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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BULLETIN 151

The Fauna of the Ross Sea

PART 3

Asteroidea

by

HELEN E. SHEARBURN CLARK

New Zealand Oceanographic Institute

Memoir No. 21

1963

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Photo: U.S. Navy

USS *Glacier* breaking through ice in McMurdo Sound; Mt. Erebus in the background. Collections of some of the Asteroids considered in the present memoir were made from *Glacier* by both Stanford University and Trans-Antarctic Expedition biologists.

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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. Further small collections were made in 1960–61 by G. A. Harlen, A. E. Gilmour, and S. C. Watts of the Institute staff and C. E. Devine, D. W. Farmer, and M. R. Gregory of Antarctic Division, D.S.I.R.

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 Miss Clark 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, as in Professor Fell's on the Ophiuroidea, 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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Asteroidea of the Ross Sea

by HELEN E. SHEARBURN CLARK, M.Sc.

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New Zealand

Abstract

Nearly 800 specimens of asteroids were collected from 82 Ross Sea stations between the shore and 1,375 m. Altogether 25 genera are recorded. Of these, one is a new genus and nine are new records for the Ross Sea. Of the 31 species, 19 are new records and four new taxa. Thirteen species enter the Magellanic region, and their distribution suggests they have migrated by way of the Palmer Archipelago. None of these species is known to be present in New Zealand or Australia, a fact which suggests there has been no effective benthal migration route between Australasia and Antarctica since early Tertiary (Eocene) times. These conclusions agree with data derived from the other echinoderm groups represented in New Zealand, Australia, Antarctica, and the Magellanic region. Only one genus of asteroid is shared by New Zealand, Antarctica, and the Magellanic region and no genera are shared by New Zealand and Antarctica alone. There are, however, at least four genera common to Antarctica and the Magellanic region. It is obvious that the New Zealand fauna is unrelated to that of Antarctica. Many of the Antarctic genera are characterised by the direct development of the young which are often "brooded" by the adult.

The underwater photographs of the Ross Sea shelf reveal some ecological details, which are discussed.

INTRODUCTION

The Ross Sea, extending roughly between 155° W and 170° E, covers nearly 664,450 square nautical miles. It is bounded to the west by Marie Byrd Land and to the east by South Victoria Land while the Ross Ice Shelf extends to nearly 78° S. The echinoderm fauna is rich, with some very extraordinary genera; and the relationship of the Ross Sea asteroid fauna to the Bellingshausen Sea, Weddell Sea, and South American waters is of particular interest.

Most of the Asteroidea discussed in this report were collected during two cruises of HMNZS *Endeavour* in connection with Ross Sea surveys carried out by the New Zealand Oceanographic Institute under the direction of Mr. J. W. Brodie. Besides biological work, physical and oceanographical studies were undertaken. The first cruise involved a survey of the Ross Sea, between 9 and 27 January 1959, under the leadership of J. S. Bullivant who was also responsible for photography. Others in the party were: 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 important assistance. A second cruise in January and February 1960, again under the leadership of J. S. Bullivant who was responsible

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for photography, included sea seismic and oceanographic work; Messrs E. C. French and G. A. Harlen were technical officers. A further cruise in January and February 1961, under the leadership of G. A. Harlen, with A. E. Gilmour, C. E. Devine, D. W. Farmer, M. R. Gregory, and S. C. Watts, resulted in the collection of more asteroids.

During the Trans-Antarctic (New Zealand) Expedition of 1956–58 a number of asteroids were collected by Dr. R. W. Balham from the HMNZS *Endeavour* and USS *Glacier*. Others were collected from holes made in the ice. In this work, Dr. Balham was ably assisted by R. E. Barwick; and the inshore specimens of this collection provide valuable data for studies on distribution. The details of these collections are given separately under "Material Examined" in each section.

Further material was collected by John H. Dearborn, who also supplied valuable photographs taken during the course of a Stanford University biological programme, under the leadership of Dr. Donald Wohlschlag, supported by grants from the United States National Foundation.

PREVIOUS WORK

The first collection of asteroids from the Ross Sea was made between 1898 and 1900 when the *Southern Cross* Antarctic Expedition, under the leadership of C. E. Borchgrevink, spent the winter on the mainland; collections were made at Cape Adare and Franklin Island at depths of 10 and 30 fathoms. Bell (1902) recorded three species:

Asterias antarctica
Asterodon grayi
Cycethra simplex

The first is now included in the genus *Diplasterias* and is a very common Antarctic echinoderm, the second is probably a species of *Acodontaster*, and the third is probably referable to *Cycethra verrucosa*.

Under the leadership of Captain R. F. Scott in the *Discovery*, extensive collections were made during the National Antarctic Expedition of 1901–04. Bell (1908) recorded eight species. Of these *Cycethra verrucosa* is an incorrect identification and *Asterias longstaffi* is apparently a nomen nudum or may belong in *Psilaster*. The remaining six new records were:

Asterias brandti
Heuresaster hodgsoni
Pentagonaster incertus
Leptoptychaster kerguelenensis
Henricia ornata

The first is now referred to the genus *Diplasterias*, the second to *Acodontaster*, the third to *Pergamaster*, the fourth is now a synonym of *Macroptychaster accrescens*, *Henricia* is probably an incorrect identification, and the specimen is probably a species of *Crossaster*.

Six species of asteroids were taken by the British Antarctic Expedition of 1907–09 under the leadership of E. H. Shackleton in the *Nimrod*. All specimens are from Cape Royds on Ross Island. Koehler (1911) recorded the following species:

Odontaster validus
Cryaster antarcticus
Porania antarctica
Coscinasterias brucei
Coscinasterias victoriae
Notasterias armata

These are common asteroids of the Ross Sea, especially the first, third, fourth, and fifth. These last two are now included in the genus *Diplasterias* while the second is now a recognised synonym of *Perknaster fuscus antarcticus*.

Sten Wallin collected two species of asteroids when he accompanied a whaling expedition to the Ross Sea in 1924, and these were recorded by Mortensen (1925):

Ripaster charcoti
Gnathaster elegans

The first belongs in the genus *Perknaster* and the second to *Odontaster*.

Between the years 1925–36 several expeditions in the *Discovery*, the *Discovery II*, and the *William Scoresby* were present in subantarctic and Antarctic waters including the Ross Sea. Fisher, in the

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Discovery reports, records the following species new to the Ross Sea:

Leptychaster flexuosus
Bathybiaster loripes obesus
Luidiaster gerlachei
Kampylaster incurvatus
Cuenotaster involutus
Paralophaster godefroyi meseres
Peribolaster macleani
Lysasterias joffrei

Several American expeditions were present in the Ross Sea in subsequent years but no additions to the asteroid fauna were recorded.

Thus, at the time of this report, the Ross Sea Asteroid fauna comprised 21 species of asteroids referred to 16 genera. These few hundred specimens had been collected mainly from shore stations, often under very difficult conditions. Most of the specimens, including the holotypes, are in the custody of the British Museum.

SCOPE

The accompanying map, showing stations from which asteroids were collected, is compiled from data supplied by J. S. Bullivant and J. H. Dearborn. Altogether nearly 800 specimens were collected. Some of the immature specimens are not discussed.

ACKNOWLEDGMENTS

I am very grateful to the many people who have assisted me during the writing of this report; in particular I wish to thank Professor H. B. Fell for his encouragement and guidance, and for allowing me to use the maps at the end of this work; Mr J. S. Bullivant of the Oceanographic Institute for his ready advice and his valuable underwater photographs and colour photographs of trawl samples on deck; Mr J. H. Dearborn of Stanford University for similar help and colour photographs, and Dr. R. W. Balham and Mr R. E. Barwick for the detailed colour notes included with their collections. Mr M. D. King has spared no efforts to obtain the excellent photographs included in this report and I am most grateful to him. Miss A. M. Clark of the British Museum (Natural History) has also been most kind in forwarding specimens for comparison and in answering numerous requests. Both Miss M. Wood of the Royal Society of New Zealand and Miss A. Art of the Victoria University Library have been most helpful in obtaining many rare references.

ATLAS

The photographs accompanying this report were taken by Mr M. D. King of the Victoria University of Wellington; they represent an almost complete atlas of known Ross Sea asteroids and include both the abactinal and actinal surfaces. These photographs are of dried material, as this, in general, illustrates the diagnostic characters best. This must be remembered when comparing fresh material, and identifications should be checked against dried spirit specimens. In general, typical examples have been illustrated, and in some instances where there are marked differences due to growth these also have been illustrated. The actual size of the specimens is noted beside the identification on the facing page.

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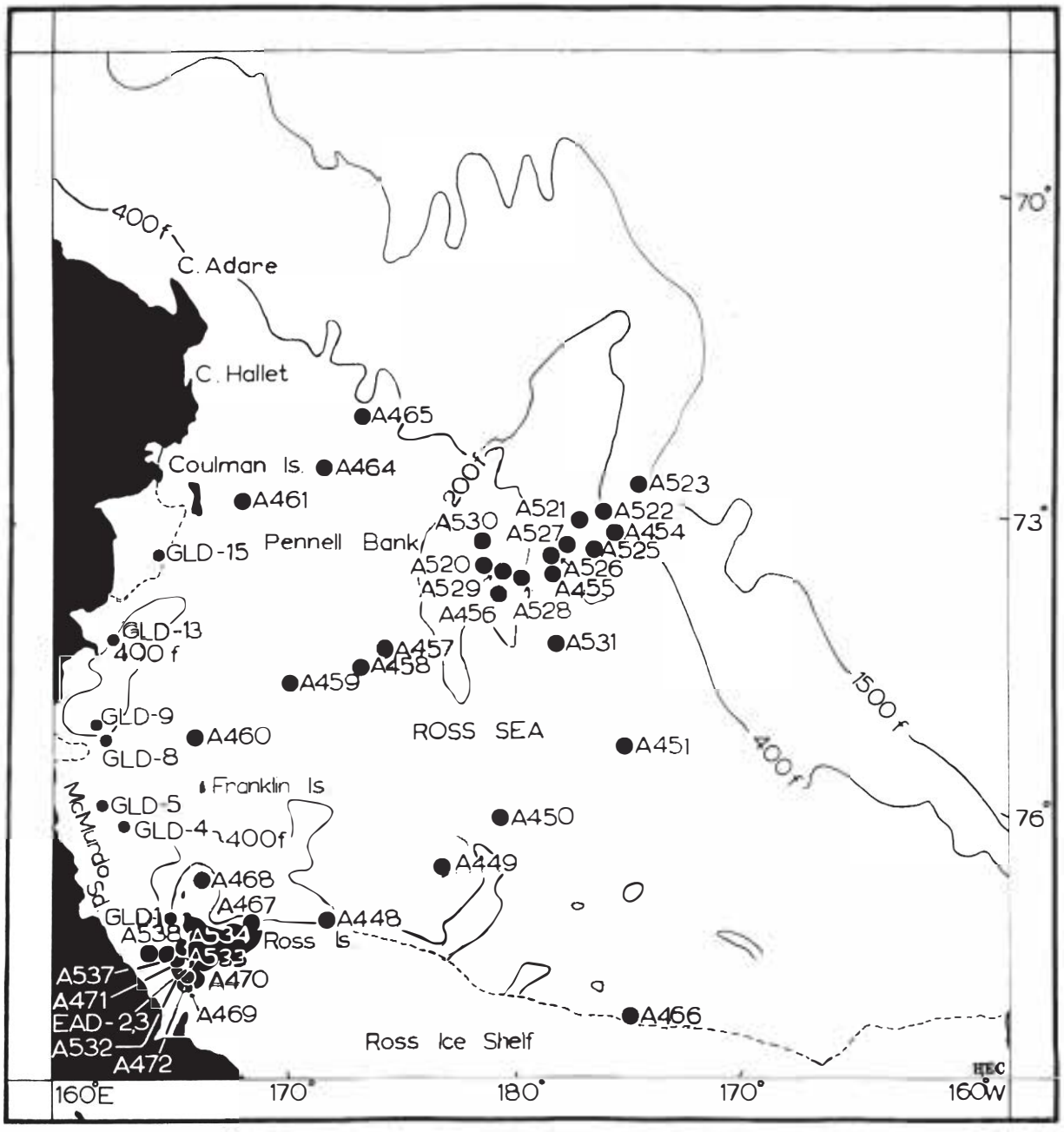

FIG. 1: Ross Sea Oceanographic and Stanford University stations from which Asteroidea were obtained.

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STATION DETAILS

(1) New Zealand Oceanographic Institute Stations, 1959-61

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. The bottom temperature is the deepest temperature recorded by a temperature-salinity cast at the station and may be up to about 50 m from the bottom.

The number of specimens of each species collected at the various stations is indicated in parentheses.

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.

Bathybiaster loripes obesus Sladen (1).
Psilaster charcoti (Koehler) (1).
Luidiaster gerlachei (Ludwig) (1, damaged).
Porania antarctica glabra Sladen (1).
Notasterias armata (Koehler) (1).
Lysasterias joffrei (Koehler) (1).
Diplasterias brucei (Koehler) (1).

Sta. A449, 11 Jan 1959, 77° 05′S, 177° 12′E, 0630–1240 h, 362 m, mud, T.A.S., G.T.O.S., bottom temp. −1·7°C, Ross Sea.

Odontaster validus Koehler (14).
Porania antarctica glabra Sladen (4).
Kampylaster incurvatus Koehler (8).
Perknaster fuscus antarcticus (Koehler) (1).
Perknaster sladeni (Perrier) (1).
Myoraster antarcticus (Koehler) (1).
Lophaster gaini Koehler (1).
Psalidaster mordax Fisher (1).

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.

Acodontaster capitatus (Koehler) (1).
Porania antarctica glabra Sladen (1).
Kampylaster incurvatus Koehler (1).
Myoraster antarcticus (Koehler) (1).
Perknaster sladeni (Perrier) (1).
Notasterias armata Koehler (3).
Lysasterias adeliae (Koehler) (1).
Diplasterias brucei (Koehler) (6).

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.

Odontaster validus Koehler (1).

Sta. A455, 15 Jan 1959, 74° 22′ S, 178° 35′ W, 0400–0920 h, 322–340 m, stones, muddy sand, bottom temp. −1·0°C, G.T.H.O., G.D., D.N., Ross Sea.

Porania antarctica glabra Sladen (1).
Perknaster densus Sladen (1).
Perknaster sladeni (Perrier) (1).
Henricia sp. (2).
Crossaster canopus H.E.S. Clark (1).

Sta. 456, 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.

Leptychaster flexuosus Koehler (1).
Luidiaster gerlachei (Ludwig) (1).
Odontaster validus Koehler (1).
Acodontaster capitatus (Koehler) (1).
Kampylaster incurvatus Koehler (1).
Perknaster sladeni (Perrier) (1).
Henricia sp. (1).
Peribolaster powelli H. E. S. Clark (2).
Notasterias armata Koehler (1).
Lysasterias adeliae (Koehler) (1, damaged).
Diplasterias brucei (Koehler) (2).

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Sta. A457, 16 Jan 1959, 75° 02′S, 175° 50′E, 0600–1200 h, 315–342 m, mud, bottom temp. −0·8°C, G.T.H.O., T.P., Ross Sea.

Leptychaster flexuosus Koehler (1, very broken).
Bathybiaster loripes obesus Sladen (3).
Luidiaster gerlachei (Ludwig) (3).
Porania antarctica glabra Sladen (1).
Kampylaster incurvatus Koehler (2).
Perknaster sladeni (Perrier) (1).
Peribolaster powelli H. E. S. Clark (1).
Diplasterias brucei (Koehler) (1).

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.

Bathybiaster loripes obesus Sladen (2).
Psilaster charcoti (Koehler) (11).
Luidiaster gerlachei (Ludwig) (1).
Odontaster meridionalis (Smith) (1).
Acodontaster capitatus (Koehler) (1).
Myoraster antarcticus (Koehler) (2).
Notasterias armata Koehler (5).

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.

Macroptychaster accrescens (Koehler) (1).
Bathybiaster loripes obesus Sladen (12).
Odontaster meridionalis (Smith) (3).
Porania antarctica glabra Sladen (1).
Myoraster antarcticus (Koehler) (1).
Notasterias armata Koehler (3).

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.

Bathybiaster loripes obesus Sladen (1, and remains of at least one other).
Psilaster charcoti (Koehler) (3).
Luidiaster gerlachei (Ludwig) (10).
Myoraster antarcticus (Koehler) (1).
Cuenotaster involutus (Koehler) (1).
Lophaster gaini Koehler (1).
Peribolaster powelli H. E. S. Clark (1).
Pteraster stellifer Sladen (2).
Notasterias armata Koehler (3).
Lysasterias adeliae (Koehler) (3).

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.

Pergamaster triseriatus H. E. S. Clark (1).
Porania antarctica glabra Sladen (1).
Perknaster sladeni (Perrier) (1).
Henricia sp. (1).
Peribolaster powelli H. E. S. Clark (1).
Pteraster stellifer Sladen (1).
Pedicellaster hypernotius Sladen (1).

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.

Porania antarctica glabra Sladen (1, damaged).

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.

Bathybiaster loripes obesus Sladen (1).
Psilaster charcoti (Koehler) (1).

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.

Odontaster validus Koehler (47).
Myoraster antarcticus (Koehler) (1).
Notasterias armata Koehler (2).
Lysasterias joffrei (Koehler) (2).
Diplasterias brucei (Koehler) (6).

Sta. A468, 26 Jan 1959, 76° 59′S, 167° 36′E, 2115–2245 h, 110 m, T.A.S., U.W.C., Sea-mount E, off Beaufort I.

Odontaster meridionalis (Smith) (7).
Odontaster validus Koehler (18).
Kampylaster incurvatus Koehler (5).
Myoraster antarcticus (Koehler) (1).
Diplasterias brucei (Koehler) (3).

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.

Odontaster validus Koehler (10).
Diplasterias brucei (Koehler) (1).

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.

Odontaster validus Koehler (1).
Porania antarctica glabra Sladen (1).

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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.

Odontaster meridionalis (Smith) (3).
Odontaster validus Koehler (54).
Porania antarctica glabra Sladen (6).
Perknaster fuscus antarcticus (Koehler) (1).
Diplasterias brucei (Koehler) (7).

Sta. A519, 26 Jan 1960, 77° 49′ 50″S, 166° 30′ 45″E, 1515–1600 h, 479 m, muddy, volcanic sand and gravel, G.H.O., McMurdo Sound. Remarks: three grab samples, two samples photographed; samples sieved.

Odontaster validus Koehler (1).

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: three grabs sampled out of five. Dredge one-third full abundant Polyzoa.

Odontaster meridionalis (Smith) (1).
Peribolaster powelli H. E. S. Clark (5).
Diplasterias brucei (Koehler) (1).

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., bottom temp. 0·0°c, Pennell Bank. Remarks: living and dead solitary corals abundant. Colour photograph of sample on deck.

Porania antarctica glabra Sladen (1).
Henricia sp. (1).
Peribolaster powelli H. E. S. Clark (1).
Pteraster stellifer Sladen (2).

Sta. A522, 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, bottom temp. 0·2°c, Pennell Bank. Remarks: D.D. three-quarters full of branchiopods, barnacles, ophiuroids.

Porania antarctica glabra Sladen (2).
Peribolaster powelli H. E. S. Clark (2).
Pteraster stellifer Sladen (2).

Sta. A523, 5 Feb 1960, 73° 34′S to 73° 31′S, 175° 47′W to 175° 34′W, 0030–0830 h, 1375–2804 m, bottom temp. 0·0°c, Pennell Bank.

Paralophaster lorioli (Koehler) (1).
Pteraster stellifer Sladen (1).

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.

Odontaster meridionalis (Smith) (2).
Peribolaster powelli H. E. S. Clark (1).
Pteraster stellifer Sladen (2).

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, euphausids; G.H.O., no sample. Colour photograph of D.D. sample on deck.

Henricia sp. (1).
Pteraster stellifer Sladen (1).

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.

Luidiaster gerlachei (Ludwig) (1).
Odontaster meridionalis (Smith) (3).
Porania antarctica glabra Sladen (1).
Henricia sp. (1).
Peribolaster powelli H.E.S. Clark (2).
Pteraster stellifer Sladen (1).
Pedicellaster hypernotius Sladen (1).
Notasterias armata Koehler (1).
Psalidaster mordax Fisher (1).
Lysasterias adeliae (Koehler) (1).

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: Three B and W photographs; layer of mud and polyzoa over layer of stones.

Odontaster validus Koehler (1).
Acodontaster capitatus (Koehler) (1).
Porania antarctica glabra Sladen (2).
Kampylaster incurvatus Koehler (2).
Perknaster sladeni (Perrier) (1).
Myoraster antarcticus (Koehler) (2).
Notasterias stolophora Fisher (1).
Diplasterias brucei (Koehler) (2).
Saliasterias brachiata Koehler (1).

Sta. A529, 8 Feb 1960, 74° 20′S, 179° 55′W, 1403–1515 h, 205–216 m, stones, U.W.C., D.D., Pennell Bank. Remarks: D.D. sample, polyzoa,

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ophiuroids and stones; three colour photographs of D.D. sample on deck.

Odontaster validus Koehler (2).
Kampylaster incurvatus Koehler (10).
Peribolaster powelli H. E. S. Clark (6).

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, two fish.

Odontaster validus Koehler (5).
Acodontaster capitatus (Koehler) (1).
Diplasterias brucei (Koehler) (1).

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

Odontaster meridionalis (Smith) (2).
Odontaster validus Koehler (18).
Porania antarctica glabra Sladen (1).
Diplasterias brucei (Koehler) (2).

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.

Odontaster validus Koehler (1).
Myoraster antarcticus (Koehler) (1).
Diplasterias brucei (Koehler) (1).

Sta. A537, 17 Feb 1960, 77° 30′S, to 77° 34′ 48″S, 165° 12′E to 1650° 19′E, 083–1030 h, 574–543 m, mud and gravel, D.D., bottom temp. —1·8°c, McMurdo Sound. Remarks: Red sponges and *Astrotoma*. Colour photographs of D.D. sample made on deck.

Odontaster meridionalis (Smith) (1).
Odontaster validus Koehler (1).
Acodontaster conspicuus (Koehler) (1).
Myoraster antarcticus (Koehler) (1).
Cuenotaster involutus (Koehler) (1).

Sta. A538, 17 Feb 1960, McMurdo Sound.
(a) 77° 29′ 12″S to 77° 30′S, 164° 39′E to 164° 38′E, 1500–1545 h, 269–256 m, sand and stones, bottom temp. —1·7°c, (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.

Porania antarctica glabra Sladen (1).

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

Endeavour, Ross Sea, January 1960.
Odontaster validus Koehler (16).

Sta. A625(3), 5 Feb 1961, 75° O′S, 163° 58·7′E, 2000–2030 h, 460 m, pebbles and sandy-mud, D.D., Ross Sea.

Odontaster meridionalis (Smith) (2).
Porania antarctica glabra Sladen (1).

Sta. A644, 1 March 1961, 72° 18′ 8″S, 170° 14′ 46″E, 530 m, sloppy black mud, G.H.O., Ross Sea.

Bathybiaster loripes obesus Sladen (1).

(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.)

247. Scott Base, Pram Point. 27 Feb 1957. Fish trap. Sea bed under pressure ice, depth 6 m. R. W. Balham.

Odontaster validus Koehler (1).

274. Scott Base, Pram Point. 23 March 1957. Fish trap. Sea bed under pressure ice, depth 6 m. R. W. Balham.

Odontaster validus Koehler (2).

289. Scott Base, Cape Armitage, 17 Apr 1957. Fish trap. Sea bed under pressure ice, depth 123 m. R. W. Balham.

Diplasterias brucei (Koehler) (1).

290. Scott Base, Cape Armitage. 17 Apr 1957 Fish trap. Sea bed under pressure ice, depth 123 m. R. W. Balham.

Odontaster validus Koehler (2).

329. Scott Base, Cape Armitage. 3 May 1957. Fish trap. Sea bed under bay ice, depth 123 m. R. W. Balham.

Odontaster validus Koehler (1).

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572. Scott Base, Cape Armitage. 23 Jan 1958. Naturalists' dredge. Sea bed under bay ice, depth 13 m. A. Packard.

Odontaster validus Koehler (6).

573. Scott Base, Cape Armitage. 23 Jan 1958. Naturalists' dredge. Sea bed under bay ice, depth 13 m. A. Packard.

Odontaster validus Koehler (5).

574. Scott Base, Cape Armitage. 23 Jan 1958. Naturalists' dredge. Sea bed under bay ice, depth 13 m. A. Packard.

Odontaster validus Koehler (5).

575. Scott Base, Cape Armitage. 23 Jan 1958. Naturalists' dredge. Sea bed under bay ice, depth 13 m. A. Packard.

Odontaster validus Koehler (3).

626. HMNZS *Endeavour.* Cape Evans, Station A. 27 Jan 1958. Petersen grab from ship. 53 m. R. E. Barwick.

Odontaster validus Koehler (2).

637. HMNZS *Endeavour.* Cape Evans. 22 Jan 1958. Foreshore. R. E. Barwick.

Odontaster validus Koehler (1).

638. HMNZS *Endeavour.* Cape Evans. 21 Jan 1958. Algae, asteroids and typical mixed plankton. (Plankton net struck bottom), depth 55 m. P. Webb.

Odontaster validus Koehler (1).

661. HMNZS *Endeavour.* Turtle Rock. 5 Feb 1958. Dip net from 6 ft below ice foot, ice edge. R. E. Barwick.

Odontaster validus Koehler (1).

672–691. HMNZS *Endeavour.* Hut Point, McMurdo Sound 77° 51'S, 166° 34'E. 5 Feb 1958. Beam trawl from ship, 124–165 m. R. E. Barwick.

672. *Odontaster validus* Koehler) (1).
675. *Odontaster validus* Koehler (75).
Porania antarctica glabra Sladen (11).
Perknaster fuscus antarcticus (Koehler) (1).
Diplasterias brucei (Koehler) (6).

702. HMNZS *Endeavour.* Cape Royds Anchorage, Backdoor Bay. 20 Feb 1958. Clinging to anchor chain. 5–9 m. R. E. Barwick.

Diplasterias brucei (Kochler) (2).

882. HMNZS *Endeavour.* Cape Royds, Backdoor Bay. Beam trawl from ship. 23 Feb 1958. R. E. Barwick. 22 m.

Odontaster validus Koehler (10).

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

Diplasterias brucei (Koehler) (2).

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

732. *Macroptychaster accrescens* (Kochler) (1).
Perknaster fuscus antarcticus (Koehler) (1).
Porania antarctica glabra Sladen (1).
747. *Odontaster validus* Koehler (2).

801. HMNZS *Endeavour.* Botany Bay, Granite Harbour, 77° 01'S, 162° 38'E. 15 Feb 1958. Beam trawl from ship. 73 m. R. E. Barwick.

Psilaster charcoti (Koehler) (1).
Odontaster validus Koehler (3).
Diplasterias brucei (Koehler) (1).

817–852. HMNZS *Endeavour.* Cape Evans, 77° 38'S, 166° 20'E. 23 Feb 1958. Beam trawl from ship. R. E. Barwick. 110 m.

837. *Diplasterias brucei* (Koehler) (8).
850. *Odontaster meridionalis* (Smith) (1).
Porania antarctica glabra Sladen (3).
Odontaster validus Koehler (68).
851. *Porania antarctica glabra* Sladen (3).

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

Odontaster validus Koehler (15).

Dominion Museum Station, Cape Hallett.

Odontaster validus Koehler (22).

"Dominion Museum, Wellington, New Zealand. Washed up on beach during 1959, Cape Hallett, Antarctica. Brian Reid Coll."

Notasterias stolophora Fisher (1).

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

(Abstract of station data supplied by John H. Dearborn)

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, USS *Glacier* Oceanographic Team; remarks, 4 ft Blake trawl used: this station equals USS Glacier Deep Freeze IV Oceanographic Sta. No. GL–5.

Psilaster charcoti (Koehler) (2).
Notasterias armata Koehler (1).

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, USS *Glacier* Oceanographic Team; remarks, triangular dredge: this station equals USS *Glacier* Deep Freeze IV Oceanographic Sta. No. 6. (GL–6).

Psilaster charcoti (Koehler) (1).

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, USS Oceanographic Team; remarks, 4 ft Blake trawl used; this station equals USS *Glacier* Deep Freeze IV Oceanographic Sta. No. GL–9.

Psilaster charcoti (Koehler) (1).
Luidiaster gerlachei (Ludwig) (2).

Sta. GLD–12, 30 Nov 1958, 74° 41·5′S, 164° 37′E, Ross Sea, Terra Nova Bay, 50 – 100 ft from shore, 15–30 m, bottom, rocky with red algae, 1500–1700 h; collectors, H. DeWitt, J. Dearborn, Capt. Houston and Dr Stover (USS *Glacier*); remarks: triangular dredge and hook and line: shore line rock and ice; position taken from the USS *Glacier* Deep Freeze IV Oceanographic Station No. GL–12; collections were made about ½–1 mile from the ship.

Odontaster validus Koehler (1).
Diplasterias brucei (Kochler) (1).

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, USS *Glacier* Oceanographic Team; remarks, 4 ft Blake trawl; this station equals USS *Glacier* Deep Freeze IV Oceanographic Sta. No. GL–13.

Odontaster validus Koehler (1).

Sta. GLD–16, 2 Dec 1958, 73° 46·7′S, 169° 09′E, Ross Sea, off Coulman Island, 836 m; bottom, gravel and pebbles; 0130–0215 h; collectors, H. DeWitt, J. Dearborn, USS *Glacier* Oceanographic Team; remarks, triangular dredge; this station equals USS *Glacier* Deep Freeze IV Oceanographic Sta. No. GL–17.

Bathybiaster loripes obesus Sladen (1).

Sta. E, in operation 26 Dec 1958 to 6 Jan 1959, McMurdo Sound, Ross Island, off Arrival Heights, 7·6 – 87·2 m; bottom, volcanic gravel to sponge complex; collectors, J. Dearborn *et. al.;* remarks, variety of gear utilised; open ice crack running out at right angle to shore line.

Diplasterias brucei (Koehler) (1).

Sta. H, in operation 29 Jan 1959 to 1 Feb 1959, McMurdo Sound, Ross Island, immediately north of Hut Point, 54 m; collectors, J. Dearborn, H. DeWitt; remarks, gear set off the ice edge, some hook and line fishing.

Diplasterias brucei (Koehler) (1).

Sta. M, 22 April 1959 to 24 Oct 1959 in operation, McMurdo Sound, Ross Island, Winter Quarters Bay, 38 m; bottom, grey-brown gravel-mud, with sponge spicules and *Limatula* shells; collectors, J. Dearborn, *et. al.;* remarks, hole blasted in ice, kept open by hand, variety of gear utilised.

Odontaster validus Koehler (2).
Diplasterias brucei (Koehler) (2).

Sta. P, in operation 8 Sept 1959 to 17 Dec 1959, McMurdo Sound, Ross Island, Winter Quarters Bay, 57 m; bottom, sponge complex; collectors, J. Dearborn, *et. al.;* remarks, seal hole kept open by hand, variety of gear utilised.

Porania antarctica glabra Sladen (2).
Perknaster fuscus antarcticus (Koehler) (1).

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Sta. V, in operation 16 Dec 1959 to 3 Jan 1960, McMurdo Sound, Ross Island, off Arrival Heights, ice crack running at right angle to shore line, 8–33 m; bottom, volcanic gravel to sponge complex as depths increase along crack; collectors, J. Dearborn, *et. al.;* remarks, several kinds of dredges hauled by hand, variety of traps utilised.

Odontaster meridionalis (Smith) (1).

Sta. CEL, 25 Jan 1960, McMurdo Sound, Ross Island, north shore of Cape Evans, off beach in front of Scott's Hut, 10 m; bottom, volcanic gravel and mud; 1700–1730 h; collectors J. Dearborn and J. Littlepage; remarks, hole dug in thin ice along pressure crack; bottom samples taken.

Perknaster fuscus antarcticus (Koehler) (3).

Sta. CEJ, in operation 26 Jan 1960 to 30 Jan 1960, McMurdo Sound, Ross Island, off north shore of Cape Evans, 12 m; bottom, gravel and rocks; collectors, J. Dearborn and J. Littlepage; remarks, 3 ft × 4 ft hole cut by hand; traps and bottom sampler utilised.

Perknaster fuscus antarcticus (Kochler) (2).

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 utilised.

Odontaster meridionalis (Smith) (1).

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 USCGS Eastwind Oceanographic Team; remarks, 4 ft Blake trawl.

Macroptychaster accrescens (Koehler) (1).
Odontaster meridionalis (Smith) (2).
Porania antarctica glabra Sladen (2).

Cape Evans, 1 Feb 1960.

Perknaster fuscus antarcticus (Koehler) (1).

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MORPHOLOGY

The morphological characters of asteroids are best seen in dried spirit specimens. After examination these can then be returned to preservative or stored in the dry state. Throughout this report a standard method of description has been used: first, a description of the general body shape; then the abactinal surface and associated structures, the marginal plates, and finally the features of the actinal surface. The characters discussed below apply especially to Antarctic asteroids.

There are generally five arms radiating from a well defined central disc; in some families of the order Forcipulatida there may be 12 or more arms. The upper or dorsal surface is known as **abactinal,** the lower or ventral surface as **actinal:** These may be separated by two distinct series of marginal plates, the upper known as the **superomarginals** and the lower as **inferomarginals,** these being well developed in the order Phanerozonida.

The abactinal surface may be paved with well developed cruciform or triradiate plates forming an open meshwork with large primary plates and smaller connecting ossicles enclosing membranous spaces (fig. 11 A); or there may be a very distinct **carinal** row of plates along the midline of each arm with small **dorsolateral plates** extending in arcs from either side; or the plates may be imbricating or overlapping as in **Kampylaster** (fig. 12 B), or they may be reduced or more or less absent as in some species of **Perknaster.** There may be a thick enveloping membrane which when present obscures the contours of the plates and may be folded into a maze of wrinkles and pustules.

The **abactinal plates** may bear one or two spines; or a slender **trunk** or **stem** crowned with a varying number of spinelets, spines, or granules which may be united in a membrane (as in *Peribolaster*, fig. 15 A) or may be free. These form **paxillae** (fig. 2 A) which may be close together and irregularly arranged on the disc and midline of the arms or more or less regularly arranged in transverse rows along the arm edges; in some specimens the plates may be naked. These spines or spinelets may be cylindrical or flattened, smooth or thorny, and blunt or sharp tipped. An **interradial septum** may be present and is always devoid of spines (fig. 15 B).

Pedicellariae are of two main types (fig. 16 A, B, C, and D); **straight,** consisting of two jaws rising from a U-shaped base; or **crossed** with the two jaws crossing basally. They may terminate in one or a number of teeth. There are many variations of these which are discussed in the text. They may be scattered over the plates of the abactinal surface or present in distinct wreaths round the spines. Straight pedicellariae are often most obvious in the furrows on the actinal surface.

In the membranous spaces between the abactinal plates there may be one or a number of blunt-tipped papulae (figs. 2 B and 10 B) present; they may also occur between the marginal plates and may sometimes be present on the actinal surface also.

The **madreporite** (fig. 2 A), generally very obvious but sometimes indistinct and covered by paxillae, is always abactinal, always interradial in position, either nearer the centre or the edge of the disc and is generally dissected by a number of fine radiating grooves.

The **marginal plates** may bear sharp conspicuous spines (fig. 4 B), or paxillae (fig. 14), or they may be naked. The superomarginals are often very small and their armature similar to that of adjacent abactinal plates. These plates generally lie opposite each other but may alternate, especially near the arm tip. There may be an unpaired, interradial marginal present in the interradial angle. Where the marginal plates are well developed they may be separated by distinct narrow grooves which may also extend on to the actinal surface. If they are bordered with small, very fine, interlocking spinelets, the grooves are termed **fascioles.**

The **actinal plates** are variously developed and one or more rows may extend to the arm tips or they may be absent altogether. These plates may bear spines, paxillae, or granules, may be naked, or there may be a thick membrane present. Near the outer edge in the interradial midline there may be one or a pair of **gonopores** present (fig. 11 B),

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but if the gonads occur in series in the arms, the gonopores are probably numerous though difficult to detect.

Along each radius is an **ambulacral groove** or **furrow;** it is lined by **ambulacral plates** and bordered by the **adambulacral plates** (fig. 15 B) bearing a number of spines which may be webbed basally. The spines which border and project into the furrow are known as **furrow-spines.** The spines outside these on the ventral surface of the plate are known as **subambulacral spines** and are often very similar to those of adjacent actinal plates. Adambulacral plates bearing only one spine are known as **monacanthid;** where two spines are present the plates are **diplacanthid.** Proximally, the first two or three pairs of adambulacral plates may be joined forming a so-called **adoral carina** (fig. 17). Within the ambulacral grooves the **tube-feet** may be arranged in two or four rows; they may be pointed or have distinct **sucking discs.**

Guarding the mouth are pairs of **oral plates** which vary in shape and size. The spines along the outer edge of the plate are known as **oral furrow spines;** those on the ventral surface are **suboral spines** (fig. 5). There may also be one to three conspicuous recurved suboral spines with hyaline tips; this character defines the family Odontasteridae.

There are two measurements commonly used in describing asteroids: R is the distance from the centre of the disc to the arm tip and r from the centre to the edge of the disc. These measurements are generally taken as averages, and are often expressed as a ratio R:r.

CHECK LIST OF ROSS SEA ASTEROIDEA

Species new to the Ross Sea are shown in boldface.

Macroptychaster accrescens (Koehler)

Leptychaster flexuosus Koehler

Leptychaster magnificus (Koehler)

Bathybiaster loripes obesus Sladen

Psilaster charcoti (Koehler)

Luidiaster gerlachei (Ludwig)

Odontaster meridionalis (Smith)

Odontaster validus Koehler

Acodontaster conspicuus (Koehler)

Acodontaster capitatus (Koehler)

Acodontaster hodgsoni (Bell)

Pergamaster triseriatus H. E. S. Clark

Pergamaster incertus (Bell)

Porania antarctica glabra Sladen

Kampylaster incurvatus Koehler

Cycethra verrucosa (Philippi)

Perknaster fuscus antarcticus (Koehler)

Perknaster densus Sladen

Perknaster sladeni (Perrier)

Henricia sp.

Crossaster canopus H. E. S. Clark

Myoraster antarcticus (Kochler)

Cuenotaster involutus (Koehler)

Paralophaster godefroyi meseres Fisher

Paralophaster lorioli (Koehler)

Lophaster gaini Koehler

Peribolaster macleani Koehler

Peribolaster powelli H. E. S. Clark

Pteraster stellifer Sladen

Pedicellaster hypernotius Sladen

Notasterias armata Koehler

Notasterias stolophora Fisher

Psalidaster mordax Fisher

Lysasterias adeliae Koehler

Lysasterias joffrei (Koehler)

Diplasterias brucei (Koehler)

Saliasterias brachiata Koehler

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SYSTEMATICS

This section contains keys to the asteroids of the Ross Sea arranged as far as possible in natural sequence. When using these keys it is necessary to compare the specimen in hand, character by character, with the numbered paragraphs of the key until an identification is reached. If the specimen does not correspond, proceed straight to the number in parentheses. Once a specimen has been identified it should be checked against the complete description and illustration.

Class ASTEROZOA

Subclass ASTEROIDEA

Asterozoa in which the alimentary organs extend into the arms which may also contain the genital organs. Within the ambulacral grooves, the rows of tube-feet, either pointed or with sucking discs, are responsible for locomotion.

KEY TO THE ORDERS OF ASTEROIDEA

1 (2) Marginal plates large and conspicuous defining the contours of the body; abactinal skeleton of paxilliform or flat, tessellate plates either smooth or with granules and spines; either naked or covered with thick or thin membrane. Pedicellariae of spiniform, pectinate, valvate, or excavate type. Papulae restricted to abactinal surface. Mouth plates prominent, ambulacral plates well spaced; tube-feet in two or four series; rays usually five. ..... **Phanerozonida** Sladen, 1889

2 (1) Marginal plates not conspicuously large; abactinal skeleton not of true paxilliform, tessellated type, but usually more or less reticulate or imbricate. Papulae often intramarginal and actinal. Tube-feet with well developed sucking discs.

3 (4) Pedicellariae rare. Abactinal skeleton of thin, close-set overlapping plates or a more or less open regular or irregular network; plates often cruciform with or without connecting ossicles. ..... **Spinulosida** Perrier, 1894

4 (3) Pedicellariae generally numerous and pedunculate; either crossed or straight. Skeletal plates with spines about which the pedicellariae are often grouped. Marginal plates often inconspicuous or aborted; ambulacral plates very crowded, tube-feet in four series. Abactinal skeleton of skeletal arches either independent or bound together by intermediate plates forming a network with rectangular or very irregular meshes. Mouth plates usually inconspicuous. ..... **Forcipulatida** Perrier, 1884

Order PHANEROZONIDA Sladen, 1889

Marginal plates usually large and conspicuous defining the contour of the body. Abactinal plates paxilliform or flat and tessellate, smooth or armed with granules or spines, naked or covered with thin or thick membrane. Pedicellariae never pedunculate forcipiform, but spiniform, pectinate, valvate, or excavate. Papulae restricted to abactinal area circumscribed by marginal plates. Oral plates prominent, ambulacral plates well spaced; tube-feet in two or four series; rays usually five.

KEY TO THE ANTARCTIC FAMILIES

1 (2) Tube-feet pointed without a definite flat sucking disc but sometimes with a small pointed knob. Ampullae double; no cribriform organs but marginal fascioles usually present; abactinal plates paxilliform. Marginal and actinal plates never bordered by a single row of webbed spinelets; neither are spinelets of paxillae webbed. Generally superomarginals small and variable; inferomarginals always massive; actinal plates with paxilliform groups of spines or spinelets; adambulacral armature always in several series intergrading into actinal spinelets. Superambulacral ossicles present. ..... **Astropectinidae** Gray, 1840

2 (1) Tube-feet with well developed sucking discs.

3 (7) No conspicuous recurved hyaline teeth on each pair of oral plates.

4 (8) Both series of marginal plates well developed and conspicuous.

