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ANTARCTIC RESEARCH EXPEDITION

1929-1931

UNDER THE COMMAND OF SIR DOUGLAS MAWSON, Kt., O.B.E., B.E., D.Sc., F.R.S.

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ASTEROIDEA

By

A. M. CLARK

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B.A.N.Z.A.R.E. Asteroid Report - Errata.

p.44 In reference under heading '*Henricia smilax* forma *tenuis*', for '*Henricia parva* (part)' read '*Cribrella parva* (part)'

p.55 9th line from bottom, should be italic capital 'S' before '*subarcuatus*'

p.56 4th line from top, insert apostrophe in 'Ludwigs'.
3rd line from bottom, substitute comma for stop before '*Remaster palmatus*'

p.57 12th line from top, insert 'rather than' before 'those' and a comma before 'having'.

p.77 Para 1, 3rd line from end, delete brackets round 'Perrier'.
2nd line from end, substitute 'C' for 'A' before '*asterinoides*'

p.98 Delete brackets round 'H.L. Clark' in heading '*Pseudophidiaster rhysus*'.

and a comma before having'.

p. 77 Para. 1, 3rd line from end, delete brackets round 'Perrier'.
2nd line from end, substitute 'C' for 'A' before '*asterinoides*'.

p. 98 Delete brackets round 'H. L. Clark' in heading '*Pseudophidiaster rhysus*'.

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Laboratoire de ZOOLOGIE
Michel JANGOUX

ASTEROIDEA

by

AILSA McGOWN CLARK,
British Museum (Natural History), London

(Tables 1-14; Pls. I-V; text-figs. 1-18.)

(*Submitted for publication, June* 1961.)

INTRODUCTION

The collection of sea-stars taken by the B.A.N.Z.A.R. Expedition and entrusted to me by the late Sir Douglas Mawson includes 77 species, subspecies or formae. Ten of these are from Australian coastal waters but all the rest were taken either at stations off the shores of Antarctica, particularly off the Enderby Quadrant, or around Kerguelen and Macquarie Island.

The following are new:—

Cycethra verrucosa mawsoni, subsp. nov.

Henricia smilax forma *tenuis*, forma nov.

Pteraster koehleri, sp. nov.

Psalidaster mordax rigidus, subsp. nov.

Kenrickaster pedicellaris, gen. et sp. nov.

Caimanaster acutus, gen. et sp. nov.

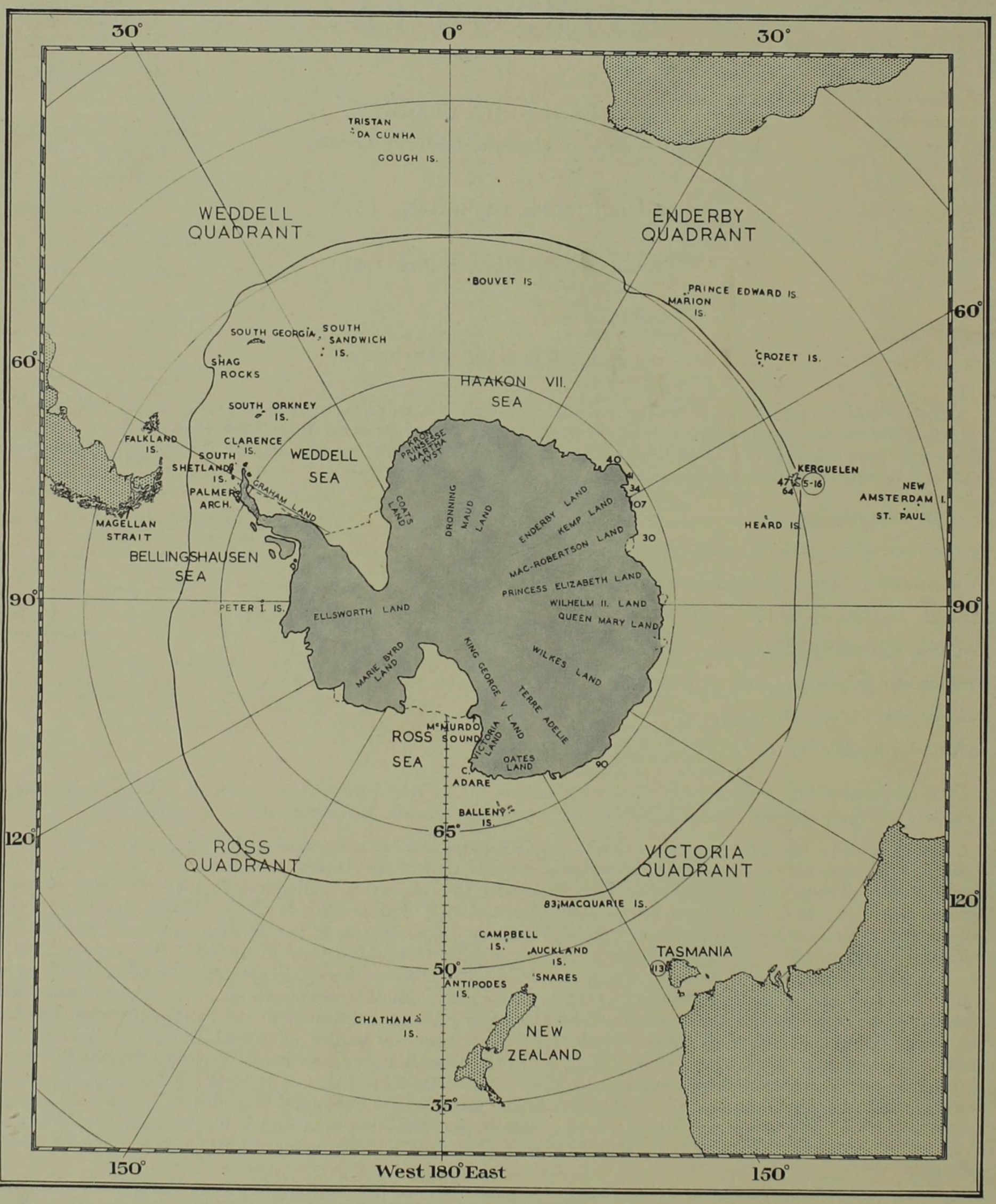
Lysasterias digitata, sp. nov.

In addition a few species from earlier collections in the Southern Ocean are dealt with in this report, including one new species, *Henricia fisheri*, and a new subspecies, *Rhopiella hirsuta kerguelenensis*.

The literature on antarctic and subantarctic sea-stars has been dominated by two men, firstly, René Koehler, who reported on a number of collections, notably that of the Australasian Antarctic (A.A.E.) Expedition in 1920 and secondly, W. K. Fisher, who dealt with the 'Discovery' collections in 1940. The area covered by the B.A.N.Z.A.R.E. stations overlaps that of the A.A.E. but is outside the collecting grounds of the 'Discovery', which concentrated on the Falkland Islands Dependencies in the Weddell Quadrant and on the Falkland-Magellan area, with a few hauls at Marion and Bouvet Islands and in the Ross Sea. Consequently, the B.A.N.Z.A.R.E. material helps to clarify the systematic position of certain species of Koehler which were transferred to other genera or reduced to synonyms by Fisher. Further modifications in the nomenclature and status of some other species were occasioned by the study of other collections in the British Museum. Besides the later 'Discovery' material, these include specimens from the earlier (National Antarctic) 'Discovery', 'Southern Cross' and 'Terra Nova' expeditions, all to the Ross Sea area; the Royal Society's Transit of Venus Expedition to Kerguelen and Sir James Clark Ross's Antarctic Expedition of 1839-42, collecting particularly at Kerguelen, the Auckland and the Falkland Islands; finally the 'Challenger' Expedition, which made hauls between Marion, Kerguelen and Heard Islands, also in the Magellan area and a few abyssal ones between c. 80° E. off Princess Elizabeth Land and Tasmania. These collections include the type specimens of many species.

Fisher and Koehler have listed the species of asteroids known from Antarctic waters but a comprehensive key to the Southern Ocean sea-stars may be useful since considerable numbers are involved and the literature is extensive. The series of keys given in the following pages are an attempt to satisfy this need, but they should be regarded as provisional. In many places they are artificial.

There is an extraordinary tendency among sea-stars of the Southern Ocean to converge on what may be called the 'spinulose' form, that is, one with the interbrachial arcs curved, the rays slightly arched, rounded laterally and tapered distally with the marginal plates inconspicuous and the abactinal surface rather uniformly covered with spinelets, much as in the five-rayed Solasterids or in the new subspecies *Cycethra verrucosa mawsoni* (pl. I, figs. 1-3). Among the Phanerozonia, which usually have prominent, block-like, marginal plates defining the edge of the body and the dorsal and ventral surfaces nearly flat, there are species like *Acodontaster*



Map of the Antarctic continent and adjacent oceans with the Antarctic Convergence shown in relation to the various islands and some of the more important B.A.N.Z.A.R.E. stations indicated by their numbers.

cremeus (Ludwig), *Leptychaster accrescens* (Koehler) and more particularly *Mimastrella cognata* (Sladen) (though, as noted on p. 11, there is some doubt as to whether this last belongs to the Phanerozonia), which approximate to this form, especially in dorsal view. Similarly, in the Forcipulata, *Granaster nutrix* (Studer) is modified in this direction, even to the extent of retaining the juvenile biserial arrangement of the tube-feet to a size when the two rows are normally staggered to form four in species of the sub-family Asteriinae. Conversely, the Asterinid *Patiria obesa* of the Spinulosa may have the marginal plates much enlarged and almost phanerozonian in character, but this is exceptional. The tendency to adopt a form other than that usual to a family has necessitated some qualification and complication in the family key so that some families appear more than once to allow for these divergent species. In subdividing the orders of Asteroids there is also great difficulty in dealing with those of the southern hemisphere because of the family Ganeriidae, which is largely confined to that part of the globe and which bridges the ill-defined gap between the Phanerozonia and the Spinulosa. Even a single species, *Cycethra verrucosa*—notorious for its variability—can show a range of form from the completely phanerozonian to the spinulose. The systematic position of the Poraniidae has also been the subject of some difference of opinion. In 1911 Fisher merged it with the family Asteropidae which he included in the Phanerozonia, but in 1919 he restored the Poraniidae with the comment that the family seems to be related to the Asterinidae and would therefore come within the Spinulosa. This disposition seems to have been followed by most workers and I concur with it myself, but Djakonov (1950, Sea-stars of the U.S.S.R.) includes the Poraniidae in the Phanerozonia.

The keys given by Fisher (1911 and 1928) to the orders and families of Asteroids, based mainly on the North Pacific species, I found needed considerable modification to fit these southern forms, but nevertheless have proved invaluable as a basis on which to work.

With regard to the area covered by the present keys, they are primarily intended for antarctic species but since some subantarctic ones may prove to extend across the Antarctic Convergence, the northern limit has been taken at about 40° S. off Chile and Argentina, round the Southern Ocean including Bouvet, Marion, the Crozet, Kerguelen, Macquarie, the Auckland, Campbell and Antipodes Islands. It excludes species only known from Tristan da Cunha (except *Henricia simplex* (Sladen), which is given for comparison), Gough Island, New Amsterdam and St. Paul and the South African and Australasian continental shelves.

In a very few instances in the keys, where no obvious differences between species present themselves from the published descriptions, only localities are given. This is intended to highlight inadequacies in our knowledge and does not necessarily imply that the species involved are synonymous. Although the genera represent what are believed to be phylogenetic groups, these keys do not pretend to give a phylogenetic picture but are intended as practical tools.

A zoogeographical observation resulting from this work is that I believe the bottom fauna of Marion Island may prove to be more closely related to that of the similarly subantarctic Falkland-Magellan area than to the fauna of Kerguelen, which, though much closer to Marion Island, is separated from it by the Antarctic Convergence. On the other hand, of the very few species taken at Macquarie Island, just about on the Convergence, though nearly three times as far from Kerguelen to the east, two have affinities with others found at Kerguelen. As yet, the material from these islands, other than Kerguelen itself, is rather sparse and much more is needed before the true limits and inter-relationships of the species concerned can properly be appreciated.

The Australian species collected by the B.A.N.Z.A.R.E. are dealt with in an appendix at the end.

COLLECTING STATIONS CONCERNED IN THIS REPORT

A full account of the Stations worked and the collecting gear used on the B.A.N.Z.A.R. Expedition is given by T. H. Johnston in Series B, vol. 1, part 1, of these reports, Biological Organisation and Station List. The localities indicated by the Station numbers and the collection numbers (referred to in the text as Coll. 1, 2, etc.) are given in the list below.

Included in the material examined are a few collections made by the Australasian Antarctic Expedition 1911-14. Details of the localities for these are included in the text.

Station 5. Three-quarters of a mile downstream from jetty, Jeanne d'Arc, on edge of Laminaria belt. 49° 33′ 00″ S., 69° 49′ 45″ E. DRS, 20 m.
Station 6. Entrance to Bras Bossière, Kerguelen. 49° 29′ 24″ S., 69° 47′ 30″ E. DRS, 4-5 m.; sand with kelp.
Station 7. Near head of Bras Bossière. DRS, 4 m.; mud.
Station 8. Bras Bossière, about 1 mile below Sta. 7. DRS, 5 m.; mussel bank with kelp.
Station 9. Islands in lower reaches of Bras Bossière. Littoral collection.
Station 12. Off Grave I., Island Harbour, Kerguelen. 49° 28′ 20″ S., 70° 04′ 30″ E. DRS, 4-5 m.; red and brown algae.
Station 13. Island Harbour. 49° 28′ S., 70° 05′ E. DRS, 15 m.
Station 15. Between Hog I. and Blakeney I., Kerguelen. 49° 27′ 20″ S., 70° 01′ 40″ E. DRS, 55 m.
Station 19. Atlas Cove, Heard I. 53° 05′ 30″ S., 73° 24′ 00″ E. Shore, from kelp holdfasts.
Station 29. Off Princess Elizabeth Land. 66° 28′ S., 72° 41′ E. TML, 1266 m.

Station 30. Off MacRobertson Land. 66° 48′ S., 71° 24′ E. TML, 540 m.
Station 34. Off Kemp Land. 66° 21′ S., 58° 50′ E. DRL, 603 m.
Station 39. Off Enderby Land. 66° 10′ S., 49° 41′ E. TML, 300 m.
Station 40. Off Enderby Land. 66° 12′ S., 49° 37′ E. TML, 300 m.
Station 41. Off Enderby Land. 65° 48′ S., 53° 16′ E. TML, 193 m.
Station 42. Off Enderby Land. 65° 50′ S., 54° 23′ E. TML, 220 m.
Station 47. Just south of Kerguelen. 49° 50′ S., 69° 33′ E. DRL, 150 m.
Station 49. W. end of Long I., Royal Sound, Kerguelen. 49° 30′ S., 69° 48′ E. DRS, 2-20 m.; kelp.
Station 50. Grotto Bay, N.W. of Port Jeanne d'Arc. 49° 32′ 00″ S., 69° 48′ 15″ E. DRS, 10 m.
Station 52. Bras Bolinder, near head of Greenland Harbour, Kerguelen. 49° 36′ 45″ S., 70° 07′ 30″ E. Littoral.
Station 53. Bras Bolinder, near mouth of Peace River, Kerguelen. DRS, 20-30 m.
Station 54. Head of Greenland Harbour. 49° 37′ S., 70° 09′ E. Beach between tide marks.
Station 55A. N.W. end of Long I. 49° 29′ 30″ S., 69° 48′ 45″ E. DRS, 15-20 m.
Station 55B. Near head of Bras Enzensperger, Royal Sound. 49° 24′ S., 69° 45′ E. DRS, 1-5 m.
Station 56A. Rivett Arm, Kerguelen. 49° 23′ 30″ S., 69° 55′ 30″ E. DRS, 4-6 m.
Station 56B Observatory Bay, Kerguelen. Littoral.
Station 58. In Hydrography Channel, S.E. from Green Island, Kerguelen. 40° 39′ S., 70° 04′ E., DRL, 50 m.
Station 59. About 1 mile N.E. of Suhm I., Royal Sound. 49° 28′ S., 70° 12′ E. OTL, 47 m.
Station 62. Poincaré Peninsula, opposite Murray I., Royal Sound. 49° 32′ S., 70° 17′ E. Shore.
Station 64. Off the entrance to Royal Sound. 49° 28′ S., 70° 33′ E. OTL, 91 m.
Station 76. East of Albany, Western Australia. 35° 18′ S., 118° 15′ E. OTL, 62 m.
Station 81. Buckle's Bay, N. end of Macquarie I. 54° 29′ S., 158° 58′ E. Intertidal.
Station 83. Off Lusitania Bay, Macquarie I. 54° 42′ 40″ S., 158° 54′ 30″ E. DRL, 69 m.
Station 90. Off Adélie Land. 66° 21′ S., 138° 28′ E. DRL, 640 m.
Station 98. Off Wilkes Land. 65° 07′ S., 107° 29′ E. DRL, 502 m.
Station 103. Off Princess Elizabeth Land. 67° 03′ S., 74° 29′ E. DRL, 437 m.
Station 105. Near Murray Monolith, MacRobertson Land. 67° 46′ S., 67° 03′ E. DRL, 163 m.
Station 106. Off MacRobertson Land. 67° 38′ S., 64° 52′ E. DRL, 17 m.
Station 107. Off MacRobertson Land. 66° 45′ S., 62° 03′ E. OTL, 219 m.
Station 112. Near Cape Maatsuyker, Tasmania. 43° 40′ S., 146° 50′ E., OTL, 84 m.
Station 113. Off Maria I., Tasmania. 42° 40′ S., 148° 27′ 30″ E. DRL, 174-155 m.
Station 115. Off N.E. Tasmania. 41° 03′ S., 148° 42′ E. DRL, 128 m.

Collection Numbers:

Coll. 282. Royal Sound, Kerguelen. 57 m.
Coll. 705. Port Jeanne d'Arc, Kerguelen. 5 fath. kelp.
Coll. 712, and 712a. Port Jeanne d'Arc, Kerguelen. Fish trap, 9 m.
Coll. 750. 759, 783, 784, 790, 792, Port Jeanne d'Arc, Kerguelen. Under stones between LW. and LWS.

SYSTEMATICS

Key to the Orders and Families of Sea-stars found in the Southern Ocean

(Modified from Fisher, 1911 and 1928.)

1 (22, 39) Marginal plates usually large and conspicuous in dorsal view, at least distally, defining the edge of the body or sometimes inclined towards the ventral surface proximally; the infero-marginals and (except in *Mimastrella*, *Leptychaster kerguelenensis* and the Luidiidae) the supero-marginals not paxilliform; abactinal plates either paxilliform with a column crowned by spinelets or flat and tessellate, covered or ringed with granules, spinelets or spines, rarely thin and scale-like with few spinelets, not forming an open reticulum (except in a few Ganeriidae); pedicellariae, if present, fascicular, pectinate, valvate or excavate, often with more than two valves which are of simple shape, and always lacking a basal piece; tube-feet always in two series though sometimes crowded and superficially appearing multiserial; rays normally five in number; shape often more or less stellate, interbrachial arcs rounded or angular, rays not constricted basally and if narrow then dorsoventrally flattened rather than cylindrical . . . . . Order Phanerozonia

2 (11) Tube-feet pointed or with a small knob terminally, no definite sucking disc.

3 (4) The interradial marginal plates with conspicuous vertical, beaded cribriform organs between them, lacking on the plates of the abruptly constricted rays or the distal-most plates in small pentagonal specimens . . Porcellanasteridae p. 10

4 (3) No conspicuous cribriform organs between the interradial marginal plates though all the marginals may have fringes of spinelets or fascioles between them.

5 (6) Actinal surface with conspicuous grooves traversing each area from the marginal fascioles to the adambulacral plates. Goniopectinidae p. 10

6 (5) Actinal surface not grooved.

7 (8) Supero-marginal plates not paxilliform, though sometimes smaller than the infero-marginals . . Astropectinidae, part p. 10

8 (7) Supero-marginal plates very reduced, paxilliform and barely, if at all, distinguishable from the adjacent abactinal plates.

9 (10) Interbrachial arcs rounded, actinal interradial areas large, triangular. Astropectinidae, part (*Leptychaster kerguelenensis* and *Mimastrella*)

10 (9) Interbrachial arcs angular, actinal areas narrow . . . . . Luidiidae p. 13

11 (2) Tube-feet with a well-developed disc.

12 (13) Marginal plates short but wide, each with a few sharp, conspicuous, spines; papulae limited to a proximal area at the base of each ray; interbrachial arcs usually angular and the rays tapering evenly from the base . . . Benthopectinidae p. 13

13 (12) Marginal plates usually about as long as wide, lacking conspicuous spines; papulae not limited to proximal areas; interbrachial arcs usually rounded.

14 (15) Each pair of oral plates with one, two or three conspicuous, distally-directed, hyaline-tipped spines . Odontasteridae p. 14

15 (14) No such spines on the oral plates.

16 (19) Abactinal plates either flat, or with a wide tabulum occupying most of the surface, or the whole plate evenly convex, armed with granules, tubercles or coarse, blunt, spinelets, sometimes only present around the edge of each plate; rarely the plates concealed by smooth skin with single spines projecting from it.

17 (18) Primary abactinal plates crescentic in shape with a few small secondary plates subdividing the pore areas in the hollow space proximal to each primary . . . . . Asterinidae, part (*Patiria obesa* with enlarged marginals)

18 (17) Abactinal plates not crescentic, not of two distinct magnitudes . . . . . Goniasteridae, part, p. 22

19 (16) Abactinal plates more or less paxilliform, only the central part convex or raised into a well-defined pedicel and bearing a cluster of spinelets which may be slender or coarse; the flat peripheral parts of the plates lobed, tending to form a small-meshed reticulum.

20 (21) About six furrow spines on each adambulacral plate; fasciculate pedicellariae usually present. Goniasteridae, part (*Pseudarchaster*)

21 (20) Only one or two furrow spines on each plate; no pedicellariae. Ganeriidae, part (*Ganeria* and subantarctic *Cycethra verrucosa*)

22 (1, 39) Marginal plates inconspicuous, particularly the supero-marginals, which are usually more or less similar to the abactinal plates, the infero-marginals sometimes (some Asterinidae and Poraniidae) defining an acute ventro-lateral angle, otherwise the sides rounded; abactinal plates either paxilliform or forming a reticulum, often more or less concealed by skin; pedicellariae rare, not highly modified and always lacking a basal piece; tube feet in two series; usually five rays, sometimes more; shape very variable, interbrachial arcs either rounded and the rays more or less short, the dorsal side usually convex and the ventral flat, or the arcs more acute and the rays more or less cylindrical, sometimes constricted basally.
Order Spinulosa

23 (32) Abactinal plates paxilliform with a limited pedicel bearing a cluster of spinelets which may be short, moderate or very long, sometimes (Pterasteridae) all paxillae roofed over with skin or (Korethrasteridae) each paxilla sheathed with skin, or (*Perknaster* in the Ganeriidae) body wall greatly thickened and enveloping the reduced spinelets and small isolated plates.

24 (29) No conspicuous skin roofing over or enveloping the paxillae although they may be entirely embedded in the thick pulpy body wall.

25 (26) Marginal plates, if distinct from the abactinal ones, low, lacking a high projecting pedicel, and interradial ones usually inclined towards the ventral surface; body form ranging from phanerozonian to spinulose, body wall sometimes very thick; five rays. . . . . Ganeriidae, p. 23

26 (25) Infero-marginals always distinct, usually the supero-marginals too, both series being paxilliform with high, narrow pedicels crowned with spinelets and lateral in position; usually five rays, sometimes seven to ten.

27 (28) Tube-feet with sucking discs . . . . . Solasteridae, p. 50

28 (27) Tube-feet tapering, with rounded knobs at the tip . . . . . Astropectinidae, part (*Mimastrella*)

29 (24) Conspicuous skin covering present.

30 (31) Each abactinal paxilla with its own sheath of skin . . . . . Korethrasteridae, p. 56

31 (30) The paxillae roofed over and linked by a continuous supra-dorsal membrane leaving a cavity below . Pterasteridae, p. 58

32 (23) Abactinal plates either evenly convex with spinelets arising from most of the surface, or forming a more or less open reticulum which may be obscured or even concealed by skin (Poraniidae, some Echinasteridae).

33 (36) Abactinal plates crescentic or rounded with only short lobes and small spaces between, often very regular in position; rays usually short, dorsal side very convex and ventral flat.

34 (35) Abactinal plates not imbricated . . . . . Ganeriidae, part (*Cycethra macquariensis*)

35 (34) Abactinal plates imbricated . . . . . Asterinidae, p. 32

36 (33) Abactinal plates forming a reticulum, not crescentic in shape but oval or lobed, meshes often large, sometimes obscured by skin; rays either short and convex dorsally or long and cylindrical.

37 (38) Whole surface covered with thick skin concealing the plates which may be armed with low tubercles, usually few in number; actinal skin usually grooved between the margins and the furrows; interbrachial arcs rounded; no sabre-shaped furrow spine . . . . . Poraniidae, p. 34

38 (37) Skin usually thin and abactinal plates armed with small spinelets, but if the skin obscures the skeleton (*Poraniopsis* and *Rhopiella*) then there are prominent, acute, single spines; ventral skin not grooved; interbrachial arcs angular or rounded; except in *Poraniopsis* a sabre-shaped furrow spine present . . . . . .Echinasteridae, p. 36

39 (1, 22) Marginal plates inconspicuous, rarely the infero-marginals defining an obtuse ventro-lateral angle, usually the sides rounded; abactinal plates forming a reticulum or more or less regular transverse and longitudinal series, or very reduced, even lacking altogether in adults or concealed by pustular skin, not paxilliform or tabulate; pedicellariae highly modified, some (the forcipulate) crossed and scissor-like with a supplementary plate between the overlapping bases of the two valves, others straight with two more simple valves mounted on a bowl-shaped basal piece, the crossed ones almost invariably present (except in the Zoroasteridae where straight ones only are found), the straight ones usually present, at least in the ambulacral furrow, often elsewhere besides, and sometimes modified into a conspicuous felipedal* form with interlocking claws on the valves; tube feet usually in four series, sometimes (Brisingidae, Pedicellasterinae, some Labidiasterinae and young *Granaster*) in two; five or more rays, usually cylindrical basally, interbrachial arcs usually acute, rarely rounded.
Order Forcipulata

40 (41) Only straight pedicellariae present; rays very long and narrow with plates in regular longitudinal and transverse series; alternate adambulacral plates carinate on the furrow face; deep-sea only . . . . . Zoroasteridae, p. 67

41 (40) Crossed and usually also straight pedicellariae present; abactinal skeleton usually reticular but if regular longitudinal and transverse rows are evident then the form is stout; consecutive adambulacral plates similar.

42 (43) Tube-feet in two series; adambulacral plates not very short; disc small, circular, well-defined; rays often more than five and expanded and specialized in the proximal part though narrow for most of their length; straight pedicellariae absent; skeleton of the narrow parts of the rays reduced to lateral bars formed by the marginals which often bear single, needle-like and very long, skin-covered spines, the length of which sometimes exceeds the width of the ray; fragile, deep-water species, often more or less broken in collecting . . . . . Brisingidae, p. 68

43 (42) Tube-feet in two, or more usually four, series; adambulacral plates short; rays not narrowing abruptly beyond the proximal part (except in some specimens of *Labidiaster*); straight pedicellariae usually present, at least in the furrow; marginal spines not needle-like in shape if single and never as long as the ray is wide . . . . . Asteriidae, p. 69

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* Following H. L. Clark I prefer to use this more comprehensible and euphonious word than Fisher's term 'unguiculate'.

Family PORCELLANASTERIDAE

This family of deep-water sea-stars is not represented in the B.A.N.Z.A.R.E. collections.

Key to the Southern Species

1 (2) A few large, spike-like spines on the dorsal surface of each ray (S. from Gough I., 51° S., 3845 m.) *Styracaster robustus* Koehler, 1908

2 (1) No large spines on the rays . . . . . *Hyphalaster* Sladen, 1883

3 (4) Supero-marginal plates of each series contiguous on the dorsal side of each ray (off Crown Princess Martha Coast, 2578 m.). *Hyphalaster scotiae* Koehler, 1908

4 (3) The two series of supero-marginal plates of each ray narrowly separated by abactinal plates (mid-way between Kerguelen and Macquarie I., 3566 m.) . . . . . *Hyphalaster planus* Sladen, 1889

Family GONIOPECTINIDAE

This family includes two subantarctic species neither of which is represented in the B.A.N.Z.A.R.E. collection.

Key to the Southern Species

1 (2) Mid-radial paxillae with 1-6 central spinelets and up to 12 peripheral ones; the paxillar columns large, over 1 mm. in height (Falkland Islands north to Rio de Janeiro, 70-1100 m.). . . . . *Ctenodiscus australis* Lütken, 1871

2 (1) Mid-radial paxillae with only one, if any, central spinelets; the columns small, less than 0·5 mm. in height (southernmost Chile, 50-1033 m.). . . . . *Ctenodiscus procurator* Sladen, 1889

Family ASTROPECTINIDAE

Key to the Southern Species

(Largely derived from Fisher, 1911 and 1940)

1 (2) Supero-marginal plates paxilliform with a slender cylindrical column, the spinelets of each one indistinguishable from and continuous with those of the adjacent, closely-placed infero-marginal. (southern Chile, Bellingshausen Sea, 320-480 m.). *Mimastrella cognata* (Sladen), 1889

2 (1) Supero-marginal plates usually large, rectangular, and quite distinct from the infero-marginals, rarely small and more or less paxilliform, but then with the low column transversely widened.

3 (12) Supero-marginal plates distinctly smaller than infero-marginals; both series uniformly covered with papilliform or squamiform spinelets, none being conspicuously enlarged.

4 (5) Adambulacral plates longer than wide with furrow margin gently curved and bearing about 8 short spinelets; no odd interradial actinal plates (N. from Queen Mary Land and mid-way between Kerguelen and Macquarie I., 3566-3612 m.). *Lonchotaster forcipifer* Sladen, 1889

5 (4) Adambulacral plates short with the furrow margin angular and bearing a few long slender spinelets; odd interradial actinal plates present . . . . . *Leptychaster*† Smith, 1876

6 (7) Papulae distributed all over the abactinal surface, all the abactinal plates being strongly lobed (Enderby and Victoria Quadrants, Ross Sea, South Georgia and Bouvet I., 110-647 m.). *Leptychaster accrescens* (Koehler), 1920*

(Bellingshausen and Ross Seas, 5-203 m.) . . . . . *Leptychaster magnificus* (Koehler), 1912*

7 (6) Papulae confined to a rather narrow marginal area where plates have short lobes; elsewhere the plates are roundish.

8 (9) Series of gonads well spaced from margin; size up to 350 mm. R (off King George V. Land and from the Ross Sea, 351-582 m.). *Leptychaster flexuosus* (Koehler), 1920

9 (8) Series of gonads near margin of abactinal area; size not known to exceed 70 mm. R. *Leptychaster kerguelenensis* Smith, 1876

10 (11) Interbrachial arcs distinctly angular (Falkland-Magellan area, 86-151 m.) . *L. kerguelenensis mendosus* (Koehler), 1923

11 (10) Interbrachial arcs curved or with a rounded angle (Kerguelen and Marion I., 0-384 m.) *L. kerguelenensis kerguelenensis* Smith, 1876

12 (3) Supero-marginals hardly, if at all, smaller than the infero-marginals; a few enlarged spines or squamiform spinelets present on some or all of the marginal plates.

13 (14) An enlarged, short, central spinelet present on the central disc plates; prominent pedicellariae present on many of the actinal plates (off Crown Princess Martha Coast and Wilhelm II Land, 2450-2579 m.). . . *Dytaster felix* Koehler, 1908

14 (13) No enlarged central spinelets on the disc plates; no prominent pedicellariae on the actinals.

15 (16) Supero-marginal plates convex dorso-ventrally, forming a wide border to the paxillar area in dorsal view (S. from Gough I., 51° S., 3118 m.) . . . . . *Persephonaster facetus* (Koehler), 1908

16 (15) Supero-marginal plates largely lateral in position with vertical fascioles between consecutive ones.

17 (18) Marginal plates appearing more or less 'shaggy', bearing flattened spinelets and vertical series of prominent spines directed distally along the arms and often long enough to overlap those of succeeding plates (Circumpolar, north to South Georgia and Bouvet I., 30-3246 m.) . . . . . *Psilaster charcoti* (Koehler), 1906

18 (17) Marginal plates appearing smooth, covered with flattened squamules and some small flattened spines (rarely undeveloped), which may be either appressed and directed dorsally or more or less erect . . . *Bathybiaster loripes* Sladen, 1889

19 (20) Marginal plates not very short, about 70 in each series when R is 100 mm. (Falkland-Magellan area, 198-490 m.; Kerguelen, shallow) . . . . . *B. loripes loripes* Sladen, 1889

20 (19) Marginal plates very short, well over 100 when R is 100 mm. (Circumpolar, north to South Georgia, Bouvet I.; 18-500 m.; Kerguelen, 232 m.) . . . . . *B. loripes obesus* Sladen, 1889

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† *Leptychaster antarcticus* (Sladen) 1889 from between Marion I. and Kerguelen is omitted from this key since even the larger type specimen has R only 15 mm. and the distribution of papulae, shape of the abactinal plates and arrangement of the gonads cannot be ascertained. According to John (1950) it differs from *L. kerguelenensis* in the adambulacral armature, having approximately three rows of about three spines each.

* The main difference between these two species according to Fisher (1940) lies in the relative number of marginal plates. Unfortunately two out of the three types of *L. accrescens* for which Koehler gave counts of these plates, have numbers approximating to those of *L. magnificus* of about the same size, as discussed further under the heading of *L. accrescens*.

Genus Mimastrella Fisher

Mimastrella cognata (Sladen)

Mimaster cognatus Sladen, 1889, 336-338, pl. xlvii, figs. 3, 4, pl. lxii, figs. 4, 5; Ludwig, 1903, 6-9, pl. ii, figs. 11-17; Fisher, 1911, 175.

Mimastrella cognata, Fisher, 1919, 217; Koehler, 1920, 258; Fisher, 1940, 82-83.

This species was not taken by the B.A.N.Z.A.R.E., but having examined the type specimens I can confirm that they too have the same puzzling spinelets that were found in Ludwig's material, which have helped make the systematic position of *Mimastrella* doubtful. Sladen included *Mimaster* (type *M.* [now *Radiaster*] *tizardi*) in a special subfamily of the Pentagonasteridae (approximating to the present Goniasteridae), Perrier (1894) put it in the Archasteridae, Verrill (1899) in the Plutonasteridae (now part of the Astropectinidae) and later (1914) in a special family while Ludwig (1903) put *M. cognatus* in the Astropectinidae. Fisher (1911) noted that *cognatus* is 'in all probability a *Leptychaster*' but in 1916 (Proc. Biol. Soc. Washington, 29) and 1919, he created the genus *Mimastrella* within the family Radiasteridae, to accommodate it. However, in 1940 he reverted to the idea that it is very close to *Leptychaster*, possibly even a subgenus, only the spinelets serving to distinguish it. In the meantime, Koehler (1920) had commented on the great resemblance of the spinelets to those of the Solasteridae, judging from Ludwig's figures.

After studying the types of *M. cognata* I am also in two minds about this. The marginal plates when denuded are seen to be paxilliform, the infero-marginals having a wedge-shaped pedicel, widest and highest at the dorsal end where it is closely associated with the tall, slender, cylindrical pedicel of the corresponding supero-marginal, which slightly exceeds it in diameter. When the spinelet-covering is intact, the two marginals appear to be continuous. The adjacent abactinal paxillae are more numerous and have distinctly more slender pedicels than the supero-marginals. The abactinal spinelets have three or four hyaline points, as in Ludwig's specimens. These spinelets are quite different to any of those found in the Astropectinidae and strongly suggest an affinity with the family Solasteridae of the Spinulosa, but on the other hand, the tapering tube feet with small, rounded, terminal knobs, are typical of the Astropectinidae and related families and are quite unknown in the Spinulosa. The paxilliform supero-marginals could ally it with either *Leptychaster kerguelenensis* of the Astropectinidae or with *Paralophaster* of the Solasteridae.

Type locality. Off southern Chile, 448 and probably 320 metres since 'Challenger' station 303 was a mistake, most likely for 308.

Range. Known from southern Chile and the Bellingshausen Sea in the above depth range.

Genus Leptychaster Smith

Leptychaster Smith, 1876, 110; Fisher, 1940, 79-83. (Type *L. kerguelenensis* Smith)

Leptoptychaster Smith, 1879, 278; Koehler, 1920, 246.

As I interpret the International Code of Zoological Nomenclature, pp. 35-37, article 32, the fact that Smith made an error in his original latinised transliteration of this name does not invalidate *Leptychaster*. As Fisher suggests, the amended spelling *Leptoptychaster* should therefore be discarded in spite of Koehler's use of it.

Leptychaster kerguelenensis kerguelenensis Smith

Leptychaster kerguelenensis Smith, 1876, 110; Fisher, 1940, 83-84.

Archaster excavatus Wyville Thomson, 1876, 72, fig. 10.

Leptoptychaster kerguelenensis Smith, 1879, 278, pl. xvii, fig. 2; Sladen, 1889, 184, pl. xxxi, figs. 1, 2, pl. xxxii, figs. 1, 2. Non Bell, 1905, 242 (which is *Dipsacaster sladeni capensis*) nec Bell, 1908, 9-10 (specimen not traced, 1959, probably *L. magnificus*).

Leptoptychaster kerguelenensis, Studer, 1884, 43; Koehler, 1917, 52, pl. vi, figs. 1, 2, 7, 12; Döderlein, 1928, 300.

Leptychaster kerguelenensis, John, 1950, 56-57; Madsen, 1955, 11.

Banzare localities: Stations 5 (1 specimen), 7 (2 specimens), 13 (1 specimen), 47 (9 specimens), 49 (2 specimens), 50 (2 specimens), 52 (2 specimens), 64 (2 specimens), Jeanne d'Arc (2 specimens), Coll. 282 (1 specimen).

Most of these specimens are of moderate size with R between 20 and 40 mm. Some of them with R/r 3·5/1 or more have very much the appearance of genera of the order Spinulosa in dorsal view, the marginal plates being restricted to the lateral and ventral surfaces while the dorsal side is more or less convex.

Type locality. Observatory Bay, Kerguelen.

Range. Known from Kerguelen and Marion Islands from the shore down to 384 metres.

Leptychaster accrescens (Koehler)

Leptoptychaster accrescens Koehler, 1920, 246-252, pl. lii, fig. 5, pl. liii, figs 1-3; pl. liv, figs. 2-9, pl. lv, fig. 1; pl. lxxiv, fig. 1; 1923, 98, pl. xiii, fig. 3.

Leptychaster accrescens, Fisher, 1940, 85-86.

Banzare localities: Stations 41 (OTL 1 specimen), 90 (3 juvenile specimens probably of this species), 107 (2 specimens).

Fisher has pointed out the very close relationship between *Leptychaster accrescens* and *Priamaster magnificus* Koehler, 1912, also referred by him to this genus. The only apparent differences between them that he could find were that in *L. magnificus* the rays are more arched, the paxillae are slightly larger and the marginal plates are less numerous.

The arching of the rays depends at least partly on the preservation, more massive specimens often having a collapsed appearance. As for the marginal plates, the following table includes the numbers of these in each series in all the larger specimens available to me besides the estimates given by Koehler for three syntypes of *L. accrescens* and one of *L. magnificus*. The specimen from 'Discovery' Winter Quarters is the type of Bell's *Asterias longstaffi* which name Fisher has declared a *nomen nudum*. The four 'Discovery' Investigations specimens from off Bouvet Island are given under the heading of *L. magnificus* although Fisher (who saw only photographs of one of them) recorded them as *L. accrescens*. However, Dr. Dilwyn John of this museum identified them in 1939 as *Priamaster magnificus* before seeing Fisher's 'Discovery' Report and the numbers of their marginal plates are closer to what might be expected in *L. magnificus* although the estimate for the smallest one is intermediate. It should be noted here that my measurements of these four specimens differ somewhat from those quoted by Fisher, particularly for this smallest one (from station 2563) for which he was given 230 mm. for R. This may be partly attributable to inexperience in allowing for distortion of starfishes, by the person concerned.

TABLE 1.

To show R (the major radius) and the average number of marginal plates in each series of some specimens of *Leptychaster accrescens* and *L. magnificus*. The asterisks mark anomalous numbers of marginals.

L. accrescens			*L. magnificus*		
Specimen	R (mm.)	Marginals	Specimen	R (mm.)	Marginals
'Discovery' sta. 148	235	98*	'Discovery' W.Q.	210	84
A.A.E. sta. 7, Syntype	210	105*	Charcot II, no. 575, Type	192	72
Banzare sta. 107	160	110	'Discovery' sta. 599	117	67
'Discovery' sta. 1660	130	94	'Terra Nova' sta. 356	100	58
Banzare sta. 41	120	85			
'Discovery' sta. 42	110	90	'Discovery' sta. 2467	265	115*
A.A.E. sta. 12, Syntype	110	64*	Bouvet I. 2467	260	107*
'Terra Nova' sta. 355	75	69	2467	240	102*
A.A.E. sta. 2, Syntype	60	75	'Discovery' sta. 2563	190	104*
'Terra Nova' sta. 316	48	66			
'Discovery' sta. 140	48	65			

When the values for R and the numbers of marginals are plotted against each other, the points for the first four specimens of *L. magnificus* are well separated from those of most examples of *L. accrescens* which lie within quite a different band. However, three of the specimens of *L. accrescens* including the two larger of the three types for which Koehler gave the numbers of marginals, fall within, or close to, the field of *L. magnificus*, as also do the very large specimens from off Bouvet Island. Unfortunately the data available is insufficient to be conclusive. Should the two prove to be synonymous then *L. magnificus* has priority.

Type locality. Off Queen Mary Land (large syntype at least), 110-201 metres.

Range. Known from the Enderby and Victoria Quadrants, Ross Sea, South Georgia (?Bouvet Island), 110-647 metres.

Genus Bathybiaster Danielssen and Koren

Bathybiaster loripes obesus Sladen

Bathybiaster loripes var. *obesa* Sladen, 1889, 242.

Bathybiaster liouvillei Koehler, 1912, 96-101, pl. vi, figs. 2-4, 12, pl. viii, figs. 5, 6; 1920, 263-266, pl. lxxiii, fig. 1; 1923, 100-101.

Banzare localities: Stations 29 (1 specimen), 90 (1 specimen).

Type locality. Off Cumberland Bay, Kerguelen, 232 metres.

Range. The subspecies *obesus* is known from deeper water off Kerguelen than *loripes*, as well as from the Weddell Quadrant including South Georgia and the Shag Rocks, from Princess Elizabeth Land (72° E.), Adélie Land and the Ross Sea and from Bouvet Island, in 18-500 metres.

Genus Psilaster Sladen

Psilaster charcoti (Koehler)

Ripaster charcoti Koehler, 1906, 4-6, pl. iii, figs. 20, 21, 31, 32; 1908, 540; 1912, 101-102, pl. viii, fig. 2; 1920, 258-259, pl li, fig. 5, pl. lii, fig. 1, pl. lxxii, fig. 1.

Ripaster longispinus Koehler, 1920, 260-262, pl. li, figs. 6-8, pl. lii, figs. 2-4, pl. lxxii, fig. 2; 1923, 95-97, pl. xii, figs. 6-8.

Psilaster charcoti, Fisher, 1940, 93-94; Madsen, 1955, 11; Bernasconi, 1956, 8-9, pl. iii, figs. 3, 4.

Banzare localities: Stations 30 (2 specimens), 40 (1 specimen), 41 (TML 2 specimens), 90 (1 specimen), 107 (2 specimens).

Type locality. Booth-Wandel Island, off Graham Land.

Range. Circumpolar including Bouvet Island (see Fisher, 1940, with the addition of Adelaide Island, off Graham Land and Peter I. Island, Bellingshausen Sea) in 30-3246 metres.

Family LUIDIIDAE

This family includes two subantarctic species neither of which is included in the B.A.N.Z.A.R.E. collection.

Key to the Southern Species

1 (2) Supero-marginal paxillae small and much more numerous than the infero-marginal plates, though corresponding in number to the adjacent lateral paxillae with which they form transverse series (Magellan Strait to Peru, 1-10 m.). *Luidia magellanica* Leipoldt, 1895

2 (1) Supero-marginal paxillae large and corresponding to the infero-marginal plates but not to the lateral paxillae, which outnumber the supero-marginals by about five to three (off southern Chile [c. 47° S.], 110 m.) . *Luidia porteri* A. H. Clark, 1917

Family BENTHOPECTINIDAE

Key to the Southern Species

1 (10) A regular interradial suture between the first marginal plates of each ray.

2 (3) One large conical subambulacral spine on each plate, except the first one which may have two; papularia oval in outline (between Marion Island and the Crozets and from South Africa, 1464 and 2514 m.) *Pectinaster echinatus* (Sladen), 1889†

3 (2) Two or more large subambulacral spines on each plate, except on the first one to three plates which may have only one; papularia bilobed distally, U- or V-shaped.

4 (5) A few proximal abactinal paxillae each with a conspicuous spine at least 2 mm. long; furrow spines few, about three on each plate (near the S. Orkney Islands, 3246 m.) . . . . . *Luidiaster antarcticus* (Koehler), 1908

5 (4) All paxillae with the central spinelet more or less enlarged but never conspicuous in size, not over 1·5 mm. long; 5-9 furrow spines.

6 (7) Pedicellariae absent (in the few specimens known); infero-marginal plates of rays with two or three accessory spines (Patagonia, 351-448 m.) . . . . . *Luidiaster planetus* (Sladen), 1889*

7 (6) Pedicellariae present, particularly on the actinal plates; only one accessory infero-marginal spine, if any.

8 (9) A central spinelet of each paxilla notably enlarged, up to 1·5 mm. long; 7-9 furrow spines on each adambulacral plate; papularia hardly extending on to the rays (Bellingshausen Sea, South Shetland Is., Kemp Land east to the Ross Sea, 160-810 m.). *Luidiaster gerlachei* (Ludwig), 1903

9 (8) Central paxillar spinelets only slightly enlarged, less than 1 mm. long; up to six furrow spines; papularia large and extending on to the rays to about the level of the fourth supero-marginal plates (Kerguelen, South Africa and Bouvet Island, 238-448 m.) . . . . . *Luidiaster hirsutus* Studer, 1883

10 (1) Odd interradial marginal plates present in some or all of the angles or the first marginals more or less asymmetrical in position.

11 (12) Abactinal plates of rays as well as of disc with up to four spinelets; an odd marginal plate of each series usually present in all five angles, the interradial supero-marginals with conspicuous single spines (W. of the Crozet Islands and (?) off S. Africa, 2026 and (?) 3474 m.) . . . . . *Benthopecten pedicifer* (Sladen), 1889

12 (11) Abactinal plates of rays with single spinelets, large specimens (R over 100 mm.) may have several spinelets on some of the disc plates; some or all of the interradial marginals irregular in position and size, rarely odd interradial ones present, (Enderby Land east to Wilhelm II Land, 300-3063 m.) . . . . . *Gaussaster antarcticus* (Sladen), 1889

Genus Luidiaster Studer

Luidiaster gerlachei (Ludwig)

Cheiraster gerlachei Ludwig, 1903, 9-17, pl. i, figs. 1-8, pl. ii, figs. 9, 10.

Luidiaster gerlachei, Ludwig, 1910, 252, 253; Fisher, 1911, 127; Koehler, 1920, 244-245, pl. lv, figs. 2-6, pl. lxv, fig. 8; Fisher,1940, 96-97; Madsen, 1955, 12.

Banzare localities: Station 34 (5 young specimens).

Type locality. Southern Bellingshausen Sea, 450-560 metres.

Range. Known from the Bellingshausen Sea and South Shetlands and from Kemp Land east to the Ross Sea, 160-810 metres.

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†In my opinion, after a study of the type specimens *Pectinaster* (formerly *Pontaster*) *forcipatus* var. *echinata* and *forcipatus* itself (both of Sladen, 1889) are each specifically distinct from the North-east Atlantic *Pectinaster filholi* Perrier, differing from it in the greater number of series of actinal plates and from each other in the proportions of these plates and the density of their spinulation.

*I am referring this species to the genus *Luidiaster* since the large 'Discovery' specimen has been found to have V-shaped papularia unlike the type species of *Pontaster*, *P. tenuispinus* (Düben and Koren). The small type specimens of *planetus* have incipiently bilobed papularia.

Genus Gaussaster Ludwig

Gaussaster antarcticus (Sladen)

Pararchaster antarcticus Sladen, 1889, 11-12.

Gaussaster vanhöffeni Ludwig, 1910, 458; Döderlein, 1928, 298-299, pl. xiv, figs. 1-4.

Benthopecten antarcticus, Ludwig, 1910, 464.

Banzare localities: Stations 39 (2 specimens), 40 (1 specimen).

Unfortunately all three specimens are juvenile, the largest having R only 14 mm. They differ from *Luidiaster gerlachei* of similar size in having single spinelets on the abactinal plates, an example of *L. gerlachei* with R 20 mm. already having circlets of spinelets surrounding an enlarged central one on many of the disc plates.

As for the nomenclature of this species, an examination of the holotype of *Pararchaster antarcticus* Sladen showed that it has odd marginal plates in only two interradii, the other three angles having paired or asymmetrical plates. Döderlein's description of the types of *Gaussaster vanhöffeni* includes no mention of irregularity in the interradial marginals but his fine photographs of four of them show that each has some asymmetry in at least one angle or even an odd interradial plate. These small B.A.N.Z.A.R.E. specimens also show irregularities in the positions of the marginals in some interradii.

The type of *G. antarcticus* was also found to have a rudimentary pectinate pedicellaria between the interradial infero-marginals in each of the three angles where these plates were duplicated. Döderlein found pedicellariae only in the dorsal interradii of the largest of his specimens (R 116 mm.). The holotype of *G. antarcticus* is badly broken but I estimate R to have been about 80 mm.; r is 11·5 mm. There are about a dozen large spines (or denuded convex spine-bearing plates) on the disc, similar in size to those of the specimen of *G. vanhöffeni* with R 53 mm. The arm plates are similarly more spaced with single spinelets. Only the largest specimen of *G. vanhöffeni* has several spinelets on some of the disc plates. The present small specimens have no large disc spines but some of the plates are enlarged and swollen as in the smallest specimen of *G. vanhöffeni* (R 19 mm.).

There are two minor differences between Sladen's type of *G. antarcticus* and Döderlein's description of *G. vanhöffeni*. Firstly the former has five furrow spines as opposed to four and secondly there are 19 or 20 adambulacral plates corresponding to the first ten infero-marginals rather than 17 as Döderlein gives. Probably neither difference is significant and I have little hesitation in referring *Parachaster antarcticus* to the genus *Gaussaster* and in declaring *G. vanhöffeni* to be synonymous with it.

This species is linked with those of *Benthopecten* by the flat, scale-like abactinal plates but the irregular interradial marginals serve to mark it off from that genus. In the same way the North Pacific genus *Nearchaster* is distinguished from *Myoraster* and *Benthopecten* on the one hand and from *Luidiaster* on the other by the irregular positions of some or all of the interradial marginals, so that it seems best to retain the genus *Gaussaster* for species with flat abactinal plates like *Benthopecten* but irregular interradial marginal plates. *Nearchaster* is distinguished from *Gaussaster* by the tabulate form of the primary abactinal plates.

Type locality. Off Princess Elizabeth Land ("Challenger" station 153), 3063 metres.

Range. Known from Enderby Land east to Wilhelm II Land, 300-3063 metres.

Family ODONTASTERIDAE

Key to the Southern Species

1 (2. A pair of equal, recurved spines at each oral angle, one on each plate.
Magellan area, north in Chile to 20° S., 0-80 m. . . . . *Asterodon singularis* (Müller & Troschel), 1843
Auckland Is., littoral . . . . . *Asterodon robustus* Fell, 1952

2 (1) A single, large recurved spine at each oral angle between the two plates, sometimes with an enlarged accessory spine (or two) on each side.

3 (10) Abactinal plates with a distinct tabulum crowned with short to fairly long spinelets; marginal plates more or less tabulate, with short spinelets or elongate granules; actinal plates spinulose . . . . . *Odontaster* Verrill, 1880

4 (7) Marginal plates large, always forming a prominent border in dorsal view, appearance more or less pentagonasteroid; dorsal side flat or slightly convex.

5 (6) Lateral faces of marginals with blunt spinelets, several times as long as broad (NW. from Bouvet Island, 3118 m.).
Odontaster pusillus Koehler, 1908

6 (5) Marginal plates with short, usually granuliform spinelets, hardly, if at all, longer than wide (Patagonia, Falkland Plateau, 8-350 m.) . . . . . *Odontaster penicillatus* (Philippi), 1870

7 (4) Marginal plates not conspicuous in dorsal view, the interradial ones entirely lateral in position, the dorsal side being more or less markedly convex,

8 (9) Radial paxillae with 20-30 spinelets, the middle ones markedly clavate; actinal plates also with numerous radiating spines, up to about 15, the central ones more clavate than the peripheral (Antarctic, circumpolar, including South Georgia, Marion Island and Kerguelen, 0-646 m.) . . . . . *Odontaster meridionalis* (Smith), 1876

9 (8) Radial paxillae with about a dozen spinelets, the middle ones not very clavate; actinal plates with up to seven similar, slender, distally directed spinelets, the outer plates with only one to three (Antarctic, circumpolar, including South Georgia and Bouvet Island, 0-653 m.) . . . . . *Odontaster validus* Koehler, 1906

10 (3) Abactinal plates not tabulate but sometimes slightly convex, bearing low granules; marginal plates not tabulate; actinal plates with granules which may become elongated towards the mouth . . . . . *Acodontaster* Verrill, 1899

11 (12) Abactinal granules very rugose on the dorsal surface, often with a prominent thorn or spike in the middle (fig. 1i) (Bellingshausen Sea, Queen Mary and Adélie Lands, 201-647 m.) . . . . . *Acodontaster cremeus* (Ludwig), 1903

12 (11) Abactinal granules smooth or rugose only round the edges and flat on top (fig. 1a-h).

13 (18) Margin moderately thick and rounded, the marginal plates largely lateral in position.

14 (15) Abactinal granules large (about 0·75 mm. high when R is 60-70 mm.) usually spaced uniformly, concealing the limits of the plates; rays attenuate, R/r 3·0-3·5/1 (Bellingshausen Sea, Enderby Land to the Ross Sea, 193-647 m.). *Acodontaster capitatus* (Koehler), 1912

15 (14) Abactinal granules smaller (less than 0·5 mm. high when R is 70 mm.), grouped together corresponding to the underlying plates; rays usually triangular, R/r rarely exceeding 3·0/1 . . . . . *Acodontaster elongatus* (Sladen), 1889

16 (17) Rays short, the extreme form (*ceramoideus*) almost pentagonal, R/r less than 2·3/1 (Falkland-Magellan area, 50-336[?841]m.). *A. elongatus granuliferus* Koehler, 1912

17 (16) Rays moderate to long, R/r 2·5/1 or more (Kerguelen, Heard and Marion Islands, South Georgia, South Shetlands, Palmer Archipelago, 91-600 m.) . . . . . *A. elongatus elongatus* (Sladen), 1889

18 (13) Margin thin and relatively sharp, especially in large specimens (R c. 70 mm.); marginal plates small and mainly horizontal in position.

19 (20) Most of the proximal infero-marginal plates with a central granule enlarged into a short, laterally-projecting spine; large specimens (R c. 85 mm.) also with a prominent central spine on each proximal actinal plate (off Graham Land, 250 m. and ? off Queen Mary Land, 291 m.) . . . . . *Acodontaster marginatus* (Koehler), 1912

20 (19) No spines or projecting granules on the infero-marginal plates though pedicellariae may be present.

21 (24) Pedicellariae, if present, then only on the actinal plates and conical or spiniform in shape (very rarely granuliform ones are found on the abactinal side); always one (or two) suboral spines thickened and more or less elongated on each side of the primary oral spine . . . . . *Acodontaster hodgsoni* (Bell), 1908

22 (23) A pair of accessory oral spines usually well developed with hyaline tips breaking the skin and directed distally and more or less horizontally; rays more or less well developed, attenuate or triangular, R/r 2·5-3·3/1 (though when R is less than 25 mm. they may be relatively shorter) (Kemp Land eastwards to the Ross Sea, South Georgia [Shag Rocks ?], 4-457 m.). forma *hodgsoni* (Bell), 1908

23 (22) One or two pairs of accessory oral spines enlarged but little bigger than the subambulacral spines and vertical in alignment, tips not breaking the skin; rays short and triangular with acute tips, R/r about 2·2/1 (Kemp Land east to Queen Mary Land, 193-540 m.) . . . . . forma *stellatus* (Koehler), 1920

24 (21) Conspicuous large, low, granuliform pedicellariae nearly always present either on the proximal actinal plates or on the more distal actinal, the abactinal and often also the marginal plates; all the suboral spines small and similar in size to the subambulacral ones.

25 (26) Proximal actinal pedicellariae conical and projecting, though the distal ones may be granuliform; no adambulacral pedicellariae; abactinal and also marginal pedicellariae usually present; oral spine large or small but usually with the hyaline tip projecting through the skin (off Queen Mary and Adélie Lands, Ross Sea, Graham Land, South Georgia [Falkland Plateau?], 46-647 m.) . . . . . *Acodontaster conspicuus* (Koehler), 1912

26 (25) Proximal actinal pedicellariae low, granuliform; proximal adambulacral pedicellariae sometimes present; abactinal pedicellariae not known; oral spine always inconspicuous, the skin still covering the tip (Adélie Land west to MacRobertson Land, Palmer Archipelago, 160-647 m.) . . . . . *Acodontaster waitei* (Koehler), 1920

Genus Odontaster Verrill

Odontaster meridionalis (Smith)

Astrogonium meridionale Smith, 1876, 109.

Pentagonaster meridionalis, Smith, 1879, 276, pl. xvi, figs. 6, 6a; Studer, 1884, 33.

Gnathaster meridionalis, Sladen, 1889, 287-288, pl. xlvii, figs. 1, 2, pl. xlviii, figs. 5, 6, pl. xlix, figs. 11, 12.

Odontaster elegans Koehler, 1912, 72-77, pl. vii, figs. 5-11.

Gnathaster elegans, Koehler, 1920, 227-228, pl. xli, figs. 7, 8, pl. lxxi, fig. 4; 1923, 85-86; Döderlein, 1928, 297.

Epidontaster pentagonalis Koehler, 1920, 235-236, pl. xxxix, figs. 3, 4, 8, pl. xli, figs. 9-11, pl. lxxi, fig. 3.

Odontaster meridionalis, Fisher, 1940, 99-101. Non *O. meridionalis*, Leipoldt, 1895, 620, which is *O. penicillatus* according to Fisher.

Banzare locality: Station 64 (two specimens).

Type locality. Observatory Bay (at the head of Royal Sound), Kerguelen.

Range. Antarctic, circumpolar (see Fisher, 1940), north to South Georgia, Marion Island and Kerguelen, 0-646 metres.

Odontaster validus Koehler

Odontaster validus Koehler, 1906, 6-8, pl. iii, figs. 22-26; 1908, 540; 1911, 27; 1912, 68-72, pl. vii, figs. 1-4, 12; Fisher, 1940, 101-104; Madsen, 1955, 12; Bernasconi, 1956, 9-10, pl. iv, figs. 3, 4.

Odontaster tenuis Koehler, 1906, 8-10, pl. iv, figs. 33-38; 1920, 232-234, pl. xl, figs. 1-3, 6, pl. xli, figs. 3, 4, pl. lxxii, fig. 4.

Cycethra verrucosa, Bell, 1908, 10, pl. v, fig. 1; 1917, 4, pl. i, figs. 1-6. Non *C. verrucosa* (Philippi), 1857, which is valid.

Gnathaster validus, Koehler, 1920, 228-232, pl. xxxiv, fig. 10, pl. xl, figs, 4, 5, 7, pl. xli, figs. 2, 5, pl. lxxii, fig. 3; 1923, 84-85.

BANZARE LOCALITIES: Station 106 (two specimens, forma *tenuis* Koehler.); MacRobertson Land, February 18th, 1931 (one damaged specimen probably of this species).

COLOUR NOTE. Magenta dorsally.

TYPE LOCALITY. Antwerp Island, Palmer Archipelago.

RANGE. Antarctic, circumpolar, north to South Georgia and Bouvet Island (but not recorded from Kerguelen), 0-653 metres.

Genus ACODONTASTER Verrill

Gnathaster (part), Sladen, 1889, 285.

