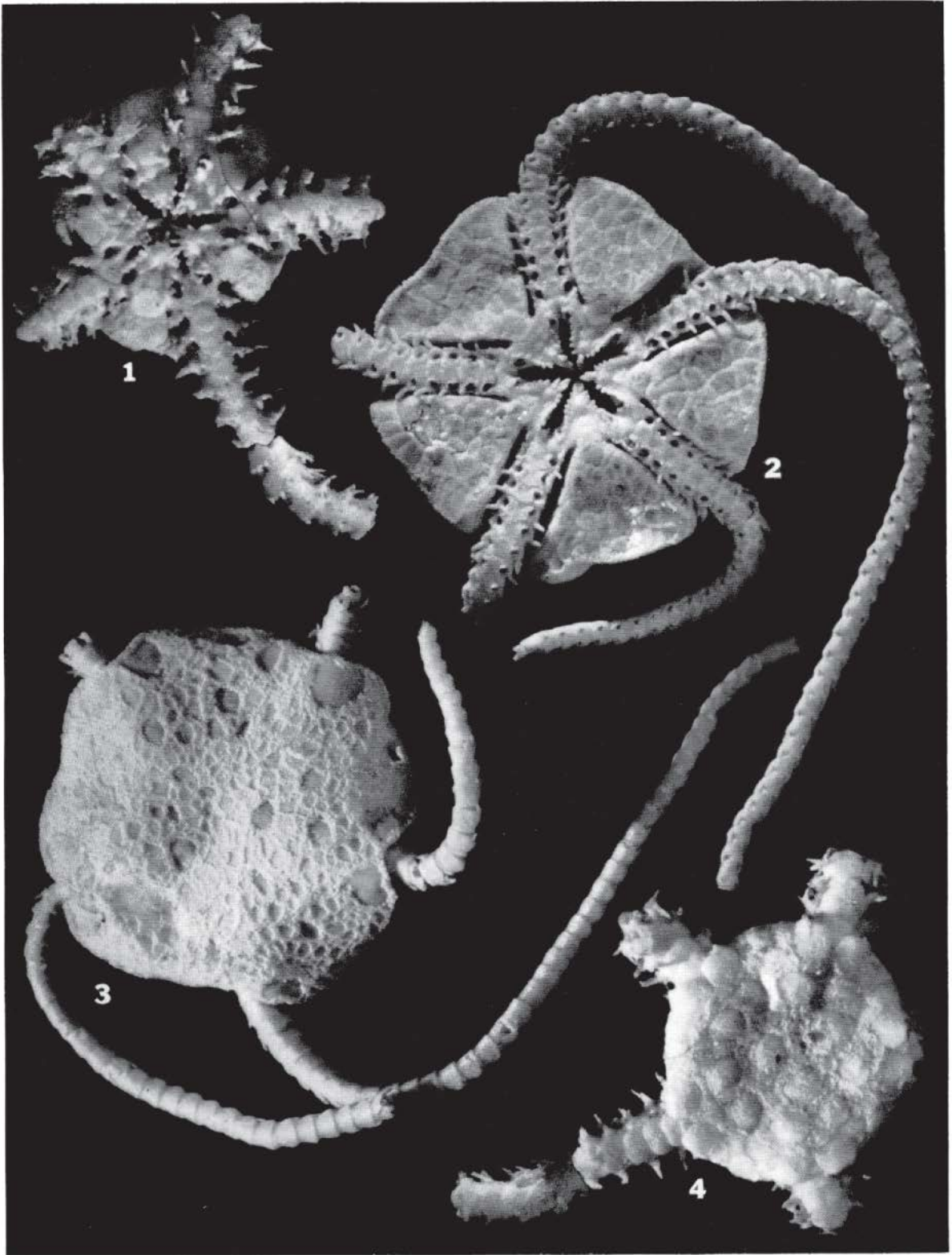


Photo: M. D. King

PLATE 6

PLATE 7

Glaciacantha jason Fell
(page 36)

1, aboral and 2, adoral aspects of holotype from Sta. GLD-15, measuring 9 mm across the disc.

Ophiura flexibilis (Koehler)
(page 52)

3, aboral and 6, adoral aspects of specimen from Sta. A450, measuring 6.8 mm across the disc.

Theodoria relegata (Koehler)
(page 56)

4, aboral and 5, adoral aspects of specimen from Sta. A460, measuring 10 mm across the disc.

All specimens on this plate are uniformly enlarged.