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5 (6) Superomarginal and inferomarginal plates more or less conspicuously alternating, with sharp and generally elongate, erect spines. Disc small, rays long and slender with papulae confined to limited areas generally at the base of the rays. Abactinal plates with few spinelets, or simple and flat. Actinal intermediate areas small and few actinal plates. Pedicellariae, when present, pectinate. ..... **Benthopectinidae** Verrill, 1889

6 (5) Marginal plates thick and massive but without spines. Abactinal plates polygonal, circular or stellate; either simple, flat, and naked or covered with granules, paxilliform, or bearing an enlarged spine. Papulae in radial areas. Plates obscured by a tough skin, either superficially smooth or covered with granules. ..... **Goniasteridae** Forbes, 1841

7 (3) One or two conspicuous recurved suboral hyaline teeth to each pair of oral plates. An odd intermarginal plate in both series. No superambulacral ossicles. Marginal, abactinal, and actinal plates well developed. ..... **Odontasteridae** Verrill, 1889

8 (4) Only one series of marginal plates conspicuous, edge of disc and arms compressed. Disc large, convex; arms very short. A membrane obscures the abactinal and actinal plates and may contain granules, small spines, or may be smooth. Actinal plates regularly arranged, fascioles often present. ..... **Poraniidae** Perrier, 1894

Family ASTROPECTINIDAE Gray, 1840

KEY TO THE ROSS SEA GENERA

1 (4) Superomarginals distinctly smaller than inferomarginals. Both series of marginals bearing a fine uniform spinulation, without enlarged spines. An unpaired interradial series of actinal intermediate plates developed, at least proximally.

2 (3) Actinal interradial area large, with several series of intermediate plates extending far into the arm. Furrow spines arranged in a V-shaped group upon a keel-like projection of the adambulacral, with the apex of the V placed deep in the furrow. Madreporite (in mature form) large, bearing several paxillae. ..... **Macroptychaster** H. E. S. Clark, 1962

3 (2) Actinal interradial area small, with several series of intermediate plates entering the arm base, but only the inner series continuing through the greater part of the arm. Madreporite small, naked, often concealed by the neighbouring paxillae. ..... **Leptychaster** Smith, 1876

4 (1) Superomarginals and inferomarginals equally developed. Marginals often bearing enlarged spines or spicules. An unpaired interradial series of actinal intermediate plates at least partially developed. Madreporite small, exposed.

5 (6) Adambulacral plates with a distinct projection into the furrow, and with the central spine of the furrow-series abruptly and conspicuously longer than those on either side ..... **Bathybiaster** Danielssen and Koren, 1883

6 (5) Adambulacral plates without a conspicuous projection into the furrow and with the furrow spines arranged in a fan ..... **Psilaster** Sladen, 1885

Macroptychaster H. E. S. Clark, 1962

No specialised marginal spines, plates armed with a uniform covering of small papilliform or squamiform spinelets. Inferomarginals larger than superomarginals and not projecting beyond them. Actinal interradial areas large with at least a partial unpaired interradial series of intermediate plates; the intermediate plates of the arm pluriserial (three or four longiseries) to at least the midradius. Madreporite (in adult) large (several times larger than the largest superomarginal) and bearing several paxillae. Furrow spines arranged in a vertical V-shaped group upon a keel-like projection (into the furrow) of the adambulacral plate, with the apex of the V placed deep in the furrow.

Type Species: Leptoptychaster accrescens Kochler.

The presence of a large madreporite bearing paxillae distinguishes this genus from *Leptychaster* which has a small madreporite devoid of paxillae. *Macroptychaster* is, in addition, distinguished by its markedly pluriserial intermediate plates in the arm and the large interradial areas. Although the madreporite does not become enlarged or paxilliferous until the adult state, the genus is characterised at most stages of growth by the pluriserial structure of the arm. This character, though not mentioned in previous descriptions, is a highly distinctive feature.

Macroptychaster accrescens (Koehler) (pl. 1; pl. 2; pl. 3, fig. 3 and 4; pl. 4; text-fig. 2)

Leptoptychaster kerguelensis Bell, 1908 (nec. Smith). National Antarct. Exped. 1901–04, 4, p. 9.

Leptoptychaster accrescens Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 246, pl. 52, fig. 5; pl. 53, fig. 1–3; pl. 54, fig. 2–9; pl. 55, fig. 1; pl. 74, fig. 1. Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, p. 98, pl. 13, fig. 3.

Leptychaster accrescens Fisher, 1940. Disc. Rpts., 20, p. 85.

Macroptychaster accrescens H. E. S. Clark, 1962. Trans, Roy. Soc. N.Z., n.s. 2(6), p. 45

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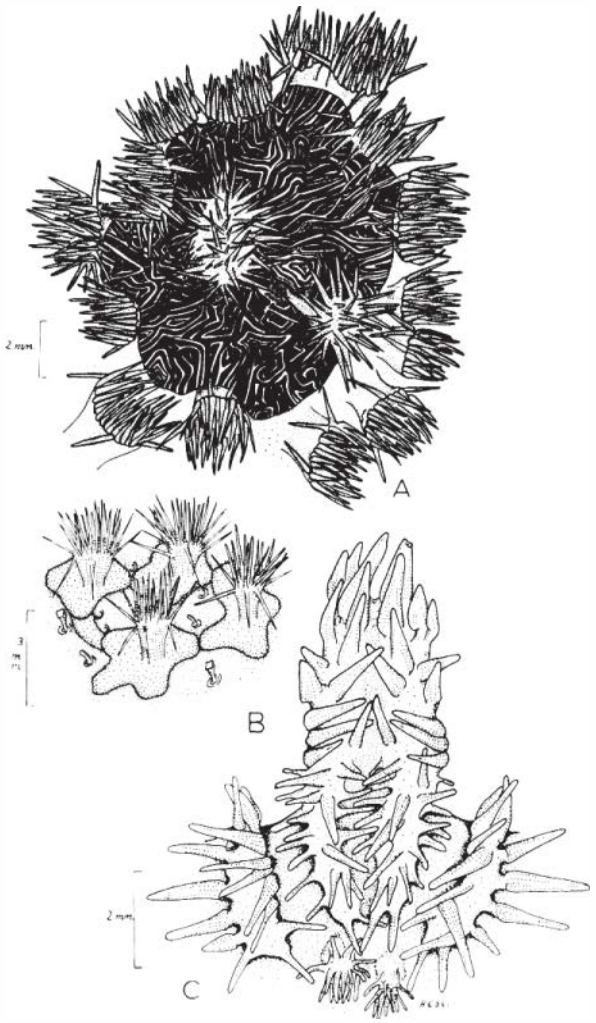

FIG. 2: *Macroptychaster accrescens* A and B from Sta. A460: A, madreporite and abactinal paxillae; B, abactinal plates, paxillae and papulae. C, (from Stanford University Collection, Sta. EAD–2) oral and proximal adambulacral plates. Each to scale shown.

Disc large, arms broad and tapering rapidly to a blunt tip which is protected by a small but conspicuous plate; abactinal surface plane; actinal surface slightly convex.

The abactinal surface is paved with plates which show no regular arrangement except along the arm edges where there are transverse rows of from five to 10. On the disc these have four to six lobes but distally the lobes are indistinct and the plates oval or rectangular. Near the arm tips the plates tend to be isolated. Elsewhere the lobes may overlap or there may be connecting ossicles present. Each plate bears a paxilla. These consist, on the disc, of a short sturdy trunk with an enlarged head on which are borne from 20 to 40 spinelets; and, distally on the arms, of a more slender trunk with fewer spinelets; these slender needle-like spinelets are furnished with fine, sharp-pointed teeth in the distal half.

Pedicellariae are absent.

From three to six papulae surround each abactinal plate over most of the surface of the disc, becoming inconspicuous towards the arm tips. Many papulae appear to expand distally into a divided "flower-like" structure though this may well be an artifact due to drying.

The madreporite, nearer the edge than the centre of the disc, is oval and measures about 10 by 11 mm; surrounding it are 10 rather enlarged paxillae which encroach on its surface. It also bears several paxillae and the surface is finely dissected.

The anus is not visible.

Between 129 and 131 supermarginal plates extend from the interradial angle to the arm tip, bordering and encroaching upon the abactinal surface. The plates are small, between 4 and 5 mm long and 2–3 mm broad; each bearing a rectangular ridge or keel on which are numerous close set spinelets similar to those already described.

The inferomarginals, confined almost entirely to the actinal surface, are not visible when the animal is viewed from above except near the arm tips. These plates, between 6 and 8 mm long, bear a ridge or keel similar to those of the superomarginals. Fascioles, occurring between the plates of both series of marginals are especially evident between the inferomarginals and are lined with numerous, fine, interlocking spinelets which differ from other spinelets in being completely smooth along their length.

The presence of small, smooth, and slightly convex accessory plates between the superomarginals and inferomarginals and apparently overlapping the bases of the supermarginal plates is a curious and interesting feature, being most evident in the interradial angles.

The actinal interradial areas are well defined and triangular, with at least one series of plates extending almost to the arm tip. The plates are oblong, slightly convex with irregular margins, imbricating, and form longitudinal rows each corresponding to one inferomarginal plate. In the interradial angle there are nine or 10 plates in one row, the number decreasing on either

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side. Each plate has an oblong ridge or keel with the spines arranged in more or less regular longitudinal rows.

The plates of the adambulacral series are distinct, two occurring together in close proximity and the angle so formed projecting into the furrow. The area between these plates is occupied by a pair of tube-feet. These plates, bearing from five to seven smooth, blunt-tipped furrow spines, have the median smaller spine situated well within the furrow.

The ambulacral grooves are almost petaloid, narrow proximally, broadening medially and narrowing again near the arm tips. The sturdy tube-feet are quadriserial, lacking well defined sucking discs and terminating in small, hemispherical nipples.

The oral plates, between 15 and 18 mm long and 5–7 mm wide, bear a variable number of furrow spines, usually between 12 and 18, those overhanging the mouth being most distinct. The many suboral spines are arranged in two rows. There is a wide muscular area, especially medially between the two oral plates.

Colour in Life: There are no accompanying colour notes but from memory J. S. Bullivant believes the N.Z.O.I. material (A460) was orange with darker brown transverse bands across the arms and brown markings on the disc. Fisher (1940, p. 86) recorded similar markings. In spirit; white or light brown with darker brown tube-feet.

Type Locality

Probably the Davis Sea near Queen Mary Land (65° 42′S, 92° 10′E) in 60 fm (111 m).

Distribution

Circumpolar, Antarctic. Recorded by the Australasian Antarctic Expedition between 64° 32′ and 66° 50′S., and 92° 10′ and 142° 6′E; by the Swedish Antarctic Expedition from South Georgia; by Fisher (1940) from South Georgia, the Ross Sea, and near Bouvet Island. *Bathymetric Range:* 97–655 m.

Material Examined

Three specimens from three stations as follows:

Sta. A460, 415–430 m (1).

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 732, Cape Roberts, 188–193 m (1).

Stanford University Station: Sta. EAD-2. 315 m (1).

Size: In the specimen from Sta. A460 on which the present description is based R = 239 mm and r = 86 mm; in the T.A.E. specimen R = 40 mm and r = 15 mm while in the specimen from the Stanford University Collection R = 53 mm and r = 18 mm. In Bell's (1908) specimen R = 212 mm and r = 58 mm while in Koehler's type material R ranged from 210 to 18 mm and r from 70 to 7 mm. In the material collected by the Swedish Antarctic Expedition R = 140 to 145 mm and r = 50 mm. In the largest specimen, discussed in Fisher's (1940) report, R = 260 mm and r = 85 mm.

Remarks

This species agrees well with Koehler's (1920, p. 85) description of *Leptoptychaster accrescens*, but there are marked differences in the details of the mouth plates, as there are more numerous furrow spines in the present specimens than either Koehler or Fisher record.

Ecology

The absence of true sucking discs on the tube-feet suggest that, as in all members of the Astropectinidae, the animal frequents a soft or muddy substrate. The substrate for A460 is recorded as gritty mud. There is no record from the Trans-Antarctic (New Zealand) Expedition Collection, while the Stanford University Collection is from a sponge complex. Koehler (1923) records specimens from grey clay and stones and Fisher (1940) records a substrate of grey or green mud with stones.

In two underwater photographs (pl. 1 and 2) taken by J. S. Bullivant at Sta. A528 and A538, starfish are evident. In A528 there is what appears to be a single large starfish. The abactinal surface is somewhat obscured by shadow; R probably measured between 190 and 200 mm. This large asteroid with five arms and obvious marginal plates has been identified tentatively as *Macroptychaster accrescens* or an equally large species of *Leptychaster*, possibly *magnificus*, as this is known from South Victoria Land; the animal appears to be feeding. There might be some grounds for supposing that there are two asteroids present and that they are in very close proximity, one overlying the other and possibly mating. If this view is held a sixth arm is envisaged just below

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the right-hand arm and a seventh slightly to the right of, and overlapping the lowermost arm; in the author's opinion, however, these are parts of adjacent polyzoa and only the one asteroid is present.

The asteroid in the second photograph from Sta. A538 has the actinal surface uppermost and the coarse, conspicuous tube-feet suggest that these lack sucking discs, and that the animal therefore belongs in the family Astropectinidae. The general habit of the animal and the position and height of the disc suggest this is probably a small specimen of *Macroptychaster accrescens*, very similar to the specimen from the Trans-Antarctic (New Zealand) Expedition Collection.

Leptychaster Smith, 1876

No specialised marginal spines; superomarginals smaller than the inferomarginals, occasionally rudimentary. Actinal interradial areas small with several series of intermediate plates entering the arm base but only the inner series continuing along the arm. Madreporite small, inconspicuous, and generally hidden by neighbouring paxillae.

Type Species: Leptychaster kerguelensis Smith.

The genus occurs in the Northern Hemisphere and in the Southern Hemisphere where it appears to be restricted to Antarctic regions. It is unknown from Australasian or Magellanic regions. Northern Hemisphere species apparently do not brood the young, the adambulacral plates are less compressed and have a curved, rather than an angular, furrow margin, and there are more numerous adambulacral spines and smaller tube-feet. There are three Antarctic species, only one of which occurs in the Ross Sea. (It is probable that *L. antarcticus* is no longer a valid species.)

A single Ross Sea species.

Leptychaster flexuosus Koehler (pl. 3, fig. 1 and 2).

Leptoptychaster flexuosus Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts. Ser. C, 8 (1), p. 252, pl. 51, fig. 1–4; pl. 75, fig. 3.

Leptychaster flexuosus Fisher, 1940. Disc. Rpts. 20, p. 84.

The disc is small and convex; the long slender arms tapering rapidly to blunt tips protected by saddle-shaped plates; arms triangular in cross section.

Abactinal surface paved with small round or oval, often slightly lobed plates showing no regular arrangement except near the margins of the disc and arms where from four to six plates form regular rows. The plates bear central trunks with from six to 12 spinelets forming compact paxillae which gave a uniform covering over the entire surface of the disc and arms and are smallest on the centre of the disc. The distal third of these spinelets is furnished on one or both sides with several sharp teeth, and the spinelet generally terminates in one or a number of very fine teeth.

Pedicellariae absent.

Papulae very indistinct and apparently confined to the margin of the disc and arms.

Neither madreporite nor anus is apparent.

The square or rectangular, indistinct and almost abortive superomarginal plates, with paxillae similar to those already described, are confined entirely to the abactinal surface. In general, each plate lies directly above an inferomarginal, but towards the arm tip they may be displaced.

Forming the rounded edge of the ray are the raised, band-like inferomarginals extending proximally some distance onto the actinal surface; separating these plates are deep, narrow fascioles lined with fine, delicate interlocking spinelets. These plates, bearing paxillae with spines similar to those already described, measure between 1·5 mm (proximally) and 2·5 mm (distally) long. In the interradial angle, part of each plate extends onto the actinal surface and between 120 and 130 marginal plates extend from the interradial angle to the arm tip.

The actinal interradial area is small and triangular; at least one row of plates extending for a quarter of the length of each arm. These rectangular, more or less regularly arranged plates bear paxillae consisting of from 12 to 20 spinelets, the outer plate of each row corresponding to one inferomarginal. Four or five plates extend from the oral to the interradial angle, the number decreasing on either side.

The more or less triangular adambulacral plates, bearing from three to six stout, blunt-tipped furrow spines and from six to 12 subambulacral spines, project well into the furrow. The most anterior and smallest furrow spine, well within the groove, is flanked by the three to five longer spines; near the arm tip the plates are indistinct and the spines very crowded.

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The ambulacral grooves are narrow, the rather stout tube-feet regularly biserial terminating in small nipples. On the inner surface of several of the tube-feet papilliform outgrowths are visible.

The oral plates are large, distinct, and about 5 mm long; of the 15 furrow spines, two are thicker and sturdier and set close together well down in the mouth while there may be 10 or more suboral spines similar to those of adjacent adambulacral plates.

Colour in Life: Unknown; in spirit, white with pale brown tube-feet.

Type Locality

Near Adélie Land in 66° 55'S, 145° 21'E., 318 fm (588 m).

Distribution

Ross Sea. *Bathymetric Range:* 201–588 m.

Material Examined

Two specimens from two stations as follows:

Sta. A456, 238–201 m (1); Sta. A457, 315–342 m (one, very broken).

Size: In the smaller specimen from Sta. A456 R = 78 mm, r = 10 mm and R/r = 7·8; in the larger, broken specimen R probably measured between 270 and 275 mm. In Koehler's (1920) specimens R measured between 130 and 135 mm and in Fisher's (1940) specimens R = 340 to 345 mm and r = 36 mm.

Remarks

In the larger, damaged specimen fron Sta. A457 the arrangement of the papulae is more evident. Four or five long, slender, papulae surround the base of the plates in the marginal areas but are absent from the midline of the arms. Between 275 and 280 marginal plates extend from the interradial angle to the arm tip. The plates of the abactinal surface have very short but distinct lobes. In the distal regions of the arms the adambulacral plates from either side almost meet across the grooves and a pair of tube-feet occur in each of these "pockets". As much of the disc has disintegrated in this specimen, it can be seen that a stout interradial septum is present; that gonads are present in tufts down the arms and apparently open by individual pores; that the ambulacral ossicles are paddle-shaped; that small, rod-like superambulacral ossicles are present and extend from the ambulacral ossicles to the actinal intermediate plates and that there is a ligament present which causes the inferomarginals to "curl" round the sides of the arms.

Although small papilliform outgrowths are present on the tube-feet they do not appear to be as numerous or as distinct as Fisher (1940, p. 84) reports.

Ecology

Both the present specimens were taken from a muddy, sandy, gritty bottom which is to be expected as the tube-feet lack a well developed sucking disc and are more or less pointed. Starfish with tube-feet of this sort are envisaged as "tottering" over the mud on their stilt-like tube-feet.

Bathybiaster Danielssen and Koren, 1883

Superomarginals and inferomarginals more or less equally developed, both series high and confined to the sides of the ray; incipient marginal spinules often present. Abactinal plates of papular areas with stellate bases. Madreporite small and exposed. An unpaired interradial series of actinal intermediate plates at least partially developed. Adambulacral plates with distinct projections into the furrow and the central spine of the furrow series abruptly and conspicuously longer than those on either side.

Type Species: Astropecten pallidus D and K.

The circumpolar Antarctic *Bathybiaster loripes obesus* and its warmer water race *B. loripes* are very similar to the North Atlantic *B. vexillifer* and *B. vexillifer robustus* and, as in those species, there is much variation. The southern forms are distinct by reason of their shorter and hence more numerous marginal plates. *Bathybiaster loripes* has been found in the Magellanic region in the Straits of Magellan and the Falkland Islands in 198–490 m, and off Kerguelen Island in very shallow water, temperature apparently being the controlling factor in its distribution.

Apart from the distinct differences in geographical distribution the rays of *obesus* are more rounded and there is no sharp line of demarcation between the marginal and abactinal surface; also the superomarginal spinule is very small or absent in *obesus* and, when there are specimens of each race for comparison, it will be seen there are many more marginal plates in *obesus* than in *loripes*.

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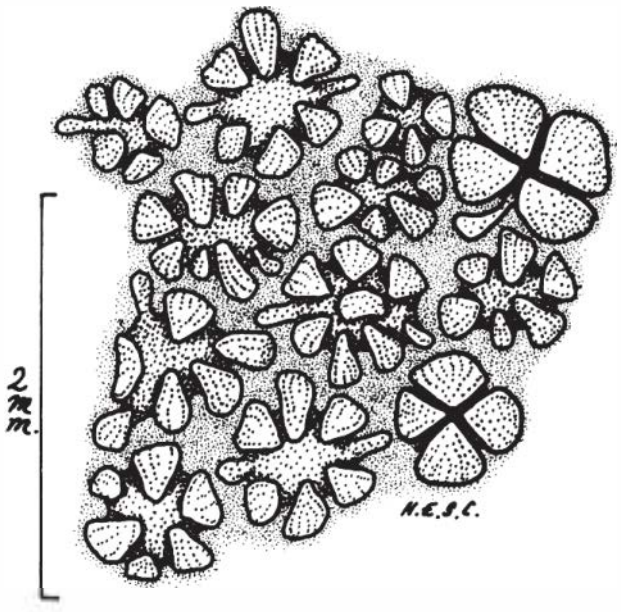

FIG. 3: *Bathybiaster loripes obesus*, abactinal surface showing paxillae and two pedicellariae on the right hand side, in a specimen from Sta. A461.

Bathybiaster loripes obesus Sladen (pl. 3, fig. 5 and 6; text-fig. 3)

Bathybiaster loripes var. *obesus* Sladen, 1889. Challenger Rpt., 30, p. 242.

Bathybiaster liouvillei Kochler, 1912, Deuxième Expéd. Antarct. Franç. Echinodermes, p. 96, pl. 6, fig. 2–4, 12; pl. 8, fig. 5 and 6; Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 263, pl. 73, fig. 1 and 2; Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, p. 100.

Bathybiaster loripes obesus Fisher, 1940. Disc. Rpts. 20, p. 90.

Arms taper evenly from the well defined disc to sharp tips; disc is convex with a central epiproctal cone.

Plates of the abactinal surface are small and either round or slightly lobed except in the papular regions where they are distinctly stellate; they show no regular arrangement except near the margin of the disc and arms where from six to eight plates form regular rows. Each plate bears a sturdy trunk, the expanded tip crowned with from five to eight short, triangular-headed granules or spinelets, which generally occupy a central position while several more slender spinelets are marginal; the spinelets or granules have a reticulate skeleton with fine lateral teeth. On the disc, the crowded paxillae are more or less rectangular, but elsewhere they are spaced, varying in shape.

Along the arms and in the interradial regions there are small "button-like" pedicellariae formed by the enlarged heads of four or five granules, the tips of which meet centrally; these stand out slightly above the level of the surrounding paxillae and are especially evident when the specimen is dry.

The four to six small, blunt-tipped papulae surrounding each plate are not present on the centre of the disc or midline of the arms.

The madreporite, interradial in position and nearer the centre than the edge of the disc, is almost circular and measures about 2 mm. Dissecting it are six deep, regular, often slightly sinuous grooves giving the whole structure a coarse and distinctive appearance. There is a large and distinctive paxilla with about 24 spinelets on the upper side of the madreporite.

The anus is present as a small aperture at the tip of the epiproctal cone.

Marginal plates, confined entirely to the arm edges encroach neither on the abactinal nor actinal surfaces. These plates are regularly arranged, of similar size, and between 110 and 112 extend from the interradial angle to the arm tip. In the interradial angle the height of the margin is at least 10 mm; at the arm tip it does not exceed 2 mm. The superomarginal plates are between 2 and 3 mm long and 0·5–1 mm wide; covering them are between 20 and 30 small, scale-like, skin-covered papillae showing no very regular arrangement; deep, narrow fascioles separating these plates are lined with slender, interlocking spinelets.

The inferomarginal plates corresponding to the superomarginals are larger, measuring between 3 and 3·5 mm long and bearing papillae similar to those already described, although one or more of these may be enlarged to form incipient spines especially in the interradial regions. Where only one spine is present it generally occurs near the superomarginals, but where several occur they are spaced vertically down the plate.

The more or less triangular interradial regions, with small, almost square regularly arranged plates, two rows of which at least, extend to the arm tips between the adambulacrals and the inferomarginals, bear two to six skin-covered papillae.

The adambulacral plates with angular projecting furrow margins are separated by wide muscular areas. There is a median, slightly curved, blunt-tipped furrow spine, two or three similar, though distinctly shorter spines on either side, and up

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to 12 irregularly arranged skin-covered subambulacral papillae. The most proximal adambulacral plates are large and narrow with a furrow series of between 20 and 24 short, sturdy spines similar to those of the oral plates and a row of shorter subambulacral spines.

Within the broad ambulacral grooves the tube-feet show a regularly biserial arrangement, a pair occupying the depression between two angular adambulacral plates. The sturdy and distinct tube-feet, which have numerous fine annulations, lack well defined sucking discs although there may be small nipples.

The oral plates are long (about 6 mm) and narrow (3 mm), the two plates being separated distally by a very distinctive muscular interval and bearing between 16 and 20 round-tipped, sturdy, furrow spines and a suboral row of much shorter and thicker spines, all with numerous small, fine teeth near the tip.

There is a well developed and distinct actinostomial ring. The oral membrane is covered with small, brown, regularly arranged papillae, and the ampullae of the tube-feet are double.

Colour in Life: Notes (by J. S. Bullivant) included with the present specimens give the colour of the largest specimen (from Sta. A644) as "yellowish brown with brown tube-feet". A colour transparency taken by G. A. Harlen at this station shows the specimen as dark brown with darker tube-feet. Koehler (1912) records the colour in living specimens as a rather pale brownish yellow. In spirit, the specimens are a very pale brown or white with darker brown tube-feet.

Type Locality

Challenger Expedition Station 149 H off Cumberland Bay, Kerguelen Island, in 127 fm (235 m).

Distribution

Antarctic, circumpolar, south of 40°. Sladen (1889) also recorded it from Heard Island. Koehler has recorded it from the South Shetlands, Adelie Land, Shag Bank, and South Georgia. Fisher (1940) records it from South Georgia, South Orkneys, Palmer Archipelago, and the Ross Sea. *Bathymetric Range:* 18–835 m.

Material Examined

Twenty-two specimens from eight stations as follows:

Sta. A448, 752 m (1); Sta. A457, 315–342 m (3); Sta. A459, 534–549 m (2); Sta. A460, 415–430 m (12); Sta. A461, 578–567 m (one and remains of at least one other); Sta. A466, 569 m (1); Sta. A644, 530 m.

Stanford University Stations: Sta. GLD–16, 835 m (1).

Size: In the present collection R varies between 162 mm and 5 mm (average 36 mm) and r between 27 mm and 3 mm (average 9 mm). The present description is based on a specimen (A461) in which R = 35 mm and r = 9 mm. Fisher (1940) records a specimen in which R = 204 mm and r = 32 mm.

Remarks

These specimens do not differ markedly from previous descriptions, although no mention has previously been made of the strange "button-like" pedicellariae. A specimen from the British Museum (Natural History) shows these structures and Miss A. M. Clark reports similar structures in specimens of *Bathybiaster loripes* from Kerguelen. In most of these specimens there is a distinct epiproctal cone; Professor H. B. Fell (private communication, December 1961) believes this is a respiratory structure. These asteroids live on soft muddy bottoms and the epiproctal cone probably projects above the mud while the animal lies buried, respiratory interchange occurring through the thin skin. Epiproctal cones are found in other members of the Astropectinidae also. The presence of the incipient spines on the inferomarginal plates is most marked in specimens where R = 70 mm or over. In the specimen from the Stanford University Collection the small paxillae rarely have more than four spines; there are also three distinct tentacles on the arm tip.

Ecology

All specimens collected by the Oceanographic Institute are recorded from a muddy substrate, while the specimen from Stanford University Station GLD–16 was recorded from a gravel and pebble bottom. Previous specimens were also taken from mud; thus the presence of pointed tube-feet and fascioles is not surprising. Possibly showers of detritus fall on the abactinal surface of the animal and it is carried to the actinal surface and finally the mouth within the fascioles by the action of the fine spinelets.

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Psilaster Sladen, 1885

Superomarginals and inferomarginals equally developed with enlarged spines or spinules. An unpaired interradial series of actinal intermediate plates at least partially developed. Madreporite small and exposed. No conspicuous projection of the adambulacral plates into the furrow and furrow spines showing a fan-like arrangement.

Type Species: Astropecten andromeda M. and T.

A single Ross Sea species.

Psilaster charcoti (Koehler) (pl. 3, fig. 7 and 8; text-fig. 4)

Ripaster charcoti Koehler, 1906. Expéd. Antarct. Franç. 1903–05, Échinodermes, p. 4, pl. 3, fig. 20–21, 31, and 32; 1908. Expéd. Antarct. Nationale Écossaise. Trans. Roy. Soc. Edin., 46 (3), p. 540; 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 101, pl. 8, fig. 2; 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 258, pl. 51, fig. 5; pl. 52, fig. 1; pl. 72, fig. 1.

Ripaster longispinus Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 260, pl. 51, fig. 6–8; pl. 52, fig. 2–4; pl. 72, fig. 2; 1923, Swedish Antarct. Expéd. Astéries et Ophiures, p. 95, pl. 12, fig. 6–8.

Psilaster charcoti Fisher, 1940. Disc. Rpts. 20, p. 93; Clark, A. H., 1950. Echinod. of the U.S. Navy Antarct. Exped. 1947–48, J. Wash. Acad. Sci. 40, p. 336; Bernasconi, 1956. Algunos Asteroideos de Antárida, Anal. Socied. Cientifica Argentina, 161, p. 8, pl. 3, fig. 3 and 4.

Arms taper evenly from the broad disc to sharp tips; both abactinal and actinal surfaces slightly convex.

The abactinal surface has small indistinctly six-lobed plates bearing a central trunk with a much enlarged head crowned with spinelets. On the disc and along the arms where the plates are irregularly arranged the paxillae are close packed and composed of from 15 to 25 spinelets; near the margin of the arms the paxillae are arranged in regular transverse rows of eight to 10 plates, with seldom more than 12 spinelets. The spinelets are thorny and thick set with enlarged heads and usually there are several slender marginal spinelets surrounding a number of larger central ones.

On the disc and the proximal regions of the arms especially when the specimen is dry, small, "button-like" pedicellariae standing slightly above the level of the surrounding paxillae are similar to those seen in *Bathybiaster loripes obesus* and consist of the enlarged and confluent heads of several spinelets. The trunk bearing this modified paxilla is distinctly larger and sturdier than those surrounding it.

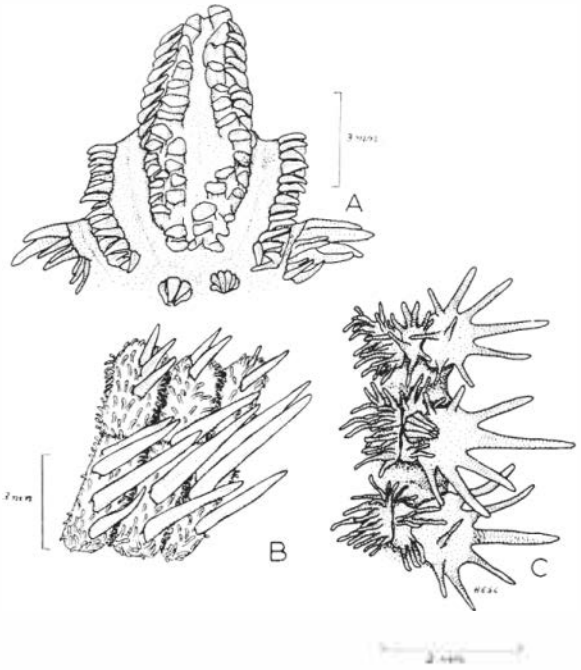

FIG. 4: *Psilaster charcoti*, A, oral plates and the adjacent long, narrow adambulacral plates in a specimen from the Stanford University Collection Sta. GLD-4; B, superomarginal and inferomarginal plates; C, adambulacral plates showing the fan-like arrangement of the furrow spines. Both B and C from a specimen from Sta. A448. Each drawing to the scale shown.

As many as eight small, inconspicuous papulae occur between the lobes of the abactinal plates but are few along the midline of the arms.

The oval madreporite, measuring about 2 mm by 1·5 mm, is interradial in position and nearer the edge than the centre of the disc; dissecting it are a number of narrow grooves and surrounding it about 12 enlarged paxillae.

There is a central inconspicuous anus.

Both the rather tumid band-like superomarginal and inferomarginal plates are confined to the lateral surfaces of the arms; the superomarginal plates, which are between 3 and 3·5 mm long and 2 and 2·5 mm broad in the interradius, seldom exceed 1 mm near the arm tip. Near the upper surface of the plate there are three or four flat spines between 2 and 3 mm long. Occupying the rest of the plate are a number of short blunt-tipped, rather inconspicuous, thorny spinelets; while towards the arm tip, the larger spines are absent altogether.

The inferomarginal plates lying directly below the superomarginals are larger (between 2·5 and

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5 mm long by 2 mm broad), bearing three or four flat spines between 2 and 5 mm long. The blunt-tipped, thorny spinelets covering the rest of the plate are similar to those already described. Rather shallow fascioles, lined with fine spinelets, occur between both series of plates.

Paving the actinal interradial regions are small, round, or oval plates arranged in regular rows, at least one row extending almost to the arm tips. On each plate there is a paxilla consisting of from six to 10 blunt-tipped sturdy spinelets, the heads of which are often somewhat enlarged and confluent.

The adambulacral plates, which do not project markedly into the furrow, bear a fan-like arrangement of spines with a prominent, blunt-tipped somewhat recurved median furrow spine and two or three shorter furrow spines on either side; there are also two or three subambulacral spines. Distinct muscular intervals are present between the plates.

The long, slender tube-feet which lack distinct sucking discs, are biserially arranged.

The oral plates are very distinct, measuring between 8 and 9 mm long and 4 mm wide; their armature consists of 15 regular, blunt-tipped, furrow spines and about 20 shorter, sturdier, suboral spines, the latter often forming a double row distally.

Colour in Life: There are no colour notes with these specimens. Koehler (1912) records the colour as a reddish brown ("laque brulée", p. 102) with lighter edges in one specimen, while the actinal surface of the second specimen is slightly brown yellow. In the Swedish Antarctic report (1923, p. 97) the colour is recorded by Koehler in young specimens as being pale yellow. Fisher (1940, p. 94) describes a large specimen as "bright pink above, yellow below" and for another specimen he notes "abactinal surface pale delicate pink, inclining to delicate purple towards and at centre". In spirits, the specimens are white or a pale fawn with darker brown tube-feet.

Type Locality

Booth-Wandel Island south of the Palmer Archipelago.

Distribution

Circumpolar, from areas south of 50° including in the west the Palmer Archipelago, South Shetlands, and the South Orkneys; and in the east off Queen Mary and Adélie Land, the Ross Sea, and Bouvet Island. *Bathymetric Range:* 30–3248 m.

Material Examined

Twenty-one specimens from eight stations as follows:

Sta. A448, 752 m (1); Sta. A459, 534–549 m (11); Sta. A461, 578–567 m (3); Sta. A466, 569 m (1).

Trans-Antarctic (New Zealand) Expedition Collection: Ser. No. 801, Botany Bay, Granite Harbour, 74 m (1).

Stanford University Stations: Sta. GLD–4, 587 m (2); Sta. GLD–5, 695 m (1); Sta. GLD–8, 631 m (1).

Size: In these 21 specimens R ranges from 90 mm (Stanford University Sta. GLD–4) to 7 mm (also Stanford University Sta. GLD–5) and r from 21 mm to 3 mm. In the average specimen R = 40 mm and r = 11 mm. The description is from a specimen (A448) in which R = 34 mm and r = 8 mm.

Remarks

There seems to be no previous record of pedicellariae on the abactinal surface, nor is there reference to the strong dorsal muscle bands which are present in many of these specimens resulting in the arms being strongly curled over the abactinal surface. They have a small but distinct epiproctal cone. In the smallest specimen (Stanford University Sta. GLD–5), where R = 7 mm, there is very little development of marginal spines; however, in a slightly larger specimen in which R = 10 mm there are at least two distinct inferomarginal spines which are most obvious in the interradial angles.

Ecology

As the tube-feet lack distinct suckers and as fascioles are present it would appear that these animals are indicative of a muddy bottom. This is true for all specimens except the Stanford University Collections (GLD–4, GLD–5, and GLD–8) which are recorded from a sponge-gorgonacean-pennatulid complex.

Family BENTHOPECTINIDAE

Verrill, 1889

A single Ross Sea genus.

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Luidiaster Studer, 1883

No unpaired interradial marginal plate, marginals with conspicuous spines. Paxillae with numerous spines and granules; papularia more or less flat and distinctly bilobed (kidney shaped). Actinal intermediate plates present in adult. Pectinate pedicellariae usually present. Adambulacral plates with two or more enlarged subambulacral spines.

Type Species: Luidiaster hirsutus Studer, 1883.

The diagnosis no longer relies on the attachment of the dorsal muscle bands since they are now considered to be of doubtful value, especially in collections where one specimen only is present or specimens have been dried. The above diagnosis included *Acanthacaster*, and in the main follows Ludwig (1910).

A single Ross Sea species.

Luidiaster gerlachei (Ludwig) (pl. 5, fig. 1 and 2; text-fig. 5)

Cheiraster gerlachei Ludwig, 1903. Seesterne. Results Voyage S.Y. Belgica, p. 9, pl. 1, fig. 1–8, pl. 2, fig. 9 and 10.

Luidiaster gerlachei Ludwig, 1910. Notomyota, eine neue Ordnung der Seesterne. Sitzungsber. k. preuss. Akad. Wiss., 23, p. 452; Fisher, 1911. U.S. National Mus. Bull. 76 (1), Phanerozonia and Spinulosa p. 127; Koehler, 1920. Australas, Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 244, pl. 55, fig. 2–6, pl. 65, fig. 8; Fisher, 1940. Disc. Rpts. 20, p. 96; Madsen, 1955. Sci. Res. Norwegian Antarct. Exped. 1927-28, 37, p. 12.

Arms tapering evenly from the small disc to sharp tips; abactinal surface slightly concave and actinal surface convex; animal compressed dorso-ventrally.

Abactinal surface covered with small, very distinctive paxillae which show no regular arrangement except towards the edges of the arms where there are transverse rows of four to six paxillae. These plates are oval or hexagonal and of two distinct sizes. The larger plates bearing tubercles or bosses with from 10 to 13 peripherally arranged, thorny spinelets (from 0·25 to 0·50 mm long), and one distinct, longer central spine (about 1 mm long), may be compared to a candle held in a very ornate candle holder. The smaller plates surrounding the larger ones and bearing paxillae with fewer peripheral spinelets and no distinct central spine are most obvious on the arms.

Pedicellariae are absent from the abactinal surface.

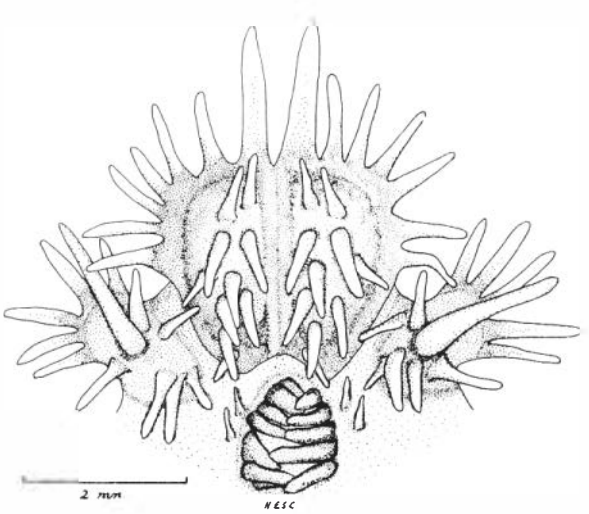

FIG. 5: *Luidiaster gerlachei*, oral and adjacent adambulacral plates and pectinate pedicellaria, in a specimen from Sta. A461.

There are five distinct, more or less kidney-shaped papular areas on the disc, one at the base of each arm; each papularia contains from nine to 13 slender, tapering papulae.

The oval and finely dissected madreporite is interradial in position and nearer the edge than the centre of the disc; surrounding it are several enlarged paxillae.

There is a central inconspicuous anus, occupying a slightly depressed area.

From 26 to 28 small marginal plates (lying opposite each other in the interradial angle and alternating distally) extend from the angle to the arm tip. The hexagonal and tumid superomarginal plates which bear a central tubercle with a single, stout, blunt-tipped spine about 1 to 2·5 mm long are each surrounded basally by between 24 and 30 short, thorny spinelets, arranged in several circles and when the central spine is removed it leaves a distinct scar. There is a noticeably naked area present between the superomarginal and the abactinal plates.

The inferomarginal plates are larger and the central spine from 2 to 2·5 mm long. There may be one or two other enlarged spines generally inserted below the large and conspicuous spine and from 36 to 40 small spinelets arranged in two or three circles round the central spine.

The actinal plates do not extend into the arms; in each interradial angle there are three or four distinct pectinate pedicellariae each involving two plates; the four or seven enlarged flattened spines of one plate are opposed to and often interlock

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with those of a neighbouring plate. From three to six small plates, each with two or three thorny spinelets, occupy the actinal intermediate regions between the pedicellariae and the inferomarginals.

The adambulacral plates, bearing from five to eight blunt-tipped furrow spines – the median being longest (about 2 mm) – and four to seven subanbulacral spines, two of which may be long and distinct (between 2 and 3 mm), have wedge-shaped keels extending into the furrows.

Within the ambulacral groove the tube-feet are regularly biserial and terminate in rather indistinct suckers.

The oral plates are wide and fan-shaped, extending well over the mouth and bearing six or seven furrow spines and from eight to 10 shorter, slender suboral spines often arranged in two rows.

Colour in Life: There are no colour notes with these specimens. Ludwig (1903) records the colour of small specimens as white, and of larger specimens as "deep red often with pale flesh-coloured flecks". Koehler (1920, p. 245) notes the colour as "pink". In spirits, the specimens are white with brown tube-feet.

Type Locality

Southern Bellingshausen Sea, about 450 m.

Distribution

Circumpolar, Antarctic, between latitudes 60° and 75°S. Ludwig's specimens were taken in the Southern Bellinghausen Sea between 70° and 70° 23'S and 80° 48' and 84° 06'W; Koehler's (1920) specimens were taken between 96° 13' and 145° 31'E and between 64° 44' and 66° 55'S, and Fisher's (1940) specimens were from the Palmer Archipelago, the South Shetlands, and the Ross Sea. *Bathymetric Range:* 160–810 m.