Acodontaster Verrill, 1899, 204; Fisher, 1940, 109 (Type *Gnathaster elongatus* Sladen).

Heuresaster Bell, 1908, 8 (Type *H. hodgsoni* Bell).

Pseudontaster Koehler, 1912, 85 (Type *P. marginatus* Koehler).

Odontaster (part), Koehler, 1912 (et al.).

Metadontaster Koehler, 1920, 191, 193 (Type *M. waitei* Koehler).

Tridontaster Koehler, 1920, 191, 193 (Type *T. laseroni* Koehler).

This formidable synonymy was drawn up by Fisher (1940) who considered the species of Koehler's three genera and of *Heuresaster* Bell to be congeneric with *Acodontaster elongatus* (Sladen). I fully agree with this and indeed find great difficulty in separating some of the species involved. Koehler based his genera on the development of the large oral spines, whether or not their tips are hyaline, the occurrence of enlarged accessory oral spines and the relative thickness of the margin of the body. Fisher pointed out that the armature of the oral plates may vary in *Odontaster*, some specimens having the primary spines better developed or even accessory spines present. He also considered that the thickness of the margin is of small importance and does not constitute a generic distinction.

Eleven nominal species have been described or included under the above generic names but Fisher believed only five of these to be valid and made the others synonyms or reduced them to infraspecific ranks. Since my observations of the B.A.N.Z.A.R.E. and British Museum material lead me to differ from Fisher in the disposition of some of these names I repeat here his table showing the interpretations of Koehler (1920 and 1923) and himself with my own conclusions alongside.

TABLE 2

Koehler	Fisher	A. M. Clark
Acodontaster elongatus (Sladen), 1889	*A. elongatus*	Valid
A. cremeus (Ludwig), 1903	synonym of *elongatus*	Possibly valid
A. capitatus (Koehler), 1912	forma of *elongatus*	Valid as species
A. granuliferus Koehler, 1912	subsp. of *elongatus*	subsp. of *elongatus*
Pseudontaster marginatus Koehler, 1912	*A. marginatus*	Valid
P. stellatus Koehler, 1920	synonym of *elongatus*	forma of *hodgsoni*
P. conspicuus Koehler, 1920	*A. conspicuus*	Valid
P. moderatus Koehler, 1923	synonym of *elongatus*	synonym of *hodgsoni*
Tridontaster laseroni Koehler, 1920	synonym of *hodgsoni*	synonym of *hodgsoni*
Metadontaster waitei Koehler, 1920	*A. waitei*	Valid
	A. hodgsoni	Valid

Some of my conclusions are based partly on microscopical examination of the abactinal granules. The B.A.N.Z.A.R.E. collection includes three specimens referable to *A. capitatus* and there are several others in the British Museum from the Ross Sea which also belong to it. All these have the abactinal granules of a slightly different shape and distinctly larger than in specimens of *A. elongatus* from the Kerguelen area and the Weddell Quadrant of the Antarctic taken by the 'Challenger' and 'Discovery'. There is also a tendency for these granules to be uniformly distributed unlike those of *A. elongatus*. Finally the rays are much more attenuate in shape in all the examples of *A. capitatus* than in most of those of *A. elongatus*.

As for *A. cremeus* (Ludwig), Koehler's photographs (1920) of the abactinal granules show that these have a very distinctive spiky form quite unlike the relatively smooth granules of both *A. elongatus* and *A. capitatus*. Unfortunately, the known specimens of *A. cremeus* are all small with R up to only 23 mm., whereas some species of *Acodontaster* may attain a size of 200 mm. major radius.

Fisher referred two other species to the synonymy of *A. elongatus*, namely *Pseudontaster stellatus* and *P. moderatus*, both of them known only from unique type specimens. I believe that they are more closely related to *A. hodgsoni* than to *A. elongatus*, since the marginal plates are much more diminutive than in any example of *A. elongatus* that I have seen. The four other species which Koehler referred to his genera *Pseudontaster*, *Tridontaster* and *Metadontaster* are also very difficult to separate from Bell's *Heuresaster hodgsoni*. Koehler used as specific characters the proportions of the rays, height of the disc, development of the accessory oral spines,

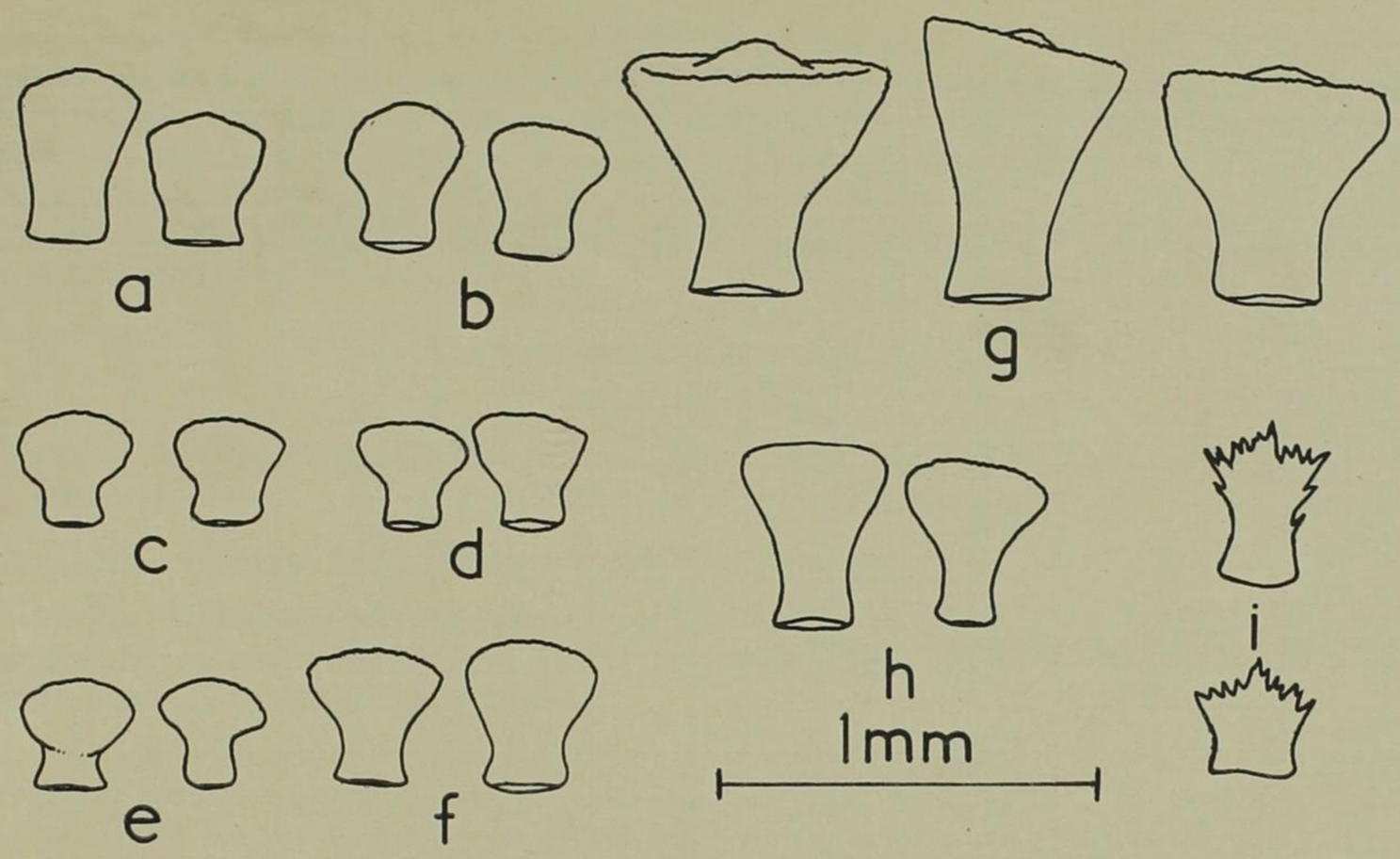


Fig. 1. *Acodontaster* spp. Proximal abactinal granules, a, to f, *A. elongatus*, a, syntype with R 75 mm., b, syntype with R 67 mm., both from 'Challenger' station 149H, off Christmas Harbour, Kerguelen, c, syntype with R 52 mm. from station 151, Heard I., d, R 40 mm. from Banzare station 47, e, R 48 mm. from 'Discovery' station 1564, off Marion I., f, R 65 mm. from 'Discovery' station 181, Palmer Archipelago; g, and h, *A. capitatus*, g, R 63 mm. from 'Discovery' Winter Quarters, McMurdo Sound, h, R 40 mm. (left) and 30 mm. (right) from Banzare station 107; i, *A. cremeus*, traced from Koehler, 1920, pl. 69, fig. 3, the magnification being approximately 1·3 x that of the other figures.

shape and distribution of the pedicellariae and distinctness of the abactinal plates. Although he characterized the genus *Metadontaster* and the species *M. waitei* by the reduced primary oral spine, he thought that in *A. conspicuus* the relative size of this spine is too variable to be of significance. However, Fisher believed a large spine *is* characteristic of *A. conspicuus* and a small one of *A. waitei*, but I have found exceptions to this among the 'Terra Nova' specimens which I am referring to *A. conspicuus*. From Koehler's photographs I conclude that his paratype of *A. conspicuus* from Adélie Land with R 60 mm. (specimen C) is referable not to *A. conspicuus* but to *A. waitei*, since not only are its oral spines small but also, and more significantly, the proximal actinal pedicellariae are flat, not conical.

None of the specimens attributed by Koehler and Fisher to *A. conspicuus* and *A. waitei* have any trace of accessory oral spines and five 'Terra Nova' specimens, named *Heuresaster hodgsoni* by Bell, similarly lack specialized suboral spines. Examinations showed that, in all the latter, some granuliform abactinal pedicellariae are present, though in the smaller of two specimens from station 316 (R 34 mm.) and in another from station 340 (R 45 mm.) these pedicellariae are few and poorly developed. Despite the absence of marginal pedicellariae, such as were found in the 'Discovery' examples of *A. conspicuus*, I am referring these Ross Sea specimens to that species. Except that none of them have the primary oral spines very prominent, there is a great similarity, especially of the larger ones, to Koehler's large type of *A. conspicuus*.

Fisher has shown that the proportions of the rays are variable in some species of this family, notably the subantarctic *Odontaster penicillatus* and *Acodontaster elongatus granuliferus*. Table 3, derived from published data or from specimens examined by me, shows that there is considerable variation in the R/r ratio in specimens belonging to this part of the genus *Acodontaster*. The ratio varies from 2·0 to 3·6/1 but only seems to exceed 3·0/1 when R is over 100 mm. If R is plotted against r, the values up to this size fall within a narrow band, the mean of which is almost a straight line, but above R 100 mm. the slope steepens, indicating that the rays become proportionally longer.

Among the lowest values for specimens larger than R 20 mm. are those of the type specimen of *Pseudontaster stellatus* and the two B.A.N.Z.A.R.E. specimens which I am calling *Acodontaster hodgsoni* forma *stellatus*. All three have the ratio only 2·1-2·2/1. Except for a few specimens of *A. conspicuus*, all the rest have ratios of 2·5/1 or more.

Also shown in table 3 are the numbers of marginal plates in each series where this can be counted or has been noted, although so far, no special significance in this factor has been found in *Acodontaster*.

Fisher has discounted the relative height of the disc as a distinctive character on the grounds that it depends largely on the preservation.

Koehler believed the development of accessory oral spines to be characteristic of *Tridontaster laseroni* but it also occurs in *A. hodgsoni*, of which species Koehler appears to have been ignorant, possibly as Bell referred

TABLE 3

Details of some specimens of *Acodontaster conspicuus*, *A. waitei*, *A. hodgsoni*, and *A. hodgsoni* forma *stellatus*.

Species & Station	R (mm.)	r (mm.)	R/r	Number of marginals	Oral spines*	Pedicellariae†		
						Dorsal	Marginal	Actinal
A. conspicuus								
Swedish Ant. E. sta. 5	120	c.54	c.2·2	—	1 m.	+	+	+ con.
Type A.A.E. sta. 1 (B)	100	c.38	c.2·6	52	1 b.	+	+	+ con.
Terra Nova sta. 316	85	35	2·4	42	1 s.	+	—	+ con.
Terra Nova sta. 356	85	35	2·4	44	1 s.	+	—	+ con.
A.A.E. Adélie (C)	60	20	3·0	—	1 m.	(+)	—	+ gr.
Discovery sta. 123	50	19	2·6	33	1 m.	+	+	+ con.
Discovery sta. 148	47	18	2·6	40	1 m.	+	+	+ con.
Terra Nova sta. 340	45	18	2·5	37	1 s.	(+)	—	+ con.
A.A.E. sta. 12 (G)	38	11	3·45	—	1 m.	—	—	—
Discovery sta. 42	36	15	2·4	c.41	1 m.	+	+	(+) con.
Terra Nova sta. 316	34	12	2·8	c.36	1 s.	(+)	—	(+) con.
Terra Nova sta. 338	28	10	2·8	c.30	1 m.	+	—	+ con.
A.A.E. sta. 3 (F)	11	5·5	2·0	—	1—	+	+	—
A. waitei								
A.A.E. Adélie (A)	180	50	3·6	—	—	—	—	+ gr.
Type. A.A.E. sta. 1 (B)	145	41	3·5	57	1 s.	—	—	+ gr.
Banzare sta. 107	120	c.45	c.2·7	c.41	1 s.	—	—	+ gr.
Banzare sta. 107	120	45	2·7	50	1 s.	—	—	+ gr.
Banzare sta. 107	c.110	40	c.2·75	43	1 s.	—	—	+ gr.
Banzare sta. 107	95	32	3·0	44	1 s.	—	—	+ gr.
Banzare sta. 107	85	30	2·8	37	1 s.	—	—	+ gr.
Discovery sta. 181	75	29	2·6	37	1 s.	—	+	+ gr.
A.A.E. sta. 12 (C)	58	21	2·8	—	1 s.	—	—	(+)
Banzare sta. 107	38	15	2·5	31	1 s.	—	—	+ gr.
Banzare sta. 107	25	9	2·8	25	1 s.	—	—	+ gr.
A. hodgsoni								
Syntype. Discovery W.Q.	200	60	3·3	—	3	—	—	+ con.
Banzare sta. 41	150	45	3·3	c.56	$1^2/_2$	—	—	—
Syntype. Discovery W.Q.	140	45	3·1	c.54	3	—	—	—
Terra Nova sta. 316	90	32	2·8	c.40	3	—	—	(+) con.
Banzare sta. 107	c.90	c.35	c.2·6	c.48	3	—	—	—
Syntype. Discovery W.Q.	85	28	3·0	c.53	3	+	—	+ con.
Discovery sta. 42	80	30	2·7	33	$1^4/_2$	—	—	(+) con.
Terra Nova sta. 338	70	27	2·6	c.44	$1^2/_3$	—	—	—
Terra Nova sta. 338	70	25	2·8	40	3	—	—	—
T. laseroni Type. A.A.E. sta. 12	60	23	2·6	47	3	—	—	+ con.
Banzare sta 105	57	21	2·7	—	3	—	—	—
Banzare sta. 105	50	20	2·5	c.38	3	—	—	(+) con.
A.A.E. sta. 12 (*laseroni*)	50	18	2·8	—	3	—	—	+ con.
Banzare sta. 105	45	16	2·8	—	3	—	—	—
Banzare sta. 105	37	13	2·8	c.34	$1^2/_2$	—	—	—
Terra Nova sta. 338	30	12	2·5	c.25	3	—	—	—
Banzare sta. 105	16	7	2·3	—	$1^2/_2$	—	—	—
P. moderatus Type. S.A.E. sta. 17	66	23	2·9	—	$1^4/_2$	—	—	(+) con.
A. hodgsoni forma *stellatus*								
Type. A.A.E. sta. 12	56	25	2·2	34	$1^4/_2$	—	—	+ con.
Banzare sta. 30	42	19	2·2	31	$1^4/_2$	—	—	(+) con.
Banzare sta. 41	42	20	2·1	32	$1^4/_2$	—	—	+ con.

* 'b' signifies big, 'm' moderate and 's' small (for example the length of the spine is 7 mm. in the type specimen of *conspicuus* and 'hardly over 3 mm.' in that of *waitei*). The number of oral spines is given as 3 when the accessory spines are well developed and more horizontal than vertical, $1^2/_2$ when they are distinctly enlarged but vertical, $1^4/_2$ when two accessory spines are enlarged on each side of the primary one or $1^2/_3$ when the accessory spines are barely larger than the other suboral spines.

† '(+)' signifies that pedicellariae are present but few in number or indistinct; 'gr.' that the proximal actinal ones are flat and granuliform and 'con'. that they are more or less spiniform and conical.

Heuresaster to the family Poraniidae. In addition, the holotypes *Pseudontaster stellatus* and *P. moderatus* have one or two distinctly enlarged suboral spines on each side of the primary one; however, these are not directed distally, nor do their tips project through their skin-covering. Koehler did not illustrate the dorsal view of *P. moderatus* but its ventral aspect and his description are very like those of some specimens of *A. hodgsoni*. *P. stellatus*, though resembling specimens of *A. hodgsoni* with coarser abactinal granulation and the accessory oral spines less well-developed, appears to be distinguished by the shorter rays. Since the B.A.N.Z.A.R.E. collection has yielded two specimens very similar to the holotype of *P. stellatus* and at the same time distinct from *A. hodgsoni*, I am unable simply to consider *stellatus* a synonym but propose the retention of the name for the short-rayed forma of *A. hodgsoni*.

A number of the species now included in *Acodontaster* are sympatric. Koehler recorded several of them from A.A.E. station 12 off Queen Mary Land, namely *A. conspicuus*, *A. waitei*, *A. hodgsoni*, *A. hodgsoni* forma *stellatus* and *A. cremeus*. From station 1 he recorded *A. conspicuus*, *A. waitei*, *A. cremeus* and *A. capitatus*. The 'Discovery' took both *A. conspicuus* and *A. hodgsoni* at station 42, while B.A.N.Z.A.R.E. stations 41 and 105 both produced *A. capitatus* and *A. hodgsoni* (41 also *A. hodgsoni* forma *stellatus*) and station 107 yielded *A. waitei* in addition to these two.

In a comparison of the three species *A. conspicuus*, *A. hodgsoni* and *A. waitei*, the intermediate one is *A. conspicuus*. It resembles *A. hodgsoni* in the body form, proportions and armature of the plates with the exceptions of the absence of enlarged accessory oral spines and the presence of specialized abactinal (often also marginal) pedicellariae. *A. waitei* seems to have diverged from *A. conspicuus* in the opposite direction from *A. hodgsoni*, having the specialized pedicellariae extending on to the proximal actinal plates though they are lost dorsally and marginally. The relationship between *A. conspicuus* and *A. hodgsoni* is discussed further under the heading of the latter species.

Acodontaster elongatus (Sladen)

text fig. 1, a-f.

Gnathaster elongatus Sladen, 1889, 288-292, pl. xix, figs. 5, 6, pl. xlviii, figs. 1-4, pl. xlix, figs. 5-10.

Acodontaster elongatus, Verrill, 1899, 204; Fisher, 1940, 109-110; Madsen, 1955, 12.

Banzare localities: Stations 47 (2 specimens), 64 (8 specimens).

As explained in the discussion of this genus, I am doubtful whether *Odontaster cremeus* Ludwig, *Pseudontaster stellatus* Koehler and *P. moderatus* Koehler can be reduced to the synonymy of *elongatus* as Fisher has done, on the evidence of the material so far recorded.

Type locality. Sladen described *A. elongatus* from a specimen with R/r 56 mm./16·5 mm., with a reference to a second specimen presumably from the same station, with R 62 mm. He listed four 'Challenger' stations as the source of his material, namely 145 (Marion Island), 149 H (off Cumberland Bay, Kerguelen), 150 (between Kerguelen and Heard Islands) and 151 (off Heard Island) but following the description and under the headings 'Young Phase' and 'Variations' he commented on one small and 'some' large specimens from Christmas Harbour, Kerguelen.

The British Museum collection includes one specimen each from stations 145 and 151 which are respectively a young one and the 'attenuate variety', the latter figured in Sladen's plate xlviii, figs. 3 and 4. No material from station 150 is now to be found although a registration number was allotted to it in the copy of the 'Challenger' Asteroid report belonging to the Echinoderm Section of the British Museum. The only other specimens present are one juvenile and three large ones labelled as from 'Christmas Harbour, 120 fathoms'. I think Christmas Harbour must be synonymous with close-by Cumberland Bay despite the disparity of seven fathoms in the depths, that of station 149 H being given as 127 fathoms. This is supported by the fact that these specimens bear the registration number written in the report alongside station 149 H and the date on the original label is the same for Cumberland Bay. The three large specimens have R about 68 mm., 72 mm. and 73 mm. and all of them resemble Sladen's figures 1 and 2 of plate xlviii. Possibly the specimen described by Sladen was from station 150 but in the absence of any material from that station it may be best to accept Christmas Harbour, Kerguelen, as the type locality and the specimen with R 68 mm. as the type. This has about 29 supero-marginal plates in each series, 30 being given in the description; otherwise it only differs in having very few actinal pedicellariae.

Range. Known from Kerguelen, Marion and Heard Islands and from the Palmer Archipelago in 91 to 600 metres; the subspecies *granuliferus* from Patagonia and the Falkland Islands in 50 to 336 (841) metres.

Acodontaster capitatus (Koehler)

fig. 1 g,h.

Odontaster capitatus Koehler, 1912, 82-85, pl. vi, figs. 5, 8, 9, 11.

Acodontaster capitatus, Koehler, 1920, 195-199, pl. xliv, figs. 1-10, pl. xlv, figs. 5, 6, pl. lxix, figs. 1, 2.

Acodontaster elongatus forma *capitatus*, Fisher, 1940, 99, 110.

Banzare localities: Stations 41 (TML 1 specimen), 105 (1 specimen), 107 (2 specimens).

Although Fisher considered *A. capitatus* to be only a forma of *A. elongatus* I believe that it is a well-marked species and have referred to it these four B.A.N.Z.A.R.E. specimens and two others from the Ross Sea besides the one from 'Discovery' Winter Quarters in McMurdo Sound which Fisher named forma *capitatus*. These I compared with the 'Challenger' and later 'Discovery' specimens of *A. elongatus*.

In the B.A.N.Z.A.R.E. and Ross Sea specimens the rays are distinctly more attenuate than in any specimen of *A. elongatus*, the tapering being abrupt proximally and then more gradual, whereas in *A. elongatus* the rays taper fairly evenly from base to tip so that their shape is more nearly triangular.

Secondly, in *A. capitatus* there is a tendency for irregular arrangement of the abactinal and marginal granules (or short spinelets according to Koehler's terminology). This usually results in a uniform covering so that the limits of the underlying plates are concealed, but in one specimen from station 107 the radial areas are preserved in a slightly distended condition as a result of which the granules of each plate are separated from those of neighbouring plates. This separation is even more marked in the specimen from McMurdo Sound seen

by Fisher which, like the specimens of *A. elongatus* from the Kerguelen area and Weddell Quadrant, has the granules in distinct groups and the limits of the supero-marginal plates also distinct, in contrast to most specimens of *A. capitatus*.

Finally, there is a difference in the proportions, and to some extent in the shape of the abactinal granules. In *A. elongatus* these are squat and usually mushroom-shaped in side view, with a stalk narrowing to a waist and the head more or less expanded and varying from rounded to acute at the edges (fig. 1 a-f). In *A. capitatus* the shape is more elongated with the head like an inverted cone flaring evenly from the waist to an acute angle with the dorsal surface. Sometimes, in both species, the dorsal surface of the granule may have the shape of a low cone but in *A. capitatus* this may be surrounded with a distinct rim (fig. 1 g).

The maximum heights of the proximal midradial granules in some of the specimens available are given in Table 4.

TABLE 4

Species and Station	R (mm.)	r (mm.)	R/r	Maximum granule height (mm.)
Acodontaster elongatus				
Christmas Harbour, Kerguelen, paratype	72	24	2·9	0·43
Christmas Harbour, Kerguelen, lectotype	68	23	2·9	0·36
Discovery sta. 181, Palmer Archipelago	65	23	2·8	0·33
Banzare sta. 47, Kerguelen	53	17	3·1	0·28
Challenger sta. 151, Heard Island, paratype	52	16	3·2	0·28
Discovery sta. 1564, Marion Island	48	18	2·7	0·28
Acodontaster capitatus				
Terra Nova sta. 338, Ross Sea	70	20	3·5	0·76
Discovery, Winter Quarters, McMurdo Sound	63	18	3·5	0·76
Banzare sta. 107, MacRobertson Land	40	12·5	3·2	0·48
Banzare sta. 107, MacRobertson Land	30	9·5	3·2	0·46
Banzare sta. 105, MacRobertson Land	18	5	3·6	0·40
Terra Nova sta. 316, McMurdo Sound	15	4·5	3·3	0·40

It can be seen that the granules are almost twice as high in specimens of *A. capitatus* as in those of *A. elongatus* of similar size. This difference, together with the attenuate rays and the usually irregular arrangement of the granules themselves, prompts me to restore *A. capitatus* to specific rank.

As for the relationship between *A. capitatus* and *A. cremeus*, Koehler distinguished them by the longer rays and more capitate abactinal spinelets (or granules) of the former. The type specimens of both were similar in size, that of *A. cremeus* having R 18·5 mm. and R/r 2·3/1, while the type of *A. capitatus* had R 20 mm. and R/r 3·3/1. The additional specimens named *A. cremeus* by Koehler in 1920 had R 14-23 mm. and R/r 2·3, 2·6 and 3·0/1, while those he named *A. capitatus* at the same time had R 17-55 mm. and a higher R/r ratio, 3·0-4·0/1. In the three larger B.A.N.Z.A.R.E. specimens of *A. capitatus* R/r is 3·1-3·2/1 though the smallest one has the ratio 3·6/1. The distinction of relative arm length thus holds good in most cases so far observed but since both species may have the intermediate ratio of 3·0/1, this character alone is insufficient to distinguish between them. However, in addition there is a difference in the shape of the rays, these being more evenly tapering and triangular in *A. cremeus* than in *A. capitatus*. Finally there is a striking difference in the microscopical structure of the abactinal granules, which have a very distinctive spiky form in *A. cremeus* (fig. 1, i) as opposed to the nearly smooth granules of *A. capitatus* and *A. elongatus*.

TYPE LOCALITY. Marguerite Bay, Graham Land, 254 metres.

RANGE. Known from the Bellingshausen Sea and from Enderby Land eastwards to the Ross Sea in 193 to 647 metres.

ACODONTASTER HODGSONI (Bell)

Heuresaster hodgsoni Bell, 1908, 8-9, pl. iii; 1917, 4.

Tridontaster laseroni Koehler, 1920, 214-219, pl. xlvii, figs. 7-10, pl. xlviii, figs. 1-7, pl. lxix, fig. 5.

Pseudontaster stellatus Koehler, 1920, 210-214, pl. 1, figs. 1-7, pl. lxx, fig. 2.

Pseudontaster moderatus Koehler, 1923, 89-94, pl. xi, figs. 6, 7.

Acodontaster hodgsoni, Fisher, 1940, 115.

BANZARE LOCALITIES: Stations 41 (TML 1 specimen), 105 (5 specimens), 107 (1 specimen).

Some comments on the synonymy of *A. hodgsoni* are given in the discussion of the genus *Acodontaster*.

This species exhibits a number of variable characters; the abactinal plates may be quite flat or more or less convex; their granulation may be fine, the granules just visible with the naked eye, or coarse and easily visible; it may form a continuous covering concealing the outlines of the plates or else there may be a distinct grouping corresponding to the plates; the proportions of the rays vary with R/r from 2·5-3·3/1 in specimens of

forma *hodgsoni* with R over 25 mm., while forma *stellatus* has the ratio about 2·2/1; the rays also vary in shape from attenuate to triangular, at the same time the interbrachial arcs may be rounded or distinctly angular; finally the degree of enlargement of the accessory oral spines is variable, these being usually about half the size of the main oral spine and similarly distally-directed with hyaline tips, but in some specimens they are hardly longer, though distinctly thicker, than the other suboral and subambulacral spines and have the skin still covering their tips.

Variations in the convexity of the abactinal plates and the coarseness of their granulation are not limited to *A. hodgsoni* but are also found in *A. conspicuus*. In fact there is a close relationship between these two species which are distinguished only by the complete absence of enlarged accessory oral spines in *A. conspicuus* coupled with the presence of granuliform abactinal (often also marginal) pedicellariae. Since these pedicellariae are sometimes absent in *A. conspicuus* (Koehler's variety *inarmata*) and, according to Fisher, the development of accessory oral spines is somewhat variable in this family, these distinctions may not always hold good. This is exemplified in the smallest syntype (R 85 mm.) of *A. hodgsoni* which has some granuliform pedicellariae but at the same time has well developed accessory oral spines. It is, however, the only such anomalous specimen I have seen.

At first, from observation of the five specimens from B.A.N.Z.A.R.E. station 105, I thought it possible to distinguish as *A. laseroni* specimens with the limits of the abactinal plates distinct, the granules coarse, the interbrachial arcs rounded and the rays more attenuate, in contrast to those of *hodgsoni*, which have uniform fine granulation concealing the plates, triangular rays and angular interbrachial arcs. But, after examination of all the available material, I found that these differences are not always correlated. Moreover, Koehler's types of *Triodontaster laseroni* show some variation, the paratype (C) having more distinct and convex plates than the holotype (B) though both have fine granules.

In the specimen with R 50 mm. from B.A.N.Z.A.R.E. station 105, the largest granules are 0·30 mm. across the head (the height being slightly less than this) while the one with R 45 mm. from the same station has the granules not more than 0·20 mm. across. Although the size may vary to this extent the shape of the granules is always similar, squat and flat-topped. This shape can be seen not only in the types of *T. laseroni* and *P. stellatus* from Koehler's photographs (1920) but also holds good for the granules of *A. conspicuus* and *A. waitei* which are indistinguishable from those of *A. hodgsoni*.

Type locality. 'Discovery' Winter Quarters, McMurdo Sound, 4 metres.

Range. Known from Enderby Land eastwards to the Ross Sea and from South Georgia (also Shag Rocks?) in 4 to 457 metres.

Acodontaster hodgsoni forma stellatus (Koehler)

Pseudontaster stellatus Koehler, 1920, 210-214, pl. l, figs. 1-7, pl. lxx, fig. 2.

Banzare localities: Station 30 (1 specimen), 41 (TML 1 specimen).

The proportions of these specimens and of the type are given in Table 3.

The one from station 30 has a swelling the size of a pea near one arm tip. Dissection showed this to be caused by a sac-like parasitic crustacean of which a second specimen was also found more proximally and laterally in the same ray. Each parasite has an opening to the exterior by a pore on the ventral side of the starfish. In spite of this infestation the gonads of the host appear to be well developed. This specimen has the disc elevated as in the type of *stellatus* but in the one from station 41 the disc has collapsed. Both have very coarse abactinal granules, about 0·30 mm. in diameter, arranged in groups corresponding to the plates. As in the type specimen the rays are triangular and more acute than in forma *hodgsoni*. In the specimen from station 30 the main oral spine is very thick but somewhat truncated with a rounded though hyaline tip; its base projects over the mouth and the proximal oral furrow spines are reduced. On the suboral surface of each plate there are only four spines of which three arise alongside the primary spine, the proximal two being much thicker and slightly longer than the others as well as much compressed laterally. In the second specimen the primary oral spine is longer and very acute distally and the two accessory spines on each side of it are less markedly enlarged, the total number of spines on the oral plates being greater.

Type locality. Off Queen Mary Land, 202 metres.

Range. Known from Enderby Land eastwards to Queen Mary Land in 193 to 540 metres.

Acodontaster waitei (Koehler)

Metadontaster waitei Koehler, 1920, 219-226, pl. xlvi, figs. 1-6, pl. xlvii, figs. 5, 6, pl. xlviii, fig. 8 (?pl. xlix, figs. 1-3), pl. lxxi, figs. 1, 2.

?*Pseudontaster conspicuus* (part), Koehler 1920, 203, 208, pl. xlii, figs. 3, 4, pl. xliii, fig. 2. (specimen C).

Acodontaster waitei Fisher, 1940, 114-115.

Banzare locality: Station 107 (7 specimens).

Some details of these specimens are given in Table 3. All of them have the primary oral spine relatively very small, at most 4·0 mm. long in one of the two largest (R 120 mm.) and 2·25 mm. long in that with R 38 mm. The other specimen with R 120 mm., has the oral spine only 3·25 mm. long and projecting vertically downwards not horizontally and distally as in the rest.

The number of actinal pedicellariae is very variable; in one of the two largest specimens there are about 70 of these in each of the five actinal areas, the series extending well over half the arm length, while in the other there are only about seven pedicellariae in each area. Even the most proximal ones are very low and granuliform in shape, in contrast with the conical proximal actinal pedicellariae of *A. conspicuus* and *A. hodgsoni*. The frequency of adambulacral pedicellariae parallels that of the actinal ones. The large specimen with many actinal pedicellariae has adambulacral ones on about the first fifteen plates of each series, while the other with only about seven actinal pedicellariae appears to have none on the adambulacrals.

In the types of *A. waitei*, Koehler commented on the absence of dorsal and marginal pedicellariae and the few actinal ones. The single 'Discovery' specimen (R 75 mm.) has about 30 in each actinal area. It also has a few proximal infero-marginal pedicellariae unlike the types and the B.A.N.Z.A.R.E. specimens.

This species appears to be distinguished by at least four characters, namely the consistently small primary oral spine, the occurrence of adambulacral pedicellariae (though this is not invariable) and the granuliform shape of even the proximal actinal pedicellariae, accompanied by retention of low granules rather than elongated ones in the proximal parts of the actinal areas. One of Koehler's paratypes of *A. conspicuus* (designated C) also has granuliform proximal actinal pedicellariae whereas the holotype of *A. conspicuus* and the 'Discovery' and Swedish Expedition specimens from the Weddell Quadrant, all have these pedicellariae conical with elongated valves though the more distal ones may be granuliform. Koehler's specimen C also appears to have rather small primary oral spines, though with hyaline tips judging from his photographs (1920, pl. xlii, fig. 2 and pl. xliii, fig. 2). One difference from *A. waitei*, however, is that Koehler notes the presence of some foramina of pedicellariae on denuded mid-radial abactinal plates though the entire pedicellariae are not distinct among the granules.

I agree with Fisher that the paratype of *A. waitei* from off Queen Mary Land, another specimen C of Koehler's designation, shown in his pl. xlix, is probably not conspecific with the holotype. It has an enlarged granule or a short spine on most of the proximal infero-marginal plates approximating to the marginal spines found in *A. marginatus* (Koehler) from west of Graham Land (1912, pl. viii, fig. 4).

TYPE LOCALITY. Off Adélie Land, 647 metres.

RANGE. Known from Adélie Land west to MacRobertson Land and from the Palmer Archipelago in 160 (?46) to 647 metres.

Family GONIASTERIDAE

KEY TO THE SOUTHERN SPECIES

1 (6) Very conspicuous, wide, bivalved abactinal and actinal pedicellariae present, some of them almost as wide as the plates bearing them.

2 (3) Marginal plates with regular peripheral series of granules* (Magellan Strait, 326 m.) . . *Hippasteria hyadesi* Perrier, 1891

3 (2) No regular peripheral series of granules on the marginal plates.

4 (5) Marginal tubercles and granules variable in number and without any regular arrangement (R 129 mm. in only specimen known) (Falkland Is., 225-251 m.) . . . . . *Hippasteria falklandica* Fisher, 1940

5 (4) Some blunt spines as well as tubercles on the marginal plates, all having a tendency, particularly on the infero-marginals, for arrangement in single vertical rows (R < 32 mm.) (S. Orkney Is., 3246 m.) . . . *Chitonaster johannae* Koehler, 1908†

6 (1) Pedicellariae, if present, small and hardly, if at all, larger than the granules, not very conspicuous.

7 (16) Abactinal plates flat, slightly convex or low tabulate, with either one to three truncated spines in the middle, or a more or less continuous covering of granules, or a bare flat centre ringed by flat, appressed granules; only in the last case are the limits of the plates well marked.

8 (9) Abactinal plates convex with one to three truncated spines in the middle (N. from Queen Mary Land, 3612 m.). *Chitonaster cataphractus* Sladen, 1889

9 (8) Abactinal plates either bare centrally or covered with granules.

10 (13) Abactinal plates bare centrally and ringed with closely appressed peripheral granules . . . *Pergamaster* Koehler, 1920

11 (12) Abactinal plates extending along the rays to the terminal plate, supero-marginals not contiguous dorsally (McMurdo Sound, off Wilkes Land westwards to MacRobertson Land, Palmer Archipelago, 176-3100 m.) *Pergamaster incertus* (Bell), 1908

12 (11) Abactinal plates not extending the full length of the rays, the distal supero-marginals of each side contiguous mid-radially (S. Shetland Is., 342 m.) . . . . . *Pergamaster synaptorus* Fisher, 1940

13 (10) Abactinal plates with granules in the middle, which may be spaced or sometimes lost through rubbing, but the peripheral granules, which are rounded, not appressed, are normally adherent.

14 (15) Granules spaced, often rubbed off, the distal marginals probably naturally bare in the centre; tong-shaped pedicellariae present with broadly spatulate flat jaws (Falkland Is., 147-151 m.) . . . . *Cladaster analogus* Fisher, 1940

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* This is presumed from Perrier's description which is entirely comparative with *H. phrygiana*. In fact the Magellanic locality of the type may be a mistake since Koehler (1926, A.A.E. Echinoidea, p. 107) notes that *H. hyadesi* is without doubt identical with *H. plana* (i.e. *phrygiana*) of northern seas.

† Although the abactinal spines of *Chitonaster cataphractus* are shorter and more truncated than they appear from Sladen's figure, in fact more like the tubercles of *C. johannae*, I think that further material may prove *C. johannae* to be more closely related to *Hippasteria falklandica*. This idea is supported by the large pedicellariae.

15 (14) Granules almost continuous, slightly grouped, persistent, marginals completely covered; pedicellariae rare, primitive, three-valved, formed of only slightly modified granules (S. Shetland Is., 342-750 m.) . *Notioceramus anomalus* Fisher, 1940

16 (7) Abactinal plates markedly tabulate, polygonal and closely covered with similar flattened granules, the limits of the plates quite distinct.

17 (18) Rays short, marginal plates with bare central patches and no spines (Falkland Plateau, Burdwood Bank, NE. Pacific, 75-850 m.). . . . . *Ceramaster patagonicus* (Sladen), 1889

18 (17) Rays well developed, marginal plates without bare patches, the infero-marginals with a few small spines (Falkland-Magellan area, 140-283 m.). . . . . *Pseudarchaster discus* Sladen, 1889

Genus Pergamaster Koehler

Pergamaster incertus (Bell)

Pentagonaster incertus Bell, 1908, 9.

Pergamaster tessellatus Koehler, 1920, 238-242, pl. xlix, figs. 5-17.

Pergamaster incertus, Fisher, 1940, 121-122, pl. ii, figs. 1, 2.

Banzare locality: Station 30 (2 specimens).

Both specimens have R about 40 mm. and thus approximate in size as well as in locality to Koehler's types of *Pergamaster tessellatus*, which are much larger than either the type of *P. incertus* from the Ross Sea or the 'Discovery' Investigations specimen from the Bellingshausen Sea. In naming the latter, Fisher pointed out that *P. tessellatus* is, at best, a forma of *P. incertus* which species Koehler left out of account in 1920 owing to Bell's inadequate description. The present specimens leave no doubt that *P. tessellatus* is a synonym of *P. incertus*.

The enlargement of one subambulacral tubercle on the distal plates is variable, as in species of some other goniasterid genera such as *Ceramaster*; one of the B.A.N.Z.A.R.E. specimens shows it clearly while in the other it is barely distinct.

Type locality. McMurdo Sound, 175-220 metres.

Range. Known from the Ross and Bellingshausen Seas and from Wilkes Land westwards to MacRobertson Land in 175 to 3100 metres.

Family GANERIIDAE

Key to the Southern Species*

1 (6) Ventral surface appearing 'shaggy' with elongate, often overlapping spines.

2 (3) Dorsal surface smooth, the plates concealed by skin and bearing only very small tubercles (between Bouvet and Gough Islands, 3845 m.) . . . . . *Scotiaster inornatus* Koehler, 1908

3 (2) Dorsal surface appearing papillose, granular or spiny . . . . . *Ganeria* Gray, 1847

4 (5) Abactinal spinelets single, rarely two on one plate (E. of the S. Orkney Is., and off Bouvet I., 3246 and 200 m.). *Ganeria attenuata* Koehler, 1908

5 (4) Several spinelets on each abactinal plate, often granuliform (Falkland-Magellan area, down to 137 m.) *Ganeria falklandica* Gray, 1847

6 (1) Ventral spinelets small, often clustered and obscured by skin.

7 (14) Abactinal skeleton more or less well developed, the plates not deeply buried in the skin; marginal plates often distinct or even prominent, especially distally . . . . . *Cycethra* Bell, 1881

8 (9) Form pentagonal; R/r less than 2/1; marginal plates very prominent and pentagonasteroid (Falkland-Magellan area, shallow water) . . . . . *Cycethra cingulata* Koehler, 1923

9 (8) Rays more or less elongated; R/r usually more than 2/1; marginal plates varying from prominent to indistinguishable.

10 (11) Adambulacral plates usually with a single transverse row of three spines, only one at the furrow margin; the whole surface of each abactinal plate convex and bearing numerous, short, almost granuliform spinelets (Macquarie I., littoral). *Cycethra macquariensis* Koehler, 1920

11 (10) Two furrow spines, at least proximally, and three to six other spines on the ventral surface of each adambulacral plate; abactinal plates with a rounded or oval raised pedicel bearing the cluster of spinelets . . *Cycethra verrucosa* (Philippi)

12 (13) R/r 2/1 or more but rarely exceeding 3/1; marginal plates more or less distinct, at least towards the arm tips (subantarctic, Patagonia and the Falkland area, down to 267 m.) . . . . . *C. verrucosa verrucosa* (Philippi), 1857

13 (12) R/r usually over 2·5/1 and often exceeding 3/1; marginal plates reduced, only distinguishable, if at all, towards the arm tips (antarctic, South Georgia, the Weddell, Enderby and Victoria Quadrants, 60-342 m.). *C. verrucosa mawsoni* subsp. nov.

14 (7) Abactinal plates reduced, deeply embedded in the skin which has a more or less pustular surface tending to conceal the very small spinelets and plates; marginal plates indistinct . . . . . *Perknaster* Sladen, 1889

15 (16) Abactinal spinelets forming a uniform covering, not clustered (Graham Land, South Georgia and Shag Rocks, 75-254 m.). *Perknaster aurantiacus* Koehler, 1912

16 (15) Abactinal spinelets in small clusters, sometimes single.

17 (18) Two furrow spines on at least the proximal adambulacral plates; up to seven subambulacral spines, usually paired (Kerguelen and Marion Island, 101-232 m.) . . . . . *Perknaster densus* Sladen, 1889

18 (17) One furrow spine, rarely one or two proximal plates with two; subambulacral spines two to five, usually in a single linear series across the plate, the outer ones sometimes paired.

19 (22) Body wall fairly rigid; pedicels of abactinal plates tall, the total height of the plate at least two and a half times the breadth of the pedicel (fig. 3p); abactinal spinelets long and slender . . . . . *Perknaster sladeni* (Perrier), 1891

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* This key is, at best, a guide, since intergrades occur between *Ganeria* and *Cycethra* and between *Cycethra* and *Perknaster*, and some of the species are extraordinarily variable.

20 (21) Pedicels three or more times as high as broad (Falkland Is., Shag Rocks, Palmer Archipelago, MacRobertson Land, 199-500 m.). . . . . *P. sladeni sladeni* (Perrier), 1891

21 (20) Pedicels about two and a half times as high as broad (South Georgia, 120-204 m.). . . . *P. sladeni georgianus* Fisher, 1940

22 (19) Body wall more or less pliable, at least when R exceeds 30 mm.; pedicels stout, low or moderate in height, rarely over twice as high as broad; abactinal spinelets more or less stout (fig. 3a-o).

23 (26) Abactinal spinelets markedly clavate.

24 (25) Abactinal plates relatively large, the primary ones with wide bases, spinelets rather flat across the distal end and with a few prominent lateral thorns towards the tip (fig. 3a, c-e) (Kerguelen and Heard Islands, 45-137 m.).
Perknaster fuscus Sladen, 1889

25 (24) Abactinal plates without extensive basal parts (except in small specimens); spinelets very bushy in the distal half with numerous thorns (Enderby Land to Adélie Land, Graham Land, South Georgia, Shag Rocks, S. Sandwich Is., 18-310 m.).
Perknaster aurorae (Koehler), 1920

26 (23) Abactinal spinelets rarely clavate, the heads usually reduced, especially in larger specimens and thorny towards the tip or simply irregular.

27 (28) Spinelets arranged in distinct groups (Graham Land and South Georgia, 0-235 m.).. . *Perknaster charcoti* (Koehler), 1912

28 (27) Little, if any, grouping of the spinelets (Weddell, Victoria and Ross Quadrants, 11-457 ['Terra Nova' st. 331] m.).
Perknaster antarcticus (Koehler), 1906

Genus Cycethra Bell

Cycethra macquariensis Koehler

Cycethra macquariensis Koehler, 1920, 139, pl. xxxiv, figs. 1-4, 6, 7, pl. lxvi, fig. 5.

Australasian Antarctic Expedition Locality: Macquarie I.; scraped from rocks (1 specimen).

The identification of this specimen necessitated a comparison between *C. macquariensis*, *Asterina hamiltoni* Koehler (1920) and *A. frigida* Koehler (1917), the type of the last-named being from Kerguelen. These three seem to be closely related with only minor differences, some of which could be attributed to size. It is significant that whereas Koehler in 1917 wrote that he found an example of *Asterina frigida* in the 'Gauss' littoral collections at Observatory Bay, Kerguelen, Döderlein, who eventually reported on the 'Gauss' material, did not include that species but instead recorded a small specimen under the name of *Cycethra verrucosa* which is otherwise unknown from Kerguelen. Regarding this specimen, Fisher (1940) commented that Observatory Bay is close to the type locality of *Perknaster densus*. However, *P. densus* is unknown from depths of less than 50 metres. Madsen (1955) has recorded a juvenile specimen from Kerguelen as *A. frigida*.

Koehler's descriptions of the three species can be summarized as follows:—

C. macquariensis. R/r 17 mm./8 mm.; rays short but distinct from disc, rounded at tips; body thick, dorsal and ventral sides flattened, sides rounded; abactinal plates not very numerous, convex, subequal and closely placed, forming indistinct longitudinal and transverse rows on the rays; those on the disc bearing about 15-20 spinelets 0·25-0·28 mm. long; the denuded plates a little irregular but rounded and sometimes widened transversely, not imbricated; around each plate four or five rather large papulae; marginal plates a little larger than the rest, quite distinct when denuded, elongated vertically or obliquely, the proximal supero-marginals twice as high as wide; 15 marginals in each series; limits of actinal plates not distinct, forming irregular rows, bearing spinelets up to 0·45 mm. long, probably four or five on each plate; adambulacral plates with one furrow spine and two subambulacral ones in a transverse row; oral plates with three furrow spines and one or two suboral ones.

Asterina hamiltoni. R/r 16 mm./8 mm.; rays distinct from disc, triangular with tips rounded; dorsal side convex, ventral flat, sides rounded; abactinal plates small, rounded, closely placed, subequal and convex, some at the base of the rays widened transversely, others irregular; all with surface convex; arrangement irregular but tendency for transverse rows laterally; 20 or more spinelets on each plate, 0·35-0·38 mm. long; four or five papulae around each plate; marginal plates larger, supero-marginals oblique, twice as long as wide, 16 in each series; actinal plates in two distinct longitudinal rows, others irregular but tending to form transverse series, each bearing usually three, less often two spines, longer than the abactinal ones; adambulacral plates with one furrow and two subambulacral spines, the latter aligned obliquely; oral plates with three (or four) furrow spines and two suboral ones.

Asterina frigida. R/r 8·5-10 mm./c.5 mm.; rays distinct though short, tips rounded, dorsal and ventral sides slightly rounded (in three specimens, the fourth having the dorsal side more convex and the ventral concave, the arms also being more nearly cylindrical); abactinal plates small, imbricated, rounded, forming fairly distinct longitudinal and oblique rows; eight or nine very short spinelets on the disc plates, five or six on the more peripheral plates; papulae present between the plates; supero-marginal plates nearly twice as high as wide with the spinelets in two regular rows on each one (probably 13 or 14 in each series, judging from the photographs); actinal plates forming fairly regular transverse series, usually with two spinelets on each, sometimes one, the spinelets longer than the abactinal ones; adambulacral plates with one furrow and two subambulacral spines in a transverse row but the latter are usually more or less oblique; oral plates with three furrow spines and one suboral.

Laboratoire de ZOOLOGIE
Michel JANGOUX

From this it appears that all three have much the same shape with R/r 2/1 or a little less and the arm tips rounded. The number of spinelets on each abactinal plate is probably proportional, allowing for the smaller size of the types of *A. frigida*, the marginal plates are similar in relative size and shape and the adambulacral armature is almost identical (in *C. macquariensis* Koehler's photographs show that the two subambulacral spines are more or less oblique in position, not always on a line with the furrow spine).

The differences seem to be that in *C. macquariensis* the abactinal plates are more spaced, the abactinal spinelets are only three-quarters as long as those of *A. hamiltoni* (the exact length in the types of *A. frigida* is not given) and the actinal spinelets are more numerous (the numbers for the two *Asterina* spp. being comparable relative to their sizes). Koehler writes that the abactinal plates of *C. macquariensis* are not imbricated, but judging from his photographs the skin was not so completely dissolved on the type of *C. macquariensis* as on that of *A. hamiltoni* so that the actual mode of junction of the plates may still have been concealed.

Of the three specimens from Kerguelen in the B.A.N.Z.A.R.E. collection which I am calling *A. frigida* one has R 10 mm. and the other two both have R about 14 mm. The latter have the proximal abactinal plates with about 12 spinelets 0·30-0·35 mm. long, the plates themselves slightly imbricated, two regular rows of spinelets on the higher proximal supero-marginal plates as in the types of *A. frigida*, actinal plates with one to four spinelets and three adambulacral spines, the two outer slightly oblique.

The small specimen now recorded from Macquarie Island has R only 6 mm. There are six to nine spinelets on the proximal abactinal plates, about 0·18 mm. long, ten marginal plates in each series, the middle supero-marginals being elongated obliquely, one to four (usually two) actinal spinelets on each plate and two subambulacral spines which may be in line with the furrow spine or arranged obliquely to it. The abactinal plates appear to be spaced to a similar degree to those of the type of *C. macquariensis* and as the spinelets are very small I use this name instead of *Asterina hamiltoni*. I doubt whether there is really a generic, let alone a family, difference between the two species.

Three relatively young specimens of *Cycethra verrucosa* from the Falkland Islands were examined for comparison. They have R/r respectively 15 mm./6 mm., 13 mm./5·5 mm., and 12 mm./5 mm., that is between 2/1 and 2·5/1 so that the rays are relatively a little longer than in the three species under discussion. The abactinal plates of the rays in *C. verrucosa* form a more open network and each has a rounded or oval pedicel bearing the cluster of spinelets even when the plate is crescentic in shape, as opposed to the whole plate being convex without a limited pedicel. The spinelets in these specimens of *C. verrucosa* are 0·29-0·35 mm. long. Other differences include the fact that the supero-marginals of *C. verrucosa* are not elongated and there are two furrow spines proximally though only a single one in the distal half of the ray.

Zoogeographically it is possible that the same species may occur at Macquarie Island and at Kerguelen. Both are close to the Antarctic Convergence and at least 30% of the shallow-water bottom-living invertebrate species are said to be common to the two islands.

TYPE LOCALITY. Macquarie I., low water.

RANGE. Only known from the shores of Macquarie Island.

CYCETHRA VERRUCOSA MAWSONI, subsp. nov.

text fig. 2a-c, j, l, n, pl. i, figs. 1-3.

Cycethra verrucosa, Koehler, 1912, 64-66; Fisher, 1940 (pt.), 130-133 (antarctic specimens). Non *verrucosa* Philippi, 1857.

?*Cycethra verrucosa*, Madsen, 1955, 12-13.

BANZARE LOCALITIES: Stations 30 (5 specimens), 39 (4 specimens), 40 (1 specimen, ? a separate forma), 41 (TML 1 specimen), 42 (1 specimen), 107 (8 specimens).

All these specimens but the two relatively small ones from stations 40 and 42 show a surprising constancy of form considering the great variation of *C. verrucosa* in the subantarctic. The interradial arcs are rounded, the disc is somewhat flattened on the dorsal side, but the rays are more convex and taper more abruptly in the first third or half of their length than distally, the tip being attenuated. The two exceptions are more angular interbrachially and the rays are slightly longer and more distinctly marked off from the disc.

Description of the holotype from station 107: R/r is 41 mm./15 mm.=2·7/1. The abactinal surface is closely covered with a coat of fine spinelets which reproduces the convex contours of the underlying plates. The larger proximal paxillae have about 20 spinelets, the number falling to about 12 on the secondary plates and the smaller distal plates. When denuded the plates are seen to form a strong, small-meshed reticulation, their lobes overlapping. On the radial areas they are somewhat irregular in arrangement so that the meshes are variable in shape. On the sides of the rays the arrangement and shape of the plates become much more regular with parallel rows in two directions approximately at right angles to each other but slightly oblique to the longitudinal and tangential axes. Mid-radially the meshes are approximately equal in

diameter to the primary plates but laterally they are much smaller. A number of small secondary plates are present within the meshes of the radial areas and tend to subdivide them. All the plates have a flat basal part with a well-defined, projecting, flat-topped pedicel, which is often oval in dorsal view. The pedicel is usually about equal in height to the thickness of the horizontal part of the plate, the total height of plate and pedicel together being about 0·4 mm.

The abactinal spinelets are clavate, expanded near the base, narrowed in the middle and flared and thorny distally (fig. 2c). The proximal ones are 0·3-0·4 mm. long.

The marginal plates are only just distinct on some parts of the rays when denuded. Proximally they are usually visible as a double series appreciably larger than the small outermost abactinal plates and distinguished by their longitudinal arrangement from the actinal plates. Distally the marginals are more irregular in size and position and the consecutive plates may become separated from each other. Throughout they are restricted to the rounded lateral areas, slightly towards the ventral side so that they are not visible at all in dorsal view. The actinal plates also form longitudinal series (as well as transverse ones) but, since each more lateral series is shorter than the next, the marginal rows cut obliquely across them. The actinal plates adjacent to the adambulacrals are slightly larger than the rest. All these plates bear a dense covering of spinelets like the abactinal plates, the larger ones each having about 10-12 spinelets.

The armature of the adambulacral plates is indistinct in the holotype. In a specimen of similar size from the same station, the plates along the whole length of the furrow each have two long furrow spines backed by up to eight progressively shorter subambulacral spines graduating in size to the actinal spinelets. The subambulacral spines may form two rows on each plate at right angles to the furrow.

Variations. The largest specimen (station 107) has R 46 mm. and the smallest 11 mm., the latter having R/r 2·2/1. The highest value of this ratio is 3·4/1 and occurs in the two atypical specimens from stations 40 and 42 which both have R 17 mm.; otherwise the highest is 3·3/1. The average is 2·9/1.

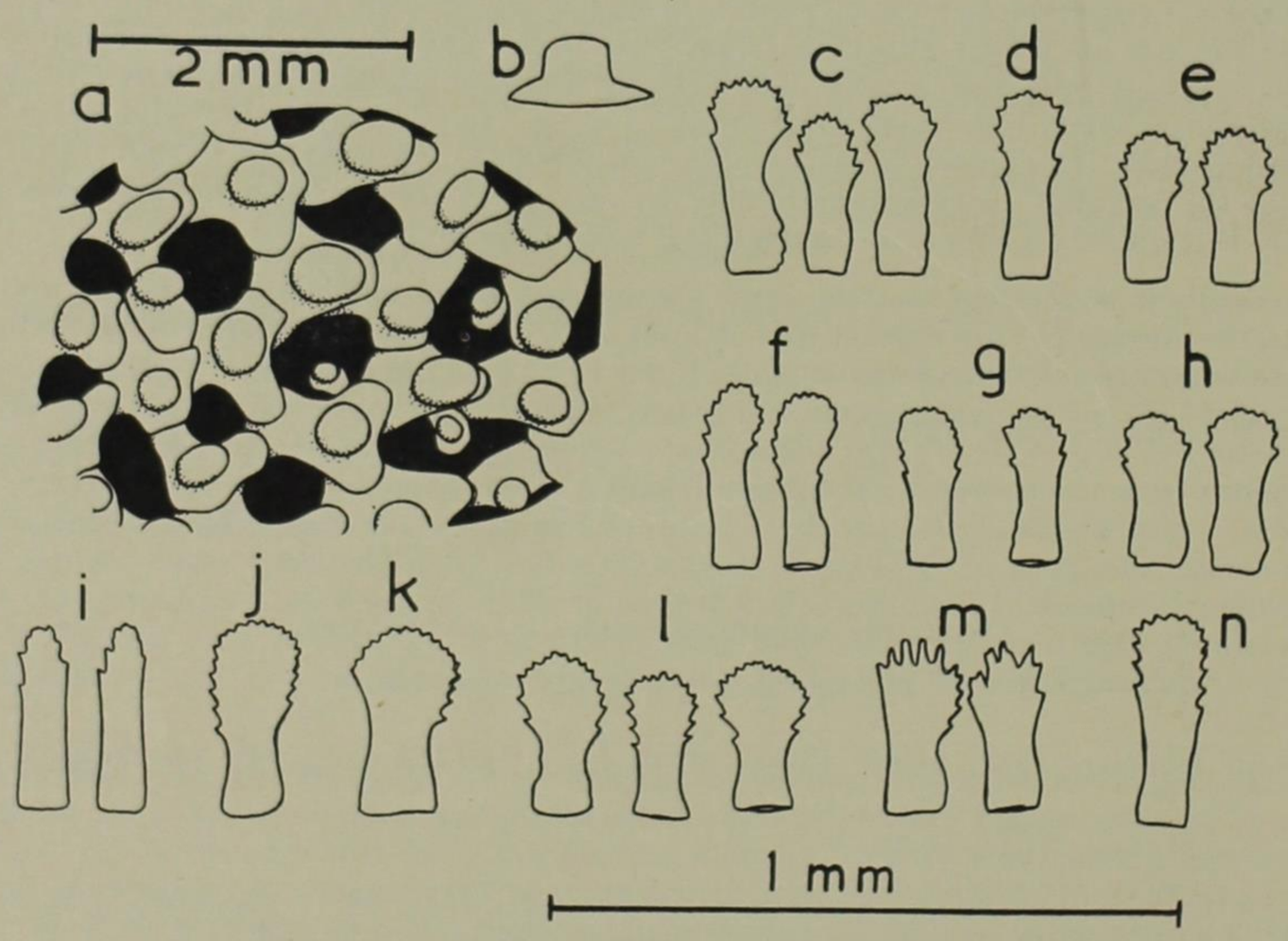


Fig. 2. *Cycethra verrucosa*, a, *C. verrucosa mawsoni*, holotype, proximal abactinal area with plates denuded, mid radius to the right and more distal plates to the top, b, one plate seen in profile; c, to n, proximal abactinal spinelets of: c, to h, *C. verrucosa mawsoni*, c, holotype, d, R 33 mm. and e, R 20 mm., both from Banzare station 107, f, R 18 mm. from station 30, g, R 17 mm. from station 42, h, R 22 mm. from station 30; i, *C. verrucosa verrucosa*, R 20 mm. from 'Discovery' station WS 84, Falkland Is., j, *C. verrucosa mawsoni*, R 35 mm. from 'Discovery' station 170, Clarence I., k, *C. verrucosa verrucosa*, R 40 mm. from 'Discovery' station WS 93, Falkland Is., l, *C. verrucosa mawsoni*, R 17 mm. from Banzare station 40, m, *C. verrucosa verrucosa*, R 22 mm. from the Falkland Is., n, *C. verrucosa mawsoni*, R 30 mm. from 'Discovery' station 167, South Orkney Is. (The 2 mm. scale refers to a and b only.)