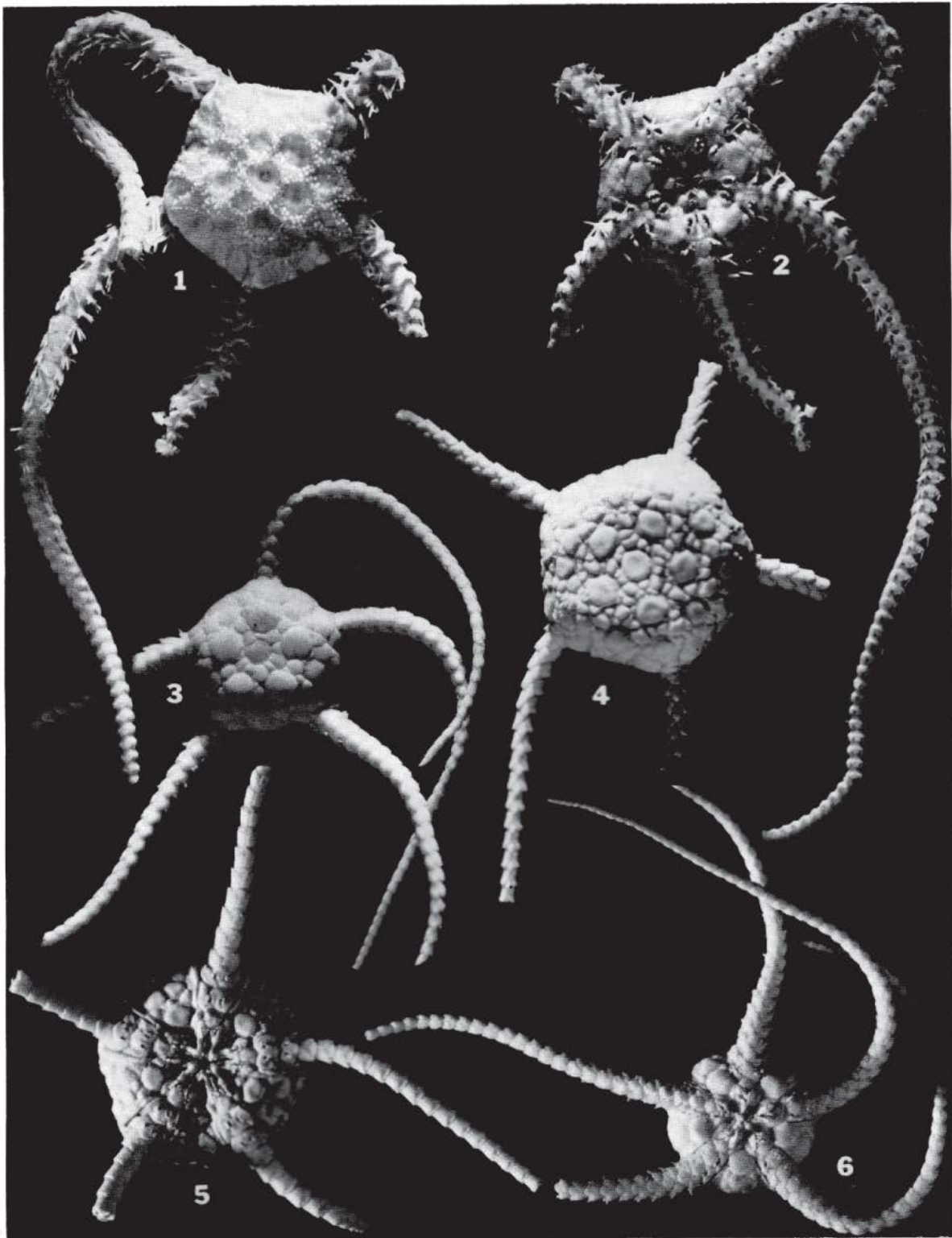


Photo: M. D. King

PLATE 7

PLATE 8

Ophiosteira bullivanti Fell (page 67)

- 1, juvenile specimen in aboral aspect, measuring 3 mm across the disc, a paratype from Sta. A526. This specimen is enlarged to exactly the same scale as fig. 3 on pl. 5: note delayed appearance of intercalary plates in *O. bullivanti*.

Ophiosteira antarctica Bell (page 65)

- 2, aboral and 3, adoral aspect of specimens measuring 10.0 and 10.5 mm across the disc, both specimens from Sta. A448.

Ophiocten megaloplax Koehler (page 49)

- 4, aboral and 6, adoral aspects of specimens measuring 4.5 and 5.0 mm across the disc, both from Sta. A448.

Ophiosteira echinulata Koehler (page 67)

- 5, aboral aspect of large specimen from Sta. A468, measuring 7.5 mm across the disc.

Fig. 1, 4, and 6 are to the same scale; and fig. 2 and 3 are to the same scale.

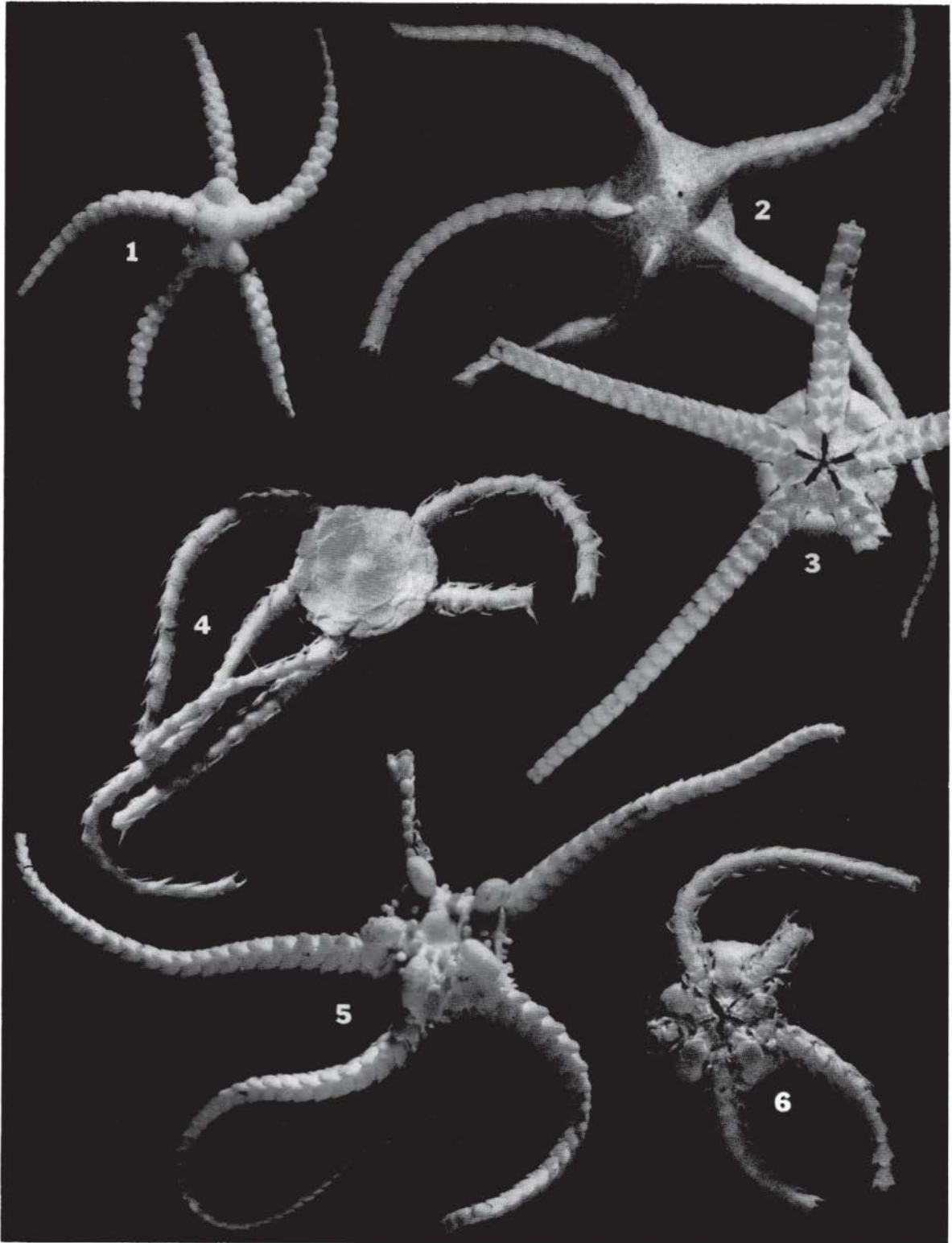


Photo: M. D. King

PLATE 8

PLATE 9

Ophiuroglypha carinifera (Koehler) (page 54)

1, left, aboral and 1, above, adoral aspects of two specimens. The larger one, to the left, measures 13.5 mm across the disc and is from Sta. A456; the smaller, above, measures 12.0 mm across the disc and is from Sta. A528.