Material Examined

Eighteen complete specimens were collected from the following seven stations:

Sta. A448, 752 m (1, part only); Sta. A456, 238–201 m (1); Sta. A457, 315–342 m (3); Sta. A459, 534–549 m (1); Sta. A461, 578–567 m (10); Sta. A527, 358–337 m (1).

Stanford University Station: GLD–8, 631 m (2).

Size: This description is from a specimen (A461) in which R = 40 mm and r = 7 mm. In the largest specimen in the present collection R = 50 mm and r = 12 mm, while in the smallest specimen R = 18 mm and r = 6 mm. The average measurements for these 18 specimens are R = 34 mm and r = 8 mm. Fisher (1940, p. 96) records the largest specimen in which R = 110 mm and r = 18 mm.

Remarks

These specimens agree in most details with previous descriptions. Where R = 25 mm or over there are often two or three enlarged inferomarginal spines present, a fact on which Fisher (1940, p. 96) also remarks. There may also be more than one enlarged spine in the abactinal paxilla of larger specimens, especially in those which surround the madreporite, and the smaller spinelets may be arranged in more than one circle. Thus, as Fisher (1940, p. 97) suggested, it is probable that *hirsutus* and *gerlachei* are races of the one species. The number of pedicellariae varies; in large specimens where R = 40 mm or over there may be as many as six pedicellariae in one interradial angle, while in very small specimens there may be only two or three or they may be completely absent from one or two of the interradial angles. In small specimens, in which R = 20 mm and less, the keels of the adambulacral plates are very pronounced and form distinct "pockets" in which the tube-feet are enclosed.

Ecology

As in all Benthopectinidae the absence of a well defined sucker on the tube-feet is indicative of a muddy substrate. The material from Stanford University Sta. GLD–8 is recorded from a complex of sponge, gorgonaceans, and pennatulaceans, whilst the substrate at all other stations was muddy or, in one instance (A527), stony.

Family ODONTASTERIDAE

Verrill, 1899

KEY TO THE ROSS SEA GENERA

1 (2) Abactinal plates with a distinct tabulum bearing well developed paxillae composed of short to fairly long spinelets. **Odontaster** Verrill 1880

2 (1) Abactinal plates without a distinct tabulum and crowned with low granules or granuliform spinelets which do not form paxillae **Acodontaster** Verrill, 1899

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Odontaster Verrill, 1880

Abactinal plates with a distinct tabulum bearing the short to long spinelets of the paxillae. Marginal plates small to well developed and more or less tabulate or spinulose. Actinal areas spinulose, often densely. A single recurved suboral, hyaline spine, common to the two oral plates at each mouth angle.

Type Species: *Odontaster hispidus* Verrill

Key to the Ross Sea Species

1 (2) Actinal plates large, more or less rectangular with many spines, the most central of which are robust, subclavate and bent towards the margins. ..... **meridionalis**

2 (1) Actinal plates small and bearing four or five rather short, cylindrical, obtusely pointed spines of similar size ..... **validus**

Odontaster meridionalis (Smith) (pl. 6, fig. 3 and 4; text-fig. 6)

Astrogonium meridionale Smith, 1876. Descript. of Species of Asteriidae and Ophiuridae from Kerguelen's Island. Ann. Mag. Nat. Hist., Ser. 4, 17, p. 109.

Pentagonaster meridionalis Smith, 1879. Rep. on Coll. from Kerguelen made during Transit of Venus Exped. 1874–75, Echinoderma, Philosophical Trans. Royal Soc. London, 168, p. 276, pl. 16, fig. 6 and 6a.

Gnathaster meridionalis Sladen, 1889. Challenger Rpt., 30, p. 287, pl. 47, fig. 1 and 2; pl. 48, fig. 5 and 6; pl. 49, fig. 11 and 12.

Odontaster elegans Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 72, pl. 7, fig. 5–11.

Gnathaster elegans Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 227, pl. 41, fig. 7 and 8; pl. 71, fig. 4; Döderlein, 1928. Deutsche Südpolar-Exped. 1901–03, 19 (2), p. 297.

Epidontaster pentagonalis Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 235, pl. 39, fig. 3, 4, and 8; pl. 41, fig. 9–11.

Odontaster meridionalis Fisher, 1940. Disc. Rpts. 20, p. 99; Clark, A. H., 1950. Echinod. of the U.S. Navy Antarct. Exped. 1947–48. Journ. Wash. Acad. Sci. 40, p. 336.

Arms distinct, short and tapering to a blunt tip protected by a rectangular plate; body somewhat compressed dorso-ventrally.

The abactinal plates which border the edges of the disc and arms, are small, four-lobed, and arranged in regular rows of seven or eight. On the centre of the disc there is no regular arrangement of the plates which are larger, with five or six indistinct, generally overlapping lobes and no connecting ossicles. Each plate bears a slender trunk or stem, the rounded head crowned with numerous (from 12 to 25) thorny-tipped spinelets forming the paxilla; the central spinelets are generally somewhat enlarged, and clavate and most obvious on the centre of the disc.

Pedicellariae are absent from the abactinal surface.

From one to five small, distinct papulae occur in the membranous areas between the lobes of the plates over most of the abactinal surface but are absent in the interradial midline.

Neither the madreporite nor the anus is obvious, both being hidden by neighbouring paxillae.

The marginal plates are distinct bordering the arms and disc, from 20 to 22 plates extending from the interradial angle to the arm tip. The oblong and rather tumid superomarginal plates bear from 24 to 28 thorny spinelets (similar to those of the abactinal paxillae) on a broad, low tabulum.

Corresponding in position to these, the inferomarginals are larger and block-like bearing up to 30 spinelets, the central spinelets being often distinctly enlarged. On the actinal surface of these plates there may be a number of fine, sharp-tipped, spinelets.

At least one row of actinal plates extends almost to the middle of the arm. In the interradial regions the plates are small, rectangular, and regularly arranged, two plates corresponding to one inferomarginal.

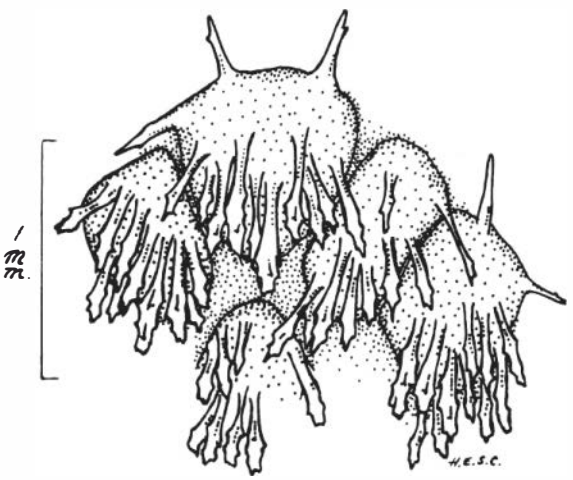

Fig. 6: *Odontaster meridionalis* actinal plates and spines in a specimen from Sta. A460. Note the more or less club-shaped spines.

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These plates, each with a large number (from nine to 18) of slender, thorny spinelets, and with the central spines often enlarged distally and bending outwards, give the entire surface a "shaggy" appearance. In three of the oral angles distinct pedicellariae are present, each formed by the much enlarged and very thorny tips of two or three spines.

The adambulacral plates are small; there are three slender, blunt-tipped, cylindrical furrow spines (1·5–2 mm long), with the median spine longest and seven to nine similar, though rather shorter, subambulacral spines arranged irregularly. These spines, rising from a slightly bulbous base, are smooth in their first quarter and then finely spinulose.

Within the narrow ambulacral grooves, the tube-feet each terminate in a distinct but small sucking disc and are biserially arranged.

The oral plates bear six or seven furrow spines arranged in a graded series with the smallest set well down in the mouth and five or six suboral spines, those adjacent to the unpaired median spine being thicker and sturdier than the others. There is one large, sturdy, hyaline median spine, common to the two-mouth plates and triangular in cross section.

Colour in Life: There appears to be a wide range of colour which Koehler (1912, p. 76) notes as ranging from yellow white through dirty yellow to a brilliant orange and a pale brown; while in another specimen the centre of the disc is grey grading to white at the arm tips. Colour notes made by R. E. Barwick during the Trans-Antarctic (New Zealand) Expedition (No. 850) record "reddish orange to light orange to bluish white to purplish white" but as the single specimen of *Odontaster meridionalis* was included with a large number of specimens of *O. validus* it is rather doubtful which colours refer to which species. In spirit, the specimens are light brown or white.

Type Locality

Royal Sound, Kerguelen Island, 5–10 fm (10–28 m).

Distribution

Circumpolar, Antarctica, extending west to South Georgia and east to Marion, Kerguelen, and Heard Islands. This is the first record of this species from the Ross Sea, though Koehler (1920) reported it from Adélie Land. *Bathymetric Range*: 15–591 m.

Material Examined

Thirty specimens from 14 stations as follows:

Sta. A459, 534–549 m (1); Sta. A460, 415–430 m (3); Sta. A468, 110 m (7); Sta. A471, 165–69 m (3); Sta. A520, 201–205 m (1); Sta. A525, 591–583 m (2); Sta. A527, 358–337 m (3); Sta. A533, 84–183 m (2); Sta. A537, 574–543 m (1); Sta. A625, 460 m (2)

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 850, 110 m (1).

Stanford University Stations: Sta. V, 29 m (1); Sta. CEK, 30 m (1); Sta. EAD-2, 315 m (2).

Size: This description is based on a specimen (A460) in which R = 18 mm and r = 8 mm. In the present collection of 30 specimens R averages 12 mm and r averages 6 mm. This species does not grow to any great size and that recorded by Fisher (1940, p. 100), in which R = 91 mm. appears to be the largest known specimen.

Remarks

There seems little to add to previous descriptions. There is, however, some variation in shape. In specimens from A468, A525, A549, and A625 the form of the body is markedly pentagonal with very short arms.

Odontaster validus Koehler (pl. 6, fig. 1 and 2; text-fig. 7)

Odontaster validus Koehler, 1906. Expéd. Antarct. Franç. 1903–05, Échinodermes, p. 6, pl. 3, fig. 22–26; Koehler, 1908. Expéd. Antarct. Nationale Écossaise, Trans. Roy. Soc. Edin., 46 (3), p. 540; Koehler, 1911. Brit. Antarct. Exped. 1907–09, 2 (4), p. 27; Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 68, pl. 7, fig. 1–4 and 12; Fisher, 1940 Disc. Rpt. 20, p. 101; Bernasconi, 1956. Algunos Asteroideos de Antartida Anal. Socied. Cientifica Argentina, 161, p. 9, pl. 4, fig. 3 and 4.

Odontaster tenuis Koehler, 1906. Expéd. Antarct. Franç. 1903–05, Échinodermes, p. 8, pl. 4, fig. 33, 34, and 36–38.

Cycethra verrucosa Bell, 1908. National Antarct. Exped. 1901–04, 4, p. 10, pl. 5, fig. 1; Bell, 1917. Brit. Antarct. Terra Nova Exped. 4 (1), pl. 1, fig. 1–6.

Gnathaster validus Koehler, 1920. Australas. Antarct. Exped. 1911–14. Sci. Rpt., Ser. C, 8 (1), p. 228, pl. 34, fig. 10; pl. 40, fig. 4, 5, and 7; pl. 41, fig. 2 and 5; pl. 72, fig. 3; Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, p. 84.

The disc is broad and distinct and the rather short arms taper to blunt tips.

The abactinal surface is paved by small, four or five lobed plates.

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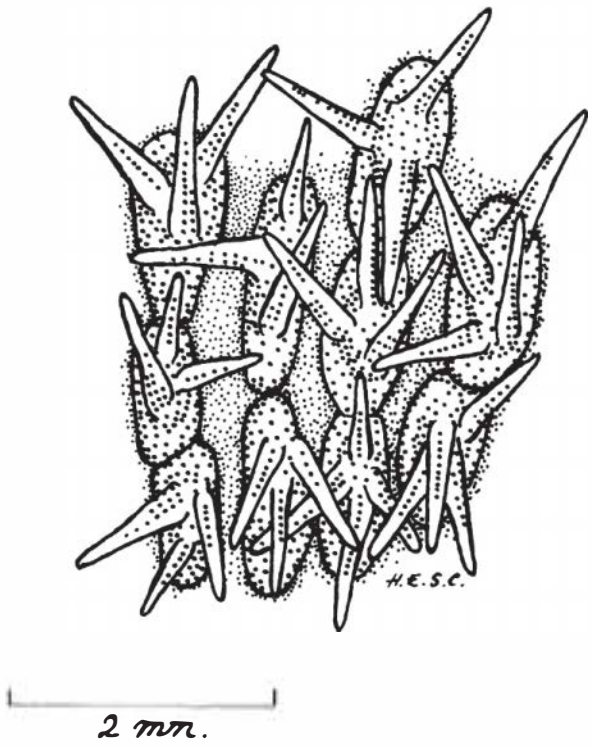

FIG. 7: *Odontaster validus* actinal plates and spines in a specimen from the Trans-Antarctic (New Zealand) Expedition Collection No. 247.

On the centre of the disc the lobes are well developed, but towards the margins they are indistinct and the plates often isolated. These plates, arranged in regular transverse and longitudinal rows, except on the centre of the disc where the arrangement is irregular and the paxillae close packed, bear a trunk or stem crowned with from 10 to 16 short, sharp-pointed, often finely spinulose spinelets; there is a peripheral series of these and also from two to six central spinelets.

Pedicellariae are absent from the abactinal surface.

The madreporite, which is nearer the edge than the centre of the disc, is more or less circular (about 2 mm), finely dissected and almost completely hidden by encroaching and somewhat enlarged paxillae.

The anus occupies a slight central depression on the disc and is not very obvious.

The block-shaped superomarginals bear distinct paxillae consisting of rather short stems or trunks, with oblong heads on which there are 11 to 14 spaced spinelets similar to those described above; they do not form a distinct border to the disc and arms. Between 40 and 42 plates extend from the interradial angle to the arm tip.

The inferomarginals are larger, corresponding exactly with the superomarginals; the nine to 13 spinelets of these paxillae are borne on a rectangular head.

In the large actinal interradial regions at least one row of plates extends for half the length of each arm. These plates are small, rectangular, slightly tumid, and arranged in regular longitudinal rows, the outermost plates of each series corresponding to one inferomarginal, and there are distinct membranous channels between each longitudinal row of plates. There are two to four subequal, blunt-tipped, cylindrical, upright spines on each plate. In each oral angle, immediately adjacent to the oral plates, there is a small, distinct pedicellaria consisting of two (or in one case three) short, upright, modified, flattened spines, the tips of which meet.

The adambulacral plates are band like and separated by distinct intervals; there is a pair of blunt-tipped furrow spines (about 2 to 3 mm long) set at a slight angle to the furrow, and four or five shorter, subambulacral spines arranged in no definite order. The most actinal of these are short and very slender, and both these spines and those of the actinal plates are finely spinulose for most of their length.

The tube-feet are biserial and terminate in small, rather indistinct, sucking discs.

The oral plates are distinct, bearing a furrow series of five or six similar rather sturdy, short, blunt-tipped spines; a large, sturdy, median, unpaired, suboral spine (triangular in cross section); and three shorter suboral spines.

Colour in Life: This species is among the most common in the Ross Sea and is visible in underwater photographs taken by J. S. Bullivant at the following stations: A468 (2), one specimen immediately above a soft branching coral; A468 (3), probably the small specimen; A469 all four specimens; A471, probably all specimens, in these the colour, orange above and white or pale below with light coloured arm tips, is characteristic of this genus as the many colour notes record; A518, one specimen to the left of the gorgonid and probably also the small specimen above and to the right of the same gorgonid; A531 (11), the specimen to the left of the crinoid; A538 (3), a small specimen with two arms apparently buried in the mud.

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Notes made by members of the Trans-Antarctic (New Zealand) Expedition record the colour of the abactinal surface in most cases as being dark carmine (No. 572, 573, and 661, with notes by R. E. Barwick; and No. 574 and 575, with notes by A. Packard); or alizarin red (No. 882 and 626, with notes by R. E. Barwick) or a beetroot red with paler margins (No. 637, notes by R. E. Barwick). Smaller specimens are recorded as being orange red (No. 661, R. E. Barwick). In a specimen from No. 572, Dr R. W. Balham records a straw colour in the marginal regions, then orange with brown, and orange with purple, on the disc. Both R. E. Barwick and A. Packard note orange eye spots in specimens from No. 572, 573, 574, and 575. The actinal or "oral" surface is recorded as light fawn, yellow, or colourless (No. 626, 661, and 882, all notes by R. E. Barwick) while in a specimen from No. 572 Dr R. W. Balham notes the colour of the oral surface as being light straw towards the outer edges of the arms which are bounded internally by a white-pink border. Colour notes recorded by R. E. Barwick for a large number of specimens from No. 850 are: "reddish orange to light orange to dark orange to bluish white to purplish white". Koehler (1906) records the colour of the type material as being dark brownish yellow, and later (1912 and 1920) he notes variations in colour of the abactinal surface from red to brick red, carmine, rosy pink, a "beautiful" orange, purplish, and violet; the colour of the actinal surface is noted as yellow. Fisher (1940) records bordeaux and pansy purple, apricot orange, and a very dark brown or almost black specimen. (Ridgeway's nomenclature.)

In a private communication (November, 1961) J. S. Pearse, a biologist at McMurdo Sound, who has been working on this species from a physiological aspect, remarks on the differences in colour between specimens from Cape Evans and N. A. F. McMurdo, which are separated by only 13 miles. The specimens from Cape Evans are generally larger with richer colouration, a deep red abactinal surface and a yellow-to-orange actinal surface, while in the smaller specimens from McMurdo the abactinal surface is pale pink and the actinal surface white. Colour photographs taken by John H. Dearborn (colour plate I) of two asteroids from Cape Evans and McMurdo illustrate this very well.

Type Locality

Antwerp Island, Palmer Archipelago.

Distribution

Circumpolar, Antarctica; north to Shag Rocks and Bouvet Island. Probably the specimen which Koehler (1908) lists from the Falkland Islands bears an erroneous label as none of the extensive collections of the RSS *William Scoresby* on the Falkland Plateau revealed a single specimen of *O. validus*. *Bathymetric Range:* 0–914 m.

Material Examined

Four hundred and twelve specimens from 40 stations as follows:

Sta. A449, 362 m (14); Sta. A454, 914–828 m (1); Sta. A456, 238–201 m (1); Sta. A467, 88–183 m (47); Sta. A468, 110 m (18); Sta. A469, 64 m (10); Sta. A470, 377 m (1); Sta. A471, 165–69 m (54); Sta. A519, 479 m (1); Sta. A528, 274–265 m (1); Sta. A529, 205–216 m (2); Sta. A530, 271–267 m (5); Sta. A533, 84–177 m (18); Sta. A534, 380–366 m (1); Sta. 537, 574–543 m (1); *Endeavour*, Ross Sea, January 1960 (16).

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 79, McMurdo Sound, 174 m (4); 247, Pram Point, 21 ft (1); 274, Pram Point, 21 ft (2); 290, Cape Armitage, 124 m (2); 329, Cape Armitage, 124 m (1); 572, Cape Armitage, 13 m (6); 573, Cape Armitage, 13 m (5); 574, Cape Armitage, 13 m (5); 575, Cape Armitage, 13 m (3); 626, Cape Evans, 53 m (2); 637, Cape Evans, shore (1); 638, Cape Evans, shore (1); 661, Turtle Rock, ice edge (2); 672, Hut Point, McMurdo Sound, 124–165 m (1); 675 Hut Point, McMurdo Sound, 124–165 m (71); 747, Cape Roberts, 188–193 m (2); 801, Botany Bay, Granite Harbour, 74 m (3); 850, Cape Evans, 111 m (68); 882, Cape Royds, 22 m (10); Dominion Museum Station (R. K. Dell), McMurdo Sound, 65 m (15); Dominion Museum Collection, Cape Hallett, on the beach (coll. Brian Reid) (22).

Stanford University Stations: Sta. GLD–12, 15–30 m (1); Sta. GLD–13, 164 m (1); Sta. No. M, 37 m (2).

Size: In the present specimens R ranges from 45 to 3 mm and r from 20 to 2 mm; for the 412 specimens R averages 16 mm and r = 8 mm. This description is from a specimen (Trans-Antarctic (N.Z.) Expedition No. 247) in which R = 35 mm and r = 13 mm. In general in this species R does not exceed 50 mm although Koehler (1906, p. 81) records a specimen in which R = 58 mm and r = 25 mm.

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Young Stages

In many young specimens in which R = 7 mm or less the spines of the abactinal and marginal paxillae are extremely thorny. There is also little differentiation of the median unpaired oral spine. In a very small specimen from A471 this spine appears to be absent from three of the oral angles and in the remaining two angles is little developed. In some instances this spine is vertical rather than horizontal. In many of these young specimens the marginals are exceptionally massive, forming a well defined border to the abactinal surface.

Remarks

In general these specimens do not differ markedly from previous descriptions; the presence, in specimens where R = 30 mm or more, of one or two enlarged accessory oral spines is by no means uncommon. In a specimen from the Trans-Antarctic (New Zealand) Expedition Collection (No. 672) there is one small two-valved pedicellaria on the abactinal surface in the interradial region but this is exceptional; the interradial regions are calcified in most of the specimens and papulae are absent from these areas. A small specimen from the same collection (No. 574) has only four arms, apparently this is not due to an injury. A small specimen from A471 has a forked arm and the ambulacral grooves also fork, while the tip of each fork is protected by a distinct plate.

Ecology

J. S. Pearse (private communication, 1961) remarks that *O. validus* is an omnivorous scavenger ingesting diatoms, small crustacea, and even seal meat. His work on reproduction has shown that gametogenesis takes about a year to complete and there is a difference in the length of time it takes to reach completion in the two colonies from Cape Evans and N.A.F. McMurdo Sound.

This appears to be one of the most common asteroids in the Ross Sea and is visible in many of the underwater photographs taken by J. S. Bullivant. The animal appears to occupy a characteristic position with the tips of the arms slightly raised; many of the preserved specimens show a similar attitude. The lighter coloured tips to the arms seen in these photographs have been commented on by R. E. Barwick (Trans-Antarctic (New Zealand) Expedition Collections No. 247). This species apparently has a wide range of habitat and is recorded in the present collections from mud substrate of various types (Sta. A449, A456, A469, A519, A530, and A537) and also from rocks, sand, and gravel (Sta. A454, A467, and A529). For the Stanford University Stations the substrate is recorded as rocky with red algae (Sta. GLD–12), sponge complex (Sta. GLD–13), and grey brown gravel-mud, sponge spicules, and *Limatula* shells (Sta. No. M).

Acodontaster Verrill, 1899

Abactinal plates without a distinct tabulum but often slightly convex and crowned with granules or occasionally rather indistinct spinelets which may be involved in a thin integument, which, however, in no way hides them. Marginal plates prominent to small, granulose, and never tabulate. Actinal areas covered with granules which may graduate into distinct spines near the oral angle.

KEY TO THE ROSS SEA SPECIES

1 (4) Abactinal plates with low, flat distinct granules.
2 (3) Conspicuous pectinate pedicellariae on abactinal surface. **conspicuus**
3 (2) No pectinate pedicellariae on abactinal surface. **hodgsoni**
4 (1) Abactinal plates bearing distinct spinelets with an enlarged and generally polygonal head. **capitatus**

Acodontaster hodgsoni (Bell)

Heuresaster hodgsoni Bell, 1908. National Antarct. Exped. 1901–04, 4, p. 8, pl. 3.

Tridontaster laseroni Koehler, 1920. Australas. Antarct. Exped. 1911–14. Sci. Rpts., Ser. C, (8) 1, p. 214, pl. 47, fig. 7, 9, and 10; pl. 48, fig. 1–7; pl. 69, fig. 5.

Acodontaster hodgsoni Fisher, 1940. Disc. Rpts., 20, p. 115.

Abactinal surface of disc and arms rounded; arms, long, broad at base, tapering rapidly and becoming very narrow. Edges of disc compressed.

Abactinal surface has small, subequal, rounded contiguous plates irregularly arranged on the disc but in regular longitudinal and transverse rows of 12–15 on the arms. Near the superomarginals the plates become regularly rectangular. There is no conspicuous carinal series of plates. Granules covering the plates are flat, close packed, and polygonal, measuring between 0·2 and 0·25 mm, and completely obscure the limits of adjacent plates.

Pedicellariae absent from the abactinal surface.

On the disc there are between four and five papulae present between the plates. Near the arm edges only one papula is present.

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The small madreporite (about 2 mm), lying nearer the centre than the edge of the disc, is dissected by fine radiating grooves.

Anus not apparent.

The marginal plates are inconspicuous; about 47 extend from the interradial angle to the arm tip. The granules of the superomarginals are similar to, though slightly larger than, those of the abactinal surface and generally bear small tubercles.

The inferomarginals corresponding to the superomarginals are covered with identical granules, all with small tubercles.

The large actinal interradial regions are covered with flat plates forming longitudinal rows parallel to the adambulacrals. In the outer regions the plates are covered by flat, closely packed granules often with small central tubercles; near the mouth they become transformed into small, short, cylindrical, round-tipped spines between 0·8 and 1 mm in length. Near the oral angle several of these spines become converted into simple fasciculate pedicellariae.

The adambulacrals bear two short, flattened, furrow spines, two smaller subambulacral spines, and several very small spines which may form fasciculate pedicellariae.

The ambulacral grooves are narrow and the tube-feet have small suckers.

There are seven to eight oral furrow spines. The suboral armature consists of one large unpaired spine with a hyaline tip, two smaller, flanking lateral spines and seven to eight even smaller spines.

Colour in Life: Unknown; in spirits, grey or light brown.

Type Locality

McMurdo Sound, South Victoria Land, 25 fm (46 m).

Distribution

Circumpolar, Antarctica. South Victoria Land, Ross Sea; off Queen Mary Land and Adélie Land, also South Georgia. *Bathymetric Range*: 46–204 m.

Material Examined

None.

Size: This species grows to a considerable size. In Bell's specimen from South Victoria Land R = 200 mm and r = 70 mm.

Remarks

The presence of three teeth in an oral angle is not of great importance as this is a very variable character in other members of the family.

Acondotaster conspicuus (Koehler) (pl. 6, fig. 7 and 8; pl. 7; text-fig. 8)

Pseudontaster conspicuus Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 202, pl. 42, fig. 1–7; pl. 43, fig. 1–10; pl. 70, fig 1; Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, p. 88, pl. 13, fig. 4–6.

Acodontaster elongatus var. *abbreviatus* Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, p. 81, pl. 10, fig. 1–3.

Acodontaster conspicuus Fisher, 1940. Disc. Rpts. 20, p. 113.

The disc is ill-defined, the arms broad at the base, tapering rapidly to blunt tips protected by distinct, saddle-shaped plates. The body is compressed dorso-ventrally and both the abactinal and actinal surfaces slightly convex.

Oblong, pentagonal, or round plates (between 1 and 2·5 mm) paving the abactinal surface are irregularly arranged on the disc and midline of the arms; towards the margin, however, there are regular transverse rows of three or four plates. These plates bear a number of small irregularly shaped and arranged granules (up to 50 on the disc and arms and as few as 15 or 10 towards the arm tips). Each granule has a very short trunk expanding distally, the whole structure being less than 0·3 mm in height and the granules tend to obscure the margins of the plates. There is a sinuous carinal series of slightly larger (about 3 mm) rather tumid plates, which, however, become smaller and indistinct towards the arm tips.

Pectinate pedicellariae occur on the plates of the carinal series. They measure proximally about 1 to 1·5 mm and consist of three or four valves; distally they seldom exceed 1 mm and consist of only two valves. In a typical trivalvate pedicellaria, each valve is boomerang shaped and the points of the three meet centrally; in quadrivalvate types the valves are smaller and the general outline of the pedicellaria is more or less square. There is no regular arrangement of these, both three- and four-valved pedicellariae occurring indiscrimately; the bivalved pedicellariae have sausage-shaped valves.

Slender, translucent papulae occur between the plates in groups of from two to six but are absent near the margins of the arms.

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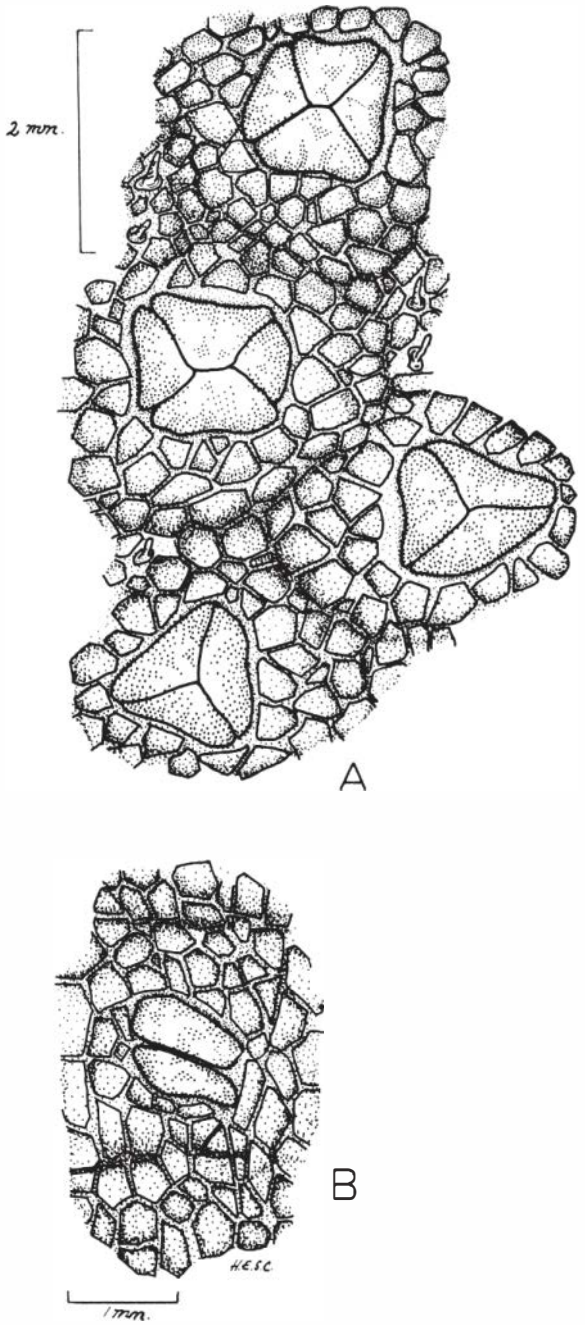

FIG. 8: *Acodontaster conspicuus* A, portion of abactinal surface showing carinal plates with three- and four-valved pedicellariae; B, marginal plate bearing a two-valved pedicellaria. Both drawings of a specimen from Sta. A537. Each drawn to the scale shown.

The large (about 5 mm) distinct, oval madreporite lies nearer the centre than the edge of the disc in an interradial position and is dissected by a great number of fine, sinuous grooves which meet centrally; the surrounding plates are large and tumid.

The anus is central and surrounded by several enlarged granules.

The marginal plates form a very thin border to the disc and arms, between 48 and 50 plates extending from the interradial angle to the arm tips. The superomarginal plates bordering the abactinal surface are generally oblong (about 3 mm by 1·5 to 2 mm) but become smaller near the arm tips; they bear two-, three-, or four-valved pedicellariae. The granules surrounding these are similar to those of the abactinal plates. There are no pedicellariae in the interradial angle or on the last quarter of the arm.

The inferomarginal plates, lying opposite the superomarginals and bearing pedicellariae and granules, differ in no way from those already described.

The actinal interradial regions are extensive, several rows of plates extending almost to the arm tips. These plates are more or less rectangular and arranged in regular longitudinal rows, two corresponding to one inferomarginal. In the outer regions of the arms the plates bear granules similar to those described. Towards the mouth, within a 23–25 mm radius, the granules become greatly elongated and are transformed into sharp-pointed spines about 2 mm long. A row of distinct pedicellariae occur on the plates adjacent to the adambulacrals but are absent towards the arm tips; there are also several aberrant pedicellariae scattered across the actinal interradial region. These pedicellariae are similar to those already described, although in the vicinity of the oral plates the valves are often greatly elongated forming a fascicle.

The adambulacral plates are oblong, bearing two blunt-tipped spatulate furrow spines (between 3 and 4 mm long) and six or seven similar, but shorter, subambulacral spines.

In the narrow ambulacral grooves the tube-feet are biserial with rather indistinct sucking discs.

There is a very sturdy, suboral, hyaline-tipped spine about 7 mm long common to the two plates in each oral angle; there are six or seven blunt-tipped furrow spines, those overhanging the mouth being shortest (about 1·5 mm long), while the remaining spines form a graded series and are about 3 mm long; there are about seven small, suboral spines.

Colour in Life: In a colour photograph by J. S. Bullivant of a trawl sample from A537, the animal is orange with lighter coloured fawn or white pedicellariae. Koehler (1920) records his

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specimens as varying from a brown to a brown yellow, "pink" or orange. In spirit, specimens are fawn-pink with a darker madreporite and tube-feet.

Type Locality

Sta. 1 (Australasian Antarctic Expedition) 66° 50'S, 142° 6'E, 354 fm (655 m).

Distribution

Probably circumpolar, Antarctic. Off Queen Mary Land and Adélie Land (Koehler, 1920), also (Koehler, 1923) off South Georgia, Graham Land. If Fisher's (1940) specimen from Sta. W. S. 865 was correctly labelled, the Falkland Plateau is the northern limit. This is the first record of this species from the Ross Sea. *Bathymetric Range:* 24–655 m.

Material Examined

One specimen from Sta. A537, 574–543 m.

Size: In the single specimen in this collection R = 104 mm, r = 40 mm and R/r = 2·60. In the material collected by Koehler (1920, p. 203) R varied from 132 mm to 11 mm and r = 41 to 5·5 mm; while in the specimens collected by the Swedish Antarctic Expedition (1923) R = 120 mm and r = 53 to 55 mm.

Remarks

Kochler (1920) figures this species in great detail. There appears to be considerable variation in the number of oral spines. An interesting feature of the present specimen, however, is the distal forking of one arm, the forks measuring 18–24 mm respectively. The ambulacral groove also forks. The adambulacral spines bordering this are quite normal and the tube-feet biserial, while the pedicellariae in this region are rather indistinct.

Ecology

The presence of rather indistinct sucking discs on the tube-feet suggest that this animal frequents a soft bottom. This is true for the present specimen which was taken from a mud and gravel substrate; Koehler's (1923, p. 88) specimens were recorded from sand and gravel and a grey clay and alga complex, while Fisher's were taken from grey mud and stones.

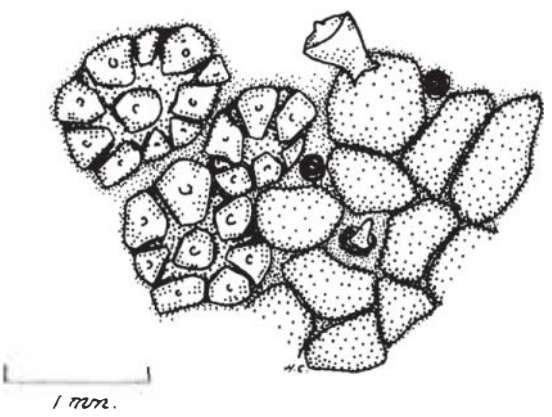

FIG. 9: *Acodontaster capitatus*, abactinal plates, papulae, and granules in a specimen from Sta. A530.

Acodontaster capitatus (Kochler) (pl. 6, fig. 5 and 6; text-fig. 9)

Odontaster capitatus Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 82, pl. 6, fig. 5, 8, 9, and 11.

Acodontaster capitatus Kochler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 195, pl. 44, fig. 1–10, pl. 45, fig. 5 and 6, pl. 69, fig. 1 and 2; Fisher, 1940. Disc. Rpts., 20, p. 110.

The disc is slightly convex and the arms taper to blunt tips protected by crescent-shaped plates. The actinal surface is convex.

Covering the abactinal surface are a number of irregularly arranged small rectangular plates bearing a number of short spinelets arranged in more or less transverse rows; there may be 11 or 12 of these spinelets to a plate on the disc and as few as four towards the arm tips. These spinelets have a slender trunk expanding distally into a rectangular or polygonal head, on the centre of which there is a small raised papilla or tubercle.

Pedicellariae are absent from the abactinal surface.

Between 16 and 23 blunt-tipped papulae, emerging from distinct pores, are confined to rather tumid papularia occurring at the base of each arm and a small, raised central area round the anus.

The small madreporite (less than 1 mm) nearer the centre than the edge of the disc, is surrounded by several enlarged granules and traversed by a number of indistinct, sinuous grooves.

The anus is central, raised and surrounded by a number of blunt-tipped spinelets.

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Between 31 and 33 marginal plates are present from the interradial angle to the arm tip. The supermarginal plates, bordering the abactinal surface, are rectangular and from 1 to 1·5 mm long and 0·75 mm wide; the spinelets or granules covering these plates are similar to those already described. In general each plate bears from 8 to 10 spinelets arranged in two more or less, longitudinal rows.

The inferomarginals, corresponding exactly to the supermarginals and bordering the actinal surface, are slightly smaller (about 1 mm by 0·5 mm wide) and bear rather short spinelets similar to those described above.

On the actinal surface the plates are arranged in more or less regular longitudinal rows, one or two of these corresponding to one inferomarginal plate; these plates bear from four to eight spinelets. Towards the oral angle the spinelets taper to a blunt or rounded tip and are not capitate. In two of these angles the heads of several spines are confluent suggesting a modified pedicellaria.

The adambulacral plates are small and rectangular, bearing two or three sturdy, projecting, blunt-tipped furrow spines about 1 mm long and from four to seven shorter, sturdier subambulacral spines arranged in more or less regular rows. The most actinal of these are small and similar to the spinelets of adjacent plates.

Within the narrow, deep ambulacral grooves the biserially arranged tube-feet have small sucking discs; these grooves are indistinct distally and more or less obscured along their length by the furrow spines.

A single, sharp-tipped oral spine, triangular in cross section and 2 to 2·5 mm in length, is common to the two-mouth plates. There are six slender furrow spines and the four to six suboral spines tend to meet above the large unpaired median spine.

Colour in Life: There are no colour notes with the present specimens. Koehler records the colour in the living specimens as white yellow (1912, p. 85) and "pink" (1920, p. 198). In spirit, the specimens are yellow, fawn, or white.

Type Locality

Entrance to Marguerite Bay, 67° 43′S, 70° 45′ 42″W.

Distribution

This species appears limited to three areas south of 60°: off Graham Land near Alexander the First Island, off Adélie Land (Koehler, 1920), and in the Ross Sea (this collection). *Bathymetric Range*: 655–201 m.

Material Examined

Five specimens from the following five stations as follows:

Sta. A450, 472–318 m (1); Sta. A456, 238–201 m (1); Sta. A459, 534–549 m (1); Sta. A528, 274–265 m (1); Sta. A530, 271–267 m, (1).

Size: In the present collection R varies between 60 and 11 mm and r between 26 and 5 mm; for the five specimens R averages 28 mm and r averages 11 mm. The description above is based on a specimen (A530) in which R=25 mm and r=10 mm. In Koehler's type material R=20 mm and r=6 mm; while in the specimens recorded in his 1920 report R varies between 55 and 17 mm and r between 2·5 and 17 mm.

Remarks

This species may be only a high Antarctic form of *Acodontaster elongatus* (Sladen) as Fisher (1940, p. 110) suggested; it is distinguished from typical *elongatus*, however, by its more slender and elongate rays, narrow supermarginal plates, and coarser granules. In the absence of material of *A. elongatus* for comparison *A. capitatus* is regarded in this report, as a distinct species.

In the largest specimen (A459), in which R = 60 mm and r = 26 mm, the small papillae or tubercles of the capitate spinelets are absent, except near the arm tips. Otherwise these specimens show no marked differences from those described in earlier reports.

Ecology

All the specimens recorded here were from a muddy or sandy bottom, with in one instance, stones. The type material was taken from rocks and gravel; the substrate is not recorded for other specimens. The presence of a muddy bottom may in part account for the ill-defined sucking disc on the tube-feet.

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Family GONIASTERIDAE Forbes, 1841

A single Ross Sea genus.

Pergamaster Koehler, 1920

No large erect spines on any part of the body, which is not covered by skin. Actinal surface granulated; all marginal and abactinal plates completely naked but bordered by single series of polygonal or quadrangular granules. Two furrow spines, single enlarged subambulacral spine, and several subambulacral granules. No pedicellariae. Oral plates inconspicuous with a series of furrow spines and a number of uniform, suboral granules similar to those of the actinal intermediate plates.

Type Species: Pergamaster tesselatus Koehler.

There are two Ross Sea species. *P. incertus* is very similar to *P. triseriatus* except for differences noted below; it has not been considered here as no material was collected. A third species, *P. synaptorous* Fisher, is recorded from off Cape Bowles, Clarence Island.

KEY TO THE ROSS SEA SPECIES

1 (2) Plates of the carina form a single longitudinal series on the arm and are distinctly larger than the abactinal plates of the disc; small tubercles or papillae are present on many of the marginal plates and on the bordering granules ..... **triseriatus** H. E. S. Clark, 1962

2 (1) Plates of the carinal series are similar in size and certainly no larger than the abactinal plates of the disc; no small tubercles present either on the marginal plates or the bordering granules ..... **incertus** (Bell), 1908

Pergamaster triseriatus H. E. S. Clark (pl. 5, fig. 3 and 4; text-fig. 10).

Pergamaster triseriatus H. E. S. Clark, 1962. Trans. Roy. Soc. N.Z. n.s. 2 (6): 45–6.

The disc is high and inflated, with slender arms tapering evenly to blunt tips protected by triangular plates, the actinal surface concave, surface of arms plane.

The abactinal surface of the disc is paved with irregularly shaped flat or tumid plates, varying in size from 1 to 3 mm. Bordering these and usually lying opposite, but sometimes alternating with granules of adjacent plates, are from eight to 11 small oblong or polygonal granules. A single series of carinal plates (contiguous laterally with the superomarginals) extending to the arm tips, are distinctly larger than adjacent abactinal plates; bordering granules, may be little developed or absent distally. On many of these granules, and on the marginal plates, there is a small central tubercle or papilla.