In some specimens the abactinal spinelets form a more continuous layer obscuring the limits of each paxilla but usually they are in distinct convex groups. The number of spinelets increases with size. The closeness of the mid-radial reticulation may vary, the meshes sometimes being relatively much smaller than in the type; in smaller specimens the secondary plates are undeveloped. The heights of the pedicels are variable; in some specimens they are about half as high again as the basal part of the plate is thick, but in a few small ones, such

as the largest from station 30, which has R 22 mm., the projection may be much less distinct and the whole plate, particularly the more lateral ones, simply convex, though a circular or oval knob-like pedicel is usually visible on the more radial plates. This specimen and one or two others have the abactinal spinelets shorter and thicker than usual (fig. 2h). It is also distinctive in being the only one in which the marginal plates are distinguishable when the spinelet-covering is intact; even here it is mainly because these plates define an angle between the flattened ventral surface and the lateral surface that they are distinct. Conversely, in at least one other specimen (from station 107 with R c. 30 mm.) the position of the marginals is only marked by a disturbed area between the regularly arranged abactinal and actinal plates.

Both the specimens from stations 40 and 42 have R/r 17 mm./5 mm., but they differ considerably in skeletal structure. In the one from station 42 the abactinal skeleton forms a close meshwork, irregular on the radial areas with very low indistinct pedicels and thin, radiating, slightly clavate, spinelets (fig. 2g) simulating those of the holotype but with the thorns blunter. The larger abactinal plates bear about 12 spinelets and the actinal plates five to seven. In the specimen from station 40 however, the abactinal skeleton is regular throughout with the mid-radial meshes about equal in diameter to the plates and the pedicels very prominent and knob-like. The paxillae with the spinelets in place appear to be much more spaced than in the one from station 42 since in addition to the wider meshwork, the spinelets themselves are much shorter, thicker and more clavate (fig. 2l) as well as being fewer, about ten in number on the larger abactinal plates, and four or five (rarely six) on the actinal plates. Both specimens have two long furrow spines, though in the outer half of the ray the proximal one may be inset. There are two or three pairs of subambulacral spines as usual. In the specimen from station 42 the adambulacral armature is more crowded, with 51 adambulacral plates in each series, but only 35 in that from station 40. In a specimen from station 30 with R 18 mm. there are 41 adambulacrals in each series while in another from the same station with R 22 mm. there are 46. The example from station 41 is similar in every way to that from station 42 except that the interbrachial arcs are not acute.

Finally there are three specimens referable to this subspecies from 'Terra Nova' station 194, off Oates Land, just clear of the Ross Sea to the west, in 330-360 metres. These were not named by Bell. The largest has R/r 19 mm./6·5 mm. They resemble the specimens from B.A.N.Z.A.R.E. stations 40 and 42.

Remarks. Cycethra verrucosa has hitherto only been found off Patagonia, the Falkland Islands and in the Weddell Quadrant of the Antarctic, the records of Bell from the Ross Sea being all based on *Odontaster* and of Döderlein from Kerguelen, I believe, on *Asterina frigida* Koehler. The present specimens resemble some of those from antarctic localities taken by the 'Discovery', notably from stations 167 (South Orkneys) and 170 (South Shetlands) with the marginal plates barely or not at all distinct when covered with spinelets. There are small differences in the abactinal spinelets, those of the 'Discovery' specimens being much more rugose and in the specimens from station 170 very markedly clavate, but it seems likely that most, if not all, of the antarctic Weddell Quadrant specimens can be referred to *mawsoni*. It is significant that Fisher did not attempt to refer any of them to the formae *nitida*, *electilis* and *pinguis* of Sladen as he did all the subantarctic examples, commenting instead that they 'are peculiar and probably constitute a distinct race'. I think it is desirable for a name to be given to these antarctic specimens in which the marginal plates are consistently and markedly reduced.

In a study of 35 specimens of *C. verrucosa* from the Patagonian area, Falkland Islands and the Weddell Quadrant, I found a definite correlation between the development of the marginal plates and the bottom temperature, specimens with reduced marginal plates being much more rare from subantarctic localities than from south of the Convergence. When this reduction does occur in subantarctic specimens the divergence is not towards *mawsoni* but in the direction of *Perknaster sladeni* (Perrier), the rays being longer but at the same time narrow from near the base, as in the type of *Cycethra lahillei* de Loriol (1904) from Southern Argentina, figured by Koehler (1923), which name I believe to be a synonym of *verrucosa*.

There is also a tendency in antarctic specimens for the R/r ratio to average a higher level, 3/1 or more, whereas only a few subantarctic ones, such as the types of forma *nitida* Sladen and of *C. lahillei* just mentioned, have very long rays.

The other character investigated is the form of the abactinal spinelets. Here again there is a tendency for geographical correlation, though with frequent anomalies. For instance, a glovelike shape of spinelet, relatively short, with a narrowed 'wrist' and finger-like distal projections (fig. 2m) was found in specimens from the eastern end of the Magellan Strait, while farther north off Argentina the spinelets were most often widest at the base and barely, if at all, clavate with blunt distal irregularities (fig. 2i). Both these types were found in specimens from the Falkland Islands but were absent in those from South Georgia and the South Orkneys and Shetlands (fig. 2j, n) where instead the spinelets were clavate, often markedly so, a form sometimes found in the Falkland Islands (fig. 2k) but not in Patagonian specimens.

TYPE LOCALITY. Off MacRobertson Land, 66° S., 62° E., 219 metres.

RANGE. Known from the Enderby and Weddell Quadrants of the Antarctic, including South Georgia, in 60 to 540 metres.

Genus Perknaster Sladen

Perknaster Sladen, 1889, 550; Fisher, 1940, 133 (Type *P. fuscus* Sladen, 1889).

Cribraster Perrier, 1891, 104 (Type *C. sladeni* Perrier, 1891); [*Cribraster* Perrier, 1888, 675 (no description or type designation)].

Cryaster Koehler, 1906, 24; 1920, 131 (Type *C. antarcticus* Koehler, 1906).

Cribrellopsis Koehler, 1917, 36 (Type *C. rallieri* Koehler, 1917).

In 1940 Fisher included the following species and subspecies in this genus:—

P. fuscus Sladen, 1889.
P. fuscus antarcticus (Koehler), 1906.
P. densus Sladen, 1889.
P. sladeni (Perrier), 1891.
P. sladeni georgianus Fisher, 1940.
P. charcoti (Koehler), 1912.
P. aurantiacus Koehler, 1912.
P. aurorae (Koehler), 1920.

As he pointed out, *Perknaster sladeni* and *P. densus* are marked off from the other species either by the relatively tall pedicels (*P. sladeni*) or the numerous adambulacral spines (*P. densus*).

The fact that Koehler included *P. aurantiacus* in *Perknaster* rather than in *Cryaster* suggests that it has a relatively strong abactinal skeleton, since until 1920 he believed that the species of his genus *Cryaster* have no abactinal plates. However, the type of *P. aurantiacus* is a dry specimen with R only 25 mm. Both the dry state and the small size would emphasize the development of the plates since they are progressively reduced with increasing size and become hidden in the thickening body wall.

Otherwise *P. aurantiacus* is marked off from the remaining species of *Perknaster* by the uniform covering of very short abactinal spinelets and by the adambulacral armature.

Koehler did not appreciate the close relationship between *P. fuscus* from the Kerguelen area and his three species of *Cryaster*—*C. antarcticus*, *C. charcoti* and *C. aurorae*—from the antarctic coast. Until he came to study the collection of the Australasian Antarctic Expedition he did not make preparations of the abactinal skin and so failed to realise that at the base of each spinelet or group of a few spinelets is a small plate, sometimes no larger in diameter than the width of a single spinelet. He distinguished his three species by differences in the development of the abactinal and actinal spinelets and their arrangement, by the number and shapes of the adambulacral spines and by the extent of crowding of the tube feet.

Concerning the development of the abactinal spinelets, Koehler himself remarked that this is very variable, the spinelets being particularly deficient in some specimens of *P. antarcticus*, notably the one from the Ross Sea which he recorded in 1911. Fisher found that the number and shapes of the adambulacral spines are also variable, at least in the specimens which he attributed to *P. charcoti*. He concluded from this that their peculiar form in the unique holotype is not diagnostic. As for the crowding of the podia, although Koehler commented on this condition in *P. antarcticus* (1906 and 1911) and in 1912 used this character to distinguish *P. antarcticus* from *P. charcoti*, Fisher (1940) considered crowded tube feet to be characteristic of *P. aurorae*. Fisher also pointed out that there is a tendency for grouping of the actinal spinelets in *P. antarcticus* as well as in *P. charcoti*, although these spinelets are relatively longer in the latter species. Having discounted so many of Koehler's differential characters, Fisher went further into the study of the abactinal plates and spinelets, distinguishing *P. charcoti* by the relative height of the pedicels which he believed to be intermediate between those of *P. fuscus* and *P. sladeni*. However, the larger specimens of *P. fuscus* and *P. antarcticus* figured here have some of the pedicels with similar proportions. The large 'Discovery' specimens from South Georgia (R 90 and 102 mm.) which Fisher called *P. charcoti* have a notable reduction of the thornlets at the tips of the abactinal spinelets when compared with large specimens of *P. aurorae*. A similar reduction probably by resorption is apparent in the larger *P. antarcticus* from the Australasian Antarctic Expedition figured by Koehler (1920, pl. 75, fig. 2b). Whether it also occurs in the type of *P. charcoti* from the coast of Graham Land needs investigation.

With regard to the degree of crowding of the tube feet, I am at a loss to account for Fisher's estimates of their number as being 84 to a ray in the paratype of *P. fuscus* with R about 35 mm. and 108 in a slightly smaller specimen of *P. aurorae*. This specimen of *P. fuscus* has the furrow spines concealing the tube feet for the most part. A count of the adambulacral plates, which must correspond to the tube feet, comes to approximately 59 in each series. This sets the number of podia at 118 for each ray. A specimen of *P. aurorae* from the 'Discovery' collections with R 33 mm. has about 62 adambulacral plates each side or 124 podia to the ray which is not significantly different. The following table taken from seven specimens of *P. fuscus* from Kerguelen (the holotype and paratype and five others from B.A.N.Z.A.R.E. station 64) and seven 'Discovery' specimens of *aurorae* from the South Sandwich Islands indicates that there is no significant structural difference and that the crowding is largely superficial, depending on the expansion of the tube feet at the time of death and on the preservation.

	P. fuscus							*P. aurorae*						
R (in mm.)	56	50	45	45	43	35	32	70	56	53	46	46	42	33
Number of adambulacral plates	80	72	70	63	67	59	68	80	82	72	70	68	65	62

This leaves only the characters furnished by the paxillae to distinguish *P. fuscus*, *P. antarcticus*, *P. aurorae* and *P. charcoti* from each other.

Small specimens, with R about 30 mm., show very little difference in the paxillae, the spinelets all having 'bushy' heads, but in larger specimens there is some divergence, as can be seen from Fisher's figures and those given here (which are all taken from proximal, mid-radial paxillae).

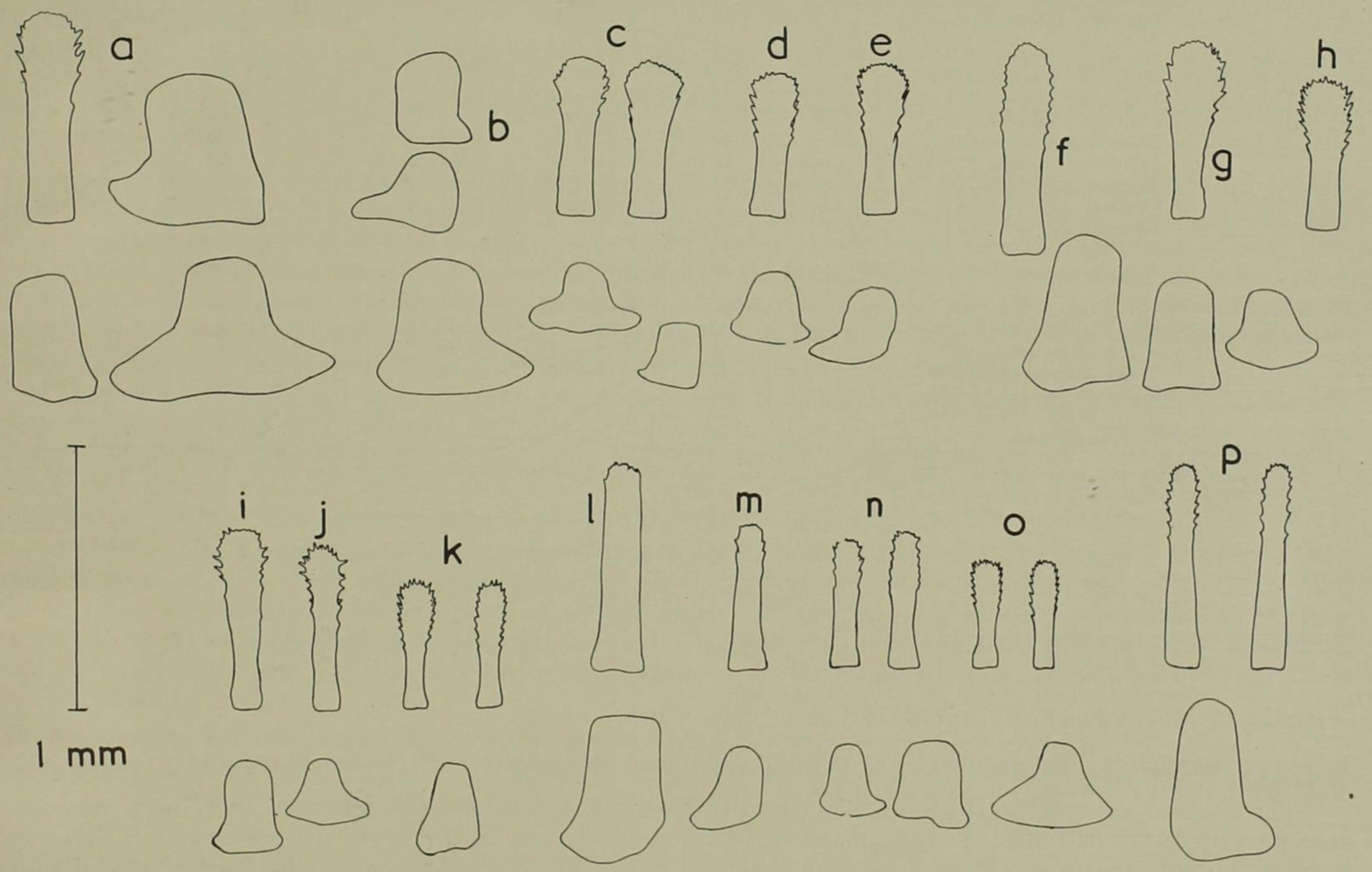


Fig. 3. *Perknaster* spp. a, to e, *P. fuscus*, a, R 56 mm. from Banzare station 64, one spinelet and three plates, b, holotype with R 45 mm., three plates, c, paratype, R 35 mm., two spinelets and two plates, d, and e, Banzare station 64, spinelet and plate from each of specimens with R 32 mm. (left) and c.40 mm. (right); f, to k, *P. aurorae*, f, R 130 mm. from 'Discovery' station 370 South Sandwich Is., spinelet and plate, g, R 56 mm., spinelet and two plates and h, R 46 mm., spinelet, both from 'Discovery' station 371, South Sandwich Is., i, and j, R 68 mm. from Banzare station 107, two spinelets and two plates, k, R 32 mm. from Banzare station 105, two spinelets and one plate; l, to o, *P. antarcticus*, l, R 137 mm. from Hut Point, McMurdo Sound, spinelet and plate, m, R 60 mm. from 'Terra Nova' station 339, Ross Sea, spinelet and plate, n, R 45 mm. from 'Terra Nova' station 356, McMurdo Sound, two spinelets and two plates, o, R 42 mm. from 'McMurdo Bay', two spinelets and one plate; p, *P. sladeni*, R 55 mm. from Banzare station 107, two spinelets and one plate.

In Table 5 are listed sizes of pedicels and spinelets from a number of specimens, including seven from the McMurdo Sound area collected during Scott's expeditions with the 'Discovery' and 'Terra Nova'. Bell named three of these *Cryaster antarcticus*. The largest ones particularly show reduction in the sizes of the heads and in the number of the spinelets. For comparison, Koehler gives the spinelet length in his A.A.E. specimens with R up to 120 mm. as not exceeding 0·6 mm.

It appears that in *P. fuscus* the abactinal spinelets are relatively much larger than in *P. antarcticus*, also that *P. aurorae* approaches *P. fuscus* in the larger size of its spinelets as well as in their more clavate form. According to Koehler, the spinelet length in the types of *P. aurorae* is 0·6-0·8 mm. when R is 25-43 mm. or 1·0-1·3 mm. when R is 100-125 mm. I find that Fisher's estimate of 1·5 mm. in the specimen from 'Discovery' station 366 (R 107 mm.) is too high, skin from the disc and from the proximal part of a ray yielding no spinelets over 1·0 mm. in length.

Structurally, therefore, *P. antarcticus* and *P. aurorae* are equally distinct from *P. fuscus* and I am accordingly restoring the first to specific rank. The geographical ranges of *P. antarcticus*, *P. charcoti* and *P. aurorae* overlap to some extent. Their validity and relationships with each other and with *P. fuscus* remain to be decided after a comparison of microscopical preparations of paxillae from the types of *P. antarcticus* and *P. charcoti*, together with an assessment of the range of variation in the paxillae of a large number of specimens of *Perknaster* from around the Antarctic continent.

TABLE 5

Paxillar measurements in some specimens of *Perknaster* spp.

Species	Station	R (in mm.)	Height of pedicels (in mm.)			Length of spinelets (in mm.)		
			range	average	no.	range	average	no.
P. fuscus	Challenger station 149D	45	0·30-0·54	0·42	10	0·54-0·63	0·59	14
	Challenger station 149D	35	0·24-0·25	0·25	4	0·52-0·62	0·57	11
	Banzare station 64	56	0·48-0·54	0·52	6	0·67-0·89	0·78	15
	Banzare station 64	45	0·23-0·36	0·29	5	0·57-0·65	0·60	9
	Banzare station 64	43	0·28-0·34	0·31	2	0·54-0·74	0·64	12
	Banzare station 64	32	0·24-0·26	0·25	4	0·50-0·61	0·55	12
	Banzare station 64	30	0·22-0·29	0·25	5	0·50-0·66	0·58	13
P. aurorae	Discovery station 370	133*	0·36-0·58	0·51	8	0·72-0·82	0·78	4
	Discovery station 366	107	—	—	—	0·78-0·89	0·86	4
	Discovery station 371	56	0·23-0·42	0·32	13	0·57-0·72	0·65	17
	Discovery station 371	46	0·27-0·42	0·37	12	0·47-0·60	0·54	16
	Discovery station 371	46	0·27-0·39	0·34	9	0·53-0·70	0·63	20
	Discovery station 371	42	0·24-0·41	0·30	10	0·51-0·63	0·58	16
	Discovery station 371	34	0·24-0·36	0·28	7	—	—	—
	Banzare station 107	75	0·30-0·40	0·35	6	0·65-0·84	0·78	16
	Banzare station 107	68	0·24-0·35	0·28	13	0·57-0·68	0·63	13
	Banzare station 41	44	0·24	0·24	2	0·41-0·48	0·46	13
	Banzare station 105	32	0·30-0·34	0·32	4	0·43-0·58	0·48	24
P. antarcticus	Hut Point	137	0·42-0·60	0·51	4	0·75-0·78	0·77	3
	Hut Point	125	0·36	0·36	3	0·84-0·94	0·89	2
	Terra Nova station 331	105	0·24-0·31	0·28	4	0·42-0·56	0·50	10
	Terra Nova station 339	60	0·27-0·36	0·32	4	0·46-0·57	0·51	17
	Terra Nova station 356	60	—	—	—	0·39-0·50	0·45	11
	Terra Nova station 356	45	0·24-0·46	0·30	24	0·46-0·54	0·51	21
	McMurdo Bay	42	0·30	0·30	1	0·36-0·45	0·42	10

* Fisher gives R 112 mm. for this specimen but a dorsal measurement of most of the upcurled arms is about 115 mm. and the ventral length 150 mm.

Perknaster fuscus Sladen

text fig. 3a-e, pl. i, figs. 4, 5.

Perknaster fuscus Sladen, 1889, 551-552, pl. lxii, fig. 1, pl. xcvii, figs. 3, 4; Fisher, 1940, 136-137, fig. A1, 2, 4, pl. v, fig. 1., pl. vi., fig. 1.

Cribrellopsis rallieri Koehler, 1917, 37-40, pl. v., figs. 6-10.

Banzare localities: Stations 52 and 53 (3 small specimens, R <20 mm., ?*P. fuscus*), Station 64 (12 specimens).

The largest specimen has R 56 mm. compared with 45 mm. in the holotype and 34-35 mm. in the paratype examined by Fisher with regard to the abactinal plates and spinelets. In the larger specimens with R >40 mm. some of the abactinal plates show a marked reduction in the size of the basal expanded part so that little is left but the column (fig. 3a, lower left). A similar form is found in the specimens of *P. charcoti* figured by Fisher (1940).

Unfortunately, in the holotype, the abactinal spinelets are damaged at the tips but in all the other specimens of *P. fuscus* examined the spinelets are markedly clavate with a broad, blunt distal end and the lateral thorns not very prominent except near the tip (fig. 3 a-e), especially in larger specimens.

Concerning the relationship between *P. fuscus* and Koehler's *Cribrellopsis rallieri*, Fisher doubted the existence of actinal papulae such as were described by Koehler in the latter, attributing this to the pustular external appearance of the skin. As he remarks, papulae, if present, would be expected to occur on the lines which separate the groups of actinal spinelets, that is between the plates, but Koehler specifically says that they are absent along these lines. Although Fisher included *Cribrellopsis* in the synonymy of *Perknaster* and omitted *C. rallieri* from the list of included species, he hesitated to make it a synonym of *P. fuscus* without examination of the actinal body wall of the type. The largest B.A.N.Z.A.R.E. specimens are similar in size to the type of *C. rallieri* (R =48 mm.) and their external resemblance is so close that I cannot believe *C. rallieri* is distinct. This can be seen from pl. i figs. 4 and 5 when compared with Koehler's pl. v., figs. 7, 10, 1917.) Apart from the papulae, the only significant difference between the description of *C. rallieri* and the specimens of *P. fuscus* seems to lie in the adambulacral spines. Koehler gives the number as two in *C. rallieri* and these are arranged in an oblique line, the outer one slightly adoral to the furrow spine. He comments that sometimes a granule is found at the base of the second spine. In most of the B.A.N.Z.A.R.E. specimens occasional isolated adambulacral plates, particularly along the proximal third of the furrow, bear only two spines and sometimes this is true of several consecutive plates, but usually there are three spines.

All these specimens of *P. fuscus* superficially appear rugose on the abactinal side, contrasting with the much smoother-looking specimens of *Perknaster* taken off the Antarctic continent which I am referring to *P. aurorae*. This is correlated with the relatively larger abactinal spinelets of *P. fuscus* but may be partly attributed to the

less thickened skin and muscular layer and the retention of larger-based abactinal plates making the body wall more rigid. It should also be mentioned that the lengths of the spinelets in some of the smaller 'Discovery' specimens of *P. aurorae* approach those found in *P. fuscus* of comparable size, but the specimens from B.A.N.Z.A.R.E. stations 41, 105, and 107 and from the Ross Sea all have the spinelets relatively much smaller.

TYPE LOCALITY. Off Royal Sound, Kerguelen, 45 metres.

RANGE. Known from Kerguelen and Heard Islands in 45 to 137 metres.

PERKNASTER AURORAE (Koehler)

text fig. 3f-k.

Cryaster aurorae Koehler, 1920, 120, pl. xxvii, figs. 1-3, 5, 6, pl. xxviii, figs. 1-11, pl. xxix, figs. 2-6, pl. xxx, figs. 2-5, pl. lxxv, fig. 1; 1923, 73.

Perknaster aurorae, Fisher, 1940, 146, fig. C 1-3, pl. vii, fig. 2.

BANZARE LOCALITIES: Stations 39 (1 specimen), 41 (OTL 1 specimen), 42 (1 specimen), 105 (4 specimens), 107 (2 specimens).

Koehler described this species from specimens ranging in size from R 17 to 140 mm. taken off Queen Mary and Adélie Lands. In 1923 he referred to *Cryaster aurorae* three small specimens with R up to only 40 mm. from the Shag Rocks, South Georgia and Graham Land. Fisher (1940) found no further examples from these localities but recorded as *Perknaster aurorae* a number from the South Sandwich Islands which he described in some detail. These appear to differ from the types in having the abactinal spinelets even more clavate and thorny, though the largest specimen, with R c. 130 mm., has the thorns resorbed (fig. 3f) and the general shape closer to those of Koehler's specimens with R 85-125 mm. (1920, pl. lxxv, fig. 1c).

The two largest specimens in the present collection, with R 75 and 68 mm. from station 107, differ slightly from those already recorded in the shape of the abactinal spinelets (fig. 3i, j) which are clavate but have the thorns directed more nearly at right angles to the long axis than in either the 'Discovery' or A.A.E. specimens. The smaller specimens from stations 41 and 105 (R 44 mm. or less) have the more numerous thorns inclined distally and connected by trabeculae as in all but the largest 'Discovery' specimens.

The two large specimens are also superficially rather different from the rest. After nearly thirty years in spirit they are grey in colour dorsally, whereas the others are various shades of light brown. Also the rays of these two are curved dorsally and the furrows are distended, with the tube feet projecting and crowded, whereas the smaller ones have the furrows contracted and the tube feet more or less retracted. The two big specimens have 80-84 adambulacral plates in each series, approximating to the number found in the 'Discovery' specimen with R 70 mm.

TYPE LOCALITY. Off Adélie and Queen Mary Lands, 45-275 metres.

RANGE. Known from Enderby Land east to Adélie Land and from Graham Land, South Georgia, Shag Rocks and the South Sandwich Islands in 45 to 310 metres.

PERKNASTER SLADENI (Perrier)

text fig. 3p

Cribraster sladeni Perrier, 1891, 104, pl. xi, fig. 2a, 2b; Koehler, 1912, 39, pl. ii, fig. 12, pl. vi, fig. 6.

Perknaster sladeni Fisher, 1940, 140, fig. B 3, 4, pl. vii, fig. 1.

BANZARE LOCALITY: Station 107 (one specimen).

R of this specimen is 55 mm. It is at once distinguished from the two examples of *P. aurorae* taken at the same station by the more rigid abactinal skeleton with more slender and numerous radiating spinelets on each paxilla. Whereas in *P. aurorae* each secondary plate usually has only a single spinelet, in *P. sladeni* there are four to six spinelets. Dissolving some of the skin in situ reveals an irregular network formed by the primary plates, with the secondary ones more or less spaced in the meshes. Ventrally the much more prominent groups of actinal spinelets, usually numbering three, also serve to distinguish this specimen from those of *P. aurorae*. The abactinal pedicels are distinctly taller than those of *P. aurorae*, *P. antarcticus* or *P. fuscus*, seven plates from the proximal part of a ray averaging 0·67 mm. in height, while 28 spinelets ranging in size from 0·58-0·84 mm. average 0·76 mm. All the spinelets are widest at the base and moderately thorny in the distal third of their lengths, as in the 'Discovery' specimens of *P. sladeni* though Fisher gives the length of these, when R is 50-53 mm., as up to 0·7 mm. and the pedicels as up to 0·55 mm. in height. Confirmation is needed that the subantarctic type specimen also has pedicels and spinelets of these proportions, but there is no doubt that this B.A.N.Z.A.R.E. specimen is conspecific with those from the Palmer Archipelago and Shag Rocks, making an interesting, though not unexpected, extension of range.

TYPE LOCALITY. Falkland Islands.

RANGE. Known from the Falkland Islands, Shag Rocks, Palmer Archipelago and MacRobertson Land in 199 to 500 metres.

Perknaster densus Sladen

Perknaster densus Sladen, 1889, 552-553, pl. xcvii, figs. 1, 2, pl. xcviii, figs. 11, 12; Fisher, 1940, 138-140, fig. A3, pl. viii, figs. 1, 2.

Banzare locality: Station 47 (8 specimens).

All these specimens are more or less distorted in preservation. The largest has R 55 mm. It has two furrow spines on each proximal adambulacral plate to a distance of about 30 mm. from the mouth. The second largest specimen has R about 38 mm. and there are two, diagonally placed, furrow spines on only the first three or four adambulacral plates.

The largest B.A.N.Z.A.R.E. specimen of the other species of *Perknaster* known from Kerguelen, *P. fuscus*, is comparable in size to that of *P. densus*. It differs in having only rare, isolated, proximal adambulacral plates with more than one furrow spine and in the sparse actinal spinelets, numbering up to four on each plate but usually only one, whereas the largest *P. densus* has clusters of usually four to eight much finer spinelets. In *P. densus* the abactinal spinelets also appear to be more numerous, numbering five or six on most proximal plates. They measure 0·47-0·49 mm. in length. The abactinal plates have large, thin horizontal bases.

Type locality. Off Cumberland Bay, Kerguelen, 232 metres.

Range. Known from Kerguelen and Marion Island in 101 to 232 metres.

Family ASTERINIDAE

Key to the Southern Species

1 (12) Abactinal plates usually thick, convex and some or all of them crescentic in shape with a conspicuous papular pore on the proximal side within the arms of the crescent.†

2 (3) Rays fairly long, R/r 2·3/1 or more (Chile, about 36°-43° S., and Argentina, about 37°-46° S., 0-107 m.). *Patiria obesa* (H. L. Clark), 1910

3 (2) Rays short, R/r about 2/1 or less.

4 (7) Form pentagonal, R/r usually much less than 2/1.

5 (6) Abactinal spinelets few, about five along one edge of each plate. (Patagonia, Falkland Is., ? Graham Land, 0-300 m.). *Patiriella fimbriata* (Perrier), 1875

6 (5) Abactinal spinelets very numerous, a cluster of up to 100 on the largest plates. (Auckland and Campbell Is., littoral). *Asterina aucklandensis* Koehler, 1920

7 (4) Interbrachial arcs indented, R/r about 2/1; abactinal plates closely covered with more or less numerous and evenly spaced spinelets.

8 (9) Abactinal plates obviously of two sizes, even when covered with spinelets; several spines along furrow margin of each adambulacral plate (both characters presumed from *A. stellifer*) (Magellan Strait, 50-70 m.). *Asterina stellifer obtusa* Leipoldt, 1895

9 (8) Abactinal plates of one magnitude; only one spine on furrow margin of each adambulacral plate.

10 (11) About 9 spinelets on each abactinal plate when R is 10 mm. or 12 when R is 14 mm. (Kerguelen, 0-20 m.). *Asterina frigida* Koehler, 1917*

11 (10) About 20 spinelets on each abactinal plate when R is 16 mm. (Macquarie I., littoral) . *Asterina hamiltoni* Koehler, 1920*

12 (1) Abactinal plates thin, flat, not crescent-shaped, papular pores inconspicuous.

13 (14) Marginal plates small, the abactinal and actinal plates decreasing in size towards the marginals. (South Shetland Is. 342-600 m.) . . . . . *Anseropoda antarctica* Fisher, 1940

14 (13) Marginal plates large and the adjacent plates not reduced in size.

15 (16) Abactinal plates of radial areas irregularly arranged, no interradial grooves in the plates themselves, though there may be a space between them in small specimens with R 6 mm. or less; margin usually rounded (Enderby Land to the Ross Sea and off the Graham Land peninsula, 93-750 m.) . . . . . *Kampylaster incurvatus* Koehler, 1920

16 (15) Two regular rows of abactinal plates radially; the interradial plates joined and grooved; margin acute owing to the tabular shape of the infero-marginal plates (Shag Rocks and Clarence I., 177 and 342 m.) . *Mirastrella biradialis* Fisher, 1940

Genus Patiria Gray

Patiria obesa (H. L. Clark)

Parasterina obesa H. L. Clark, 1910, 334-335, pl. iii, figs. 1, 2.

Patiria obesa, Madsen, 1956, 24, pl. iii, figs. 1-5.

This subantarctic species was not taken by the B.A.N.Z.A.R.E. However, it should be recorded that, while examining the 'Discovery' specimens of *Cycethra verrucosa*, I found that four of those which Fisher had named forma *nitida* are not *Cycethra* at all but are Asterinids close to, if not identical with, *Patiria obesa*. When the abactinal plates were denuded they were revealed as crescentic in shape and non-paxilliform. These specimens were from stations WS 776 (off Cape Tres Puntas, Argentina, c. 46° S., 107-90 m.) and WS 852 (off Argentina, c. 44° S., 84 m.).

They differ slightly from the Chilean specimens of *P. obesa* figured by H. L. Clark and by Madsen, in having more finger-like rays, broader and more rounded at the tips. In some of them the distal supero-marginal plates are conspicuously enlarged on the dorsal surface.

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† Juvenile specimens of *Cycethra* may run down to here.

* I can find no better distinction between these two species.

Madsen has recorded an Argentinian specimen of *P. obesa* from near Mar del Plata (37° 30′ S.), of which the depth is not given. The 'Discovery' specimens therefore provide a considerable extension of the depth range.

TYPE LOCALITY. Talcahuano, Chile.

RANGE. Known from about 36-43° S. off Chile and 37-46° S. off Argentina in 0 to 107 metres.

Genus ASTERINA Nardo

ASTERINA FRIGIDA Koehler

Asterina frigida Koehler, 1917, 46-48, pl. vi, figs. 9-11, pl. vii, fig. 8; Madsen, 1955, 13.

?Cycethra verrucosa, Döderlein, 1928, 296. Non *verrucosa* Philippi 1857, which is valid.

BANZARE LOCALITIES: Stations 5 (1 specimen), 56A (2 specimens).

Some remarks concerning this species are given under the heading of *Cycethra macquariensis* on p. 24 and p. 25.

TYPE LOCALITY. Kerguelen (details unknown).

RANGE. Known from shallow inlets at head of Royal Sound, Kerguelen, in 0-20 m.

Genus KAMPYLASTER Koehler

KAMPYLASTER INCURVATUS Koehler

Kampylaster incurvatus Koehler, 1920, 138-139, pl. xxxvi, figs. 4, 6-8, 12, pl. xxxvii, figs. 1-3, pl. lxvi, fig. 10; Fisher, 1940, 150-152, fig. D3; Madsen, 1955, 13.

Cycethra verrucosa, Grieg, 1929, 6. Non *verrucosa* Philippi, 1857, which is valid.

BANZARE LOCALITIES: Stations 39 (14 specimens), 40 (5 specimens), 41 (TML 7 specimens), 42 (3 specimens), 107 (2 specimens).

Most of these specimens are preserved in an arched position with the dorsal side convex, as is usual in this species. The largest specimen has R about 13 mm.

Fisher (1940) has distinguished the genus *Mirastrella* (type *M. biradialis*) from *Kampylaster* by the presence of a double series of radial plates along each ray, tabulate infero-marginal plates with a marginal fringe of spinelets, specialized abactinal interradial grooves and the absence of a basal expansion to the abactinal spinelets of *Mirastrella*.

Koehler described *Kampylaster incurvatus* as having four series of plates along the dorsal side of each ray flanked by the marginals, that is two radial rows and two adradial ones. However, Fisher seems to think that a single radial series is normal in *Kampylaster*, his larger specimens having the adradial plates approximating from each side and tending to separate the consecutive plates of the radial row.

In some of the B.A.N.Z.A.R.E. specimens from stations 41, 42 and 107 with R 5 mm. or more which have been partially cleared of spinelets, the abactinal plates form a continuous, smooth surface, imbricating inwards from the marginals with no regular radial rows. The infero-marginal plates give a rounded edge to the body in these specimens. There are no signs of interradial grooves. In the larger specimens with R exceeding 7 mm. the spinelets have a thorny, globose head, a narrow waist and an expanded discoidal base, but smaller specimens have spinelets with narrower heads and bases, approximating to a dice-box shape.

Of the five specimens from station 40, the largest (R 9 mm.) resembles those just mentioned, having the disc rounded at the edges. The second largest (R 8 mm.), though also with a continuous covering of abactinal plates lacking regular radial rows, does have the edge of the disc more acute. Its infero-marginal plates are not tabular but the distal ones particularly appear distinctly convex in profile (i.e. in dorsal or ventral view) giving a scalloped appearance to the denuded ray. There are no interradial grooves and the abactinal spinelets have expanded discoidal bases. The three small specimens from this station, with R about 5 mm., are more markedly divergent; the infero-marginals are tabulate with a short, ventro-laterally directed process on each bearing a fan of four or five very thorny-tipped spinelets; the plates of the radial areas are small and not imbricated but isolated in the skin though one row of plates adjacent to the supero-marginals is large and overlapping as in the larger specimens; finally there is a suggestion of interradial grooves, though this is due to the separation of the plates. All the specimens from station 39 are small, with R up to 6 mm. and are similar to the small ones from station 40, with more or less isolated radial plates and apparently sharp edges to the discs.

A denuded juvenile of *K. incurvatus* with R less than 2 mm., from the brood of a 'Discovery' specimen, was found to have the abactinal plates continuous and imbricating throughout.

The types of *Mirastrella biradialis* are also small with R up to 6 mm. But the infero-marginal plates have a higher tabulum with five or six lateral granules and about three terminal spinelets; the interradial grooves are formed by the plates themselves and the abactinal plates are continuous and overlapping throughout.

It may be that these small B.A.N.Z.A.R.E. specimens from stations 39 and 40 have a paedomorphic tendency with retarded development of the abactinal plates and juvenile prominence of the infero-marginals. The smaller specimens of similar size from stations 41, 42 and 107 all approximate more to the adult form.

TYPE LOCALITY. Off Adélie Land, 276 metres.

RANGE. Known from Enderby Land eastwards to the Ross Sea and from the Palmer Archipelago and South Shetlands in 93 to 750 metres.

Family PORANIIDAE

The only Southern Ocean species of this family at present accepted is *Porania antarctica* Smith, with synonyms *P. magellanica* Studer, *P. armata* Koehler and *P. spiculata* Sladen. It has two subspecies overlapping in range, *antarctica* from the Magellan area, Marion Island and Kerguelen and *glabra* Sladen from antarctic localities and again from Kerguelen—this island being the type locality for both subspecies. Fisher and Madsen think that the Magellanic form may be distinct from the Marion-Kerguelen *antarctica* in which case the name *magellanica* is available for it.

Genus PORANIA Gray

PORANIA ANTARCTICA Smith

Porania antarctica Smith, 1876, 108; 1879, 275-276, pl. xvii, fig. 1; Studer, 1885, 160; Sladen, 1889, 360, pl. lix, fig. 3; Perrier, 1891, 107; Ludwig, 1903, 22-24, pl. ii, figs. 18-20; 1905, 51-53, pl. vi, fig. 1; Koehler, 1906, 10; 1911, 27-28; 1912, 66-68; 1917, 42-43; 1920, 178-179, pl. xxxiii, figs. 6, 7; 1923, 74-75; Fisher, 1940, 154-155; Madsen, 1956, 27-28.

Porania magellanica Studer, 1876, 459; Sladen, 1889, 363, pl. lix, fig. 5.

Porania glaber Sladen, 1889, 360-362, pl. lix, figs. 1, 2.

Porania spiculata Sladen, 1889, 362-363, pl. lix, fig. 4.

Porania armata Koehler, 1917, 43-46, pl vii, figs. 3, 4, 7, 12; Döderlein, 1928, 297.

Porania antarctica glabra, Fisher, 1940, 155-158; Madsen, 1955, 14.

BANZARE LOCALITIES: Stations 8 or 15 (2 juvenile specimens), 12 (1 young specimen), 34 (2 specimens), 39 (3 young specimens), 40 (2 young specimens), 41 (TML, 7 young specimens, OTL, 3 young specimens), 42 (6 young specimens), 52 and 53 (3 young specimens), 90 (4 specimens), 105 (42 young specimens), 107 (1 young specimen).

The holotype of *P. antarctica* has R 50 mm. and is very similar to the types of *P. armata* Koehler (also from Kerguelen) which name Fisher believes is synonymous with subspecies *glabra* and Madsen with subspecies *antarctica*. The distinction between the two subspecies is supposed to be the presence of abactinal tubercles in *antarctica* and their absence in all but some juvenile specimens of *glabra*. However, four out of the seven large syntypes (R 70-90 mm.) of *glabra* have a few diminutive tubercles and in one of them these are almost as numerous as in the type of *antarctica*, the slight difference between them being enhanced by the poorer preservation of the latter specimen, the greater dehydration causing shrinkage of the body wall and unnatural prominence of the skeleton.

The B.A.N.Z.A.R.E. collected only six specimens of *Porania* at Kerguelen and, unfortunately, all these are small with R $<$20 mm. Four of them have abundant abactinal tubercles and are similar to others of about the same size from the South Shetlands and Clarence Island which Fisher named *glabra*; the other two have no tubercles.

As for Marion Island specimens, those taken by the 'Challenger' and 'Discovery' are variable in the development of the abactinal tubercles. The minimum in the adult specimens is about the same degree of development as is shown by the type of *antarctica* which represents about the maximum found in adult Kerguelen specimens. Most of the Marion Island examples have much more highly developed tubercles, like specimens from the Magellanic area. From the zoogeographic viewpoint I believe it is more probable that the same subspecies occurs at Marion Island as in the Falkland-Magellan subantarctic area and that this is distinct from the subspecies at Kerguelen, across the Antarctic Convergence. However, Fisher referred to *P. antarctica glabra*, three specimens from off Marion Island, which he considered to be intermediate between *glabra* and *antarctica*, since two of them have about ten small abactinal tubercles, though the third has only a single one. These are very like the four types of *glabra* which have a few tubercles. From the present evidence it appears that adult Kerguelen specimens exhibit a narrow range of tubercle development from none at all to only a few incon-

spicuous ones, while at Marion Island the maximum is much greater with numerous tubercles. I have not seen many specimens from the Magellanic region but the tendency there seems to be for a moderate number of enlarged tubercles rather than many small ones.

Also very variable are the shape of the body—the sides of the disc and rays ranging from evenly rounded to acutely angular at the margin—and the development of the marginal fringe of spines. Dr. H. B. Fell and Miss Helen Clark of the Victoria University of Wellington, who are working on the A.N.A.R.E. collections from off MacRobertson Land and others from the Ross Sea, suspect that there is a distinct type of *Porania* in the MacRobertson Land area differing from *glabra* in having the marginal spines greatly reduced, often completely absent and at the same time the margin almost invariably simply rounded. Prompted by them, I examined the British Museum material from other parts of the Southern Ocean with regard to these characters and to the position of the genital pores, which they had found to be on the abactinal surface above the marginal plates in MacRobertson Land specimens but on the actinal side in others from the Ross Sea. The numerous small B.A.N.Z.A.R.E. specimens from off Enderby and MacRobertson Lands agree with their findings, most specimens having few, if any, marginal spines, the margin rounded and the genital pores situated above the marginal plates. Unfortunately in specimens of *Porania* of size larger than R 20 mm. it is almost impossible to distinguish the genital pores externally among the numerous papular openings. Dissection will reveal the direction in which the genital duct leaves the gonad but it is difficult to follow it to its conclusion. Most of the available specimens from Kerguelen are of large size and even in the few small ones (such as some of the syntypes of *P. spiculata*) the openings are imperceptible. Several larger ones from this area which were dissected have the ducts passing towards the abactinal side and in one of them the openings to the exterior are probably at about 5/6 r from the centre. Abactinally directed ducts were also found in the large specimens from Bouvet Island and the Palmer Archipelago taken by the 'Discovery', but in 29 small specimens from South Georgia the openings are distinct. Here too they are situated on the abactinal side, about the width of a marginal plate above the marginal series as in the B.A.N.Z.A.R.E. specimens from off Enderby and MacRobertson Lands. In contrast, six small specimens from the Ross Sea area were found to have a pair of pores, sometimes a single pore in each interradius on the *actinal* side just proximal to the marginal plates. This confirms the findings of Fell and Helen Clark in Ross Sea material.

As for the shape of the margin and the development of the marginal fringe, most of the Marion and Kerguelen specimens have the edge rounded. The marginal spines are inconspicuous in dorsal view though nearly always forming a complete series, except towards the arm tips in those with the abactinal tubercles undeveloped. This applies to the few small specimens as well as to the larger ones. In the Ross Sea area, however, although the smaller examples usually have the margins obtuse and the fringe inconspicuous dorsally, when R exceeds 20-25 mm. the shape is much more flattened and the margin acute with the fringe fairly prominent. The same appears to be true on average in the Weddell Quadrant, though unfortunately no good size ranges are found in the material from any one area, there being only small specimens from South Georgia and the South Shetland area and only large ones from the South Sandwich Islands and the Palmer Archipelago. The large specimens from antarctic Bouvet Island also have the margin more or less acute unlike those from Marion Island, and Kerguelen. The Bouvet specimens are remarkable in having a particularly rigid skeleton.

The small South Georgia specimens are similar in size to those from MacRobertson and Enderby Lands in the B.A.N.Z.A.R.E. collection, but only one out of the 29 examined has the marginal spines completely lacking although several others have as few as four spines in each interradial arc. In most of them the marginal spines are inconspicuous in dorsal view, the edge being rounded and the marginal plates displaced ventrally in the interradii. The form with paucispinous marginals, so common in the vicinity of MacRobertson Land, thus appears to be exceptional in the South Georgia area.

However, the B.A.N.Z.A.R.E. also took six other specimens of *Porania* from stations off the Antarctic continent which are very different from these paucispinous ones, having the body flattened and a complete fringe of spines along the acute margin; also the abactinal side is more or less rugose owing to a number of fine tubercles, though these may be inconspicuous. Unfortunately I have not been able to distinguish the external positions of their genital pores. Four of these specimens are from off Adélie Land (station 90) and range in size from R 12 to 23 mm., while the other two are from off Kemp Land (station 34) (which is between MacRobertson and Enderby Lands) and have R 24 and 40 mm. Since even the smallest ones have the same flattened form coupled with numerous marginal spines, the marked difference from the rounded paucispinous Enderby and MacRobertson specimens cannot be attributed to size difference. These six specimens are more like the few from the Ross Sea area with R over 25 mm. which I have seen, though small examples from there are usually more rounded laterally. It is to be hoped that Fell and Helen Clark are able to clarify the interrelationships of the antarctic Poranias from their material.

To sum up, I believe that *P. glabra* should be considered as a synonym or, at best, a forma of *P. antarctica* since the type specimen of the latter exhibits almost the minimum development of the multi-tubercular form which has been considered as characteristic of *P. antarctica*. At the same time there are probably at least two other distinct forms, an extremely paucispinous (possibly dwarfed) one from the Enderby Quadrant of the antarctic and another from the Ross Sea, the latter possibly warranting a higher taxonomic rank since it is distinguished by the different position of the genital openings.

TYPE LOCALITY. Swain's Bay, Kerguelen, 18 metres.

RANGE. Known from Kerguelen, Marion and Bouvet Islands, the Falkland-Magellan area north off Chile to about 30° S. and off Argentina to 35° S., South Georgia, the Shag Rocks, South Sandwich, South Shetland and Clarence Islands, the Bellingshausen Sea and Enderby Land eastwards to the Ross Sea, in 4 to 2926 metres.

Family ECHINASTERIDAE

As usual with this difficult family the identification of the new material poses a number of problems, even with regard to the generic names to be used. Of the two largest genera, *Henricia* is commonly distinguished from *Echinaster* by the small, numerous abactinal spinelets which are not isolated from each other and by the presence of actinal papulae. However, even Fisher, who probably had the widest experience of this family, has included in *Henricia* Perrier's *Echinaster ornatus* from South Africa as well as a specimen from Marion Island which he believed to be referable to *Cribrella simplex* Sladen, though both of these have no actinal papulae.

On geographical grounds there is no definite distinction since *Henricia* has some equatorial (though deep-water) species as well as the more numerous cold temperate and polar species. Nearly all the well-authenticated species of *Echinaster* are from tropical or warm temperate waters; however, several species have been described from the Southern Ocean under the name of *Echinaster*. These include *E. spinulifer* Smith from Kerguelen, *E. smithi* Ludwig from the Bellingshausen Sea west of Graham Land and *E. diffidens* Koehler (1923) from Graham Land and South Georgia, besides three species from the Australasian Antarctic Expedition—*E. hirsutus*, *E. pterasteroides* and *E. smilax* of Koehler, 1920. In none of these have actinal papulae been described.

The B.A.N.Z.A.R.E. took some specimens from Kerguelen which are identifiable with *E. spinulifer* and at the same time indistinguishable from Sladen's *Cribrella simplex* var. *granulosa*, which I believe to be a synonym. In the holotype of *E. spinulifer* the abactinal spinelets are in linear series along the skeletal meshes, not isolated, but some of the other specimens have the spinelets more numerous and crowded. In wet specimens the interstitial papulae simulate the spinelets so that there seems to be a continuous covering of granules over the whole dorsal surface. In spite of the absence of actinal papulae I am referring *spinulifer* to *Henricia* on account of the multiple abactinal spinelets, just as Fisher has done with species such as *Echinaster ornatus*.

Koehler, 1920, gave photographs of the holotype of *E. smithi* which show that the abactinal plates form quite regular longitudinal and transverse series, somewhat as in *E. brasiliensis*. This regular arrangement certainly excludes *E. smithi* from *Henricia*.

Fisher (1940) has referred *Echinaster diffidens* to *Henricia* on the evidence of some small specimens (R 17 mm. or less) from subantarctic localities on the Falkland Plateau. These specimens appear to show some differences from the types, which were from the Antarctic, notably the much more open abactinal reticulation with several papulae within each mesh and the more numerous and elongate actinal and marginal spinelets. Koehler emphasized the resemblance of *E. diffidens* to his *E. smilax* but the 'Discovery' specimens seen by Fisher are more like *Henricia pagenstecheri*. Even the types of *E. diffidens*, however, differ from *E. smilax* in having the abactinal spinelets serially arranged, not isolated, and I think *diffidens* should be included in *Henricia* on this account whether or not the 'Discovery' specimens are conspecific with Koehler's.

The B.A.N.Z.A.R.E. took no specimens referable to *E. smithi* or *H. diffidens* but at several stations in the Enderby Quadrant Echinasterids of four other kinds were taken, including the two species Koehler named *Echinaster hirsutus* and *E. smilax*. I have concluded from this material that *E. pterasteroides* is a synonym of *E. hirsutus*. In 1940 Fisher proposed a new genus, *Rhopiella*, for type *R. koehleri* a new species from the Palmer Archipelago and the South Sandwich Islands. He included in the genus also *E. hirsutus*, *E. pterasteroides* and tentatively *E. smilax*, also, even more doubtfully, *E. smithi*. (This last suggestion must have been made without reference to Koehler's photographs of the type of *E. smithi* which show that the rays are narrow and constricted at the base and as well the abactinal plates being serially arranged, both characters at marked variance with his diagnosis of *Rhopiella*). *E. hirsutus* is certainly congeneric and, I believe, even conspecific with *Rhopiella koehleri*, but the position of *E. smilax* is debatable. It seems to fall between *E. hirsutus* and the specimens called *Cribrella parva* by Koehler in 1920, which I believe included two separate forms. The type of *C. parva* Koehler, 1912, was from the South Shetlands and Fisher considers it is an antarctic race of *Henricia pagenstecheri*. If that is so, then there is a distinct species in the Enderby and Victoria Quadrants, since *H. pagenstecheri* has actinal papulae and I can find none in the B.A.N.Z.A.R.E. specimens that are conspecific with a proportion of those which Koehler identified as *C. parva* in 1920. Unfortunately Koehler did not mention the occurrence of actinal papulae in his description of the type of *C. parva*. It can only be assumed that they were inconspicuous, if not absent. I am therefore identifying some of the present specimens with *parva* while others with the spinelets of a slightly different shape and more isolated in arrangement I am describing as a new forma *tenuis* of *smilax*. It appears from the intergrades found that *parva*, *tenuis* and *smilax* probably hybridize, but these intergrades are few and the majority of specimens can be given one name or another without much hesitation. Since the differences

between them are slight and a generic distinction between *smilax* and *parva* is inconceivable, it seems best to refer *smilax* also to *Henricia*. Its spinelets are much more diminutive than in most species of *Echinaster* and their isolation is only a little more marked than in *Henricia asthenactis* Fisher from the North Pacific.

It should be mentioned that Döderlein (1928) has recorded *Echinaster smilax* from Wilhelm II Land with the comment that inconspicuous actinal papulae are present. Possibly he was deceived by the pitted appearance of the actinal skin which is also present in some of the B.A.N.Z.A.R.E. specimens but not in others.

Echinaster smithi is therefore left as the only representative of the genus *Echinaster* in the Southern Ocean.

With regard to the brood-rearing habits of the antarctic members of the Echinasteridae, this phenomenon has already been recorded in *Cribrella* (now *Henricia*) *parva* by Koehler in 1920 and in *Rhopiella koehleri* by Fisher (1940). The present collection shows that it also occurs in *Henricia smilax* and in *Rhopiella hirsuta* (though I believe this is only subspecifically distinct from *R. koehleri*). It may prove to be general in the polar species of the family; at least the northern *Henricia sanguinolenta* has long been known to incubate the brood, as well as species such as *H. leviuscula* from the North Pacific.

Key to the Southern Species

1 (2) Abactinal plates arranged in regular longitudinal and transverse rows (Bellingshausen Sea, 450 m.). *Echinaster smithi* Ludwig, 1903

2 (1) Abactinal plates forming an irregular reticulum, rarely indistinct longitudinal series may be evident.

3 (9) Abactinal plates with isolated, prominent spines, at least one millimetre long; rays more or less triangular, always widest at the base.

4 (5) No spine on the furrow face of the adambulacral plates; no intermarginal papulae (Patagonia, Gough I., South Africa, 30-420 m.) . . . . . *Poraniopsis echinaster* Perrier, 1891

5 (4) A furrow spine present on each adambulacral plate; intermarginal papulae present . . *Rhopiella hirsuta* (Koehler), 1920

6 (7, 8) Usually four subambulacral spines (Palmer Archipelago, S. Sandwich Is., 93-335 m.) . . *R. hirsuta koehleri* Fisher, 1940

7 (6, 8) Usually three subambulacral spines (Enderby Land to Adélie Land, 163-655 m.). . . . *R. hirsuta hirsuta* (Koehler), 1920

8 (6, 7) Usually two subambulacral spines (Kerguelen, 51-220 m.) . . . . . *R. hirsuta kerguelenensis* subsp. nov.

9 (3) Abactinal plates with small, usually numerous, rarely isolated, spinelets, less than a millimetre in length; rays usually almost cylindrical, often constricted at the base . . . . . *Henricia* Gray, 1840

10 (26) Subambulacral spines usually 4-5 in number, normally arranged in a single, sometimes irregular, row across the plate, rarely some of the spines duplicated on odd plates; abactinal spinelets usually in linear series or isolated, rarely more numerous.

11 (15) Proximal actinal papulae present between the actinal plates or between the actinal and infero-marginal plates. *H. pagenstecheri* group

12 (13, 14) South Georgia, Shag Rocks, 17-250 m.* . . . . . *Henricia pagenstecheri* (Studer), 1885

13 (12, 14) Tristan da Cunha, 80-274 m.* . . . . . *Henricia simplex* (Sladen), 1889

14 (12, 13) Auckland and Campbell Is., shore* . . . . . *Henricia lukinsi* (Farquhar), 1898

15 (11) Actinal papulae absent or only occurring between the infero-marginals and adambulacrals distally beyond the partial actinal series of plates.

16 (17) Up to seven, commonly three or four, papulae in each abactinal mesh (Marion and the Crozet Is., 108-385 m.) *Henricia fisheri*, sp. nov.†

17 (16) One to three, usually only one, abactinal papulae in each mesh.

18 (21) Abactinal spinelets few, isolated, usually only 4-6 around each mesh, that is one on each skeletal plate; spinelets smooth or only slightly rugose at the tip (fig. 5p-s, v-y)‡ . . . . . *Henricia smilax* (Koehler), 1920

19 (20) Abactinal spinelets usually tapering from the base to a truncated, fairly smooth, tip (fig. 5v, w); abactinal reticulation coarse (fig. 5a) (Enderby Land eastwards to the Ross Sea, 47-603 m.) . . *H. smilax* forma *smilax* (Koehler), 1920

20 (19) Abactinal spinelets narrowest in the middle, tapered only near the tip and rounded (fig. 5x, y); abactinal reticulation delicate and open (fig. 5b) (Enderby to Queen Mary Lands, 193-300 m.) . . . . *H. smilax* forma *tenuis*, forma nov.

21 (18) Abactinal spinelets in continuous linear series along the meshes, usually at least 10 around each mesh; spinelets more or less thorny towards the tip.

22 (23) Actinal spinelets reduced in size and number, the adambulacral spines standing out prominently in a *chevaux-de-frise* and sometimes separated from the actinal spinelets by a naked area (Kerguelen, 0-90 m.) . . *Henricia spinulifera* (Smith), 1876

23 (22) Actinal spinelets well-developed, except sometimes interradially, not abruptly smaller than the adambulacral spines which are graduated in size to them.

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* I can find no reliable characters by which to distinguish these three species, Fisher's use of the occurrence of actinal papulae having proved mistaken for separating *H. pagenstecheri* and *H. simplex*. Fisher himself has discarded Mortensen's distinctions between *H. pagenstecheri* and *H. lukinsi*.

† One of the type specimens of *Henricia diffidens* (Koehler) 1923 from South Georgia (pl. ix, fig. 10 of that work), appears to have multiple papulae though the description specifically states that the papulae are single as in the specimen from station 6 off Graham Land (pl. viii, fig. 1). Fisher (1940) has referred to *H. diffidens* some subantarctic specimens which also have several papulae in each of the much larger and more irregular meshes. Since Koehler emphasized the resemblance of *H. diffidens* to *H. smilax*, the latter consistently having single papulae, I am assuming that the multi-papular specimens are referable to another species. The (?larger) specimen from Swedish Antarctic Expedition station 6, which both answers the description and is the only one figured both dorsally and ventrally, should be taken as the holotype of *H. diffidens*. Further discussion of this species is given under the heading of *H. parva*.

‡ The position of *H. diffidens* at this point of the Key is again uncertain, since, although Koehler included the species in *Echinaster* and emphasized its close relationship with *E. smilax*, he described the abactinal spinelets as 'forment de petites rangées dressés qui suivent les sinuosités du réseau calcaire'. This would seem to refer *H. diffidens* to 21. The spinelets themselves are more thorny at the tips than those of *H. smilax* to judge from the description. Both these characters link *H. diffidens* with *H. parva* and, in fact, I can find no reliable character by which to separate them, though if the specimen of *H. diffidens* from Swedish station 6 is taken as the type than the abactinal spinelets are more sparse than is usual in *H. parva*.

24 (25) S. Shetland Is., Enderby to Adélie Lands, 163-456 m. . . . . *Henricia parva* (Koehler), 1912

25 (24) Off Graham Land [? South Georgia], 125 [?75]-150 m. . . . . *Henricia diffidens* (Koehler), 1923

26 (10) Subambulacral spines more numerous, arranged in two rows or in clusters on all the plates; abactinal spinelets numerous, usually in multiple series or clusters.

27 (30) Abactinal spinelets of solid form, semi-opaque, with irregular tips (fig. 5m, n); subambulacral spines often in two rows, similarly solid.

28 (29) Actinal and marginal plates linked by bar-like plates, most of them not directly in contact with one another (fig. 6a); abactinal reticulation very open (Falkland-Magellan area, Tristan da Cunha, Macquarie I., vicinity of Tasmania, 0-450 m.). *Henricia obesa* (Sladen), 1889

29 (28) No bar-like connecting plates between marginals and actinals which are all in direct contact; abactinal reticulation compact (Auckland, Campbell and Chatham Is., shore). . . . . *Henricia aucklandiae* Mortensen, 1925*

30 (27) Abactinal spinelets tapering abruptly within the first half of their length and for the rest only fenestrated and opaque through the centre, the few lateral flanges being transparent and terminating in usually sharp points (fig. 5 f, g, j, l); subambulacral spinelets fine, numerous and clustered.

31 (32) Larger specimens (R > 30 mm.) with abactinal reticulations subdivided, primary and secondary reticulations being distinct when the plates are denuded (Marion and the Crozet Is., 91-284 m.). . . . . *Henricia praestans* (Sladen), 1889

32 (31) No distinction of secondary and primary reticulations (presumed in *H. compacta* since the unique holotype has R only 15·5 mm.).

33 (34) Falkland-Magellan area, 74-341m† . . . . . *Henricia studeri* (Perrier), 1891

34 (33) Tasman Sea W. of South Island, New Zealand, 503 m.† . . . . . *Henricia compacta* (Sladen), 1889

Genus Rhopiella Fisher

Rhopiella hirsuta (Koehler)

text figs. 4a, b, e-i, 5c, pl. ii, figs. 1, 2.