Ophioceres incipiens Koehler (page 69)

2, right, aboral aspect and 2, below, adoral aspect of a specimen measuring 8.5 mm across the disc, from Sta. A520.

Specimens carrying the same number are magnified to the same scale.

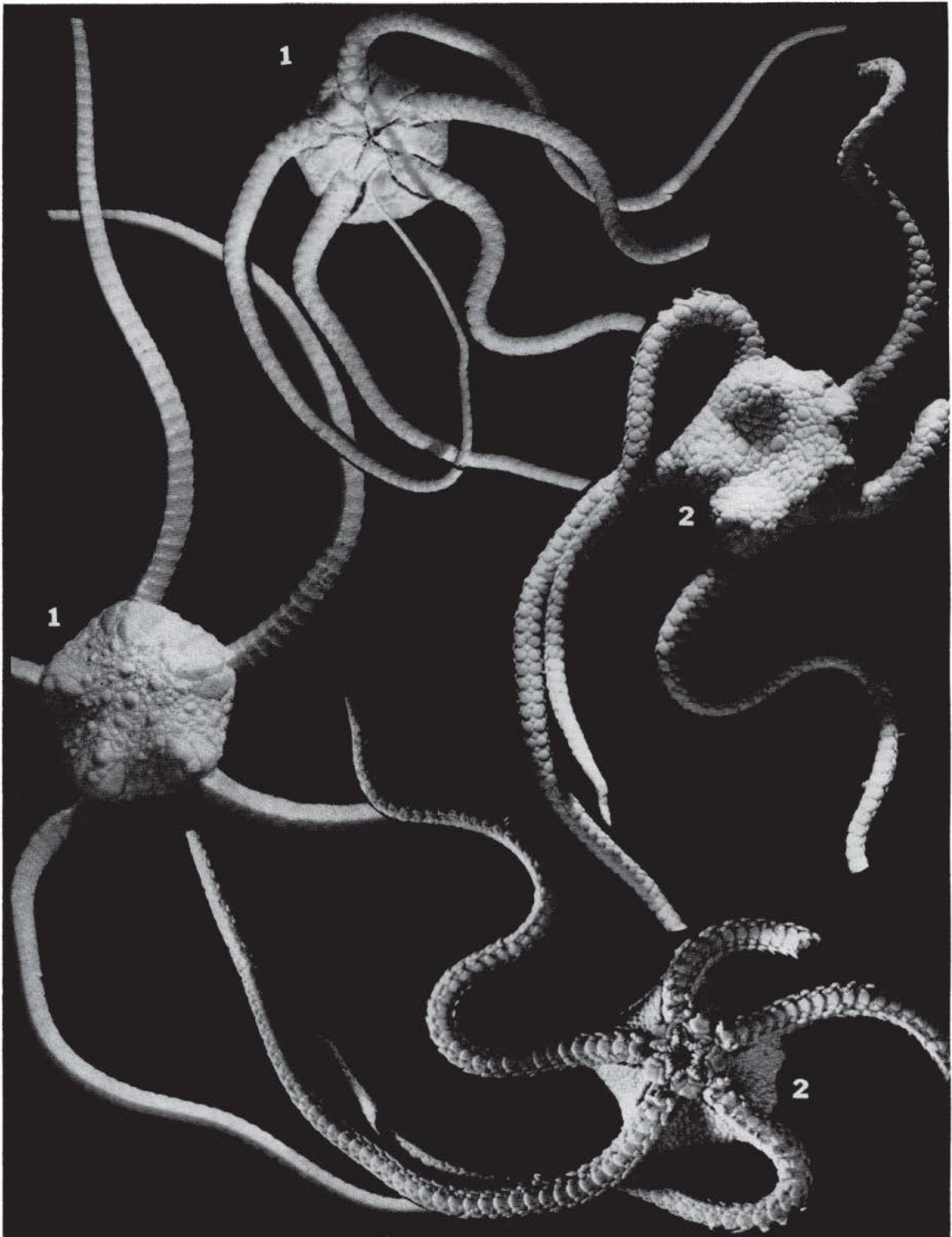


Photo: M. D. King

PLATE 9

PLATE 10

Known Ross Sea Euryalae all shown to the same scale. Details of smaller species are shown on pl. 11

***Astrotoma agassizii* Lyman** (page 26)

1. Specimen of average size. 18 mm across the disc, from Sta. A531.
2. Giant specimen. 57 mm across the disc, thickness of arm at base 12.5 mm, from Sta. EAD-3.
4. Specimen 32 mm across disc, with very long arms, from fishtrap at Hut Point (Ross Island) in 164 fm.

***Astrochlamys bruneus* Koehler** (page 28)

3. Solitary specimen, measuring 12 mm across disc, from Sta. A521.
7. Solitary specimen, 6.5 mm across disc, from Sta. A521.
8. Large specimen (15 mm across disc) presumed to be female, carrying presumed dwarf-male (9 mm across disc), from Sta. A521.

***Astrohamma tuberculatum* (Koehler)** (page 29)

- 5, adoral aspect and 6. lateral aspect, of two individuals, each 12 mm across the disc, from Sta. A465.



Photo: M. D. King

PLATE 10

PLATE 11

***Astrochlamys bruneus* Koehler** (page 28)

1. Solitary specimen. 12 mm across the disc, from Sta. A521.
4. Large specimen, presumed to be female (15 mm across disc), carrying presumed dwarf-male (9 mm across disc), from Sta. A521.
7. Solitary specimen. 6.5 mm across disc, from Sta. A521.

***Astrohamma tuberculatum* (Koehler)** (page 29)

2. lateral aspect and 5. adoral aspect, of two individuals, each 12 mm across the disc, from Sta. A465. Specimen 5 is enmeshed with part of an antipatharian coral upon which it probably lives.

***Ophiura crassa* Mortensen** (page 52)

3. adoral aspect and 6. aboral aspect. of two specimens, measuring each 5.0 mm across the disc, both from Sta. A455.

Fig. 1, 2, 4, 5, and 7 are to the same scale.