Pedicellariae are absent.

From three to five slender, translucent papulae occur between the bordering granules but are absent from the interradial areas and fewer on the arms.

The madreporite is about 2 mm in diameter and dissected by a number of deep sinuous grooves, and is interradial in position and nearer the centre than the edge of the disc. The plates and granules bordering it are somewhat enlarged.

The anus is central on the disc, surrounded by several enlarged granules.

The very distinctive, tumid superomarginals form a well defined edge to the disc and arms, and are confined to the abactinal surface; from 25 to 27 plates extending from arm tip to arm tip. In the interradius these plates are rectangular (2–3 mm high and 2 mm wide). Towards the arm tip the plates are almost square (about 2 mm), proximally four or five small, rectangular granules border these plates, and distally they may be absent.

From 33 to 35 inferomarginal plates extend from arm tip to arm tip, they are rectangular proximally (2 mm by 1 mm) and almost square distally (2 mm); three or four granules border these plates but may be absent near the arm tips. In two of the interradii there is a median, very small, unpaired triangular plate with the point of the triangle directed abactinally.

Paving the triangular, actinal interradial areas are small, more or less regular, oblong plates, at least one row of plates extending almost to the midpoint of each arm; beyond this the adambulacrals are contiguous with the inferomarginals. These plates bear from four to 10 irregularly shaped, tumid, often finely spinulose granules, with a small, generally acentric tubercle.

Plates of the adambulacral series are rectangular (2 mm by 1 mm) and bear two sturdy, club-shaped furrow spines; near the mouth these may be 2 mm long, and distally they are granuliform. The subambulacral armature, arranged in two transverse rows, consists of a single, enlarged subambulacral spine (this is absent, however, from the adambulacral plates immediately adjacent to the oral plates) and three or four subambulacral granules similar to those of the actinal plates.

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The ambulacral grooves are deep and almost obscured by the adambulacral spines. The tube-feet are biserial with distinct sucking discs.

Each oral plate bears three sturdy, blunt-tipped furrow spines from 2 to 2·5 mm long and similar to adjacent adambulacral spines, and from four to eight suboral granules. Of these, several may be very small and obscure the junctions of the two plates.

Colour in Life: Unknown; in spirits, specimens are white with pale brown tube-feet.

Type Locality

Off Coulman Island, 73° 20′S, 174° 00′E, 369–384 m.

Distribution

Known only from the Ross Sea. *Bathymetric Range:* 369–384 m.

Material Examined

One specimen from Sta. A464, 369–384 m.
Size: In the holotype R = 41 mm and r = 17 mm.

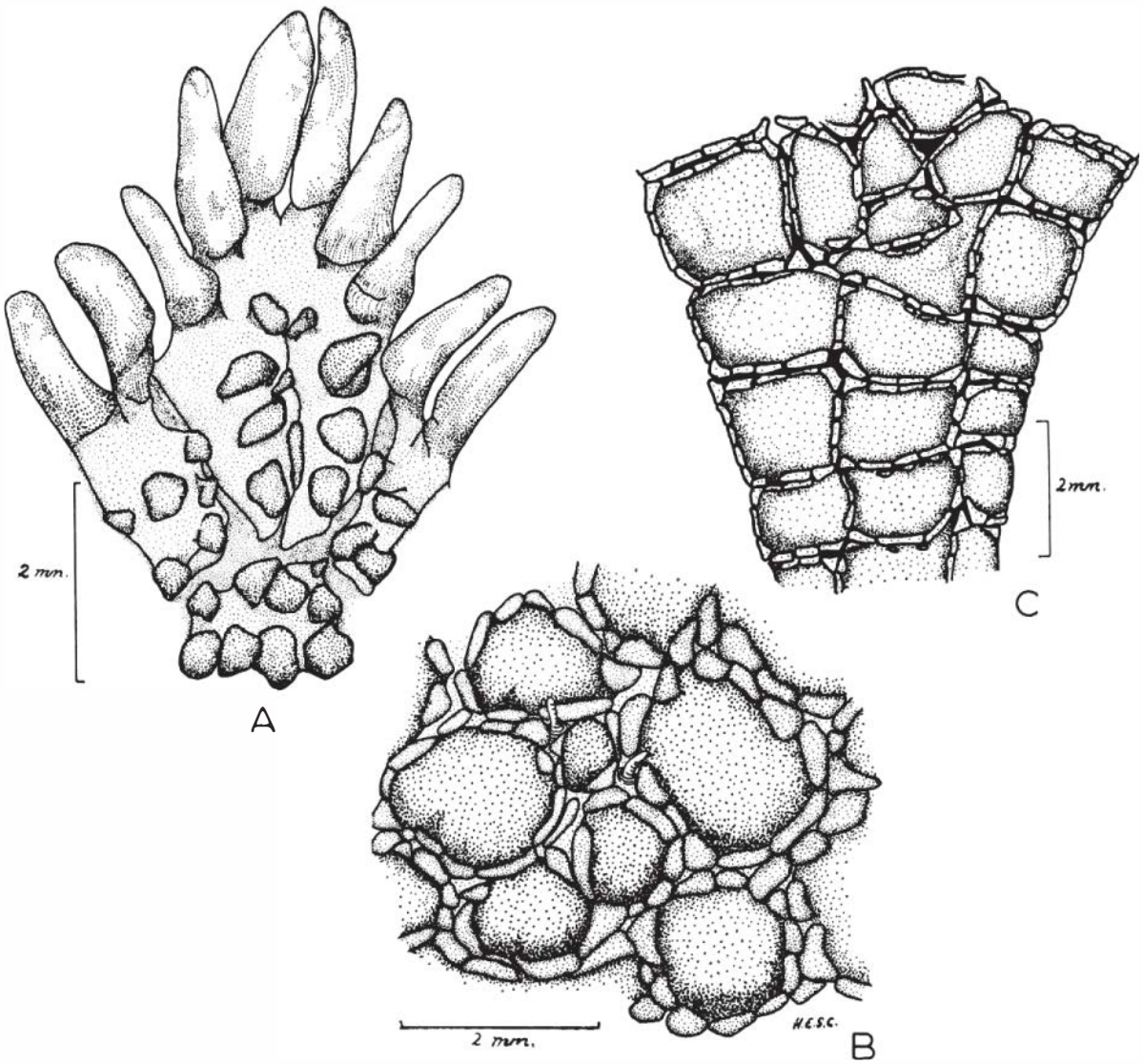

FIG. 10: *Pergamaster triseriatus*, all drawn from the holotype, each to the scale shown. A, oral and proximal adambulacral plates; B, abactinal plates, surrounding granules and papulae; C, portion of arm showing the smaller abactinal plates and the larger plates of the carinal series flanked by superomarginal plates.

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Remarks

This species can be distinguished from *P. incertus* by the carinal plates which are markedly larger than the proximal abactinal plates and are the only abactinal plates to enter the arm. Distinct tubercles or papillae occur on the marginal plates and bordering granules.

Ecology

This species is recorded from a sand and pebble substrate.

Family PORANIIDAE Perrier, 1894

A single Ross Sea genus.

Porania Gray, 1840

Marginal plates with spines or spinclets. Abactinal plates, which may or may not bear spines, generally forming a distinct network or reticulum. Actinal area with large intermediate plates. Plates of both surfaces covered with a membrane of varying thickness; on the actinal surface distinct fascioles may be present.

Type Species: Porania gibbosa Gray, 1840.

A single Ross Sea species.

Adult specimens of *Porania antarctica* have well developed abactinal spines which are absent in *P. antarctica glabra;* furthermore *P. antarctica glabra* does not range as far south as the Antarctic convergence except at Kerguelen.

Porania antarctica glabra Sladen (pl. 5, fig. 5 and 6; text-fig. 11).

Porania glaber Sladen, 1889. Challenger Rpt., 30, p. 360, pl. 59, fig. 1 and 2.

Porania spiculata Sladen, 1889. Challenger Rpt., 30, p. 362, pl. 59, fig. 4.

Porania antarctica Studer, 1885. Die Seesterne Süd – Georgiens, Jahrb. wiss. Anstalten zu Hamburg, p. 160; Ludwig, 1903. Seesterne Results Voyage de S. Y. Belgica, p. 22, pl. 2, fig. 18–20; Koehler, 1906. Expéd. Antarct. Franç. 1903–05, Échinodermes, p. 10; Koehler, 1911. Brit. Antarct. Exped. 1907–09, 2 (4), p. 27; Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 66; Koehler, 1917. Echinod. aux îles de Kerg. (M. Rallier du Baty, 1913–14), Ann. de l'Inst. Oceanographique, 7, fasc. 8, 42: Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 178, pl. 33, fig. 6 and 7; Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, pars, p. 74 (Graham Land, South Georgia).

Porania armata Koehler, 1917. Echinod. aux îles de Kerg. (M. Rallier du Baty, 1913–14), Ann. de l'Inst. Oceanographique, 7, fasc. 8, p. 43, pl. 7, fig. 3, 4, 7, and 12; Doderlein, 1928. Deutsche Südpolar-Exped., 1901–03, 19 (2), p. 297.

Porania antarctica glabra Fisher, 1940. Disc. Rpts., 20, p. 155, Madsen, 1955. Sci. Res. Norwegian Antarct. Exped. 1927–28. 37, p. 14.

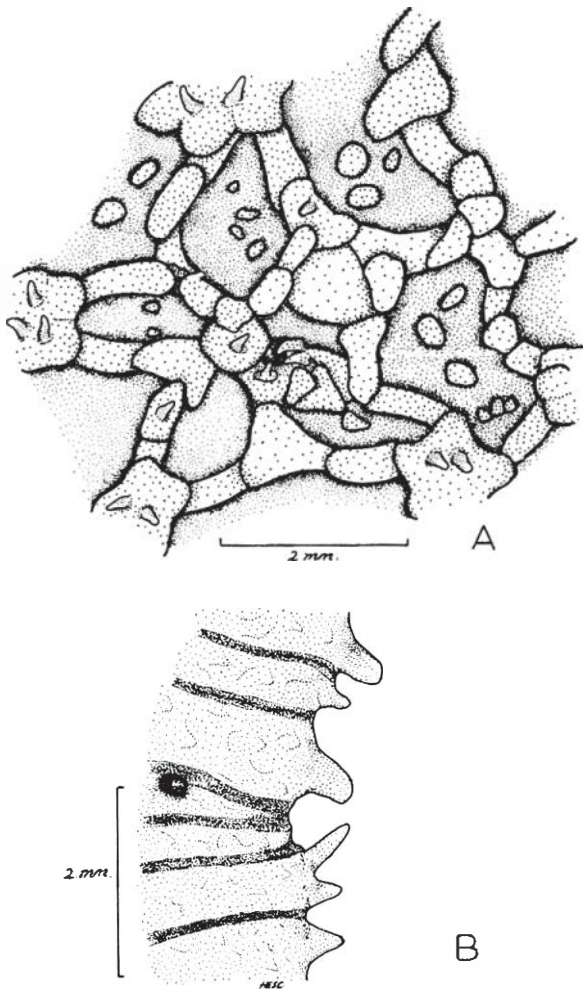

FIG. 11: *Porania antarctica glabra*, A, arrangement of abactinal plates in a specimen from Sta. A450. Note the very small spines and the central anus; B, portion of actinal surface of a specimen from Sta. A450 showing the short marginal spines, the wrinkled, enveloping membrane, the fascioles and single gonopore. Each drawing to scale shown.

From the high and inflated disc the short arms taper rapidly to blunt tips, the edges of the disc and arms are compressed, the actinal surface is more or less plane, and the interradial areas are slightly concave.

Paving the abactinal surface are irregularly shaped plates of varying sizes covered by a thin membrane which does not hide their contours. Occupying the centre of the disc is a distinct, five-lobed plate; a number of rectangular, almost square, or triangular plates connect with this central plate forming a reticulum, in the meshes of which may be small, oval plates, either isolated or in groups. There is a carinal series of plates

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extending to the arm tips; this series consists of large saddle-shaped or triangular primary plates alternating with smaller, oblong, connecting ossicles. From each of the primary plates there is a row of three to six small, rectangular ossicles extending at an angle across the arm to the interradial region; here and there these show an indistinct distal branching. Protecting the arm tip are a large number of overlapping scale-like plates. There is a fine powdering of numerous tiny excrescences or spicules on the plates of the disc and to a lesser extent on the arms; the interradial septa are well developed and covered by a thickening of the membrane which is traversed in these regions by distinct grooves or fascioles.

Pedicellariae are absent.

Small, very slender, and sharp-tipped papulae occurring over the disc and arms are few and scattered in the interradial regions and on the centre of the disc, but between 20 and 30 occur in the membranous areas between the plates.

The madreporite, interradial in position and nearer the centre than the edge of the disc, is oval (3 mm by 2 mm) and dissected by a number of fine, sinuous grooves meeting centrally.

There is a small but conspicuous anus on the disc between the lobes of the central plate, guarded by 12–14 short, upright spinelets.

As the edges of the disc are so compressed there is difficulty in distinguishing the superomarginal and inferomarginal plates. The marginal plates may bear one or two short, truncated, flattened spines which form a well defined fringe to the disc and arms but are absent from the distal third of the arm.

The membrane which obscures the small, rectangular, more or less regularly arranged plates of the actinal surface, is traversed by distinct, narrow fascioles, grooves, or furrows which may branch distally. Generally these grooves correspond to one or two adambulacral and marginal plates and spines.

The rectangular adambulacral plates bear a distinctive armature consisting of a small, blunt-tipped, membrane-invested furrow spine (about 2 mm long) and a broad, flat, truncated subambulacral spine. Proximally only one subambulacral spine is present, distally there may be sporadically two or even three, the innermost always being the largest and most distinctive.

Near the mouth the deep ambulacral grooves are narrow but broaden medially and become very narrow again towards the arm tips. The tube-feet are biserially arranged, crowded, slender and probably very flexible, terminating in well developed sucking discs.

The oral plates are slightly tumid and very distinctive, bearing five flattened, membrane-invested furrow spines and two prominent suboral spines similar to those of the neighbouring abactinal plates.

Colour in Life: There is a considerable range in colour. Notes by R. E. Barwick for specimens from No. 850 (Trans-Antarctic (New Zealand) Expedition) record: "reddish orange to dark orange to bluish white to purplish white". For specimens from No. 851 the colour is noted for the actinal surface as "bluish-grey interradially or yellowish white", and, for the abactinal surface, "bluish white or yellowish white". Koehler (1912, p. 67) records the colour of the abactinal surface as varying from grey or grey-blue to paler orange or red with the edges of the arms often paler or almost white; the actinal surface is recorded as white-yellow to yellow or a pale reddy orange.

Type Locality

Off Cape Maclear, Kerguelen Island, 30 fm (55 m).

Distribution

Circumpolar, Antarctic and Magellanic. If Sladen's (1889, p. 362) report of this species from the Arrou Islands (5° 41′S, 134° 4′ 30″E) is correct, and Sladen remarks (p. 362) that he can "detect no difference worthy of note between the example from the Arrou Islands and those from off Heard Island", then this species extends into the Indian Ocean. Ludwig (1903, p. 22) also records this species from the Chonos Archipelago (Chile, South America) while Koehler (1917, p. 42) records it from Penas Gulf (Chile). *Bathymetric Range*: 12–1335 m.

Material Examined

Forty-nine specimens from 23 stations as follows:

Sta. A448, 752 m (1); Sta. A449, 362 m (4); Sta. A450, 472–318 m (1); Sta. A455, 322–340 m (1); Sta. A457, 315–342 m (1); Sta. A460, 415–430 m (1); Sta. A464, 369–384 m (1); Sta. A465,

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399 m (1 damaged); Sta. A470, 377 m (1); Sta. A471, 165–69 m (6); Sta. A521, 582–558 m (1); Sta. A522, 1335 m (2); Sta. A527, 358–337 m (1); Sta. A528, 274–265 m (2); Sta. A533, 84–183 m (1); Sta. A538, 256–348 m (1); Sta. A625, 460 m (1).

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 98. Cape Roberts, 190–196 m (1); 675, Hut Point, McMurdo Sound, 124–165 m (11); 850, Cape Evans, 111 m (3); 851, Cape Evans, 111 m (3).

Stanford University Stations: Sta. P, 57 m (2); Sta. EAD–2, 315 m (2).

Size: The majority of these 49 specimens are small (R averages 10 mm and r averages 7 mm); in general R does not exceed 12 or 13 mm, but in two larger specimens R=61 mm and r=44 mm (A460) and R=52 mm and r=34 mm (A448). These last two specimens are regarded as being the only two adult specimens present (Fisher, 1940, p. 156, regards specimens in which R is over 30 mm as adult). This description is based on the large, adult specimen from A460. This species attains a large size: Sladen (1889, p. 360) records a specimen in which R=91 to 97 mm and r=35 mm.

Young Stages

In young stages (from A449, A470, A521, A522, A533, and Trans-Antarctic (New Zealand) Expedition Collection: Ser. No. 675) in which R=3 to 5 mm, the arms are distinct, and the arm tips often curl upwards, while the tips are protected by distinct saddle-shaped plates which bear from nine to 11 small, sharp-tipped spinelets or tentacles. The plates of the abactinal surface are often confluent and the membranous intermediate areas few and small; neither papulae nor the fine powdering of spicules seen in larger specimens are present. Plates of the carinal series bear distinct, small tubercles or spines and these may also occur on the larger primary plates on the disc. Marginal spines are distinct, and where two occur on the one plate they are well separated from each other. In some specimens the marginal fringe extends for at least three-quarters the length of each arm, but in others it barely enters the arm. Both the abactinal and actinal membranes show great variation in their development. They may be very thick and completely obscure the plates or very thin and the contours of the plates very obvious. In many of these small specimens the actinal plates are rather tumid and never more than three or four occur in one interradius. The armature of the oral plates show interesting variations. In specimens where R=3 mm there are never more than three oral spines to a plate (the number increases to five in the larger specimens); and the adambulacral plates bear a normal number of spines, but these are slender, sharp-tipped, and lack the enveloping membrane. Within the furrow the tube-feet are very regularly arranged and do not show the crowded condition seen in larger specimens. In slightly larger specimens where R=6–8 mm there is a tendency towards a reduction in the number of abactinal tubercles, which are confined mainly to the proximal carinal plates. Much variation occurs in the number of marginal spines – generally in the interradial areas there are two spines to the one plate, but towards the arm tips there is only one. In specimens where R=10 to 17 mm (A460, A471, A528, and A625, much of the material in the Trans-Antarctic (New Zealand) Expedition Collections and from the Stanford University Collections) a varying number of gonopores are present in the interradial regions of the actinal surface. In general only one gonopore is present in each interradius but in at least one specimen (Sta. EAD–2, R=17 mm and r=9 mm) there is a distinct pair of gonopores in each interradius.

Remarks

Most variation occurs in the number and arrangement of the marginal spines, and in the degree of development of the covering membrane and the abactinal tubercles which are present in younger specimens but which disappear in older specimens. There is also considerable variation in the number and development, within one individual of the gonopores. Thus, three interradial regions may have well developed gonopores while there may not be one at all in the remaining two areas; or a gonopore may be well developed in one interradius and very small in another. There are no signs of gonopores in the two larger specimens.

Ecology

The presence of fascioles or grooves on the abactinal surface, in the interradial regions, and on the actinal surface suggest this species obtains its food from plankton showers which are conveyed to the actinal surface and finally the mouth along the fascioles. The steep angle of the abactinal surface and its general smoothness may be correlated with this method of feeding. This species appears to inhabit a wide variety of substrates. Most of the N.Z.O.I. specimens are reported from

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mud or gritty and sandy mud, or from patches of pebbles and stones, while those from the Stanford University Collection are recorded from a sponge complex.

Order SPINULOSIDA Perrier, 1894

Marginal plates usually inconspicuous. Abactinal skeleton reticulate or imbricate, sometimes greatly reduced. Numerous abactinal spines, isolated, in fascicles or in paxillae. Pedicellariae rare, never forcipiform (crossed). Papulae dorsal, or intramarginal or actinal. Oral plates medium sized or large; adambulacral plates not crowded. Tube-feet biserial, with well developed sucking discs.

Key to the Antarctic Families

1 (4) Mouth plates small; ambulacral furrows narrow.

2 (3) Abactinal skeleton well developed and formed of closely imbricating plates bearing small spines; actinal skeleton of imbricating plates with a tuft or fan of spinelets. ..... **Asterinidae** Gray, 1840

3 (2) Abactinal skeleton with plates in longitudinal and transverse rows forming an irregular or regular more or less open mesh work; or skeleton much reduced. Plates with isolated spines or groups of spines but never fans of spines ..... **Echinasteridae** Verrill, 1867

4 (1) Mouth plates large; ambulacral furrows wide, adambulacral armature pectinate.

5 (6) Marginal plates paxilliform in one or two series. Spinelets of abactinal paxillae never united by membrane but fascicular or penicillate. Actinal intermediate plates present. Adambulacral armature in two series at right angles ..... **Solasteridae** Perrier, 1884

6 (5) Marginal plates either hidden by a supradorsal membrane or if visible never conspicuous and paxilliform. Abactinal plates with spines more or less united by membrane. Actinal intermediate plates absent or indistinguishable. Adambulacral armature in one or two series.

7 (8) No supradorsal membrane forming a special nidamental cavity; no spiraculae. Interbrachial septa partly calcified. Adambulacral armature, forming with that of inferomarginals, a single transverse series, never webbed. Abactinal plates round or lobed forming a wide mesh ..... **Korethrasteridae** Danielssen & Koren, 1884

8 (7) A complete supradorsal membrane present with spiraculae. Interbrachial septa not calcified. Actinolateral spines present. ..... **Pterasteridae** Perrier, 1875

Family ASTERINIDAE Gray, 1840

A single Ross Sea genus

Kampylaster Koehler, 1920

Disc very convex, arms small, not well differentiated from the disc and often folded ventrally. Abactinal surface paved with imbricating scale-like plates bearing a number of short, thorny-headed spinelets or granules. Superomarginals and inferomarginals distinct and somewhat tumid. Actinal interradial areas paved by large, distinct plates, arranged in regular longitudinal and transverse rows bearing two to four spines. Adambulacral plates with one furrow and two or three subambulacral spines. Oral plates with three furrow spines.

Type Species: Kampylaster incurvatus Koehler.

This genus comprises only the one species.

Kampylaster incurvatus Koehler (pl. 9, fig. 1 and 2; text-fig. 12)

Kampylaster granulatus Koehler, 1920. Australas. Antarct. Exped. Sci. Rpts., Ser. C, 8 (1), p. 8 (nomen nudum).

Kampylaster incurvatus Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 138, pl. 36, fig. 4, 6, 7, 8, and 12; pl. 37, fig. 1, 2, and 3; pl. 66, fig. 10; Fisher, 1940. Disc. Rpts., 20, p. 150, fig. D, 3–3d; Madsen, 1955. Sci. Res. Norwegian Antarct. Exped. 1927–28, 37, p. 13.

The disc is convex and the short, rather indistinct arms bent ventralwards, each terminating in an almost square plate.

Numerous small, hemispherical, scale-like, porcellanous plates pave the abactinal surface of the disc and arms, showing no very regular arrangement and bearing a number of short spines or granules, each of these, rising from a broad, flattened base, expands distally into a thorny head. The expanded lobes or bases of these granules form a calcereous layer over the small, overlapping plates.

Pedicellariae are absent.

Papulae are inconspicuous.

The very small madreporite is nearer the edge than the centre of the disc, and is indistinct until the covering granules have been removed; it is oval, about 1 mm long, and traversed by three thick ridges.

Surrounding the central anus are five slightly enlarged, thorny-tipped spines.

Small, more or less oval, inconspicuous superomarginal plates border, and are confined to, the abactinal surface. They are thicker than the plates of the disc but bear similar granules, and they overlap the plates of the inferomarginal series.

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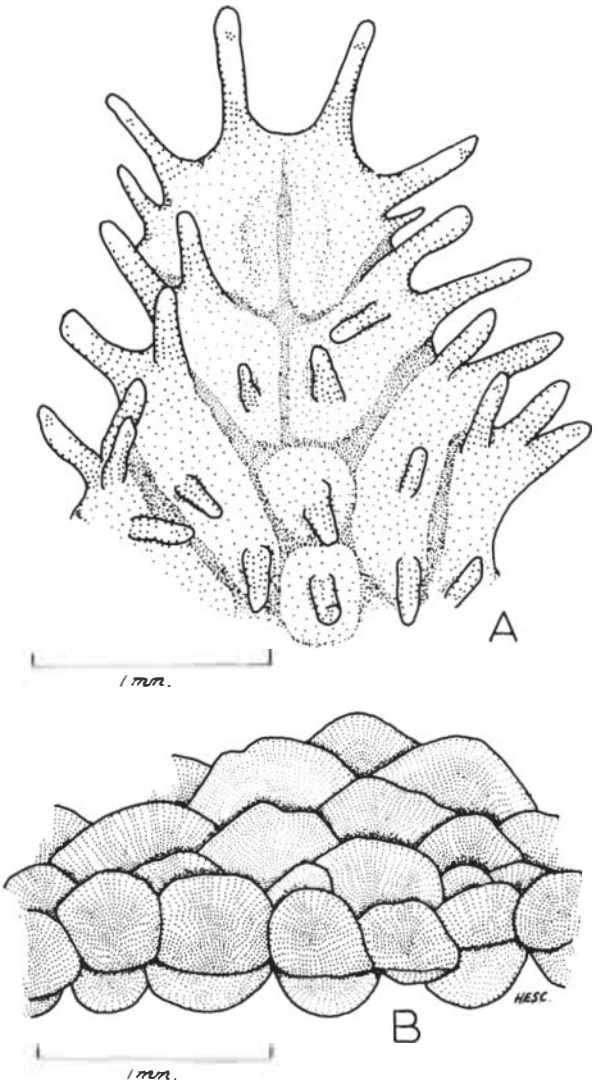

FIG. 12: *Kampylaster incurvatus*, A, oral, adambulacral and actinal plates; and B, portion of abactinal surface near the interradial angle, showing the scale-like, overlapping plates and both series of marginal plates. Both drawings of a specimen from Sta. A449.

The distinctly tumid, almost rectangular plates of the inferomarginal series, which border the actinal surface, are fewer in number than the superomarginals, from 17 to 20 extending from arm tip to arm tip. They bear spinelets similar to those already described.

The triangular actinal interradial regions are paved by rectangular or oval plates bearing one to four short, cylindrical, thorny-tipped spines which are longest on the plates near the oral angle, they are arranged in longitudinal rows, in general, one row corresponds to one adambulacral and one inferomarginal plate.

Either two or three spines occur on the rectangular adambulacral plates; the cylindrical, thorny-tipped furrow spine is longest, about 0·75 mm to 1 mm. The subambulacral spines form a graded series; where two occur they may either be set behind one another or beside each other, parallel to the furrow.

The ambulacral grooves are wide medially but narrow distally and proximally. The tube-feet are short and biserial, and have distinct suckers.

The small oral plates bear three tapering, blunt, and thorny-tipped spines (about 1–1·5 mm long) forming a graded series, the longest projecting over the mouth.

Colour in Life: Unknown; in spirit, brown or white with darker tube-feet.

Type Locality

Off Adélie Land, 66° 32′S, 141° 39′E. 151 fm (279 m).

Distribution

Probably circumpolar, Ross Sea, and Palmer Archipelago. *Bathymetric Range:* 93–750 m.

Material Examined

Twenty-nine specimens from seven stations as follows:

Sta. A449, 362 m (8); Sta. A450, 472–318 m (1); Sta. A456, 238–201 m (1); Sta. A457, 315–342 m (2); Sta. A468, 110 m (5); Sta. A528, 274–265 m (2); Sta. A529, 205–216 m, (10).

Size: It is difficult to record exact measurements as the arms in most specimens are folded ventrally. Probably in these 29 specimens R averages 11 mm and r 10 mm. The present description is based on a specimen from A529 in which R = 10 mm and r = 6 mm.

Remarks

In the present collection there are no specimens carrying young, but Fisher (1940, p. 151) records specimens (with R = 10 mm) carrying young; in these the rays are bent strongly ventralwards. Probably, when not brooding, this species assumes a normal sea star position, but in preservative the disc is convex, the arms directed ventralward and the animal "rolled up". Fisher (p. 151) observed that the very indistinct papulae occupied a radial petaloid area extending from the centre of the disc

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for two-thirds the length of the arm. He also recorded a short interradial septum. There are no remarkable differences in the several very young specimens in this collection.

Ecology

The present specimens are recorded from a muddy or muddy and sandy or stony substrate.

Family ECHINASTERIDAE Verrill, 1867

There is one well established Ross Sea genus, *Perknaster*. Bell (1902) reported *Cycethra simplex* (now synonomised with *Cycethra verrucosa*) from South Victoria Land. The fact that there have been no further records of *Cycethra* from the Ross Sea and there are no specimens in this collection casts some doubt on the correctness of Bell's identification. In the absence of material no description is given here. This highly polymorphic species is said by Fisher (1940, p. 130) to be one of the most variable known sea stars, embracing a "complex of a considerable number of intergrading small species and formae, which may be likened to an asymmetrical net. Some of the more conspicuous nodes have received names." This species is characteristic of the Falkland-Magellan region, and if it does indeed occur in the Ross Sea its distribution is of great interest.

Perknaster Sladen, 1889

Abactinal and actinal skeleton of lobed plates, generally isolated and often greatly reduced in adult specimens. Abactinal plates bearing small spines often more or less obscured by a great development of the abactinal membrane. No actinal papulae. Adambulacral spines never in a double longitudinal series. No spine in the furrow.

Type Species: Perknaster fuscus Sladen.

KEY TO THE ROSS SEA SPECIES

1 (4) Suboral spines two to four.

2 (3) Abactinal skeleton of small, generally imbricating plates or ossicles with from two to seven spines forming a close-meshed reticulum. ..... **sladeni** Perrier

3 (2) Abactinal skeleton with scattered more or less isolated plates bearing from one to three short spinelets. ..... **fuscus antarcticus** (Koehler)

4 (1) Suboral spines usually seven or eight, rarely four or five. ..... **densus** Sladen

This is a highly variable genus, there is a distinct degeneration of the abactinal and actinal skeleton which may be so extensive in larger specimens that only isolated plates are present.

Perknaster fuscus antarcticus (Koehler) (pl. 8, fig. 1 and 2.)

Cryaster antarcticus Koehler, 1906. Expéd. Antarct. Franç. 1903–05, Échinodermes, p. 24, pl. 1, fig. 1; pl. 2, fig. 10; Koehler, 1911. Brit. Antarct. Exped. 1907–09, 2 (4), p. 28, pl. 4, fig. 1 and 2; Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 30, pl. 3, fig. 6 and 7; Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 126, pl. 27, fig. 4, 7, 8, 9, and 10; pl. 29, fig. 1; pl. 30, fig. 1 and 6; pl. 75, fig. 2.

Perknaster fuscus antarcticus Fisher, 1940. Disc. Rpts., 20, p. 137, fig. B, 1–1a, pl. 6, fig. 2; Madsen, 1955. Sci. Res. Norwegian Antarct. Exped. 1927–28. 37, p. 13; Bernasconi, 1956. Algunos Asteroideos de Antartida, Anal. Socied. Cientifica Argentina, 161, p. 11, pl. 5, fig. 3.

The abactinal and actinal surfaces are plane, the long, slender, upturned arms taper to sharp tips.

A thick membrane more or less obscures the small isolated plates of the abactinal surface; these plates bear one to three short, thorny-tipped, membrane-covered spines and are distinctly more numerous near the arm tips.

Pedicellariae are absent.

The small, indistinct, slender papulae, occurring between the abactinal plates on the surface of the disc and arms, emerge from poorly defined pores.

The madreporite is large, almost circular (about 4 mm), tumid, distinct, and dissected by a great number of fine, deep, radiating grooves. It is interradial in position lying midway between the centre and edge of the disc and the spines immediately surrounding it are somewhat enlarged.

Surrounding the very distinct, more or less central anus is a conspicuous ring of imbricating plates, each bearing two to four spines.

Neither series of marginal plates are very distinct. On the actinal surface, in the interradial regions, there are two rows of plates with lateral overlapping lobes. The upper plates bearing a transverse comb of three, four, or very occasionally five membrane-covered spines are presumably the superomarginals, while the lower plates, the inferomarginals, bear rows or more generally groups of three to five spines. Near the arm tips neither series of plates is apparent.

A thick membrane obscures the actinal plates which are arranged in more or less regular longitudinal rows, at least one row extending almost to the arm tips. Each plate bears two or three membrane-covered, thorny-tipped spines similar to those of the abactinal surface. Rather indistinct fascioles occur between the rows of plates.

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The adambulacral plates, also membrane-covered, carry either one or two furrow spines. Where two occur, forming a slightly oblique row (on the plates adjacent to the oral angle), the most proximal is the shorter and the larger spine is blunt-tipped, flattened, and spatulate measuring (proximally) between 2 and 3 mm, distally seldom exceeding 2 mm. Where only one furrow spine occurs, it is often greatly enlarged distally and the tip more or less divided into two lobes. There are generally three (sometimes four) thorny-tipped subambulacral spines; the outer are short and similar to the neighbouring actinal spines. Both these and the furrow spines are enveloped in membrane.

The ambulacral grooves are narrow near the mouth but they widen distally and remain wide to the arm tips, enclosing two rows of tube-feet each with distinct sucking discs.

Each oral plate bears four or five furrow spines. The most anterior is long, blunt-tipped, and similar to the adambulacral furrow spines while the remainder form a graded series which are shorter, almost cylindrical, and webbed basally. The suboral spines, varying from two to four, are short, of similar size to the subambulacrals, cylindrical, thorny-tipped, and basally webbed. The two oral plates are separated by a wide muscular interval.

Colour in Life: There are no colour notes with the present specimens. Koehler (1920, p. 12) gives detailed notes of colour ranging from various shades of red with darker spots or stripes to a background colour of yellow or light orange with red markings. In spirits, specimens are dark brown or black to a lighter brown with lighter arm tips to (in the smaller specimens) a distinct white yellow colour.

Type Locality

Probably Palmer Archipelago near Port Lockroy.

Distribution

Circumpolar, Antarctica, south of 60°. *Bathymetric Range:* 10–362 m.

Material Examined

Eleven specimens from eight stations as follows:

Sta. A449, 362 m (1); Sta. A471, 165–69 m (1).

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 675, Hut Point, McMurdo Sound, 124–165 m (1); 732, Cape Roberts, 188–193 m (1).

Stanford University Stations: Sta: P, 57 m (1); Sta. CEI, 10 m (3); Sta. CEJ, 12 m (2); Cape Evans, 1 Feb 1960, 8 ft (1).

Size: In these 11 specimens R ranges from 118 to 18 mm averaging 47 mm and r ranges from 27 to 7 mm averaging 16 mm. This description is based on a specimen (Stanford University, Sta. CEI) in which R = 45 mm and r = 16 mm. Koehler's type material in which R = 140 mm and r = 54 mm appears to be the largest known specimen.

Remarks

This is a very variable species, especially in the development of the abactinal skeleton and membrane, the marginal plates, the body form, and the oral armature. Most of the present specimens differ in some aspect and these differences are noted below:

A449 (R = 21 mm and r = 10 mm). In this specimen as many as five spines are present on both the actinal and abactinal plates; the papulae emerge from distinct pores.

A471 (R = 60 mm and r = between 25 and 30 mm). The disc is greatly inflated, the slender arms curled above the abactinal surface, the abactinal skeleton almost absent, and the isolated plates obscured by the covering membrane and the long, slender papulae; the marginal plates are indistinct or absent. Spines of the actinal surface are distinctly longer than those of similar specimens.

Trans-Antarctic (New Zealand) Expedition Collection No. 675 (R = 38 mm and r = 12 mm). The abactinal membrane is greatly thickened and distended into sack-like pustules surrounding the spines, and the fascioles are very obvious on the actinal surface.

Trans-Antarctic (New Zealand) Expedition Collection No. 732, (R = 18 mm and r = 7 mm). The general appearance of the animal is different and the angle between the arms more acute than in other members of this species. The abactinal membrane is not well developed and the plates are distinct while the papulae, absent from the interradial regions, appear to emerge from distinct holes or pores. The features of the actinal surface do not, however, appear to differ markedly from those already described.

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Specimens collected by the Stanford University group are closely similar but there is great variation in the armature of the oral plates. Thus in a specimen from Sta. CEI only two of the oral plates bear suboral spines and these are small and inconspicuous. Another specimen from Station CEJ, in which R = 40 mm and r = 14 mm, shows an uncommon development of the oral plates in one angle, possibly due to injury, there are two very short, furrow spines present and between 12 and 22 irregularly arranged, short, thorny-tipped, membrane-invested, suboral spines. In a specimen from Sta. O there are only three oral furrow spines present.

The largest specimen in this collection from Cape Evans (R = 118 mm and r = 25 mm) shows well developed fascioles. The actinal surface of the disc is strongly convex and the slender, sinuous arms are almost carinated distally. Beneath the membrane, near the arm tips, a double series of irregularly lobed, overlapping plates separated by a distinct channel are visible.

There appears to be a distinct degeneration of the abactinal skeleton in older specimens and a great thickening of the muscular layer of the body wall, the skin thickening and surrounding the spines and structures of the abactinal surface in a maze of wrinkles and pustules. In the absence of material of typical *fuscus* from Kerguelen or Heard Island the variety *antarcticus* is maintained here. Fisher (1940, p. 138) distinguishes the two varieties on the basis of the smaller, more closely placed, more delicate abactinal spines in *antarcticus* and by the fact that the inferomarginals are less well developed, which is probably not a reliable character.

Ecology

This species appears to tolerate a wide variety of substrates ranging from mud to gravel and stones.

Perknaster densus Sladen (pl. 8, fig. 3 and 4)

Perknaster densus Sladen, 1889. Challenger Rpt., 30, p. 552, pl. 97, fig. 1 and 2; pl. 98, fig. 11 and 12; Fisher, 1940. Disc. Rpts., 20, p. 138, fig. A, 3-3f; pl. 8, fig. 1 and 2.

The interbrachial areas are angular and the disc and arms convex abactinally; the arms taper rapidly to blunt tips protected by small, hemispherical, smooth plates. The actinal surface is concave.

The small plates paving the abactinal surface of the disc and arms may be oval with smaller, connecting ossicles, or cruciform, or triradiate with overlapping lobes; on the disc and arms these form a close meshed reticulum with indistinct membranous areas. Crowning the short, broad tabulum of these plates are from seven to 15 small, upright, round-tipped, thorny spinelets; on the smaller paxillae there are only two to five spines. Both spines and plates are sheathed in membrane which contracts when the specimen is dry, forming a collar at the base of the paxillae.

Pedicellariae are absent.

Small, scattered papulae, which are indistinct distally, occur between the plates of the disc and on the proximal part of the arms.

The madreporite is interradial in position, nearer the centre than the edge of the disc, small, oval, tumid, and dissected by a large number of very fine, deep grooves. It is surrounded by four enlarged paxillae, each bearing 21 to 25 spinelets slightly longer than those of adjacent paxillae.

Neither series of marginal plates is distinct. However, on removing the spinelets from the interradial angle a row of slightly larger plates (presumably the inferomarginals) with broad and distinctly oval tabulae can be seen extending for some distance along the arms before becoming indistinct.

Small, oval or oblong imbricating plates pave the extensive actinal interradial regions showing a more or less regular arrangement into longitudinal rows, especially near the oral plates, and bearing from seven to 12 thorny, round-headed spinelets similar to, but slightly longer (especially near the interradial angle) than those of the abactinal surface.

The narrow, oblong, tumid adambulacral plates, separated by muscular intervals, bear two distinct, broad-tipped, often somewhat flattened furrow spines and six to nine subambulacral spines arranged in more or less regular transverse rows. These spinelets are thorny and similar to, but longer than, those of adjacent actinal paxillae. Near the oral angle there may be three distinct furrow spines and only five or six subambulacral spines.

The ambulacral grooves are narrow and deep, and the tube-feet regularly biserial with distinct sucking discs.

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It is unfortunate that the oral plates in this specimen are damaged; there appear to be four, or in one case five, furrow spines, the most anterior flattened and large. The number of suboral spines varies from four to five short spines in a single row to, more typically, eight or nine in a double row.

Colour in Life: Unknown; in spirit, light brown or fawn.

Type Locality

Off Cumberland Bay, Kerguelen, 127 fm (235 m).

Distribution

Kerguelen and Marion Island and (this collection) the Ross Sea; probably circumpolar, Antarctica. *Bathymetric Range*; 101–340 m.

Material Examined

One specimen from Sta. A455, 332–340 m.

Size: In the single specimen in this collection R=30 mm and r=14 mm; previous specimens were larger.

Remarks

Near the arm tips the adambulacral plates may carry up to eight or nine subambulacral spines; both Fisher and Sladen report only five to seven. Unlike Fisher's (1940) material the number of adambulacral furrow and subambulacral spines decreases in the distal part of the arms to one or two furrow spines and three or four subambulacrals.

Perknaster sladeni (Perrier) (pl. 8, fig. 5 and 6)

Cribraster sladeni Perrier, 1891. Echinodermes Mission Scientifique du Cap Horn 1882–83, 6 (3), p. 104, pl. 11, fig. 2a and 2b; Koehler, 1912. Deuxieme Expéd. Antarct. Franç. Échinodermes, p. 39, pl. 2, fig. 12; pl. 6, fig. 6.

Perknaster sladeni Fisher, 1940. Disc. Rpts. 20, p. 140, fig. B, 3–3c, 4–4c, pl. 7, fig. 1.

The disc is strongly convex the slender arms taper to blunt tips and the actinal surface is concave.

Small, generally oval but sometimes slightly lobed plates paving the abactinal surface are spaced on the disc, and crowded on the arms: These plates bear a slender trunk or stem with from two to seven slender, finely thorny, blunt-tipped spines which form a dense covering over the disc and arms but are less crowded distally. A thick membrane sheaths the abactinal spines but contracts when the specimen is dry.

Pedicellariae are absent.

Papulae, each emerging from a very distinct pore, occur singly in the membranous spaces between the abactinal plates on the disc and proximal part of the arms, but are smaller and fewer in number near the arm tips.

The madreporite, small, indistinct, tumid, and nearer the centre than the edge of the disc, is dissected by a number of very deep, sinuous grooves.