Echinaster spinulifer, Sladen, 1889, 555. Non *spinulifer* Smith, 1876, which is a valid sp. of *Henricia*.

Echinaster hirsutus Koehler, 1920, 113-115, pl. xii, fig. 9, pl. xxiv, figs. 6-9, pl. lxvi, fig. 2.

Echinaster pterasteroides Koehler, 1920, 115-118, pl. xvi, figs. 4, 5, 8, pl. xxv, figs. 3-5, pl. lxvi, fig. 3.

Rhopiella hirsuta, Fisher, 1940, 160.

Rhopiella koehleri Fisher, 1940, 160-162, fig. E2, pl. x, figs. 1, 2.

The B.A.N.Z.A.R.E. took 20 specimens referable to *R. hirsuta* at stations off MacRobertson, Kemp and Enderby Lands. In these the abactinal skeleton is open with the larger meshes often subdivided partially by secondary plates. Not more than one papula occurs in any one mesh or subdivision and sometimes there are none at all, but some specimens exhibit a pock-marked condition of the skin resulting in the semblance of five or six pores in some of the meshes. It is probably as a result of similar pocketing of the skin in the two type specimens of *hirsuta* that Koehler described them as having one to six papulae in each mesh. The holotype of *Echinaster pterasteroides* shows a similar pock-marked appearance in Koehler's photographs. He described it as having two to six papulae in each mesh and distinguished *E. pterasteroides* from *E. hirsuta* by the more numerous and larger papulae which he thought to be more variable in size, by the finer abactinal spines and the fact that they elevate the dorsal skin noticeably and finally by the less robust appearance in *E. pterasteroides*.

Koehler's assessment of the number of papulae I believe to be wrong in both cases. Their supposedly variable size in the type of *E. pterasteroides* is improbable and supports my contention that Koehler mistook the pocketing of the skin for papular pores. The degree of elevation of the skin around the abactinal spines varies according to the preservation. It shows considerable differences in the B.A.N.Z.A.R.E. specimens. As for the difference in robustness of the types of *E. hirsutus* and *E. pterasteroides*, I doubt if this is significant and it is probably at least partly illusory, due to differences in preservation and partly to the slightly larger spine size and total size in the types of *E. hirsutus*. Table 6 shows that the range of variation in spine length is sufficiently wide to include that of the types of both *E. hirsutus* and *E. pterasteroides*. I therefore regard them as synonymous.

TABLE 6

To show the size and range of lengths for proximal spines of some of the B.A.N.Z.A.R.E. specimens (B) of *R. hirsuta*, and of the 'Discovery' specimens (D) which Fisher named *Rhopiella koehleri*, for comparison with Koehler's estimates.

R (in mm.)	42	42	34	30	30	30	30	27
Spines (in mm.)	1·1-1·2	1·3-1·45	1·0-1·1	1·0-1·1	1·0-1·2	0·9-1·2	1·2-1·3	0·8-1·0
Station	B. 40	B. 30	B. 107	B. 34	B. 107	B. 107	B. 107	B. 40
R (in mm.)	40	33 Type	28	27	23	28	22	
Spines (in mm.)	1·1-1·45	0·9-1·0	1·0-1·3	1·0-1·2	1·0-1·2	1·4	1·0	
Station	D. 181	D. 190	D. 363	D. 363	D. 363	*hirsuta* (after Koehler)	*pterasteroides* (after Koehler)	

* The use of this name for what has often been called *H. compacta* in the past is explained on p. 49.

† Without larger specimens of *H. compacta* no adequate comparison with *H. studeri* can be made.

It being established that in *E. hirsuta* the papulae are single, the only important character distinguishing *Rhopiella koehleri* of Fisher is lost, though the presence of four sub-ambulacral spines in most of the 'Discovery' specimens of *R. koehleri* from the Weddell Quadrant may serve to mark it off as a separate subspecies.

With regard to this character, Koehler observed that there are four subambulacral spines in the two types of *E. hirsuta* but in the B.A.N.Z.A.R.E. specimens only the one from station 105 has four of these spines on a significant number of plates, the rest having predominantly three. However, the adjacent actinal plates each bear a single spine in series with the subambulacral ones which could easily be taken for a fourth subambulacral one, as can be seen from fig. 4a, b. This figure is also intended to show the difference in the adambulacral plates of *Rhopiella* as opposed to *Henricia*, the plates themselves being relatively longer with the raised part bearing the spines not so high or so crest-like as it is in *Henricia*. The innermost series of actinal plates is also more closely linked to the adambulacrals in *Rhopiella*.

There are two further specimens which I am referring to *Rhopiella hirsuta*. These were taken by the 'Challenger' at Kerguelen and were recorded as *Echinaster spinulifer* by Sladen, who appears to have been misled by Smith's description of that species just as Koehler was when he stressed the close relationship between *hirsuta* and *spinulifer*. These two specimens have the same wide-based rays, open-meshed abactinal skeleton and more or less rugose spines as *hirsuta*, the largest spines being over a millimetre long. The main difference between them and the B.A.N.Z.A.R.E. specimens lies in the frequency of the spines. These are much fewer in the Kerguelen form, single spines occurring only at the intersections of the skeleton with not the slightest suggestion of a serial arrangement. The ventral spines are also fewer and there may be only two subambulacral spines on each plate. There is also a minor difference in the shape of the abactinal spines which tend to be more blunt at the tip than in the specimens from the Antarctic continent. Since these differences are in characters which are variable in *R. hirsuta* I am designating these 'Challenger' specimens only as a subspecies *kerguelenensis* of *R. hirsuta*.

Rhopiella hirsuta hirsuta (Koehler)

text fig. 4a, b, f-h.

Echinaster hirsutus Koehler, 1920, 113-115, pl. xii, fig. 9, pl. xxiv, figs. 6-9, pl. lxvi, fig. 2.

Echinaster pterasteroides Koehler, 1920, 115-118, pl. xvi, figs. 4, 5, 8, pl. xxv, figs. 3-5, pl. lxvi, fig. 3.

Banzare localities: Stations 30 (5 specimens), 34 (1 specimen), 40 (3 specimens), 105 (1 specimen), 107 (10 specimens).

In addition to the descriptive notes given above, there is also some variation in the shape of the abactinal spines. The extremely rugose type figured by Fisher for *R. koehleri* (1940, fig. E2 and fig. 5c of this work) is only found in the larger specimen from B.A.N.Z.A.R.E. station 40 besides one of those from 'Discovery'

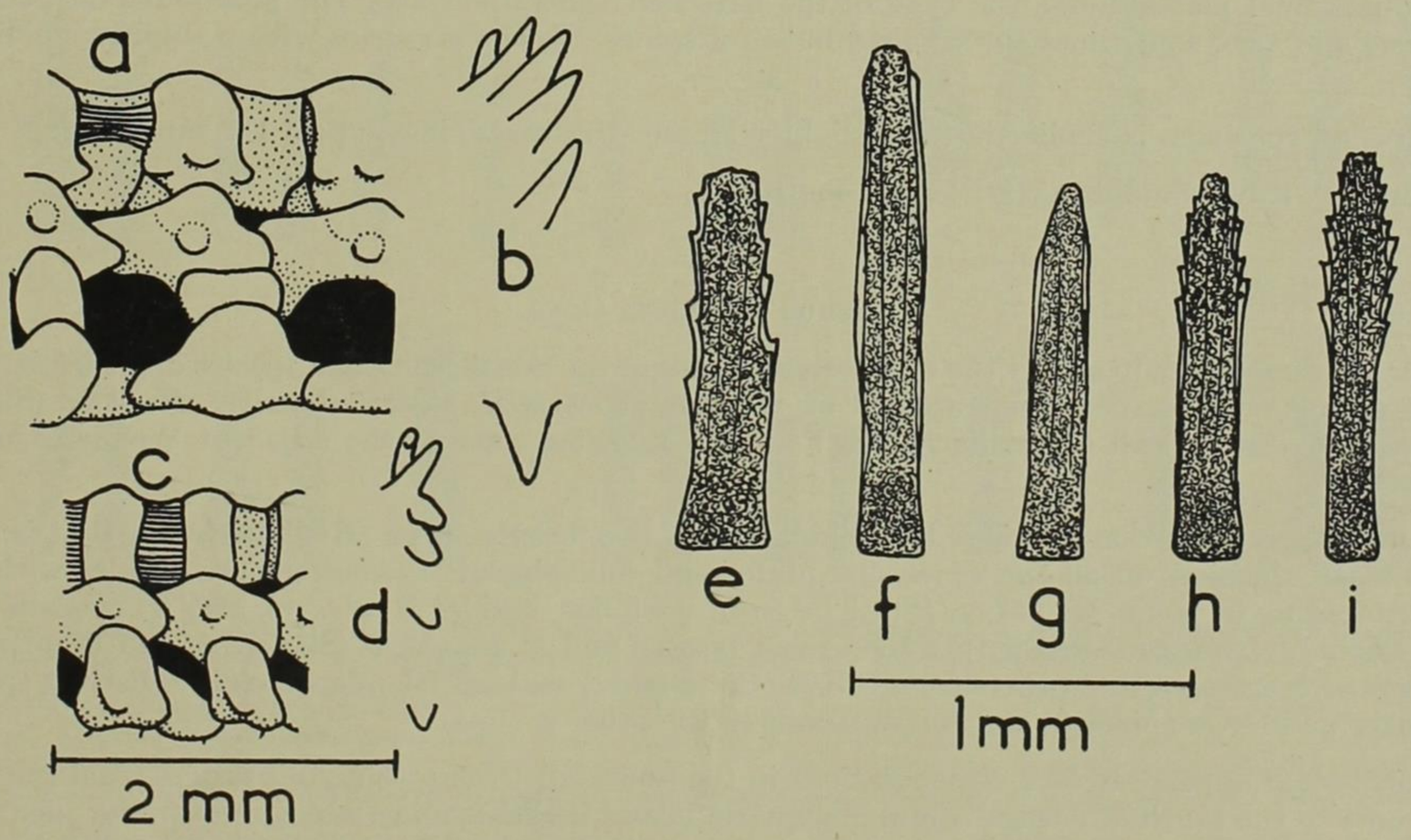


Fig. 4. a, and b, *Rhopiella hirsuta hirsuta*, R 42 mm. from Banzare station 40, a, denuded adambulacral, actinal and infero-marginal plates at about 15 mm. distance from the mouth which is to the left, the adambulacral muscles only drawn in one place, b, the same complete with spines and skin-covering; c, and d, *Henricia smilax*, R 30 mm. from Banzare station 39, c, denuded plates about 12 mm. from the mouth and d, the same, intact; e, to i, proximal abactinal spines of e, *Rhopiella hirsuta kerguelenensis*, holotype, 'Challenger' station 149D, f, to h, *R. hirsuta hirsuta*, f, R 42 mm. from Banzare station 30, g, R 30 mm. from Banzare station 107, h, R 27 mm. from Banzare station 105, i, *R. hirsuta koehleri*, R 28 mm. from 'Discovery' station 363, South Sandwich Is.

station 363. In the other specimens of both collections the spines are usually less rugose, more cylindrical for most of their length or even tapering from the base (fig. 4g). I have not observed any significant flattening of the spines at the distal end such as Koehler noted, which Fisher took to be another difference between *R. hirsuta* and *R. koehleri*.

The largest B.A.N.Z.A.R.E. specimens of *R. hirsuta hirsuta*, one each from stations 30 and 40, both have R/r 42 mm./10 mm. and the breadth at the base of the ray, measured between two adjacent interradial angles is 10·5 mm. in one and 11 mm. in the other. The smaller specimens have R/r less than 4·2/1, the minimum value in those with R exceeding 25 mm. being 3·0/1; the average of nine specimens is 3·6/1.

Finally there is some variation in the relative numbers of the abactinal spines. These may be fairly numerous, two or three occurring together at some of the intersections of the skeleton while others are so close along the meshes as nearly to be termed serially arranged. However, the larger specimens particularly have the spines more spaced from each other.

Brood rearing. One of the six larger specimens from station 107 is in the incubating position with a number of young contained within the cavity, each having R about 4 or 5 mm. and about 15 pairs of tube feet along each ray.

Type locality. Off Adélie Land, 276-647 metres.

Range. Known from Enderby Land to Adélie Land in 163 to 655 metres.

Rhopiella hirsuta kerguelenensis, subsp. nov.

text fig. 4e, pl. ii, figs. 1, 2.

Echinaster spinulifer, Sladen, 1889, 555. Non *spinulifer* Smith, 1876 which is a valid sp. of *Henricia*.

'Challenger' station 149D, 20th January, 1874. Royal Sound, Kerguelen. 49° 28′ S., 70° 13′ E. 51 m.; volcanic mud. One specimen.

'Challenger' station 149H, 29th January, 1874. Off Cumberland Bay, Kerguelen. 48° 45′ S., 69° 14′ E. 220 m.; volcanic mud. One specimen.

The larger of these two, taken as the type, is that from station 149D. It has R/r 29 mm./8 mm. =3·6/1. The rays are inflated and widest at the base with the outer half of their length attenuated. The abactinal spines are sheathed with skin and spaced, occurring only singly at the intersections of the skeleton, of which the meshes are very open. There are rarely more than four spines around each mesh and usually fewer. The spines themselves are up to 1·1 mm. long, irregularly rugose, usually blunted at the tip and with the base widened (fig. 4e). The infero-marginal plates define the edge of the flattened ventral surface. The adambulacral plates bear a furrow spine and two, sometimes three subambulacral spines, usually in series with a slightly smaller actinal spine.

The second specimen is similar but has slightly larger abactinal spines, up to 1·2 mm. long.

Type locality. Royal Sound, Kerguelen, 51 metres.

Genus Henricia Gray

Fisher has done much to clarify the inter-relationships of the Southern Ocean species of *Henricia*, arranging them into groups or superspecies exemplified by the three species *H. studeri* (Perrier), *H. obesa* (Sladen) and *H. pagenstecheri* (Studer) all occurring in the Falkland-Magellan area or the adjacent Weddell Quadrant of the Antarctic.

The *studeri* group is characterised by spinulation of the 'bristly' type (Heding, 1935), that is, there are numerous small spinelets on all the superficial plates and the spinelets themselves are slender with few thin flanges terminating in points (fig. 5f, g, j, l). The group includes, besides *H. studeri*, also *H. abyssalis* (Perrier) of South Africa, *H. praestans* (Sladen) of the Crozet Islands and *H. compacta* (Sladen) of the Tasman Sea (not *H. compacta* of Mortensen and others from the Chatham and Auckland Islands which is a distinct species with much thicker and fewer spinelets and comes nearer to the other groups).

Henricia obesa appears to lack close relations in the Southern Ocean, though it ranges from the Falkland-Magellan area to the south of Australia and Macquarie Island if Fisher and I are correct in our identifications. H. L. Clark isolated the southern Australian specimens as *H. hyadesi*, of which the type locality is also in the Falkland-Magellan area, but Fisher believes *hyadesi* is only a slender-rayed form of *H. obesa*; its range appears to be co-extensive with that of *H. obesa*. Mortensen has recorded *H. obesa* from Tristan da Cunha and there is a small *Henricia* sp. from that island in the British Museum which is probably referable to this species. *H. obesa* is characterized by the open-meshed abactinal skeleton, the fairly solid spinelets tapering to an irregular, more or less truncated, tip and the groups or double rows of spinelets on the adambulacral plates.

The species of the *pagenstecheri* group have only small clusters of abactinal spinelets of solid form which may be arranged in linear series, sometimes rather isolated, along the meshes of the skeleton; the marginal, actinal and adambulacral spinelets also tend to form linear series, one row along each line of plates transverse to the furrow. The group includes *H. diffidens* (Koehler) from Graham Land, South Georgia and the Falkland-Magellan area, *H. simplex* (Sladen) from Tristan da Cunha (see below) and *H. lukinsi* (Farquhar) from the subantarctic islands of New Zealand.

The identification of the B.A.N.Z.A.R.E. specimens of this genus prompted an examination of the type specimens of *H. simplex*, *H. compacta*, *H. praestans*, *H. obesa* and *H. sufflata* of Sladen as well as of *Echinaster spinulifer* Smith, which I am also referring to *Henricia*. The 'Discovery' and 'Terra Nova' collections were also largely re-examined.

Sladen included in *Cribrella simplex* a number of specimens taken at five different 'Challenger' stations, off Inaccessible and Nightingale Islands, both in the Tristan da Cunha group and far to the south-east, off the Crozet, Prince Edward and Marion Islands. However, the specimen described and figured by Sladen is one of four from Inaccessible Island. This has R/r 27 mm./6 mm. The rays are narrow and cylindrical and not inflated at the base. The abactinal spinelets are few and in small groups; they seem to have been rubbed as all those dissolved out of the skin were found to be broken at the tip. The papulae are mostly single but there may be two within a single mesh. The marginal and actinal plates form regular longitudinal series though the actinal plates extend for less than half the arm length. There are linear transverse series of about five spinelets forming combs on each infero-marginal plate. Some proximal actinal papulae are present, three or four in each interradial area, but these do not form a continuous series. The adambulacral spines are usually in linear series but, as in Sladen's figure, one, or occasionally two, spines may be displaced so that a double row results. The three other specimens from this station are similar, all having a few proximal actinal papulae.

The larger specimen of the two from Nightingale Island has R/r 33 mm./6 mm. The abactinal spinelets (fig. 5k) are better preserved than in the holotype and are more numerous, tending to form linear series along the rather more compact meshes of the skeleton. The actinal papulae form almost continuous series from the base of the ray and the actinal plates extend for about half the arm length.

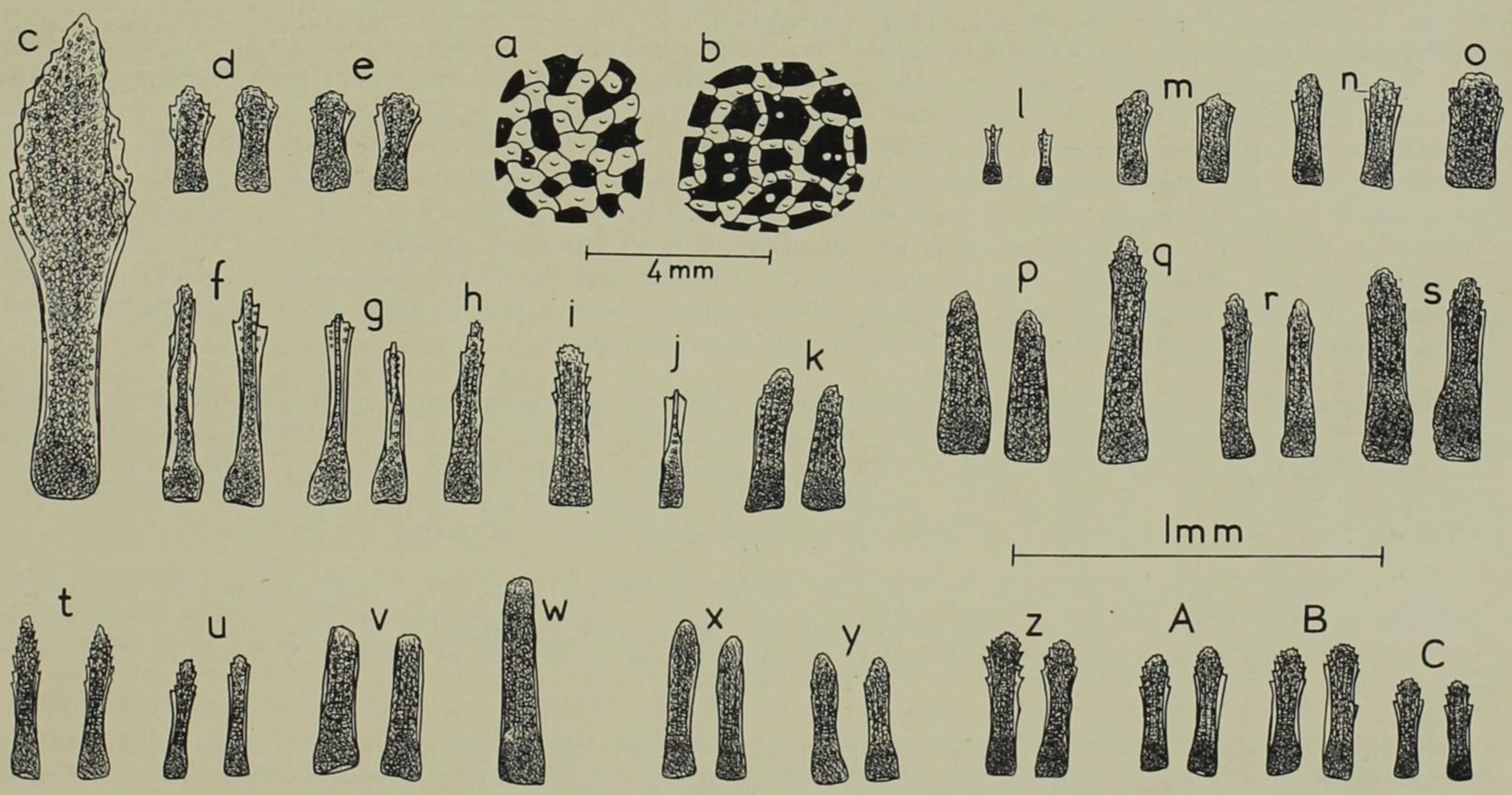


Fig 5. a, and b, parts of proximal abactinal mid-radial areas of a, *Henricia smilax* and b, *H. smilax* forma *tenuis*, holotype, both from Banzare station 107, the more proximal plates to the top; c, abactinal spine of *Rhopiella hirsuta koehleri*, paratype, from 'Discovery' station 363, South Sandwich Is., for comparison with d, to z, and A, to C, abactinal spinelets of *Henricia* spp.; d, and e, *H. spinulifera*, d, holotype, R 14 mm., e, syntype of *Cribrella simplex* var. *granulosa*, R 15 mm., f, and g, *H. praestans*, f, holotype, R c.90 mm., g, paratype of *Cribrella simplex*, R 40 mm. from Marion I., h, *Henricia* sp., paratype of *C. simplex*, R 65 mm. from 'Challenger' station 145A, Prince Edward I., i, *H. fisheri*, paratype of *C. simplex*, R 26 mm. from 'Challenger' station 148, Crozet Is., j, *Henricia* sp. of the *studeri* group, paratype of *C. simplex*, Nightingale I., k, *H. simplex*, paratype, R 33 mm. from Nightingale I., l, *H. compacta*, holotype, R 15·5 mm. from 'Challenger' station 166, W. of New Zealand, m, *H. aucklandiae*, R 23 mm. from the Chatham Is., n, *H. obesa*, R 22 mm. from Banzare station 83, Macquarie I., o, *H. ornata*, R 30 mm. from Three Anchors Bay, South Africa, p, and q, *H. smilax*, 'McMurdo Bay', p. R 30 mm. and q, R 28 mm. (4-rayed specimen), r, and s, *H. smilax*, atypical forms, Banzare station 30, R c.20 mm. in both, t, *H. parva* (?), R 20 mm. from Banzare station 42, u, *H. diffidens* (?), R 17 mm. from 'Discovery' station WS 840, Falkland Plateau, v, *H. smilax*, R 27 mm. from Banzare station 41, spinelet type 'A', w, *H. smilax*, R 28 mm. from Terra Nova station 194 off Oates Land, x, *H. smilax* forma *tenuis*, holotype, R 34 mm., spinelet type 'B', y, *H. smilax* forma *tenuis* (?), R 25 mm. from Banzare station 41, z, *H. parva*, R 28 mm. from Banzare station 107, spinelet type 'C', A, *H. parva*, R 33 mm. from Banzare station 40 B, and C, *H. parva*, B, R 22 mm. from 'Discovery' station 1948 and C, R 18 mm. from station 170, both Clarence I.

The second specimen from Nightingale Island is smaller and poorly preserved but its spinelets are much more numerous and are of the *H. studeri* type, contracted near the base and with few flaring points (fig. 5j). It clearly belongs to a species of the *studeri* group but its condition is such that it cannot with certainty be referred either to *H. studeri* or *H. abyssalis*, the two closest species geographically.

The two specimens which Sladen named *Cribrella simplex* from Marion Island were also found to have spinelets of the *H. studeri* type (fig. 5g) and numerous adambulacral spines. A comparison with the much larger holotype of *H. praestans* (Sladen) from near the Crozet Islands (R about 90 mm. as opposed to 30-40 mm. in these two) shows many similarities, notably the wide-meshed abactinal skeleton with the meshes subdivided by secondary plates. However, in the holotype, the spinelets, though similarly elongated, are more irregular and solid (fig. 5f) lacking the few, long, complete flanges terminating simultaneously near the tip. This modification may be due to senescence.

The paratype of *Cribrella simplex* from the Crozet Islands, however, is not referable to *H. praestans*. Nor do I think it is conspecific with the holotype of *H. simplex*, though it is related to the 'Discovery' specimen from Marion Island named *H. simplex* by Fisher. The disc is constricted interradially and the rays are markedly inflated near the base. There are no proximal actinal papulae and the row of actinal plates extends for nearly three-quarters of the arm length. Both infero-and supero-marginal series form regular longitudinal and transverse rows, but there are only one to three, rarely four, spinelets on each. The adambulacral spines usually form linear transverse series. The abactinal skeleton is fairly open with several papulae within most of the meshes. The spinelets are similar in size to those of the Nightingale Island specimen but with more numerous points at the tip (fig. 5i). Although resembling the holotype of *H. simplex* in the linear arrangement of the adambulacral spines and very regular series of marginal plates, this form differs in the absence of proximal actinal papulae, the greater extent of the actinal plates, the fewer spinelets and the more numerous abactinal papulae. I believe that it is a distinct species and accordingly am describing it in this paper under the name of *Henricia fisheri*.

Finally there are three paratypes of *Cribrella simplex* from Prince Edward Island, one large one, R 65 mm., with attenuate rays and two smaller ones with R 16 and 20 mm. The large one has some similarity to *H. praestans* but the abactinal spinelets, though sometimes elongate, are all more solidly constructed (fig. 5h). There is one big spine on each adambulacral plate backed by a cluster of spines, the two nearest the furrow being larger than the rest. The abactinal reticulation is fairly regular with no appearance of primary and secondary meshes, unlike the very large holotype of *H. praestans*, nevertheless, I think that it may prove to come within the range of variation of *H. praestans* when that species is better known. The two small specimens are only alike in having the adambulacral spines in linear series, the smaller has the abactinal network more open with up to six papulae in each mesh, whereas in the other there is usually only one papula, rarely two, in each mesh. There are no proximal actinal papulae in either of these two, though the large specimen appears to have some, the clusters of elongate actinal spinelets tending to conceal them. The smallest specimen, that with numerous abactinal papulae, is probably conspecific with the Crozet Islands paratype and the 'Discovery' specimen from Marion Island which I propose to call *H. fisheri*. The other I am unable to place.

The range of *H. simplex* is therefore limited to the Tristan da Cunha group of islands. Fisher (1940) has referred to *H. pagenstecheri* a juvenile specimen from Tristan with R only 6 mm. because it has actinal papulae, unlike his Marion Island specimen which he mistakenly believed to represent *H. simplex*. There is considerable resemblance between *H. simplex* and *H. pagenstecheri* but without examination of some larger specimens as well as the types of *H. pagenstecheri*, no definite conclusion about their relationship can be reached.

As for Sladen's variety *granulosa* of *Cribrella simplex*, I believe that it is synonymous with *Echinaster spinulifer* (Smith). As mentioned in the discussion of this family, I am referring the species *spinulifer* to *Henricia* in spite of the lack of proximal actinal papulae. It was collected at several of the B.A.N.Z.A.R.E. Kerguelen stations.

From B.A.N.Z.A.R.E. station 83, off Macquarie Island, come nine specimens which I finally identified as *Henricia obesa* (Sladen). H. L. Clark has recorded *Henricia hyadesi* (Perrier) from several localities in the vicinity of Tasmania. Fisher notes that some of Dr. Clark's specimens are not specifically distinct from *H. obesa*, like the more slender-rayed Patagonian specimens, including the type of *H. hyadesi*.

Finally there are a number of specimens from stations in the Enderby Quadrant of Antarctica. These fall into three main groups, all of which may occur at a single station. One of them is the form which Koehler named *Echinaster smilax* in 1920 and the other two were both included by him under the name of *Cribrella parva*. One of the latter has the abactinal spinelets isolated, slender and tapering at the tip as shown in Koehler's plate xxv figure 10 and plate lxvi figure 4b, while the other has the spinelets more numerous with a tendency for grouping or arrangement in linear series and the shape more clavate, as in Koehler's plate xxvi figure 9. The latter does approximate more to the description of the holotype of *parva* (Koehler 1912) in which the spinelets are described as being in small groups of four to six or eight, while their shape is cylindrical and short with the tip ovoid and often a little enlarged; the surface is rugose and the tip has some small teeth or spinules which are more or less numerous but always quite distinct.

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The three forms are most reliably distinguished by the shape of their abactinal spinelets, though all those with *smilax*-type spinelets (here designated A, fig. 5v) that is stout at the base and tapering markedly at first and then more gradually to a blunt tip, were found to have a more or less closely reticulated abactinal skeleton, the plates of the proximal half of the ray always equalling or exceeding in area the spaces between them. Conversely, those with spinelets of the second type (B, fig. 5x, y), that is, slender, slightly waisted, and tapering at the tip, nearly all have the skeletal reticulum very open, the plates being narrow and leaving large spaces between them. However, spinelets of the third type (C, fig. 5z, A-C), that is, clavate with more or less rugose tips and, at the same time much more abundant, may belong to specimens with either close or open skeletons although the majority are intermediate. The strength of the skeleton cannot therefore be regarded as diagnostic but may be significant in some cases in combination with another character such as the spinelets being of a certain type or else arranged in series rather than isolated. Superficially all three forms are very much alike, the rays are wide at the base, rarely constricted interradially and R/r averages 4·7/1, 4·9/1 and 4·5/1 respectively in 18, 9 and 17 specimens of the three forms, though the maximum value of 6·4/1 as well as the minimum one of 3·75/1 are both found among specimens of the last group (C). R ranges from 12 to 45 mm. in the specimens measured but is usually about 25 to 30 mm.

Unfortunately there are a few examples whose spinelets do not conform exactly to any of these three types but are intermediate. Two each from stations 30 and 107 have spinelets which may be termed A(B) or B(A) (figs. 5r and s) though in all of them the abactinal reticulum is moderate or close. One specimen from station 42 has spinelets near the B type but more slender and elongated than usual and with the tips unusually rugose (fig. 5t). Also these spinelets are numerous and arranged in linear series, not isolated as in the other B-type specimens. Another from station 41 has a similar arrangement of the spinelets in series but in shape they are indistinguishable from the B-type. In both of these two specimens the abactinal reticulations are close, which constitutes yet another difference from the normal B-type. This, with the serial arrangement of the spinelets, suggests that, in spite of the differences in the shape of the spinelets, these two specimens are more closely related to those with C-type spinelets which I am calling *Henricia parva*. However, these intergrades represent only a small proportion of the specimens obtained and the great majority could be recognised as one of the three main types with little hesitation. Of the other two main lots, the A-type specimens are here referred to *Echinaster smilax*, which I think is better placed in *Henricia*, as explained in the discussion of the family. The B-type specimens are intermediate between *H. smilax* and *H. parva* in some ways, but I think the fewer abactinal and adambulacral spinelets ally them more closely to *H. smilax*. I am therefore proposing a new forma *tenuis* of *Henricia smilax* to accommodate them. The name suggests the slender spinelets and delicate reticulations of the abactinal skeleton, which distinguish it from forma *smilax*.

The Echinasterids taken in the Ross Sea area by the 'Discovery' and 'Terra Nova' under Scott and named *Henricia ornata* by Bell are, I believe, also referable to *Henricia smilax*. *H. ornata* is a shallow-water species from South Africa with numerous, close-set, very short and thick abactinal spinelets (fig. 5o), whereas all these seven antarctic specimens have few, isolated, relatively long and skin-covered spinelets as in *H. smilax* though the spinelets themselves differ slightly. Three of the specimens are from 'Terra Nova' station 194, off Oates Land, just clear of the Ross Sea to the north-west at a depth of 330-360 metres. The other four were taken by the 'Discovery', three in McMurdo Bay (or Sound) in 48-220 metres and the fourth off Coulman Island on the west side of the Ross Sea in 183 metres. Two of the Oates Land specimens have the spinelets truncated, similar to the A-type but a little larger, 0·50-0·55 mm. long. The third specimen from this station is humped up in the incubating position, the dozen or more young being fairly advanced with about 10 pairs of tube-feet on each ray. The spinelets of this specimen are more thorny and tapering at the tips. Similar thorny spinelets are found in two of the McMurdo Sound specimens, one of which has only four rays. R of the four-rayed specimen is 28 mm. and the spinelets are about 0·6 mm. long (fig. 5q). The reticulation of the skeleton is moderately coarse. The smallest specimen from this station has similar spinelets and skeleton but the largest, R 30 mm., has very much shorter ones only 0·40-0·45 mm. long and very different in shape, tapering evenly from the base to a rounded or nearly acute, slightly rugose tip (fig. 5p). In spite of these variations in the shape of the spinelets, other factors including the frequency and arrangement of these and the linear, or occasionally more or less staggered, placing of the adambulacral spines, are constant in all seven specimens and no separation seems to be warranted. They are closely related to *Henricia smilax*, differing only in the slightly larger spinelets of most of them. It is unfortunate that Koehler did not figure in detail the spinelets of his Adélie Land specimens since that locality is very close to Oates Land. He described the species from the A.A.E. material taken off Queen Mary Land which is closer to the B.A.N.Z.A.R.E. stations.

Henricia smilax (Koehler)

text figs. 4c, d, 5a, p-s, v, w, pl. iii, figs. 1-4.

Echinaster smilax Koehler, 1920, 111-113, pl. xii, fig. 10, pl. xxv, figs. 1, 2, 6, 7, pl. lxvi, fig. 1; Döderlein, 1928, 295, pl. xiii, figs. 2a, b.

? *Rhopiella smilax* Fisher, 1940, 160.

Banzare localities: Stations 30 (6 specimens), 34 (1 specimen), 39 (2 specimens), 40 (1 specimen), 41 (TML 4 specimens, OTL 2 specimens), 105 (1 specimen) 107 (7 specimens).

Description. In all these specimens the surface is covered with an opaque skin which is pushed up into a conical eminence by each of the isolated spinelets. The reticulation of the skeleton is coarse with nearly all the plates three- or even four-lobed and articulating with usually more than two other plates (fig. 5a). The area occupied by the plates is greater than, or at least equal to, the area of the spaces between, each of which contains a single papula. Normally there are only four or five spinelets around each papula but in the specimen from station 105 the spinelets are less widely spaced, the skeleton being also particularly compact, and there may be up to six spinelets round the papulae.

The spinelets themselves are fairly constant in shape, tapering distinctly at first from the wide base and then more gradually and evenly for the other three-quarters of their length to a more or less truncated and, sometimes slightly rugose tip (fig. 5v). There is rarely a slight narrowing in the middle.

The actinal plates have similar isolated, skin-covered spinelets. One row of these plates adjacent to the adambulacrals is notably regular and extends for most of the length of the ray. The infero-marginal series meets this actinal one within a third of the arm length from the mouth, being separated from it proximally by several very short rows of actinal plates. Often these plates have no spines or only very short ones in larger specimens such as those from station 107, so that the much longer adambulacral spines stand out prominently from the ventral surface. In other specimens the actinal spines are better developed and the adambulacral ones are consequently less noticeable. There are usually three, sometimes four, subambulacral spines in a single row at right angles to the furrow on each plate.

The largest specimens have R up to 45 mm. but in most it does not exceed 30 mm. The rays are nearly always widened at the base, taper abruptly at first and then more gradually, but rarely there may be interradial constrictions of the disc so that the widest part of the ray is just beyond the base.

As noted under the discussion of the family, one of the specimens from 'Terra Nova' station 194, off Oates Land, is in the brood-rearing position with about a dozen young within the hollow formed.

Remarks. Fisher (1940) tentatively referred this species to his new genus *Rhopiella* in spite of the much smaller abactinal spinelets and the compact skeletal reticulation. I find there is also a difference in the shape of the adambulacral plates, those of *smilax* having the form usually found in *Henricia* with a prominent raised crest across each plate transverse to the furrow, more or less flat on the ventral surface and with strong muscles linking the crests of adjacent plates for almost their entire widths (fig. 4c). In *Rhopiella hirsuta* the raised part is lower but more extensive and its surface may be convex, often with a distinct lateral tubercle bearing the outermost subambulacral spine; the muscles are narrower and join only the middle parts of adjacent plates (fig. 4a).

In view of the close relationship and probable hybridization of *smilax* with *Henricia parva* and the fact that all the well-authenticated species of the genus *Echinaster* come from temperate and tropical waters, I do not think that *smilax* with its diminutive spinelets can be left in that genus. In spite of the absence of actinal papulae and the sparse abactinal spinulation I am therefore referring the species to the genus *Henricia*. As remarked in the discussion of this family, certain other species already included in *Henricia* also exhibit these aberrant characters.

In 1923 Koehler described *Echinaster diffidens* from Graham Land and South Georgia, with the comment that it is closely related to *E. smilax*. However, since the abactinal spinelets are said to be arranged in series I believe it is with *Henricia parva* that the affinities of *diffidens* lie; certainly the species is referable to the genus *Henricia*.

Döderlein (1928) has recorded *Henricia smilax* from Wilhelm II Land and noted that inconspicuous actinal papulae are present. In his photograph of the ventral side numerous dark spots can be seen but a similar pitted appearance is evident in some of the B.A.N.Z.A.R.E. specimens though completely lacking in others and I believe he was mistaken as to their nature.

Type locality. Off Queen Mary Land, 201 and 220 metres.

Range. Known from Enderby Land eastwards to the Ross Sea in 47 to 603 metres.

Henricia smilax forma tenuis, forma nov.

text fig. 5b, x, y, pl. iii, fig. 5, 6.

Henricia parva (part) Koehler, 1920, 119 (specimen A), pl. xxvi, figs. 3-5, pl. lxvi, fig. 4.

Banzare localities: Stations 39 (1 specimen), 41 (TML 1 specimen, OTL 3 specimens), 42 (4 specimens), 103 (1 specimen), 107 (9 specimens).

Description. The holotype is from station 107. R/r is 34 mm./8 mm. but as the disc is unnaturally flattened r was probably about 7·5 mm. in life so that the ratio should be about 4·5/1. The arm breadth at the base is 8 mm.

As in forma *smilax* the whole body is covered with opaque skin; on dissolving this with bleach, the skeleton is seen to be much more open, some of the plates being simply bar-like while others are, at most, three-lobed. There are also secondary plates within some of the larger meshes of the reticulation tending to subdivide them (fig. 5b).

The papulae are still single but when the meshes are subdivided there is one papula in each part. Each is ringed by four to six of the widely spaced spinelets. These are slender, 0·40-0·45 mm. long with a narrowed waist, or sometimes simply cylindrical for most of their length; the base is always the widest part. The tip is usually tapered or rounded, rarely truncated (fig. 5x).

The ventral aspect with rows of spaced actinal and marginal spinelets, more or less bare interradial areas and with the adambulacral spines prominent, is similar to that observed in forma *smilax*.

Variations. R/r varies from 4·5 to 5·9/1, averaging 4·9/1 in nine specimens measured in which R is from 12 to 45 mm. The maximum and minimum values are both found in specimens from station 107. The abactinal skeleton is open in most of the specimens but sometimes the area occupied by the plates is approximately equalled by the spaces between, although this may be attributable in some cases, as in one with R 45 mm. from station 41, to unnatural contraction and distortion of the reticulum. The abactinal spinelets may also vary, another specimen from station 41 having them more distinctly waisted and tapering at the tip (fig. 5y) than in the holotype, while others have spinelets approaching the A-type of *smilax*, with most of the length cylindrical and the tip more or less truncated.

Remarks. There is little difference between this form and *smilax* but the combination of more slender spinelets and more open skeleton together justify a distinct name.

One of the specimens from station 41 is humped up in the incubating position with a mass of about 35 eggs within the brood cavity formed.

Koehler's specimen A of *H. parva* (1920, pl. xxvi, fig. 3-5 and probably also pl. lxvi, fig. 4) is almost certainly referable to *H. smilax* forma *tenuis*; it has the same slender smooth-tipped abactinal spinelets and apparently a more delicate skeleton. It was from A.A.E. station 3 off Adélie Land. The same may be true of his specimen C (pl. xxv, fig. 10. 10, pl. xxvi, figs. 10, 11) which has more isolated spinelets than the others though it appears to have a coarse skeleton like *smilax*.

TYPE LOCALITY. Off MacRobertson Land, 219 metres.

RANGE. Known from Enderby Land to Queen Mary Land, in 193 to 437 metres.

HENRICIA PARVA (Koehler)?

text fig. 5t, z, A-C, pl. iii, figs. 7, 8.

Cribrella parva (part) Koehler, 1920, 118-119 (specimen B at least) pl. xxvi, figs. 6-9. ? *C. parva* Koehler, 1912, 40, pl. iv, figs. 3, 8. Non *Henricia pagenstecheri parva*, Fisher, 1940, 168.

BANZARE LOCALITIES: Stations 30 (7 specimens), 39 (9 specimens), 40 (1 specimen), 41 (TML 4 specimens), 42 (4 specimens), 105 (3 specimens), 107 (3 specimens).

The largest specimens have R 32 mm. but the average is about 25 mm. R/r ranges from 3·75 to 6·4/1, averaging 4·5/1 in 17 specimens measured. The arm breadth (br) at the base is about equal to, or slightly greater than r; when R/r is 23 mm./5 mm., br is 5·5 mm.

The abactinal reticulation is usually moderately coarse but in a few specimens, such as the three from station 107, it is more open, while in five from stations 41, 42 and 39 it is compact.

In nearly all the specimens the abactinal spinelets are more or less clavate and rugose at the tip (fig. 5z), though the shaft may or may not be waisted. The only exceptions are two specimens, one each from stations 41 and 42 (fig. 5t), already mentioned in the discussion of the genus, where the spinelets are nearer the B-type but their arrangement in linear series and the closeness of their skeletal reticulation preclude their inclusion in *H. smilax* forma *tenuis*.

The spinelets are arranged along the skeletal plates in linear series but at the nodes there may be rather open groups of three to five.

Judging from Koehler's photograph (1920, pl. xxvi, fig. 9), at least specimen B of those to which he then gave the name *Cribrella parva* has clavate spinelets as in his holotype of the species, but the one figured in detail (pl. lxvi, fig. 4b, probably also pl. xxvi, fig. 5, specimen A) is of the B-type which I have referred to forma *tenuis* of *Henricia smilax*. As already mentioned, I am not certain that Koehler was correct in referring any of his A.A.E. specimens to the species *parva*. The problem appears to hinge on the occurrence of actinal papulae in the holotype. Koehler does not mention them but Fisher has attributed to *H. pagenstecheri parva* two specimens from near the type locality (South Shetlands) which do have such papulae. I cannot find any undoubted papulae in these B.A.N.Z.A.R.E. specimens and it is possible that on this account the form found between Enderby and Adélie Lands may be distinct from that of the Weddell Quadrant.

In 1923 Koehler described a species *Echinaster diffidens* from five specimens taken by the Swedish Antarctic Expedition, one at station 5 and two each at stations 6 and 22. Stations 5 and 6 are off Graham Land while station 22 is off South Georgia, all being antarctic localities. Koehler gave photographs of the dorsal and ventral views of a specimen from station 6 (pl. viii, figs. 1, 2) a ventral view of a specimen from station 5 (pl. ix, fig. 9) and a dorsal view of one from station 22 (pl. ix, fig. 10). This last appears to have the papular pores in groups of one to six and finer spinelets in closer series along the skeletal meshes than in the specimen from station 6, which has single papulae and more spaced spinelets and resembles *H. smilax*. If any specimen is taken as the holotype of *E. diffidens* it should be this one from station 6 since it is the only one figured both dorsally and ventrally besides answering the description.

Koehler distinguished *E. diffidens* from *E. smilax* by the relatively shorter rays (not significant in my view), the smaller and more spinulose-tipped spinelets and particularly by the occurrence of five or six adambulacral spines (including the furrow spine) rather than about four which is the number found in the types of *E. smilax*. Both these last characters as well as the more serial arrangement of the abactinal spinelets are similar to what is found in *Henricia parva*, which species Koehler left out of consideration having referred *diffidens* and *smilax* to *Echinaster* and *parva* to *Cribrella*. Without a direct comparison between the type of *C. parva*, the A.A.E. specimens attributed to it by Koehler and the types of *E. diffidens* I cannot come to any conclusion about the means of distinction of these species. The problem has been further complicated by Fisher naming as *H. diffidens* and *H. pagenstecheri parva* some 'Discovery' specimens of which the former are from subantarctic localities and the latter have proximal actinal papulae. Both these identifications need confirmation.

Type locality. Off the South Shetland Islands, 420 metres.

Range. Known from the South Shetlands and from Enderby Land to Adélie Land in 163 to 456 metres.

Henricia fisheri, sp. nov.

text fig. 5i, pl. ii, figs. 3, 6.

Henricia simplex (part) Sladen, 1889, 547-548 (only station 148).

Henricia simplex, Fisher, 1940, 168-169, pl. xi, fig. 3.

'Discovery' Station 1564. Off Marion I. 46° 36·5′ S., 38° 02·3′ E. 108-113 m. One specimen.

'Challenger' Station 148. Off Crozet Is. 46° 47′ S., 51° 37′ E. 385 m. One specimen.

Description. The 'Discovery' specimen is taken as the type since it is considerably larger than the one collected by the 'Challenger'. R/r is 36 mm./8 mm. and the maximum br is 10 mm. There are marked interradial constrictions and the rays are widened initially but soon taper at first abruptly then more gradually in the outer third to a half of their length so that they are attenuate and slender at the tip.

The abactinal reticulation is moderately compact, the area of the plates approximating to the area of the meshes between. The larger meshes become partially or completely subdivided by secondary plates, but each mesh contains from one to about seven papulae, commonly three or four in the proximal areas.

Most of the abactinal spinelets are spaced out but there may be two, rarely three, placed close together at the nodes. The larger meshes are encircled by up to ten spinelets but usually there are about six. The spinelets themselves are sheathed in skin. When denuded they are seen to be opaque, widest at the base and terminating in a wide irregularly rugose tip with a number of hyaline points, as in the spinelets of the 'Challenger' specimen shown in fig. 5i.

In ventral view the actinal and infero-marginal plates are very regularly arranged in longitudinal series. The actinal plates each bear one, sometimes two, spinelets, the series of spinelets extending to a distance of about 20 mm. from the mouth or just over half R. Interradially on the disc there are some additional actinal plates each with one or two spinelets. The infero-marginals bear two to four spinelets in a transverse row often corresponding with the adjacent actinal spinelet, though the actinal plates, like the adambulacrals, are a little more numerous, 20 of them corresponding to about 16 infero-marginals. Intermarginal papulae are present but there is only a single actinal one close to an interradius.

The adambulacral plates have one spine in the furrow and usually four larger subambulacral ones in a straight line across the plate.

The smaller 'Challenger' specimen is briefly described in comparison with *H. simplex* under the discussion of the genus *Henricia* (p. 42).

Remarks. This is another species of *Henricia* which lacks actinal papulae but otherwise agrees better with this genus than with *Echinaster*. It has some similarities with *H. smilax* and *H. diffidens* but the more numerous abactinal papulae serve to distinguish it.

Type locality. Off Marion Island, 108-113 metres.

Range. Also known from south of the Crozet Islands, 385 metres.

Henricia spinulifera (Smith)

text fig. 5d, e, pl. ii, figs. 4, 5.

Othilia spinulifera Smith, 1876, 107.

Echinaster spinulifer, Smith, 1879, 274, pl. xvi, fig. 4; Studer, 1884, 25; Koehler, 1912, 222, 253; 1917, 33-34, pl. iii, figs., 3, 8, pl. v, fig. 17. Non *E. spinulifer*, Sladen, 1889, 555, which is *Rhopiella hirsuta kerguelenensis* subsp. nov.; nec G. A. Smith, 1923, which is *Henricia pagenstecheri*.

Cribrella simplex var. *granulosa* Sladen, 1889, 548.

Cribrella simplex var. *granulata*, Koehler, 1917, 35-36, pl. i, figs. 1, 6, 7, pl. ii, figs. 4, 5.

Banzare localities: Stations 6 (1 specimen), 13 (1 specimen), 53 (1 specimen), 55A (1 specimen), 59 (1 specimen).

A comparison of the single small type specimen of *Othilia spinulifera* with R only about 14 mm. and the 18 syntypes of Sladen's *Cribrella simplex* variety *granulosa* reveals no significant difference between them. Sladen was misled by Smith's inclusion of *spinulifera* in the genus *Echinaster* which is characterized by isolated abactinal spines or spinelets. The two 'Challenger' specimens from Kerguelen to which he gave the name *E. spinulifer* are quite different from the type specimen and are, in fact, referable to the genus *Rhopiella* which Fisher split off from *Echinaster* in 1940. Their abactinal spines are few, widely spaced and at least 1 mm. long, producing a 'shaggy' appearance and the adambulacral spines are webbed with skin. The rays are wide at the base and merge into the disc.

The type of *O. spinulifera* is not in good condition. It has probably dried up at some time though now in spirit, as the papulae and the skin covering the spinelets are shrunken. The length of the spinelets therefore appears to be greater than in specimens of the variety *granulosa* of the same size where the skin obscures the size and shape, though in fact they are almost identical (fig. 5d and e) as can be seen by denuding them. In number the spinelets are fewer than in most, but not all, of the specimens of *granulosa*. The better preservation of the 'Challenger' material, with the papulae extended and the spinelets appearing similarly rounded owing to their skin covering, produces an apparently continuous granulation when seen without magnification, though when cleared of spinelets, the reticulations of the underlying skeleton appear usually as open as in the type of *O. spinulifera*. Some of the specimens of *granulosa* do have the spinelets in groups or double lines rather than in the single linear series along the reticulations of the skeleton found in Smith's type, but others are indistinguishable from it with fewer spinelets and a distinctly reticular appearance.

In the types of *C. simplex* var. *granulosa*, R ranges from 10 mm. to 30 mm. and R/r varies from 3·2/1 to 5·3/1, averaging 4·2/1. The larger specimens more often have longer, narrower rays with R/r above the average. The relative width of the rays also varies considerably, being more or less proportional to r.

The tendency for linear arrangement of the marginal and actinal spinelets and of the adambulacral spines is present in the types of both *Othilia spinulifera* and *C. simplex* var. *granulosa*, though the larger specimens of the latter may have one or more of the subambulacral spines paired or one spine set obliquely on occasional proximal plates. All have a thinner, more or less curved, spine deep in the furrow.

No proximal actinal papulae are visible in any of the syntypes although there may be some outside the adambulacral plates beyond the twelfth plate, rarely a few plates earlier. Despite this absence of proximal actinal papulae I am convinced that *O.* (or *Echinaster*) *spinulifera* should be included in the genus *Henricia* as already explained.

Koehler (1917) named two Kerguelen specimens with R 11 mm. *Echinaster spinulifer* and a third one with R 19 mm. *Cribrella simplex* var. *granulosa* (*granulata* in the heading only). His excellent photographs show that these specimens do resemble the appropriate types but here again the differences are not significant, the smaller specimens having wider rays and more sparse abactinal spinelets.

The Kerguelen specimens of *Henricia* including those taken by the B.A.N.Z.A.R.E. differ from the holotype of *H. simplex* (which is from Tristan da Cunha) in lacking proximal actinal papulae, in having much less regular and distinct series of plates and in possessing adambulacral spines which are abruptly larger than the adjacent actinal and infero-marginal ones. This prominence of the adambulacral spines is clearly visible to the naked eye and is often emphasized interradially by a reduction in the size, or even the absence, of some of the actinal spinelets. In the Tristan specimens of *H. simplex* the adambulacral spines do not stand out conspicuously from the ventral surface and there are some proximal actinal papulae present. The difference between *H. simplex* and *H. spinulifera* is certainly a specific one. Some of the subantarctic specimens from the Crozet, Prince Edward and Marion Islands which Sladen included in *Cribrella simplex* but which I believe to be distinct, may be more closely related to *H. spinulifera*. However, none of them exhibits this conspicuous *chevaux-de-frise* effect of the adambulacral spines.

Type locality. Observatory Bay, Royal Sound, Kerguelen.

Range. Only known from Kerguelen in 0 to 90 metres.

HENRICIA OBESA (Sladen)

text figs. 5n, 6a-c.

Cribrella obesa Sladen, 1889, 544-545, pl. xcvi, figs. 3, 4, pl. xcviii, figs. 5, 6.

Cribrella hyadesi Perrier, 1891, 100-102, pl. ix, fig. 1.

Henricia hyadesi, H. L. Clark, 1910, 336, pl. ii, fig. 5.

Henricia obesa, Fisher, 1940, 164-166, pl. xi, fig. 2; Madsen, 1956, 30.

BANZARE LOCALITY: Station 83 (9 specimens).

Affinities. In spite of the extension of the geographical range I can find no significant differences between these specimens from Macquarie I. and others of *H. obesa* of comparable size from the Falkland-Magellan area. H. L. Clark (1916) has recorded as *Henricia hyadesi* eleven specimens taken by the 'Endeavour' in 50-200 fathoms (90 to 360 metres) in the vicinity of Tasmania and further west off southern Australia. Fisher (1940) declared the Magellanic species *H. hyadesi* to be a synonym of *H. obesa*, with which I agree, but after an examination of three of Dr. Clark's eleven specimens he referred one from the Great Australian Bight to the *compacta* (or *studeri*) group and the two others, from south of Gabo Island, Victoria and from east of Maria Island, Tasmania, to *Henricia sufflata* (Sladen), of which the unique holotype is from north of the Kermadec Islands, not from the Southern Ocean. Having examined the type of *H. sufflata* I can say that the Macquarie Island specimens at least are much more like *H. obesa* although the largest of them has R only 26 mm., whereas it is 75-80 mm. in the type of *H. sufflata*.

Since denuding parts of the skeleton has revealed some additional features not previously described and has shown a few discrepancies in Sladen's description of *H. sufflata*, I am giving (p. 49) some additional notes on the type specimen. These show that *H. sufflata* differs from *H. obesa* in the more delicate abactinal reticulation, the fewer abactinal spinelets, which are grouped rather than serially arranged, the smaller size of the marginal plates relative to the adambulacrals and the greater extent of the intermarginal plates.

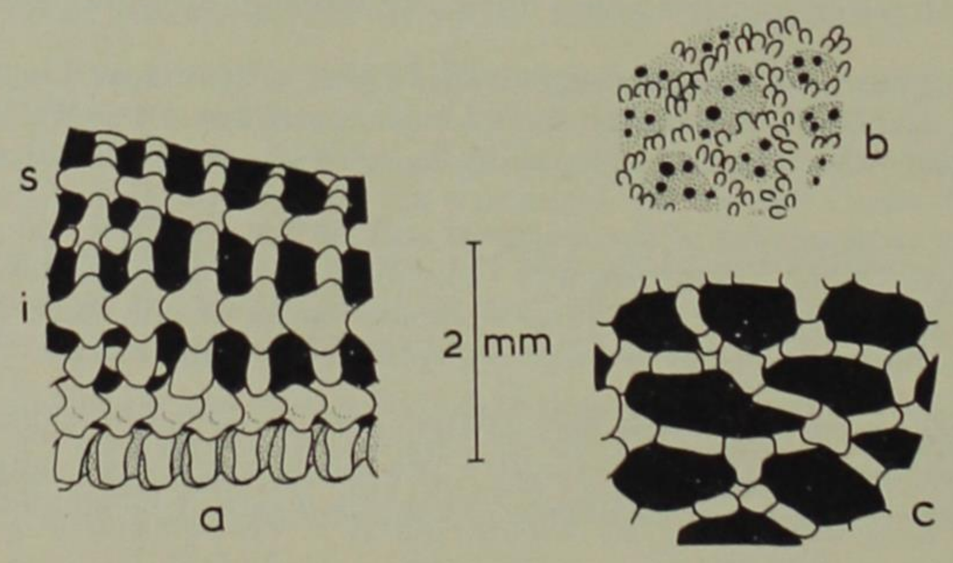


Fig. 6. *Henricia obesa*, R 22 mm. from Banzare station 83, Macquarie I., a, ventro-lateral view of part of a ray, the proximal-most adambulacral plate (to the left) being the tenth, i infero-marginals, s supero-marginals; b, and c, intact and denuded proximal abactinal mid-radial areas, the more distal plates to the top in each.

I give here some figures of a specimen from Macquarie Island with R/r 22 mm./5·5 mm.=4·0/1; br is 6·5 mm. and the arms taper evenly from a wide base to a blunt tip. In the nine B.A.N.Z.A.R.E. specimens R ranges from 9 to 26 mm. and R/r from 4·0 to 4·3/1. They have been compared with some specimens of *H. obesa* from 'Discovery' station WS 86 (Falkland Islands, about 150 metres) which have R 26 mm. or less. The only differences I found were in variable characters such as the extent of the bar-like plates linking the proximal actinal and marginal plates which is slightly greater in the Macquarie specimens (these plates being variable in development according to the relative arm width in Falkland-Magellan specimens of *H. obesa*) and minor differences in the number and shape of the spinelets (which tend to be fewer in the Macquarie specimens and more serially arranged instead of in elongate groups).

The only other Echinasterid species known from this part of the Southern Ocean are *Henricia lukinsi* (Farquhar) of the *pagenstecheri* group and *H. aucklandiae* Mortensen, both from the Auckland and Campbell Islands south of New Zealand (the latter also from the Chatham Islands). The name *H. aucklandiae* must be used

for probably all the specimens which have been referred to *Henricia compacta* (Sladen) except the holotype, which was from the Tasman Sea to the west of New Zealand. An examination of this has shown that it is quite different from the figures of *H. compacta* var. *aucklandiae* given by Mortensen in 1925 and from a specimen from the Chatham Islands sent to the British Museum by Dr. H. B. Fell of Wellington. Fell (1952) declared the Chatham Islands form to be indistinguishable from that found in the Auckland and Campbell Islands, so the name *H. aucklandiae* can be used to cover them all. As Fisher (1940) noted, *H. compacta* is related to *H. studeri*, *H. abyssalis* and *H. praestans*, having numerous and finely pointed spinelets, whereas in *H. aucklandiae* they are coarse (fig. 5m) and few, notably the adambulacral spines, the species being more nearly related to the *pagenstecheri* group.

Both *H. aucklandiae* and *H. lukinsi* differ from *H. obesa* in having a more compact skeleton with smaller meshes and in the absence of any bar-like plates linking the actinal and marginal plates. Only one of the twenty echinoderm species known from the subantarctic islands of New Zealand—the echinoid *Pseudechinus novae-zelandiae*—has also been recorded from Macquarie Island, according to Fell, and the species of *Henricia* seem to provide no other exception to this limitation. The abyssal depths between apparently serve as an effective barrier.

The southern New Zealand species *Henricia ralphae* Fell (1952a) differs in having fewer actinal plates and more numerous and clustered abactinal spinelets than *H. obesa*, though the skeletal reticulation is similarly very wide.

Finally the Kerguelen species *H. spinulifera* (Smith) is lacking in actinal papulae and looks very different from *H. obesa* in ventral view with the prominent adambulacral spines standing out from the reduced actinal and marginal spinelets.

TYPE LOCALITY. Port William, Falkland Islands, 22 metres.

RANGE. *Henricia obesa* thus has a very wide geographical range in the Southern Ocean. Besides the Falkland-Magellan area it is now recorded from Macquarie Island and also probably occurs off the south coast of Australia. In addition Mortensen has recorded it from the littoral zone of Tristan da Cunha and there is a small dry specimen in the British Museum from that island which substantiates the record. Elsewhere it is not known from above low water mark, the depth range in the Falkland-Magellan area being 22 to about 450 metres.

HENRICIA SUFFLATA (Sladen)

Cribrella sufflata Sladen, 1889, 549-550, pl. xcvi figs. 5, 6, pl. xcviii, figs. 1, 2.

'Challenger' station 170, 14th July, 1874. North of the Kermadec Islands, 29° 55′ S., 178° 14′ W. 950 m. One specimen.