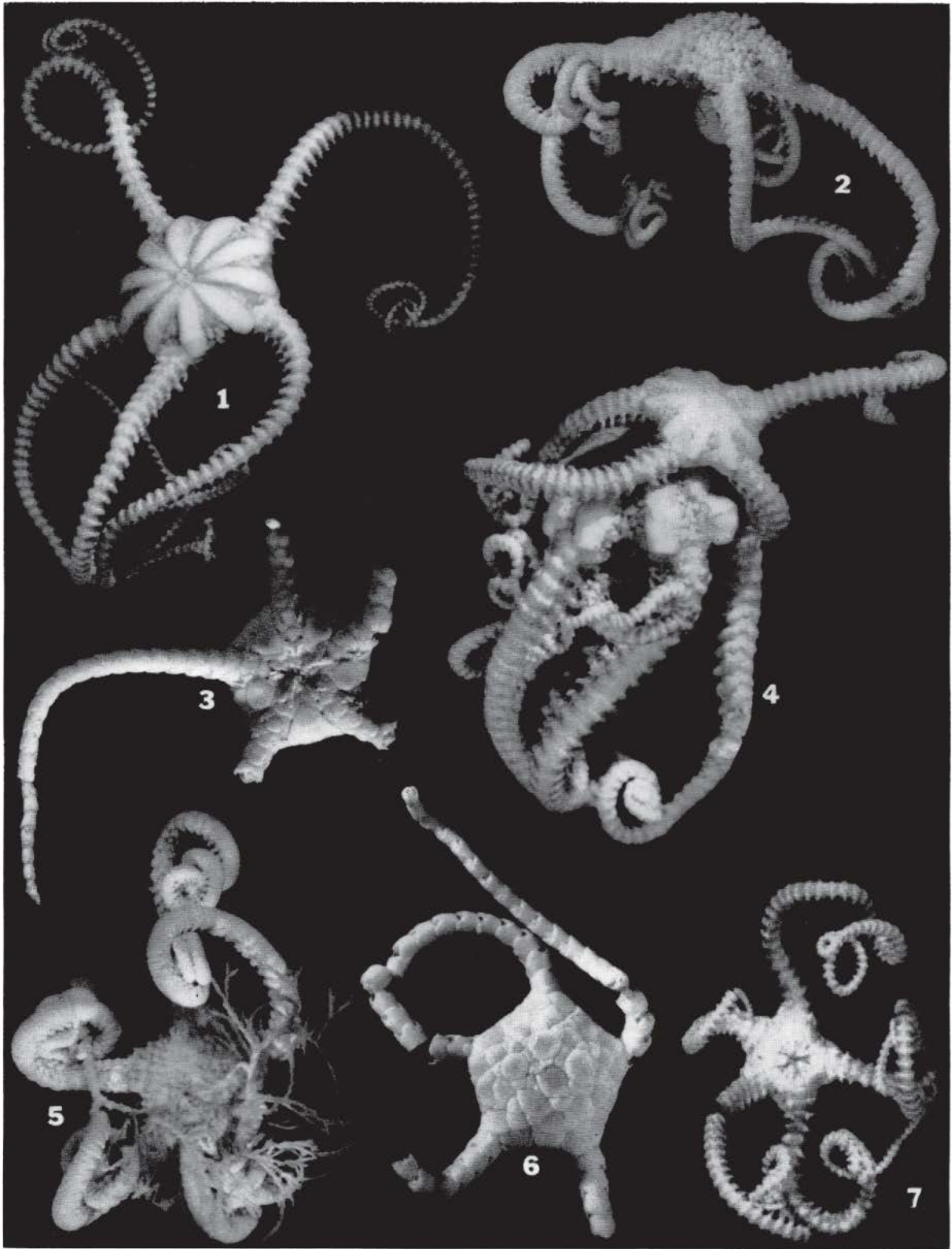


Photo: M. D. King

PLATE 11

PLATE 12

Ophiurolepis gelida (Koehler) (page 58)

1. Aboral aspect of large specimen 17 mm across disc, Sta. A530.
3. Aboral aspect of large specimen 15 mm across disc, heavily parasitised by the sponge *Iophon radiatus*, Sta. A519.
4. Aboral aspect of specimen with central thickenings on disc-plates, measuring 13.5 mm across disc, from Sta. A530.
5. Adoral aspect of specimen 14.0 mm across disc, from Sta. A530.

Ophiurolepis brevirima Mortensen (page 60)

2. Aboral aspect of specimen 11 mm across disc, from Sta. A529.

All specimens on this plate are uniformly enlarged, and to the same scale as for pl. 13.