The anus is small, centrally placed, and surrounded by a naked membranous area.

Neither series of marginal plates is distinct.

Paving the interradial areas of the actinal surface are small, rectangular or oblong plates bearing from two to four or five spines; these are similar to the abactinal spines but are more slender, taper to a sharp tip, and are more obviously spinulose; they are also heavily sheathed in membrane. Only two spines are present adjacent to the oral plates; these are distinctly curved and the tips almost meet forming a simple pedicellaria.

The rather short adambulacral plates bear a crowded series of furrow spines; near the mouth there are generally two or three in a slightly oblique row; near the arm tip only a single furrow spine is present. The outer furrow spine is distinct, large (about 2 mm), smooth, membrane covered and blunt tipped; there are two or three slightly shorter suboral spines.

The rather deep ambulacral grooves are narrow proximally, broaden medially, and become very narrow and almost obscured by the adambulacral spines distally. The tube-feet are biserial with distinct and rather large sucking discs.

Each oral plate bears four long, tapering, smooth furrow spines, and two or three slightly shorter, suboral spines.

Colour in Life: Unknown; in spirits, grey white or fawn with darker tube-feet.

Type Locality

Malouines Islands, Falkland group.

Distribution

Falkland Islands, Shag Rocks, Palmer Archipelago, and (this collection) the Ross Sea. *Bathymetric Range:* 199–500 m.

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Material Examined

Seven specimens from seven stations as follows:

Sta. A449, 362 m (1); Sta. A450, 472–318 m (1); Sta. A455, 322–340 m (1); Sta. A456, 238–201 m (1); Sta. A457, 315–342 m (1); Sta. A464, 369–384 m (1); Sta. A528, 274–265 m (1).

Size: In these seven specimens R varies between 12 and 40 mm and averages 26 mm; r varies between 5 and 15 mm and averages 9 mm. This description is based on a specimen from Station A528 in which R = 25 mm and r = 10 mm. Previous specimens were larger.

Remarks

In the largest specimen (A457, R = 40 mm and r = 15 mm) there is a distinct difference in the arrangement of the actinal plates. These bear three spines in more or less distinct, regular, longitudinal rows separated by membranous areas. In the smaller specimens (A449, A450, and A464 where R is less than 20 mm), the spines of the abactinal paxillae are more numerous, up to 10, and the tips more thorny.

Notes on Some Small Specimens Belonging in the Family Echinasteridae: (pl. 9, fig. 4 and 5)

The disc is small and convex. The long arms are broad basally but taper to blunt tips. The actinal interradial regions are small and slightly depressed.

The abactinal skeleton is reticulate. The primary plates, bearing one, two, or very occasionally three short, thorny-tipped spines are generally cruciform but sometimes triradiate; joining these are small, oblong, secondary ossicles which never bear spines. Within the membranous spaces enclosed by these plates there may be small, isolated, triangular or oval plates, each with a short spine. A thin membrane obscures the contours of the abactinal plates. There is a narrow interradial septum devoid of spines.

There are no pedicellariae present, either here or on the actinal surface.

Single papulae occur in the membranous spaces between the abactinal plates, and a small circular hole or pore occurs directly above them in the membrane. Similar pits or holes are present in the membrane above the ill defined marginal plates and are also present on the actinal plates although in the interradial region one or two of these, near the outer edge of the disc, may be gonopores.

The madreporite is small, interradial in position, and nearer the centre than the edge of the disc. Dissecting it are a number of deep grooves and surrounding it are several thorny spines.

The anus is central on the disc and protected by about six short, thorny-tipped spines.

Neither series of marginal plates is very distinct. The cruciform superomarginals bear a single spine similar to that of the disc, while the large inferomarginals bear a transverse series of two or three basally webbed spines.

On the actinal surface the interradial regions are small and devoid of spines. At least two rows of actinal plates extend along the arms for three-quarters of their length, each bearing a single, small, tapering spine.

The adambulacral plates are narrow, with a small membrane-covered spine set deep in the furrow and a transverse row of (proximally) three short, sturdy, blunt-tipped, and thorny spines united basally by a membrane and (distally) four or five longer, more slender spines in a transverse series. The two small, deep furrow spines of opposite adambulacral plates nearly meet centrally.

Within the narrow, deep, ambulacral grooves the tube-feet, with distinct sucking discs, are very regularly biserially arranged, a pair occurring between the small furrow spines.

The oral plates are small with three or four short, blunt-tipped, furrow spines and two similar suboral spines.

Colour in Life: Unknown; in spirits, grey-pink or white.

Type Locality

Ross Sea, 201–582 m.

Distribution

Ross Sea, 201–582 m. *Bathymetric Range:* 201–582 m.

Material Examined

Seven specimens from six stations as follows:

Sta. A455, 322–340 m (2); Sta. A456, 238–201 m (1); Sta. A464, 369–384 m (1); Sta. A521, 582–558 m (1); Sta. A526, 461–465 m (1); Sta. A527, 358–337 (1).

Size: These specimens are small and R ranges from 8 to 26 mm, averaging 18 mm; r ranges from 3 to 5 mm, averaging 4 mm.

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Remarks

If the small holes in the membrane are papular pores (and the author believes they are) then these specimens appear to be most closely allied to *Henricia*, which has several southern representatives. They also agree with this genus in characters of the adambulacral armature and abactinal skeleton. The only other genus with intermarginal and also actinal papulae is a tropical genus *Othilia*, the oral armature of which however is very different. On the other hand, if these are not papular pores there is a marked resemblance to *Rhopiella* which also lacks intermarginal and actinal papulae but which differs in having very extensive actinal interradial regions which these specimens lack. They are also similar to *Echinaster*, which lacks intermarginal and actinal papulae, but they differ from this genus in features of the adambulacral armature.

Family SOLASTERIDAE Perrier, 1884

Key to the Ross Sea Genera

1 (8) Rays 5.

2 (3) Both series of marginal paxillae well developed. Abactinal skeleton of cruciform or lobed plates. Generally a single series of spaced, actinal intermediate plates with or without paxillae. Adambulacral armature in two series ..... **Lophaster** Verrill, 1878

3 (2) Only the inferomarginals well developed: superomarginals inconspicuous similar to the actinal paxillae or absent altogether.

4 (7) Abactinal skeleton well developed, no thick masking skin or integument present.

5 (6) Abactinal plates cruciform or lobed forming a well developed reticulate skeleton. Actinal intermediate plates present or absent. Adambulacral armature in two series. No specialised longitudinal dorsal muscle band present. ..... **Paralophaster** Fisher, 1940

6 (5) Abactinal plates small and oval or slightly lobed. Small actinal intermediate areas. Adambulacral armature in two series. A specialised internal longitudinal muscle lying between adambulacral and superomarginal plates ..... **Myoraster** Fisher, 1940

7 (4) Abactinal skeleton very reduced and plates hidden by a thick integument which also surrounds the spines of the abactinal paxillae or fascicles. Inferomarginals well developed and joined to the adambulacral plates by two distinct ridges of modified actinal plates. Actinal surface membrane covered; fascioles present. ..... **Cuenotaster** M. P. Thiéry, 1920

8 (1) Rays many, from seven to 14. Abactinal skeleton reticulate, with cruciform or lobed plates bearing paxillae or pseudo-paxillae. Actinal plates extending for some distance along the ray. ..... **Crossaster** Müller and Troschel, 1840

Crossaster Müller and Troschel, 1840

Rays seven to 14. Abactinal skeleton of cruciform or stellate plates either closely packed or forming, with slender intermediate ossicles, an open meshwork. Superomarginals indistinct; very similar to abactinal paxillae. Inferomarginals large and distinct. Abactinal paxillae spaced or crowded, small or large, fasciculate, tabulate or penicillate. Actinal intermediate plates extending more or less along the ray.

Type Species: Asterias papposa Linnaeus.

Crossaster canopus n. sp. (pl. 10, fig. 1 and 2; pl. 11)

There are eight arms. The abactinal surface of the disc and arms is slightly convex; the arms curl above the disc, and the actinal surface is plane.

The cruciform plates of the abactinal surface, bearing paxillae consisting of very short, rather indistinct trunks with enlarged heads on which there are from seven to 12 short, thorny-tipped spinelets, are covered by a thick skin. On the disc these plates show no regular arrangement, but on the arms they are arranged in more or less regular longitudinal and transverse rows.

Pedicellariae are absent.

Small papulae occur singly between the lobes of the abactinal plates, but appear to be absent from the centre of the disc and distal half of the arms.

The interradial madreporite lies nearer the centre than the edge of the disc and is very small and indistinct, being almost completely hidden by neighbouring paxillae.

The superomarginal plates are very small and not easily distinguishable from adjacent abactinal paxillae. The 18 to 20 inferomarginals are well developed and extend from the interradial angle to the arm tip; they consist of a broad and sturdy paxillar trunk with from 10 to 12 short, thorny-tipped spinelets.

On the actinal surface, the small plates, which bear one or two short, thorny-tipped spinelets, are almost completely obscured by membrane, but at least one row extends into the arms to about the level of the eighth inferomarginal plate.

The adambulacral plates bear three (proximally), or more usually two, slender, smooth, blunt-tipped, basally webbed furrow spines which project over the furrow. The three, four, or occasionally

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five subambulacral spines occurring at right angles to the furrow are webbed basally, sturdy, blunt-tipped, and thorny, the two outer spines on each plate being generally longest.

The ambulacral grooves are narrow and the tube-feet regularly biserial, with distinct sucking discs.

Unfortunately, the oral spines of this single specimen are much broken but there appear to be seven furrow spines, the two most anterior being longest and projecting over the mouth, and also two stouter, suboral spines.

Type Locality: Ross Sea, Pennell Bank, 322–340 m.

Distribution

Known only from the Ross Sea.

Material Examined

One specimen from the following station:

Sta. A455, 322–340 m.

Size: In the single specimen in this collection R = 22 mm and r = 8 mm.

Remarks

This species differs from *Crossaster australis* (from the Straits of Magellan) in lacking a conspicuous interradial septum. It is similar to *Crossaster hypothrissus* and *C. regularis* as the spines of the abactinal paxillae are bi- or tri- dentate, but its nearest affinities are probably with *C. diamesus*, from which it differs in features of the abactinal surface. *C. canopus* is named after the southern star, *Canopus*, the trivial name being treated as a nominative in apposition.

Myoraster Fisher, 1940

Disc small, rays five. Abactinal surface with small oval or lobed plates and no connecting ossicles; paxillae small, close packed, and bearing very slender spinelets terminating in two or three distinct prongs. Superomarginals small, reduced, scarcely larger than abactinal paxillae. Inferomarginals with short trunks or stems with numerous, close packed, thorny-tipped spinelets. Actinal areas small, at least one row of plates extending almost to the arm tips. Adambulacral armature consisting of two series of spines webbed basally and at right angles to each other. Suboral spines often in two rows. A specialised internal longitudinal muscle lying between the adambulacral and superomarginal plates.

Type Species: *Lophaster antarcticus* Koehler.

A single Antarctic species.

Myoraster antarcticus (Koehler) (pl. 10, fig. 5 and 6)

Lophaster antarcticus Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 46, pl. 3, fig 4 and 5: Kochler, 1920, Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (I), p. 144, pl. 32, fig. 8–11; pl 33, fig. 3 and 4; pl. 67, fig. 1–5; pl. 68, fig. 1 and 2; Koehler, 1923. Swedish Antarct. Exped. Astérics et Ophiures, p. 75.

Myoraster antarcticus Fisher, 1940. Disc. Rpts. 20, p. 181.

The disc is plane and slightly convex in the interradial regions. The arms are convex, tapering to sharp tips; the actinal surface is plane.

The small, round, or slightly lobed plates which pave the abactinal surface of the disc and arms are generally overlapping without connecting ossicles. These plates, with short, distinct paxillae which are close packed and numerous on the centre of the disc and arms, form transverse rows of six or seven plates in the interradial regions and proximal margins of the arms. There is a short, slender trunk or stem terminating in a broad head bearing a large number (up to 35) of very slender, often skin-covered, spinelets. Generally, these have a reticulate structure terminating in three or four exceedingly sharp teeth, the most median being the longest; occasionally, especially towards the arm tips, the sharp teeth of the spinelets are replaced by distinctly inflated lobes, such as Koehler (1920, pl. 67, fig. 3) illustrates. There is a distinct interradial septum.

Pedicellariae are absent.

Papulae are indistinct and apparently scattered over the surface of the disc and arms.

The small madreporite, almost totally obscured by neighbouring paxillae and dissected by a number of deep, sinuous grooves, is interradial in position and nearer the edge than the centre of the disc.

The anus is not visible.

Plates of the superomarginal series are very small and not easily discernible, being only slightly larger than the neighbouring abactinal paxillae and lying in the interradial angle nearly opposite the inferomarginals but, elsewhere alternating and near the arm tips becoming indistinct. The outer spinelets of the paxillae may be of the ordinary sharp-tipped type while the inner spinelets may show very distinct lobes.

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Between 20 and 24 inferomarginals, with very large and distinct paxillae, extend between the interradial angle and the arm tip; each consists of a short, sturdy, compact trunk bearing a vast number of very slender spinelets terminating in one or three very sharp teeth. There are no lobed spinelets.

On the actinal surface, the small interradial areas enclose about 14 or 15 more or less oval plates, at least one row extending for three-quarters the length of each arm. These plates, bearing paxillae of from seven to 15 spinelets, are similar to the abactinal spinelets although they are slightly more flattened and may have from four to six teeth, of which the median is the longest.

The band-like adambulacral plates are separated from each other by broad muscular intervals and generally bear four tapering furrow spines, of which the two median spines are longest (about 2 mm) and the outer spines very small indeed. The plates are joined basally by a slender webb and are coarsely toothed distally. The subambulacral spines, generally four, form a slightly curved row at right angles to the furrow spines, and are also webbed basally, coarsely toothed, somewhat flattened, and finely reticulate.

Within the narrow ambulacral grooves the tube-feet are biserial with distinct sucking discs.

The eight or nine oral furrow spines form a graded series, with the two spines overhanging the mouth being longest. These spines are smooth for most of their length although finely denticulate distally. The five to seven shorter suboral spines are often arranged in two rows.

Colour in Life: No colour notes accompany the present specimens. Koehler (1912, p. 49) records the colour of living specimens as varying from grey to a white disc and white or pale yellow arms, later (1920, p. 145) he notes the colour as "yellow" and "pale yellow".

Type Locality

Between Jenny and Adelaide Island, 67° 43′S, 70° 45′ 42″W, 254 m.

Distribution

Probably circumpolar, Antarctica. South Georgia and South Sandwich Islands, Palmer Archipelago and Bellinghausen Sea, Adélie Land, and (this collection) the Ross Sea. *Bathymetric Range:* 99 – 740 m.

Material Examined

Twelve specimens from 10 stations as follows:

Sta. A449, 362 m (1); Sta. A450, 472–318 m (1); Sta. A459, 534–549 m (2); Sta. A460, 415–430 m (1); Sta. A461, 578–567 m (1); Sta. A467, 88–183 m (1); Sta. A468, 110 m, (1); Sta. A528, 274–265 m (2); Sta. A534, 380–366 m (1); Sta. A537, 574–543 m (1).

Size: In these 11 specimens R ranges from 138 to 14 mm, averaging 38 mm, and r ranges from 40 to 5 mm, averaging 11 mm. Unfortunately, as much of the material is damaged, this description is from a smaller specimen (A461) in which R = 15 mm and r = 5 mm. Koehler's type material was small with R not exceeding 28 mm; in later specimens from Adélie Land R = 120 mm. Fisher (1940, p. 18) records the largest specimen, in which R = 160 mm and r = 46 mm, from South Georgia.

Remarks

These specimens agree well with earlier descriptions and the spines are similar to those illustrated by Koehler (1920, pl. 67). There seems to be some variation in the oral armature of this species. In the type material only seven furrow and six suboral spines are recorded, while Koehler (1920) records up to 10 furrow and up to nine suboral spines. Four specimens (two from A459 and one from both A460 and A537) show an interesting variation in the abactinal paxillae. These have longer, more slender spinelets and the paxillae are less closely packed. All of these specimens are damaged and it is difficult to determine the details of the actinal surface, but they do not seem to differ appreciably from other specimens of this species. A damaged specimen, from A537, has six arms which is most unusual. The longitudinal muscle band described by Fisher (1940, p. 183) is not always apparent, especially when the specimen is dried.

Ecology

This species appears to tolerate a wide variety of substrates ranging from rocks and gravel to stones and sand, gritty mud, and mud.

Cuenotaster M. P. Thiéry, 1920

Abactinal skeleton generally very reduced and plates hidden by a thick integument which also surrounds the spines of the abactinal paxillae or fascicles. Papulae distinct and isolated. No superomarginal plates. Inferomarginals distinct, well

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developed, paxilliform, and joined to the adambulacral plates by two distinct ridges of modified actinal plates. Actinal surface membrane covered; fascioles present.

Type Species: Leucaster involutus (Koehler).

A single Ross Sea species.

As *Leucaster*, proposed by Koehler (1912), was preoccupied, M. P. Thiéry suggested replacing it by *Cuenotaster* and Koehler (1920) adopted this suggestion.

Cuenotaster involutus (Koehler) (pl. 10, fig. 3 and 4; text-fig. 13)

Leucaster involutus Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes, p. 55, pl. 5, fig. 1–3, 6, 7, 10, and 11.

Cuenotaster involutus Kochler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 159, pl. 33, fig. 5, pl. 65, fig. 4; Koehler, 1923. Swedish Antarct. Expéd. Astéries et Ophiures, p. 75; Döderlein, 1928. Deutsche Südpolar Exped. 1901–03, 19 (2), p. 295; Fisher, 1940. Disc. Rpts. 20, p. 184; Clark, A. H., 1950. Echinod. of the U.S. Navy Antarct. Exped. 1947–48, 40, p. 337.

The disc, which is more or less plane or slightly convex, is depressed interradially; the long, slender, flexible arms are blunt tipped and convex abactinally; the actinal surface is convex.

Small, scattered plates, embedded in a thick integument and bearing indistinct fascicles or paxillae consisting of a short trunk or stem with two to 10 small, skin-covered spinelets, are present on the abactinal surface of the disc and arms. These paxillae are of two sizes. The larger, with from seven to 10 spinelets, project slightly above the level of the surrounding structures and are only conspicuous when the specimen is dry; the smaller paxillae, most evident near the arm tips, seldom consist of more than three or four thorny-tipped spinelets. On the disc and arms the paxillae are close packed and numerous; along the arm edges they are more or less evenly spaced and give a very distinctive and curiously harsh feeling to the surface when the animal is dry. A short interradial septum is present.

Pedicellariae are absent.

Very distinctive papulae, which occur on the disc and for most of the length of the arms, expand distally into an inflated, flat, rosette-like structure. This, with the integument which invests the spines, tends to completely obscure the abactinal skeleton.

The very tumid, almost circular madreporite (about 3 mm) is interradial in position, nearer the edge than the centre of the disc, and is dissected by a large number of very sinuous grooves. The adjacent paxillae are large and distinct.

The anus which occupies a central position on the disc is small and surrounded by several enlarged, thorny-tipped spinelets.

There are no supermarginal plates; the inframarginals are large and distinctive, each bearing a paxilla consisting of a short, very sturdy stem or trunk crowned with from seven to 15 tapering,

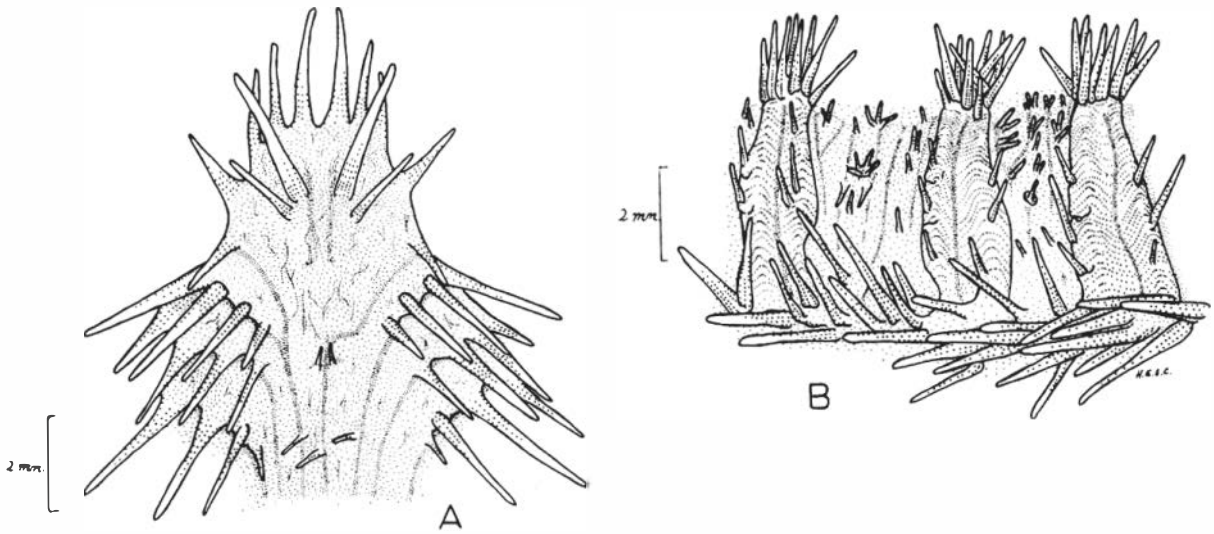

FIG. 13: *Cuenotaster involutus*, A, actinal surface showing the oral and adambulacral plates; note the wrinkled membrane, the shallow fascioles, and the small spines of the actinal plates; B, inferomarginal paxillae and ridges of modified actinal plates running to the adambulacral plates. The specimen illustrated is from Sta. A537. Each drawing is to the scale shown.

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blunt-tipped, and more or less equal spinelets (between 1·75 and 2 mm long). From either side of the trunk of each paxilla two well marked, membranous-covered ridges (composed of two or three modified actinal plates bearing short, blunt-tipped spinelets) run ventralwards to join with the adambulacral plate. Separating two inferomarginal plates is a conspicuous, more or less naked area with only a few, scattered spinelets and narrow, occasionally branching, fascioles. A fasciole also occurs between the two ridges running from any one inferomarginal plate and there are three or four adambulacral plates between the ridges of the inferomarginals. Near the arm tip these ridges are much reduced and inconspicuous.

The actinal intermediate areas are small, and some plates at least extend almost to the arm tips; the plates are covered by a membrane traversed by shallow fascioles, between which are short, sharp-tipped, usually isolated spinelets.

The rectangular, membrane-covered, adambulacral plates, each bear a row of four upright, tapering thorny-tipped spines set at right angles to the furrow. Of these, the furrow spine and the third spine measure between 3 and 3·5 mm while the second spine is longest (about 4 mm) and the fourth and outermost spine is small, seldom exceeding 2 mm.

The ambulacral grooves are wide. The tube-feet are very regularly biserial and terminate in distinct sucking discs.

The oral plates are large. There are five distinct, blunt, thorny-tipped furrow spines forming a graded series, those overhanging the mouth being longest, (about 4 mm) and two slightly sturdier suboral spines, the most anterior measuring between 4 and 5 mm.

Colour in Life: There are no colour notes with these specimens but a colour transparency by J. S. Bullivant of a trawl sample from Sta. A537 records the abactinal surface as being grey brown, lighter near the arm tips with an almost green tinge on the disc, while in a second transparency the actinal surface is a lighter, grey brown. Koehler (1912, p. 60) notes the colour in a living specimen as brown yellow (abactinal surface) and much paler (actinal surface). Very small specimens were white or grey white. Fisher (1940, p. 185) records the colour of a living specimen as dull, greenish grey. In spirits, the large specimen was dark chocolate brown with lighter pink brown actinal surface and inferomarginals, tube-feet dark brown; the small specimen was light pinky brown with lighter spines and marginal paxillae.

Type Locality

Amirauté Bay, King George Island, South Shetlands, 75 m.

Distribution

Probably circumpolar, Antarctica. This is the first record from the Ross Sea. *Bathymetric Range:* 60–794 m.

Material Examined

Two specimens were examined from two stations as follows:

Sta. A461, 578–567 m (1); Sta. A537, 574–543 m (1).

Size: The description is based on the larger specimen (A537) in which R = 56 mm (approx.) and r = 14 mm; in the smaller damaged specimen (A461) R = 12 mm and r = 4 mm. In Koehler's material the type measures R = 100 mm and r = 34 mm, while in the second, even larger specimen R = 105 mm and r = 32 mm. Later specimens were smaller.

Remarks

The small specimen (A461) is unfortunately much broken but the distinctive inferomarginals and adambulacral plates are present. There is no thick masking integument in this small specimen and each abactinal plate is more or less distinct, either round or slightly lobed with the lobes overlapping. There are paxillae of two distinct sizes present bearing from two to nine or ten short, thorny, blunt-tipped spinelets. Papulae are fewer and each emerges from a very distinct pore. The actinal interradial areas are very small and there is no membranous covering; the plates are oval and isolated. The most anterior of the suboral spines is very large and distinctive, otherwise both these and the adambulacral spines do not appear to differ greatly from the larger specimen. It seems probable that the integument thickens and that there is a reduction in the skeleton as the animal becomes older, and the plates also possibly alter in shape with age. Koehler (1912) reports only four furrow spines on the oral plates. This specimen has five distinct spines.

Ecology

This species frequents a wide variety of substrates and has been reported from mud, sand, stones, and rocks. The present specimens are from sandy mud and stones and mud. Fisher (1940, p. 185) has

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suggested that this animal "may perform undulating movements of the rays and walk on the tips of its extended podia, as do some species of *Luidia*".

Paralophaster Fisher, 1940

Five rays. Abactinal plates cruciform or lobed without intermediate connecting ossicles and forming a well developed reticulate skeleton; plates paxilliform. No differentiated superomarginal paxillae. Actinal intermediate plates present or absent. Adambulacral armature consisting of a furrow series and a subambulacral series at right angles to this.

Type Species: Solaster godefroyi Kochler.

Fisher (1940, p. 176) records a new subspecies, *P. godefroyi meseres* from the Ross Sea, characterised by its well developed actinal intermediate plates with from two to five spines, and by two adambulacral furrow spines. *P. lorioli* differs from this in having naked actinal interradial areas and four or five adambulacral furrow spines.

Paralophaster lorioli (Kochler) (pl. 12, fig. 1 and 2)

Solaster lorioli Koehler, 1908. Expéd. Antarct. Nationale Écossaise. Trans. Roy. Soc. Edin., 46 (3), p. 558, pl. 4, fig. 40 and 41.

Paralophaster lorioli Fisher, 1940. Disc. Rpts. 20, p. 175; Madsen, 1955. Sci. Res. Norwegian Antarct. Exped. 1927–28, 37, p. 14, pl. 1, fig. 5 and 6, text-fig. 2.

The disc and abactinal surface of the arms are convex, the arms are long and tapering to sharp tips, the actinal surface is convex.

The abactinal surface has an irregular reticulum of cruciform or occasionally two or three lobed plates without connecting ossicles. These plates have a central paxilla consisting of a very short, broad trunk bearing (on the disc and proximal part of the arms) between 10 and 12 slender, flaring spinelets; near the arm tips the spinelets are shorter and there are only six or seven. These spinelets are cylindrical and smooth for three-quarters of their length, but distally are thorny and usually terminate in a single hyaline point.

Pedicellariae are absent.

The papulae, which occur in the membranous areas, are very indistinct.

The small, indistinct, madreporite lies nearer the edge than the centre of the disc.

There are no distinct superomarginal plates present. The inferomarginals are obvious and spaced, nine or ten extending from the interradial angle to the arm tip. In the interradial angle the compact and sturdy trunks of the oblong inferomarginals are crowned with as many as 12 spines, while near the arm tips there are seldom more than six. These spines are of two types: the majority are slender, cylindrical, and thorny tipped like the abactinal spines, while the rest, especially those in the centre of the paxillae, are distinctly flattened and blade like and have from three to seven sharp, conspicuous teeth on one side only.

The very small actinal interradial areas are naked.

Each of the band-like adambulacral plates has a rounded margin projecting somewhat into the furrow; proximally there are four or five slender, tapering furrow spinelets, distally, generally only three. At right angles to these, on a slight boss, are four or five subambulacral spines which may be webbed basally and are flattened and blade like and bear a number (from six to eight) of lateral teeth on one side only. Both these spines and those of the inferomarginals are essentially similar to those illustrated by Madsen (1955, p. 14, text-fig. 2).

Within the fairly wide ambulacral grooves the tube-feet are biserially arranged, each terminating in a small sucking disc.

The oral plates are large and distinctive, with nine tapering, smooth, basally webbed spines and five shorter suboral spines in a single row.

Colour in Life: Unknown; in spirit, very pale white or brown, darker tube-feet.

Type Locality

Weddell Sea, 67° 33′S, 36° 35′W, 2500 "brasses" (approximately 3625 m).

Distribution

Weddell Sea – the type locality – and Bridgman Island (Madsen, 1955), and (this collection) the Ross Sea. It is a very, deep-water species. *Bathymetric Range*: 750–4570 m.

Material Examined

One specimen from the following station:

Sta. A523, 1375–2804 m.

Size: In this single, damaged specimen R=15 mm and r=5 mm. In the type material R=22 mm and r=5 mm, Madsen's (1955) material was larger, R=27 and 28 mm, and r=about 9 mm.

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Remarks

This specimen has characters similar to those described by Madsen. These include particularly the nature of the inferomarginal and subambulacral spines which are very distinctive indeed.

Lophaster Verrill, 1878

Five arms. Cruciform or lobed abactinal plates (without intermediate connecting ossicles) forming a skeleton of quadrangular or polygonal meshes. Two well developed series of marginal paxillae; usually a single series of spaced actinal intermediate plates (with or without paxillae) extending for some distance along the arm. Adambulacral armature in two series, with subambulacral spines in a row at right angles to furrow spines. An interbrachial septum present.

Type Species: *Solaster furcifer* Düben and Koren.

There are a number of Antarctic species present. All of these, except *Lophaster gaini*, are restricted to the South Shetlands, Marion Island, and the Magellanic region.

Lophaster gaini Koehler (pl. 12, fig. 3 and 4; text-fig. 14)

Lophaster gaini Koehler, 1912. Deuxiéme Expéd. Antarct. Franç. Échinodermes. p. 42, pl. 4, fig. 4, 5, 12, and 13; Koehler, 1920. Australas. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 143, pl. 31, fig. 8 and 9; pl. 66, fig. 8; Fisher, 1940. Disc. Rpts., 20, p. 173.

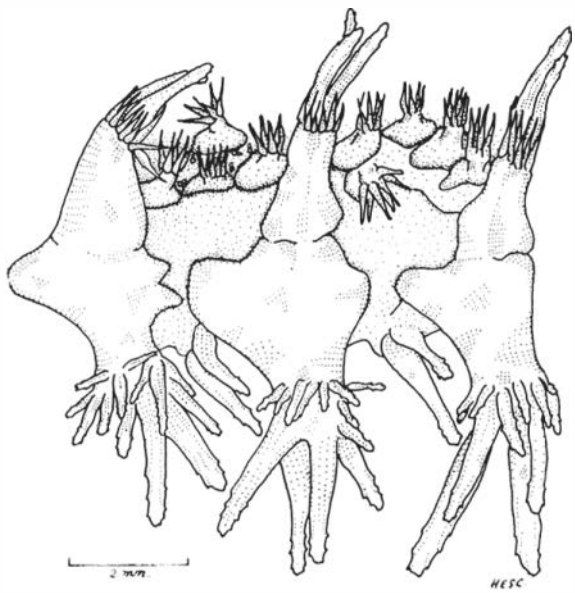

FIG. 14: *Lophaster gaini*, showing the small superomarginal and larger, sturdier inferomarginal paxillae and abactinal paxillae in a specimen from Sta. A449.

The disc is broad and slightly concave centrally, while the surface of the arms is plane. The arms are broad basally and taper evenly to blunt tips protected by small square plates. The actinal surface is slightly concave.

There is a thin abactinal membrane covering the two- to five-lobed plates of the abactinal surface; these may be isolated or have overlapping lobes, there are no connecting ossicles. These plates are irregularly arranged except along the arm edges where there are transverse rows of three to five plates. On the larger four- or five-lobed plates the paxillae consist of slender trunks or stems with 13 to 20 small, slender, and cylindrical spinelets which terminate in a hyaline, needle-like, and very distinctive point, these may or may not be spiny for three-quarters of their length. The smaller paxillae on the two-lobed plates have two to four spinelets only. The distinct, interbrachial septa are devoid of spines.

Pedicellariae are absent.

From two to six small, blunt-tipped papulae, each emerging from a distinct pore, are present over the surface of the disc and arms in the membranous spaces between the abactinal plates, but are absent from the interradial septa and the last quarter of the arm.

The madreporite, which lies nearer the centre than the edge of the disc on an interradial septum, is oval (about 2 mm), slightly tumid, and regularly dissected with about five slightly enlarged paxillae surrounding it.

The anus is not visible.

Plates of the marginal series form a conspicuous border to the arms; the superomarginal plates are distinctly larger than adjacent abactinal paxillae but smaller than the inferomarginals and have a trunk about 2 mm long crowned with one to four stout, central spines (finely spinulose and between 1 and 2 mm long), and from 5 to 12 smaller basal spines, each with a needle-like point similar to the spinelets of the abactinal paxillae. These paxillae lie more or less flat against the arms.

The inferomarginals lie opposite the superomarginals, except near the arm tips where they may be slightly displaced to one or other side, they stand out from the ray and bear paxillae consisting of a trunk or stem crowned with two to five sturdy, thorny, blunt-tipped, central spines and 6 to 12 basal, shorter, thorny spines, each terminating in a single hyaline tip similar to those described. The first two inferomarginal plates

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are very small and confined to the actinal surface, but from the third proximal adambulacral plate to the arm tip the inferomarginals are contiguous with the adambulacrals. Between 27 and 29 plates occupy the area from the interradial angle to the arm tip.

The plates of the actinal interradial regions are oval; proximally, they have one to three thorny-tipped spinelets, which may be webbed basally, and distally 8 to 10 spinelets.

The band-like adambulacral plates (separated by distinct membranous areas) bear four (occasionally three) blunt-tipped, thorny, basally webbed furrow spines; of these, the two median spines are longest and those on either side are very short and inconspicuous. There are three, or occasionally five, subambulacral spines forming a row at right angles to the furrow spines; these spines are not webbed basally and the two proximal spines are about 4 mm long.

There are eight distinct, basally webbed furrow spines on the oral plates forming a graded series with two long (about 5 mm), blunt-tipped, thorny, furrow spines overhanging the mouth and three shorter suboral spines.

Within the ambulacral grooves the tube-feet are biserially arranged with distinct sucking discs.

Colour in Life: No colour notes are included with these specimens. Koehler (1912, p. 46) notes the colour in the living animal as red to light bluish purple (abactinal surface) and a very pale red-yellow (actinal surface); and (1920, p. 143) he records the colour as "red". In spirits, specimens are light brownish yellow with lighter adambulacral, oral spines, and marginal plates, and, darker brown tube-feet.

Type Locality

Amirauté Bay, King George Island, South Shetlands, 420 m.

Distribution

Probably circumpolar, Antarctica. Localities recorded are: South Shetlands, Palmer Archipelago, Adelaide Island, Adélie Land, Queen Mary Land, and (this collection) the Ross Sea. *Bathymetric Range:* 203–578 m.

Material Examined

Two specimens from two stations as follows:
Sta. A449, 362 m (1); Sta. A461, 578–567 m (1).

Size: In the smaller specimen (A449) which is described here, R = 75 mm and r = 16 mm, in the second specimen (A461) R = 170 to 175 mm and r = 40 mm. This latter appears to be the largest specimen yet recorded.

Remarks

In the larger specimen (A461) the interradial septum is less clearly defined and on the actinal surface there are only three adambulacral furrow spines although four occur sporadically. The actinal interradial plates of this larger specimen are isolated and distinctly oval, and the paxillae never bear more than six spines. On one oral plate, only two suboral spines are present.

Ecology

Both the present specimens are recorded from a muddy substrate. Previous specimens were recorded from rocks and gravel, or rocks and blue mud (Koehler, 1912, pp. 46, 47), or mud (Fisher, 1940).

Family KORETHRASTERIDAE Danielssen and Koren, 1884

A single Ross Sea genus.

Peribolaster Sladen, 1889

Abactinal skeleton of cruciform plates forming, with connecting ossicles, a more or less regular network with large quadrangular meshes. Primary plates bearing fascicles of delicate, subequal spinelets enveloped in membranous sheaths. One to several papulae in each mesh; no actinal papulae. No actinal intermediate plates. Adambulacral armature and inferomarginal spines forming a distinct transverse series. Large mouth plates with a prominent median keel. Tube-feet in two or four rows. No pedicellariae.

KEY TO THE ROSS SEA SPECIES

1 (2) Oral armature consisting of three oral furrow spines and one suboral spine ... **macleani** Koehler, 1920

2 (1) Oral armature consisting of three oral furrow spines and two suboral spines. ... **powelli** H. E. S. Clark, 1961

A species from the Chatham Islands, *P. lictor* Fell, also has three oral furrow spines and two stouter, recurved, suboral spines but these are anterior in position and occur in close proximity to one another. *P. lictor* is also distinct in having a transverse row of five spines, four adambulacrals, and one inferomarginal.

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Peribolaster powelli n. sp. (pl. 9, fig. 6 and 7; text-fig. 15)

The disc and abactinal surface of the arms are strongly convex, The arms are short and taper to sharp tips protected by small, saddle-shaped plates, the actinal surface is concave.

The irregular abactinal meshwork of primary cruciform or triradiate plates and small, oval, secondary connecting ossicles, encloses large membranous areas; near the arm tips the plates are small with long slender lobes and may sometimes be more or less isolated. The primary plates, with fascicles of four to six slender, pointed spines (2 to 3 mm long) united in membranous sheaths, probably form an open cup-shaped structure in life but in preservative and dry they are flat and collapsed; near the arm tip there may be as few as two spines in a fascicle. There is a distinct, depressed, interradial septum devoid of spines, and partly calcified.

Pedicellariae are absent.

From 2 to 20 small, round-tipped papulae, are present round the periphery of the large, confluent, membranous areas, but become indistinct distally and are absent from the last third of the arm.

The tumid madreporite, which is nearer the centre than the edge of the disc on an interradial septum, measures about 2 mm in diameter and is dissected by a number of coarse and more or less straight grooves.

Surrounding the more or less central anus are four short, clubbed, finely spinulose granules or spines.

The triradiate superomarginals bear fascicles of slender, membrane-invested spines similar to those of the abactinal surface.

The inferomarginal plates form a conspicuous edge to the actinal surface and have each a conspicuous, flattened, spatulate, broad-tipped spine between 2 and 3 mm long. Several of these terminate in three or four unequal awns.

The triangular, membranous, actinal intermediate regions are devoid of spines and plates.

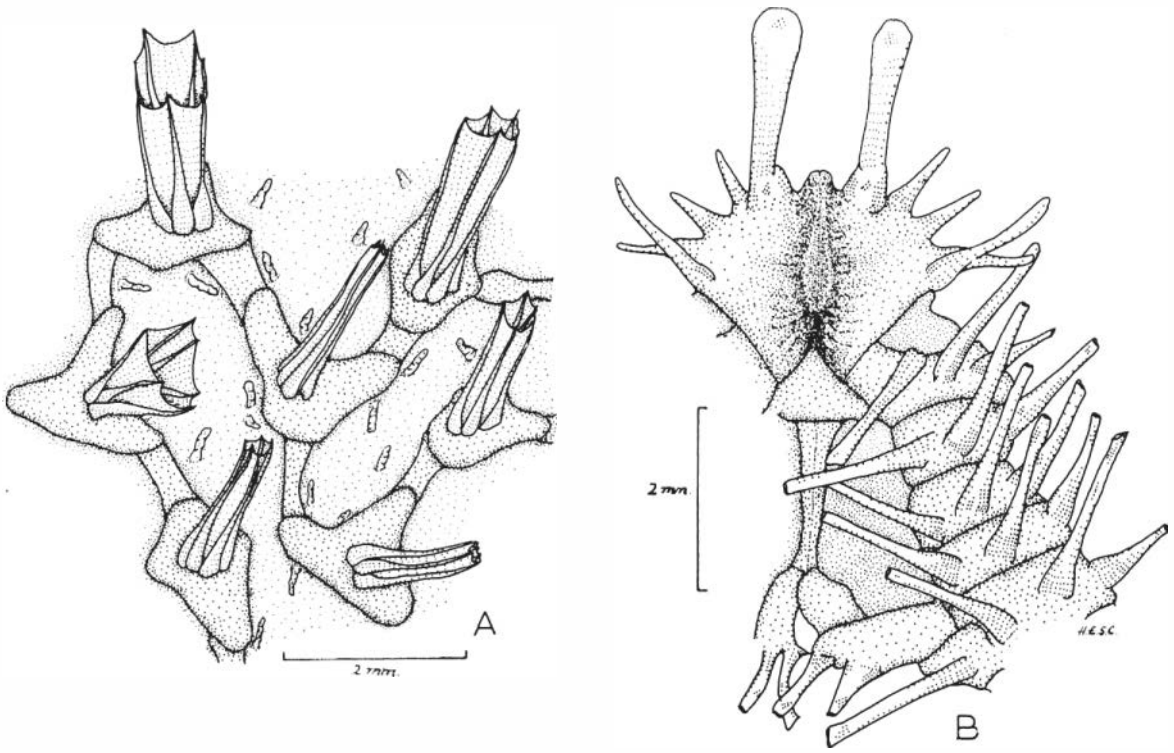

FIG. 15: *Peribolaster powelli* holotype. A, abactinal surface showing fascicles, plates, connecting ossicles, and papulae. B, actinal surface showing oral and adambulacral plates, the interradial septum, and inferomarginal plates. Both drawings to scale shown.

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Each narrow adambulacral plate bears a small, somewhat flattened furrow spine (between 0·5 and 1 mm long). Within the groove there are two (or occasionally three) longer (about 2 mm) tapering, blunt, or round-tipped subambulacral spines forming a transverse row.

Within the narrow ambulacral grooves the tube-feet are slender with distinct sucking discs.