Supplementary description of the holotype:

The abactinal plates form a delicate reticulation, most of them being narrow and bar-like. The larger meshes are partially or completely subdivided by additional plates and within each mesh, proximally at least, there are usually two or three papulae, rarely only one. The granuliform appearance of the spinelets described by Sladen is an illusion caused by their loose skin covering. When this is dissolved away, the spinelets are found to be slender, usually tapering beyond a narrowed waist but sometimes as wide at the head as at the base and terminating irregularly with a few points. The longest are 0·4 mm. long. They are arranged in groups of usually three or four, rarely more, and rarely extend serially along the meshes of the skeleton. The marginal plates form conspicuous regular series, as in *H. obesa*, but they are relatively smaller and are more numerous than the adambulacral and actinal plates, 22 infero-marginals corresponding to 20 adambulacrals, unlike *H. obesa* where 16-18 infero-marginals usually correspond to 20 adambulacrals. Another difference is that an inter-marginal series of plates extends for over half the arm length in the type of *H. sufflata*, whereas in *H. obesa* the intermarginals are restricted to the proximal quarter or less of the arm. The inner actinal series of plates extends for about two-thirds of the arm length as in *H. obesa*. Following the short second actinal series there are a few bar-like plates linking the infero-marginals and the inner actinal row; similar plates link the marginal and intermarginal plates for the proximal half to two-thirds of the arm length until the two series approximate sufficiently for the lobes of the cruciform plates to overlap without the need for additional links.

The adambulacral spines are in two irregular transverse rows except at the lateral edge of the plate where there is usually a longitudinal row of three spines. Next to this is a double longitudinal row of 7-9 spinelets on the actinal plates. The infero-marginals are elongated and ridged transversely to the arm axis and their spinelets form a double comb along the ridge.

Family SOLASTERIDAE

Key to the Southern Species

1 (22) Rays five, rarely six.

2 (11) Supero-marginal plates well-developed and markedly different from the adjacent abactinal paxillae. *Lophaster* Verrill, 1878

3 (8) Marginal plates tall and markedly projecting, slightly spaced.

4 (5) Abactinal spinelets needle-like, tapering to a single point; supero-marginal plates spaced from infero-marginals, both series with a few enlarged central spinelets or spines (Bellingshausen Sea, South Shetlands, Queen Mary Land and the Ross Sea 'Terra Nova' stations 314, 316, 338, 340, 355, 202-547 m.) . . . . . *Lophaster gaini* Koehler, 1912

5 (4) Abactinal spinelets flanged, terminating in three or more prongs or spikes; marginal paxillae with numerous, almost equal-sized spinelets . . . . . *Lophaster stellans* Sladen, 1889

6 (7) Southern Patagonia, Falkland area, Bellingshausen Sea (? South Orkney Is.), Wilkes Land, 25-2423 (?3246) m.* *L. stellans stellans* Sladen, 1889

7 (6) Off Marion Island, 101-106 m.* . . . . . *L. stellans marionis* Fisher, 1940

8 (3) Marginal plates compact, not spaced and not projecting prominently from the sides of the rays.

9(10) Rays long and slender, R/r more than 4/1; abactinal spinelets with about half their length made up of usually three very long prongs (Queen Mary Land, 202 m.) . . . . . *Lophaster tenuis* Koehler, 1920

10 (9) Rays short and tapering, R/r 3/1 or less; abactinal spinelets with blunt, slightly fanned rugose tips, no long prongs (South Shetland Is. and MacRobertson Land, 200-610 m.) . . . . . *Lophaster densus* Fisher, 1940

11 (2) Supero-marginal plates hardly, if at all, larger than the abactinal paxillae.

12 (13) Infero-marginal plates prominent but few, widely spaced from each other, a double ridge running from each one to the adambulacral plates; abactinal surface covered with thick skin tending to conceal the plates in large specimens; one furrow spine (Bellingshausen Sea, S. Shetland and S. Orkney Is., South Georgia, Wilhelm II Land to Adélie Land and the Ross Sea ['Terra Nova' stas. 294, 314, 316, 340, 348], 60-700 m.) . . . . *Cuenotaster involutus* (Koehler), 1912

13 (12) Infero-marginal plates in a continuous series, though their ridges may be slightly spaced; no double ridges across the actinal areas; abactinal plates not embedded in thick skin; several furrow spines. . . . . *Paralophaster* Fisher, 1940

14 (15) Marginal plates relatively few in number, not more than 12 in each series when R is 20-30 mm.; larger marginal spines comb-like, with a series of points along one side (Weddell Sea and S. Shetland Is., 750-4572 m.) *Paralophaster lorioli* (Koehler), 1908

15 (14) Marginal plates more numerous, at least 16 and often more when R is 20-30 mm.; marginal spines spike-like or with irregular points along the length or similar ones at the tip only, not comb-like.

16 (17) Supero-marginal plates distinctly larger than the adjacent paxillae; proximal paxillae with about 30-40 spinelets, some of which have acute points while others may have three slender lobes with blunted ends (Bellingshausen Sea, S. Shetland and S. Sandwich Is., South Georgia, Adélie Land and the Ross Sea ['Terra Nova' station 338], 99-750 m.) *Paralophaster antarcticus* (Koehler), 1912

17 (16) Supero-marginal plates barely, if at all, larger than the adjacent abactinal paxillae; proximal abactinal paxillae with less than 20 spinelets which all have acute points at the tip.

18 (19) Marginal plates numerous, 29 when R is only 15 mm. (in the unique type) (Kerguelen) *Paralophaster incertus* (Koehler), 1917

19 (18) Up to 26 marginal plates when R is <50 mm., though there may be 28 when R is about 70 mm. *Paralophaster godfroyi* (Koehler), 1912

20 (21) Even small specimens (R<20 mm.) with abactinal spinelets needle-like, tapering to a single point (Bellingshausen Sea, 250-400 m.) . . . . . *P. godfroyi godfroyi* (Koehler), 1912

21 (20) Only large specimens (R>60 mm.) with abactinal spinelets needle-like, tapering to a single point, smaller ones always with one to many additional lateral points (fig. 7a-h) (Enderby Land eastwards to the Ross Sea, 180-2450 m.) *P. godfroyi asperatus* (Koehler), 1920

22 (1) Rays seven to ten.

23 (24) Abactinal skeleton an open, somewhat irregular, reticulum, paxillae small and widely spaced with long, needle-like spinelets (South Africa, Tristan da Cunha, Gough and Marion Islands, 80-800 m.) . . *Crossaster penicillatus* Sladen, 1889

24 (23) Abactinal paxillae joined more rigidly and closely by the tips of the lobes, evenly spaced and with spinelets of short to medium length . . . . . *Solaster regularis* Sladen, 1889

25 (26) Furrow spines short; usually 8 or 9 rays, rarely 7; size not known to exceed R 59 mm. (Kerguelen, Bellingshausen Sea, S. Shetland Is., Enderby Land eastwards to Wilhelm II Land, Ross Sea, 183-603 m.) . *S. regularis subarcuatus* Sladen, 1889

26 (25) Furrow spines longer; usually 9 or 10 rays, rarely 8; size up to about R 100 mm. (Patagonia, Falkland area, 65-350 m.) *S. regularis regularis* Sladen, 1889

Genus Lophaster Verrill

Lophaster stellans Sladen

Lophaster stellans Sladen, 1889, 460-461, pl. lxxi, figs. 4, 5, pl. lxxii, figs. 11, 12; Ludwig, 1903, 27-28, pl. iii, figs. 23, 24; Koehler, 1920, 151; Fisher, 1940, 170-171, fig. E3; Madsen, 1956, 31-32.

Lophaster pentactis Perrier, 1891, 112-113, pl. ix, fig. 3a-e; Koehler, 1920, 151, pl. xxxi, figs. 6, 7, pl. lxviii, fig. 3.

? *Lophaster abbreviatus* Koehler, 1908, 557-558, pl. iv, figs. 42, 43.

Banzare locality: Station 98, (1 specimen).

R/r of this specimen is 25 mm./8-9 mm.

Fisher has cast doubt on the identity of the specimen from 'Challenger' station 303, off the Chonos Archipelago at a depth of 2423 metres. According to Murray, 1895, station 303 was not a dredging station and the number was probably a mistake for 308 where the depth was 320 metres. This specimen is the holotype of *L. stellans*, the two other 'Challenger' examples from stations 308 and 309 being smaller with narrower rays,

* The only difference I can find between the unique type of *L. marionis* and specimens of *L. stellans* of the narrow-rayed forma *pentactis* is one of degree, the paxillae being slightly taller in the Marion Island specimen.

approximating to the shape of the type of *L. pentactis* Perrier, which name I agree with Fisher is worth retaining for the more slender-rayed forma of this species. The two paratypes of *L. stellans* also have more numerous abactinal paxillar spinelets than the holotype, the one from station 308 (R 30 mm.) having 15 or 16 spinelets on the larger proximal paxillae while that from station 309 (R 25 mm.) has 10 or 11 spinelets. The holotype has only eight or nine spinelets at the most and the paxillae are all lower and narrower at the head than those of the *pentactis* form. This difference in the paxillae is also noticeable in the 'Discovery' specimens of the two forms, the narrower-rayed examples having distinctly taller paxillae with wider heads. The trend away from the type of *L. stellans* is carried further in the unique type specimen of *Lophaster marionis* Fisher 1940, from Marion Island, which has the rays a little narrower, the paxillae a little taller and the subambulacral spines a little spikier than in any specimen of *pentactis* I have seen. Possibly further material from the Marion Island area will show that a shorter-rayed form also occurs there. Since the differences between the type of *L. marionis* and *L. stellans* forma *pentactis* are only of degree, I do not think that *L. marionis* is more than subspecifically distinct. In his comparisons of *L. marionis*, Fisher made several assumptions about *L. stellans* which are incorrect, at least for specimens of size about 30 mm. R, like the type of *L. marionis*.

Firstly, he says that *L. stellans* 'has a series of well-developed actinal paxillae extending to the end of the ray while *L. marionis* has none'. This is contradicted by his statement that *L. marionis* has about eight actinal plates with one to four spinelets on each. In neither *L. stellans* nor *L. marionis* would I describe the actinal plates as paxilliform since the small clusters of spinelets which they bear are not mounted on a boss. As for the extent of the actinal plates, Sladen described the type of *L. stellans* (R 32 mm.) as having not more than ten in each interradial area, that is up to four or five in each series, of which most, but not all, bear tufts of three or four spinelets. The paratypes and 'Discovery' specimens of similar size have much the same disposition, though the number of actinal plates with spinelets is usually even less in those of the narrow-rayed *pentactis* form, from two to four on each side. Thus there is no significant difference in this character.

Secondly, Fisher gives the number of subambulacral spines in *L. stellans* as six or five, only sporadically four, compared with four or three in *L. marionis*. However, the holotype of *L. stellans* also has three or four subambulacral spines (rarely five from my observations) and the type of *L. pentactis* (R 31 mm.) has about four, also the 'Discovery' specimens of similar size.

Finally, Fisher describes the abactinal paxillar spinelets of *L. stellans* as having five or six prongs at the tip rather than three or four like *L. marionis*. I can only say that the specimen of *L. stellans* of which he figured the spinelets is exceptional. In the holotype of *L. stellans* most of the spinelets are damaged at the tip but the majority probably had no more than four points. The two paratypes of *L. stellans* and the type of the forma *pentactis* figured by Koehler (1920, pl. lxviii, fig. 3) as well as two 'Discovery' specimens from stations WS 799 and WS 83 examined by me, all have the spinelets predominantly with three terminal spikes or prongs, sometimes four and in the discussion of *L. gaini* Fisher himself (1940, p. 173) notes that 'in *stellans* the spinelets are characteristically 3- or 4-pronged'.

The B.A.N.Z.A.R.E. specimen is of the *pentactis* form with tall pedicels and fairly narrow rays. The larger proximal paxillae have about 15 spinelets. The subambulacral spines proximally number five or four and the more lateral ones particularly are distinctly thorny towards the tip, as in Ludwig's antarctic specimens and in the type of *L. marionis*, but some of the Falkland specimens also resemble it in this respect. Since Ludwig found *L. stellans* in the Bellingshausen Sea, the species will probably prove to be circumpolar in the Antarctic. The only difference between the present specimen and those from subantarctic waters (including the type of *L. marionis*) seems to be that here the number of papulae is smaller, rarely more than four in each area on the disc and often only one, whereas six or more is common in subantarctic specimens. The abactinal spinelets again usually have three terminal spikes although Ludwig's specimens apparently have four.

The species *Lophaster abbreviatus* Koehler 1908, from 3246 metres off the South Orkney Islands, was described from a single specimen with R/r 11 mm./5 mm. (i.e. 2·2/1). Both marginal series of plates are paxilliform like those of *L. stellans*, with which species Koehler compared it and the smaller numbers of spines and spinelets may be attributable to the small size. The relatively short rays are to be expected in forma *stellans* at this size. A specimen from 'Discovery' station WS 246 has R/r 7 mm./3 mm. (2·3/1), but there are already four furrow spines proximally and four subambulacral spines as opposed to three and two in the type of *L. abbreviatus*. Considering the existence of other antarctic records of *L. stellans* and the great depth of the type locality, it is reasonable to expect the species to occur in deep water off the South Orkney Islands.

TYPE LOCALITY. ? South of Wellington Island, southern Chile, 320 metres.

RANGE. Known from Patagonia, the Falkland Islands, the Bellingshausen Sea and Knox Land in the Victoria Quadrant in 25 to 463 metres (?South Orkney Islands, 3246 metres, *L. abbreviatus*).

LOPHASTER DENSUS Fisher

Lophaster densus Fisher, 1940, 173-175, fig. E4, pl. xiii, figs. 2, 3.

BANZARE LOCALITY: Station 30 (1 specimen).

R/r is 23 mm./8 mm.; in the holotype of *L. densus* R is 19 mm. As in the type specimen the appearance simulates that of *Leptychaster*. The actinal surface is flat and the infero-marginal plates define a distinct ventro-

lateral angle. The supero-marginals are only a little smaller, slightly irregular in position but usually tend to alternate with the lower series.

The abactinal spinelets are similar to those figured by Fisher, having usually three flanges but with blunt or irregular tips.

TYPE LOCALITY. Bransfield Strait, South Shetland Islands, 200 metres.

RANGE. Known from the South Shetlands and from MacRobertson Land in 200 to 610 metres.

Genus PARALOPHASTER Fisher

Lophaster (part) Koehler, 1912, 46; 1920, 144.
Solaster (part) Koehler, 1912, 50; 1920, 153, 157.
Paralophaster Fisher, 1940, 175-176 (Type *Solaster godfroyi* Koehler, 1912).
Myoraster Fisher, 1940, 181 (Type *Lophaster antarcticus* Koehler, 1912).

Since the present collection includes a number of specimens attributable to a subspecies of *Paralophaster godfroyi* I was able to discover by dissection that the actinolateral longitudinal muscle, supposed by Fisher to be characteristic of *Lophaster antarcticus* and on the strength of which he created for it the genus *Myoraster*, also occurs in *P. godfroyi*. With only the type specimen of *P. godfroyi meseres* available to him Fisher was unable to investigate the musculature of his other new genus *Paralophaster*. The differences between *P. godfroyi* and *M. antarcticus* lie mainly in the slightly more prominent supero-marginal paxillae of the latter, which are, however, still considerably smaller than those of *Lophaster*, the more numerous paxillar spinelets and the occurrence of unique supernumerary lobate spinelets in most specimens of *M. antarcticus*. These characters do not seem to me to be of generic importance and consequently I am reducing *Myoraster* to the snyonymy of *Paralophaster*, the latter name having page priority in Fisher 1940. The generic diagnosis may therefore be expanded to include mention of the well-developed actinolateral muscle.

There are two other species also probably referable to this genus, namely *Solaster lorioli* Koehler, 1908, from the South Shetland-Weddell Sea area, which Madsen, 1955, has shown to have very distinctive comb-like marginal spinelets, and *S. incertus* Koehler 1917, from Kerguelen, which appears to have some resemblance to *P. antarcticus*.

PARALOPHASTER ANTARCTICUS (Koehler)

Lophaster antarcticus Koehler, 1912, 46-50, pl. iii, figs. 4, 5; 1920, 144-151, pl. xxxii, figs. 8-11, pl. xxxiii, figs. 3, 4, pl. lxvii, figs. 1-5, pl. lxviii, figs. 1, 2; 1923, 75.

Myoraster antarcticus, Fisher, 1940, 181-183.

BANZARE LOCALITY: Station 107, (OTL, 1 specimen).

This single specimen is very large with R 112 mm. It is distinguishable from the specimens of *P. godfroyi asperatus* which were taken with it by the more numerous paxillar spinelets, 36 on a large proximal paxilla examined, and their very compact arrangement. They include some of the unique trilobed spinelets characteristic of the species. Another difference is that the sides of the rays are more rounded in *P. antarcticus* with the infero-marginal plates less projecting. The supero-marginal paxillae are just distinct but little more so than in some specimens of *P. godfroyi asperatus*. Judging from published data and from the specimens available to me, *P. antarcticus* tends to have a few more marginal plates in each series than *P. godfroyi asperatus* of about the same size but in smaller specimens, R $<$40 mm., this does not always hold good. For instance an example of *P. antarcticus* with R 70 mm. from 'Terra Nova' station 338 has about 33 infero-marginals in each series compared with not more than 28 marginals in any of the 37 specimens of *P. godfroyi asperatus* up to the same size, but two small 'Discovery' specimens of *P. antarcticus* with R 32 mm. and 23 mm. have 24 and 22 marginals respectively while two others of *P. godfroyi asperatus* with R 30 mm. and 28 mm. have 26 and 23 marginals although the usual number in the subspecies *asperatus* at that size is only 20.

Koehler has already compared this species with *Lophaster gaini*. It is intermediate between *L. gaini* and *Paralophaster godfroyi* but I think it is more closely linked to the latter by the reduced supero-marginal plates and the development of the actino-lateral muscle. A dissected specimen of *L. gaini* has the corresponding muscle very slender and almost thread-like even interradially, not forming a conspicuous band as it does in the other two species.

TYPE LOCALITY. Bellingshausen Sea, between Jenny I. and Adelaide I., 254 metres.

RANGE. Known from the Bellingshausen Sea, South Shetland Is., South Sandwich Is., South Georgia, MacRobertson Land, Adélie Land and the Ross Sea (77° S., 164° E.) in 99 to 750 metres.

Paralophaster godfroyi asperatus (Koehler)

text fig. 7a-l.

Solaster lorioli (part), Bell, 1917, 4; Döderlein, 1928, 296, pl. xii, fig. 5. Non *lorioli* Koehler, 1908 which is a valid species of *Paralophaster*.

Solaster godfroyi Koehler, 1920, 153-157, pl. xxxv, figs. 1-4, pl. lxvi, fig. 9. Non *godfroyi* Koehler, 1912.

Solaster asperatus Koehler, 1920, 157-159, pl. xxxiii, figs. 8, 9, pl. lxv, fig. 3.

Paralophaster godefroyi meseres Fisher, 1940, 176-177, fig. F2, pl. xii, figs. 2, 3.

Banzare localities: Stations 41 (TML 2 specimens, OTL 6 specimens), 42 (1 specimen), 107 (OTL 10 specimens).

Remarks. Only the specimens from station 107 exceed a size of R 25 mm. The small one from station 42 has six rays. It is in poor condition but seems to be conspecific with the rest.

A number of 'Terra Nova' specimens from the Ross Sea area to which Bell had given the name *Solaster lorioli* also prove to be conspecific with these B.A.N.Z.A.R.E. ones and some of them are better preserved with more of the delicate spinelets intact. They are from 'Terra Nova' stations 316, 338, 339, 340 and 355.

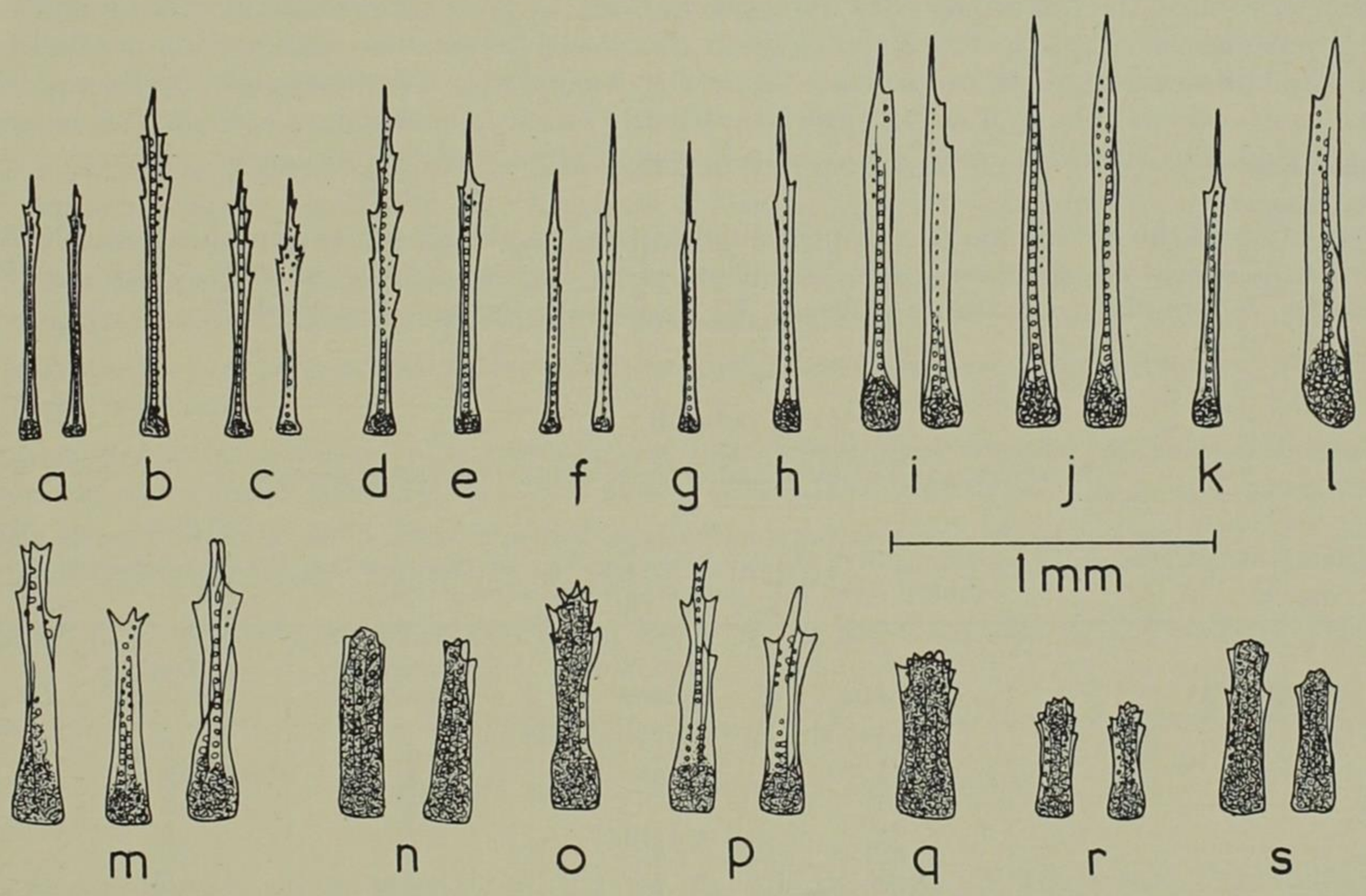


Fig. 7 a, to l, *Paralophaster godfroyi asperatus*, a, to j, abactinal interradial spinelets or spines, and k and l, infero-marginal spines: a, R 9 mm. from 'Terra Nova' station 355, Ross Sea, b, R 15 mm. from 'Terra Nova' station 316, McMurdo Sound, c, R 18 mm. from Banzare station 41, d, R 20 mm. from 'Terra Nova' station 340, Ross Sea, e, R 28 mm. from Banzare station 107, f, R 30 mm. from station 107, g, R 31 mm. from 'Terra Nova' station 355, h, R 47 mm. from 'Terra Nova' station 316, i, R 65 mm. and j, R 70 mm. both from Banzare station 107, k, infero-marginal spine corresponding to c, and l, corresponding to g,; m, and n, *Solaster regularis regularis* abactinal spinelets, m, of holotype, R 90-100 mm., n, R 40 mm. from 'Discovery' station WS 97, Falkland Is., o, to s, *Solaster regularis subarcuatus*, o, R 40 mm. from 'Discovery' station 170, Clarence I., p, holotype, R 38 mm., q, R 26 mm. from Banzare station 42, r, R 18 mm. from station 34, s, R 25 mm. from station 39.

A comparison of abactinal spinelets from specimens of different sizes showed some variation in the occurrence of lateral points. These spinelets (fig. 7a-j) always terminate in a needle-like spine (often broken) but at about two-thirds to three-quarters of their length, or for an even greater extent in a few specimens, they may bear some points on the lateral flanges. The number and size of the points is greater in smaller specimens, particularly those from the Ross Sea, but when R exceeds 30 mm. there are usually only one or two and at a size of R 60 or 70 mm. the flanges simply taper off distally or terminate in a small shoulder. This approaches the straight tapering form of spinelet illustrated (diagrammatically) by Koehler in 1912 from one of the small paratypes of *Solaster godfroyi* (probably that with R 14 mm.). It is this simple type of spinelet in such a small specimen which leads me to maintain *asperatus* as a distinct subspecies of *P. godfroyi* for specimens from outside the Weddell Quadrant, although only the small type specimens of *godfroyi* are as yet known from within that area.

The type of *Solaster asperatus* with R only 8·5-9 mm. was taken at the same A.A.E. station off Queen Mary Land as the large one (R 70-80 mm.) which Koehler referred to *S. godfroyi*. Each of these has spinelets approximating in form to those found in B.A.N.Z.A.R.E. specimens of comparable size.

Synonymy. In 1940 Fisher described a new subspecies *P. godefroyi meseres* from the Ross Sea, basing it on a single 'Discovery' specimen with R 28 mm. He believed this to be distinguished from the types of *P. godfroyi* by the fewer and more nearly equal-sized paxillar spinelets (5-8 proximally as opposed to 8-14 in *P. godfroyi*), the occurrence of irregular points on these spinelets and the lesser development of the flanges on the infero-marginal spines. With regard to the first character, Koehler's plate iv, fig. 11 (1912) of a paxilla in lateral view suggests that the most peripheral spinelets are not shorter than the central ones although his description states otherwise. Since the paxilla described was from one of the two smaller types, R 14 or 4 mm., the larger number of spinelets as well as their simple shape probably provides a significant difference from the Enderby Land to Ross Sea form.

In his comparison of the type of subspecies *meseres* with the much larger A.A.E. specimen which Koehler named *Solaster godfroyi*, Fisher commented on the relatively small number of infero-marginal spines in the latter. However, it appears that he mistranslated 'cinquantaine' as 15 rather than 50. The larger number compares well with the 20-25 spines in *meseres* at less than half the size.

Thirdly, Fisher compared *meseres* with the type of *Solaster asperatus*, which species he also referred to *Paralophaster*, finding that *meseres* differed primarily in having only two furrow spines on most of the adambulacral plates with three on the first three plates, whereas the much smaller *asperatus* is described as having four spines. At the same time the latter has only five oral marginal spines, *meseres* having six or seven. In addition Fisher noted that *asperatus* has up to 12 spinelets on the abactinal paxillae rather than 5-8 as in *meseres*, but here again he has mistranslated, since "dizaine' means 10 rather than 12 although in fact some of the present small specimens of *asperatus* have over 10 spinelets. Finally the infero-marginal spinelets of *asperatus* are said to be no larger than the abactinal ones, whereas in *meseres* they are distinctly larger.

To assess some of the variations of subspecies *asperatus* I made counts of the numbers of infero-marginal plates, furrow spines, oral marginal spines and spinelets of the largest paxillae of 37 B.A.N.Z.A.R.E. and 'Terra Nova' specimens, ranging in size from 9 to 70 mm. R. The results are given in Table 7.

TABLE 7

Some characters of specimens of *Paralophaster godfroyi asperatus*.

Where a number is given in brackets for the furrow spines it signifies that this only occurs on one to three of the proximal-most plates; with the oral spines, the brackets signify variations from the usual number. The paxillar counts are of the largest paxillae except for the primary ones. T.N. indicates Terra Nova station.

Station	R (in mm.)	Marginal plates	Furrow spines	Oral spines	Paxillar spinelets
Banzare 107	70	28	4	9	15
T.N. 340	70	27	4	7(8)	—
Banzare 107	65	26	4	9	15
Banzare 107	60	24-5	4	8	—
Banzare 107	55	26	4	9	13
T. N. Balleny	55	26	(4)3	—	15
Banzare 107	55	23	(4)3	5-7	16
T.N. 316	52	25	4	9	16
T.N. 316	48	25	(3)2	6(7)	13
T.N. 316	47	24	3	—	16
Banzare 107	42	23	3	6	12
T.N. 316	38	26	(4)3	8	12
Banzare 107	38	23	3	6	—
T.N. 338	37	24	3	8	11
T.N. 316	35	20	(4)3	—	9
T.N. 355	31	20	4	6(7)	—
T.N. 316	31	20	(3)2	6(7)	12
Banzare 107	30	20	(4)3	6	—
Banzare 107	30	26	(4)3	—	11
T.N. 339	28	23	3	7	10
T.N. 316	27	19-21	(3)2	—	10
Banzare 41	23	20	3	6(5)	11
T.N. 316	23	20	4	7	12
T.N. 340	20	18	3	6(7)	12
Banzare 41	20	17	(3)2	6	9
Banzare 41	17	17	4	6	—
Banzare 41	16	17	4	—	—
T.N. 316	15	16	3	6	12
T.N. 316	15	14	2	6	7
Banzare 42	14	15	(4, 3)2	6(5)	15
T.N. 316	14	15	3	8	—
T.N. 316	13	16	(3)2	6	8
Banzare 41	13	13	(3)2	5	12
T.N. 41	12	14	(4)3	—	11
Banzare 41	10	14	4	—	10
T.N. 355	9	13	4	6	9
	9	13	2	5-6	11

It can be seen from the table that in the larger specimens, R >50 mm., the number of furrow spines is proximally four, falling more or less quickly to three and distally two, but in the small specimens, R <20 mm., the number may be predominantly two with three on only one to three, if any, proximal plates, or there may be four spines on several proximal plates giving way to three. The larger number is found particularly in the specimens from B.A.N.Z.A.R.E. station 41 (off Enderby Land). Döderlein also gave the number as four in his specimens from off Wilhelm II Land, of which one, presumably the largest, had R 27 mm., as in the type of *meseres*.

The number of oral spines appears to be correlated with the total size, though with a few exceptions.

The counts of paxillar spinelets were made from slide preparations of two paxillae from each specimen, selecting the largest other than the primary interradial ones, the skin being dissolved in a bleaching fluid. In only a few cases was the preservation good enough for counts to be made in situ. The maximum number of spinelets found was 16 but the smaller specimens usually had no more than twelve. The relative sizes of the spinelets proved to be somewhat variable, the specimen from 'Terra Nova' station 316 with R only 15 mm. having the largest spinelets as much as 1·0 mm. long, while the maximum in even the largest specimens is only 1·1 mm. The usual maximum length in specimens with R <20 mm. is about 0·75 mm.

Since all the small specimens from B.A.N.Z.A.R.E. station 41 have four furrow spines on at least the proximal-most plates like the type of *asperatus* they were examined particularly with regard to the other characters supposed to distinguish *asperatus* from *meseres*, namely the number of paxillar spinelets (supposedly larger in *asperatus*) and their size relative to that of the infero-marginal spinelets. No significantly larger number of spinelets was found in these specimens as opposed to the rest and the infero-marginal spinelets proved to be 20-25% as long again as the abactinal ones, much as in the others.

The shape of the marginal spinelets, where these were examined, was found to simulate that of the abactinal spinelets of somewhat larger specimens. For instance, the tapering marginal spinelets of a specimen with R 31 mm. (fig. 71) resemble the abactinal spinelets of another with R 65 mm. (fig. 7i). The small specimens with R <20 mm. have the number of points on the marginal spinelets usually smaller than on their own abactinal spinelets but similar to those found in specimens with R about 30 mm.

I can therefore find no correlation of characters to justify the retention of the subspecies *meseres* as distinct from *P. godfroyi asperatus*.

With regard to the development of the supero-marginal plates, these may be just distinguishable, especially distally, standing out a little laterally from the abactinal paxillae, but usually they are in series and almost identical with the lateral-most paxillae.

TYPE LOCALITY. Off Queen Mary Land, 202 metres.

RANGE. Known from Enderby Land eastwards to 178½° W. in the Ross Sea, in 180 to 2450 metres.

Genus SOLASTER Forbes

SOLASTER REGULARIS SUBARCUATUS Sladen

text fig. 7o-s.

Solaster subarcuatus Sladen, 1889, 455-457, pl. lxx, fig. 2, pl. lxxii, figs. 7, 8; Döderlein, 1928, 296, pl. xii, fig. 4.

Solaster octoradiatus Ludwig, 1903, 25-27, pl. iii, figs. 21, 22; Bell, 1908, 11; 1917, 4.

Solaster regularis subarcuatus, Fisher, 1940, 179-180.

BANZARE LOCALITIES: Stations 30 (1 specimen), 34 (1 specimen), 39 (1 specimen), 41 (TML, 6 specimens), 42 (2 specimens), 107 (5 specimens).

All of these specimens have eight rays except two from station 107 which have nine like the type specimen. The largest one has R 38 mm.

Most specimens have the paxillae rather small and compact, the proximal ones having about 4-12 spinelets, but the two examples from stations 30 and 34 have wider paxillae, the proximal ones with up to 20 spinelets. This variation has already been noted in the subspecies *subarcuatus* as well as in *S. regularis* itself. The spinelets themselves vary slightly in the number of points at the head, which may be few and large or more numerous and small. Usually the spinelets are stout but narrowed in the middle and about equally broad at head and base but sometimes they are less clavate and even slightly tapered all the way from the base with few points at the tip. A comparison of the abactinal spinelets of the type specimen of *s. subarcuatus* from the vicinity of Kerguelen with that of *s. regularis* from Patagonia (fig. 7p and m) shows a great similarity. In both, the spinelets are longer and generally more tapering than in specimens from around the Antarctic continent. This slender form of spinelet is, however, not characteristic of subantarctic specimens since one from the Falkland Islands (fig. 7n) has shorter and blunter spinelets approaching in shape those of some antarctic specimens with fewer points at the tip. The spinelets therefore provide no reliable guide to the distinction of antarctic and subantarctic forms.

The only specimen known from the Kerguelen area is the type of *S. subarcuatus*. More material from Kerguelen is needed to clarify the interrelationships between the two subspecies *regularis* and *subarcuatus*. Zoogeographically it is probable that the Kerguelen form is closer to the Antarctic one and accordingly I am

following Fisher in using this name for antarctic specimens and in considering *S. octoradiatus* Ludwig to be a synonym of it. Only the large size attained by subantarctic *S. regularis regularis* and a slight difference in the proportions of the furrow spines, serve to differentiate it from *subarcuatus* of Kerguelen. Should the two prove to be indistinguishable, then Ludwigs name is available for the subspecies from around the Antarctic continent, since the type locality of *S. octoradiatus* is the Bellingshausen Sea.

TYPE LOCALITY. Between Kerguelen and Heard Islands, 275 metres.

RANGE. Known from the Kerguelen area, the Bellingshausen Sea and South Shetland Islands, from Enderby Land eastwards to Wilhelm II. Land and from Coulman Island in the Ross Sea in 183 to 603 metres.

Family KORETHRASTERIDAE

KEY TO THE SOUTHERN SPECIES

1 (2) Abactinal plates joined directly to one another by wide, rounded lobes, only rarely linked by supplementary plates, the meshes small; abactinal spines very wide at the tip and scoop-shaped, those of each plate joined by skin into a hollow, funnel-like fascicle, the heads of the expanded fascicles approximating closely and tending to conceal the dorsal surface (Bellingshausen Sea, Clarence I., South Georgia, Shag Rocks, Falkland Is. and MacRobertson Land, 10-540 m.)
Remaster gourdoni Koehler, 1912

2 (1) Abactinal plates with narrow lobes, the primary ones linked to each other (except in very small specimens) by narrow supplementary plates, meshes large; abactinal spines narrow or spatulate but not scoop-shaped, joined into more solid fascicles which are spaced out so that the dorsal surface is clearly visible between them . . *Peribolaster* Sladen, 1885

3 (4) Three, sometimes four adambulacral spines, of which the innermost may sometimes be termed a furrow spine; not known to exceed a size of 40 mm. R (Enderby Land eastwards to the Ross Sea, 163-581 m.) . *Peribolaster macleani* Koehler, 1920

4 (3) Four or five subambulacral spines as well as one or two furrow spines present; known to reach a size of 90 mm. R (Southern Chile, Falkland area, Marion I., 81-133 m.) . . . . . *Peribolaster folliculatus* Sladen, 1889

Genus REMASTER Perrier

REMASTER GOURDONI Koehler

text fig. 8a-e.

Remaster gourdoni Koehler, 1912, 60-64, pl. v, figs. 4, 5, 9, 12, pl. viii, fig. 7; 1923, 76, pl. ix, fig. 1; Fisher, 1940, 186-188.

Anareaster ganymede Fell & H. E. Clark, 1959, 185-187, figs. 1-3.

BANZARE LOCALITIES: Stations 30 (1 specimen), 107 (DRL and OTL 11 specimens).

The largest specimen has R/r 25 mm./13 mm. and is therefore twice the size of any example of *R. gourdoni* so far recorded from the Weddell Quadrant, although to date as many as 48 specimens are known from that part of the Antarctic.

Dr. H. B. Fell and Miss Helen Clark have recently described a new genus and species of the Korethrasteridae called *Anareaster ganymede*, based on a specimen with R 30 mm. from MacRobertson Land. I believe that they were mistaken about the true nature of the paxillae of *Remaster gourdoni* and in a letter to me Dr. Fell has conceded that *gourdoni* and *ganymede* are congeneric, but he has pointed out that it is by no means certain that *gourdoni* is congeneric with the deep-water West Indian type species of the genus. *Remaster palmatus* Perrier. Judging from the preliminary description of *Anareaster ganymede*, these B.A.N.Z.A.R.E. specimens are conspecific with it. Prompted by Dr. Fell I compared the paxillar spines of a 'Discovery' specimen of *R. gourdoni*

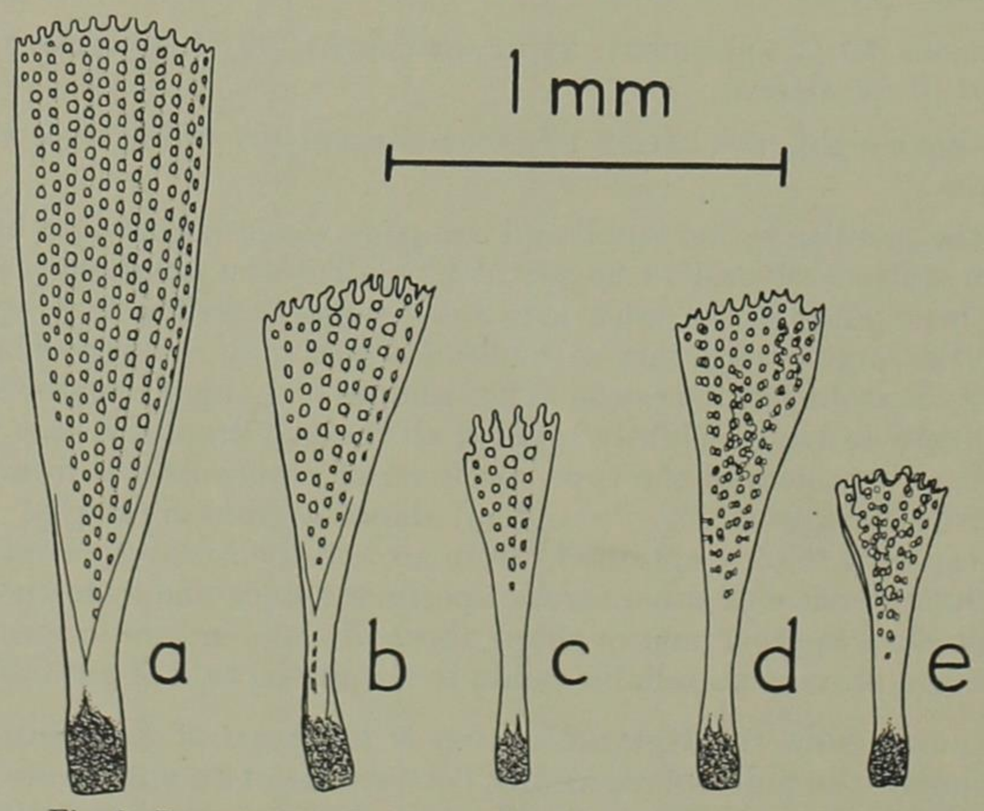


Fig. 8. *Remaster gourdoni*, proximal abactinal spines from specimens with a, R 15 mm., b, R 11 mm. and c, R 9 mm., all from Banzare station 107, d, and e, both with R 10 mm. from 'Discovery' station 170, Clarence I.

from Clarence Island (station 170) having R 10 mm. with those of the best-preserved specimen from B.A.N.Z.A.R.E. station 107 with R 15 mm. and found a marked difference in the size and shape of the spines. These were distinctly scoop-shaped, and averaged over 2 mm. in length in the B.A.N.Z.A.R.E. specimen (fig. 8a) but flat and triangular, averaging only 0·85 mm. in the 'Discovery' specimen at two-thirds the size (fig. 8d). However, since then I have made further preparations of specimens from both MacRobertson Land and the Weddell Quadrant which have shown that there is considerable variation in the shape and size of the spines, both with growth and individually. The larger of two specimens from B.A.N.Z.A.R.E. station 107 with R 10 mm., has the average spine length over 1·5 mm., this is over 50% more than the average in the other specimen, where R is 9 mm. The length of 1 mm. in the latter is comparable with the length given by Koehler for the type of *R. gourdoni* where R is 11·5 mm. Judging from Koehler's rather diagrammatic figure 5 of plate v, 1912, the spines of the type, which was from the Palmer Archipelago, resemble in shape those of the larger B.A.N.Z.A.R.E. specimens, those of the 'Discovery' specimens having the sides almost parallel for much of the length, the scoop-shape being quite distinct (though the perforations extend rather improbably right to the base in his figure).

TABLE 8

Measurements of spines of *Remaster gourdoni*.

Station	R (in mm.)	Proximal paxillar spines		
		Range of length (mm.)	Average (mm.)	Number
Discovery station WS 177	9	0·63-0·76	0·69	7
Discovery station 170	10	0·79-0·90	0·85	6
Discovery station 170	10	1·10-1·60	1·30	7
Banzare station 107	8·5	0·84-1·14	0·98	26
Banzare station 107	9	0·86-1·10	1·00	10
Banzare station 107	10	1·27-1·98	1·56	8
Banzare station 107	11	1·16-1·50	1·34	10
Banzare station 107	15	1·79-2·40	2·02	12
Banzare station 107	15	2·03-2·50+	2·19	7
Banzare station 107	25	2·38-2·60+	2·51	5

Table 8 shows the measurements of spines in some of the available specimens. Unfortunately, owing to the mutilation involved and the incidence of broken spines, the numbers are rather small.

The holotype of *Anareaster ganymede* (R 30 mm.) appears to have the spines about 1·8 mm. long, judging from the magnification of the figure. If so, this is relatively small compared with their size in the largest B.A.N.Z.A.R.E. specimen, which also differs in having as many as five spines on two or three of the proximal-most adambulacral plates, though all the smaller specimens have only four like the Weddell Quadrant specimens. This large specimen has up to four papulae in each area, though there are more often two.

Possibly the difference in the paxillar spines and the fact that the MacRobertson Land form appears to reach a much greater size may warrant a subspecific distinction from the Weddell Quadrant *R. gourdoni* but since the paxillar spines of the holotype of *R. gourdoni* seem to be more like those of the MacRobertson Land specimens, no decision can be reached on this problem until these spines, or those of other specimens from the type locality, have been examined. I can find no other important differences.

TYPE LOCALITY. Off Port Lockroy, Palmer Archipelago, 70 metres.

RANGE. Known from the Bellingshausen Sea, Clarence Island, South Georgia, the Shag Rocks, Falkland Islands and from MacRobertson Land in 10 to 540 metres.

Genus PERIBOLASTER Sladen

PERIBOLASTER MACLEANI Koehler

pl. iv, figs. 3, 4.

Peribolaster macleani Koehler, 1920, 161-164, pl. xxxi, figs. 2-5, pl. xxxiii, figs. 1, 2, pl. lxviii, fig. 4; Fisher, 1940, 191.

BANZARE LOCALITIES: Stations 30 (3 specimens), 40 (3 specimens), 41 (TML, 1 specimen), 105 (1 specimen), 107 (13 specimens).

Many of the specimens are small but one from station 107, has R/r 40 mm./15 mm. (r not including the height of the lateral paxillae). The number of subambulacral spines is no greater in the larger specimens than in the smaller.

The specimen from station 41 is in particularly good condition so I include photographs of it for comparison with *P. folliculatus* and with *Remaster gourdoni*, since the types of *P. macleani* were not in a very good state. There are also in the British Museum two specimens of *P. macleani* from 'Terra Nova' stations 294 and 295 in the Ross Sea at 289 and 348 metres.

TYPE LOCALITY. Off Adélie Land, 276 metres.

RANGE. Known from Enderby Land eastwards to the Ross Sea in 163 to 581 metres.

Family PTERASTERIDAE

Key to the Southern Species

1 (24) Webs of thick skin present between the adambulacral spines of each plate.

2 (19) Fans of adambulacral spines similar, not alternating; paxillae with three to fifty or more spinelets, of which no single central one is enlarged . . . . . *Pteraster* Müller & Troschel, 1842

3 (16) Oral marginal spines webbed with skin.

4 (5) Web of oral marginal spines of each pair of plates continuous across the jaw angle (subgenus *Retaster*) (Falkland-Magellan area, 27-448 m.) . . . . . *Pteraster gibber* (Sladen), 1882

5 (4) A separate web on the marginal spines of each oral plate (subgenus *Pteraster*)

6 (7) About nine rays (off MacRobertson Land, 540 m.) . . . . . *Pteraster koehleri*, sp. nov.

7 (6) Five or six rays.

8 (13) Up to six but usually four spinelets on each proximal paxilla, one of which may be enlarged . *Pteraster affinis* Smith, 1876

9 (10) Spinelets rather short, thick and opaque (fig. 10f, g) (Kerguelen, 0-91 m.) . . . . *P. affinis affinis* Smith, 1876

10 (9) Spinelets slender and cylindrical, more or less transparent (fig. 10c-e).

11 (12) Pedicels high and narrow, usually three to six times as high as wide when R exceeds 30 mm., rarely more than four paxillar spinelets; usually six to eight oral marginal spines (Falkland-Magellan area, Marion Island [? Argentina, 39° S.], 74-341 m.) *P. affinis lebruni* Perrier, 1891

12 (11) Pedicels low, usually less than three times as high as wide, four to six paxillar spinelets; not more than five oral spines (Kemp Land eastwards to the Ross Sea, 219-603 m. [? Weddell Quadrant down to 740 m.]) *P. affinis aculeatus* Koehler, 1920

13 (8) Ten or more paxillar spinelets, the peripheral much larger than the slender central ones.

14 (15) Less than ten slender central paxillar spinelets and about four to six larger peripheral ones (south of Kerguelen, 150-274 m.; also a subspecies from the Falkland Plateau, 81-341 m.) . . . . . *Pteraster rugatus* Sladen, 1882

15 (14) Very numerous paxillar spinelets, often 50 or more (Wilkes and MacRobertson Lands, 1266 and 3100 m.) *Pteraster florifer* Koehler, 1920

16 (3) Oral marginal spines simply sheathed with skin, not connected together (subgenus *Apterodon*) . *Pteraster stellifer* Sladen, 1882

17 (18) Paxillar spinelets cylindrical or very slightly widened towards the tip (Falkland-Magellan area and Weddell Quadrant, 79-500 m.) . . . . . *P. stellifer stellifer* Sladen, 1882

18 (17) Paxillar spinelets conspicuously flared towards the tip (Kemp Land eastwards to Adélie Land, 201-655 m.) *P. stellifer hunteri* Koehler, 1920

19 (2) Fans of adambulacral spines alternating in extent over the furrow, sometimes every second plate with an additional spine, at least in larger specimens (R > 20 mm.); paxillae usually with one larger central spinelet and about five to ten smaller peripheral ones . . . . . *Diplopteraster* Verrill, 1880

20 (21) Seven or eight spines on some adambulacral plates alternating with five (Kerguelen, 233 m.) *Diplopteraster peregrinator* (Sladen), 1882

21 (20) Four or five adambulacral spines.

22 (23) Marion Island, 99-126 m.* . . . . . *Diplopteraster semireticulatus* (Sladen), 1882

23 (22) Falkland area, Burdwood Bank, southern Argentina, 74-270 m.* . . . *Diplopteraster verrucosus* (Sladen), 1882

24 (1) No webs of skin (or only transparent ones) between the adambulacral spines . . . *Hymenaster* W. Thomson, 1873

25 (32) Only one or two spines on each adambulacral plate.

26 (29) A single adambulacral spine on most plates, though some proximal plates may have two†

27 (28) Most paxillae with three spines (south from Australia, 50° S., 123° E., 3292 m.) . *Hymenaster nobilis* W. Thomson, 1876

28 (27) Paxillae with three to five spines (same locality) . . . . . *Hymenaster formosus* Sladen, 1882

29 (26) Two adambulacral spines on most plates.

30 (31) Paxillae with four or five spinelets (R 42 mm.) (same locality) . . . . . *Hymenaster sacculatus* Sladen, 1882

31 (30) Paxillae with eight to twelve spinelets (R 18 mm.) (Bellingshausen Sea, 400-450 m.) . *Hymenaster perspicuus* Ludwig, 1903

32 (25) Three or more spines on each adambulacral plate.

33 (44) Three adambulacral spines on most plates.

34 (35) Only two spines on each oral plate; paxillae with five to eight spinelets (off Dronning Maud Land, 2579 m.) *Hymenaster campanulatus* Koehler, 1908

35 (34) Two suboral and three or more marginal spines on each oral plate; usually up to five paxillar spinelets.

36 (37) Supra-dorsal membrane containing granular bodies (between Marion I. and the Crozets, 2514 m.) *Hymenaster graniferus* Sladen, 1882

37 (36) No granular appearance in the supra-dorsal membrane.

38 (41) Five or six marginal oral spines on each plate and two suborals.

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* I can find no significant difference between these. All four of the recorded specimens of *D. semireticulatus* have only five rays whereas *D. verrucosus* has five to eight rays. Sladen's inclusion of them in different genera may be accounted for by the small size of the type specimen of *D. semireticulatus*, since a juvenile *Diplopteraster* sp. lacks the characteristic alternation of the adambulacral combs and is usually indistinguishable from *Pteraster* sp.

† The unique holotype of *Hymenaster nobilis* (R 138 mm.) has two adambulacral spines on the first four to six plates of each series. There is a short (usually broken) suboral spine on each plate and four marginal spines, though the innermost of these is inset slightly on the ventral surface of the plate and might be taken for a second suboral spine. In the type of *H. formosus* (R 19 mm.) most of the adambulacral spines have been lost but on a few plates about 1/3 R from the mouth there are two spines. The oral plates have spines of the same number and position as those of the type of *nobilis*. The other characters by which Sladen distinguished these two types deal mainly with the appearance of the supra-dorsal membrane. I believe these supposed differences can be attributed to the very different sizes of the specimens and consequent differences in the thickness of the membrane as well as to variable conditions of preservation which often give rise to modifications in the appearance of specimens of this family.

39 (40) Adambulacral spines short, equal, not webbed; segmental papillae with a rounded free end* (south from Australia, 50° S., 123° E., 3292 m.) . . . . . *Hymenaster crucifer* Sladen, 1882

40 (39) Adambulacral spines large, the innermost a little smaller, linked by skin; segmental papillae with a more acute tip* (off Dronning Maud Land, 2579 m.) . . . . . *Hymenaster fucatus* Koehler, 1908

41 (38) Three marginal oral spines and two suborals.

42 (43) South from Australia, 50° S., 123° E., 3292 m.† . . . . . *Hymenaster caelatus* Sladen, 1882

43 (42) Southern Ocean, 54° S., 108½° E., 3566 m.† . . . . . *Hymenaster latebrosus* Sladen, 1882

44 (33) Four or more adambulacral spines, at least on the proximal plates.

45 (46) Only three large, similar, oral spines on each plate, two near the furrow towards the apex and one suboral (off the South Orkney Is., 3246 m.) . . . . . *Hymenaster edax* Koehler, 1908

46 (45) At least four oral spines.

47 (48) One suboral spine; segmental papillae with a prolonged acute tip, the skin covering a fan of 5-7 spinelets of which the central one is longest (between Marion I. and the Crozets, 2514 m.) . . . . *Hymenaster coccinatus* Sladen, 1882

48 (47) Two (three) suboral spines; segmental papillae small, either largely covered with the actinal skin or with 'two or three small prolongations'.

49 (50) Segmental papillae free of the actinal skin; three or four marginal oral spines (off Dronning Maud Land, 4791 m.) *Hymenaster densus* Koehler, 1908

50 (49) Segmental papillae with only the latero-distal margin free; usually two oral marginal spines (Crozet Is. area, 2514-2926 m.) *Hymenaster praecoquis* Sladen, 1882

Genus Pteraster Müller & Troschel

Subgenus Pteraster

Pteraster affinis Smith

text figs. 9, 10a-g.

Pteraster affinis Smith, 1876, 108; 1879, 275, pl. xvi, fig. 5; Koehler, 1911a, 27; 1917, 48, pl. x, fig. 11.

Pteraster lebruni Perrier, 1891, 144, pl. xiii, figs. 4a-b; Ludwig, 1903, 29, pl. iii, figs. 25-28; Fisher, 1940, 194-196; Madsen, 1956, 32-33.

Pteraster brachiatus Koehler, 1917, 49-52, pl. vii, figs. 1, 2, 6, pl. x, figs. 6-10.

Pteraster aculeatus Koehler, 1920, 168-170, pl. xxxviii, figs. 3-5, pl. lxv, fig. 5.

Pteraster lebruni brachiatus, Fisher, 1940, 196-197.

Fisher (1940) listed a number of species which he believed to be closely related to, if not indistinguishable from, *Pteraster lebruni*. These species are:—

P. brachiatus Koehler, 1917. Kerguelen.

P. aculeatus Koehler, 1920. Off Queen Mary Land.

P. rugatus Sladen, 1882. Between Kerguelen and Heard Island.

P. marplatensis Bernasconi, 1935. Off northern Argentina.

P. argentinus Bernasconi, 1935. Off northern Argentina.

Of these he thought that *Pteraster brachiatus* and *P. marplatensis* represent, at best, races of *P. lebruni* and that *P. argentinus* is also very closely related to it. *Pteraster aculeatus* he compared with *P. affinis* Smith from Kerguelen, which was excluded from his list since it was described by Smith as having five to ten paxillar spinelets unlike *P. lebruni*. Finally, Sladen's description of the small type of *P. rugatus* (R only 9·5 mm.) stating that there are five or six paxillar spinelets, three or four adambulacral and three oral spines, was compared by Fisher with a similarly small specimen of *P. lebruni* having about three paxillar spinelets, five adambulacral and five oral spines.

An examination of the types in the British Museum has shown that the number of paxillar spinelets was wrongly assessed in the original descriptions of both *P. affinis* and *P. rugatus*. In *P. affinis* there are usually only four spinelets, as in *P. lebruni*, but in *P. rugatus* there are about five peripheral spinelets and in addition four to six much more slender, needle-like ones in the centre. The B.A.N.Z.A.R.E. has taken six specimens of *Pteraster* at station 47, south of Kerguelen, which I have referred to *P. rugatus* since they have paxillae of the same kind. As detailed under the heading of *rugatus*, five of the 'Discovery' Falkland Islands specimens named *P. lebruni* by Fisher, but conspicuous in having particularly short rays, were found to have paxillae of the *rugatus* type. Such paxillae also occur in *Pteraster gibber* (Sladen), another species known from the Falkland area but distinguished by having the oral marginal spines of each pair of plates webbed continuously across the jaw angle. For this reason *P. gibber* falls within the subgenus *Retaster* unlike *P. affinis* and *P. lebruni* which are referable to *Pteraster* sensu stricto.

The elimination of these five relatively short-rayed specimens leaves all those of *P. lebruni* which I have seen from the Falklands area with R/r ranging from 2·2 to 3·0/1, while the 'Discovery' specimens from Marion Island which Fisher named *P. lebruni brachiatus* have ratios of 2·25 to 3·2/1. Perrier gives the proportions of the somewhat contorted type of *lebruni* as 30 mm./8 mm. or 3·75/1 but judging from his photograph I would put the ratio as nearer 3·0/1.

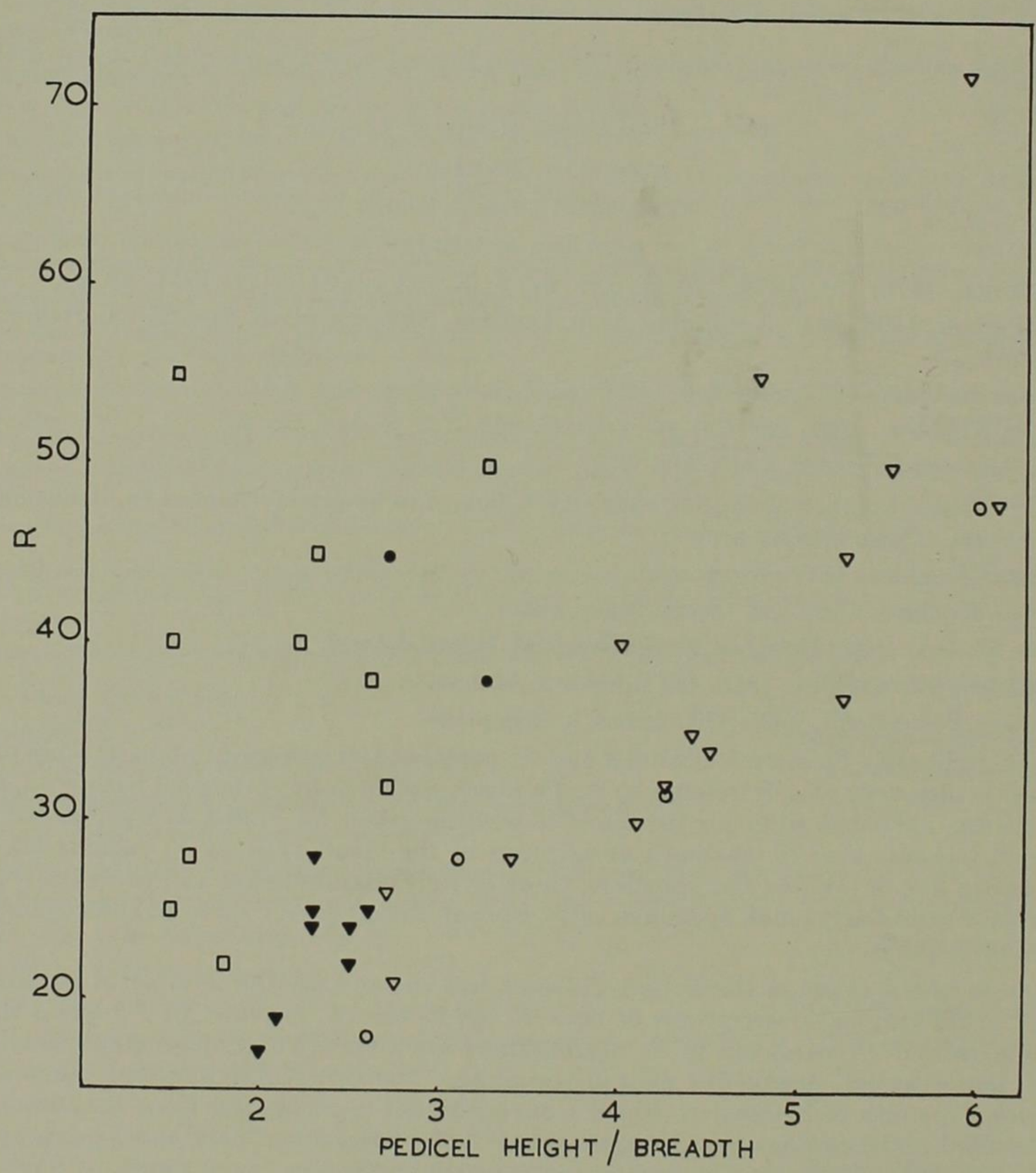
In a comparison between the specimens of *Pteraster* sensu stricto from the Southern Ocean in the British Museum and in the B.A.N.Z.A.R.E. collections which have less than seven paxillar spinelets, correlations were found between certain characters and the localities.