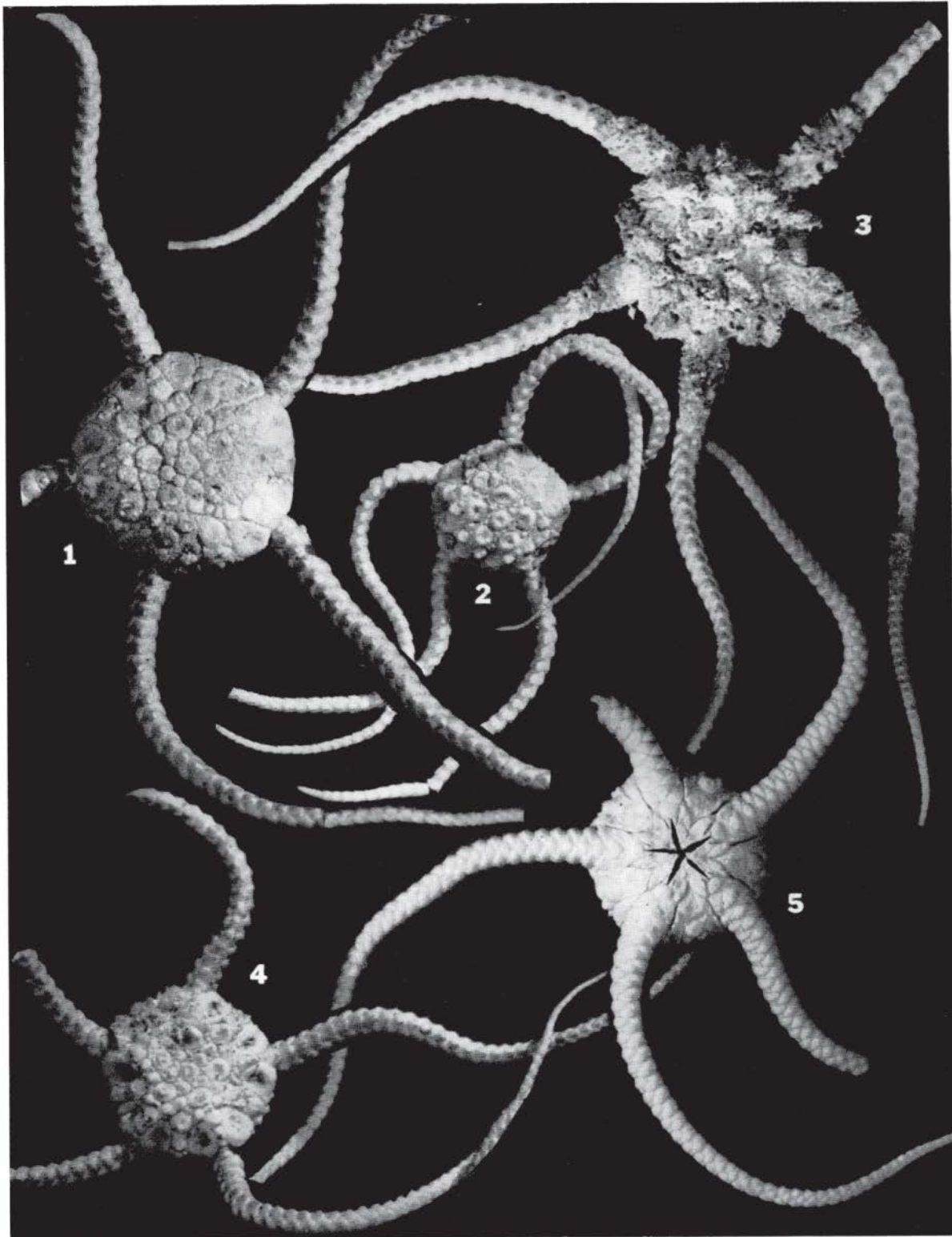


Photo: M. D. King

PLATE 12

PLATE 13

Ophiurolepis martensi (Studer) (page 61)

2. Aboral aspect of specimen 13·0 mm across disc, from Sta. A467.
5. Adoral aspect of specimen 11·0 mm across disc, from Sta. A467.

Ophiurolepis tuberosa (Mortensen) (page 62)

1. Adoral aspect of specimen 12·5 mm across disc, from Sta. A460.
4. Adoral aspect of specimen 8·0 mm across disc, from Sta. A460.

Ophiurolepis brevirima Mortensen (page 60)

3. Aboral aspect of specimen 13·5 mm across disc, from Sta. A459.
6. Adoral aspect of specimen 13·0 mm across disc, from Sta. A459.

All specimens on this plate are uniformly enlarged, and to the same scale as for pl. 12.

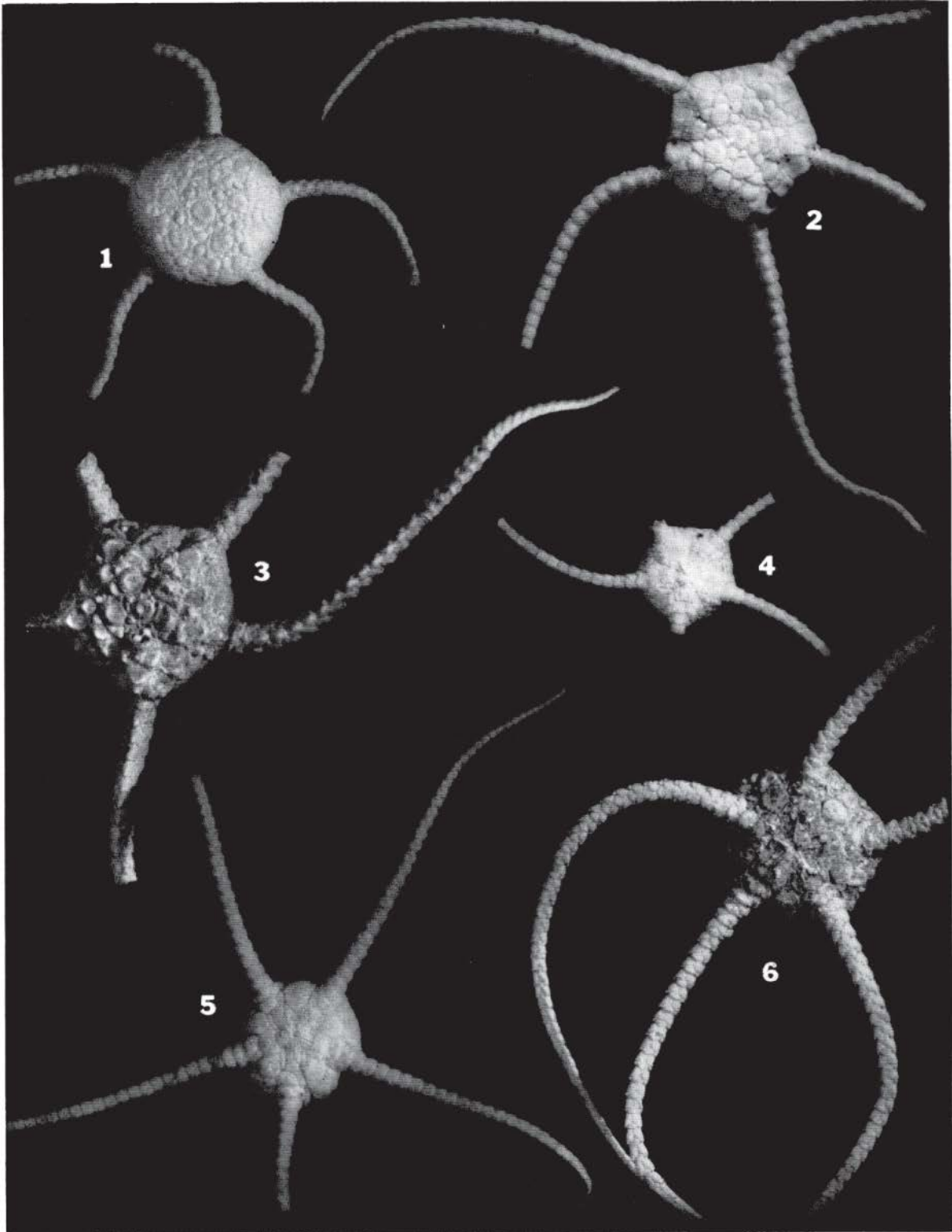


Photo: M. D. King

PLATE 13

PLATE 14

Ophiacantha pentactis Mortensen (page 31)

1. Aboral aspect of specimen 16 mm across the disc, from Sta. A455.

Ophiacantha vivipara Ljungman (page 30)

2. Aboral aspect of specimen 12.0 mm across disc, from Sta. A538.

Ophiura ambigua (Lyman) (page 51)

3. 6. Aboral aspects of specimens 16.0 and 11.5 mm across the disc, from Sta. A527 (fig. 3), and Sta. A454 (fig. 6).