The oral plates are distinct and rather tumid; they have three small, slightly thorny-tipped furrow spines and two larger, sturdier suboral spines, the most anterior overhanging the mouth. The suboral spines are round-tipped, scoop-shaped, flat, and about 2 to 2·5 mm long.

Colour in Life: Unknown; in spirits, white with grey brown membranous areas and light brown tube-feet.

Type Locality

Ross Sea.

Distribution

Known only from the Ross Sea, 201–1335 m. *Bathymetric Range:* 201–1335 m.

Material Examined

Twenty-two specimens from 10 stations as follows:

Sta. A456, 238–201 m (2); Sta. A457, 315–342 m (1); Sta. A461, 578–567 m (1); Sta. A464, 369–384 m (1); Sta. A520, 201–205 m (5); Sta. A521, 582–558 m (1); Sta. A522, 1335 m (2); Sta. A525, 591–583 m (1); Sta. A527, 358–337 m (2); Sta. A529, 205–216 m (6).

Size: In these 22 specimens R averages 22 mm and ranges from 27 to 5 mm; r averages 6 mm and ranges from 13 to 2 mm. In the holotype (A456), R = 25 mm and r = 9 mm.

Young Stages

The nine small specimens (R = 10 mm or less) from Sta. A520, A522, A525, and A529 show certain interesting features. On the abactinal surface of the disc there is a conspicuous ring of larger, lobed primary plates enclosing a membranous area in which there is a small, central, round, or oval isolated plate. The secondary plates or ossicles may be absent (especially in specimens where R = 6 mm or less) and the lobes of the primary plates overlapping or isolated, while the spines composing the fascicles are distinctly more hyaline in appearance. The anus and interradial septa are always very distinct and well developed. In the smallest and best preserved specimen (A525, R = 5 mm and r = 3 mm) the madreporite consists of a small pore or hole surrounded by six or seven oblong, keel-like granules. On the actinal surface, the innermost, small adambulacral furrow spine is often absent especially in the distal regions of the arms near the oral angle. However, on the first one or two adambulacral plates these spines are visible deep within the grooves, and may be developed in one or two oral angles only, or may be absent altogether. The form of the inferomarginal spines is also evident. They consist of three or four very slender acicular spines united in a membranous web. On the oral plates the most distal suboral spines may be very poorly developed and small.

Remarks

In the largest specimen in this collection (A461) the nature of the papulae is worthy of note; these are large, inflated, or lobed distally and very obvious. Otherwise the rest of these specimens show no very noteworthy differences.

Ecology

This species tolerates a wide variety of substrates from mud to sandy mud, pebbles, and stones.

F mily P T E R A S T E R I D A E Perrier, 1875

A single Ross Sea genus.

Pteraster Muller and Troschel, 1842

Distinct supradorsal membrane present supported by spines of underlying paxillae. Small spicules and muscle bands often present. Abactinal skeleton reticulate. Adambulacral armature in the form of a transverse, webbed comb. Actinolateral spines forming a free independent lateral fringe.

Fisher (1940, p. 191) distinguishes three subgenera of *Pteraster* based on the presence or absence of membrane between the oral furrow spines. The present specimens are included in the subgenus *Apterodon* (Fisher, 1940) as the oral furrow spines are not united in a web.

A single Ross Sea species.

Pteraster (Apterodon) stellifer Sladen (pl. 9, fig. 8 and 9)

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Pteraster stellifer Sladen, 1882. J. Linnean Soc., of London (Zool.) 16, p. 193; Sladen, 1889. Challenger Rept., 30, p. 474, pl. 74, fig. 1 and 2; pl. 77, fig. 1 and 2; Bernasconi, 1937. Anales Mus. Argentino de Ciencias Naturales, 29, p. 176; Fisher, 1940. Disc. Rpts. 20, p. 199.

Pteraster hunteri Koehler, 1920. Australas, Antarct. Exped. 1911–14, Sci Rpts., Ser. C, 8 (1), p. 165, pl. 37, fig. 4–10; pl. 38, fig. 8; pl 65., fig. 7; Koehler, 1923. Swedish Antarct. Exped. Astéries et Ophiures, p. 81; Bernasconi, 1937. Anales Mus. Argentino de Ciencias Naturales, p. 176.

The abactinal surface is strongly convex; the arms very short, sharp pointed, and recurved at the tips; the actinal surface, slightly convex.

The supradorsal membrane is very distinct and supported by paxillar spines. Cruciform or triradiate plates with small, secondary connecting ossicles form the irregular meshwork of the abactinal skeleton. The primary plates bear a central trunk or stem with six to eight slender, thorny-tipped, needle-like spines and generally also a central longer spine abutting against, and sometimes penetrating, the supradorsal membrane; the spines of the paxillae are united in an indistinct web of membrane. A distinct interradial septum is present.

Pedicellariae are absent.

Small, single papulae occur in the membranous spaces between the abactinal plates, but appear to be absent from the centre of the disc and proximal region of the arms. Above the arms in the supradorsal membrane there are numerous, small spiraculae present; near the arm tips these are indistinct and scattered. The central raised osculum on the supradorsal membrane is protected by about 12 slender, upright, membrane-invested spines; the anus lies beneath on the disc.

The actinal surface is very distinctive with a transverse comb of five or six adambulacral spines. The furrow spine is very small and placed deep in the groove, the remaining needle-like, reticulate, and hyaline spines (between 1 and 2 mm long) are webbed, the membrane extending almost to the tips of the spines. There are also slender, reticulate, webbed actinolateral spines present projecting out from the adambulacral plates; the web of membrane may be contracted between two spines, so forming a wavy margin. One actinolateral spine corresponds to one adambulacral plate, and the web of membrane from the innermost adambulacral spine joins the actinolateral spine.

The straight ambulacral grooves are not very wide and the tube-feet are strictly biserial with distinct sucking discs.

Each oral plate has a distinct oral keel medially and five or six slender, spinulose, furrow spines lacking a basal membrane; there are one or two blunt-tipped and sturdier suboral spines.

Colour in Life: There are no colour notes with these specimens. Koehler (1920, p. 167) notes the colour in a living specimen as "yellow"; in spirits, the specimens are white with light brown tube-feet.

Type Locality

Off the entrance to Smyth Channel, Chile, 52° 45′ 30″S, 73° 46′W, 245 f (453 m).

Distribution

Circumpolar, Antarctica. Magellanic and Falkland region, also the South Shetlands, South Indian Ocean, 64° to 66°S, 96° to 140°S, Queen Mary Land, Adélie Land, and (this collection) the Ross Sea. *Bathymetric Range:* 79–1335 m.

Material Examined

Twelve specimens from eight stations as follows:

Sta. A461, 578–567 m (2); Sta. A464, 369–384 m (1); Sta. A521, 582–558 m (2); Sta. A522, 1335 m (2); Sta. A523, 2762–2804 m (1); Sta. A525, 591–583 m (2); Sta. A526, 461–465 m (1); Sta. A527, 358–337 m (1).

Size: In these 12 specimens R averages 8 mm and ranges from 13 to 5 mm; r averages 5·5 mm and ranges from 11 to 3 mm. This description is based on a specimen from A526 in which R = 12 mm and r = 9 mm. For details of the abactinal skeleton a slightly smaller specimen from A527 was used. In material from earlier expeditions R varied between 20 and 36 mm.

Remarks

There is little variation in these specimens; however, in several specimens where the adambulacral armature is well preserved, the web of the two adambulacral plates immediately adjacent to the oral plates extends from side to side forming a distinct "barrier" behind the oral plates. The number of oral furrow spines also differs and ranges from three in some small specimens to, more usually, four or five. It is unfortunate that many of these specimens are damaged.

None of these specimens are carrying young; Fisher (1940, p. 200) reports specimens with young which can be seen in the nidamental cavity beneath the supradorsal membrane.

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Order FORCIPULATIDA

Perrier, 1884

Pedicellariae numerous, pedunculate forcipiform (crossed) or forciform (straight). Abactinal skeleton of skeletal arches (transverse on rays) often with intermediate ossicles forming a network with regular or irregular meshes. Mouth plates small, inconspicuous. Tube-feet in four series.

One Ross Sea family.

Family ASTERIDAE Gray, 1840 emend. Fisher, 1928

KEY TO ANTARCTIC SUBFAMILIES

1 (2) No marked adoral carina, first pair of postoral adambulacral plates separated. Inferomarginals with never more than one prominent spine. Rays, five or six; skeleton an open network of cruciform or triradiate plates; spines small; crossed pedicellariae scattered, never in circles about spinelets; no pedicellariae on adambulacral spines. Tube-feet biserial or quadriserial proximally. **Pedicellasterinae** Fisher, 1918

2 (1) An adoral carina of at least one and usually several pairs of post-oral adambulacral plates in contact. Tube-feet quadriserial, at least proximally.

3 (4) Adambulacral spines without attached pedicellariae singly or in clusters although they may occur on the oral spines. Rays, five to many. Abactinal skeleton well developed with plates often in definite longiseries. Two sheathed inferomarginals and one series of actinal plates. Spines prominent and spaced, wreathed with ordinary crossed pedicellariae and peculiar macrocephalous crossed pedicellariae **Coscinasteriinae** Fisher, 1923

4 (3) Adambulacral spines carry pedicellariae singly or in clusters or are without pedicellariae. Abactinal spines not as a rule prominent and spaced; but short slender to stout, conical, tubercular, sub-globose variously granuliform, single or in groups. Abactinal plates in more or less definite longiseries, or irregularly reticulate or abortive. Actinal plates present or absent. **Asteriinae** Verrill, 1914 emend. Fisher.

Subfamily PEDICELLASTERINAE Fisher, 1918

Pedicellaster Sars, 1861

Skeleton of quadrate meshes; inferomarginals not conspicuously large. Crossed pedicellariae of two kinds; larger, with slender jaws and usually four curved, prominent terminal teeth and several thorn-like teeth on the shank; smaller crossed pedicellariae of normal type. Furrow narrow, tube-feet biserial.

A single Ross Sea species.

Pedicellaster hypernotius Sladen, 1861 (pl. 12, fig. 5)

Pedicellaster hypernotius Sladen, 1889. Challenger Rpts. 30, p. 558, pl. 105, fig. 5–7; Fisher, Disc. Rpts., 20, p. 214, fig. F, 3.

Pedicellaster antarcticus Ludwig, 1903. Results Voyage de S. Y. Belgica. Seesterne, p. 35, pl. 4, fig. 32–38; Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 106 and 109, pl. 16, fig. 11; pl. 17, fig. 8 and 9.

The disc is very small, the arms convex and long tapering to blunt tips.

Forming the abactinal skeleton is a more or less regular meshwork of small cruciform or triradiate plates enclosing quadrangular membranous areas. These plates bear very short, stumpy spines terminating in three or four distinct prongs; the carinal plates bear only a single spine.

Numerous very small crossed pedicellariae are scattered over the abactinal surface giving it a distinctly granuliform appearance. There are two types; the smaller ones about 0·22 mm long with broad, finely toothed tips to the jaws are more numerous; the larger, about 0·5 mm long, are more slender, and the jaws terminate in one to three sharp, interlocking teeth with several smaller teeth on the shank. These larger pedicellariae are most obvious on the sides of the arms.

From one to three small, indistinct papulae are present in the membranous areas but these are indistinct or absent distally.

Neither madreporite nor anus is apparent.

The marginal plates are indistinct but a row of larger plates along the arm margin with stout spines probably corresponds to inferomarginals.

There appears to be one, if not two, series of actinal plates extending along the arm. The actinal interradial regions are small.

The small adambulacral plates bear two stout, smooth, subequal spines terminating in several short prongs, with small, squat, straight pedicellariae occurring along the furrow margin for at least half the length of the arms.

The ambulacral grooves are broad, and the tube-feet regularly biserial, wth distinct sucking discs.

It is unfortunate that these specimens are so broken that the oral plates are very indistinct; it appears that each bears two stout furrow spines with a very much longer and more slender furrow spine deep within the mouth.

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Colour in Life: Unknown; in spirits, white or pale brown with darker tube-feet.

Type Locality

Off Marion Island, 46° 43′S, 38° 4′ 30″E, 140 fm (259 m).

Distribution

Off Marion Island, the Bellingshausen Sea, along the Antarctic Archipelago to South Georgia and Shag Rocks and, this collection, the Ross Sea. *Bathymetric Range*: 93–450 m.

Material Examined

Two specimens from two stations as follows:

Sta. A464, 369–384 m (1); Sta. A527, 358–337 m (1).

Size: Both specimens are of similar size, R probably measuring about 15 mm and r about 3 mm. Both are damaged: A527 had six arms and is broken; A464 had five arms only.

Remarks

It is unfortunate that these specimens are damaged, but they do not appear to differ markedly from previous descriptions.

Subfamily COSCINASTERIINAE Fisher, 1923

Key to the Ross Sea Genera

1 (2) Rays, five. Abactinal skeleton well developed with distinctive spiniferous carinals and connecting ossicles. Distinctive crossed pedicellariae of macrocephalous type. ..... **Notasterias** Koehler, 1911

2 (1) Rays many, from eight to 12. Abactinal skeleton often much reduced and plates isolated. Distinct crossed pedicellariae of macrocephalous type, but these are distinctly smaller than in *Notasterias*. ..... **Psalidaster** Fisher, 1940

Notasterias Koehler, 1911

Five rays. Abactinal skeleton reticulate, carinals cruciform, spiniferous and sometimes alternating with smaller secondary plates; short dorsolateral arcs of plates, with or without spines, connecting with superomarginals. Crossed pedicellariae very distinctive of macrocephalous type, with terminally hooked jaws and a flaring base; ordinary, smaller crossed pedicellariae also. Marginals large, cruciform; actinal plates sometimes with spines. Papulae on either side of carinal plates and intermarginally. Adambulacral plates diplacanthid or monacanthid.

Key to the Ross Sea Species

1 (2) Small macrocephalous pedicellariae (not exceeding 0·75 mm) occurring in true circumspinal basal wreaths round the carinal spines and on the abactinal side of the superomarginal spines. No crossed pedicellariae of ordinary type or straight pedicellariae on abactinal surface; straight pedicellariae present in the furrows. Actinal papulae. ..... **stolophora** Fisher, 1940

2 (1) Large macrocephalous pedicellariae present but never in true circumspinal wreaths, several large pedicellariae attached to bases of carinal and inferomarginal spines. Crossed and straight pedicellariae of normal type on abactinal surface. No actinal papulae. ..... **armata** Koehler, 1911

Notasterias armata Koehler, 1911 (pl. 13, fig. 5 and 6; text-fig. 16, 17, and 18)

Notasterias armata Koehler, 1911. Brit, Antarct. Exped. 1907–09, 2 (4), p. 39, pl. 5, fig. 6–11; pl. 6, fig. 1–8; Koehler, 1912. Deuxième Expéd. Antarct. Franç. Échinodermes. p. 25, pl. 1, fig. 8; Koehler, 1920. Australas. Antarct. Exped. 1911–14. Sci. Rpts., Ser. C, 8 (1), p. 58, pl. 7, fig. 8 and 9; pl. 8, fig. 2–8; pl. 9, fig. 1–6; pl. 10, fig. 1–9; pl. 60, fig. 1; pl. 61, fig. 1; Fisher, 1930. U.S. National Mus. Bull. 76 (3) Forcipulata (concl.), p. 244; Fisher, 1940. Disc. Rpts. 20, p. 225, fig. J, 2a, 4–4b; fig. K, 1.

The five arms taper from the rather small disc to blunt tips. The actinal surface is concave.

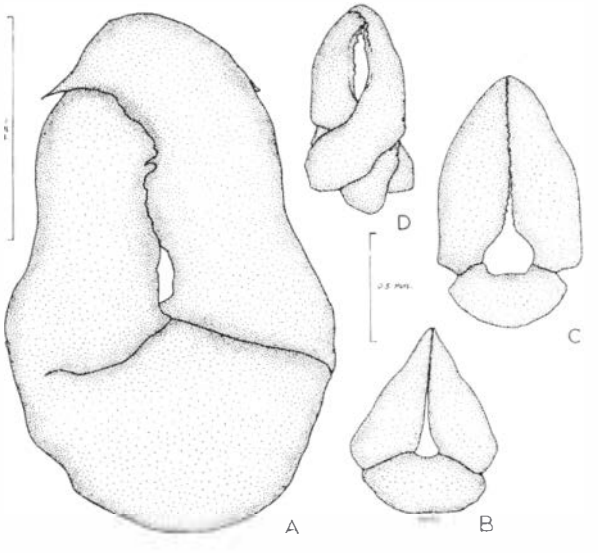

FIG. 16: *Notasterias armata*, A, B, and C, straight pedicellariae; note in A the jaws terminating in a typical "beak"; D, crossed pedicellaria. A, B, and D from a specimen from Sta. A460; C, from a specimen from A459. Each drawing to the scale shown.

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Plates of the abactinal surface form a regular network with a central eight- or nine-lobed plate surrounded by five tumid, conspicuously lobed, primary plates, each bearing a central, stout, tapering, blunt-tipped, and thorny spine (about 4 mm long).

The spines of the smaller two- or three-lobed secondary plates are considerably shorter. Near the disc these carinal plates are five-lobed, the most distal being covered by the proximal lobe of the following plate. Towards the arm tip there are seldom more than three lobes and there may be small connecting ossicles devoid of spines. The small, oblong arcs of two or three dorsolateral plates which extend on either side of the carina seldom bear spines. A membrane is present on the disc and proximal regions of the arms.

The distinctive crossed macrocephalous pedicellariae which occur singly at the base of the spines on the disc and arms are between 2 and 3 mm long, with a broad base, each jaw terminating in a distinct and sharp "beak". Near the arm tips they are smaller. Very small, squat, straight pedicellariae occur scattered on the disc and in the interradial regions.

Papulae occur singly, or in groups of two or three in the membranous spaces between the lobes of the disc and the marginal plates.

A small, interradial, almost circular (about 1 mm) madreporite occupies a secondary plate midway between the edge and centre of the disc and is dissected by a number of deep, coarse grooves.

The anus is situated between two lobes of the large central plate and protected by several small granules or plates.

The superomarginal and inferomarginal plates border the almost vertical face of the arms. In the cruciform superomarginal series the distal lobe of one plate overlaps the proximal lobe of the following plate; near the arm tips the small secondary plates bear no spines. The primary plates, with long, tapering, blunt, and thorny spines which are about 4 mm long proximally, and about 2 mm distally, bear a single large, macrocephalous pedicellaria.

Plates of the inferomarginal series have slightly shorter, less distinct lobes and bear spines similar to, but shorter than those of the superomarginal plates. At the base of these plates there are small, crossed pedicellariae of normal type and single papulae in the membranous spaces.

The actinal interradial regions are small and at least one row of more or less oblong plates with short spines extends for about three-quarters the length of each arm. There is a short, rather indistinct adoral carina of two plates.

The small, rectangular adambulacral plates extend well into the furrow, and although mainly monacanthid may be sporadically diplacanthid. Straight pedicellariae of normal size and shape occur at the base of these spines in the furrow, but are generally absent near the arm tips.

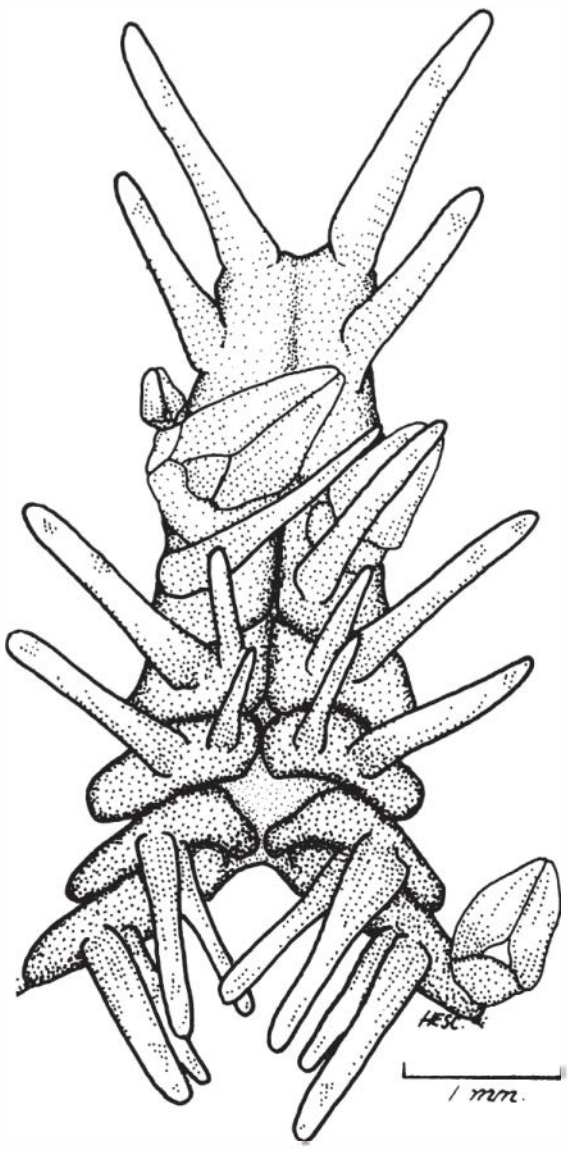

FIG. 17: *Notasterias armata*, oral plates, large, straight pedicellariae, and an adoral carina of three adambulacral plates, in a specimen from Sta. A460.

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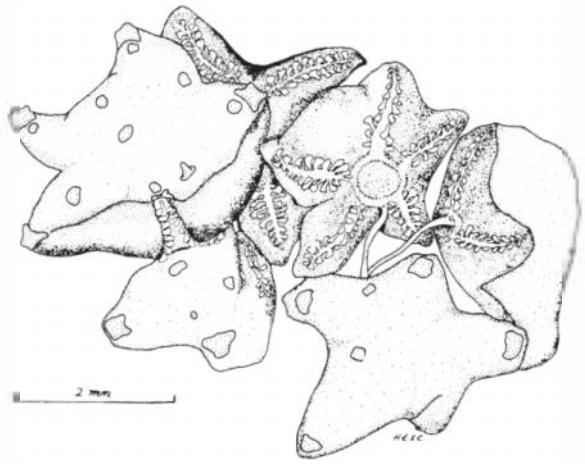

FIG. 18: *Notasterias armata*, a group of six young asteroids: note the cushion-like form, the abactinal plates and very small spines, and the attachment strands. Adult specimen from Sta. A456.

The ambulacral grooves are wide, and the tube-feet quadriserial with distinct sucking discs.

The oral plates bear a single, slender furrow spine and a slightly longer suboral spine. Small, straight pedicellariae may be present.

Colour in Life: No colour notes accompany the present specimens. Koehler (1912, p. 26) notes living specimens as "orange" and (1920, p. 70) as "creamy white" and "colour red dorsally though some only mottled red with creamy areas; creamy white centre".

Type Locality

Cape Royds Bay, Ross Sea, depth 10–18 "brasses" (approximately 18–33 m.).

Distribution

Probably circumpolar. Antarctic Archipelago (Alexander I Island), Ross Sea and South Victoria Land, Adélie Land, and off Queen Mary Land.
Bathymetric Range: 18–752 m.

Material Examined

Twenty specimens from nine stations as follows:

Sta. A448, 752 m (1); Sta. A450, 472–318 m (3); Sta. A456, 238–201 m (1); Sta. A459, 534–549 m (5); Sta. A460, 415–540 m (3); Sta. A461, 578–567 m (three, and also four broken arms); Sta. A467, 88–183 m (2); Sta. A527, 358–337 m (1).

Stanford University Station: GLD–4, 587 m (1).

Size: It is unfortunate that several of these specimens are damaged, R averages 46 mm and ranges from about 88 mm to 8 or 9 mm; r averages 9 mm and ranges from 17 to 3 or 4 mm. The description is based on a specimen (A460) in which R = 38 mm and r = 8 mm. This species reaches a considerable size, Koehler (1920) records a specimen from Adélie Land in which R = 125 to 130 mm and r = 19 mm.

Remarks

These specimens agree with previous descriptions, but there are some interesting features in small specimens in which R = between 9 and 16 mm and r between 3 and 4 mm. In these, the abactinal membrane appears to be extensively thickened and almost totally obscures the plates; the actinal plates are little developed and do not bear spines; the adambulacral plates are mainly diplacanthid; the spines of the abactinal plates are small and conspicuously thorny-tipped and the inferomarginals may be somewhat spatulate with flattened tips. In a small specimen (A450, R = about 12 mm and r = about 4 mm) there are straight pedicellariae present on the abactinal surface in the interradial regions and there are more numerous, small, crossed pedicellariae on the superomarginals.

A specimen with four arms (A467, R = 46 mm and r = 9 mm) shows a fifth, very small regenerating arm, not visible from the abactinal surface, which tapers to a sharp point. The tube-feet are regularly biserial; the adambulacral spines short, squat, and diplacanthid and the radial water canal very obvious.

Notes on a Brooding Specimen (Sta. A456):

This specimen occupies a typical brooding position, the disc being strongly convex and the animal supporting itself on bent arms. This appears to be the first record of this species being taken with young and it is of interest in view of Koehler's suggestion (1920, p. 70) that pelagic larvae would be found in this species, as the eggs are small. There are probably between 100 and 150 young present in a mass surrounded by the mouth and arms, varying in colour in preservative, from straw to a very dark brown. There is also much variation in size. Each young star is cushion-shaped with very short rather indistinct arms, the abactinal surface is smooth and convex, the arm tips are protected by shield-shaped plates bearing two or three spines or knobs on the margin, and there may be a small, central lobed plate present. On the actinal surface the water vascular system is just apparent. There

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is a longitudinal radial canal extending between the two rows of small knob-like tube-feet and there are also short, indistinct lateral canals. The membranous connecting strand extending between the young stars and the parent may branch, joining with other young. It is difficult to understand how the adult animal feeds with the young crowded round the mouth; possibly it exists on accumulated reserves. Brood protection occurs in both Arctic and Antarctic waters and may not necessarily be related to water temperature; it seems probable that food supplies have an important bearing on this problem.

Ecology

This species tolerates a wide variety of substrates, from a soft mud to sandy mud, stones, and rocks.

Notasterias stolophora Fisher, 1940 (pl. 15, fig. 1 and 2)

Notasterias stolophora Fisher, 1940. Disc. Rpts. 20, p. 226, fig. J, 1–1e and 2b; pl. 17, fig. 4.

The disc is slightly concave; the arms are convex and broad proximally, tapering to sharp tips protected by indistinct plates bearing a number of slender thorny-tipped spinclets. The actinal surface is concave.

The abactinal skeleton is irregularly reticulate and the plates obscured by a thick membrane. The lobed central plate and the primary plates of the disc bear one or two short, distally flattened spines terminating in about six hyaline points. Near the arm tips the cruciform carinal plates may alternate with smaller secondary plates. The primary and dorsolateral plates bear short spines similar to those of the disc, but near the arm tips these spines may be absent. There is an interradial septum devoid of spines.

Wreaths of two to six small, macrocephalous pedicellariae occur at the bases of the spines of the disc, carina, dorsolateral plates, and upper or abactinal surface of the superomarginal spines and are similar to those of *Notasterias armata*, with the jaws terminating in a "beak-like" projection; they do not exceed 0·5 mm in length and are broad basally. No ordinary crossed or straight pedicellariac occur on these plates.

Small, indistinct papulae are present in two series in the membranous spaces between the carinal and superomarginal plates; these are indistinct distally.

The madreporite is not apparent.

The anus is small, situated near the centre of the disc, and protected by four small plates or granules.

Plates of the marginal series form a distinct border to the arms; the cruciform superomarginals with short spines are surrounded on the abactinal side by half wreaths of macrocephalous pedicellariae.

The infcromarginal plates are also cruciform bearing single spines surrounded basally by wreaths of macrocephalous pedicellariae.

The actinal interradial regions are indistinct and the small plates have each a single short spine which is absent from the last part of the arm.

The adambulacral plates are small and regularly diplacanthid except for the first two or three adjacent to the oral angles which are monacanthid; these spines are slender, about 1 mm long, and thorny tipped.

The ambulacral grooves are wide and the tube-feet irregularly quadriscrial with distinct sucking discs.

In each oral angle there arc four long, slender furrow spines projecting over the mouth; two of these, shorter than the others, appear to be webbed basally. There are two suboral spines. There is an adoral carina, composed of the first two or three adambulacral plates. Small, straight pedicellariac occur on the oral plates and adambulacral plates for some distance along the furrow.

Colour in Life: There arc no colour notes with these specimens. Fisher (1940, p. 226) records the colour in life as "pale yellow green". In spirit, the specimens are white, with darker brown membranous areas and tube-feet.

Type Locality

East of Joinvillc Island, Antarctic Archipelago, 63° 29·6′S, 54° 03·1′W, 247 m.

Distribution

Joinville Island, Antarctic Archipelago, and (this collection) the Ross Sea. *Bathymetric Range:* 247–274m.

Material Examined

Two specimens from two stations as follows: Sta. A528, 274–265 m (one specimen and one with the following label: "Dominion Museum. Wellington, N.Z. Washed up on beach during 1959, Cape Hallett, Antarctica. Brian Reid. Coll.").

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Size: In the specimen from A528 (described here) R = 20 mm and r = 5 mm; in the smaller damaged specimen collected during the Trans-Antarctic (New Zealand) Expedition from Cape Hallett R = 18 mm and r = 4 mm. In the larger type material R = 27 mm and r = 6·5 mm.

Remarks

These specimens are very similar to Fisher's material but the actinal papulae are indistinct or absent. In the larger specimen one arm is very short and apparently in the process of regenerating. In the slightly smaller, rather flattened specimen the enveloping membrane is more or less absent and the contours of the plates distinct. The abactinal plates are cruciform or triradiate with rounded tips. The dorsolateral arcs consist of two, or exceptionally three, small, oval plates. The marginal plates are cruciform also and in one interradial angle there are one or two very small oval connecting ossicles between the downward lobes of the superomarginal plates and the upper lobes of the infero-marginal plates. The actinal plates are very distinct, oblong, inconspicuously lobed and bear single spines, and are present for about three-quarters the length of each arm between the inferomarginals and adambulacrals. The most distal one or two plates do not bear spines. The adoral carina is distinct, consisting of two plates.

Psalidaster Fisher, 1940

Eight to 12 rays. Abactinal plates lobed forming an irregular reticulum; skeleton often much reduced and plates isolated in large specimens. Abactinal and marginal spines single; large, distinct, crossed pedicellariae with tapering jaws terminating in one or two small teeth which interlock with those of the adjacent jaw. Marginal plates form two prominent lateral series. Abactinal and intermarginal papulae present. No actinal plates or papulae. Adambulacral plates sporadically diplacanthid, monacanthid, or triplacanthid; adoral carina long and narrow, composed of four to six plates. Tube-feet slender, four ranked in adult specimens.

Type Species: Psalidaster mordax Fisher.

A single species.

Psalidaster mordax Fisher (pl. 14, fig. 1 and 2)

Psalidaster mordax Fisher, 1940. Disc. Rpts, 20, p. 229, fig. K, 2–2g, 3 and 3b; pl. 18, fig. 1 and 2.

Both surfaces of the disc are plane. The tapering arms are convex.

The lobed abactinal plates and connecting ossicles form a very irregular reticulum; on the disc, the plates are covered by a thick membrane which is little developed or absent on the arms. These plates bear one (occasionally two) smooth, thorny-tipped, cylindrical, tapering spines on a knob or boss; on the disc these measure between 1 and 1·5 mm long, but near the arm tip they are shorter and the thorny tip less conspicuous.

One or two large, distinctive crossed pedicellariae (between 0·5 and 1 mm long) are present at the base of the abactinal spines; the jaws of these pedicellariae terminate in two sharp-pointed teeth which interlock with those of the adjacent jaw. The bases of the pedicellariae are broad. Very small, straight pedicellariae occur scattered on the plates of the disc and proximal part of the arms.

Small, single inconspicuous papulae occur in the membranous spaces between the abactinal plates. They are most obvious on the disc but very indistinct on the arms.

The inconspicuous madreporite is interradial in position, near the edge of the disc, and almost completely obscured by neighbouring spines.

The anus is inconspicuous and central on the disc.

Both series of marginal plates are well developed. The superomarginals are cruciform with the lateral lobes overlapping. The plates bear spines like those of the abactinal surface but slightly longer; one or two large, distinct crossed pedicellariae occur at the bases of these spines.

In general, the inferomarginals are triradiate with the dorsal lobes often obscured by the downward projecting lobes of the superomarginals; these bear one or sometimes two thorny-tipped spines and one to three crossed pedicellariae basally. Small, very inconspicuous papulae are present in the membranous spaces between the marginal plates.

On the actinal surface there is an adoral carina of three or four plates; there are no actinal plates or papulae.

The adambulacral plates are small and rectangular and the proximal two or three plates bear only one spine, distally there are two forming a transverse row; the spines are slender, with blunt, thorny tips and measure between 0·75 and 1·5 mm long.

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The ambulacral grooves are wide and the tube-feet show a crowded biserial arrangement terminating in very distinct sucking discs.

In the oral angles the plates are distinct; each oral plate bears one long furrow spine (between 0·75 and 1·5 mm long) and a second, shorter slightly curved spine, both projecting over the mouth. There is one shorter suboral spine.

Colour in Life: Unknown; in spirit, white with light brown or yellow membranous areas and tube-feet.

Type Locality

Falkland Islands, 52° 55¾'S, 60° 55'W. 351–367 m.

Distribution

Known only from the Falkland Islands and (this report) the Ross Sea. *Bathymetric Range:* 337–367 m.

Material Examined

Two specimens from two stations, as follows:

Sta. A449, 362 m (1); Sta. A527, 358–337 m (1).

Size: In this collection, in the specimen with 12 arms (A449) on which this description is based R = about 20 mm and r = 4 mm; in the smaller specimen (A527) with only eight arms R = about 16 mm and r = 4 mm. In the type material with 11 rays R = 135 mm and r = 27 mm; in the paratype R = 110 mm and r = 23 mm.

Remarks

The difference in size between this material and Fisher's type material probably accounts for the absence of the quadriserially arranged tube-feet here and the slight differences in the oral armature. The absence of the folded integument in these specimens may be due to the small size and the fact that the specimens are dry. The large conspicuous crossed *Notasterias*-type pedicellariae make this species very distinctive.

Subfamily ASTERIINAE Verrill, 1914 emend. Fisher

Key to the Ross Sea Genera

1 (4) Adambulacral plates with two (rarely three spines) never carrying attached pedicellariae although large and small straight pedicellariae may occur on the surface of the plates.

2 (3) Both series of marginal plates normally developed. Superomarginals, inferomarginals and actinal spines forming longiseries with circlets or bouquets of pedicellariae. **Diplasterias** Perrier

3 (2) Either the superomarginals or both series of marginal plates indistinct. Abactinal skeleton an irregular network of plates, no carinal series. **Saliasterias** Koehler

4 (1) Adambulacral plates with a single spine, without attached pedicellariae. Abactinal skeleton much reduced. Dermis thick. **Lysasterias** Fisher

Lysasterias Fisher, 1908

Abactinal and marginal skeleton much reduced composed of lateral tongues of plates abutting onto the adambulacral plates; dorsal surface with reduced, disconnected, scattered plates or a rudimentary reticulum (principally on the disc), or in mature specimens, no plates. Integument thick and raised in mamillated pustules especially round the spines. Adambulacrals monacanthid. No actinal spines; plates, if present, very rudimentary. Gonads opening ventrally.

Type Species: Anasterias perrieri Studer, 1885.

This genus appears to be closely related to the Subantarctic genus *Anasterias*, from which it differs in having the spine sheaths developed into glandular pustules and in having no actinal plates.

These two species can be easily distinguished on the basis of the superomarginal plates, which are well developed with distinct spines in *Lysasterias adeliae*. In *L. joffrei* there are no superomarginal spines and the plates are very small and isolated.

Lysasterias adeliae (Koehler) (pl. 13, fig. 3 and 4)

Anasterias adeliae Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 26, pl. 1, fig. 1, 2, 5–8, and 10; pl. 56, fig. 1.

Lysasterias adeliae Fisher, 1930. U.S. National Mus. Bull. 76 (3) Forcipulata (concl.), p. 236; Fisher, 1940. Disc. Rpts., 20, p. 244.

The disc and proximal surface of the arms are more or less plane but convex near the arm tips; the arms taper gradually to a sharp tip.

The abactinal skeleton is much reduced. There is a circle of lobed plates on the disc enclosing four oval, isolated plates and small, isolated plates also occur irregularly along the surface of the arms. In each interradius a distinct septum is present composed of two rows of four- or five-lobed plates. The plates of the disc and arms bear small, short, tapering, blunt-tipped spines and are invested in thick integument; in dry specimens this integument often forms a flaring and broad tip to the spines.

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Numerous, small, crossed pedicellariae occur scattered over the abactinal surface of the disc and arms. They are especially evident near the arm tips and are surrounded by pustules of thick integument; no straight pedicellariae are present.

Numerous papulae are present on the disc and arms.

The madreporite, interradial in position and midway between the centre and edge of the disc, is almost circular (about 2 mm), tumid, and dissected by a number of coarse grooves. It is surrounded by three or four slightly enlarged, thorny-tipped spines.

The anus is not apparent.

Both series of marginal plates bear spines. The plates are small, and triradiate and joined laterally by oblong connecting ossicles; near the arm tip the plates are often isolated. These plates bear short, tapering, blunt-tipped spines and are surrounded by integument and several small, crossed pedicellariae similar to those of the abactinal surface.

The inferomarginal plates are larger, forming a well developed margin to the arms. The dorsal lobes are well developed but the lateral lobes are indistinct and coalesce with adjacent plates. The thorny spines of these plates are invested in integument and are larger and stouter than those of the superomarginals. There are basal collars of numerous, crossed pedicellariae which are larger than those of the abactinal surface; straight lanceolate pedicellariae are also present. Papulae occur in the membranous spaces between the lobes of these plates.

The actinal interradial areas are very small without actinal spines. There is a short adoral carina.

Along the furrows, the narrow adambulacral plates are strictly monacanthid. The single spine is about 3 mm long, slender, blunt tipped, and its distal half is finely spinulose.

The ambulacral grooves are wide and deep. The quadriserial tube-feet are slender and terminate in distinct sucking discs.

The oral plates are small with two short, slender furrow spines and two very much longer, equally slender, smooth suboral spines. Small straight pedicellariae are abundant on both the oral plates and the furrow face of the adambulacrals.

Colour in Life: There are no colour notes with these specimens Koehler (1920, p. 29) records the colour of a living specimen as "mottled brown". In spirit, the abactinal surface of the disc and arms is dark brown or black passing to lighter brown near the arm tips. The plates and spines of the disc, marginal and adambulacral plates are light in colour and the tube-feet yellow brown.

Type Locality

Adélie Land, 12 fm (22 m).

Distribution

Palmer Archipelago, Adélie Land, and the Ross Sea. This is the first record from the Ross Sea. It is probable that this species is circumpolar. *Bathymetric Range*: 22–578 m.

Material Examined

Six specimens from four stations as follows:

Sta. A450, 472–318 m (1); Sta. A456, 238–201 m (1, damaged); Sta. A461, 578–567 m (3); Sta. A527, 358–337 m (1).

Size: In these six specimens R averages 32 mm and r averages 7 mm; a specimen from A527 in which R=40 mm and r=9 mm is described. In a large and damaged specimen (A456) in the present collection R=about 110 mm and r=about 18 mm. This specimen probably belongs in this species, and if so, is the largest specimen yet recorded.

Remarks

In the small specimens (R=12 mm or less) the carinal plates are well developed forming a continuous series to the arm tips. Both series of marginal plates are present and there are small straight pedicellariae on the abactinal surface. These were not recorded in the type material, but Fisher (1940, p. 244) notes them in his specimens and they are also present and abundant in the large, battered specimen from A456. In two small specimens (A461, R=12 mm and 10 mm) the abactinal membrane is very thick, totally obscuring the abactinal spines and pedicellariae. The abactinal and marginal skeleton appears to degenerate with age, as in small specimens the plates of the abactinal surface are well developed. This genus, with others such as *Perknaster*, appears to have suffered a serious disturbance of calcium metabolism.

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Lysasterias joffrei (Koehler) (pl. 13, fig. 1 and 2)

Paedasterias joffrei Koehler, 1920. Australas. Antarct. Exped. 1911–14. Sci. Rpts., Ser. C, 8 (1), p. 30, pl. 1, fig. 3, 4, and 9; pl. 2, fig. 7, 8, and 9; pl. 56, fig. 2.

Lysasterias joffrei Fisher, 1930. U.S. National Mus. Bull. 76 (3) Forcipulata (concl.) p. 236; Fisher, 1940. Disc. Rpts., 20, p. 245; Clark, A. H., 1950. Echinod. of the U.S. Navy Antarct. Exped. 1947–48, 40, p. 337; Bernasconi, 1956. Algunos Asteroideos de Antartida. Anales Socied. Cientifica Argentina, 161, p. 15.

The disc and arms are convex, the actinal surface, concave.

The abactinal skeleton is greatly reduced and there is a thick membrane; centrally on the disc there is a circle of small, overlapping or triradiate plates, enclosing several smaller central plates. The interradial septum is composed of three or four small, lobed plates. There are no regularly arranged carinal plates but two or three small, tumid, isolated plates occur at intervals down the centre of the arm. The larger of these may bear short, blunt-tipped spines surrounded by pustules of integument.

Small, crossed pedicellariae with distinctly rounded tips occur scattered over the abactinal surface and are more or less obscured by the surrounding membranous pustules; they are very numerous near the arm tips. Straight, pedunculate pedicellariae with oblong rounded tips are most obvious on the disc and proximal parts of the arms.

Slender, extended papulae occur over the surface of the disc and arms, and are not easily distinguished from the membranous pustules.

The madreporite is interradial in position, nearer the centre than the edge of the disc, almost circular (about 2 mm) and dissected by a number of fine radiating grooves.

The anus is not apparent.

Only the inferomarginal plates are well developed. The superomarginals are present as small, oblong ossicles which may be joined proximally to the inferomarginal plates by connecting ossicles or may be completely isolated and distally very indistinct; in general they bear no spines but there may be occasional small spines near the arm tips.

The inferomarginals are well defined forming a conspicuous margin along the lower surface of the arms; each plate bears a relatively short, blunt-tipped, membrane-invested spine with a distinct collar of crossed pedicellariae, and these are distinctly larger than the abactinal pedicellariae. Straight pedicellariae with distinctive round tips to the jaws are present at the base of these spines and on the superomarginal plates.