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* I doubt whether these differences will hold up under direct comparison of the type specimens.

† I can find no reliable distinction between these.

Firstly, the height of the pedicels relative to their thickness was found to increase with size in the Falklands and Marion Island specimens. For example, one with R 26 mm. has the pedicels from the mid-radial area, at a distance of one-third to a half R from the centre, about 0·48 mm. high and 0·18 mm. in thickness halfway up the column, a ratio of 2·7/1, whereas another specimen with R 50 mm. has these pedicels about 1·2 mm. high and 0·22 mm. wide, a ratio of 5·5/1. In the largest specimen, R 72 mm., the pedicel height is about 2·1 mm. In the two 'Discovery' specimens from Antarctic localities, one from the South Shetlands and the other off South Georgia, also the 'Terra Nova' and B.A.N.Z.A.R.E. specimens from off Antarctica, the height does not exceed 1 mm. and the ratio of height to thickness appears to have little correlation with size. This can be seen from the scatter diagram. Unfortunately, none of the Kerguelen specimens available to me has R greater than 28 mm. so that the pedicels are low throughout, with heights not exceeding 0·65 mm. There does seem to be an increase in the relative height of the pedicels with size but without more material it cannot be determined whether the rate of increase is the same as in the Marion and Falkland Islands specimens.



□ Victoria and Enderby Quadrants.
○ Marion Island
● Weddell Quadrant.
▽ Falkland—Magellan specimens.
▼ Kerguelen.

Fig. 9. Scatter diagram of specimens of *Pteraster affinis* from different localities plotting the relative height of the proximal abactinal pedicels against R.

Secondly, there are some differences in the paxillar spinelets in specimens from different areas. In all of them the spinelets are of two distinct sizes, usually one larger and two or more smaller on each paxilla. The lengths of the spinelets seem to be least in those specimens from Kerguelen, which are also distinguished by a more opaque appearance due to excessive fenestration. At the same time the spinelets are somewhat thicker than usual, particularly towards their tips (fig. 10f, g). Owing to their length and delicacy, it is rare that complete spinelets are obtained in preparations and it is only in some of these Kerguelen specimens that I have been able to extract some intact. The figures given in the table otherwise merely provide minimum lengths, but serve for comparison; for example they show that whereas a Kerguelen specimen with R 25 mm. has the larger spinelets

about 1·4 mm. long, the Marion Island one with R 28 mm. has spinelets over 1·6 mm. and another from off MacRobertson Land with R 25 mm. has them more than 2·0 mm. long. Some of the specimens from this last locality have the spinelets (fig. 10b) more transparent, with fewer fenestrations than even those from the Falklands and from Marion Island which are closely comparable with each other in appearance (fig. 10d and e).

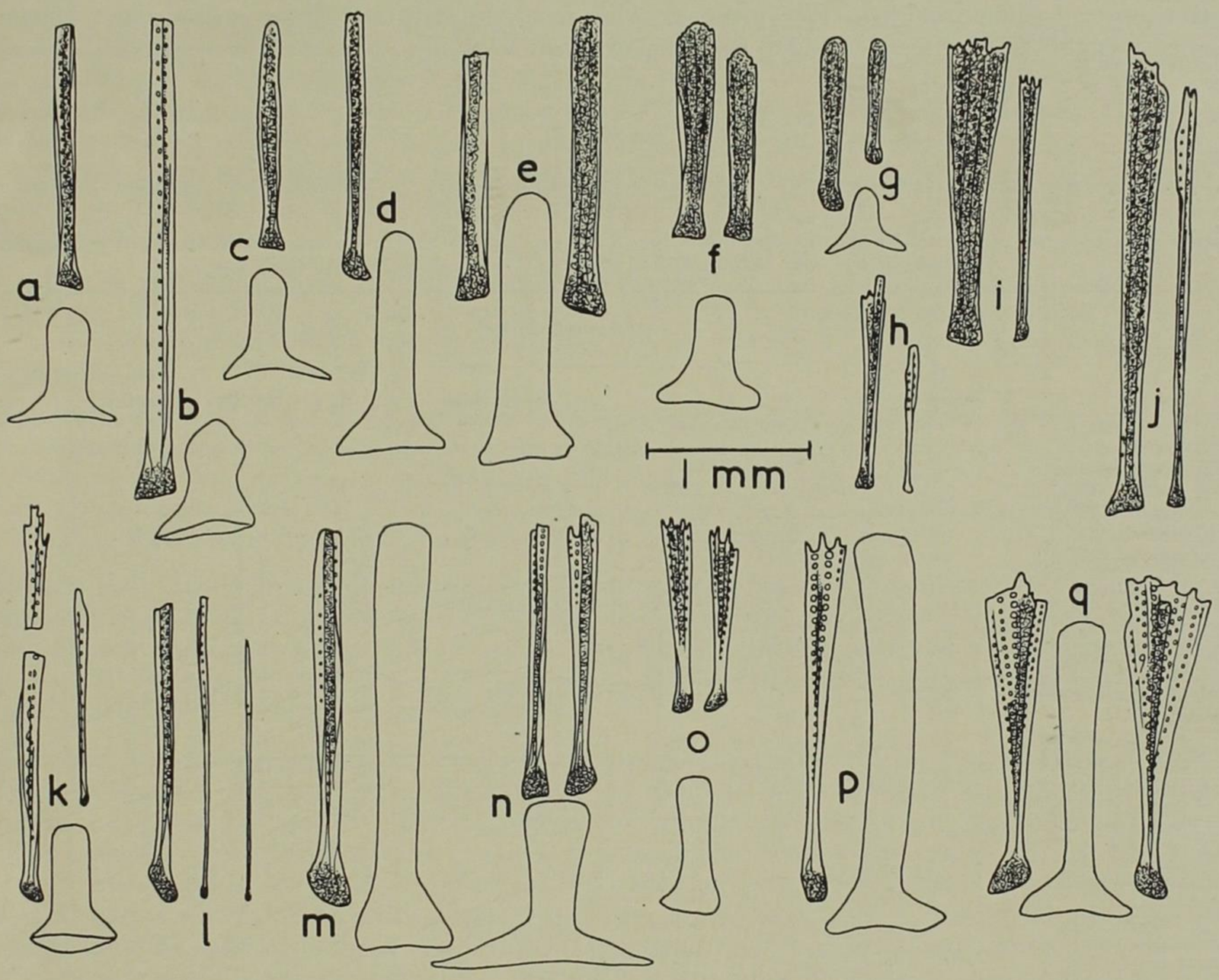


Fig. 10. *Pteraster* spp. a, to g, *P. affinis*, abactinal spinelets and pedicels, in a, to c, the spinelets are of the larger magnitude, in e, to g, both magnitudes are shown but in the preparation for d, all the spinelets obtained were of one—presumably the smaller—magnitude; a, and b, *P. affinis aculeatus*, a, R 38 mm., b, R 40 mm., both from Banzare station 107; c, to e, *P. affinis lebruni*, c, R 38 mm. from 'Discovery' station 148, South Georgia, d, R 48 mm. from 'Discovery' station 1562, Marion I., e, R 48 mm. from 'Discovery' station WS 93, Falkland Is.; f, and g, *P. affinis affinis* f, R 28 mm. from Banzare station 64, g, larger syntype, R 17 mm.; h, and i, *P. rugatus*, h, holotype, R 9·5 mm., peripheral (left) and central spinelets, i, R 18 mm. from Banzare station 47; j, *Pteraster* aff. *rugatus*, R 30 mm. from 'Discovery' station WS 871, W. of the Falkland Is.; k, *P. koehleri*, holotype, R 21 mm. from Banzare station 30, all peripheral spinelets broken; l, *P. florifer*, R c.22 mm. from Banzare station 29, one peripheral (left) and two central spinelets; m to o, *P. stellifer stellifer*, m, holotype R 34 mm., n, R 23 mm. from 'Discovery' station WS 85, Falkland Is., o, R 10 mm. from 'Discovery' station 652, Burdwood Bank; p, and q, *P. stellifer hunteri*, p, R 18 mm. from Banzare station 107, q, R 16 mm. from station 30.

Thirdly, the occurrence of deposits in the supra-dorsal membrane is variable. They are present, though few in number, in the B.A.N.Z.A.R.E. specimens from Kerguelen, but seem to be completely absent in most of those from stations 34 and 107, off Kemp and MacRobertson Lands and in others from 'Terra Nova' stations 194 (off Oates Land), 339 and 340 (in the Ross Sea at about 164° E. and 250-300 metres depth.) However, at least one specimen from B.A.N.Z.A.R.E. station 107 and two from 'Terra Nova' station 355 (Ross Sea at 166° E. and about 550 metres), like the 'Discovery' specimens from the South Shetlands and South Georgia, do have such deposits. The supposed absence of these deposits in *Pteraster affinis* was believed by Koehler to constitute an important distinction from *P. brachiatus*. The very flaccid condition of the syntypes of *P. affinis* implies a degree of decalcification which may account for the absence of deposits. The 'Challenger' specimens of *P. affinis* from Kerguelen, some of them with the rays relatively as short as in the syntypes, possess some inconspicuous deposits. The opacity of the membrane seems to vary at least partly according to the preservation. For instance, the three specimens from B.A.N.Z.A.R.E. station 64 were each preserved in a different jar; one is distinctly more transparent than the other two and all three are different in colour.

Finally, the number of marginal oral spines ranges from three to eight, but in the Falkland and Marion Island specimens with R over 20 mm. there are rarely less than six, whereas those from around the Antarctic continent, including the Weddell Quadrant, have not more than five oral spines even when R is over 40 mm.

In Table 9 most of these differences have been expressed numerically. I should note that Fisher gives the number of oral spines as eight in the largest Marion Island specimen but I can count no more than seven on any oral plate. The heights of the pedicels given include the thicknesses of the very thin basal parts of the plates.

Since these variations appear to be correlated to some extent with locality, I believe it is necessary to distinguish three subspecies, one from Kerguelen, another from the Falkland-Magellan area and Marion Island and the third from off Antarctica, for which the names *affinis*, *lebruni* and *aculeatus* respectively, are available.

TABLE 9

Table of some characters of specimens of *Pteraster affinis* and related forms from the Southern Ocean and South Atlantic.

(In the pedicel measurements, the total height of column and base is given and the breadth is taken half-way up the column. Spinelets of two magnitudes were usually found, though rarely complete with their tips.)

Station	R (mm.)	r (mm.)	R/r	Paxillar spines		Pedicels		Oral spines	Adambulacral spines
				No.	Length (mm.)	Ht. (mm.)	Ht./Br.		
P. affinis lebruni									
Falkland-Magellan area:									
Discovery station WS 782	72	31	2·3	3, 4	2·6+, 1·9+	2·1	5·9	7, 8	7, 8
Discovery station WS 97	55	24	2·3	c.4	2·6+, 1·6+	1·9	4·75	7	7
Discovery station WS 871	50	20	2·5	3, 4	2·3+, 2·2+	1·2	5·5	8	7
Discovery station WS 93	48	22	2·2	3, 4	–	1·8	6·1	7, 8	7
Discovery station WS 243	45	20	2·25	3, 4	1·7+, 1·7+	1·25	5·25	7	7(6)
Discovery station WS 81	40	17	2·35	c.3	2·6+, 1·9+	1·0	4·0	5	6
Discovery station WS 81	37	14	2·6	c.4	2·3+, 1·9+	1·15	5·25	6	6
Discovery station WS 93	35	16	2·2	3(4)	1·9+	1·0	4·4	6	5
Discovery station WS 93	34	14	2·4	3(4)	2·1+, 2·0+	1·0	4·5	6, 7	6
Discovery station WS 81	32	11	2·9	c.3	1·9+, 1·5+	0·7	4·25	5, 6	6
lebruni holotype	30	8	3·75	–	–	–	–	6	5
Discovery station WS 85	30	12	2·5	c.3	2·3+, 1·0+	0·9	4·1	6	6
Discovery station WS 84	28	11	2·55	c.4	– 1·5+	0·8	3·4	5	7, 6
Discovery station WS 871	26	11	2·4	c.3	1·4+, 1·2+	0·5	2·7	6	6
Discovery station WS 871	21	7	3·0	c.3	1·2+, 1·1+	0·45	2·75	6	6
Northern Argentina:									
marplatensis holotype	44	20	2·2	3(4)	–	–	–	8(7)	8(7)
argentinus holotype (6 rays)	40	20	2·0	3, 4	2·3, 1·6	0·4	–	6	6
Weddell Quadrant:									
Discovery station 1958	45	17	2·6	3, 4	1·7+, 1·4+	0·8	2·7	5	5
Discovery station 148	38	16	2·4	4(3)	1·5+, 1·3+	0·6	3·25	5	6
Marion Island:									
Discovery station 1562	48	15	3·2	c.4	1·7+	1·3	6·0	7(6)	7
Discovery station 1562	32	12	2·7	c.4	1·8+, 1·6+	0·8	4·25	–	–
Discovery station 1562	28	10	2·8	4(3)	1·6+	0·55	3·1	7	7
Discovery station 1563	18	7	2·6	3-5	1·0+	0·4	2·6	6	6
Discovery station 1562	14	6	2·3	c.4	–	–	–	5	5
Discovery station 1563	13	5·5	2·4	3, 4	–	–	–	5	5
Discovery station 1563 (4)	12	5	2·4	3-5	–	–	–	5	5
P. affinis affinis									
Kerguelen:									
brachiatus syntype (6)	35	13·5	2·6	<6	–	–	–	5	5
Banzare station 64	28	10·5	2·7	3, 4	1·5, 1·4	0·65	2·3	–	4
Banzare station 64	25	10	2·5	3, 4	1·4, 1·1	0·65	2·6	6	5
Banzare station 49	25	9	2·8	3, 4	1·4, 1·2	0·55	2·3	–	5
Banzare station 64	24	9	2·7	3, 4	1·1+	0·5	2·5	6	5
Challenger station 149D	24	10	2·4	3, 4	1·4, 1·3	0·55	2·3	5(6)	5
Banzare station 52 or 53	22	11	2·0	4(3)	1·2, 1·1	0·5	2·5	–	5, 6
Banzare station 52 or 53	19	9·5	2·0	4(3)	0·9	0·4	2·1	5	6
Challenger station 149D	19	9	2·1	c.3	–	–	–	–	5
Challenger station 149D	18	8	2·25	3(4)	–	–	–	5?	5
affinis syntype	17	8	2·1	c.4	1·1, 0·9+	0·3	2·0	4	4
Challenger station 149D	16	8·5	1·9	3(4)	–	–	–	(6)5(4)	5, 6
Challenger station 149D	16	8	2·0	3, 4	–	–	–	6	6
Challenger station 149D	13	7·5	1·7	3, 4	–	–	–	4, 5	4
P. affinis aculeatus									
Ross Sea-Kemp Land:									
Banzare station 34	55	22	2·5	6-4	2·8+	0·75	1·5	5	6
Banzare station 107	50	18	2·8	5, 4	2·2+, 1·7+	0·9	3·25	5	5
Terra Nova station 340	45	16	2·8	c.4	2·5+, 2·2+	0·85	2·3	5	5
Terra Nova station 339	40	17	2·35	5-3	2·3+, 1·6+	0·75	2·2	5	6
Banzare station 107	40	17	2·35	4, 5	3·1+, 2·5+	0·55	1·5	3-5	4
Banzare station 107	38	14	2·7	4(3)	1·6+, 1·6+	0·6	2·6	4	5
Banzare station 107	32	14	2·3	c.4	1·7+, 1·2+	0·65	2·7	5	5
Terra Nova station 194	28	10	2·8	c.4	1·1+, 1·0+	0·35	1·6	5	5
Banzare station 107	25	12	2·1	c.4	2·0+, 2·1+	0·45	1·5	4	4
Terra Nova sta. 355	22	9	2·4	5-3	1·6+, 1·4	0·45	1·8	4, 5	5
aculeatus holotype	18	9	2·0	5, 6	3+ –	–	–	4	4
P. flabellifer									
South Africa:									
flabellifer holotype (6)	30	16	1·9	5, 6	–	–	–	7	7, 6
Africana station 728	40	16	2·5	c.6	– , 2·6	1·7	6·4	7	–

In view of the variations in appearance of the supra-dorsal membrane and in the range of R/r shown by the specimens studied, coupled with the fact that the paxillar spinelets are comparable in number (about four in the types of *P. affinis* and 'less than six' in *P. brachiatus*), there seem to be no grounds for maintaining two subspecies, or even formae, among Kerguelen specimens. Fisher reduced *P. brachiatus* to the level of a subspecies (of *P. lebruni*) on the evidence of specimens not from the type locality—Kerguelen—but from Marion Island, which I believe are indistinguishable from *P. lebruni* itself but are subspecifically distinct from Kerguelen specimens. Since *P. affinis* has 15 years priority, *P. brachiatus* becomes a synonym and the Patagonian *P. lebruni* must also give way to it. The only significant differences between *P. affinis affinis* and *P. affinis lebruni* are provided by the paxillar spinelets. Since Marion Island lies to the north of the Antarctic Convergence and Kerguelen is on or south of it, despite their geographical proximity, their bottom faunas might be expected to show some differences in composition. I have found this to be the case with other Asteroids formerly thought to be common to both islands and I think that the Marion Island fauna has greater affinity for the Falkland-Magellan one.

The antarctic specimens from the Ross Sea to Kemp Land I believe also warrant a distinct subspecies, characterized by the relatively few oral marginal spines, the usual absence of deposits from the supra-dorsal membrane, the lower pedicels which are very variable in relative height and the sometimes more transparent paxillar spinelets.

It is unfortunate that the 'Discovery' only took two specimens from antarctic localities in the Weddell Quadrant. These have deposits present in the supra-dorsal membrane like Falkland specimens but their paxillae are relatively low and the oral spines number only five although R is 45 and 38 mm. Thus they seem to fall between *P. affinis lebruni* from the Falkland-Magellan area and *P. affinis aculeatus* from Kemp Land east to the Ross Sea. Further material is needed before any conclusion can be reached.

As already mentioned, Fisher has commented on the close relationship between *P. lebruni* and *P. marplatensis* Bernasconi from 39° S. off Argentina. The table given here confirms that the large number of oral marginal spines is not outside the range shown by Falkland specimens of *P. affinis lebruni* of comparable size. Bernasconi's second species, *P. argentinus*, appears to be distinguished only by having six rays but this number is also found in the larger syntype of *P. brachiatus* from Kerguelen.

From South Africa Mortensen (1933) has described a *Pteraster* also with separate webs on the marginal spines of each oral plate, which he called *P. flabellifer*. The British Museum has a specimen from west of Cape Province which, in 1952, I named *P. affinis*, following H. L. Clark, but which I now believe to be referable to *P. flabellifer*. Like the type of that species it seems to lack deposits in the supra-dorsal membrane, has five or six spinelets in the paxillae and seven oral spines. The pedicels are relatively very high, more so than in any specimen of *P. affinis* which I have seen. Since H. L. Clark and Mortensen have both been unable to find more than a subspecific difference between several South African echinoderms and species already known from the North Atlantic, it is possible that a similar close relationship exists between the northern *Pteraster militaris* and *P. flabellifer*, though more material from the Cape region is needed before this can properly be investigated. Fisher has also commented on the resemblance between *P. militaris* and *P. lebruni* (i.e., *P. affinis*).

Pteraster affinis affinis Smith

text fig. 10f, g.

Pteraster affinis Smith, 1876, 108; 1879, 275, pl. xvi, fig. 5; Koehler, 1911a, 27; 1917, 48, pl. x. fig. 11.

Pteraster brachiatus Koehler, 1917, 49-52, pl. vii, figs. 1, 2, 6, pl. x. figs. 6-10. Non *P. lebruni brachiatus*, Fisher, 1940, 196-197, which is *P. affinis lebruni*.

Banzare localities: Stations 49 (1 specimen), 52 or 53 (2 specimens), 64 (3 specimens).

An examination of the larger syntype of *P. affinis* Smith from Observatory Bay, near the head of Royal Sound, Kerguelen (presumably from shore collecting) showed that the number of paxillar spinelets is three or four, of which one is usually slightly enlarged. There are also four webbed oral marginal spines and four adambulacral spines in each comb. R/r is 17 mm./8 mm. =2·1/1. Smith's figure shows the interbrachial arcs as acute whereas in fact they are rounded. Both specimens are somewhat decalcified and flaccid which may explain the absence of deposits from the supra-dorsal membrane.

Koehler distinguished *P. brachiatus* from *P. affinis* on the grounds of three characters, the types of *brachiatus* having relatively longer rays (R/r =35 mm./12-15 mm. =c.2·6/1 and 20 mm./6-7 mm. =c. 3·0/1), the supra-dorsal membrane thicker and more opaque with deposits and five rather than four adambulacral spines. The B.A.N.Z.A.R.E. and other specimens in the British Museum show that all these points are variable or else can be attributed to differences in preservation.

The three specimens which Koehler (1911a and 1917) named *Pteraster affinis* had R 17-20 mm. or 7 mm., R/r being about 2/1. Like the types of *P. brachiatus* they were probably taken by shore collecting but the exact localities are unknown. The low value of R/r can be at least partly attributed to the relatively small size.

Type locality. Observatory Bay, Kerguelen, littoral.

Range. Known only from south-east Kerguelen down to a depth of 91 metres.

PTERASTER AFFINIS ACULEATUS Koehler

text fig. 10a, b.

Pteraster aculeatus Koehler, 1920, 168-170, pl. xxxviii, figs. 3-5, pl. lxv, fig. 5.

BANZARE LOCALITIES: Stations 34 (1 specimen), 107 (OTL 6 specimens).

The proportions of these specimens and of the holotype of the subspecies *aculeatus* can be compared in the table.

In the holotype the abactinal spinelets were projecting unnaturally through the skin and Koehler estimated their length at over 3 mm. Some of the present specimens are better preserved with the paxillae more erect but unfortunately the spinelets are invariably broken at the tip owing to pressure of the specimens against each other. In only one, which has R 40 mm., were spinelets over 3 mm. long found. The type was much smaller with R. only 18 mm.

There is some variation in the degree of fenestration of the spinelets. In the B.A.N.Z.A.R.E. specimens with R 55, 40 and 25 mm. (fig. 10b) these are more or less tricarinate in cross section with series of holes only up the middle and the flanges imperforate and transparent as in Koehler's pl. lxv, fig. 5 of spinelets of the holotype. At the same time, the pedicels of the paxillae are very low, only 1·5 times as high as wide. The specimens with R 50, 38 and 32 mm. on the other hand have the spinelets more cylindrical, irregularly fenestrated and consequently less transparent (fig. 10a) and the pedicels are moderate in height, 2·6-3·25 times as high as wide. The one with R 50 mm. also seems to have some small deposits in the supra-dorsal membrane though I have been unable to find any in the others. Koehler made no mention of their presence or absence in the type. The 'Terra Nova' specimens from Oates Land and from the Ross Sea all have the more irregularly fenestrated type of spinelet but the proportions of the pedicels are intermediate, the height ranging from 1·6 to 2·3 times the width of the column. Also the two specimens from station 355, which is furthest to the east in the Ross Sea, both have deposits in the supra-dorsal membrane.

All these Antarctic specimens have only four or five marginal oral spines, relatively fewer than in *P. affinis lebruni*, and the paxillae often have five or even six spinelets whereas specimens of *P. affinis lebruni* and *P. affinis affinis* rarely have over four. I am therefore referring them to the subspecies *aculeatus* in spite of the differences in the spinelets and pedicels. Those with irregular spinelets and higher pedicels, together with others from the Weddell Quadrant, serve to link *P. affinis aculeatus* with *P. affinis lebruni* and to limit its distinction to the infra-specific level.

TYPE LOCALITY. Off Queen Mary Land, c. 65° S., 96° E., 594 metres.

RANGE. Known from Kemp Land, 58° 50′ E. eastwards to the Ross Sea, 166° 8′ E. in 219 to 603 metres, possibly also from the Weddell Quadrant, South Georgia and the South Shetland Islands down to 740 metres.

PTERASTER KOEHLERI, sp. nov.

text fig. 10k, pl. iv, figs. 1, 2.

BANZARE LOCALITY: Station 30 (1 specimen).

Description. The unique holotype has nine rays. R/r is 21 mm./15 mm.

The supra-dorsal membrane is semi-opaque with numerous spiracles. There are no calcareous deposits in it.

The paxillae have a moderately high column, about 0·75 mm. high and 0·2 mm. in breadth. Each paxilla has six or seven slender spinelets which are slightly flanged with few series of fenestrations. None of the spinelets is notably enlarged but there may be one (rarely two) smaller ones on some of the paxillae. The larger spinelets were probably about 2 mm. long when complet .

The actino-lateral membrane is conspicuous interradially but narrow distally.

The tube feet are crowded but biserial in arrangement.

There are only four adambulacral spines on each plate and the consecutive combs are similar, not alternating in position.

Each oral plate bears a marginal series of seven, rarely six, slender spines, of which the two or three outermost are aligned parallel to the first adambulacral comb, the whole series forming two sides of a square containing the much larger suboral spine which is sheathed in skin except for its hyaline tip. The marginal spines of each oral plate are webbed together but the web does not join those of each pair of plates across the jaw angle. The species therefore falls within the subgenus *Pteraster*.

Remarks. The multi-rayed condition of this specimen suggests its possible inclusion in the genus *Diplopteraster* which includes *D. verrucosus* (Sladen) from the Falkland-Magellan area with five to eight rays. However, *Diplopteraster* is characterized by an alternation in the position and number of the adambulacral spines of consecutive plates and by the quadriserial arrangement of the tube feet. Even if the relatively small size accounted for the absence of these two features, the present specimen is also excluded from *Diplopteraster* by the separate webs of oral marginal spines (all four known species of *Diplopteraster* having the webs continuous across each

jaw angle as in the subgenus *Retaster* of *Pteraster*) and by the conspicuously enlarged suboral spine, *Diplopteraster* having this spine no larger than the innermost marginal oral spine.

Another characteristic of *Diplopteraster* is the enlargement of a single central spinelet on each paxilla surrounded by a ring of peripheral ones. A preparation of paxillae from the holotype of *D. peregrinator* (Sladen) from Kerguelen, shows that like the other species of the genus this too has the central spinelet slightly enlarged.

Pteraster obscurus (Perrier) from arctic waters, the only known species of *Pteraster* with up to nine rays, has oral armature of the *Retaster* and *Diplopteraster* type.

The southern species of *Pteraster* with which *koehleri* appears to have most in common is *P. flabellifer* Mortensen from South Africa. This too lacks deposits in the supra-dorsal membrane and has seven oral marginal spines. The paxillae have five or six similar spinelets. *P. flabellifer* differs in having six or seven adambulacral spines and extremely tall pedicels (at least in the 'Africana' specimen already mentioned here under the heading of *P. affinis*). The type of *P. flabellifer* has six rays but the 'Africana' specimen has only five.

A range of five to nine rays within a single species is unknown in the Pterasteridae, *P. obscurus* having six to nine and *D. verrucosus* five to eight. *P. koehleri* probably shows some variation in the number but it is most likely that the multirayed condition is characteristic.

Pteraster rugatus Sladen

text fig. 10h, i.

Pteraster rugatus Sladen, 1882, 192; 1889, 473-474, pl. lxxiv, figs. 3, 4, pl. lxxvii, figs. 3, 4.

Banzare localities: Station 47 (6 specimens).

All these specimens are in poor condition. The largest has R/r = 18 mm./10 mm. The mid-radial abactinal paxillae have four to six peripheral spinelets and five to eight much more slender central ones. Dissolution of a patch of skin in the holotype has shown that here also there are several needle-like central spinelets within the five or six larger peripheral ones noted by Sladen. All the spinelets are slightly and often regularly expanded towards the tip, unlike those of *Pteraster florifer* and the difference in size between central and peripheral spinelets is much more marked in *P. rugatus*. However, in smaller specimens of *P. rugatus*, such as the type, the central spinelets are only perforated towards their outer ends, as in *P. florifer*. The largest B.A.N.Z.A.R.E. specimen is twice the size of the holotype and its spinelets are much larger, the longest nearly 2 mm. long, with more numerous holes, the fenestrations extending the whole length of each spinelet, even in the more slender central ones (fig. 10i). Somewhat similar distally-expanded spinelets were figured by Koehler for *P. hunteri* but there the spinelets are narrower at the base and the distal parts are more open with larger fenestrations than in these specimens of *P. rugatus*. In *P. hunteri* there is no web of skin between the marginal oral spines unlike *P. rugatus* and *P. affinis*; the paxillae are also distinct, *P. hunteri* having six or more spinelets with a single enlarged central one; it also lacks the deposits in the supra-dorsal membrane usually found in the other two species.

These B.A.N.Z.A.R.E. specimens of *P. rugatus* resemble the type in having the webs of skin on the oral and adambulacral spines rather thick and opaque and the spines themselves rather few in number, about three oral and four adambulacral ones on each plate respectively.

Fisher (1940) surmised that *P. rugatus* is closely related to *P. lebruni* (i.e. *P. affinis*), but the discovery of the additional diminutive central paxillar spinelets indicates that it is a distinct species. The rays are also shorter than in most examples of *P. affinis lebruni*, though some small specimens of *P. affinis affinis* have a similarly pentagonal form. *Pteraster* (*Retaster*) *gibber* (Sladen), known from the Falkland-Magellan area, has similar paxillae to *P. rugatus* but differs in the web of the oral marginal spines being continued across each jaw angle.

When examining the 'Discovery' specimens from the Falklands area named *Pteraster lebruni* by Fisher, I found that four from station WS 871 and a fifth from WS 81, all of which were at first noticeable for having R/r only 2/1 or less, have up to 12 spinelets in each paxilla, the central ones being more slender than the peripheral. The largest specimen has R/r 30 mm./15 mm.; there are six marginal oral spines on each plate, webbed together, and five or six spines on the proximal adambulacral plates. The pedicels of the paxillae are very tall and slender, the mid-radial ones at about one-third R from the centre being about 2 mm. high and only 0·25 mm. in width half-way up the column, which is slightly expanded towards the top. The spinelets (fig. 10j) are up to 3 mm. long and very variable in thickness, the central ones being much more delicate than the peripheral though all are fenestrated for their whole length and more or less expanded towards the tip. There seem to be no deposits in the supra-dorsal membrane. The smallest of the five specimens (R = 16 mm.) also has six marginal oral spines.

These Falkland specimens thus differ from the Kerguelen ones in having relatively more numerous oral spines and in lacking deposits in the supra-dorsal membrane. However, in view of the variations in these characters in *Pteraster affinis* from different parts of its range the distinction between *P. rugatus* from the Kerguelen area and this Falkland Islands form is probably no more than an infra-specific one.

Type locality. 'Challenger' station 150, between Kerguelen and Heard Islands, c. 52° S., 71° E., in 274 metres.

Range. Known only from south of Kerguelen in 274 and 150 metres.

Pteraster florifer Koehler

text fig. 10 l.

Pteraster florifer Koehler, 1920, 170-173, pl. xxxviii, figs. 1, 2, 6, 7, pl. lxv, fig. 9.

Banzare locality: Station 29 (1 specimen).

R/r = c. 22 mm./14 mm. = 1·6/1.

This specimen is in considerably better condition than the holotype but unfortunately it contracted in death with the ventral surface deeply concave so that the spines of the oral plates are compacted together and concealed. However, by splitting one interradius it was possible to determine that on one jaw angle there are five marginal oral spines on each of the two oral plates, those of each plate having a separate web of skin between the spines. The species is therefore referable to the subgenus *Pteraster*. Close behind the marginal spines there are two suboral spines on each plate, of which the more interradial one is twice as large as the other; at the same time it is no thicker and probably no longer than the innermost and largest oral marginal spine. Koehler was unable to assess the oral armature of the type. He gives the number of adambulacral spines as six, or on the proximal plates seven, R being about 25 mm., but in this specimen the most proximal adambulacral plates have six spines the following ones having five.

The dorsal surface has a plush-like appearance as the tips of the very numerous needle-like spinelets have penetrated through the skin in preservation. The proximal paxillae have 55-70 spinelets of which 12-20 peripheral ones are distinctly larger than the rest with serial fenestrations running almost the entire length; the more slender inner spinelets are hair-like towards the base, only expanding slightly and developing fenestrations in the outer one-third to two-thirds of their length (fig. 10l). The spinelets are about 2·5-3 mm. in length and the columns of the proximal paxillae are fairly tall, c. 1·6 mm. in height and 0·25 mm. in minimum width, which is towards the base as they expand slightly towards the top.

The supra-dorsal membrane appears to lack deposits.

This species is easily distinguished from the other Southern Ocean members of the genus by the enormous numbers of paxillar spinelets.

Type locality. Off Wilkes Land, 3100 metres.

Range. Known from Wilkes and Princess Elizabeth Lands in 3100 and 1266 metres.

Subgenus Apterodon Fisher

Pteraster stellifer hunteri Koehler

text fig. 10 p, q.

Pteraster hunteri Koehler, 1920, 165-168, pl. xxxvii, figs. 4-10, pl. xxxviii, fig. 8, pl. lxv, fig. 7. Non *P. hunteri* Koehler, 1923, 81, which is probably *P. stellifer stellifer*.

Banzare localities: Stations 30 (5 specimens), 34 (1 specimen), 103 (1 specimen), 107 (OTL 7 specimens).

Fisher considered *Pteraster hunteri* to be a synonym of *P. stellifer* Sladen, but the paxillae of the holotype of *stellifer* and the 'Discovery' specimens from the Falklands area are quite distinct from those of the B.A.N.Z.A.R.E. specimens which come from the same antarctic quadrant as the types of *P. hunteri*.

However, in the B.A.N.Z.A.R.E. material the number of paxillar spinelets, at least for mid-radial paxillae at one-third to a half R from the centre, is greater in all the specimens examined than Koehler's estimate of about six peripheral and one central spinelet in *P. hunteri*. I find usually 10-12 spinelets even in specimens with R only 10 mm. The spinelets themselves are similar to those figured by Koehler, all of them markedly flared with several diverging longitudinal rami beyond the solid basal third separated by series of fenestrations which distally may be very large. The degree of flaring does vary to some extent. It is greatest in a specimen with R 16 mm. from station 30 (fig. 10q) but much less marked in another with R 18 mm. from station 107 (fig. 10p). The spinelets are up to 2·4 mm. long when R is 16 mm.

The holotype of *P. stellifer* from the western end of the Magellan Strait has R 34 mm.; there are only seven or eight paxillar spinelets, as Sladen estimated, and the longest of these are 2·2 mm. in length. In shape the spinelets have parallel sides, except for a very few which are slightly flared towards the tip but far less so than in any specimen of *P. hunteri*. The fenestrations are small and mostly limited to the central core of the spinelet, the flanges being semi-transparent (fig. 10m).

In the specimens from the Falkland area there are usually about eight paxillar spinelets which are also parallel-sided or only slightly flared (fig. 10n). One with R 17 mm. has the longest spinelets 1·75 mm. in length. There are two small specimens from 'Discovery' station 652 on the Burdwood Bank south of the Falklands Islands which are particularly interesting in that their spinelets are more or less flared with several points at the tip like those of *P. hunteri* (fig. 10o). As can be seen from the table, the larger of these two has nine to eleven

paxillar spinelets, though the smaller one has only eight or nine. This larger number also approximates to that found in the B.A.N.Z.A.R.E. specimens of *P. hunteri*. The single antarctic specimen taken by the 'Discovery' at station 175 in the Bransfield Strait is smaller still (R only 9 mm.) but this too has rather numerous spinelets, nine to eleven. However, these spinelets are straight or only very slightly flared like those of the Falklands specimens. As can be seen from Table 10, the pedicels of the various groups also show some differences in size and proportions.

TABLE 10

Comparison of some measurements of *Pteraster stellifer stellifer* and *P. stellifer hunteri*.

Station	R (in mm.)	Pedicels		Spinelets	
		Height(mm.)	Ht./Br.	Number	Longest (mm.)
P. stellifer stellifer					
Holotype	34	2·6	10·0	7, 8	2·2
Discovery station WS 85	23	1·0	3·6	8, 9	1·6
Discovery station WS 85	17	0·8	3·6	7(8)	1·75
Discovery station WS 824	14	0·8	3·9	c.8	1·4
Discovery station 652	12	0·75	4·2	9-11	1·1
Discovery station 652	10	0·7	3·8	8, 9	1·15
Discovery station 175	9	0·8	4·5	9-11	1·1
Discovery station WS 871	9	0·8	4·5	c.8	1·5
Discovery station WS 824	8	0·5	3·3	—	1·0
P. stellifer hunteri					
Banzare station 107	25	2·1	8·9	11-13	2·8+
Banzare station 107	17	2·4	10·0	10-12	2·25+
Banzare station 30	17	1·7	8·8	10-12	2·4
Banzare station 30	16	1·8	8·9	10, 11	2·15
Banzare station 107	10	1·25	6·6	10-12	1·62
Banzare station 107	7·5	0·8	5·3	9-11	—

It is unfortunate that the type of *P. stellifer* is the only specimen available from the western end of the Magellan Strait since the proportions of its pedicels are so different from those found in specimens from the Falklands area and from the Weddell Quadrant. Larger specimens from the Falklands and smaller ones from western Patagonia are needed to ascertain the constancy of the difference in this character. Possibly a distinct subspecies should be recognised for the Falkland and Weddell Quadrant form of *P. stellifer*, although most of the specimens agree with the holotype of *P. stellifer* in the shape of the spinelets. The B.A.N.Z.A.R.E. specimens resemble the type in the proportions of the pedicels, but have more numerous and differently-shaped spinelets. Although the specimens from the Burdwood Bank are intermediate in having the spinelets somewhat flared and the pedicels a little higher than in the Falklands form, the present evidence is insufficient to reduce *P. hunteri* to a synonym and I think it should be retained as a distinct subspecies of *P. stellifer* from the Enderby and Victoria Quadrants of the Antarctic.

TYPE LOCALITY. Off Queen Mary Land, about 65° S., 97° E., 595-655 metres.

RANGE. Known off Antarctica from Kemp Land (c. 59° E.) eastwards to Adélie Land (c. 142° E.) in 201 to 655 metres.

Genus HYMENASTER Thomson

HYMENASTER sp. juv.

BANZARE LOCALITY: Station 83 (1 specimen).

This specimen has R only 3·5 mm. About 11 pairs of tube feet have been developed in each ray. The proximal paxillae have about six cylindrical, or slightly tapering, spinelets and the distal ones have three or four. There are probably two marginal and one suboral spine on each oral plate and two spines on most adambulacral plates (where these are intact), arranged across the plate so that only one is a furrow spine.

A number of species of *Hymenaster* have been recorded from that part of the Southern Ocean to the south of Australia, notably by Sladen. Of these only *H. sacculatus* has two adambulacral spines but these are placed on a line only a little oblique to the furrow, not at right angles to it. Possibly the present specimen from Macquarie I. may represent the young form of a species in which larger specimens have three or more adambulacral spines such as *H. caelatus* or *H. latebrosus*.

Family ZOROASTERIDAE

Koehler (1908) has recorded *Zoroaster tenuis* Sladen from 3186 metres between Gough and Bouvet Islands although the type locality of the species is off New Guinea and the single type specimen was immature with R only 15·5 mm. No other records of this family from the Southern Ocean were found, though another species of *Zoroaster* evidently occurs off southern Australia and east of New Zealand (Fell, 1958).

Family BRISINGIDAE

Key to the Southern Species

1 (2) Arm bases closely appressed with interlocking spines forming brood pouches between them for the length of the swollen genital area which terminates abruptly (pl. iv, fig. 5; papulae present proximally (South Georgia, the South Shetland Is., Enderby to Adélie Lands and from southern Argentina, 120-640 m.) . . . . . *Odinella nutrix* Fisher, 1940

2 (1) No brood pouches between the genital areas of the rays which taper off distally; no papulae present

3 (8) Abactinal skeleton of the proximal, genital, parts of the rays consisting of spaced arches or costae, sometimes rudimentary; rays very easily broken off (disc is unknown in all three species, only isolated rays having been taken)

4 (5) Only two or three, barely complete, proximal costae, others rudimentary; four, sometimes three, furrow spines on each adambulacral plate (south from Australia, c. 43° S., 134° E., 4755 m.) . . . *Brisingella* discincta* (Sladen), 1889

5 (4) About eight complete costal arches present proximally; one small furrow spine

6 (7) One subambulacral spine on each plate throughout (between Marion I. and the Crozets, 2515-2926 m.) *Brisingella* membranacea* (Sladen), 1889

7 (6) Two subambulacral spines, at least proximally (off Princess Elizabeth and Wilhelm II Lands, 2450-3398 m.) *Brisingella* submembranacea* (Döderlein), 1928

8 (3) Abactinal skeleton of the genital areas consisting of thin, more or less overlapping, scale-like plates forming a continuous covering; rays less easily broken at the base, the disc usually obtained with some rays attached

9 (10) Plates of disc and genital areas of the rays each with a single spine of moderate size, longer than the plate is wide (Weddell Sea and Kron Prinsesse Martha Kyst, 4572-4790 m.) . . . . . *Freyella† giardi* Koehler, 1908

10 (9) Plates of disc and genital areas with numerous very fine spinelets less than 0·5 mm. long

11 (12) Eleven rays (in the three specimens known) (between Marion I. and the Crozets and north from Queen Mary Land, 62½° S., 2515-3612 m.) . . . . . *Freyella fragilissima* Sladen, 1889

12 (11) Six or seven rays

13 (14) Primary plates of disc not distinct; seven rays in the unique type (off Princess Elizabeth Land, 3425 m.) *Freyella† drygalskii* (Döderlein), 1928

14 (13) Centrodorsal and primary interradial plates of disc conspicuously enlarged; rays six in the four specimens known (off Ellsworth, Dronning Maud and Princess Elizabeth Lands, 2450-2800 m.) . . . *Belgicella racovitzana* Ludwig, 1903

Note: Isolated rays of *Labidiaster* and particularly *L. annulatus*, in which the skeleton is reduced, may easily be confused with some species of the Brisingidae, in which family it was included by various authors before Fisher transferred it to the Asteriidae. It would run down to *Brisingella* in the key above but is distinguished by the absence of the single, needle-like, infero-marginal spines with their sacculate sheaths, the presence of straight as well as crossed pedicellariae, and the shorter adambulacral plates.

Genus Odinella Fisher

Odinella nutrix Fisher

pl. iv, figs. 5, 6.

Odinella nutrix Fisher, 1940, 207-214, fig. G1-6, H1-9, pls. xiv, xv, xvi, figs. 1-11, pl. xvii, figs. 1-3.

Banzare localities: Stations 34 (1 specimen), 40 (1 damaged, immature specimen), 90 (1 adult and one juvenile specimen), 107 (10 damaged specimens).

The specimen from station 34 has R/r 100 mm./10 mm. The diameter of the disc and genital region together is about 40 mm. The adult from station 90 has R/r 60 mm./6 mm. and is unusual in having only nine rays. The juvenile from the same station has twelve rays like one specimen from station 107. All the rest have thirteen rays.

In comparing these specimens with the type material of *Odinella nutrix*, a frequent asymmetry of the proximal costal arches in the genital region was found. Two B.A.N.Z.A.R.E. and one of two 'Discovery' specimens examined have one arch fewer on one side of a ray than on the other so that the dorsal link-up of the arches from each side is often oblique. The differences are set out in Table 11. The holotype of *O. nutrix* was not examined with regard to the exact positions of the proximal costal arches owing to my reluctance to mutilate it.

The specimen from B.A.N.Z.A.R.E. station 34 off Kemp Land differs from the rest in having very few plates and spines on the distal parts of the swollen genital areas so that costal arches III and IV are not linked up across the mid-radial line. This paucispinous condition can be seen in pl. iv, fig. 5. The Adélie Land specimen, as well as the damaged ones from MacRobertson Land, has spines over the whole dorsal surface of the convex genital areas and, at least in the former, the arches are linked together, though more or less diagonally owing to the odd arches.

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* Fisher (1928) noted that *Brisinga membranacea* and *B. discincta* (of which only detached rays are known) are probably referable to *Brisingella*. This presumably applies also to *Brisinga submembranacea* described by Döderlein in the same year and said to be almost indistinguishable from *B. membranacea*.

† Fisher (1928) made no mention of *F. giardi* in his survey of *Freyella* but he mentioned *F. fragilissima* in 1919 as probably belonging to *Freyella* rather than to *Freyellaster*, though he did not go so far in the later paper. Döderlein (1928) included the species *drygalskii* in *Freyellidea* Fisher 1917, although Fisher meanwhile (1919) had reduced that name to the synonymy of *Freyella*. Without knowledge of the form of the gonads in these species their generic positions must remain uncertain.

Laboratoire de ZOOLOGIE
Michel LANGOUX

The modification of the costal arches in the genital area progresses with increased size, a smaller 'Discovery' specimen with R about 40 mm. having the expanded area ending at the third arch which bears only a few spines with sacculi like the succeeding costae.

TYPE LOCALITY. East Cumberland Bay, South Georgia, 179-235 metres.

RANGE. Known from South Georgia, the South Shetland Islands, Enderby to Adélie Lands and from southern Argentina in 120-640 metres.

TABLE 11

The adambulacral plates corresponding to one complete and two half series of proximal costal arches in four specimens of *Odinella nutrix*.

The positions of the bases of the proximal costal arches relative to the adambulacral plates are shown for four adjacent lateral areas, the two middle lines of figures in each case being those of the two sides of a single ray, which had been detached so that the counts could be made. The brackets signify the odd arches.

Costal arches	1	2	3	4	5
Banzare station 90 R 60 mm.	2-3	5-6	9	12	15-16
	2-3	6		10	13
	2-3	5	(7-8)	11	14
	2-3	4-5	8	11	14
Banzare station 34 R 100 mm.	2-3	4-5	7	10	13-14
	2-3		7-8	10	13
	2-3	(4-5)	7	10	13
	2-3	4-5	7	10	13
Discovery station 39 R c. 45 mm.	2-3	5	8-9	12	15
	2-3	5-6		12	16
	2-3	5-6	(9)	12	15
	2-3	5	8-9	12	15
Discovery station 42 R c. 75 mm.	2-3	5	8	11	14
	2-3	5-6	8	11	14
	2-3	5	8	11	14
	2-3	5-6	8-9	11-12	14

Family ASTERIIDAE

The most notable feature of the genera of this family which occur in the Southern Ocean is the fact that none of them have crossed pedicellariae in association with the adambulacral spines. Since this is the only character given in Fisher's key of 1928 (intended primarily for North Pacific Asteroids) to distinguish the Coscinasteriinae from the Asteriinae, I find it impossible to separate these two subfamilies in the key which follows. Most species of the Coscinasteriinae have very conspicuous, single, abactinal spines with wreaths of pedicellariae around them, as opposed to smaller and more numerous spines or spinelets with pedicellariae either scattered or in wreaths in the Asteriinae, but this is by no means diagnostic. The genus *Diplasterias* particularly seems to me to be on the borderline. It is included in the Asteriinae by Fisher but *D. brucei* (Koehler) and its synonym *victoriae* (the type of which had smaller and more numerous abactinal spines) were both referred to *Coscinasterias* by Koehler in 1911.

Fisher himself commented in 1923 (p. 248) "It is well to regard these groups (i.e. the subfamilies of Asteriidae) as convenient sections in which to arrange genera of ascertained relationship rather than as units segregated from one another." However, he added, "The Coscinasteriinae is one of the best marked and most easily recognised". That may be true for the North Pacific species, but is certainly not always so for these from the Southern Ocean, which makes it questionable whether the Coscinasteriinae is worth distinguishing at all. It is beyond the scope of this paper to go into this problem more fully.

The B.A.N.Z.A.R.E. collection has yielded two new genera of this family, one of which I have called *Kenrickaster* and the other, which is represented by only a single small specimen, *Caimanaster*. These are extraordinary in having a few relatively large crossed pedicellariae arising from the skin covering the ventral surface of each adambulacral plate. The abactinal spines are few and rather prominent as in the Coscinasteriinae and the peculiar form of the crossed pedicellariae in *Caimanaster* also suggests affinity with this subfamily since the genera of Asteriinae rarely exhibit much deviation from the usual form of these organs. Unfortunately, all the present specimens of these two genera are relatively small, R being only 33 mm. in the holotype of *Kenrickaster pedicellaris*, and even less in that of *Caimanaster acutus*.

The following series of keys are therefore considerably modified from those given by Fisher in 1928 to the subfamilies of the Asteriidae and in 1930 to the southern genera of the Asteriinae, owing to this difficulty in separating out the Coscinasteriinae. Also the present keys exclude genera such as the South African *Perissasterias* and the Australian *Uniophora* since these are not strictly Southern Ocean genera but occur only on the southern limits of the respective continental shelves.

Key to the subfamilies of Asteriidae found in the Southern Ocean

1 (2) Fifteen to fifty rays, new ones being interpolated during growth; adoral carina very long, composed of five to eight pairs of adambulacral plates; rays long and skeleton a very open-meshed reticulum, which, in one species, is lost beyond the proximal part of the ray; crossed pedicellariae in prominent annular bands across the rays, except proximally, as well as in wreaths around the spines; no actinal plates . . . . . Labidiasterinae

2 (1) Not more than twelve rays, diminutive rays if present only resulting from regeneration; adoral carina usually made up of only one to three pairs of adambulacral plates, though a few multibrachiate species may have up to six pairs, rarely no carina developed; rays and skeleton variable; crossed pedicellariae scattered or in wreaths around the spines, not in bands across the rays; often more than one infero-marginal spine; actinal plates nearly always present.

3 (4) No marked adoral carina, the first pair of adambulacral plates in each interradius separated, or only in contact by their proximal angles; crossed pedicellariae never closely associated with individual spines or spinelets; tube feet in two rows. Pedicellasterinae

4 (3) One to three or more pairs of proximal adambulacral plates in contact, forming an adoral carina; crossed pedicellariae either scattered or in wreaths round the spines or spinelets; tube feet quadriserial at least proximally Coscinasteriinae and Asteriinae

Subfamily LABIDIASTERINAE

Key to the Southern Species

1 (2) Abactinal plates present in transverse arcs to the tips of the rays; disc spines of two sizes, some being distinctly enlarged. (Patagonia and the Falkland Plateau, north to about 41° S. on the Pacific coast and 38° S. on the Atlantic, 0-183 m.) *Labidiaster radiosus* Lütken, 1871.

2 (1) Abactinal plates present proximally for only about one third of the arm length, absent on the distal part; all the disc spinelets small and similar. (Kerguelen and Heard Islands, Weddell Quadrant including South Georgia and Shag Rocks, 93-440 m.) *Labidiaster annulatus* Sladen, 1889.

Genus Labidiaster Lütken

Labidiaster annulatus Sladen

? *Gymnobrisinga sarsii* Studer, 1884, 13-14, pl. iii, fig. 5.

Labidiaster annulatus Sladen, 1889, 595-597, pl. cviii, fig. 1; Koehler, 1917, 7-9, pl. i, figs. 2, 4, 5; Fisher, 1940, 219-222, fig. I 3; Madsen, 1955, 15; Bernasconi, 1956, 13-14, pl. i, fig. 1, pl. ii, fig. 1.

Labidiaster radiosus, Koehler, 1906, 24; 1912, 7-10, pl. i, fig. 1. Non *L. radiosus* Lütken, 1871, which is valid.

Labidiastrella annulata, Verrill, 1914, 352, 373.

Banzare locality: Station 47 (1 disc and many rays).

The disc is 60 mm. in diameter and the detached rays up to 175 mm. long so that R/r was 205 mm./30 mm.

The crossed pedicellariae resemble Studer's diagrammatic figure of a pedicellaria from the single ray taken by the 'Gazelle' at 47° 08′ S., 64° 51′ 07″ E. off Kerguelen in 210 metres, to which he gave the name *Gymnobrisinga Sarsii*. At that time only *Labidiaster radiosus*, with its skeletal bars persisting to the ends of the rays, was known and indeed Studer compared the pedicellariae of the two. *G. sarsii* he distinguished by the absence of an abactinal skeleton and the arrangement of the crossed pedicellariae in bands across the ray just as in the outer two-thirds of the ray of *L. annulatus*. If Studer's specimen is still in existence (probably in the Berlin Museum) and examination of it proves my supposition correct then it would be best to declare *Gymnobrisinga*, with *G. sarsii*, as rejected generic and specific names, so as not to invalidate the well-known *Labidiaster annulatus*.

Type locality. Sladen's description was compounded from a number of syntypes but the specimen illustrated in his Plate cviii is one from 'Challenger' station 151 off Heard Island in 137 metres.

Range. Known from Kerguelen and Heard Islands, Peter I Island, the Palmer Archipelago, the South Shetland, Orkney and Sandwich Islands, South Georgia and the Shag Rocks in 93 to 440 metres. The 'Challenger' specimen supposed to be from station 191 in the Arafura Sea, as Madsen suggests, was probably mis-labelled, and should have been 151. The usual parchment station number label in the jar is lacking.

Subfamily PEDICELLASTERINAE

Key to the Southern Species

1 (6) Actinal crossed pedicellariae enlarged, with two pairs of large teeth at the distal end of each valve; abactinal crossed pedicellariae of the more usual form with fine teeth in the terminal part . . . . . *Pedicellaster hypernotius* Sladen, 1889

2 (3) Actinal crossed pedicellariae with about six median teeth on the shaft of each valve (Fig. 11a) as well as the two pairs of distal ones. (Marion Island, 256 m.) . . . . . *P. hypernotius hypernotius* Sladen, 1889

3 (2) Actinal pedicellariae usually with only two (one to three) median teeth (Fig. 11, b, c.)

4 (5) Abactinal skeleton a delicate reticulum, the total area of the meshes exceeding that of the plates. (Weddell Quadrant including South Georgia, 93-450 m.) . . . . . *P. hypernotius antarcticus* Ludwig, 1903

5 (4) Abactinal skeleton coarse, the area of the plates equal to or exceeding that of the meshes. (Enderby Land to Queen Mary Land, 220-382 m.) . . . . . *P. hypernotius formatus* Koehler, 1920

6 (1) Crossed pedicellariae all similar and unmodified, the actinal ones only a little enlarged . . . . *Anteliaster* Fisher, 1923

7 (8) Abactinal spinelets relatively small (see Table 12), usually with a truncated crown having all points on the same level, sometimes the head more bush-shaped; subantarctic specimens with very numerous abactinal pedicellariae obscuring the skeletal reticulum though antarctic specimens have fewer pedicellariae and the reticulum is distinct. (Falkland Is., South Georgia and Shag Rocks, 79-341 m. [Marion I., 101-113 m.]) . . . . . *Anteliaster australis* Fisher, 1940

8 (7) Abactinal spinelets larger, usually with bush-shaped crown, some of the points occurring laterally below the tip; always with sparse abactinal pedicellariae not obscuring the reticulum. (Kerguelen, 0-46 m.) . *Anteliaster scaber* (Smith), 1876

Genus Pedicellaster Sars

Pedicellaster hypernotius formatus Koehler

text fig. 11c.

Pedicellaster formatus Koehler, 1920, 106-110, pl. xvi, figs. 1, 9, 10, pl. xvii, figs. 6, 7, pl. lviii, fig. 4.

Pedicellaster antarcticus, Döderlein, 1928, 295. Non *P. antarcticus* Ludwig, 1903, which is a valid subspecies of *P. hypernotius* in my opinion.

Banzare locality: Station 39 (1 specimen).

Like Döderlein's this specimen is small, R being about 16 mm., and there is no distinct longitudinal arrangement of the spinelets, though transverse lines can just be made out. It also has the abactinal spinelets and pedicellariae somewhat spaced, not crowded together as they are in the much larger holotype of *P. formatus* (R 38-40 mm.). However, when denuded, the abactinal plates are seen to form a moderately heavy and slightly irregular reticulum, the total area occupied by the plates being hardly less than that of the spaces between. This approximates to the coarse reticulum found in the type of *P. formatus* and contrasts with the delicate and regular abactinal skeleton of the Weddell Quadrant specimens taken by the 'Discovery'. These were named *P. hypernotius* by Fisher but I believe they represent a distinct subspecies for which the name *antarcticus* Ludwig is available.

Most of the abactinal spinelets are broken in this specimen but some appear to have been stout with a terminal flared crown of about four points while others taper from the base to a very narrow tip with only one to three small points. The length of these spinelets is about 0·35 mm.

The holotype and single paratype of *Pedicellaster hypernotius* Sladen came from subantarctic waters off Marion Island. The holotype has R 25 mm. and superficially resembles Koehler's photograph of the type of *P. formatus* in the relatively dense covering of abactinal pedicellariae and spinelets and in the indistinct serial arrangement of the plates, particularly longitudinally. When denuded, the coarseness of the reticulum is seen to be intermediate between that of the type of *P. formatus* and that of the 'Discovery' specimens of subspecies *antarcticus*, though the meshes are fairly regular in shape like the latter.

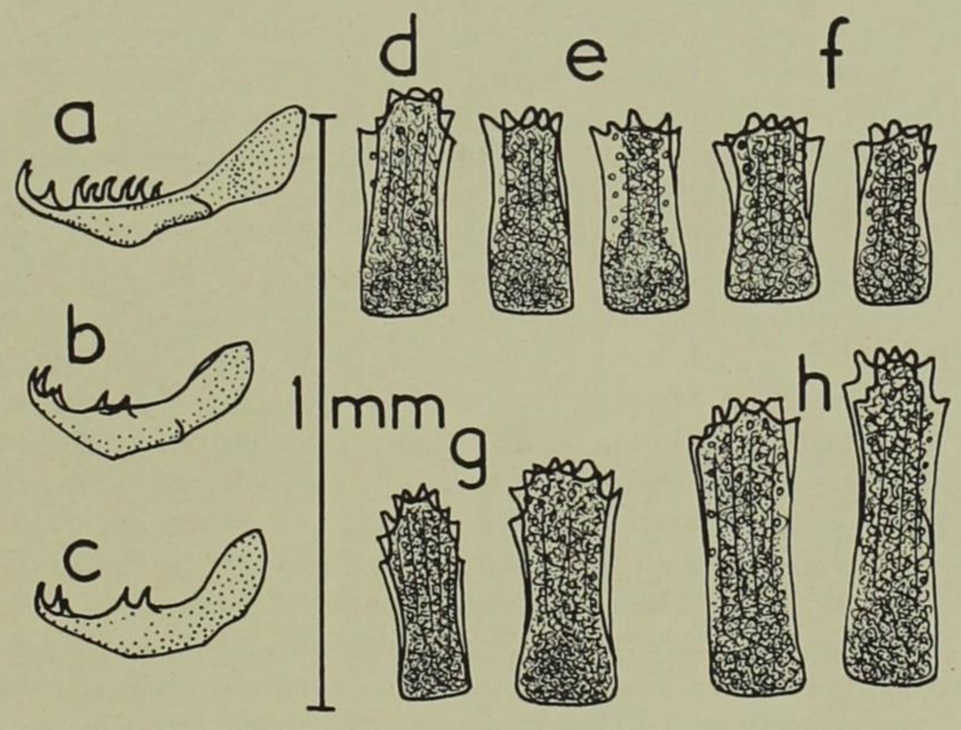


Fig. 11. a, to c, *Pedicellaster hypernotius*, single valves of actinal crossed pedicellariae, a, *P. hypernotius hypernotius*, holotype, R 25 mm., b, *P. hypernotius antarcticus*, R 16 mm. from 'Discovery' station 181, Palmer Archipelago, c, *P. hypernotius formatus*, R 16 mm. from Banzare station 39; d, to h, *Anteliaster* spp., proximal abactinal spinelets, d, *A. australis*, R 32 mm. from 'Discovery' station WS 81, Falkland Is., e, *A. australis*, holotype, R 35 mm., f, *A. australis*, R 14 mm. from 'Discovery' station 156, South Georgia, g, *A. scaber*, holotype, R 18 mm., h, *A. scaber*, R 20 mm. from Banzare station 52 or 53.

However, it is largely on account of the ventral crossed pedicellariae that I am maintaining both *formatus* and *antarcticus* as subspecies distinct from the subantarctic *P. hypernotius hypernotius* of which both type specimens have these pedicellariae with about six median teeth on each valve as well as the usual two pairs of distal ones. In contrast, all the antarctic specimens examined, those from the Weddell Quadrant as well as the B.A.N.Z.A.R.E. specimen, like the type of the subspecies *formatus*, have only two, sometimes one or three, median teeth (fig. 11b and c). Although Ludwig's figure of a pedicellaria from a type specimen of the subspecies *antarcticus* (1903, pl. iv, fig. 35) appears to show four median teeth on one valve (only three on the other), this figure is so diagrammatic that the distal-most one of the four could easily be one of the paired distal teeth seen in perspective.