Ophionotus victoriae Bell (page 47)

5. Aboral aspect of specimen 21 mm across disc, from Sta. A516.

Ophiosparte gigas Koehler (page 34)

4. Aboral aspect of specimen 40 mm across the disc, from Sta. GLD-15.

Ophiacantha antarctica Koehler (page 32)

7. Aboral aspect of specimen 8.5 mm across disc, from Sta. A461.

All specimens on pl. 14 and 15 are enlarged uniformly.



Photo: M. D. King

PLATE 14

PLATE 15

Ophiacantha vivipara Ljungman (page 30)

1. Adoral aspect of specimen 12.0 mm across disc, from Sta. A538.

Ophiacantha pentactis Mortensen (page 31)

2. Adoral aspect of specimen 16 mm across the disc, from Sta. A455.

Ophiosparte gigas Koehler (page 34)

3. Adoral aspect of a specimen 40 mm across the disc, from Sta. GLD-15.

Ophiura ambigua (Lyman) (page 51)

- 4, 5. Adoral aspect of specimens 11.5 mm and 16.0 mm across the disc, from Sta. A527 (fig. 4), and Sta. A454 (fig. 5).

Ophiacantha antarctica Koehler (page 32)

6. Adoral aspect of specimen 8.5 mm across the disc, from Sta. A461.

Ophionotus victoriae Bell (page 47)

7. Adoral aspect of specimen 21 mm across the disc, from Sta. A516.

All specimens on pl. 14 and 15 are enlarged uniformly.

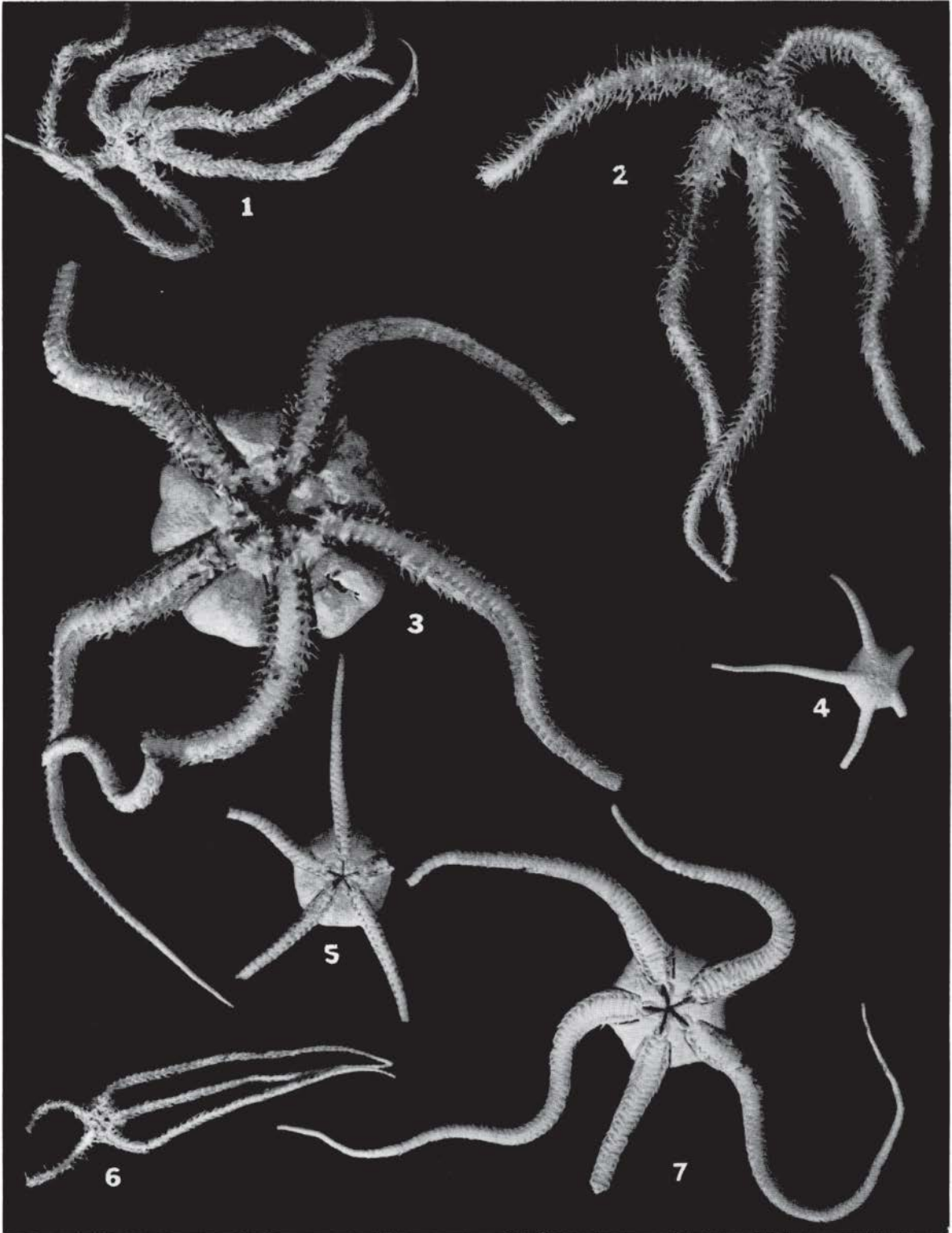


Photo: M. D. King

PLATE 15

PLATE 16

Toporkovia antarctica (Lyman)
(page 43)

1. Aboral aspect of specimen 10 mm across the disc, from Sta. A449.

Amphiura algida Koehler
(page 40)

2. Adoral aspect of specimen 4.0 mm across the disc, from Sta. CEK.

Amphiodia joubini (Koehler)
(page 40)

3. Aboral aspect of specimen 9.0 mm across disc, from Sta. A530.

Amphiura belgicae
(page 38)

4. Aboral aspect of specimen 9.0 mm across disc, from Sta. A457.

All specimens on pl. 16 and 17 are enlarged uniformly.