On the actinal surface, the interradial regions are very small and membrane covered, without actinal spines. There is a short, indistinct adoral carina consisting of three plates.

The adambulacral plates are very narrow and separated by broad membranous areas; the adambulacrals are mainly monacanthid but an occasional diplacanthid plate occurs. The spines are slender, about 3 mm long, thorny in their last half, and blunt-tipped. Straight pedicellariae of normal type occur on the furrow faces of these adambulacral plates and pedunculate straight pedicellariae are present in the interradial regions.

The ambulacral grooves are deep and fairly narrow. The tube-feet, arranged in four rows, are slender with distinct sucking discs.

There are two oral furrow spines in each angle, two slightly longer suboral spines, and also straight pedicellariae.

Colour in Life: There are no colour notes with these specimens. Koehler (1920, p. 34) records the colour as probably "lemon yellow". In spirits, the disc and proximal regions of the arms are a dark brown or almost black shading to white on the margin and near the arm tips. The isolated plates and spines are white and the tube-feet brown.

Type Locality

Near Adélie Land, 66° 50'S, 142° 6'E, 354 fm (655 m).

Distribution

Probably circumpolar, Antarctica. It is recorded from near Clarence Island, South Shetlands; Palmer Archipelago, Adélie Land, and the Ross Sea. This species has also been taken from Mawson Base in MacRobertson Land (specimen from National Museum of Victoria, Australia). *Bathymetric Range*: 88–810 m.

Material Examined

Three specimens from two stations as follows:
Sta. A448, 752 m (1); Sta. A467, 88–183 m (2).

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Size: In the three present specimens R averages 43 mm and r averages 9 mm. The description is from the largest specimen (A467) in which R = 60 mm and r = 12 mm. This species apparently grows to a large size and Bernasconi (1956, p. 15) records a specimen in which R = 105 mm and r = 15 mm.

Remarks

The only point in which these specimens disagree with the description of the type material is the presence of pedunculate straight pedicellariae on the actinal surface, but Fisher (1940) noted these in his material. On the larger damaged specimen, which lacks two arms, the membranous pustules are greatly developed, almost completely obscuring the spines and small pedicellariae. In the smallest specimen the abactinal pustules and membrane are greatly reduced and there are a number of small, straight pedicellariae scattered abundantly over the dorsal surface, pedunculate straight pedicellariae being present in the interradial regions. Near the arm tips, short, inconspicuous superomarginal spines are present. There are no actinal spines.

Ecology

The present specimens are recorded from mud (A448) and rocks (A467).

Diplasterias Perrier, 1888

Abactinal skeleton irregularly reticulate; carinal series distinct with plates bearing one to several slender spines often sheathed in membrane and surrounded by a basal collar of crossed pedicellariae. Superomarginal plates distinct with one or two spines; surrounded basally by pedicellariae. Inferomarginal spines one or two, sporadically three, and forming definite longitudinal series separated from the superomarginals by a well defined intermarginal channel. Adambulacral plates diplacanthid, no attached pedicellariae. Actinal plates and spines in one or two series. Adoral carina of two to four plates. Young brooded by adult.

Type Species: *Diplasterias lütkeni* Perrier.

A single Ross Sea species.

Diplasterias brucei (Koehler) (pl. 2a; pl. 14, fig. 5, 6, and 7)

Stolasterias brucei Koehler, 1908. Trans. Roy. Soc. Edin., 46 (3), p. 569, pl. 5, fig. 46 and 47.

Coscinasterias brucei Koehler, 1911. Brit. Antarct. Exped. 1907–09. 2 (4), p. 30, pl. 5, fig. 5.

Coscinasterias victoriae Koehler, 1911. Brit. Antarct. Exped. 1907–09, 2 (4), p. 32, pl. 5, fig. 3 and 4; Koehler, 1912. Deuxième Expéd. Antarct. Franç. Echinodermes, p. 24.

Podasterias brucei Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 42, pl. 11, fig. 5–7; pl. 13, fig. 1–9; pl. 14, fig. 4, 7–11; pl. 15, fig. 4 and 5; Koehler 1923. Swedish Antarct. Exped. Astéries et Ophiures, p. 35, pl. 13, fig. 2; Döderlein, 1928. Deutsche Südpolar-Exped. 1901-03, 19 (2), p. 295; Greig, 1929. Some Echinoderms from the South Shetlands. Bergens Mus. Arbok, art. 3, p. 5.

Diplasterias brucei Fisher, 1930. U.S. National Mus. Bull. 76 (3), Forcipulata, p. 231. Fisher, 1940. Disc. Rpts., 20, p. 253; Madsen, 1955. Sci. Res. Norwegian Antarct. Exped. 1927–28, p. 16; Bernasconi, 1956. Anales Socied. Cientifica Argentina, 161, p. 18, pl. 5, fig. 1 and 2.

The disc is small, convex abactinally, and concave actinally. The slender arms taper gradually to blunt tips.

There are five primary cruciform plates on the disc, separated by smaller two- or three-lobed secondary plates, and a central lobed plate connected to the primary plates by small ossicles. There are one to three short, sturdy, blunt-tipped spines on the central and primary plates, while on the secondary plates there are never more than two shorter spines. There is a distinct carina of cruciform plates extending almost to the arm tip, each plate with one short spine. Arcs of small, oblong, dorsolateral plates extend from the carinal plates to the superomarginals. Proximally these have very short, sharp-tipped spines, which are absent distally, and on the arm tips the plates are very indistinct and the membranous areas small. A thick enveloping membrane is present, masking the plates and spine bases. An interradial septum devoid of spines is also present.

Two to four small, crossed pedicellariae occur in membranous sheaths at the spine bases; small lanceolate straight pedicellariae may also be present, especially on the disc and at the base of the arms.

There are one to three papulae in the membranous spaces between the plates of the disc and arms, but distally these are indistinct or absent.

The madreporite, which occupies a secondary plate of the disc, is interradial in position, more or less oval, tumid, and dissected by a number of deep grooves.

The anus is small, indistinct, acentral, and protected by three or four small, flattened granules or plates.

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Plates of the marginal series are well developed, forming a distinct border to the vertical faces of the arms. The superomarginal plates are cruciform with the upper lobes overlapping the plates of the dorsolateral arcs while the ventral lobes overlap the dorsal lobes of the inferomarginal plates. The superomarginals have each one short, cylindrical spine, about 1 to 1·5 mm long, with a rather thorny flattened tip and are surrounded basally by one to four straight or crossed pedicellariae.

The inferomarginals correspond exactly with the superomarginals but have shorter lobes. They bear a single flat, thorny-tipped spine slightly shorter and sturdier than those of the superomarginals, and there are both straight and crossed pedicellariae present with one or two papulae in the membranous spaces between the plates. Between 35 and 37 marginal plates are present from the interradial angle to the arm tip.

The actinal interradial regions are membrane covered and the plates very small, at least one row extending along the arm to about the level of the fourth or fifth inferomarginal. These plates bear a slender, tapering spine.

In general, the small oblong adambulacral plates are diplacanthid, but there may be one or two monacanthid plates near the oral angles. The furrow spine (between 1 and 1·5 mm long) is smooth in its first half, then finely thorny with a somewhat flattened tip. The subambulacral spine is shorter and the tip less flattened. Straight pedicellariae occur in the furrows at the base of these spines.

The ambulacral grooves are wide but narrow distally. The tube-feet are small and quadriserial with distinct sucking discs.

The oral plates are short with two furrow spines, of which the median is the longest projecting well over the mouth; the second is smaller and slightly recurved. There is also a single, longer, sturdier suboral spine. Both large and straight pedicellariae occur in clusters on these plates, and there is a short adoral carina of about two plates.

Colour in Life: Detailed colour notes for this species were made by members of the Trans-Antarctic (New Zealand) Expedition. Dr R. W. Balham (Ser. No. 289) notes the colour of the aboral surface as light blue-green with white spines and a whitish border to the disc and arms, and the arm tips blood red; the oral region light grey-green within the furrows and the outer areas grey-white. R. E. Barwick (No. 702) records the colour of the oral surface as white or pale yellow and the aboral surface as pale grey to blue-grey; and (No. 834) pale orange or pale blue-grey with a prominent red eye spot at each arm tip. Two colour transparencies taken by John H. Dearborn (May 1961) show a uniform light brown abactinal surface.

Koehler (1920, p. 49) records notes from a living specimen as "brownish dorsally" and (p. 34) "creamy white with red blotches". In spirits, specimens are yellow or light brownish-grey with lighter spines, dark membranous areas, and dark tube-feet.

Type Locality

Scotia Bay, South Orcades, depth, 10 "brasses" (approximately 18–19 m).

Distribution

Probably circumpolar. Antarctica, extending north to South Georgia where a six-rayed form is present. *Bathymetric Range:* 0–752 m.

Size: In these 58 specimens R ranges from 130 to 4 mm and averages 28 mm; r ranges from 17 to 1 mm and averages 5 mm. The description is from a specimen (A530) in which R = 30 mm and r = 8 mm. This species reaches a considerable size and specimens where R reaches 120 mm are not unusual; this collection includes probably the largest known specimen (Stanford University Sta. M) in which R = 130 mm and r = 17 mm.

Material Examined

Fifty-nine specimens from 23 stations as follows:

Sta. A448, 752 m (1); Sta. A450, 472–318 m (6); Sta. A456, 238–201 m (2); Sta. A457, 315–342 m (1); Sta. A467, 88–183 m (6); Sta. A468, 110 m (3); Sta. A469, 64 m (1); Sta. A471, 165–69 m (7); Sta. A520, 201–205 m (1); Sta. A528, 274–265 m (2); Sta. A530, 271–267 m (1); Sta. A533, 84–183 m (2); Sta. A534, 380–366 m (1).

Trans-Antarctic (New Zealand) Expedition Collections: Ser. No. 289, Cape Armitage, 124 m (1); 675, Hut Point, McMurdo Sound, 124–165 m (6); 702, Cape Royds, Backdoor Bay, 5–9 m (2); 716, Franklin Island, 73–110 m (2); 801, Botany Bay, Granite Harbour, 73 m (1); 837, Cape Evans, 11 m (8).

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Stanford University Stations: GLD–12, 15–30 m (1); Sta. E, 7–87 m (1); Sta. H, 54 m (1); Sta. M, 38 m (2).

Young Stages: Ten young specimens (R = 12 mm or less) were collected from Sta. A450, A467, A468, A533, and Trans-Antarctic (New Zealand) Expedition Collection Sta. 716. These small specimens show an interesting arrangement of the abactinal plates, the central plate of the disc being isolated, and never connected by intermediate ossicles to the outer circle of plates which are always reasonably well developed. The dorsolateral series of plates are absent except in specimens where R = 10 mm or more. Thus, in smaller specimens, there is a distinct and clear membranous area present between carinal and superomarginal plates; in a slightly larger specimen (A468, R = about 7 mm and r = about 2 mm) only every second dorsolateral arc is developed. In these specimens the dorsolateral plates are small and oblong and appear to originate near the inferomarginals; additional plates being added as the animal grows. Both the superomarginal and carinal plates are small, distinctly lobed plates which do not develop for some time. The crossed pedicellariae are very few, small, and scattered, especially at the bases of the superomarginal spines. Both carinal and superomarginal spines are small and blunt-tipped and, especially in the smallest specimens, extremely thorny distally. The arm tip is protected by a distinct plate bearing eight or nine slender spines. Neither papulae, madreporite, nor anus are apparent on these very small specimens. The superomarginal plates are always reasonably well developed, but in small specimens, where R = 4 mm and less, the inferomarginals occur only sporadically and are always absent for some distance on either side of the interradial angle. Actinal spines are absent in these small specimens. The adambulacrals are regularly diplacanthid except for the first one or two plates which may be monacanthid; the oral armature appears to be very similar to that in larger specimens. The tube-feet are regularly biserial and do not show the quadriserial state typical of adults until R = 10 or 12 mm or more.

Remarks

An underwater photograph taken by J. S. Bullivant at Sta. A469 shows a large specimen of *Diplasterias brucei*, the habit of the animal suggesting that it is feeding (pl. 2a).

This species varies greatly, especially in the degree of development of the abactinal membrane, which may be very thick almost completely hiding the contours of the abactinal and lateral plates or, in small specimens, it may be more or less absent leaving the contours of the plates very distinct.

Similarly, actinal spines are only developed in specimens where R = 30 mm or more, and both these and the inferomarginals may bear spines with distinctly large and flattened tips. The dorsolateral series of plates and spines are very reduced or absent in small specimens, but in larger specimens (R = 30 mm or more) they may be more distinct. In some specimens the carina is indistinct, little developed, and more or less straight; in others it may be very sinuous, its sinuosity possibly increasing with the age of the specimen. Several specimens show an uneven development of the arms. This species broods its young and most previous specimens have been taken with upwards of 100 young round the mouth; a colour transparency taken at Station R in McMurdo Sound by J. H. Dearborn in December 1959, shows a large specimen of *Diplasterias brucei* with numerous (probably between 100 and 150) young clustered round the mouth. These all appear to have five arms and are well developed, but it is difficult to make out additional details.

Notes on a Large Specimen: In the large specimen (Stanford University Collection Sta. M), in which R = 130 mm and r = 17 mm, the carinal series is relatively inconspicuous and there are several rows of dorsolateral plates and spines present. A rather heavy membrane is present at the bases of these spines, the crossed pedicellariae are very small, and the straight pedicellariae are not conspicuous. The spines of the actinal and inferomarginal plates and the adambulacral furrow spines are most conspicuous, however, being short and expanding distally into a flattened, fan shape, often with crenulate margins (pl. 14, fig. 7). Koehler (1923, p. 36) notes a similar condition of the adambulacral spines in a specimen where R = 120 mm and r = 21 mm.

Ecology

This species appears to frequent a wide variety of substrates which range from mud of all types to gravel and rocks.

Saliasterias Koehler, 1920

Nine or 10 rays. Skeleton irregularly reticulate without a carinal or dorsolateral longiseries; on sides of ray transverse arcs of plates the lowest

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being the inferomarginals, these arcs correspond with two adambulacrals and alternate with conspicuous, quadrangular membranous spaces containing three or four papulae. Inferomarginal spines two or three. Adambulacral plates with two slender cylindrical spines. Crossed pedicellariae present on the disc; more numerous on the rays. Straight pedicellariae on disc and along furrows.

Type Species: Saliasterias brachiata Koehler.

A single known species.

Saliasterias brachiata Koehler (pl. 14, fig. 3 and 4).

Saliasterias brachiata Koehler, 1920. Australas. Antarct. Exped. 1911–14, Sci. Rpts., Ser. C, 8 (1), p. 54, pl. 11, fig. 1–4; pl. 12, fig. 1–8; pl. 58, fig. 3; Fisher, 1923. Ann. Mag. Nat. Hist. Ser. 9, Vol. 12, Nov., p. 603; Fisher, 1930. U.S. National Mus. Bull. 76 (3), Forcipulata (concl.), p. 239.

There are nine arms. These are convex abactinally and plane actinally, slender, tapering, and curled over the abactinal surface. The disc is plane.

Plates of the abactinal surface are distinctly bar like with only short lateral lobes. There is no regular arrangement of these on the disc but proximally on the arms they are arranged in regular transverse series between which are oblong membranous areas; near the arm tips these areas are very large. The plates, with groups or fascicles of three to six short, slender, tapering, smooth, distally thorny spines are covered by membrane which is often much reduced or absent on the arms.

Crossed pedicellariae are present on the disc and arms, being especially numerous near the arm tips. These are small with fine teeth on the distal margin of the jaws. Straight pedicellariae of usual type occur sparsely on the abactinal surface.

Small, indistinct papulae are present on the membranous areas of the disc and proximally on the arms.

The madreporite is not conspicuous and the central anus is very small.

On the lateral surfaces of the arms there are transverse arcs of plates. The lower, the inferomarginals, correspond to two adambulacral plates; between these are conspicuous quadrangular membranous areas with indistinct papulae. The inferomarginal plates bear one to three short, thorny-tipped spines and two or three crossed pedicellariae are present basally.

There are no actinal plates, the adoral carina is very short and the interradial regions are heavily calcified.

The first two proximal adambulacral plates are monacanthid and the rest diplacanthid with the two spines in a transverse row; these spines are slender, thorny tipped, and between 1 and 2 mm long. Straight pedicellariae are present at the base of these plates, in the groove.

Within the broad ambulacral grooves the tube-feet are proximally biserial and distally irregularly quadriserial with distinct sucking discs.

Each oral plate bears a slender, tapering, furrow spine about 2 mm long projecting over the mouth. There is generally a much smaller, curved furrow spine present, and one slightly shorter suboral spine. Straight pedicellariae occur at the bases of these spines.

Colour in Life: There are no colour notes with this specimen. Kochler (1920, p. 56) records the colour in a living specimen as "flesh". In spirits, white or pale yellow with light brown tube-feet.

Type Locality

Off Adélie Land, 66° 50′S, 142° 6′E. 354 fm (655 m).

Distribution

Adélie Land, and this collection, the Ross Sea. *Bathymetric Range*: 28–655 m.

Material Examined

One specimen from the following station:

A528, 274–265 m.

Size: In this single specimen with nine arms, R = about 20 mm and r = about 5 mm. In the type material R varied between 28 and 12 mm and r between 5 and 10 mm; two specimens had nine arms and the smallest 10.

Remarks

Koehler (1920, p. 52) notes that specimens are capable of regeneration and schizogony, and (1920, pl. 12, fig. 8) shows a specimen with regenerating arms.

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ECOLOGY AND ZOOGEOGRAPHY

Throughout this report ecological and other features of special interest have been discussed under the individual species and are therefore not included here. However, it seems probable that both thermal and bathymetric tolerance influence the distribution of the Ross Sea asteroid fauna and these factors are therefore discussed. The method of plotting, and mode of analysis of the data, is that employed by Fell (1961).

Thermal Tolerance

Distributions recorded in the literature show that only 13 of the 37 species from the Ross Sea extend into Subantarctic or south temperate zones. This is shown in diagrammatic form for the Magellanic region (text-fig. 19), the approximate 200 m isotherms (taken from Sverdrup, Johnson, and Fleming 1942, Chart IV) and general sea-floor contours being included on the map. Seven species are strongly eurythermal, tolerating bottom temperatures between −2° and +5°C. Of these *Porania antarctica glabra* also extends into the South Indian Ocean to Kerguelen and Marion Islands, and possibly further north to the Arrou Islands. Other species extending in the Southern Indian Ocean to Kerguelen, Marion, Prince Edward, and Crozet Islands are *Odontaster meridionalis*, *Perknaster densus*, and *Pedicellaster hypernotius*. Most other species show a moderate tolerance between −2° and 0°C.

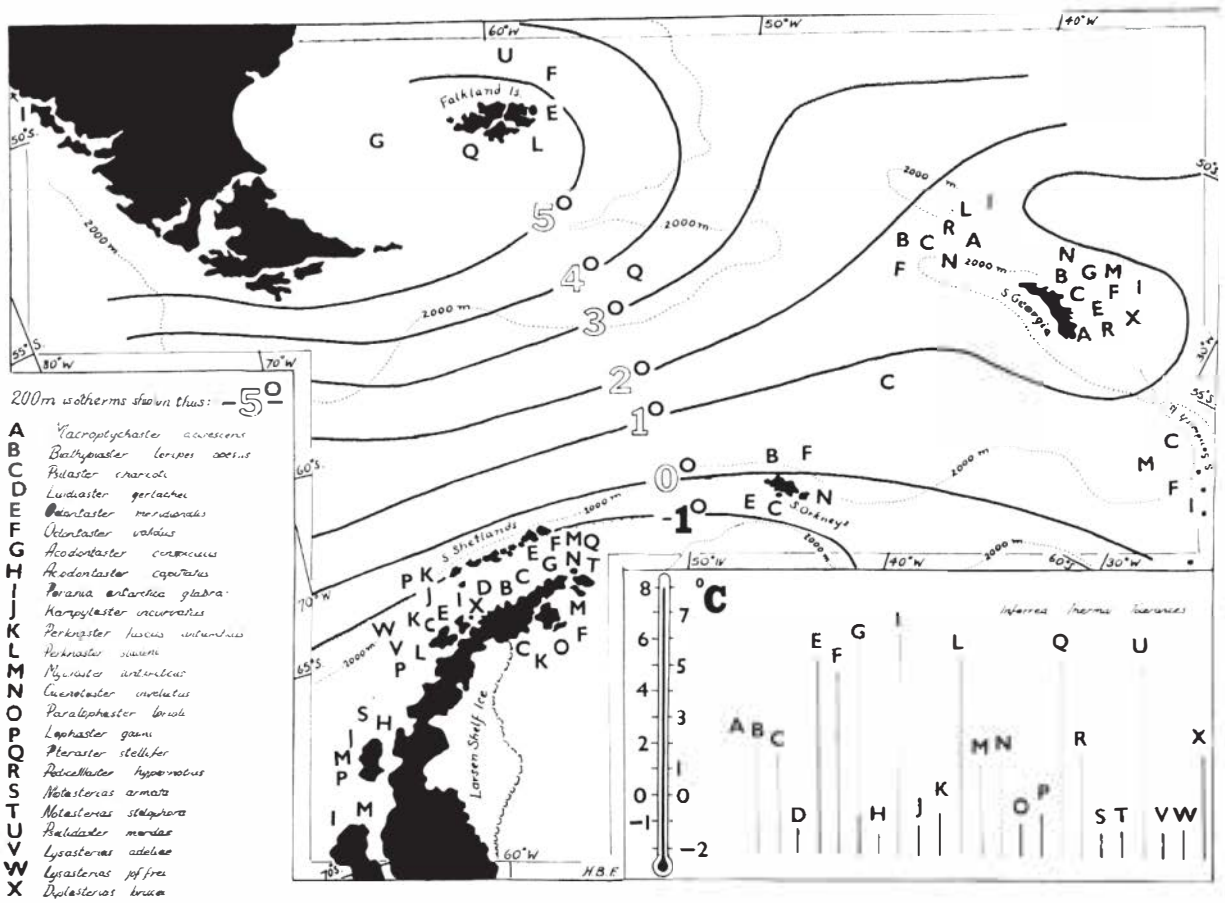

FIG. 19: Thermal tolerances of Ross Sea Asteroidea which enter the Magellanic region. For a more detailed explanation see text.

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There are similar isotherms off the southern coast of New Zealand and the Bounty, Antipodes, and Auckland Islands; here we might expect to find species of *Porania*, possibly *Odontaster* and also *Pteraster*. None of these has, however, been found, and their absence cannot be attributed to insufficient collecting as many expeditions have taken material at similar depths in these regions.

The fauna of these southern islands is of Indo-West-Pacific origin. There are two highly eurythermal genera present which might also be expected to occur in Antarctic waters – *Henricia* and *Asterodon*. *Henricia compacta* is known from the Chatham Island group and *H. ralphae* from off east Otago, New Zealand. Species of *Henricia* also occur in the Falkland Islands, *H. pagenstecheri* in South Georgia, and *H. diffidens* off Graham Land. Species of *Asterodon* occur along the coasts of Tierra del Fuego and the west coast of South America. These may both be cases of epiplanktonic drift from New Zealand such as Fell (1953) describes.

Bathymetric Tolerance

Fell (1953) believes that shallow-water links are of the utmost importance in the dispersal of echinoderms. Thus the southern islands of New Zealand (with the exception of Macquarie) have a fauna of New Zealand origin, and examination of the contour map of the ocean floor shows shallow-water connections with New Zealand. Macquarie Island, on the other hand, is separated by deep water and its asteroid fauna is essentially Subantarctic.

A similar relationship exists between South America and the Antarctic Continent. A shallow-water route can be traced from the Palmer Archipelago through the South Orkney Islands, South Shetland Ridge, and Falkland Islands to the South American shelf. Thus Antarctica has shallow-water links with South America and shares certain of its genera, while the southern islands of New Zealand have an Indo-Pacific fauna similar to that of New Zealand. The results of this report are in full agreement with the views expressed by Fell (1953).

General Zoogeography

There is a distinct thermal hiatus between South Georgia and the Falkland Islands and this defines a strictly Antarctic and a peripheral Antarctic fauna (Fell, 1961). The first of these includes asteroids found in Antarctica, the Palmer Archipelago, and islands of the Scotia Arc up to and including South Georgia (text-fig. 20). Genera characteristic of this region are *Macroptychaster*, *Bathybiaster*, *Psilaster*, *Luidiaster*, *Kampylaster*, *Myoraster*, *Cuenotaster*, *Notasterias*, and *Lysasterias*. This area agrees well with that defined by Ekman (1953).

Both Ekman and Fell base their conclusions on benthal forms: they suggest that the shortness of the larval life and the fact that many larval forms appear to be benthic and often show direct development and viviparity in genera such as *Kampylaster*, *Pteraster*, and *Notasterias* may be important in the distribution. Fell (1953) suggested that epiplanktonic distribution of adults may be more important than transportation of true planktonic stages. He subsequently pointed out (1961), however, that as Antarctic echinoderms, unlike Subantarctic species, may have little or no opportunity for epiplanktonic distribution, their distribution might well be strictly benthal.

The Magellanic region contains species with South American affinities except for the few strongly eurythermal species shared with Antarctica – *Porania*, *Odontaster*, *Perknaster*, *Pteraster*, and probably *Psalidaster*.

The New Zealand asteroid fauna is of Indo-West-Pacific origin and is the south-eastern limit for genera such as *Dipsacaster* (which, since it has species in the north-east Pacific, is apparently in the process of spreading south), *Luidia*, *Maculaster*, *Asterodiscus*, *Nectria*, *Pentagonaster*, and *Brisingenes*. There are many Indo-West-Pacific species with southern limits in Australia. Such southern genera as have a circumpolar distribution are believed to owe this fact to the influence of the West Wind Drift (Fell, 1962).

Antarctic Connections with New Zealand

It would seem, therefore, that the asteroid faunas yield no support for believing that there have ever been land connections between Antarctica and New Zealand. The Antarctic fauna is highly distinctive and probably the result of isolation over a very long period. The only other fauna which is in any way comparable is that of the Arctic, but here the resemblance is confined to features which are evidently a response to a cold water environment, e.g., direct development or reduction of skeleton. The greater incidence of direct development in Antarctic

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asteroids suggests that the Antarctic has presented rigorous environmental conditions for a longer period of time than the Arctic.

Asteroid Fauna of the Ross Sea

It cannot be said that certain species are restricted to the Ross Sea, for as yet comparatively little work has been carried out in the Bellingshausen and Weddell Seas. On the whole, the Ross Sea asteroid fauna is closely similar to that of west Antarctica and Adélie Land. It also seems that most species found in the Ross Sea are circumpolar Antarctic species, although more collections are needed to verify this statement.

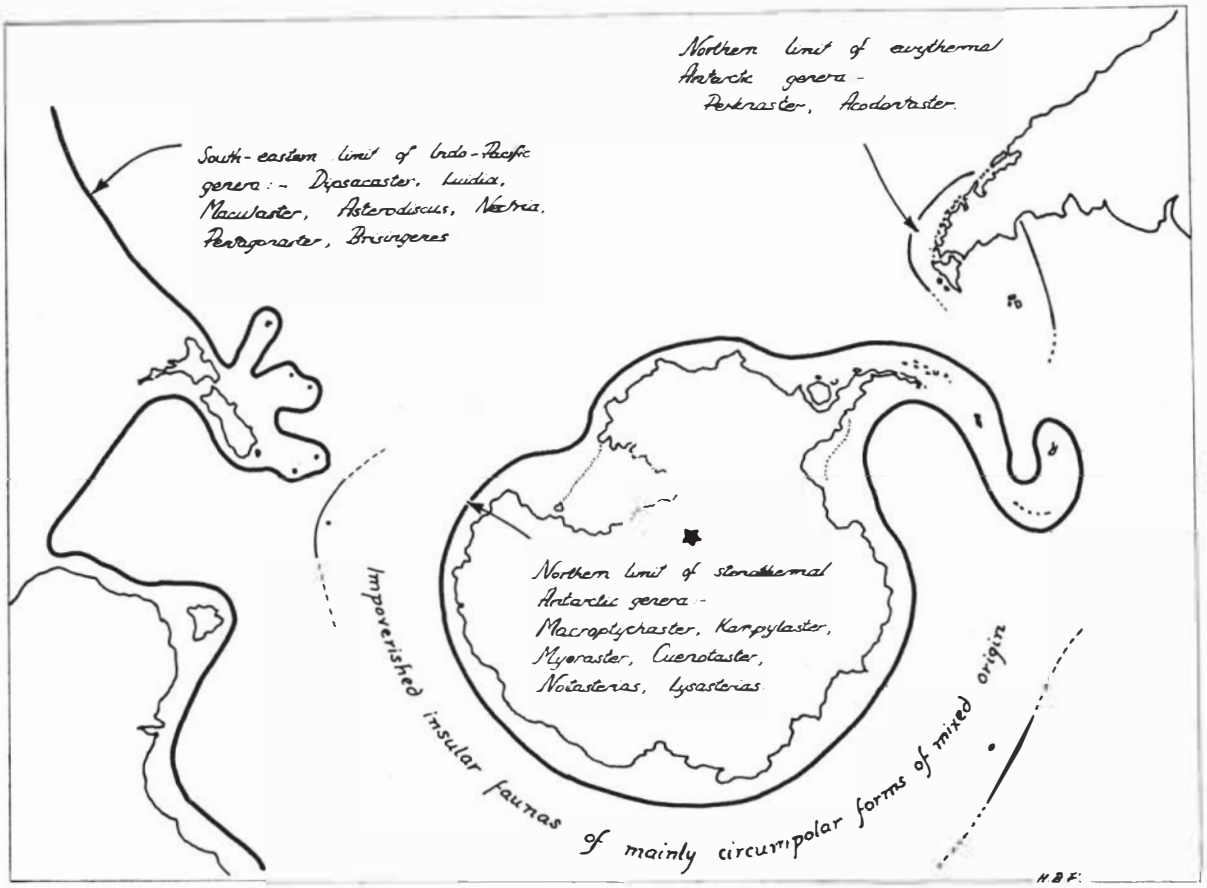

FIG. 20: General zoogeography of the Asteroidea of Antarctica and the South Pacific.

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COLOUR PLATE 1

Odontaster validus Koehler: Specimens from various Ross Sea localities showing range in colour.

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Photos: J. H. Dearborn

COLOUR PLATE 1

Inset

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COLOUR PLATE 2

A. and B. **Odontaster validus** Koehler – abactinal and actinal surfaces.

C. **Diplasterias brucei** (Koehler) – with young surrounding the mouth.

D. **Perknaster fuscus antarcticus** Sladen.

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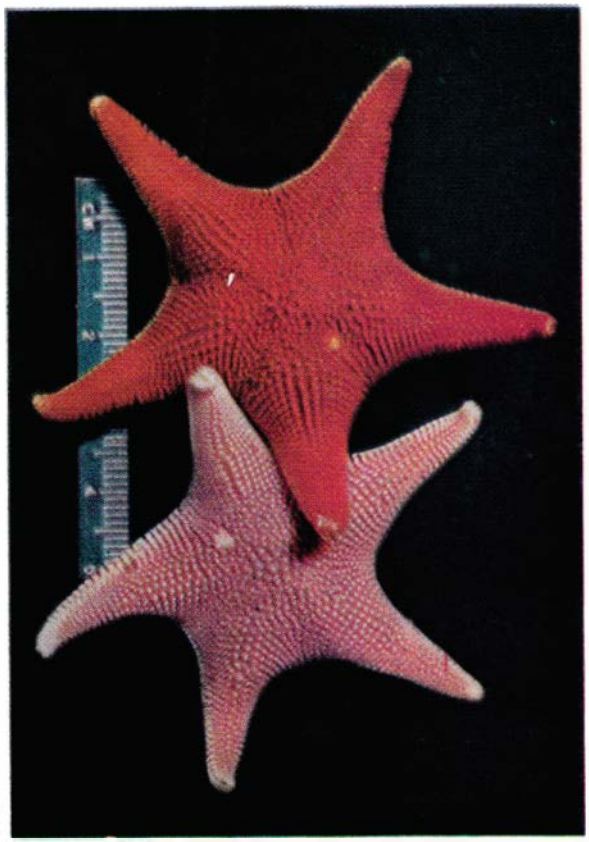
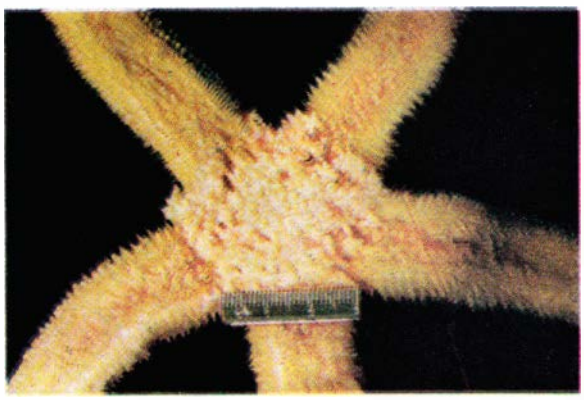


(a)

(b)



(c)

(d)

Photos : J. H. Dearborn

COLOUR PLATE 2

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PLATE 1

Enlargement of portion of original monochrome photograph from Sta. A528, Pennell Bank, depth 274–264 m. The asteroid may be *Macroptychaster accrescens* or the closely allied *Leptychaster magnificus*, R measures between 190 and 200 mm. It has been suggested that two asteroids are present in very close proximity, if this view is held a sixth arm is envisaged below the right-hand arm and a seventh slightly to the right of and overlapping the lowermost arm. In the author's opinion these are both parts of adjacent polyzoa and only one asteroid is present.

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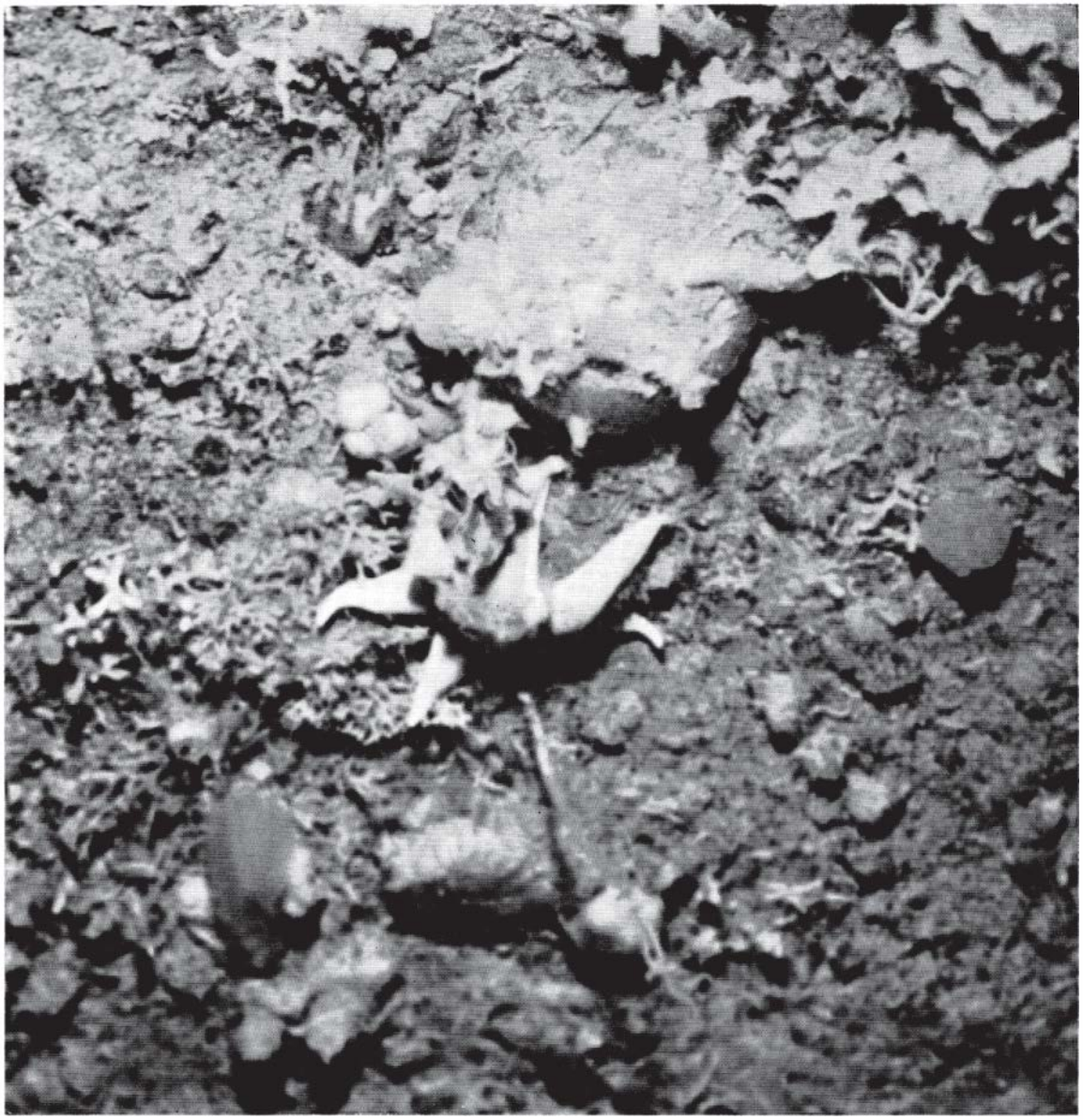

Photo: J. S. Bullivant

PLATE 1

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PLATE 2

Upper photograph: Monochrome enlargement of colour transparency taken at Sta. A538, McMurdo Sound, depth 260 m.

Lower photograph: Sta. A469, Ross Island, 64 m.

1. **Diplasterias brucei,** probably feeding.

2 and 3. **Odontaster validus** showing a very characteristic position with the arm tips upraised.

4. Possibly a small specimen of **Porania antarctica glabra.**

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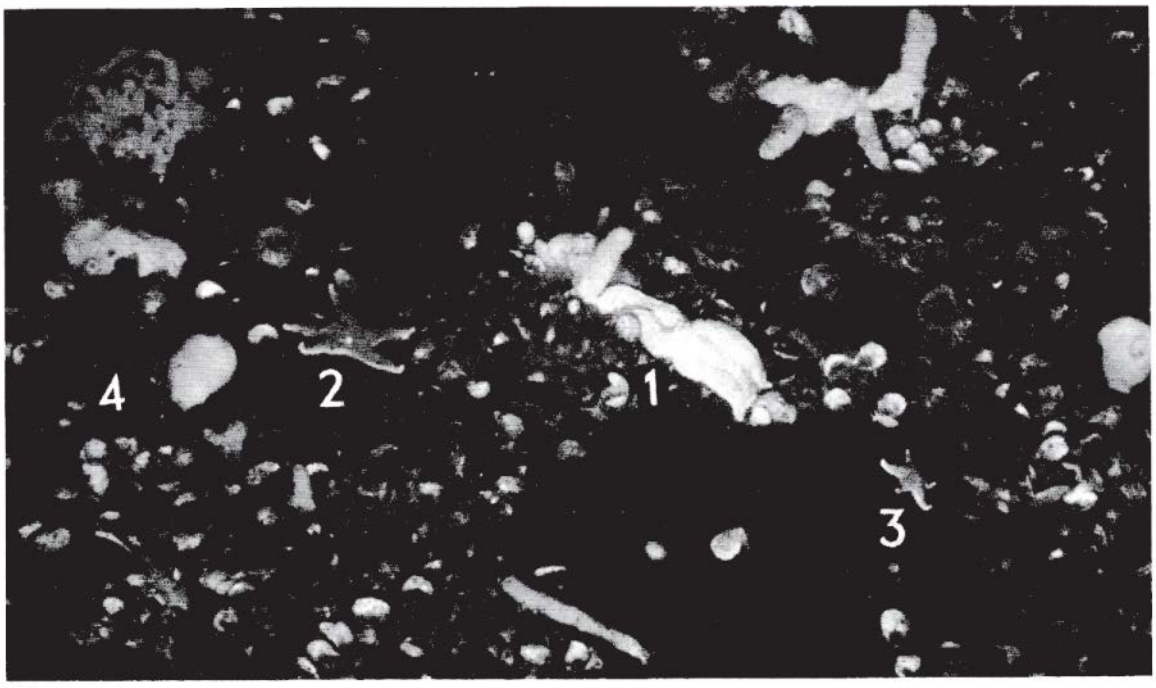
PLATE 2



Photos: J. S. Bullivant

PLATE 2A

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PLATE 3

Leptychaster flexuosus Koehler

(page 26)

1. Actinal and 2, abactinal aspects of specimen from Sta. A456, in which R = about 78 mm and r = 10 mm.

Macroptychaster accrescens (Koehler)

(page 23)

3. Abactinal and 4, actinal aspects of specimen from Sta. A460, in which R = 239 mm and r = 86 mm.

Bathybiaster loripes obesus Sladen

(page 28)

5. Abactinal and 6, actinal aspects of a specimen from Sta. A461, in which R = 35 mm and r = 9 mm.

Psilaster charcoti (Koehler)

(page 30)

7. Actinal and 8, abactinal aspects of specimen from Sta. A448, in which R = 34 mm and r = 8 mm.

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PLATE 3

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PLATE 4

Macroptychaster accrescens (Koehler)

(page 23)

Actinal surface showing: arrangement of the actinal plates in the interradial regions and along the arms; the massive inferomarginal plates and the tube feet. (Specimen from Sta. A460 in which R = 239 mm and r = 86 mm.)