Fisher has compared the pedicellariae of the 'Discovery' specimens with those of *Pedicellaster magister* from the North Pacific, which similarly has only two, sometimes three or rarely four median teeth (1928, pl.

xxvi). He has also described a subspecies *P. magister orientalis* distinguished largely by the fact that these pedicellariae usually have four or five median teeth.

There may also be a difference between *hypernotius* and *formatus* in the relative size of the abactinal spinelets. When R is about 39 mm. in *formatus* these spinelets are 1·0-1·5 mm. long. In both type specimens of *hypernotius* (R 25 and 18 mm.), the longest spinelets are just under 0·55 mm. in length. In the larger specimen some of the spinelets are much thicker than those from the type of *formatus* figured by Koehler, though in the smaller one they are relatively more slender. The number of points to the spinelets is usually four in *hypernotius* but some of the 'Discovery' specimens of *antarcticus* commonly have five or six. The latter also show some variation in the proportions of the spinelets.

Type locality. Off Queen Mary Land, 220 metres.

Range. Known from Enderby Land eastwards to Queen Mary Land (49-95° E.) in 220-382 metres.

Genus Anteliaster Fisher

Anteliaster scaber (Smith)

text fig. 11g, h.

Pedicellaster scaber Smith, 1876, 107; 1879, 274, pl. xvi, fig. 3; Sladen, 1889, 558; Döderlein, 1928, 295, pl. xiii, figs. 1a, b.

? Non *Anteliaster scaber* Fisher, 1940, 217, figs. F4, 4a.

Banzare locality: Station 52 or 53 (1 specimen).

This specimen has R/r 20 mm./4 mm. It was compared with the holotype and 'Challenger' specimens of *Pedicellaster scaber* Smith also from Kerguelen, as well as with the 'Discovery' material of the genus *Anteliaster*. In all these the crossed pedicellariae are of a single kind with relatively fine teeth. *P. scaber* is therefore referable to *Anteliaster*. Fisher surmised this from study of the small Marion Island specimens taken by the 'Discovery', the largest of which has R 10 mm. However, since some other Asteroid species from subantarctic Marion Island show a closer affinity with forms from the Falkland-Magellan area than with those from Kerguelen, across the Antarctic Convergence, I suspected that these 'Discovery' specimens might not be *A. scaber* but more closely related to *A. australis* Fisher, of the Falklands (type locality) and South Georgia area. I disagree with Fisher that their spinelets and pedicellariae are quite distinct. In preparations from seven specimens of *A. australis* including the holotype and in one from 'Discovery' station 1564 off Marion Island, the spinelets were always most commonly of the truncated form with the crown terminating abruptly in points all at about the same level. This is shown in Fisher's fig. F4a right and in my fig. 11e and f. The bushy-headed type of spinelet with lateral points shown in Fisher's fig. F4a left and 11c (the latter of a paratype of *A. australis*) is much less common. I disagree also with Fisher's figure of the pedicellariae of *A. australis* (fig. I1, 1a) which suggests that there is an enlarged tooth at each end of the terminal curved lip. This is not distinct in any pedicellariae in my preparations of *A. australis*. Also the more extensive median series of teeth is only found in the larger pedicellariae, the smaller ones of the holotype of *A. australis*, as well as all the pedicellariae of smaller specimens, being indistinguishable from those of the Marion Island specimens or indeed from those of *A. scaber* from Kerguelen. Although there is no difference in the shape of the pedicellariae in *A. australis* and *A. scaber*, there is a difference in the shape and more particularly in the relative size of the spinelets. In *A. scaber* these usually have the bushy-headed form found in a small proportion of the spinelets of *A. australis* with points extending down the sides (fig. 11g and h), though some may be truncated. They are also distinctly larger in *A. scaber* than in specimens of *A. australis* of comparable size or in the Marion Island specimens examined. The lengths of spinelets and pedicellariae in these specimens are shown in Table 12.

TABLE 12

Station	R (mm.)	Abactinal spinelets (mm.)	Abactinal pedicellariae (mm.)
Anteliaster scaber			
Holotype, Kerguelen	18	0·42-0·45	c.0·3
Banzare station 52 or 53	20	0·42-0·58	0·29-0·34
Challenger station 149D	13	0·35-0·40	0·26-0·29
Challenger station 149D	9	0·37-0·42	0·26-0·29
Discovery station 1564	10	0·26-0·29	c.0·22
Anteliaster australis			
Holotype, Discovery station WS 248	35	0·37-0·40	0·26-0·29
Discovery station WS 248	37	0·37-0·40	0·20-0·24
Discovery station WS 81	32	0·40-0·42	c.0·29
Discovery station WS 85	30	0·40-0·47	0·26-0·30
Discovery station WS 85	28	0·34-0·40	0·26-0·29
Discovery station WS 248	23	0·37-0·40	0·26-0·29
Discovery station WS 875	15	0·32-0·34	0·21-0·24
Discovery station 156	14	0·29-0·34	0·21-0·26
Discovery station 160	13	0·26-0·29	0·21-0·24
Discovery station 160	10	0·24-0·26	c.0·21

There is a discrepancy between my measurements of spinelets for the specimen from 'Discovery' station 1564 and those given by Fisher for another, presumably of similar size, from station 1563, which he illustrated, putting the lengths at 0·31 and 0·38 mm. Unfortunately the latter is not in the British Museum collection. There is some variation in the relative sizes of the spinelets but, even so, this difference is excessive and needs confirmation.

Apart from these characters, the Kerguelen specimens of *A. scaber* differ from the Falkland Islands material of *A. australis* in the small number of their abactinal pedicellariae. These are fewer than the spinelets and do not encroach on the papular areas so that the reticular form of the skeleton is quite distinct. In the subantarctic specimens of *A. australis* the pedicellariae are so dense all over the surface that a 'rather uniform granular appearance' results, as Fisher noted and the reticulations of the skeleton are concealed. This abundance of the pedicellariae is not shared by the three specimens from the antarctic 'Discovery' stations 156 and 160, off South Georgia and the Shag Rocks, in which the superficial appearance resembles that of *A. scaber*, the pedicellariae being fewer than the spinelets. Unfortunately these specimens are all small but it is to be expected that there is a constant difference between the antarctic and subantarctic forms. The South Georgia specimens are distinguishable from *A. scaber* by the relatively smaller spinelets, which also have the truncated form usual in *A. australis*. Until larger specimens from the Weddell Quadrant of the Antarctic and from Marion Island are available, the geographical limits of *A. australis* must remain uncertain.

Pedicellaster sarsii Studer, 1885, known from a single small (R 9 mm.) specimen from South Georgia, apparently has quadriserial tube feet and is unlikely to belong to the Pedicellasterinae.

Type locality. Observatory Bay, Kerguelen, on kelp roots.

Range. Known from Kerguelen in 0-46 metres.

Subfamilies COSCINASTERIINAE and ASTERIINAE

Key to the Southern Species

1 (10) Single-toothed macrocephalous pedicellariae present at least in association with the carinal spines (these pedicellariae being crossed ones with the bases of the valves much thickened for muscle attachment and one huge tooth on each valve overlapping that of the corresponding valve, the size often being so large that they are conspicuous to the naked eye); five rays *Notasterias* Koehler, 1911

2 (3) Macrocephalous pedicellariae numerous but small, up to only 0·7 mm. long and scattered between the abactinal spines as well as around their bases; some dorso-lateral spines often present proximally (Enderby to Adélie Lands, 110-647 m. [South Victoria Land, 47-51 m.]) . . . . . *Notasterias haswelli* Koehler, 1920

3 (2) Macrocephalous pedicellariae from 0·6-3·5 mm. long, usually few and conspicuous abactinally and always attached around, not between, the spines; dorso-lateral spines very rare

4 (7) Adambulacral plates predominantly monacanthid, though a few, usually isolated, plates may have two spines; skeletal meshes large; often a number of ordinary, small, crossed pedicellariae present actinally

5 (6) Abactinal meshes rectangular and regular (Dronning Maud Land, 2580 m.) . . . *Notasterias pedicellaris* (Koehler), 1908

6 (5) Abactinal meshes irregular (South Shetland Is., Kemp to Adélie Lands, 110-830 m.) . *Notasterias bongraini* (Koehler), 1912

7 (4) Proximal adambulacral plates always diplacanthid, with occasional exceptions, sometimes diplacanthid for the whole extent of the furrow; skeletal meshes moderate or small; few, if any, actinal pedicellariae present and these may be macrocephalous

8 (9) Macrocephalous pedicellariae usually large, 1·0-2·5 mm. or more long; actinal papulae usually absent (Bellingshausen Sea, Enderby Land east to the Ross Sea, 27-647 m.) . . . . . *Notasterias armata* Koehler, 1911

9 (8) Macrocephalous pedicellariae small, up to 0·8 mm. long in the holotype; actinal papulae present (Palmer Archipelago, 247 m.) *Notasterias stolophora* Fisher, 1940

10 (1) If macrocephalous pedicellariae are present then these are inconspicuous and have two terminal teeth and the rays number about eleven; otherwise the crossed pedicellariae have no great muscular development and their teeth are many and not very large

11 (14) Macrocephalous pedicellariae present with two divergent teeth at the tip of each valve; about eleven rays; abactinal skeleton a delicate reticulum . . . . . *Psalidaster mordax* Fisher, 1940

12 (13) Abactinal skeleton very delicate, supero-marginal plates aligned obliquely to the corresponding infero-marginals, at least in preserved specimens; one apical spine on each oral plate (Falkland Is., 351-367 m.) . *P. mordax mordax* Fisher, 1940

13 (12) Abactinal skeleton fairly rigid, the reticulum being well articulated though the plates are narrow; supero-marginals situated directly over the corresponding infero-marginals; two apical spines on each oral plate (MacRobertson Land, 163 m.) *P. mordax rigidus*, subsp. nov.

14 (11) No macrocephalous pedicellariae; if more than nine rays are present then the skeleton is very solid.

15 (18) One to three, relatively large, mostly crossed, pedicellariae on the skin covering the ventral surface of each adambulacral plate

16 (17) Adambulacral plates diplacanthid; crossed pedicellariae of unspecialized form (off Enderby and MacRobertson Lands, 219-540 m.) . . . . . *Kenrickaster pedicellaris*, gen. et sp. nov.

17 (16) Adambulacrals monacanthid; crossed pedicellariae each resembling a crocodile's jaws with large, similar, recurved teeth along the gradually tapering valves (fig. 14) (off Enderby Land, 180-209 m.) . *Caimanaster acutus*, gen. et sp. nov.

18 (15) No pedicellariae on the ventral surfaces of the adambulacral plates, though straight ones are usually present along the furrow margin or in the furrow.

19 (64) Adambulacral plates predominantly diplacanthid or with three or four spines, rarely isolated plates with single spines

20 (21) Marginal and abactinal skeleton completely absent, the surface covered with papillae each containing an isolated spinelet (Palmer Archipelago, 0-6 m.) . . . . . *Adelasterias papillosa* (Koehler), 1906

21 (20) Marginal and usually abactinal skeleton more or less well developed.

22 (39) Crossed pedicellariae associated with the abactinal and marginal spines, either in groups at their bases or in clusters around them; usually not more than one spine on each plate; rarely (*Cryptasterias*) the abactinal plates and spines reduced and delicate

23 (26) Abactinal plates much reduced, forming a delicate reticulum, with small or rudimentary spinelets less than 1 mm. long, abactinal surface soft and pustular or papillose . . . . . *Cryptasterias* Verrill, 1914

24 (25) About eight rays, abactinal spinelets numerous (Falkland Is., 25-30 m.) . . . *Cryptasterias brachiata* Koehler, 1923

25 (24) Five rays, some of the abactinal pustules spineless (Palmer Archipelago, South Orkney and Shetland Is., 0-36 m.) *Cryptasterias turqueti* (Koehler), 1906

26 (23) Abactinal plates forming a stout reticulum, spines large, particularly the carinal ones, dorso-lateral spines sometimes reduced

27 (36) Actinal plates spineless, if present at all

28 (33) Five rays

29 (30) Carinal spines inconspicuous (Kerguelen, littoral) . . . . . *Diplasterias kerguelenensis* (Koehler), 1917

30 (29) Carinal spines conspicuously enlarged

31 (32) Most infero-marginal plates with two spines; carinal and supero-marginal spines capitate (Falkland Plateau, 155 m.) *Lethasterias australis* Fisher, 1940

32 (31) Infero-marginal spines single throughout; abactinal and marginal spines pointed (Bellingshausen Sea, 450-560 m.) *Sclerasterias candicans* (Ludwig), 1903

33 (28) Six or more rays

34 (35) Usually six, sometimes seven, rarely five, rays (South Georgia, Marion I., Kerguelen and Heard I., 0-234 m.)* *Diplasterias meridionalis* (Perrier), 1875

35 (34) Eight to ten rays in the nine specimens known (Shag Rocks, 160-177 m.) . . . *Diplasterias radiata* (Koehler), 1923

36 (27) One or more rows of actinal plates present, each with one, sometimes two, spines

37 (38) Dorso-lateral spines more or less reduced, even absent in some specimens; carinal and supero-marginal spines usually very prominent; six rays in South Georgia specimens, otherwise five (Weddell Quadrant, Dronning Maud Land, Enderby Land eastwards to the Ross Sea, 18-732 m.) . . . . . *Diplasterias brucei* (Koehler), 1908†

38 (37) Dorso-lateral spines numerous, carinal ones barely, if at all, distinct (Falkland-Magellan area, South Georgia, Clarence I., Bellingshausen Sea, 0-320 m.) . . . . . *Diplasterias brandti* (Bell), 1881†

39 (22) Crossed pedicellariae not associated with individual spines but scattered between the spines or spinelets which are usually small and may appear granuliform

40 (57) At least the carinal and sometimes also the dorso-lateral plates forming longitudinal series which are quite distinct through the covering of spinelets or granules; in addition the plates often form transverse series

41 (54) Infero-marginal plates large and prominent, often forming a marked ventro-lateral angle to the ray and dwarfing the single row of narrow actinal plates, which may even be lacking in small specimens; if the actinal plates are similar to the infero-marginals then the adambulacral plates each have three or four spines.

42 (51) Five rays; not fissiparous (i.e. not reproducing by division and regeneration) so that all the rays are similar in size; madreporite single; dorso-lateral areas wide, usually three or more plates between carinals and supero-marginals on each side, rarely forming distinct longitudinal series; surface of denuded supero-marginal plates not beaded

43 (44) Abactinal armature consisting of very heavy, closely-placed, capitate granules; carinal plates conspicuously broader than the dorso-lateral ones (Chile, from 52° S. north to Peru, littoral) . . *Stichaster striatus* (Müller & Troschel), 1840

44 (43) Abactinal armature consisting of spaced spinelets, two to six times as long as wide; carinal plates usually larger but not much broader than the dorso-lateral ones . . . . . *Smilasterias* Sladen, 1889

45 (46) Adambulacral plates each with a series of three or four spines, usually four when R>50 mm.; actinal plates extending for at least half the arm length and the proximal ones each with a spine (sometimes two) (Marion and Heard Islands and the Falkland Is., 79-267 m.) . . . . . *Smilasterias scalprifera* (Sladen), 1889

46 (45) Adambulacral plates diplacanthid (rarely three spines on some plates when R>50 mm.); actinal plates few, narrow and normally spineless

47 (48) Skeleton very solid; dorso-lateral plates with tendency to form longitudinal series; abactinal spinelets very short and stout, the length less than three times the median width (Macquarie I., 69 m.) *Smilasterias* sp. cf. *irregularis* H. L. Clark, 1928

48 (47) Skeleton moderately strong, the meshes nearly equal in area to the plates, which are arranged in a reticular form or in transverse ribs; abactinal spinelets more slender, the length usually four to five times the median width

49 (50) Surface of the abactinal plates smooth or gently rounded; infero-marginal and adambulacral spines chisel-shaped; no marked ventro-lateral angle (between Kerguelen and Heard Islands and from the Palmer Archipelago, 93-335 m.) *Smilasterias triremis* (Sladen), 1889

50 (49) Surface of abactinal plates raised into small tubercles forming bases for the spinelets; infero-marginal and adambulacral spines slender, only slightly flattened and tapering distally; infero-marginal plates defining a marked ventro-lateral angle (Princess Elizabeth Land, 1266 m.) . . . . . *Smilasterias* sp. cf. *triremis* (Sladen), 1889

51 (42) Six (or more) rays, rarely five; fissiparous; more than one madreporite; dorso-lateral areas narrow, usually with only one or two plates lateral to each carinal one, often forming distinct longitudinal series; surface of denuded supero-marginals beaded . . . . . *Allostichaster* Verrill, 1914

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* Madsen (1956, 33-34) has suggested, I believe correctly, that some of the specimens from 'Challenger' station 151 off Heard Island were mistakenly labelled 191, a station from the Arafura Sea, north of Australia. This would account for the remarkable extension of range shown by *Labidiaster annulatus*, which is otherwise only known from Southern Ocean localities. Also supposedly from station 191 were *Porania spiculata*, which Fisher has made a synonym of the antarctic *P. antarctica glabra*, and *Diplasterias vesiculosa*, which I believe is a synonym of *D. meridionalis*, also known only from the Southern Ocean. A comparison of the type of *D. vesiculosa* with specimens of *D. meridionalis* shows no significant difference; both are distinguished from the rest of the genus by the absence of actinal spines. I think that Sladen was influenced by superficial differences and by the apparently remote locality when describing both *Diplasterias vesiculosa* and *Porania spiculata* as new species.

Bernasconi (1956) has recorded as *D. meridionalis* a five-rayed specimen with R 80 mm. from the South Shetland Islands. Although like *D. meridionalis* this has no actinal spines, I think the identification needs confirmation. The 'Discovery' failed to take any specimens of this species in that area, obtaining only one small specimen of *D. brucei* and two of *D. brandti* off nearby Clarence Island. I have examined the latter and both of them have actinal spines, at least proximally, though the smaller has R only 35 mm.

† In some specimens of *D. brucei* from the Ross Sea, such as those which Koehler first named *Coscinasterias victoriae* (1911) the dorso-lateral spines are better developed and the appearance is not unlike that of *D. brandti*. According to Fisher, the two species are also distinguished by the number and size of the crossed pedicellariae, which, he says, are fewer and smaller in *D. brucei*. *D. brandti* is not known from the Antarctic outside the Weddell Quadrant.

If larger specimens of the five-rayed *D. kerguelenensis* and the eight- to ten-rayed *D. radiata* prove to have actinal spines then they would fall into this section of the key.

52 (53) Rays very stout, tapering rather abruptly near the tip which is consequently blunt; abactinal spinelets and infero-marginal spines very coarse

? South Africa* . . . . . *Allostichaster capensis* (Perrier), 1875

Auckland I. north to Cook Strait, New Zealand, littoral* . . . . *Allostichaster insignis* (Farquhar), 1895

53 (52) Rays tapering more evenly from just beyond the base to a fairly acute tip; spines and spinelets moderately coarse (Falkland Is., Patagonia and Tristan da Cunha, 0-100 m. [? Juan Fernandez I., R=6 mm.])* *Allostichaster inaequalis* Koehler, 1923

54 (41) Infero-marginal plates similar to the adjacent actinal plates of which there are usually at least two series proximally; no marked ventro-lateral angle, the ray being almost cylindrical; never more than two adambulacral spines *Cosmasterias* Sladen, 1899

55 (56) No meshes or papulae between the infero-marginal and actinal plates; abactinal and supero-marginal spines aligned in very regular transverse series (W. end of Magellan Strait, 448 m.) . . . . *Cosmasterias polygramma* (Sladen), 1889†

56 (55) Meshes for papulae present between the infero-marginal and actinal series of plates; abactinal and supero-marginal spinelets not arranged in very straight transverse rows and sometimes very reduced in number (Falkland Plateau and Patagonia, N. to c. 30° S. in Chile and 40° S. in Argentina, also from South Georgia, 0-636 m.) *Cosmasterias lurida* (Philippi), 1858†

57 (40) Dorsal surface uniform, the skeleton reticular but, in spirit specimens, usually concealed by the more or less continuous covering of spinelets and pedicellariae; the carinal plates indistinct among the rest

58 (59) Nine or ten rays (Adélie, MacRobertson and Enderby Lands, 27-647 m.) . . . *Saliasterias brachiata* Koehler, 1920

59 (58) Five rays

60 (61) Marginal plates not superficially distinct; abactinal reticulum masked by close granulation; interbrachial arcs rounded; size small, R up to about 20 mm. (South Georgia, South Sandwich, Orkney and Shetland Is. and Graham Land, 0-250 m.) *Granaster nutrix* (Studer), 1885

61 (60) Marginal plates and abactinal reticulum well developed and superficially distinct; interbrachial arcs acute; R often > 50 mm. *Neosmilaster* Fisher, 1930

62 (63) Abactinal skeleton an open reticulum, the plates narrow and bar-like; actinal plates reduced and usually spineless, not extending beyond the base of the ray (South Georgia, South Orkney and Shetland Is., Palmer Archipelago, Shag Rocks, 1-300 m .) . . . . . *Neosmilaster georgianus* (Studer), 1885

63 (62) Abactinal reticulum compact, the plates rounded and the meshes small; actinal plates bearing spines and extending along the ray, usually a second series present proximally (Falkland-Magellan area and South Georgia, 99-160 m.) *Neosmilaster steineni* (Studer), 1885

64 (19) Adambulacral plates predominantly monacanthid

65 (84) No connected abactinal skeleton in the rays though a few small plates may be articulated in a short chain based on each infero-marginal and rare isolated plates occur dorsally; abactinal surface soft, and flexible, skin pustulate, the pustules containing only one or a few crossed pedicellariae; Antarctic except Kerguelen. . . . *Lysasterias* Fisher, 1908

66 (67) Eight rays (Clarence I., 342 m.) . . . . . *Lysasterias heteractis* Fisher, 1940

67 (66) Five rays

68 (75) Supero-marginal plates T-shaped or at least expanded at the dorsal end into a club-shape (fig. 16a-c), usually contiguous or linked together by supplementary plates and usually each bearing a single spine; infero-marginal plates usually contiguous‡

69 (70) Felipedal straight pedicellariae present (Enderby and MacRobertson Lands, 163-300 m.) . *Lysasterias digitata*, sp. nov.

70 (69) Only lanceolate straight pedicellariae present

71 (72) Crossed pedicellariae with very coarse teeth (Adélie Land and the Ross Sea, 22-289 m.) *Lysasterias adeliae* (Koehler), 1920

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* Madsen (1956) reduced *A. inaequalis* to the synonymy of *A. capensis* following Mortensen's suggestion (1941) that they were possibly identical and his own belief that a distribution in the littoral zones of both South Africa and southern South America is 'not extraordinary'. In view of the great amount of collecting which has been done in recent years all round the South African coast and the complete failure to find further material of *A. capensis*, I believe that Mortensen was correct in his other suggestion that the original locality was a mistake. The three small types were from 'S. Africa' and were presented to the British Museum by Dr. Andrew Smith of Chatham about 1844. Dr. (later Sir) Andrew Smith had earlier led an expedition to the interior of Africa starting from Algoa Bay (about 34° S.). In 1847 a fourth specimen of *A. capensis* and some examples of *Ophiocoma valenciae* presented by him and said to be from 'Cape of Good Hope' were registered. *O. valenciae* has not been recorded from as far south as Algoa Bay though Cape Town University has a record from about 31° S., so it is probable that these specimens were not collected by Smith's expedition but were acquired from other sources. Apparently his collection of fishes, at least, includes many vague or incorrect localities.

It may be significant that Dr. Andrew Smith was a friend of Dr. M'Cormick, surgeon of the 'Erebus' during the Antarctic Expedition of Sir James Ross, when collections were made at Auckland Island as well as on the New Zealand mainland, M'Cormick being in charge of the zoological collections. Strangely enough, a proportion of these collections was registered in the British Museum as received from Lieut. A. Smith, including some from Australasia and the Auckland Islands. This was presumably Alexander Smith, mate on the 'Erebus', who was promoted to Lieutenant during the voyage. The collections of this Expedition were also registered about 1844.

I think that there are two possibilities here, either Dr. Smith acquired the specimens of *capensis* from M'Cormick, or else there was confusion of the two Smiths in the British Museum, between the receipt and registration of the specimens. In any case there is a reasonable possibility that they came from the Auckland Islands or New Zealand, rather than from South Africa.

Unfortunately I have no material of *Allostichaster* from the Falkland-Magellan area or from Tristan da Cunha, but Prof. H. B. Fell has sent me four examples of *A. insignis* from Wellington. One of these has R 13 mm. like the largest types of *A. capensis* with which they were compared. The arrangement and shapes of the spines and spinelets are almost identical and the rays are similarly stout in shape. Judging from these specimens and Koehler's photographs of *A. insignis* (1920) and of *A. inaequalis* (1923) together with the figures of Mortensen (1941) and Bernasconi (1941) of the latter species, the Patagonian and Tristan da Cunhan species *A. inaequalis* is distinguished from the New Zealand area *A. insignis* (and *A. capensis*) by its more pointed rays and less coarse armature.

† Leipoldt (1895) considered *Stichaster polygrammus* Sladen to be a synonym of *C. lurida*. This was not endorsed by Fisher (1930) who followed Verrill (1914) by including the species in the genus *Cosmasterias*. The holotype of *C. polygramma* has a far more regular appearance with smaller and more numerous spinelets arranged in straighter lines than in any specimen of *C. lurida* I have seen. It approximates in this respect to the types of *Smilasterias scalprifera*. However, the actinal plates of *C. polygramma*, which form two series proximally, are similar in shape and only a little smaller than the infero-marginal plates.

Madsen (1956) has included *Asterias alba* and *A. obtusispinosa* of Bell (1881) as synonyms of *C. lurida*, although Fisher (1940) tentatively included them in the synonymy of *Diplasterias brandti*. I believe that Madsen is correct.

‡ Owing to the tendency for reduction of the marginal skeleton with increasing size it is necessary to qualify most of these statements.

72 (71) Crossed pedicellariae with fine teeth

73 (74) Marginal crossed pedicellariae half again to twice the size of the abactinal ones (Palmer Archipelago and Ross Sea, 160-335 m.) *Lysasterias* sp. cf. *adeliae* (Koehler), 1920

74 (73) Marginal pedicellariae not much larger than the abactinal ones, the ranges of size overlapping (Weddell Quadrant [including South Georgia], Queen Mary and Adélie Lands, also McMurdo Sound and Coulman I., Ross Sea [early 'Discovery' collection], 5-647 m.)* . . . . . *Lysasterias perrieri* (Studer), 1885

75 (68) Supero-marginal plates rhombic, oval or bar-like, not widest near the dorsal end, the consecutive ones nearly always separate and spineless

76 (77) Felipedal pedicellariae present (Bellingshausen Sea, 450 m.) . . . . *Lysasterias chirophora* (Ludwig), 1903

77 (76) Straight pedicellariae simply lanceolate or spatulate, lacking terminal claws

78 (81) Supero-marginal plates each with a spine

79 (80) About four small plates in series with each pair of marginal plates (Bellingshausen Sea and South Shetland Is., 560 m.) *Lysasterias belgicae* (Ludwig), 1903

80 (79) No supplementary plates in series with the marginals (Bellingshausen Sea, 450 m.) . *Lysasterias lactea* (Ludwig), 1903

81 (78) Supero-marginal plates spineless, except for one or two near each arm tip

82 (83) Marginal crossed pedicellariae much larger than the abactinal ones (MacRobertson and Adélie Lands, Ross Sea, South Shetland Is. and Clarence I., 163-810 m.) . . . . . *Lysasterias joffrei* (Koehler), 1920

83 (82) Marginal pedicellariae hardly if at all larger than the abactinal ones, the ranges of size overlapping (Palmer Archipelago, 70 m.) . . . . . *Lysasterias hemiora* Fisher, 1940

84 (65) Abactinal skeleton continuous though the reticulum may be very delicate; abactinal surface usually more or less rigid, skin sometimes pustular; abactinal spinelets or spines more or less numerous.

85 (86) Supero-marginal and abactinal spines single, each with a large pustule containing a wreath of crossed pedicellariae; usually seven to nine rays, rarely six, ten or even five (South Georgia, 10-55 m.) . . *Diplasterias octoradiata* (Studer), 1885

86 (85) Supero-marginal and abactinal plates with one or more spinelets or granules or naked, the whole surface pustular or more or less smooth; crossed pedicellariae often rare or absent, never occurring in distinct wreaths in pustules surrounding single spines; rays usually five, sometimes six, rarely up to eight from the Falkland-Magellan area, the outlying islands of the Southern Ocean and New Zealand.†

87 (90) Abactinal spinelets very short, granuliform, not much higher than wide, if at all, and on the carinal plates arranged in transverse arcs of usually three; five rays

88 (89) Dorso-lateral plates forming regular longitudinal series, the skeletal meshes roughly rectangular; carinal plates conspicuously enlarged (Auckland, Campbell and Antipodes Is., and New Zealand, littoral) . *Calvasterias suteri* (de Loriol), 1894

89 (88) Abactinal skeleton reticular, the skeletal meshes more or less irregular and the dorso-lateral plates not forming very distinct longitudinal series (Macquarie I., littoral) . . . . . *Anasterias directa* (Koehler), 1920

90 (87) Abactinal spinelets usually higher than wide but if granuliform then placed singly or in slightly spaced, more or less continuous, series along the abactinal reticulations, no special grouping on the carinal plates; five or more rays

91 (96) Six or more rays

92 (93) Abactinal armature consisting of short, more or less capitate, but waisted, spinelets, their length at least twice their median width (or half again as great as the width of the head); the head armed with a number of acute, distally-directed, points (Kerguelen, 0-201 m.) . . . . . *Anasterias perrieri* (Smith), 1876

93 (92) Abactinal armature consisting of markedly capitate, almost granuliform, spinelets not narrowest in the middle but with a very short stalk tapering basally, the large head convex or flat-topped and covered with rounded prominences; Macquarie and Heard Islands

94 (95) Abactinal granules rounded and spaced; skeleton fairly open‡ (Macquarie I., littoral) *Anasterias mawsoni* (Koehler), 1920

95 (94) Abactinal granules crowded and often polygonal; skeletal reticulation close‡ (Macquarie and Heard Islands, littoral) *Anasterias sphoerulatus* (Koehler), 1920

96 (91) Five rays

97 (98, 99) Kerguelen and the Crozet Is., littoral . . . . . *Anasterias rupicola* (Verrill), 1876

98 (97, 99) Auckland, Campbell and the Antipodes Is., littoral . . . . . *Calvasterias laevigata* (Hutton), 1879

99 (97, 98) Falkland-Magellan area, in chronological order:—*Anasterias antarctica* (Lütken) 1857 [with synonyms *Asterias rugispina* Stimpson, 1860, *A. cunninghami* Perrier, 1875, *A. verrilli* Bell, 1881 and *A. hyadesi* Perrier, 1886]. *A. varia* (Philippi) 1870 [with *Asteracanthion fulgens* Philippi, 1870 a synonym, according to Madsen]. *A. minuta* Perrier 1875, *A. spirabilis* (Bell) 1881, Proc. Zool. Soc., London, p. 513 [of which *Kalyptasterias conferta* Koehler 1923 is a synonym], *A. stolidota* (Sladen) 1889 (possibly a synonym of *A. varia*), *A. studeri* Perrier, 1891 and *A. pedicellaris* (Koehler) 1923 (possibly a synonym of *A. studeri* in my opinion); also *Calvasterias asterinoides* Perrier, 1875 if the types were from the Magellan area and not the Auckland Islands.

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* Specimens of the subantarctic *Anasterias minuta* with particularly weak skeletons may fall into this section of the key.

† The specific limits of most of the 'species' of *Anasterias* are very poorly defined and their variability is so great that most of them should be considered rather as formae. There is small reason to suppose that the relative abundance of straight or of crossed pedicellariae is of sufficient importance by itself to distinguish species in this genus any more than in other forcipulate genera. The relative lengths of the rays, strength of the skeleton and number and shape of the abactinal spinelets are also variable. Madsen's recent distinction of *A. varium* (Philippi) from *A. antarctica* (Lütken), by the relatively fewer marginal plates in the former, does not hold good, since a specimen of *A. antarctica* in the British Museum from Punta Arenas (the type locality) named by Lütken himself and appearing very similar to the photographs of the holotype given by Madsen, has only 18 plates in each series although R is 30 mm., whereas according to Madsen, specimens with R about 22 mm. have already 23 to 25 marginal plates in *A. antarctica* but only 16 to 18 in *A. varium*. There are also only minor differences between *Calvasterias suteri* from the subantarctic islands of New Zealand and *Anasterias* (formerly *Parastichaster*) *directa* (Koehler) from Macquarie Island, likewise between *C. laevigata* and more strongly calcified specimens of *Anasterias* from the Magellanic region such as the holotype of *Anasterias* (formerly *Calvasterias*) *stolidota* (Sladen).

In view of this, the distinction of the species of *Anasterias* in a key is very unsatisfactory, particularly with regard to the Magellanic ones which I am simply listing. A thorough revision of the genus is needed which is beyond the scope of the present work.

‡ These characters are variable in Magellanic species of *Anasterias* and further material may show that only one multibrachiate species occurs at Macquarie Island.

Note on Falkland-Magellan Species of *ANASTERIAS*. With regard to *A. spirabilis*, Bell's description emphasizes the extremely pustular appearance of the abactinal surface and his holotype is certainly conspecific with Koehler's specimens of *A. conferta*. Perrier (1891) was mistaken in referring Magellanic specimens to *A. spirabilis* as the species appears to be limited to the Falkland Islands. As for *A. minuta*, I believe that Fisher was wrong to give this name to specimens from the Falklands when the type was probably from the Magellan Strait (the 'Astrolabe' does not appear to have collected at the Falklands, judging from the narrative). All the specimens of *Anasterias* from the Magellan Strait in the British Museum can be referred to *A. antarctica* (except for a few strongly-calcified ones from the western end which may be distinguished as *A. stolidota* or *A. varia*, if those are separable. Also Madsen has commented that Perrier's description of the type of *A. minuta* (R 12 mm.) with the rays short and obtuse so that the form resembles *Asterina gibbosa* agrees much more with the form of *A. antarctica*. All the Discovery Falkland specimens which Fisher called *A. minuta* and some others conspecific with them collected by the F.I.D.S. at Port Stanley, have narrow, evenly-tapering rays, at all sizes, not at all like *Asterina*, and are probably conspecific with the eight, also from the Falklands, which Perrier (1891, pp. 92, 97-99) named *Anasterias* (i.e., *Lysasterias*) *perrieri* (Studer), using *A. minuta* for a number of other specimens from the Magellan Strait and Tierra del Fuego. The latter together with others which he called *A. spirabilis*, I believe were really *A. antarctica*, the '*minuta*' specimens being those with weaker skeletons. However, since Fisher himself had examined the holotype of *A. minuta* in Paris, it seems best for the present to retain the name *A. minuta* for the poorly-calcified Falkland form, (which would otherwise be nameless), until a direct comparison of the holotype with the Falkland form can be made. At the same time it is desirable that the affinities of the type species of *Calvasterias*, *C. asterinoides* (Perrier) should be investigated. It is closely related to *Anasterias*. The syntypes of *A. asterinoides* were also collected by the 'Astrolabe', supposedly (but almost certainly wrongly) from the Torres Strait. This is discussed further on pp. 93-94.

Genus Notasterias Koehler

Notasterias Koehler, 1911, 35-38 (Type, *N. armata* Koehler, 1911).

Autasterias Koehler, 1911, 38 (Type, *Asterias pedicellaris* Koehler, 1908).

The identification of the B.A.N.Z.A.R.E. specimens of *Notasterias* occasioned a re-examination of those members of the genus in the British Museum collected in the early years of this century by the 'Southern Cross', 'Discovery' and 'Terra Nova' in the Ross Sea area. It should be noted that the specimens from 'Terra Nova' stations 339 and 340 which Bell (1917) named *Asterias pedicellaris*, are, in fact, *Notasterias armata*. Most of the others are also referable to *N. armata* but a few were found to be anomalous. These all have diplacanthid adambulacral plates for at least the proximal half of each furrow so that they cannot be identified as either *N. pedicellaris* or *N. bongraini*.

The first of them, one from 'Terra Nova' station 338, with R 45 mm., was found to have a series of actinal papulae such as were found in the type of *N. stolophora* from off the Palmer Archipelago. Fisher distinguished *N. stolophora* from *N. armata* on the occurrence of these papulae in combination with macrocephalous pedicellariae of relatively small size, up to only 0·8 mm. length in the type of *N. stolophora* (R 27 mm.), the numerous pedicellariae being arranged in wreaths around the spines. However, the 'Terra Nova' specimen has pedicellariae up to 2·0 mm. long and rarely more than one associated with each carinal spine.

Secondly, there are three specimens from off Cape Wadsworth, Coulman Island, Ross Sea, collected by the 'Discovery' under Scott. The largest of these (R 32 mm.) has up to three actinal papulae on some of the actinal areas though the smaller specimens (both with R about 18 mm.) have none. In contrast to the first specimen, these three differ from most examples of *N. armata* of comparable size in having the macrocephalous pedicellariae small, up to only 0·8 mm. long in the larger specimen or 0·7 mm. in the smaller ones. Another difference from *N. armata* is that the abactinal spines are rather short and blunt-tipped and there are even a few dorsolateral spines present, especially in the larger specimen. Also, both marginal series of spines in all three are accompanied only by macrocephalous pedicellariae, whereas in all the other specimens of *N. armata* with R less than 40 mm. which I have examined, at least the infero-marginals bear ordinary crossed pedicellariae, though sometimes the proximal spines have some small macrocephalous pedicellariae in addition.

Possibly these four unusual specimens could all be referred to *N. stolophora* because of the actinal papulae but the considerable variation in size, number and arrangement of the macrocephalous pedicellariae in *N. armata*, as shown in Table 13, makes it doubtful whether *N. stolophora* is distinct. The combination of actinal papulae and small macrocephalous pedicellariae, which even at a moderate size are the only kind found on the marginal plates, is clearly not constant.

Finally, there is a specimen with R 22 mm. from off Cape Adare, South Victoria Land, taken by the 'Southern Cross', which has relatively small macrocephalous pedicellariae, up to 0·6 mm. long and the spines rather short and blunt, something like those of the Cape Wadsworth specimens but more capitate. However, this specimen differs in having the macrocephalous pedicellariae placed between the spines, not around their bases. Such an arrangement approximates to that found in *Notasterias haswelli* under the heading of which this specimen is discussed further.

TABLE 13

Measurements of some specimens of *Notasterias armata*, *N. bongraini*, and the type of *N. stolophora*.

D indicates 'Discovery' 1901-1904, T.N. 'Terra Nova', and S.C. 'Southern Cross'. Under 'marginal pedicellariae' M indicates macrocephalous, and X ordinary crossed pedicellariae. Brackets indicate exceptional occurrences.

Station	R (in mm.)	Longest carinal spine (in mm.)	Longest carinal pedicellaria (in mm.)	No. of carinal pedicellariae on each plate	Type of supero-marginal pedicellariae	Type of infero-marginal pedicellariae	No. and extent along furrow of adambulacral spines
N. armata							
D., E. end Ross Barrier	90	5·0	3·0	3, 4	M	M	2 for c. ¼
Banzare station 107	65	6·0	2·0	1-5	M	M	2
T.N., station 340	62	4·0	2·5	0-3	M(X)	M	2 prox.
Banzare station 107	53	3·0	1·2	4-7	M	M	2 prox.
S.C., Cape Adare	48	3·5	2·5	1-3	M	M&X	2 prox.
T.N., station 338	45	3·5	2·0	0, 1	M	X	2 for ½+
D., Winter Quarters	45	4·5	2·5	0-2	M	M&X	2 for ½+
T.N., station 339	45	4·0	2·5	1, 2	M	M&X	2 for ½
Banzare station 34	45	1·5	1·0	2-5	M	M	2
Banzare station 34	42	2·3	1·0	0-3	M	M	2 for ½+
Banzare station 107	40	2·5	2·0	0, 1	M(&X)	X	2 for ½
Banzare station 107	35	2·2	1·6	1, 2	M(&X)	X	2 prox.
S.C., Cape Adare	35	2·5	2·0	1, 2	M(&X)	X	2 prox.
Banzare station 41	32	2·0	1·5	1, 2	(M)&X	X	2 for ½
D., Cape Wadsworth	32	1·0	0·8	2-4	M	M	2
T.N., station 339	28	2·0	1·5	0, 1	(X)	X	2
S.C., Cape Adare	28	2·2	2·2	0, 1	M&X	X	2 prox.
S.C., Cape Adare	22	2·0	2·0	1, 2	M(&X)	X	2 prox.
S.C., Cape Adare	18	2·0	1·5	0, 1	X	X	2 for ½+
Banzare station 107	13	1·0	0·8	0, 1	X	X	2 for ½
N. stolophora							
Holotype	28	1·7	0·8	5-8	M	M	2
N. bongraini							
Discovery station 1957	53	2·5	1·7	2-5	M&X	X	1(2)
Banzare station 107	45	3·5	2·8	1, 2	X	X	1(2)
Banzare station 107	36	2·5	2·0	1, 2	X	X	1(2)
Banzare station 107	33	2·5	2·0	0-2	X	X	1
Banzare station 34	33	2·5	2·0	1, 2	M&X	X	1

Table 13 also shows the type of pedicellariae associated with the marginal spines, whether macrocephalous (M), ordinary crossed (X) or both. Larger specimens of *N. armata* tend to have all macrocephalous ones but smaller examples have both kinds or ordinary crossed ones alone, as Koehler observed in the types (1911). Where the carinal pedicellariae are relatively small they are usually more numerous and tend to form wreaths around each spine.

Notasterias haswelli Koehler

Notasterias haswelli Koehler, 1920, 70-74, pl. i, fig. 11, pl. v, fig. 11, pl. vii, figs. 1-7, pl. ix, fig. 7, pl. lxii, fig. 1.

Banzare localities: Stations 30 (1 specimen), 42 (1 specimen), 105 (1 specimen).

The specimens from these three stations have R respectively 32 mm., 55 mm. and 75 mm. The two larger ones differ from the types of *N. haswelli* in possessing a number of abactinal straight pedicellariae. These are up to 0·8 mm. long in the specimen with R 55 mm., but not more than 0·7 mm. in the largest one. The macrocephalous pedicellariae of the latter, however, reach the greatest size of 0·6 mm., the other two B.A.N.Z.A.R.E. specimens having them up to only 0·5 mm. The syntypes of *N. haswelli* have R up to only 37 mm. Koehler gave the length of the macrocephalous pedicellariae of the one from Adélie Land as up to 0·7 mm., but in those from Queen Mary Land it apparently does not exceed 0·45 mm.

The B.A.N.Z.A.R.E. specimens have about half of their crossed pedicellariae grouped around the bases of the spines, the rest being spaced out between, as in the types.

As already mentioned in the discussion of the genus *Notasterias*, a specimen collected by the 'Southern Cross' off Cape Adare in 47-51 metres, may also be referable to *N. haswelli*. It has macrocephalous pedicellariae up to only 0·6 mm. in length, which are placed between the abactinal spines, not around their bases. In *N. haswelli* these pedicellariae usually occur in both situations. Another difference is that in the Cape Adare specimen the abactinal spines, which include some proximal dorso-lateral ones, are only 1 mm. long and markedly capitate and very rugose at the tip. Usually in *N. haswelli* the spines are tapering and more or less acute. Nevertheless, this specimen comes closer to *N. haswelli* than to any species of *Notasterias* so far described. Apart from the characters already mentioned, it has single macrocephalous pedicellariae placed dorsally to each proximal supero-marginal spine, but the distal supero-marginal spines bear one or two much smaller, ordinary crossed pedicellariae. The infero-marginal spines similarly carry a few ordinary crossed pedicellariae. The adambulacral plates are diplacanthid for the proximal half of each series.

Type locality. Off Queen Mary Land, 110 metres.

Range. Known from Enderby Land eastwards to Adélie Land and (?) the Ross Sea off South Victoria Land in 110 to 647 metres.

Notasterias armata Koehler

Notasterias armata Koehler, 1911, 39-41, pl. v, figs. 6-11, pl. vi, figs. 1-8; 1912, 25-26, pl. i, fig. 8; 1920, 58-70, pl. vii, figs. 8, 9, pl. viii, figs. 2-8, pl. ix, figs. 1-6, pl. x, figs. 1-9, pl. lx, fig. 1, pl. lxi, fig. 1; Fisher, 1930, 244; 1940, 225-226, fig. J2a, 4, K1.

?*Notasterias bongraini*, Bernasconi, 1956, 14-15, pl. iii, figs. 1, 2 (diplacanthid). Non *bongraini* Koehler, 1912, which is valid.

Banzare localities: Stations 34 (2 specimens), 41 (OTL 2 specimens), 107 (OTL 17 specimens).

As can be seen from Table 14, there is some variation in the relative size of the macrocephalous pedicellariae. When these are smaller they are more numerous and tend to form wreaths around the carinal spines.

One specimen from station 41 and two from station 107 have some straight pedicellariae placed singly in the dorso-lateral and intermarginal areas. These may have the valves simply tapering but in one specimen they are expanded at the tips into what Koehler calls a 'palette' shape.

Type locality. Cape Royds Bay, McMurdo Sound, 18-33 metres.

Range. Enderby Land eastwards to the Ross Sea and from the Bellingshausen Sea, in 27 to 647 metres.

Notasterias bongraini (Koehler)

Autasterias bongraini Koehler, 1912, 26-29, pl. ii, figs. 10, 11; 1920, 74-78, pl. vi, figs. 5-10, pl. lix, fig. 1.

Notasterias bongraini, Fisher, 1940, 227-228, fig. J2c-e, 3; Madsen, 1955, 15. ?Non *bongraini*, Bernasconi, 1956, which is possibly *N. armata*.

Banzare localities: Stations 34 (1 specimen), 107 (DRL, 6 specimens, OTL 2 specimens).

In dorsal view specimens of *N. bongraini* are indistinguishable from *N. armata*, but the predominantly monacanthid adambulacrals and the frequent development of many small crossed pedicellariae on the ventral sides of the infero-marginal spines, though the latter condition is not invariable, serve to distinguish this species.

I think it possible that *N. bongraini* will prove to be synonymous with *N. pedicellaris* (Koehler), 1908, of which only the types from Dronning Maud Land are known.

Type locality. Admiralty Bay, South Shetland Islands, 420 metres.

Range. Known from the South Shetland Islands and from Kemp Land eastwards to Adélie Land in 110 to 830 metres.

Genus Psalidaster Fisher

Psalidaster mordax rigidus, subsp. nov.

text fig. 12, pl. v, figs. 5, 6.

Banzare locality: Station 105 (2 specimens).

Description. The holotype has R/r 75-80 mm./ 14-15 mm. There are eleven rays which are sharply marked off from the disc and slightly constricted at the base.

The dorsal surface resembles that of *Diplasterias brandti*, except that the crossed pedicellariae in the big pustules around the spines are relatively larger and the spines themselves are more inconspicuous. There are no distinct carinal rows of spines, the pustules being crowded together with little space between. At the bases of the rays the pustules are smaller, most of them with two to four crossed pedicellariae, leaving space for groups of up to six papulae between them, but over most of the abactinal surface the pustules are larger with four to six pedicellariae round each spine and the interstices are smaller with only two or three papulae. Rarely there may be two spines in a single pustule. The spines are up to 1·6 mm. long and either stout and blunt at the rugose tip or more slender and tapering to a more acute, though still rugose, tip. The pedicellariae are identical with those of subspecies *mordax*, each valve having two large divergent teeth at the narrowed tip with a series of fine denticulations leading from them down the middle. The base is considerably expanded for the large muscles. The abactinal pedicellariae are up to 0·75 mm. long and the marginal ones are 0·7-0·8 mm. long.

The marginal spines and pustules form two conspicuous regular series along the sides of the rays; the supero-marginal pustules are square (at least under preservation) and are placed directly over the corresponding rectangular infero-marginal ones which are higher (or wider) than long. The single supero-marginal spines are barely larger than the abactinal ones but the infero-marginal spines, of which there are usually two, one below the other, on each plate, are up to 1·75 mm. long. The proximal supero-marginal pustules have five or six pedicellariae and the infero-marginals eight or nine. There are single intermarginal papulae present.

The abactinal skeleton forms a wide-meshed reticulum but the plates are fewer, stouter and more solidly joined than in the types of the subspecies *mordax*, where the recticulum is very delicate. The supero-marginals

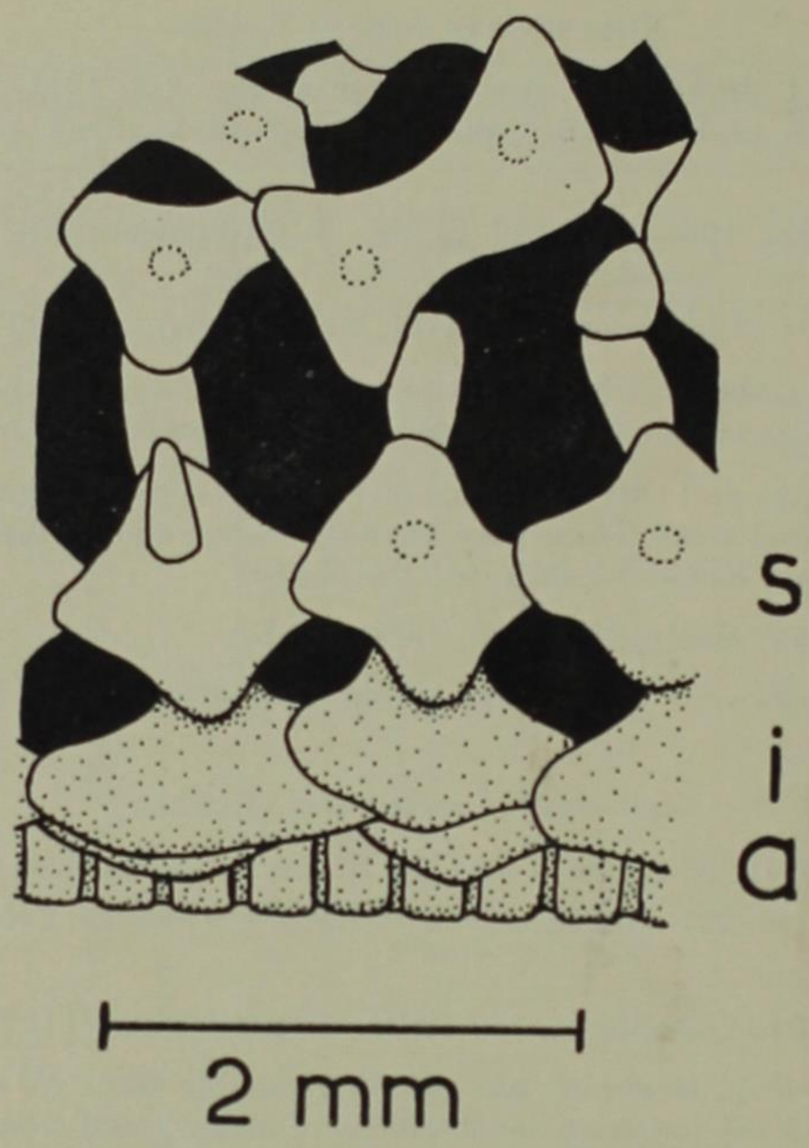


Fig. 12. *Psalidaster mordax rigidus*, paratype, R 83 mm., ventro-lateral view of denuded proximal part of detached ray, the more distal plates to the right; s, supero-marginals, i, infero-marginals, a, actinal plates.

are cruciform and the intermarginal meshes squarish. Rudimentary actinal plates occur between the proximal infero-marginals and adambulacrals. In the paratype, R 83 mm., the supero-marginals are more rhombic in shape (fig. 12) with the lobes less prolonged. The intermarginal meshes are smaller and more rounded.

The adambulacral plates are diplacanthid; the two similar spines are up to 2·1 mm. long and both are placed on the inner half of the ventral surface of the plate (i.e. towards the furrow), the outer half being covered with naked skin. In the paratype there are some straight pedicellariae on these naked areas up to about 1 mm. long, as well as between the pustules abactinally, but the holotype seems to lack straight pedicellariae outside the furrow.

The oral plates are long and narrow. Each usually has two spines at the apex, the interradial one much larger than the other, which is also offset and arises from the furrow side of the plate. In addition, there is a large suboral spine near the distal end of the plate. About five pairs of adambulacral plates form the adoral carina. The first two or three of these have only a single spine, slightly smaller than the suboral and larger apical oral spines but similar to the other adambulacral spines. The outer plates of the carina each have two spines which are subequal on the more proximal plates. The straight pedicellariae lining the furrow are a little larger on the adoral plates than elsewhere.

Remarks. The main difference between these antarctic specimens which I am calling subsp. *rigidus* and the types of *P. mordax* from the Falkland Islands is that, as suggested by the name, the present ones have a less delicate abactinal skeleton. Also the pustules are more prominent with much thicker skin in the B.A.N.Z.A.R.E. specimens. The alternating arrangement of the marginal plates in *P. mordax* with the supero-marginals aligned obliquely to the infero-marginals may be due to consolidation of the more delicate skeleton in preservation, but the supero-marginal plates themselves are more oblong in shape in *P. mordax* with a larger ventral lobe articulating with the infero-marginal. The skeleton of the new subspecies *rigidus* approximates to that of *Notasterias armata* as figured by Fisher (1940, fig. K1) even to the presence of actinal plates, though these are rudimentary in the new form. The presence of two apical spines on each oral plate in these B.A.N.Z.A.R.E. specimens may also constitute a valid distinction from *P. mordax*.

Genus Kenrickaster, gen. nov.*

Diagnosis. A genus of Asteriidae distinguished by the presence of crossed pedicellariae on the ventral surface of the adambulacral plates. The adambulacrals are diplacanthid with usually two relatively large pedicellariae on the skin covering the hollowed part of the plate distal to the two spines (fig. 13d). Similar crossed pedicel-

* Named after Dr. Walter Kenrick Fisher.

lariae occur in pustules around the infero-marginal, some or most of the supero-marginal and sometimes also some of the carinal spines. The carinal and marginal plates are all monacanthid with conical spines of moderate size. Dorso-lateral spines are absent, even in the largest specimen (R 33 mm.). The dorso-lateral plates are ovate and tend to form transverse series linking the prominent longitudinal series of usually four-lobed carinal plates with the similarly but more regularly cruciform supero-marginals on each side. A single series of up to six, rudimentary, spineless actinal plates occurs on each side in the larger specimens, the plates being sandwiched between the adambulacrals and the infero-marginals. Lanceolate straight pedicellariae occur sporadically dorso-laterally, also on some of the proximal adambulacral plates and actinal areas and in large numbers along the furrows. The whole surface is covered with a thick skin forming pustules around the spines (except the adambulacral ones) and cups around the straight and adambulacral crossed pedicellariae. Felipedal pedicellariae are unknown. The adoral carina is formed of one pair of post-oral adambulacral plates.

TYPE SPECIES. *Kenrickaster pedicellaris*, sp. nov.

Remarks. The exact position of this genus is uncertain. It would run down to *Diplasterias* in Fisher's key to the southern genera of the Asteriinae (1930) but for the presence of crossed pedicellariae on the adambulacral plates. Another difference is the small number of pedicellariae found on the dorsal side.

Since none of the Southern Ocean genera of the Asteriinae has crossed pedicellariae on the adambulacral spines it is difficult to distinguish between them and the sub-family Coscinasteriinae and I am inclined to associate *Kenrickaster* with the latter group, particularly with the genus *Notasterias*, despite the absence of the very characteristic macrocephalous pedicellariae of that genus. The single, conical marginal and carinal spines and the absence of dorso-lateral spines are similar in the two genera and the presence of crossed pedicellariae on the adambulacral plates in *Kenrickaster* may have originated from an extension of the pedicellariae from the ventral side of the infero-marginal plates such as is found in *Notasterias bongraini*.

KENRICKASTER PEDICELLARIS, sp. nov.

text fig. 13 a-f, pl. v, figs. 1, 2.

BANZARE LOCALITIES: Stations 30 (4 specimens), 39 (8 specimens), 107 (OTL 2 specimens).

Description. The holotype is from station 39. R/r is 33 mm./5 mm. =6·6/1. Br is 6 mm.

The whole surface is covered with thick skin, which, in the preserved specimen, tends to assume a slightly warty or even wrinkled appearance. The disk is delimited by a circle of prominent spines from which radiate the slightly zig-zag series of small, single, carinal spines each about 0·6 mm. long, projecting as conical eminences, the thick skin-covering forming pustules around them and around the few straight pedicellariae which alone are found in the dorso-lateral areas. The marginal plates are similarly armed with single spines though these are slightly larger than the carinal ones.

Denuding the dorsal surface reveals numerous transverse series of ovate, spine-less dorso-lateral plates linking most of the carinal plates with the supero-marginals on each side. In shape the carinals are usually four- or sometimes three-lobed and the supero-marginals are regularly cruciform but with the dorsal lobe abbreviated. The infero-marginals are an inverted T-shape; the vertical lobe articulating with the corresponding supero-marginal while the arms of the T meet the adjacent infero-marginals. Five or six, rudimentary actinal plates are sandwiched between the proximal infero-marginals and the adambulacrals on each side.

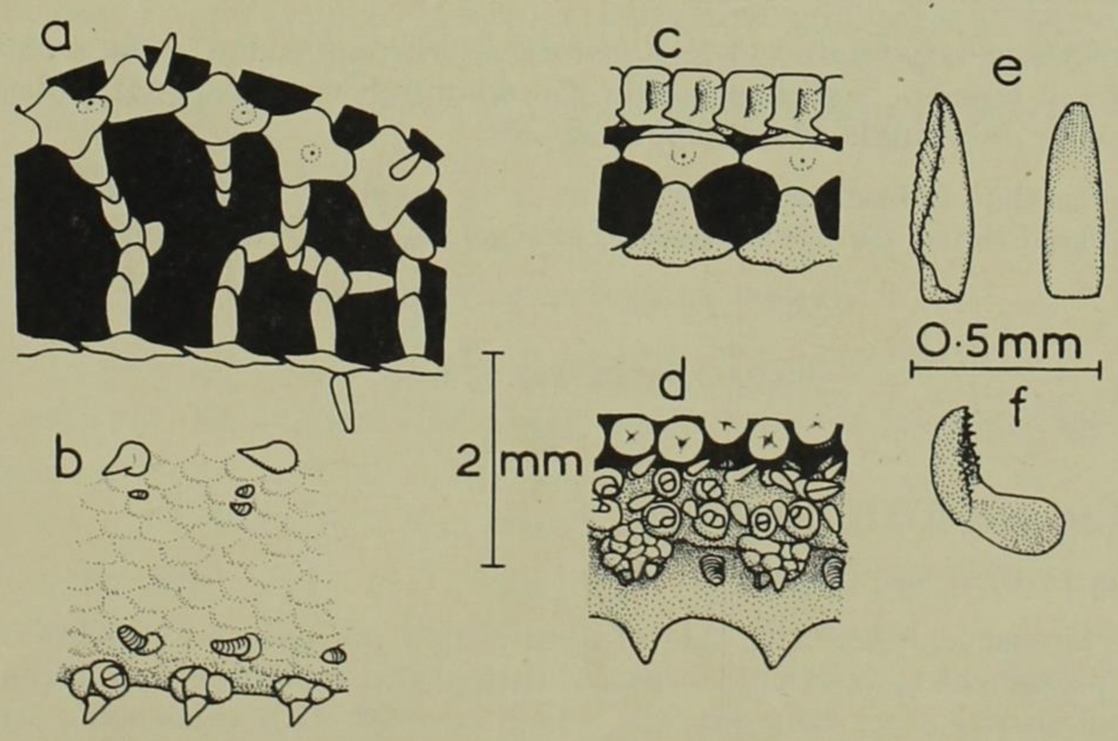


Fig. 13. *Kenrickaster pedicellaris*, holotype, R 33 mm. a, and b, denuded and intact carinal (uppermost) to supero-marginal plates from proximal parts of rays, the more distal plates being to the left; c, and d, denuded and intact ventral sides of proximal parts of rays, the more distal plates to the right, the lowermost plates in c, being the supero-marginals; e, and f, valves of straight and crossed adambulacral pedicellariae.

There are no crossed pedicellariae accompanying the carinal or proximal supero-marginal plates but the other supero-marginals may have one or two such pedicellariae placed above the spine. The infero-marginal pustules are larger and usually contain two crossed pedicellariae dorsal to the spine.