Photo: M. D. King

PLATE 16

PLATE 17

Toporkovia antarctica (Lyman)
(page 43)

1. Adoral aspect of specimen 10 mm across the disc, from Sta. A449.

Amphiura algida Koehler
(page 40)

2. Aboral aspect of specimen 4·0 mm across the disc, from Sta. CEK.

Amphiura belgicae Koehler
(page 38)

3. Adoral aspect of specimen 9·0 mm across the disc, from Sta. A457.

Amphiodia joubini (Koehler)
(page 40)

4. Adoral aspect of specimen 9·0 mm across the disc, from Sta. A530.

All specimens on pl. 16 and 17 are enlarged uniformly.

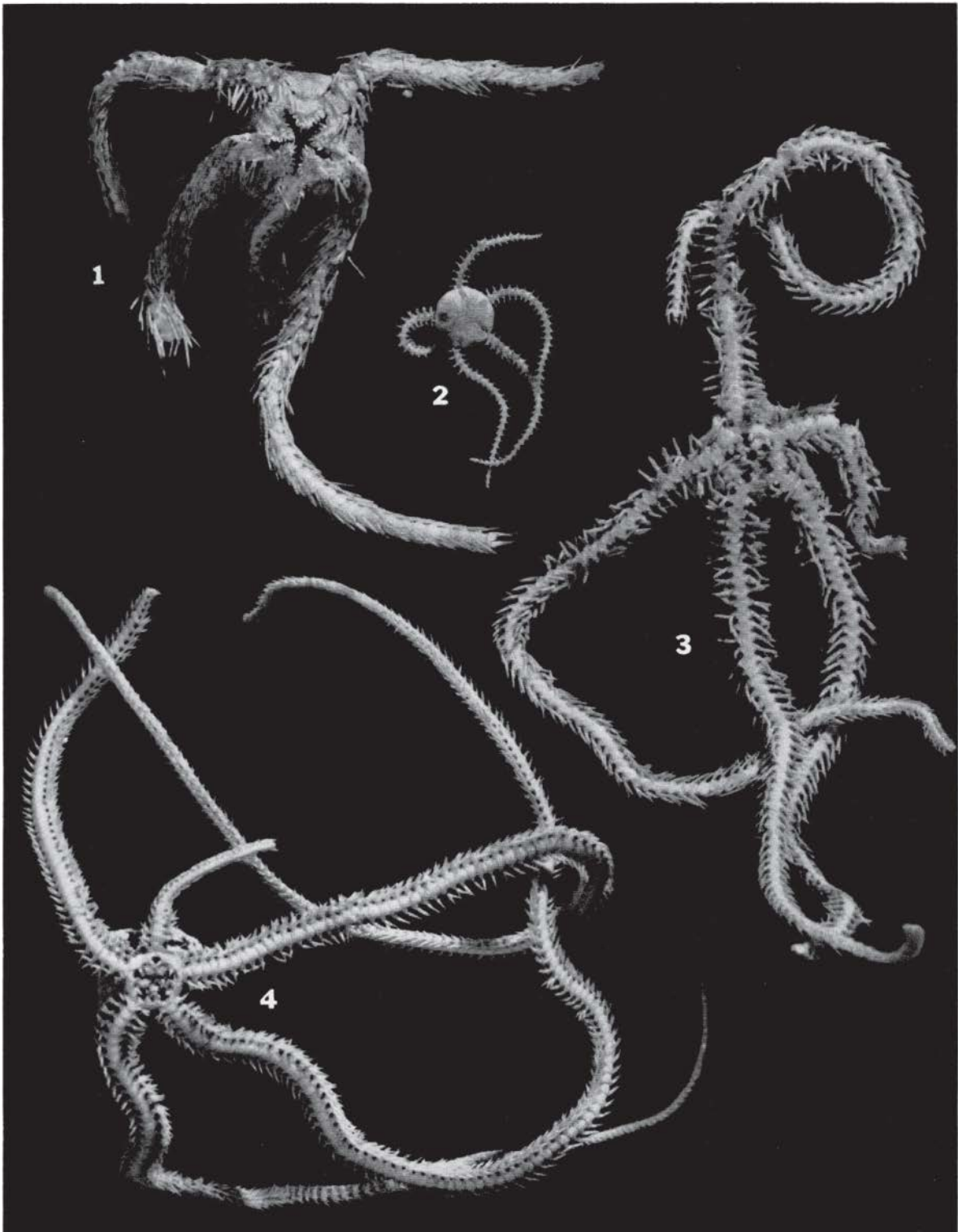


Photo: M. D. King

PLATE 17

PLATE 18

Toporkovia antarctica (Lyman) (page 43)

1. Details of adoral aspect of disc of specimen 10 mm across disc, from Sta. A449

Amphiura algida Koehler (page 40)

2. Aboral aspect of specimen 4.0 mm across the disc, from Sta. CEK.

Ophiura ambigua (Lyman) (page 51)

3. Adoral aspect of specimen 16 mm across the disc, from Sta. A454.

Astrotoma agassizii Lyman (page 26)

4. Adoral aspect of specimen 18 mm across disc, from Hut Point, Ross Island, in 164 fm

Ophionotus victoriae Bell (page 47)