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PLATE 4

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PLATE 5

Luidiaster gerlachei (Ludwig)
(page 32)

1. Abactinal and 2, actinal aspects of specimen from Sta. A461, in which R = 40 mm and r = 7 mm.

Pergamaster triseriatus H. E. S. Clark
(page 43)

3. Actinal and 4, abactinal aspects of holotype from Sta. A464, in which R = 41 mm and r = 17 mm.

Porania antarctica glabra Sladen
(page 45)

5. Actinal and 6, abactinal surfaces of specimen from Sta. A460, in which R = 61 mm and r = 44 mm.

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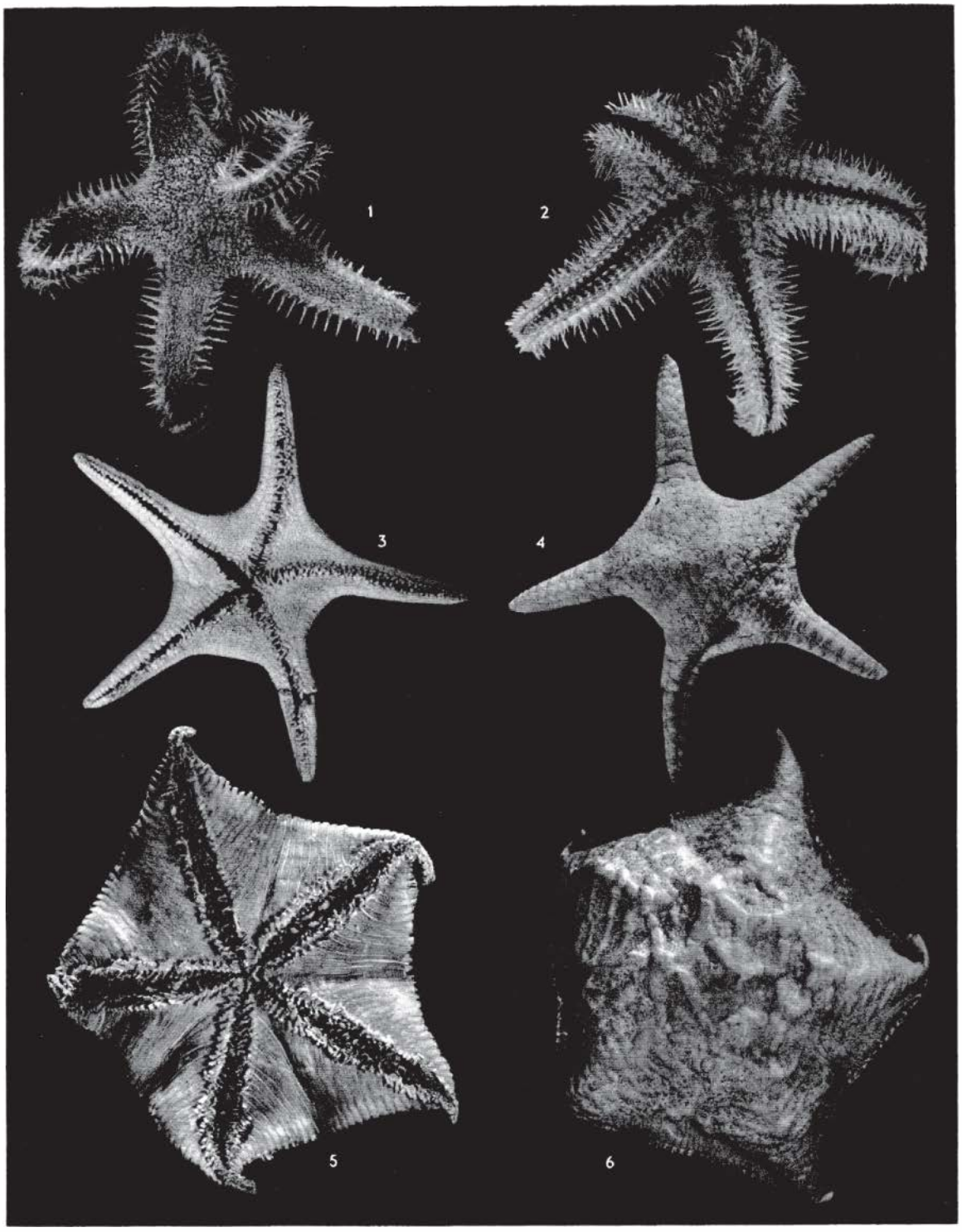

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PLATE 5

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PLATE 6

Odontaster validus Koehler

(page 35)

1. Actinal and 2, abactinal aspects of specimen from Trans-Antarctic (New Zealand) Expedition No. 247, in which R = 35 mm and r = 13 mm.

Odontaster meridionalis (Smith)

(page 34)

3. Abactinal and 4, actinal aspects of specimen from Sta. A460, in which R = 18 mm and r = 8 mm.

Acodontaster capitatus (Koehler)

(page 41)

5. Actinal and 6, abactinal aspects of specimen from A530, in which R = 25 mm and r = 10 mm. Note the distinct papularia on the abactinal surface.

Acodontaster conspicuus (Koehler)

(page 39)

7. Actinal and 8, abactinal aspects of specimen from Sta. A537, in which R = 104 mm and r = 40 mm.

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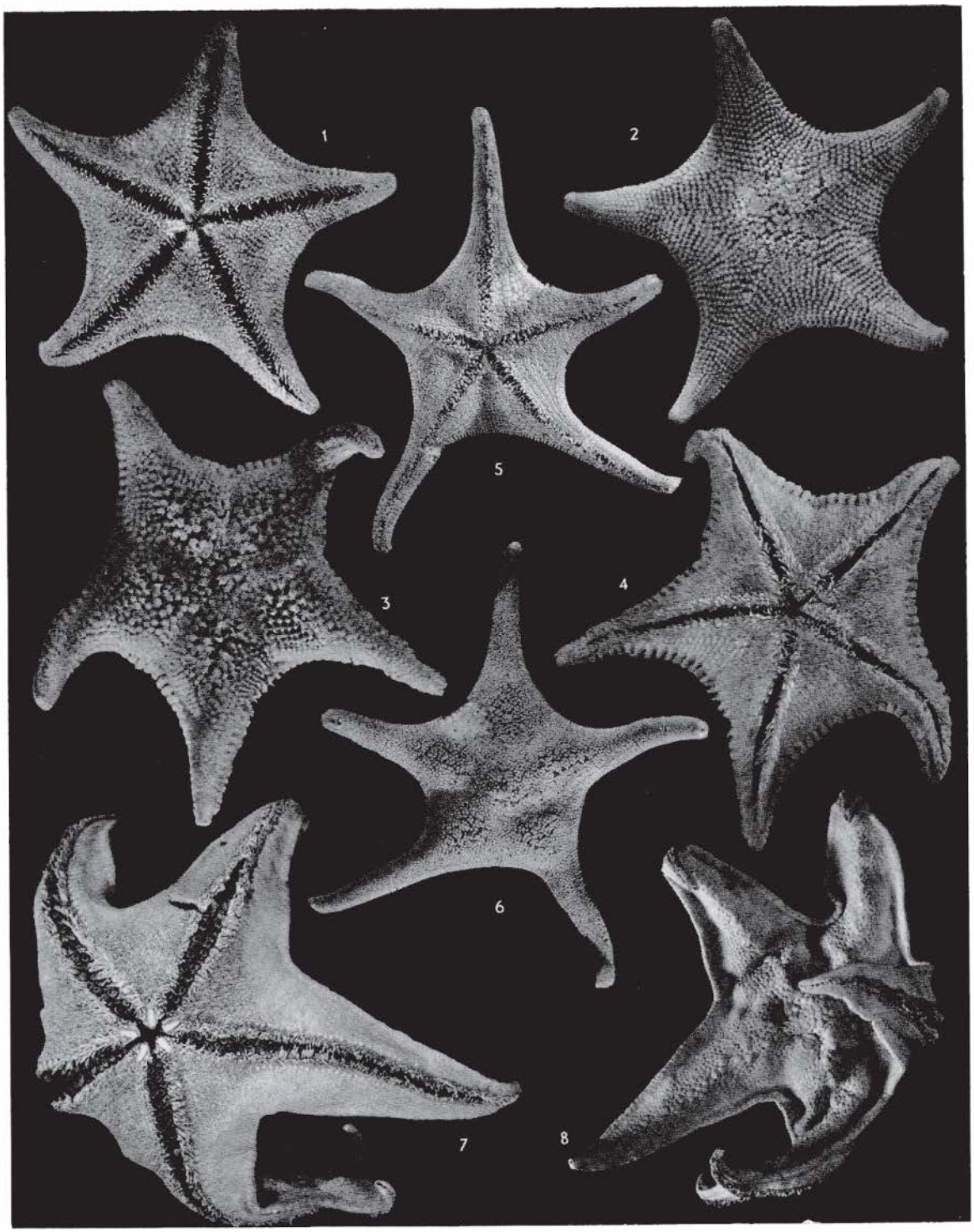

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PLATE 6

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PLATE 7

Acodontaster conspicuus (Koehler)

(page 39)

Actinal surface of specimen from Sta. A537 in which R = 104 mm and r = 40 mm. Note: the transition from granules to spines near the oral angle; the large, median, suboral, hyaline tipped spines and the characteristic valvate pedicellariae.

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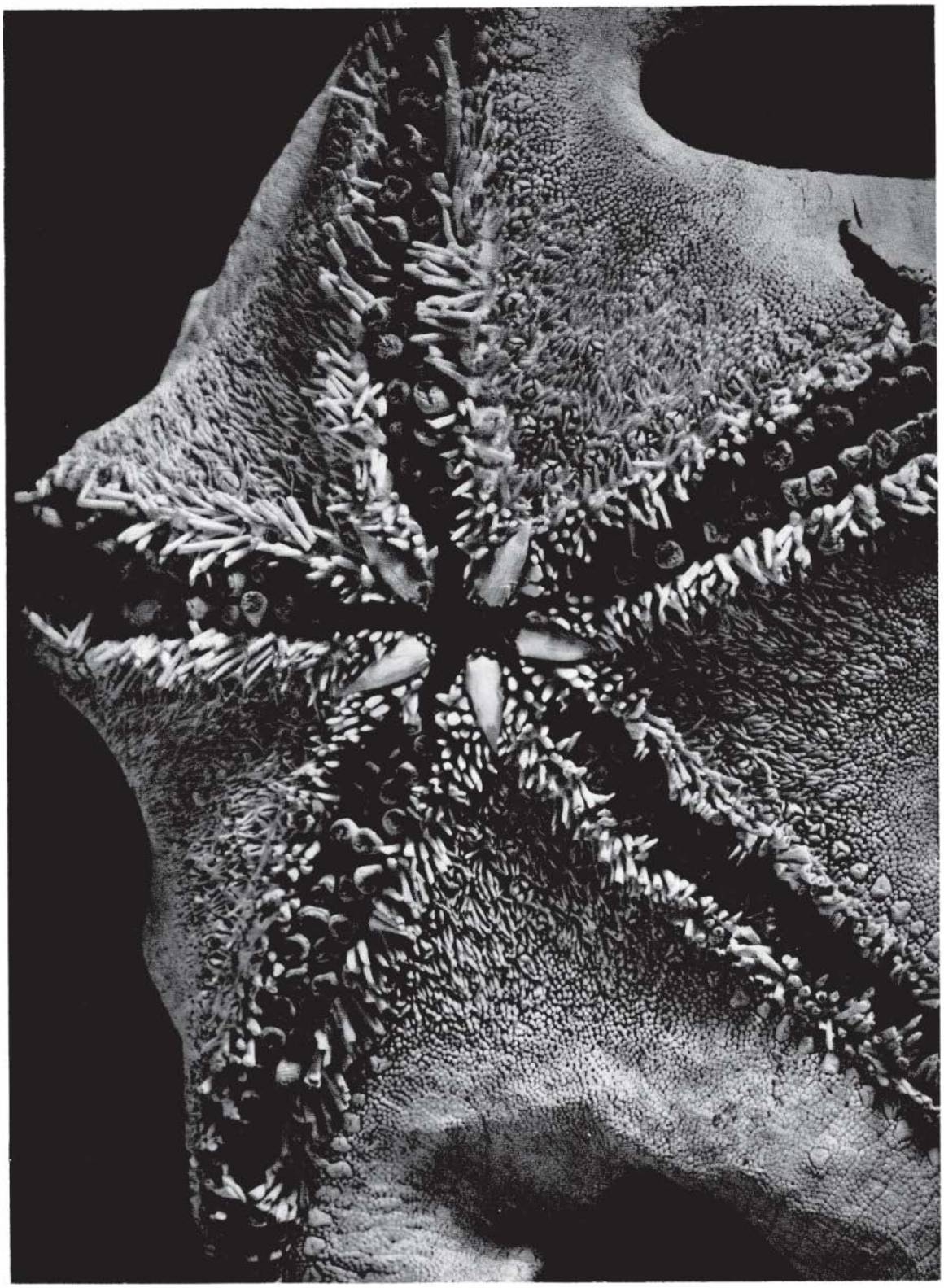

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PLATE 7

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PLATE 8

Perknaster fuscus antarcticus (Koehler)

(page 50)

1. Actinal and 2, abactinal aspects of a specimen from the Stanford University Collection Sta. CEI, in which R = 45 mm and r = 16 mm.

Perknaster densus Sladen

(page 52)

3. Abactinal and 4, actinal aspects of specimen from Sta. A455 in which R = 30 mm and r = 14 mm.

Perknaster sladeni (Perrier)

(page 53)

5. Actinal and 6, abactinal aspects of specimen from Sta. A528, in which R = 25 mm and r = 10 mm.

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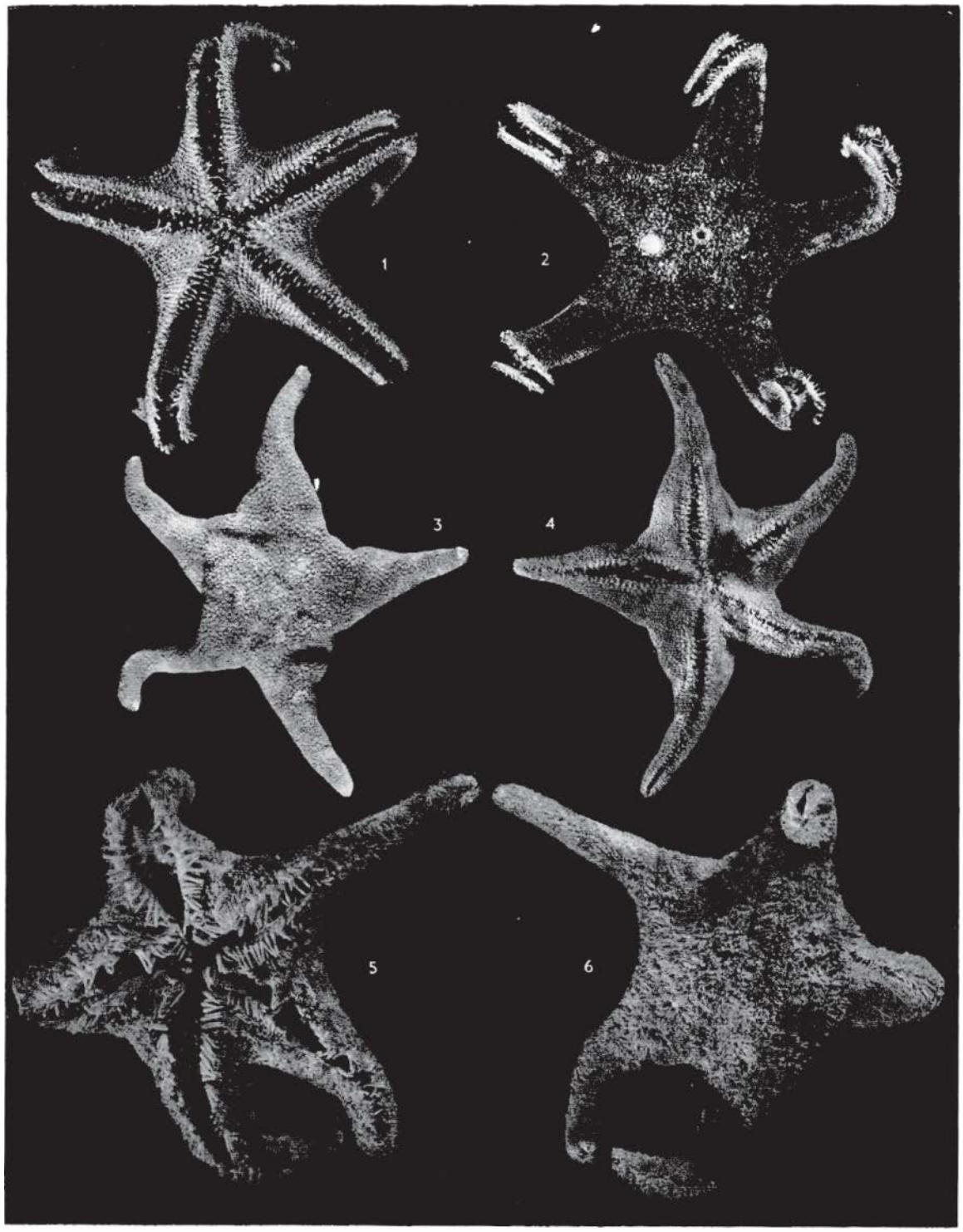

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PLATE 8

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PLATE 9

Kampylaster incurvatus Koehler

(page 48)

1. Abactinal and 2, actinal aspects of specimen from Sta. A529 in which R = 10 mm and r = 6 mm; 3, a specimen from Sta. A449 showing the characteristic position of this specimen when brooding or in preservative.

Henricia sp.

(page 21)

4. Actinal and 5, abactinal aspects of specimen from Sta. A455 in which R = 19 mm and r = 4 mm.

Peribolaster powelli H. E. S. Clark

(page 63)

6. Actinal and 7, abactinal aspects of specimen from Sta. A456, in which R = 25 mm and r = 9 mm.

Pteraster stellifer Sladen

(page 64)

8. Abactinal and 9, actinal aspects of specimen from Sta. A526, in which R = 12 mm and r = 9 mm.

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PLATE 9

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PLATE 10

Crossaster canopus H. E. S. Clark
(page 55)

1. Actinal and 2, abactinal aspects of holotype from Sta. A455 in which R = 22 mm and r = 8 mm.

Cuenotaster involutus (Koehler)
(page 58)

3. Abactinal and 4, actinal aspects of specimen from Sta. A537, in which R = about 56 mm and r = about 14 mm.

Myoraster antarcticus (Koehler)
(page 56)

5. Actinal and 6, abactinal aspects of specimen from Sta. A461, in which R = 15 mm and r = 5 mm.

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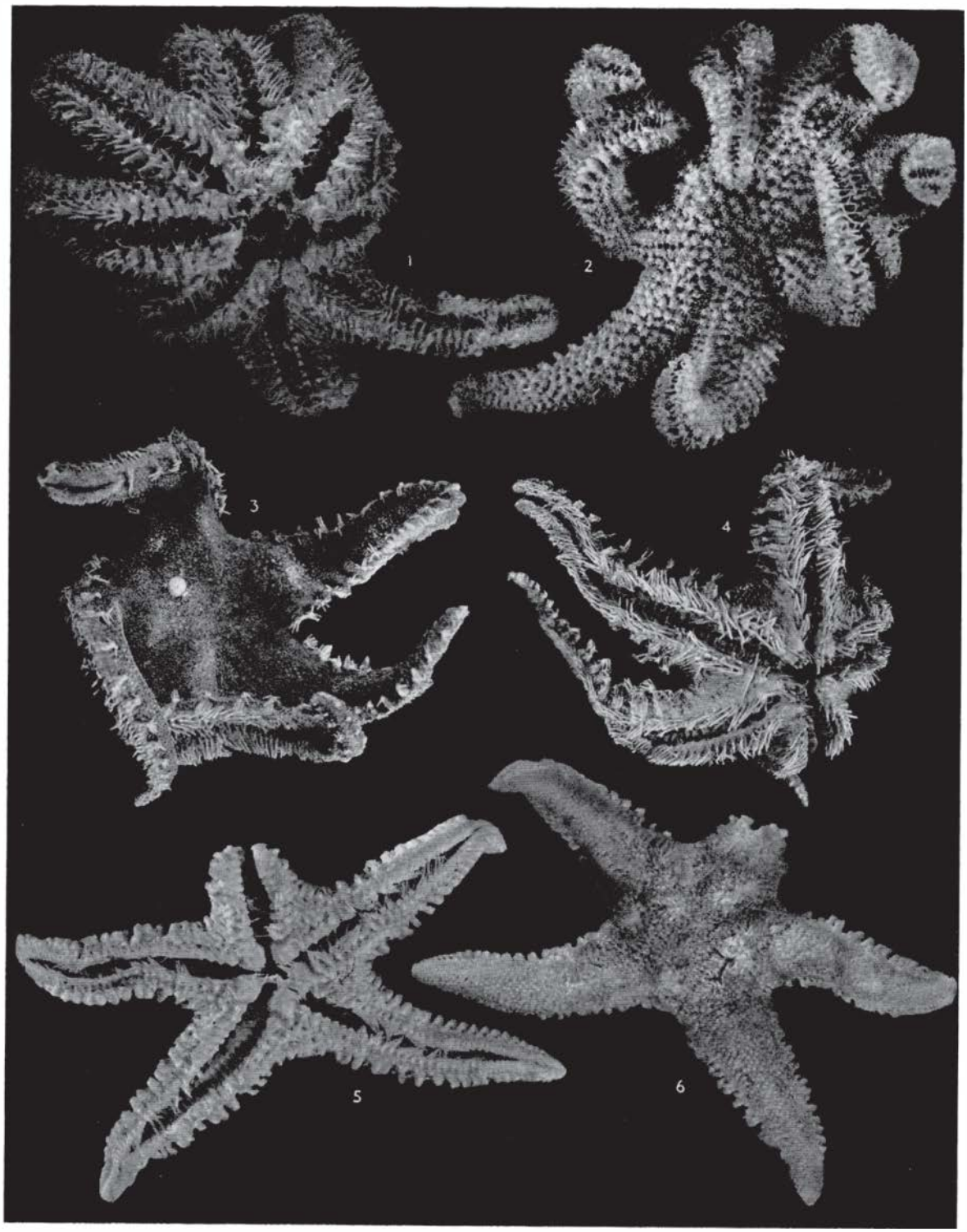

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PLATE 11

Crossaster canopus H. E. S. Clark
(page 55)

Abactinal aspect of holotype from Sta. A455, R = 22 mm and r = 8 mm.

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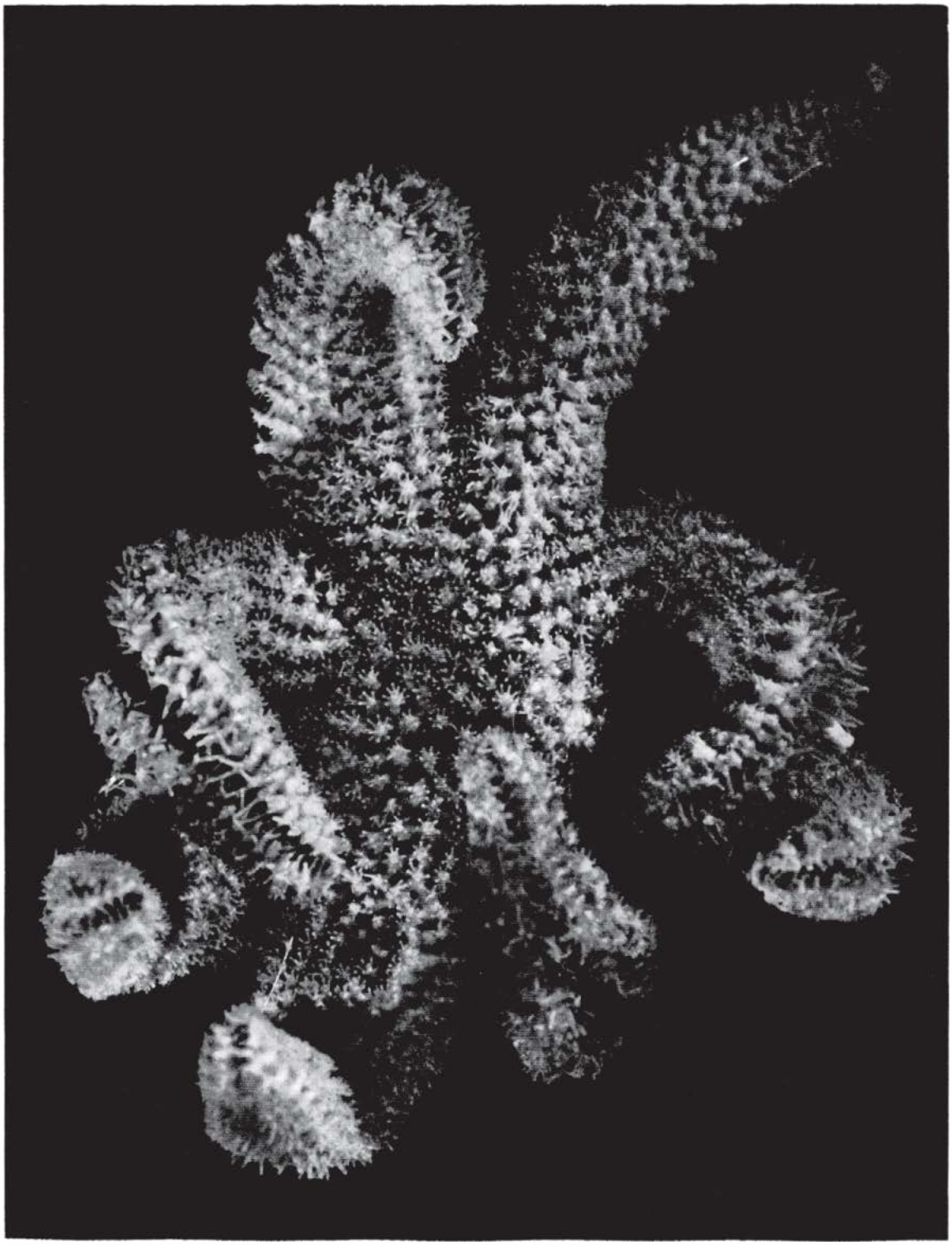

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PLATE 12

Paralophaster lorioli (Koehler)

(page 60)

1. Actinal and 2, abactinal aspects of specimen from Sta. A523 in which R = 15 mm and r = 5 mm.

Lophaster gaini Koehler

(page 61)

3. Abactinal and 4, actinal aspects of specimen from Sta. A449, in which R = 75 mm and r = 16 mm.

Pedicellaster hypernotius Sladen

(page 66)

5. Specimen from Sta. A464 showing both surfaces, R = about 15 mm and r = about 3 mm.

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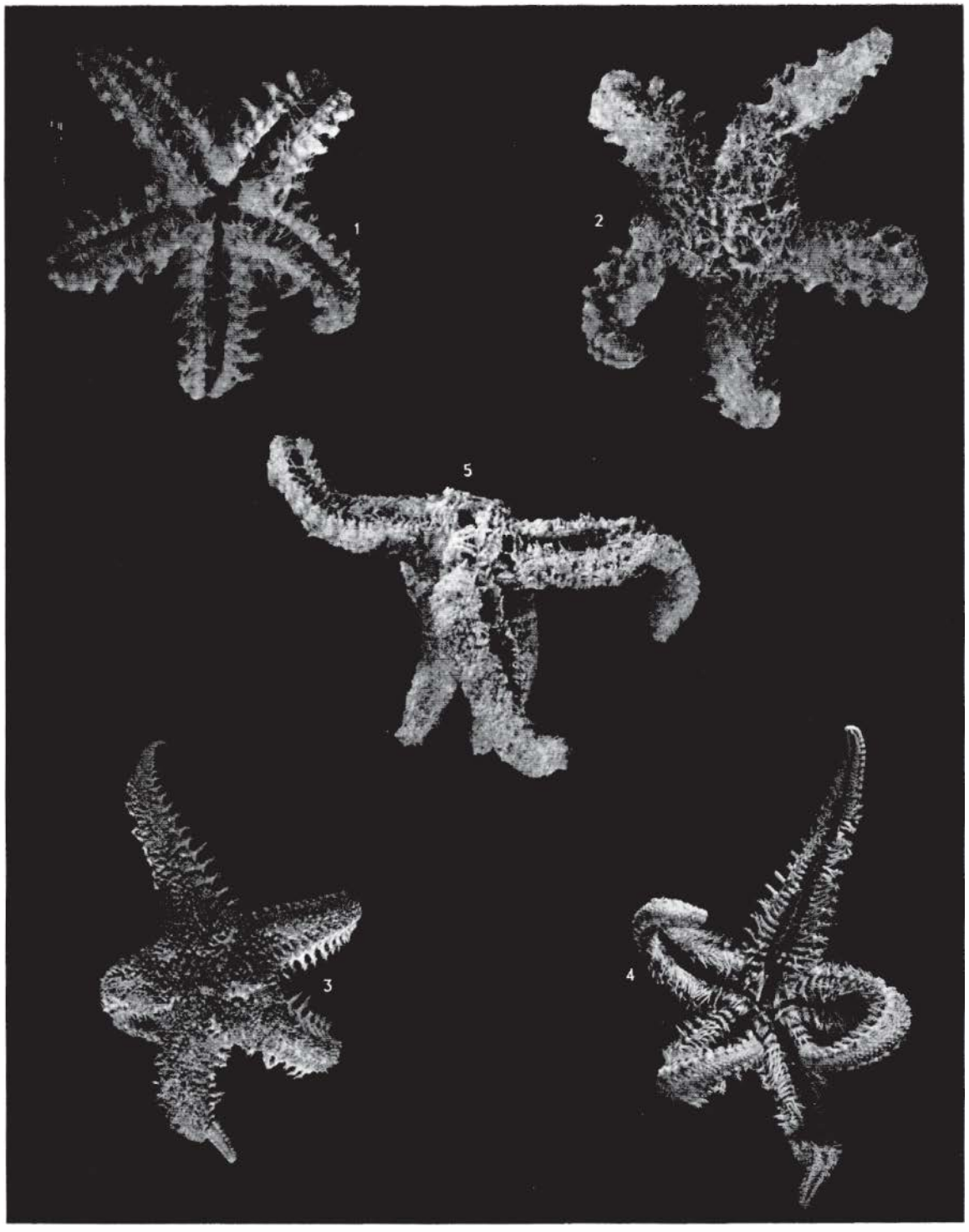

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PLATE 12

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PLATE 13

Lysasterias joffrei (Koehler)

(page 74)

1. Actinal and 2, abactinal aspects of specimen from Sta. A467 in which R = 60 mm and r = 12 mm.

Lysasterias adeliae (Koehler)

(page 72)

3. Abactinal and 4, actinal aspects of specimen from Sta. A527 in which R = 40 mm and r = 9 mm.

Notasterias armata Koehler

(page 67)

5. Actinal and 6, abactinal aspects of specimen from Sta. A460 in which R = 38 mm and r = 8 mm.

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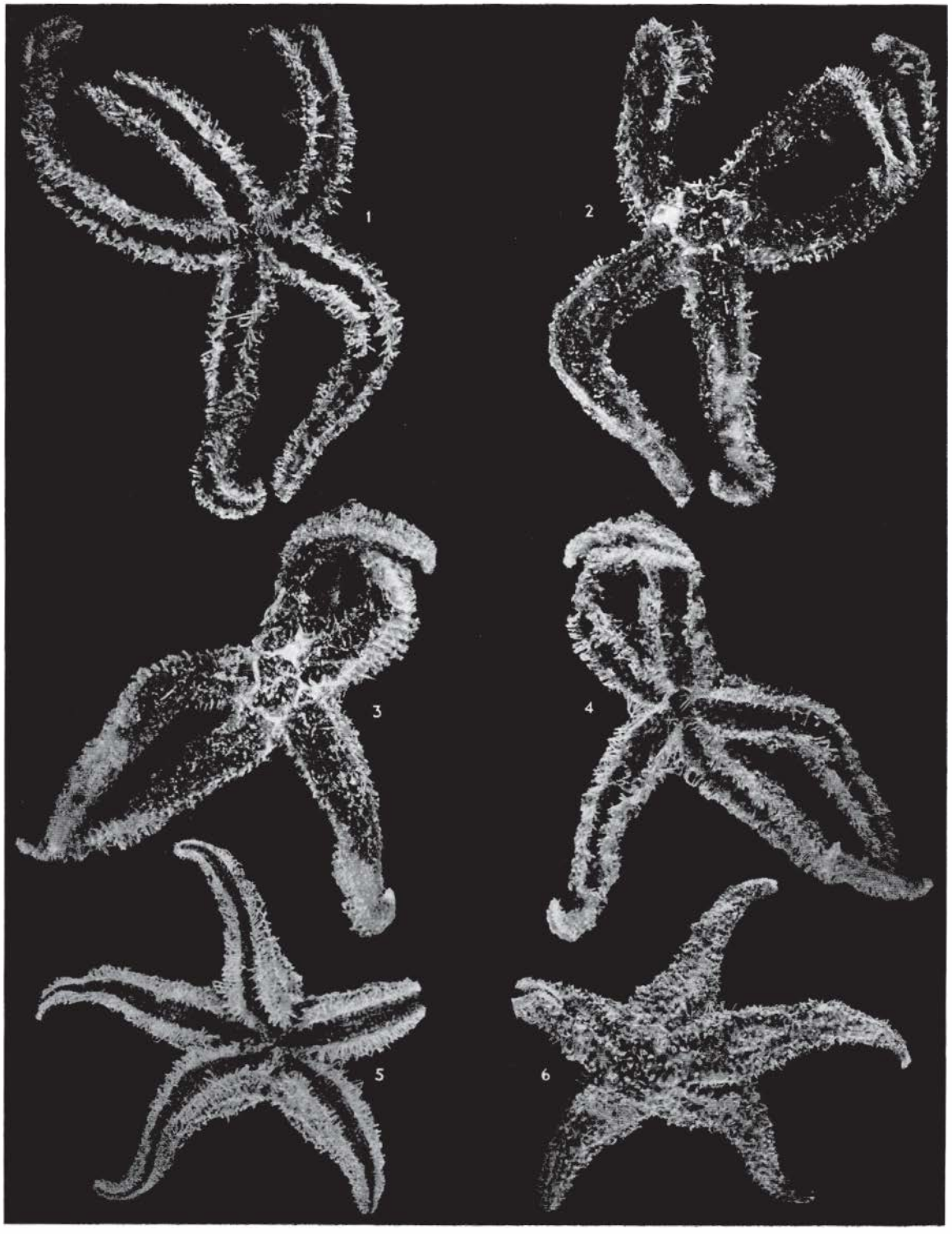

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PLATE 13

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PLATE 14

Psalidaster mordax Fisher

(page 71)

1. Abactinal and 2, actinal aspects of specimen from Sta. A527, in which R = about 20 mm and r = 4 mm.

Saliasterias brachiata Koehler

(page 78)

3. Actinal and 4, abactinal aspects of specimen from Sta. A528, in which R = about 20 mm and r = about 5 mm.

Diplasterias brucei (Koehler)

(page 75)

5. Abactinal and 6, actinal aspects of specimen from Sta. A530, in which R = 30 mm and r = 8 mm.

7. Portion of arm of large specimen in the Stanford University Collection Sta. M (R = 130 mm and R = 17 mm) showing the fan- or paddle-shaped marginal spines.

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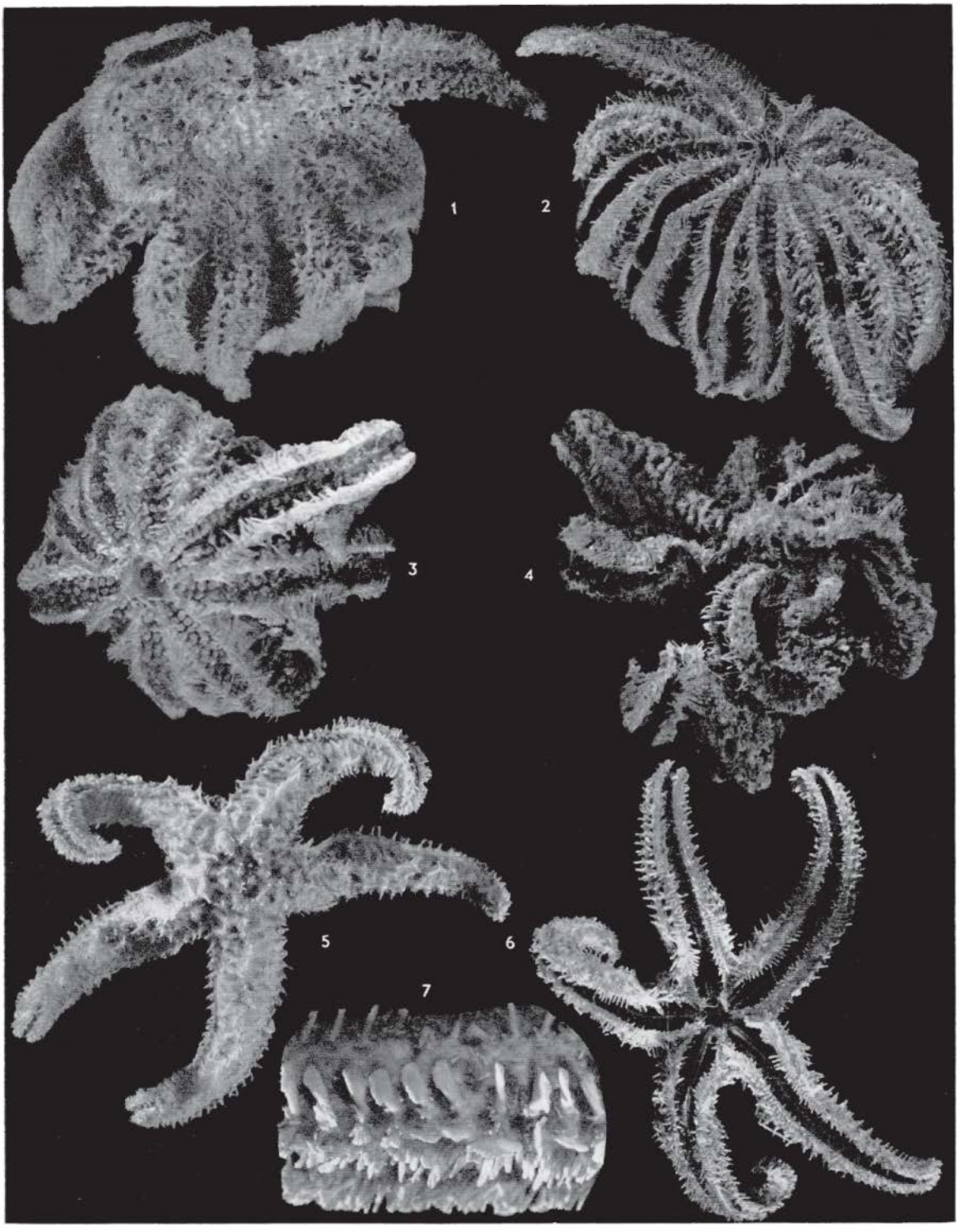

Photo: M. D. King

PLATE 14

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PLATE 15

Notasterias stolophora Fisher
(page 70)

1. Abactinal and 2. actinal aspects.

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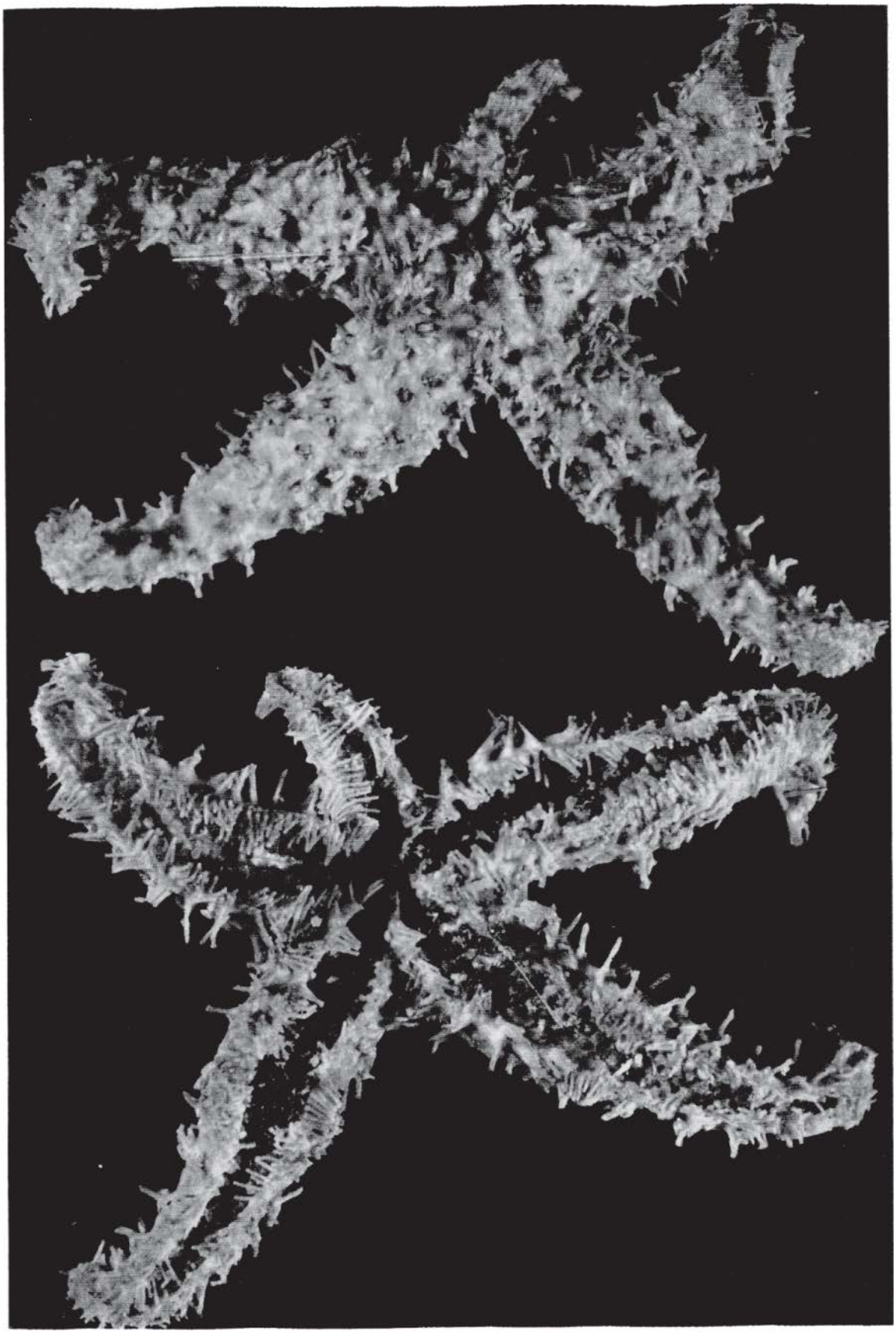

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PLATE 15

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