5. Adoral aspect of specimen 21 mm across the disc, from Sta. A516.

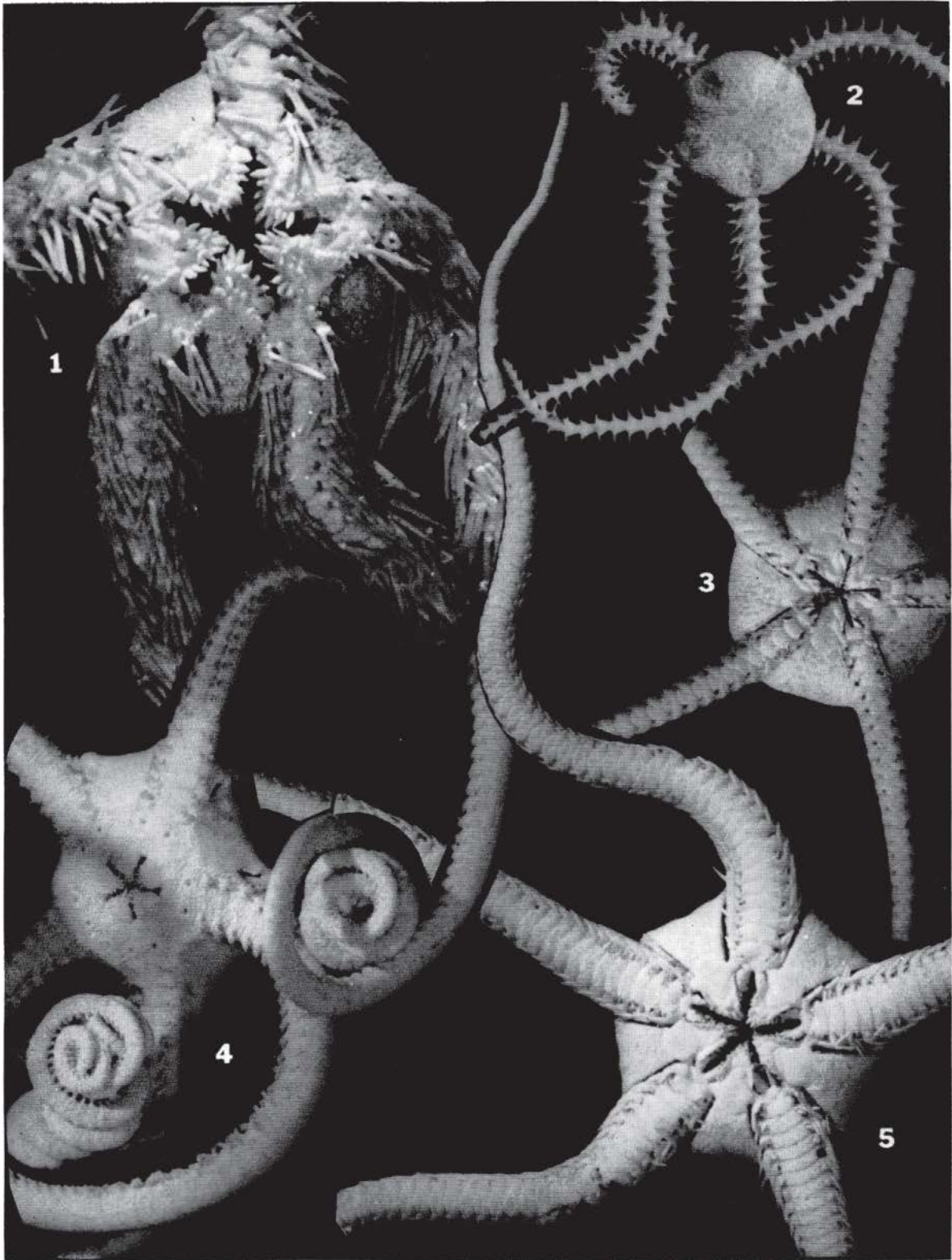


Photo: M. D. King

PLATE 18

PLATE 19

Ophiomastus bispinosus Mortensen
(page 53)

- 1, aboral and 3, adoral aspects of specimen measuring 6.0 mm across the disc, from Sta. A464.
2, aboral and 4, adoral aspects of specimen measuring 4.0 mm across the disc, from Sta. A464.

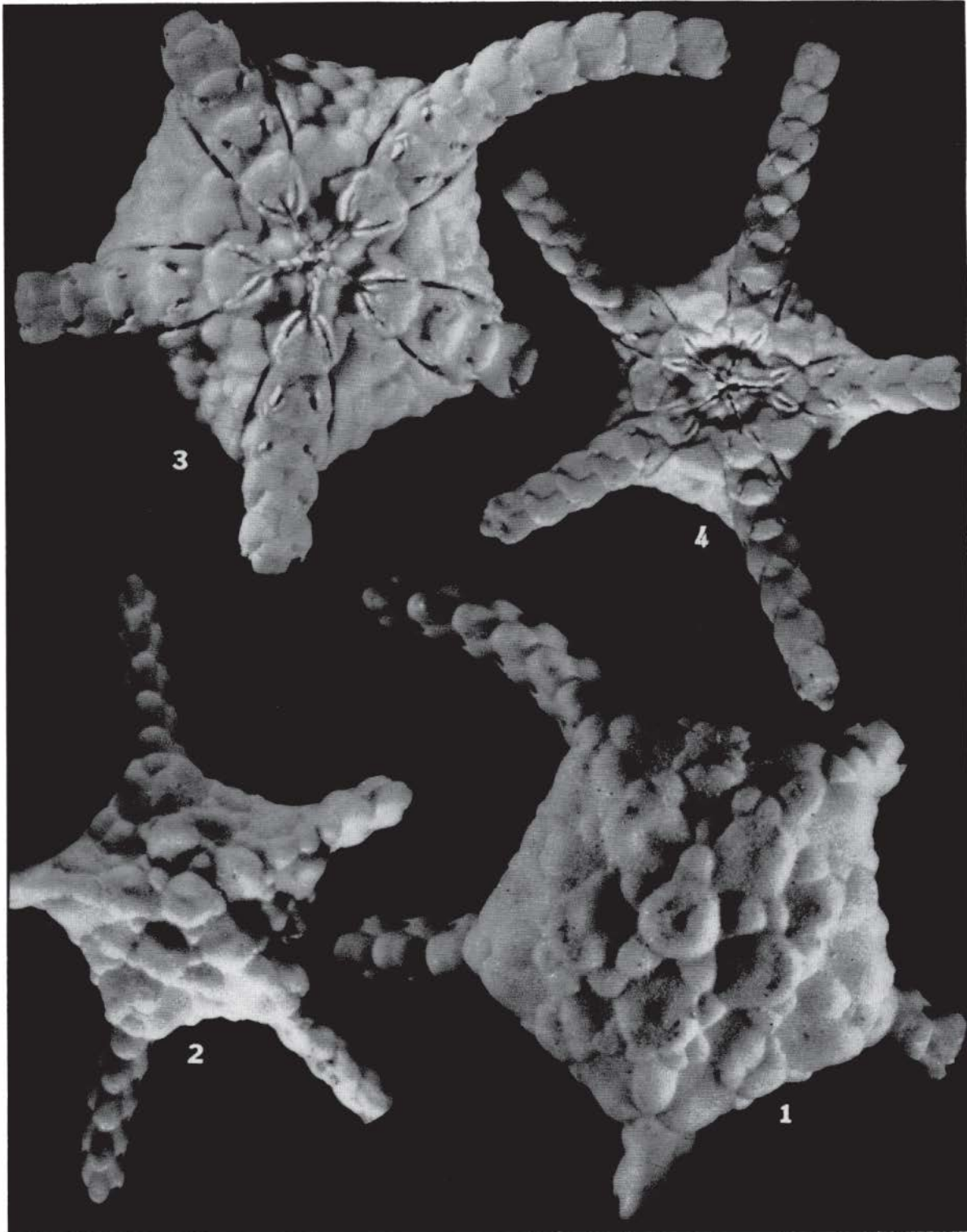


Photo: M. D. King

PLATE 19