The papulae are single and few in number. There is a row of them on each side of the carinal series of plates, another just above the supero-marginals and a third intermarginal row. Actinal papulae are absent.

The adambulacral plates when denuded are seen to have a raised ridge at right angles to the furrow and the furrow margin itself is somewhat thickened (fig. 13c). The first three or four plates have a single adambulacral spine on the ridge close to the furrow margin, but all the rest have a second spine on the middle of the ridge. These spines are slender and about 1 mm. in length. Distal to each pair of spines and projecting from cups of the skin covering the hollowed part of the plate there are usually two crossed pedicellariae similar in magnitude to the spines themselves. Only the first few plates where the spines are deficient may lack one or both of these pedicellariae, or have one replaced by a straight pedicellaria; distally there may be three of them on some of the plates and together these form a dense covering to the ventral surface continuous with the pedicellariae of the infero-marginal pustules, only the tips of the adambulacral and infero-marginal spines projecting from a mass of pedicellariae. Proximally there may be a few straight pedicellariae on the skin covering the actinal plates. Most of the adambulacrals also bear a lanceolate pedicellaria within the furrow margin.

The oral plates are much elongated. In the middle of its length each has a slender, suboral spine, similar to the adambulacral ones, projecting ventrally, with a second spine at the apex towards the mouth. There may also be a small furrow spine projecting laterally near the apex besides several straight furrow pedicellariae. The adoral carina is formed of only one pair of adambulacral plates.

The tube feet are arranged in two rows but these are slightly zig-zag proximally.

The crossed pedicellariae have about ten to twelve rather coarse, graduated teeth (fig. 13f) on each valve. The marginal and carinal ones are similar to the adambulacral, all being about 0·45 mm. long. The straight pedicellariae taper evenly to a rounded tip and measure about 0·55 mm. in length.

Variations. Some of the other specimens have slightly more numerous abactinal pedicellariae than the type, a number of straight ones arising on the dorso-lateral areas while the distal and even the proximal carinal plates may bear single crossed pedicellariae. The tube feet are usually in four rows, at least proximally.

In all specimens the dense covering of crossed pedicellariae on the ventral side of the rays is very conspicuous especially distally.

Caimanaster, gen. nov.*

Diagnosis. A genus of Asteriidae distinguished by the presence of large crossed pedicellariae of peculiar form on the ventral surface of the adambulacral plates. These pedicellariae have long tapering valves with a series of similar, recurved teeth along their inner edges. The adambulacral plates are monacanthid. The carinal and marginal plates are also monacanthid with conical spines of moderate size. They are linked together by spineless dorso-lateral plates.

Type species. *Caimanaster acutus*, sp. nov.

Remarks. This genus is clearly related to *Kenrickaster* by the similarity of the skeleton and the occurrence of relatively large, mostly crossed, pedicellariae on the adambulacral plates. It differs in the form of these pedicellariae and in having only single adambulacral spines.

It is with reluctance that I describe a new genus from a single, probably immature, specimen, but the pedicellariae are so unusual that I cannot place it in any genus already described.

Caimanaster acutus, sp. nov.

Text fig. 14.

Banzare locality: Station 41 (OTL, 1 specimen).

Description. R/r is 14-15·5 mm./3 mm.

The dorsal view is almost identical with that of *Kenrickaster pedicellaris* except that no papulae are visible; each ray similarly has prominent rows of single, spaced, carinal and supero-marginal spines up to about 0·8 mm. long, with naked dorso-lateral areas between, the whole covered with thick skin, which is wrinkled in the preserved specimen and raised into conical, wide-based eminences by the spines. When denuded, the plates are also seen to be similar to those of *K. pedicellaris*, the carinal plates being four- or sometimes three-lobed, each bearing a single, conical, pointed spine and linked with the supero-marginal plates on each side by transverse,

* The name is derived from the crocodile-like appearance of the crossed pedicellariae in side view.

rarely branching or anastomosing, series of oval or rectangular dorso-lateral plates. The carinal series is slightly zig-zag in arrangement and the first spine in the series forms part of a ring of about fifteen spines around the disk. In the centre of the disk is a pair of spines sharing the same skin sheath.

No crossed pedicellariae occur in association with the carinal or supero-marginal spines, unlike *K. pedicellaris*, but a few very large, straight pedicellariae, which taper evenly to rounded tips, are present, especially distally. There are up to seven of these near the tip of each ray besides one or two proximally. The largest are about 0·85 mm. long. Three or four similar straight pedicellariae are placed inter-marginally on each side of each ray.

The infero-marginal spines are also single and skin-covered but are longer than the other spines, up to 1·2 mm. in length and have the sheath fitting closely for the whole length, not expanded round the base. The denuded marginal plates are very similar to those of *Kenrickaster pedicellaris* figured. The supero-marginals are four-lobed with the dorsal lobe very small, though in this specimen it arises distal to the spine and consequently merges more or less with the distal lobe. The latter is overlapped to a greater extent than in *K. pedicellaris* by the proximal lobe of the succeeding plate. The infero-marginals are three-lobed with a raised boss for the spine. Each corresponds to about three adambulacral plates.

No actinal plates are present, even proximally.

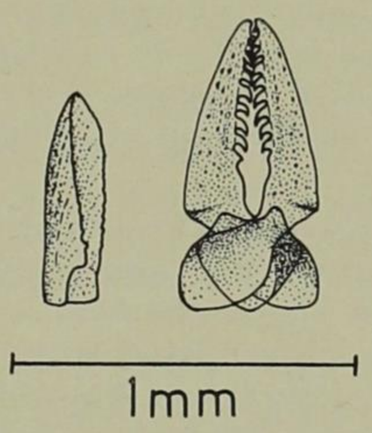


Fig. 14. *Caimanaster acutus*, holotype. Right, adambulacral crossed pedicellaria; left, valve from straight pedicellaria.

The adambulacral plates each bear a single, slender spine up to 1·1 mm. long on the furrow margin. Between these spines and the infero-marginal ones on the skin covering the adambulacral plates are crowded a number of very large, mostly crossed, but sometimes straight pedicellariae, the crossed ones of most unusual form. Usually two of these correspond to each adambulacral plate. Sometimes the outer one is displaced and arises between the consecutive infero-marginal spines. The arrangement is very similar to that in *Kenrickaster* except that the pedicellariae are relatively larger and modified in shape and there is only one adambulacral spine instead of two. The valves of these crossed pedicellariae are long and tapering with the edges of the jaws straight and bearing a prominent series of similar, recurved teeth, the whole resembling in profile the jaws of a crocodile (fig. 14). The length is up to 0·85 mm. so that these pedicellariae appear almost as long as the adambulacral spines. The straight pedicellariae are similar in size to the largest crossed ones.

The oral plates each bear an apical spine similar to the adambulacral spines and a suboral one near the distal end of the plate. One pair of adambulacral plates is partly in contact, forming an incipient adoral carina.

Remarks. The lack of papulae and of abactinal crossed pedicellariae may be attributable to the relatively small size.

Genus Diplasterias Perrier

Diplasterias brucei (Koehler)

pl. v, figs. 3, 4.

Asterias neglecta Bell, 1902, 215. Non *neglecta* Bell, 1881, which is a synonym of *D. brandti*.

Stolasterias brucei Koehler, 1908, 569-572, pl. v, figs. 46, 47.

Asterias brandti (part) Bell, 1908, 7; 1917, 3. Non *brandti* Bell, 1881, which is a valid species of *Diplasterias*.

Coscinasterias brucei, Koehler, 1911, 30-31, pl. v, figs. 3, 4.

Coscinasterias victoriae Koehler, 1911, 32-35; 1912, 24-25.

Podasterias brucei, Koehler, 1920, 42-52, pl. xi, figs. 5-7, pl. xiii, figs. 1-9, pl. xiv, figs. 4, 7-11, pl. xv, figs. 4, 5; 1923, 35-36, pl. xiii, fig. 2; Döderlein, 1928, 295.

Podasterias fochi Koehler, 1920, 35-42, pl. xiv, figs. 1-3, 12, pl. xv, figs. 1-3, pl. xvi, figs. 2, 3, 7, pl. lviii, fig. 1.

Diplasterias brucei, Fisher, 1930, 231; 1940, 253-254; Madsen, 1955, 16; Bernasconi, 1956, 18-19, pl. v, figs. 1, 2.

Banzare localities: Stations 39 (3 specimens), 40 (2 specimens), 41 (TML, 10 specimens), 42 (11 specimens), 90 (1 specimen), 105 (52 specimens), 107 (OTL, 8 specimens).

Most of these specimens are small with R less than 40 mm., but there are three very large ones from stations 105 and 107 with R well over 100 mm. These are not well preserved and have a close resemblance to the similarly large types of *Podasterias fochi* Koehler, of which even the smallest had R 140 mm. Koehler (1920) distinguished *P. fochi* from *P. brucei*, by the less rigid and longer, more slender and more flattened rays, the side walls low and the dorsal surface rounded so that the transverse section of the ray would not be pentagonal as it usually is in *P. brucei*; the dorsal spines of *P. fochi* are less well developed, the carinal row being less marked and the marginal as well as the carinal spines themselves smaller and more numerous, with fewer pedicellariae; finally the preserved specimens of *P. fochi* are darker in colour than those of *P . brucei*. At the same time as he described *P. fochi*, Koehler decided that his own species, *Coscinasterias victoriae*, comes within the range of variation of *P. brucei*. He had earlier (1911) included *brucei* with *victoriae* in *Coscinasterias* and differentiated them by the thinner and longer rays, the smaller and more numerous carinal and dorso-lateral spines and the occurrence of an actinal row of spines in *C. victoriae*, in fact by very much the same characters as he was using to distinguish *P. fochi*. A comparison between the photographs of the A.A.E. and 'Gauss' specimens named *P. brucei* and *P. fochi* by Koehler in 1920 (pl. xv) is complicated by the different enlargements used, so that the example of *P. brucei* (figs. 4 and 5) with R 85 mm. appears larger than that of *P. fochi* with R 140 mm. It is evident that the rays are relatively more slender in the types of *P. fochi* but the small size of the dorsal spines is exaggerated. I think it is significant that Koehler referred only the very large A.A.E. specimens to *P. fochi* and all the small ones to *P. brucei*. The difference in appearance is probably at least partly a result of the poorer preservation of the large specimens, as with the B.A.N.Z.A.R.E. material. However, a specimen with R about 60 mm. from B.A.N.Z.A.R.E. station 105 also has rather smaller and more numerous dorsal spines than usual though the carinal row is fairly distinct.

The early 'Discovery', 'Terra Nova' and 'Southern Cross' specimens from the Ross Sea are better preserved than most of the B.A.N.Z.A.R.E. ones so that the skin appears pulpy with the wreaths of pedicellariae around the spines much more prominent and the spines themselves apparently shorter. However, these other specimens also exhibit considerable variation in the relative lengths of the rays, which are sometimes very slender, as well as in the number, size and shape of the spines. Many of the larger specimens have the dorsal surface of the rays hardly arched at all so that the transverse section of the ray would be rectangular, not pentagonal; also the large B.A.N.Z.A.R.E. specimens, though resembling the types of *P. fochi*, have the lateral walls of the rays relatively higher. However, they are similar in the numerous dorso-lateral spines, the carinal ones being inconspicuous. In the Ross Sea material the dorso-lateral spines are usually undeveloped in those with R $<$50 mm., while about half of the larger specimens still have these spines few or inconspicuous though in the rest they are more numerous and prominent. I think that the more robust appearance of the Ross Sea and smaller B.A.N.Z.A.R.E. specimens is largely due to better preservation. As a result of these considerations I am referring *P. fochi* to the synonymy of *Diplasterias brucei*.

Koehler also compared *P. fochi* with *P.* (now *Diplasterias*) *brandti*, which he believed to be more closely related to it than *D. brucei*, distinguishing them by the larger size of *P. fochi*, the less transparent and more pigmented skin and the fewer and smaller pedicellariae. However, *D. brucei* is similarly distinguished from *D. brandti* by the smaller and fewer pedicellariae according to Fisher (1940) who also commented on the variable development of the pedicellariae in different specimens of *D. brandti*. Differences in colour of preserved specimens are not usually reliable for distinguishing between asteriid species.

One of the two specimens from B.A.N.Z.A.R.E. station 40 (pl. v, fig. 3) is unusual in having the spines, particularly the infero-marginal ones, elongated and more or less acute at the tip. R is 45 mm. and the longest carinal, supero-marginal and infero-marginal spines measure respectively 1·5 mm., 2·2 mm. and 2·5 mm., only the infero-marginals being at all flattened and rounded rather than pointed at the tips. A 'Discovery' specimen from McMurdo Sound with R 43 mm. has these spines respectively 1·0 mm., 1·5 mm. and 1·7 mm. long, all of them being truncated while the infero-marginal ones are particularly flattened and square-tipped. There is some variation in the shape of the spines in different specimens but the one from station 40 is an extreme case.

TYPE LOCALITY. Scotia Bay, South Orkney Islands, 18 metres.

RANGE. Known from South Georgia (six-rayed forma), the South Shetland, Orkney and Sandwich Islands, the Palmer Archipelago and Dronning Maud Land as well as from Enderby Land eastwards to the Ross Sea, in 18 to 732 metres.

DIPLASTERIAS MERIDIONALIS (Perrier)

Asterias meridionalis Perrier, 1875, 340 (76 of separate); Smith, 1879, 272, pl. xvi, fig. 1; Studer, 1885, 153; Sladen, 1889, 569.

Asterias mollis, Studer, 1877, 457; 1884, 8. Non *A. mollis* Hutton, 1872, which is a valid species of *Sclerasterias*.

Asterias studeri Bell, 1881, 91; Studer, 1884, 8-9, pl. i, fig. 1.

Diplasterias meridionalis, Perrier, 1891, 7; Fisher, 1930, 231; 1940, 251-252, fig. M2, pl. xxi, fig. 4, pl. xxii, fig. 1; Madsen, 1955, 16; [?] *meridionalis*, Bernasconi, 1956 (five-rayed).

Podasterias meridionalis, Koehler, 1917, 20-24, pl. ii, figs. 11, 12, pl. iii, figs. 1, 2, 4-7, pl. vi, fig. 8, pl. vii, fig. 9; 1923, 31-35, pl ii, fig. 1; Döderlein, 1928, 294-295.

BANZARE LOCALITIES: Stations 5 (1 specimen), 6 (1 specimen, from kelp), 8 and 15 (4 specimens), 47 (18 specimens), 52 and 53 (6 specimens), 55A (2 specimens), 55B (1 specimen), 59 (5 specimens), 64 (76 specimens) and coll. 750. Of all these 115 specimens two have seven rays and the rest have six.

TYPE LOCALITY: Unknown. Taken by 'Erebus' during Ross's Antarctic Expedition, probably at Kerguelen.

RANGE. Known from Kerguelen, Marion Island, and South Georgia, in 0 to 234 metres.

Genus SMILASTERIAS Sladen

Asterias (subgenus *Smilasterias*) Sladen, 1889, 562, 568; Fisher, 1940, 260 (Type *Asterias scalprifera* Sladen, 1889).

Since Sladen described *Asterias scalprifera* and *A. triremis*, only one other species, *S. irregularis* H. L. Clark (1928) has been added to this genus. The unique type of *S. irregularis* was said to be from South Australia; unfortunately it is in poor condition. The B.A.N.Z.A.R.E. has taken a single specimen from Macquarie Island which I believe to be affiliated to *S. irregularis*. However, as mentioned below, both *S. irregularis* and this Macquarie Island specimen seem to be intermediate between *Smilasterias* and *Allostichaster* in the form of the skeleton and shape of the abactinal spinelets. More material of both of them may show that neither is congeneric with *Smilasterias scalprifera*, the type species.

There is also a single specimen from B.A.N.Z.A.R.E. station 29, off Princess Elizabeth Land, which is more closely related to *S. triremis*, though not identical with it. I have compared this with some of the numerous syntypes of *S. triremis* from between Kerguelen and Heard Island, as well as with the two larger types of *S. scalprifera* from Marion Island and the smaller one from Heard Island, together with the 'Discovery' material of both these species, *S. triremis* from the Palmer Archipelago and *S. scalprifera* from the Falkland Islands as well as from Marion Island.

This comparison showed up some minor differences between the types of both species and the corresponding 'Discovery' specimens, although it should be taken into account that the largest type of *S. triremis* has R only 35 mm.,.while in the smallest 'Discovery' specimen R is 40 mm. In the Kerguelen specimens of *S. triremis* the dorso-lateral plates tend to form transverse ribs between the carinal and supero-marginal plates, and are not regularly linked together longitudinally. In contrast, a Palmer Archipelago specimen has the skeleton much more reticular, with the consecutive transverse bars connected together at one or two places on each side by additional plates. Secondly, the Kerguelen specimens have numerous felipedal pedicellariae of a great range of sizes, the largest over 1 mm. long in some specimens while the smaller ones gradually approximate in shape to ordinary lanceolate straight pedicellariae, differing only in having two or three incurved claws or teeth at the tip of each valve. Straight pedicellariae similar to these smaller ones, about 0·25-0·30 mm. long, are found in the channel between the infero-marginal and adambulacral spines in both the specimen from B.A.N.Z.A.R.E. station 29 and a 'Discovery' specimen from station 181 (Palmer Archipelago), the latter having such pedicellariae also scattered on the marginal and abactinal areas among the crossed pedicellariae.

In the three types of *S. scalprifera* and the 'Discovery' Marion Island specimens the straight pedicellariae are all of the lanceolate type with valves tapering to a rounded or acute tip. When acute, the tip may be very slightly incurved but never forms a distinct claw. However, the Falkland specimens of *S. scalprifera* have these pedicellariae modified in the direction of those of *S. triremis*, most of them having a small median claw with sometimes a still smaller process set back from it on each side. The shape is therefore intermediate between that found in the types of *S. scalprifera* and that of *S. triremis*. The 'Discovery' specimens of *S. scalprifera* also differ from the types in having the rays less attenuate; otherwise I can find no significant difference.

Fisher distinguished *S. triremis* from *S. scalprifera* by the infero-marginal and adambulacral spines, which are longer and broader, though fewer, in *S. triremis*, by the smaller size of the furrow pedicellariae and by the absence of actinal spines or larger lanceolate pedicellariae in the actinal areas proximally. I would modify this last statement, since the types of *S. triremis* usually do have some large felipedal pedicellariae in this position. Other differences are the greater specialization of the small straight pedicellariae in *S. triremis* already mentioned and the fact that the abactinal spinelets are somewhat more slender and less clavate, being usually about four times as long as their median width (if not more), while those of *S. scalprifera* are nearer three times as long as their median width and are distinctly 'waisted' with an enlarged head. This is true of the 'Discovery' specimens as well as of the types.

Since both the B.A.N.Z.A.R.E. specimens which I am referring to this genus are relatively small and in rather poor condition, as well as being unique, I do not propose to erect new species for them. I hope that more material of *Smilasterias* spp. will be forthcoming from recent collections.

SMILASTERIAS sp. (cf. TRIREMIS Sladen)

text fig. 15d-f.

BANZARE LOCALITY: Station 29 (1 specimen).

Description: This specimen is not in good condition. One ray has been broken and is regenerating. R/r is 21 mm./4·5 mm. and br is 5 mm.

The abactinal surface is quite closely covered with fine spinelets but even so the position of the carinal series of plates is distinct; when denuded they are seen to be conspicuously larger than the dorso-lateral plates or even the supero-marginals which slightly outnumber them. In shape the carinal plates resemble a kite with the lateral lobes towards the distal end and the long proximal lobe overlapping the shorter distal lobe of the preceding plate. The entire carinal series stands out slightly from the dorsal surface. The proximal plates each bear about seven spinelets which arise from small tubercles on the surface of the plate. Similar tubercles are found on the dorso-lateral plates, where they have a tendency to form irregular tangential series across the ray. The numerous dorso-lateral plates are irregularly lobed and crowded together, leaving only small spaces between them. There is a barely distinct tendency for a transverse arrangement, more noticeable with the naked eye than under magnification. Proximally there are about five plates between the carinal and marginal series on each side.

The slender abactinal spinelets are about 0·4 mm. long with an irregular, slightly rugose and sometimes slightly clavate tip. The length is about five times the median width. The frequent crossed pedicellariae scattered between the spinelets are of the usual form found in this and related genera, with fine teeth towards the tip and a transparent middle part to each valve.

The supero-marginal plates are cruciform with the dorsal lobe reduced. The proximal plates each have about five tubercles bearing spinelets similar to the abactinal ones except for the lowest which is larger and transitional to the infero-marginal spines.

The infero-marginal plates define a distinct ventro-lateral angle. Their vertical lobe articulates with the corresponding supero-marginal and the rest of the plate forms a slightly oblique ridge which, on the proximal half of the ray, bears four, sometimes five, long spines. These spines are the largest on the entire body and measure up to 1·4 mm. in length. The upper- or proximal-most ones on each plate are the largest and are slender, slightly flattened and tapering in the rugose distal third of their length to an acute tip. The lower- or distal-most ones are more flattened and wider at the tip.

About three rudimentary actinal plates are sandwiched between the proximal infero-marginal and adambulacral plates of each series.

The adambulacral plates each bear two similar spines, not markedly flattened or spatulate and a little smaller than the infero-marginal spines.

Some small actinal straight pedicellariae occur between the infero-marginal and adambulacral spines. These are of an incipient felipedal form, each valve having one to three curved claws or teeth at the tip interlocking with those of the corresponding valve. None exceeds 0·25 mm. in length. There are ordinary small lanceolate pedicellariae within the furrow.

Affinities: This specimen is most closely related to *Smilasterias triremis* (Sladen) and *S. scalprifera* (Sladen) both with type localities in the Kerguelen-Heard Island area or Marion Island. The superficial appearance of both species, with a fairly close covering of small spinelets but the carinal row of plates distinct, is similar to that of the present specimen, but their denuded carinal plates are seen to be hardly at all larger than the dorso-lateral plates, also the latter are arranged in much more regular transverse series with larger spaces between them. In addition the surfaces of the plates are much smoother without the very noticeable tubercles found on the B.A.N.Z.A.R.E. specimen. The abactinal spinelets in *S. triremis* are slightly thicker, about four times as long as wide, though similarly about 0·4 mm. in length, at least when R is 35 mm. In *S. scalprifera* the spinelets are thicker still, three to three and a half times as long as their median width, besides being distinctly clavate. The largest type of *S. scalprifera* from Marion Island, with R 58 mm., has the spinelets about 0·5 mm. long, while the smallest one, from Heard Island, with R 25 mm., has spinelets about 0·35 mm. long. The greatest resemblance to this B.A.N.Z.A.R.E. specimen is in the form of the marginal plates with the infero-marginals defining a marked ventro-lateral angle to the ray and the actinal plates reduced or rudimentary. The largest syntype of *S. triremis*, R 35 mm., and the smallest paratype of *S. scalprifera* both have only three or four very narrow, spineless actinal plates sandwiched between the proximal infero-marginals and the adambulacrals like this B.A.N.Z.A.R.E. specimen, though the larger 'Discovery' specimens of *S. triremis* from the Palmer Archipelago and the two larger types of *S. scalprifera* all have more extensive series of actinals and these are spinous to some extent in *S. scalprifera*. As for numbers of spines, the types of *S. triremis* have only three infero-marginal spines, even on the proximal plates, likewise the larger 'Discovery' specimens. However, the smallest type of *S. scalprifera* already has four spines on most infero-marginal plates, the largest type often having five. In both species, however, these spines are always much flatter, broader and blunter at the tips compared with those of the B.A.N.Z.A.R.E. specimen. The adambulacral spines are similarly rather flattened in both sets of types; they number only two on a plate in *S. triremis* (rarely three in the larger 'Discovery' specimens) but there are four on many plates in the largest type of *S. scalprifera* and two or three in the smallest one.

Although the B.A.N.Z.A.R.E. specimen approaches *S. scalprifera* most closely in the large number of infero-marginal spines, it is linked rather with *S. triremis* by the form of the straight pedicellariae. In *S. triremis* these are all of the felipedal type, with the exception of those in the furrow, and each valve has two or more

terminal claws or teeth. There is a great range of size in these pedicellariae, from 0·25 to over 1·0 mm. in one specimen, the larger ones having a constriction in the valves towards the base, while the smaller ones are more evenly tapering. The straight pedicellariae of the B.A.N.Z.A.R.E. specimen are indistinguishable in size and shape from the smallest ones of *S. triremis*. In *S. scalprifera*, on the other hand, the straight pedicellariae are simply lanceolate in the types though in specimens from the Falklands area they approximate in shape to those of *S. triremis*.

The 'Discovery' specimens of *S. triremis* from the Palmer Archipelago resemble this one in the uniformly small size of the straight pedicellariae, otherwise they differ from it in the same ways as the types. A partly denuded specimen of *S. scalprifera* from station WS 825 in the Falklands area shows enlarged carinal plates comparable in size to those of the B.A.N.Z.A.R.E. specimen, but again much smoother in texture.

The Macquarie Island specimen I am describing below under the heading of '*Smilasterias* sp., cf. *irregularis*' has a much heavier skeleton than this one, though the dorso-lateral plates are equally multi-lobed and do not form distinct transverse series—indeed, if anything, they form irregular longitudinal series. It also has fewer and shorter abactinal and marginal spinelets and spines, there being only two spines on most infero-marginals.

Smilasterias sp. (cf. irregularis H. L. Clark)

text fig. 15a, b.

Banzare locality: Station 83 (1 specimen).

Description. R/r is 20 mm./5 mm.

The abactinal spines or spinelets are spaced and tend to form longitudinal and obliquely transverse series. When denuded, the carinal series is revealed as large and distinct for its whole length, most of its plates bearing a spinelet on each of the three exposed lobes (fig. 15a). The supero-marginal plates are almost as large as the carinals and much higher than wide; they bear three, sometimes only two, spaced spinelets in an irregular vertical row. Their surface is quite smooth. Between them and the carinal plates proximally there are four slightly irregular, longitudinal series of plates, of which the three inner usually each bear a spinelet. The plates of the outermost series correspond to the supero-marginal plates and are more or less rectangular in shape whereas the others are lobed. There are no distinct transverse ribs of plates as in *Smilasterias triremis* and *S. scalprifera*. The stout abactinal and supero-marginal spinelets are short, up to 0·6 mm. long and usually slightly expanded towards the rounded tip. The length is about two and a half times the median width. There are numerous crossed pedicellariae of the form usual to *Smilasterias* and *Allostichaster*, scattered between the spinelets.

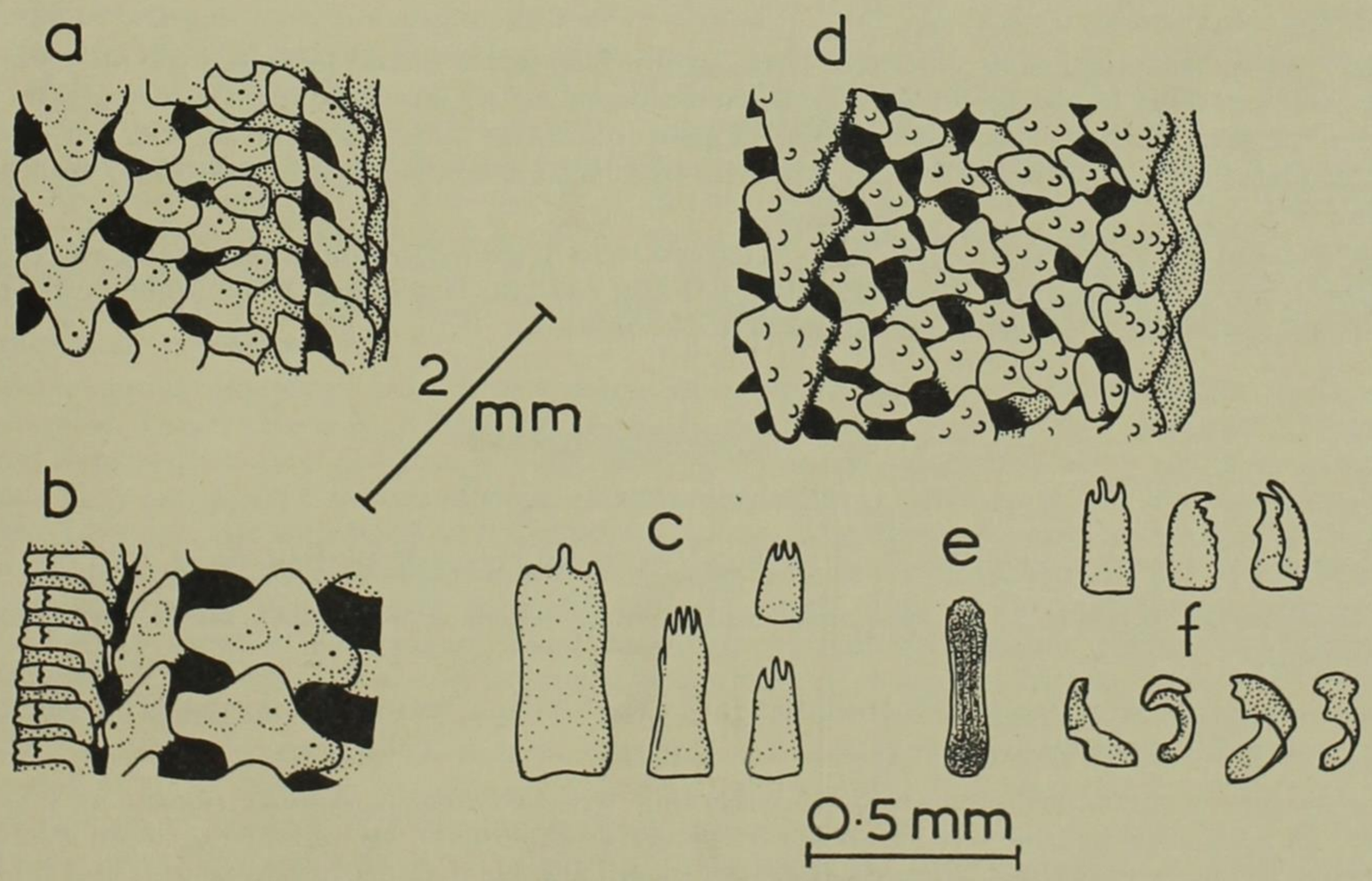


Fig. 15. *Smilasterias* spp. a, and b, *Smilasterias* sp. cf. *irregularis*, R 20 mm. from Banzare station 83, denuded plates from proximal part of a ray, a, dorso-lateral view, the proximal-most carinal plate at lower left being the fourth one, the extreme right-hand plates being the infero-marginals, b, ventro-lateral view of adambulacral to supero-marginal plates, the proximal-most to the top; c, *S. triremis*, syntype with R 28 mm. from 'Challenger' station 150, between Kerguelen and Heard Islands, valves of ventral straight pedicellariae; d, to f, *Smilasterias* sp. cf. *triremis*, R 21 mm. from Banzare station 29, d, dorso-lateral view of proximal part of a ray, as in a, e, abactinal spinelet, and f, valves of actinal straight and abactinal crossed pedicellariae.

The infero-marginal plates usually each bear two flattened, spatulate spines, expanded towards the tip and up to 1 mm. long. Some of the plates just beyond the base of the ray have three spines. These follow an almost longitudinal line. Proximally there are six or seven very narrow actinal plates sandwiched between the infero-marginals and adambulacrals. These plates are spineless though there are a few lanceolate straight pedicellariae up to 0·5 mm. long carried on the skin covering them. Straight pedicellariae also occur in the furrow but are not found dorsally. The adambulacral plates are diplacanthid, the spines being up to 1 mm. long but more slender than the infero-marginal spines. Only the first pair of adambulacral plates forms the adoral carina.

Affinities. Superficially this specimen from Macquarie I. resembles the type of *Allostichaster regularis* figured by Dr. H. L. Clark (1928), but a comparison with the B.A.N.Z.A.R.E. specimens of *A. regularis* shows that the abactinal skeleton differs in consisting of several series of plates on either side of the large carinal row, rather than a single series with connecting secondary plates as there is in *A. regularis.*

The unique holotype of *Smilasterias irregularis* H. L. Clark (1928) on the other hand, appears to have two, possibly three rows of dorso-lateral plates on each side proximally. Unfortunately it is in poor condition. The locality is said to be South Australia. The longest ray measures 49 mm. According to the description, the abactinal skeleton is closely reticulate, the longitudinal rows not conspicuous basally but the carinal series fairly distinct distally. The abactinal plates each carry a few spaced, low, blunt, but not at all capitate, spinelets and more numerous scattered pedicellariae. The supero-marginal plates are much higher than long and each carries two or three small, blunt, spaced spines in an irregular vertical series, as well as some pedicellariae. The infero-marginal plates are low, longer than high and form an angular margin to the ray. Each bears two flat spines with rectangular tips, the basal ones 2 mm. long. No actinal plates are present according to Dr. Clark but he may have missed them as I believe he did also in the types of *Allostichaster regularis*. The adambulacral plates are diplacanthid, the proximal spines nearly 2 mm. long. Small straight pedicellariae occur in the furrow but not elsewhere actinally except for a single stout one in one interradius.

The B.A.N.Z.A.R.E. specimen differs from *S. irregularis* in the more regular abactinal plates, with the carinal series distinct throughout and in the more capitate spinelets. The different lengths of the spines may be relatively comparable but the presence of some actinal plates in the smaller Macquarie specimen may distinguish it. The fact that the straight pedicellariae outside the furrow are more numerous is probably not significant.

This differs from the types of *S. triremis* taken south of Kerguelen in the longitudinal rather than transverse alignment of the dorso-lateral plates, the stouter, more capitate abactinal spinelets, more numerous abactinal pedicellariae which are all crossed, not mixed as in *tiremis*, the absence of felipedal pedicellariae and the more solid skeleton. From *S. scalprifera*—the type species of *Smilasterias*—it also differs in the abactinal spinelets and skeleton and in the fewer infero-marginal and adambulacral spines, even the smallest type of *S. scalprifera*, from Heard Island, with R 25 mm., having three to five, usually four, infero-marginal spines and three adambulacral ones.

However, the most conspicuous difference between this Macquarie Island form and the others is the much more solid skeleton. This tendency for greater calcification seems to be characteristic of sea-stars from this locality, even the Macquarie species of *Anasterias*—a genus otherwise noted for its weak skeleton—having very much stouter plates in comparison with related species from Kerguelen and more particularly from the Magellanic region.

In fact, so great are the differences between *S. triremis* and *S. scalprifera* on the one hand and *S. irregularis* and this Macquarie Island form on the other, that I think, the two latter may prove to be better placed in a distinct genus intermediate between *Smilasterias* and *Allostichaster*.

Genus Saliasterias Koehler

Saliasterias brachiata Koehler

Saliasterias brachiata Koehler, 1920, 54-56, pl. xi, figs. 1-4, pl. xii, figs. 1-8, pl. lviii, fig. 3.

Banzare localities: Stations 30 (2 specimens, only one of which is complete), 40 (3 specimens), 105 (1 specimen).

The specimens from Stations 40 and 105 all have R about 38 mm. as in the holotype. The other specimens are a little smaller. All of them have nine rays.

The occurrence of this multibrachiate species together with *Psalidaster mordax rigidus* at station 105 is noteworthy. As Fisher has pointed out, there is a considerable superficial resemblance between *Psalidaster* and *Saliasterias* but the more numerous, almost serially arranged, abactinal spines of *Saliasterias* and more particularly the unspecialized form of the crossed pedicellariae, which are not clustered around the individual spines in pustules, serve to distinguish them on detailed examination.

Type locality. Off Adélie Land, 647 metres.

Range. Known from Enderby, MacRobertson and Adélie Lands in 27 to 647 metres.

Genus Lysasterias Fisher

Anasterias (part) Studer, 1885, 153; Ludwig, 1903, 42-43; Koehler, 1906, 12; 1908, 566-569; 1912, 10; Verrill, 1914, 354; Koehler, 1920, 11-17; 1923, 11. Non *Anasterias* Perrier 1875.
Lysasterias Fisher, 1908, 88; 1908a, 356; 1923, 606; 1930, 235-236; 1940, 239-240. (Type *Anasterias perrieri* Studer, 1885).
Paedasterias Verrill, 1914, 355; Koehler, 1920, 11, 16, 30. (Type *Anasterias chirophora* Ludwig 1903).

The genus *Lysasterias*, because of its much reduced skeleton, is difficult to subdivide. Fisher (1940) apparently recognised eight species, *L. perrieri* (Studer) 1885 (with synonyms *Anasterias tenera* Koehler 1906, *A. cupulifera* Koehler 1908, *A. lysasteria* Verrill 1914 and *A. victoriae* Koehler 1920), *L. belgicae*, *L. lactea* and *L. chirophora*, all of Ludwig 1903, *L. adeliae* and *L. joffrei* of Koehler 1920 and *L. hemiora* and *L. heteractis* of Fisher 1940.

The last-named species is distinguished by having eight rays. The rest have been characterized by the development of the skeletal plates, notably the marginals, the occurrence, position or relative sizes of the various types of pedicellariae and the appearance of the skin pustules. Fisher believes that, at least in *L. perrieri*, there is progressive degeneration of the skeleton as growth proceeds. A similar reduction is shown in the B.A.N.Z.A.R.E. specimens of another species, though a small series of *L. perrieri* from the Ross Sea which I have studied suggests that this is not always the case. There is, however, some variation in the strength of the marginal plates in specimens of similar sizes from the same locality and, as in the case of *L. perrieri* from East Cumberland Bay, South Georgia, there may be a tendency for either particularly strong or weak skeletal development in all individuals from a certain area.

The genus *Lysasterias* was split by Verrill, partly on the grounds of a mis-translation. He distinguished *Anasterias chirophora* Ludwig in a distinct genus *Paedasterias*, marked off by the presence of felipedal pedicellariae and the supposed absence of supero-marginal plates. Fisher (1940) pointed out that it was the supero-marginal spines which Ludwig noted were lacking; he therefore reduced *Paedasterias* to the synonymy of *Lysasterias*. Koehler (1920) had added a new species, *P. joffrei*, to *Paedasterias*, characterized by more reduced supero-marginal plates, the series consisting of only five or six bar-like rudimentary plates proximally in the unique type specimen. Large straight, spatulate pedicellariae, which Koehler termed 'palette' pedicellariae, were also found in *P. joffrei*. However, judging from his figures, the only ones which approach the felipedal form at all are those which have been damaged towards the tip. The pedicellariae are certainly much less specialized than those of *L. chirophora*. Fisher's 'Discovery' specimen of *L. joffrei* from the Ross Sea also has large straight pedicellariae, some of which are spatulate and others tapering, but none that could be described as felipedal. In the other species of the genus only lanceolate straight pedicellariae of small or moderate size are known.

The B.A.N.Z.A.R.E. specimens of *Lysasterias* fall within two groups. Those in one group, without exception, possess well-developed felipedal pedicellariae as figured by Ludwig for *L. chirophora*, but except for the largest one, which has R 72 mm. (station 41) all of them have better developed marginal plates, usually with a more or less complete series of supero-marginal spines; at the same time the crossed pedicellariae are of a narrow range of sizes, the smallest not less than two-thirds the size of the largest. The types of both *L. chirophora* and *L. joffrei* exhibit a considerable range in the size of the crossed pedicellariae, the longest being about three times as long as the shortest in *L. chirophora* or two and a half times in *L. joffrei*. Unfortunately Ludwig did not illustrate the marginal plates of *L. chirophora* or give any details of their variation with size in his specimens. Presumably his description of them was derived from the largest specimen (R 76 mm.) and this could well fit the specimen of similar size from B.A.N.Z.A.R.E. station 41. However, the consistently narrow range in the size of the crossed pedicellariae in all the B.A.N.Z.A.R.E. specimens with felipedal pedicellariae forces me to erect a new species to accommodate them. This I am calling *L. digitata* because of the finger-like processes on these characteristic pedicellariae.

The second group comprises only three specimens, two from station 107 and one from station 105 (both off MacRobertson Land). These lack felipedal pedicellariae, the only straight ones being small and tapering. At the same time the marginal skeleton is very reduced, the supero-marginals being spineless and rhombic or pear-shaped. They are linked together by supplementary plates only in the specimen from station 105, while in the other two they are only connected or articulated with the corresponding infero-marginals. At the same time the supero-marginal pustules are barely, if at all, distinct from the abactinal ones. The crossed pedicellariae exhibit a moderate range of sizes (see Table 14) approximating closer to the wide range found in *L. joffrei* than to the narrow range of *L. hemiora*, which has similarly reduced marginal plates. The other species of *Lysasterias* in which the marginals are very reduced, apart from *L. chirophora* with its felipedal pedicellariae, are *L. belgicae* and *L. lactea* of Ludwig, but both of these have supero-marginal spines. Only one relatively small specimen of *L. lactea* is known and it is possible that larger ones might lack such a series of spines. The species was not figured at all by Ludwig. The same author's figure of the marginal plates of *L. belgicae* (pl. vi, fig. 62) shows four tapering series, each of five or six roughly rectagular plates, the series extending laterally from an infero-marginal plate; the consecutive infero-marginals are separated from each other by more than their own lengths. Even allowing for the fact that this is an internal view, the shapes and arrangements of the plates are quite unlike those of any specimen of *Lysasterias* which I have seen. The terminal and narrowest ossicle of each series is the supero-marginal according to Ludwig and usually bears a spine. In Koehler's figure (1906, pl. iii, fig. 28) of the marginal plates of *Anasterias tenera* (which Fisher has referred to the synonymy of *L. perrieri*) there are chains of five to seven ossicles, but the uppermost or supero-marginal ones are conspicuously enlarged and in contact with each other as are the consecutive plates of the lowermost, infero-marginal series.

TABLE 14

Data of specimens of *Lysasterias* spp., from published and unpublished sources.

Species	Station	R (in mm.)	Length of crossed pedicellariae (in mm.)		Supero-marginal plates	Supero-marginal spines	Infero-marginal plates	Extra-adambulacral straight pedicellariae
			Abactinal	Marginal				
L. perriéri	A.A.E. station 1	80	Up to 0·6	Up to 0·8	T-shaped, touching?	+	—	moderate, tapering
L. perrieri	Discovery, Coulman I.	74	0·48-0·53	0·53-0·66	T-shaped, linked	+	overlapping	moderate, tapering
L. adeliae	A.A.E., Adélie Land	38-44	Up to c.0·45	Up to c.1·0	T-shaped, linked	+	overlapping	—
L. adeliae	T.N. station 294	80	0·58-0·65	0·98-1·14	club-shaped, linked	+	overlapping	—
L. belgicae	Belgica no. 815	75, 110	0·4, 0·9-1·17		triangular, separate	+	separate	—
L. lactea	Belgica no. 276	29	0·2-0·22, 0·65-0·73		— separate	+	—	—
L. chirophora	Belgica stations	up to 76	0·3-0·37, 0·6-0·94		— separate	—	separate	felipedal
L. digitata	Banzare station 41	72	0·42-0·53	0·55-0·63	club-shaped, separate	—	separate	felipedal
L. digitata	Banzare station 40	50	0·37-0·42	0·45-0·53	club-shaped, separate	—	touching	felipedal
L. digitata	Banzare station 40	50	0·37-0·42	0·50-0·53	T-shaped, linked	+	overlapping	felipedal
L. digitata	Banzare station 40	40	0·30-0·37	0·50-0·65	T-shaped, linked	+	overlapping	felipedal
L. digitata	Banzare station 40	18	—	—	T-shaped, touching	+	overlapping	felipedal
L. digitata	Banzare station 105	50	0·37-0·45	0·45-0·48	T-shaped, linked	+	overlapping	felipedal
L. digitata	Banzare station 105	35	c.0·37	0·40-0·45	T-shaped, linked	+	overlapping	felipedal
L. hemiora	Discovery station 189	66	0·35-0·38	0·33-0·45	bar-like, separate	—	separate	small, tapering
L. joffrei	A.A.E. station 1	80-85	0·4 -0·5	c.1·0	rudimentary	—	—	large, spatulate
L. joffrei	Banzare station 107	100	0·53-0·63	0·76-0·92	rhombic, separate	—	separate	small, tapering
L. joffrei	Banzare station 107	45	0·37-0·42	0·45-0·58	rhombic, separate	—	separate	small, tapering
L. joffrei	Banzare station 105	55	0·26-0·34	0·37-0·53	pear-shaped, linked	—	touching	small, tapering
L. joffrei	T.N. station 316	90	0·50-0·71	0·87-0·98	oval, separate	—	overlapping	large, tapering
L. joffrei	Discovery station 1660	53	0·42-0·76	0·92-0·98	oval, separate	—	touching	large, oblong
L. heteractis	Discovery station 170	87	0·45-0·55	0·75-0·85	oval, separate	+	touching	small, tapering
L. 'adeliae'	Discovery station 181	65	c.0·5	c.0·9-1·0	T-shaped, touching	+	overlapping	large, slender
?	T.N. station 340	85	0·50-0·58	0·79-0·92	club-shaped, linked	+	overlapping	moderate, tapering
?	T.N. station 340	65	c.0·55	0·70-0·80	club-shaped, linked	+	overlapping	moderate, tapering

Since all twenty-two specimens of *Lysasterias digitata* have some felipedal pedicellariae it is probable that these are rarely absent in that species, but I agree with Fisher that the occurrence of ordinary straight pedicellariae is not diagnostic. I think that this probably applies also to the large, spatulate, straight pedicellariae of *L. joffrei*. Since the three B.A.N.Z.A.R.E. specimens of my second group approach *L. joffrei* in the very reduced marginal plates and the fairly wide range of sizes of the crossed pedicellariae, I am referring them to that species despite the absence of large straight pedicellariae.

As for the distribution of the various species of *Lysasterias*, all of them have been recorded from the Bellingshausen Sea-Weddell Quadrant area (though I am uncertain about Fisher's record of *L. adeliae* from there) while from Queen Mary Land to the Ross Sea only *L. perrieri* (as *Anasterias victoriae*), *L. adeliae* and *L. joffrei* were known up to now. The early 'Discovery' collections from Coulman Island and McMurdo Sound in the Ross Sea, include some examples of *L. perrieri* and the 'Terra Nova' took one of *L. adeliae* but neither of these species is repesented in the B.A.N.Z.A.R.E. collections. Fisher's 'Discovery' specimen from the Palmer Archipelago is in a somewhat decalcified state but I doubt whether his identification of it as *L. adeliae* is correct because the crossed pedicellariae have the usual, very finely rugose valves found in most species of *Lysasterias*, rather than the characteristic, markedly spinous, almost toothed ones found both in the types of *L. adeliae* and in a specimen from 'Terra Nova' station 294 which I am also referring to that species. The latter exhibits two distinct sizes of crossed pedicellariae as in the type of *L. adeliae*.

There are two large specimens (R 85 and 65 mm.) of *Lysasterias* from 'Terra Nova' station 340, also from the Ross Sea, which I cannot place at all. They have finely rugose crossed pedicellariae in two sizes, though the difference is not very great, particularly in the smaller one. These specimens, like those Fisher named *L. adeliae*, have a very solid marginal skeleton, though the supero-marginals are more club- than T-shaped, since the handle part articulating with the infero-marginal is wide and the head is firmly linked to the adjacent supero-marginals by short supplementary plates. In my view these specimens are excluded from *L. adeliae* by the relatively smooth-valved crossed pedicellariae, from *L. hemiora* and *L. perrieri* by the two sizes of these, from *L. chirophora* and the new *L. digitata* by the absence of felipedal pedicellariae and from *L. joffrei*, *L. belgicae* and *L. lactea* by the well-connected marginal seketon. It is to be hoped that the recent collections in the Ross Sea will help to clarify the limits of the different species to be found in this area.

In listing the species referable to *Anasterias* (including *Lysasterias*) Koehler, (1920, 14) included *A. haswelli*. I assume that this is a mistake for *Notasterias haswelli*, especially since there is a juxtaposition of some of the illustrations of that species with those of '*Anasterias*'.

Comparative lists of some data on the species of this genus are given in Table 14.

Lysasterias digitata, sp. nov.

text fig. 16b-d, pl. vi, figs. 1-4.

Banzare localities: Stations 40 (4 specimens), 41 (OTL 1 specimen), 105 (17 specimens).

Description. The holotype is from Station 41. R/r=72 mm./12 mm., br.=12-14 mm.

The specimen is well preserved with the abactinal pustules, which are moderate in size, quite prominent. Only two or three small spines are visible on each ray projecting through the pustules. A smaller specimen (R 50 mm. pl. vi, fig. 4) from station 105, which has been dried to reveal the abactinal plates, shows that apart from the ring of plates on the disc, there are about sixteen plates on each ray arranged at intervals along the mid-radial line, each with a single spine; in addition there are a few laterally-placed spineless plates.

In the holotype the supero-marginal pustules are quite distinct, though this is due more to their position corresponding to the infero-marginal ones than to their size which is hardly larger than the abactinal pustules. Proximally there is a wedge-shaped space between the two marginal series but from about the eighth infero-marginal they are contiguous. The infero-marginal pustules are about twice as large as the rest and each has a stout spine projecting through it.

Most of the abactinal pustules contain only a single crossed pedicellaria though some may have two and others none. These pedicellariae are flattened across the base and nearly triangular in side view, the bases of the valves not being expanded downwards as in Koehler's figures of the crossed pedicellariae of *L. joffrei* (1920, pl. lvi, fig. 2a). They range in length from 0·42 to 0·53 mm. The infero-marginal pedicellariae are more numerous, about six occurring on each proximal plate. They range in length from 0·55 mm. to 0·63 mm. and are similar in shape to the abactinal ones.

The denuded proximal marginal plates are shown in figure 16b. They are somewhat reduced, the consecutive infero-marginals being separated from each other while the supero-marginals are club-shaped, only a little expanded at the upper end and not linked together by additional plates. Three (or four) adambulacral plates correspond to each infero-marginal. There are no actinal plates.

Interbrachially in the wedge-shaped areas between the series of marginal plates there are some large felipedal pedicellariae, 1·15-1·20 mm. long (fig. 16d).

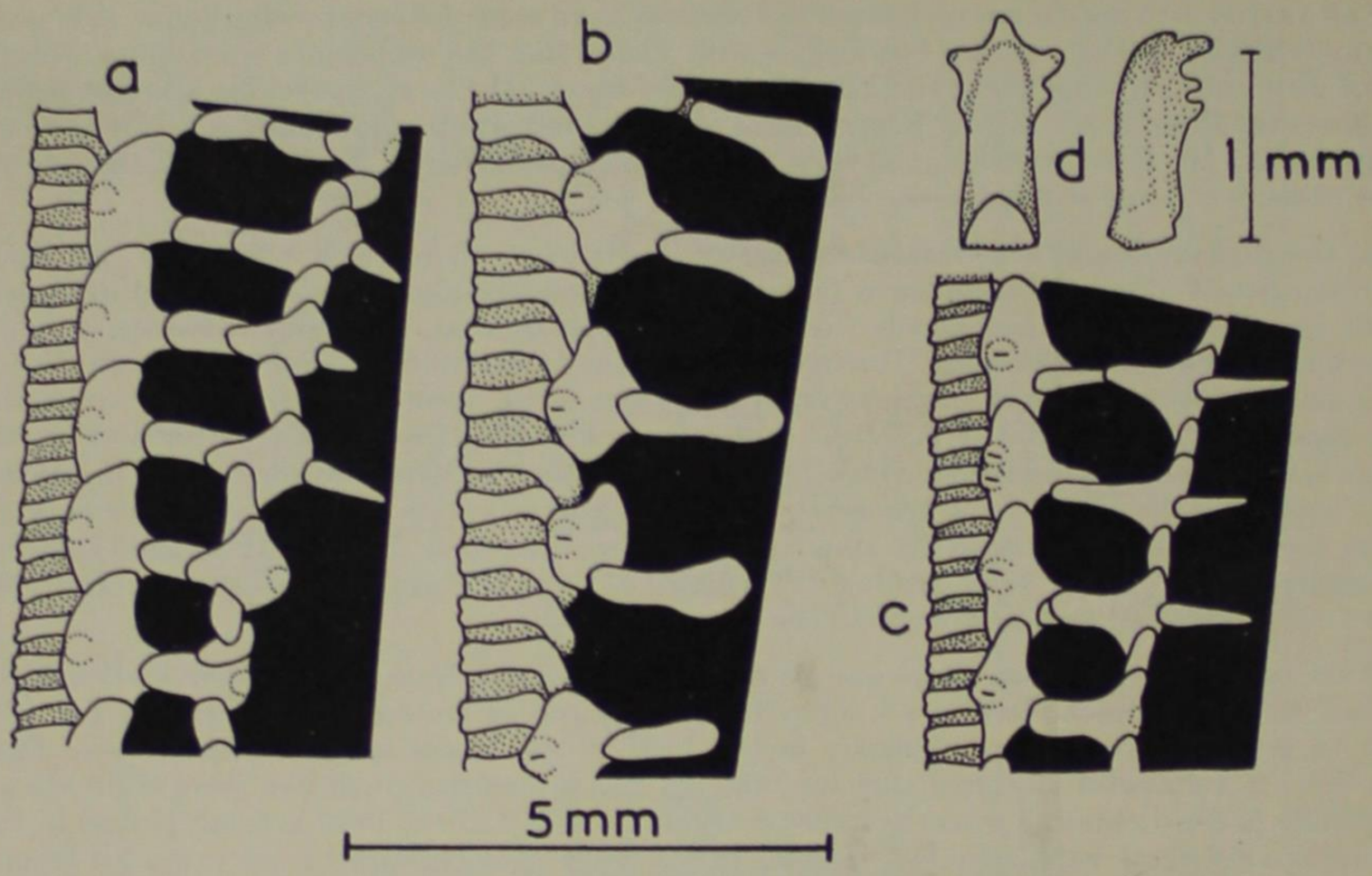


Fig. 16. *Lysasterias* spp. a, to c, denuded proximal plates of one side of a ray in ventral and slightly lateral view showing adambulacrals (left) to supero-marginals, the more distal plates to the bottom, a, *L. perrieri*, R 35 mm. from Cumberland Bay, South Georgia, b, and c, *L. digitata*, b, holotype, R 72 mm. from Banzare station 41, c, paratype, R 50 mm. from station 105; d, *L. digitata*, holotype, valves of interbrachial felipedal pedicellariae. In a, the first complete infero-marginal drawn is the third, in b, the fifth and in c, the sixth.

The adambulacral plates are monacanthid as usual in the genus and there are some small straight pedicellariae within the furrow.

Other specimens. The four from station 40 are all smaller than the holotype. They too have moderately large pustules also with very few pedicellariae and the supero-marginal pustules are just distinct. The smallest one (R 18 mm.) has the supero-marginal plates T-shaped and overlapping and each has a prominent spine. That with R 40 mm. has the proximal supero-marginals more delicately T-shaped, the cross-bars rapidly becoming abbreviated on the following plates; they are linked together by supplementary plates and each bears a slender spine up to 1·4 mm. long. The two specimens with R 50 mm. have only a few, if any, of the proximal supero-marginals T-shaped, most of them being club-shaped; they may be linked or not, though the infero-marginals are mostly touching if not overlapping. One of these two specimens (fig. 16c) has a series of supero-marginal spines each less than a millimetre long and not projecting through the pustules. In the other these spines are lacking proximally.

Thus there appears to be a progressive reduction of the skeleton with increased size as Fisher has observed in *L. perrieri*. All four specimens possess felipedal pedicellariae some of which may be placed dorsally. Also the seventeen specimens from station 105 (off MacRobertson Land) all have some of these characteristic pedicellariae. Most of the latter have R between 35 and 50 mm. and some of them have the marginal plates more solidly united, as they appear in Koehler's photographs of *Anasterias victoriae* (i.e. *L. perrieri*). Their pustules are smaller than in the specimens from off Enderby Land but this may be attributable to differences in preservation. Small supero-marginal spines are usually present in all of them, though the series may be incomplete in some. As shown in fig. 16c the infero-marginal spine may be duplicated.

Remarks. I had at first attributed the specimens from station 105 to *L. perrieri* after comparison with Koehler's description and figures of *A. victoriae*, but the presence of felipedal pedicellariae in every one of them precludes this. The discovery of a species in which this characteristic form of pedicellaria occurs but which may show at the same time a better developed marginal skeleton support's Fisher's view that Verrill's genus *Paedasterias* is untenable. It is unfortunate that Ludwig did not make observations on the variations with size of the skeletal development of his specimens of *L. chirophora*, which is the only species of the genus with pedicellariae like those of *L. digitata*. The one described—presumably that with R 76 mm.—seems to have marginal plates comparable in development with those of the holotype of *L. digitata*, but without an illustration it is impossible to be sure. However, the two are distinguished by the small range of size of the crossed pedicellariae in *L. digitata* as opposed to those of *L. chirophora* in which the largest of these pedicellariae may be over three times the size of the smallest.

Type locality. Off Enderby Land, 180-209 metres.

Range. Known only from Enderby Land and MacRobertson Land in 163 to 300 metres.

Lysasterias joffrei (Koehler)

Paedasterias joffrei Koehler, 1920, 30-34, pl. i, figs. 3, 4, 9, pl. ii, figs. 7-9, pl. lvi, fig. 2.
Lysasterias joffrei, Fisher, 1940, 245; Bernasconi, 1956, 15-16.

Banzare localities: Stations 105 (1 specimen), 107 (OTL 2 specimens).

Some details of these three specimens are given in Table 14. Unfortunately the largest one has been considerably compressed and distorted in preservation. In all of them the supero-marginal pustules are indistinct so that superficially they resemble *L. hemiora* Fisher. *L. joffrei* differs from *L. hemiora* mainly in having a marked difference in size between the abactinal and the marginal crossed pedicellariae.

As can be seen from the table the difference in size between marginal and abactinal pedicellariae is somewhat less in the B.A.N.Z.A.R.E. specimens from station 107 than in the others, but even so the difference is still much greater than that found in the type of *L. hemiora*. Unfortunately Bernasconi did not give details of pedicellaria lengths in her very large specimen (R 105 mm.) from the South Shetlands, saying only that the marginal ones are larger.

From my own observations on the narrow size range of crossed pedicellariae shown by a number of specimens of *L. digitata* contrasting with the wide range in the 'Terra Nova' and type specimens of *L. adeliae*, I think that the relative size of these organs does provide a valid specific character. For this reason, despite the presence of only small lanceolate straight pedicellariae in the B.A.N.Z.A.R.E. specimens rather than large, more or less spatulate, ones, I believe that they should be referred to *L. joffrei* rather than to *L. hemiora*, though more material of the latter species than the unique type is needed to show its range of variation.

The type of *L. joffrei* had no supero-marginal plates beyond the first five or six, which are described as narrow and elongate. Bernasconi's large specimen also has elongate supero-marginal plates like the holotype of *L. hemiora*. However, the B.A.N.Z.A.R.E. and larger 'Discovery' specimens have the supero-marginals rhombic or ovate in shape, not much elongated. In all of them the supero-marginals are spineless, but the small specimen (R c. 24 mm.) from 'Discovery' station 1957 in the South Shetlands area, named *L. joffrei* by Fisher, does have small supero-marginal spines; also the plates themselves are nearly triangular and are linked together as well as to the corresponding infero-marginals by narrow supplementary plates. the whole producing a slender longitudinal 'ladder' of plates along the side of the ray. Similar slender supplementary plates are present in the specimen from B.A.N.Z.A.R.E. station 105, though here the supero-marginal plates are spineless.

As can be seen from Table 14, there is a large specimen from 'Terra Nova' station 316 (McMurdo Sound, 348-457 metres) which I have identified as *L. joffrei*. Unfortunately it is not in good condition, having dried up at some time so that the pustules are shrivelled. The supero-marginal ones are not distinct.

Type locality. Off Adélie Land, 647 metres.

Range. Known from the Ross Sea and Adélie and MacRobertson Lands as well as from the South Shetlands in 163 to 810 metres.

Genus Anasterias Perrier

Anasterias Perrier, 1875, 345 (81 of separate); 1891, 91-92; Fisher, 1908, 52; 1908a, 356; 1930, 221-223; 1940, 231-233. (Type *A. minuta* Perrier, 1875). Non *Anasterias* Studer, 1885, nec Ludwig, 1903, renamed *Lysasterias* by Fisher in 1908.

Asteroderma Perrier, 1888, 763; 1891, 96. (Type *A. papillosum* Perrier, 1888).

Sporasterias Perrier, 1894, 107; Ludwig, 1903, 39; Verrill, 1914, 355-356; Koehler, 1917, 12, 1920; 78-79, 1923; 14-25; Fisher, 1923, 605; 1930, 239-240. (Type *Asterias rugispina* Stimpson, 1860).

Parastichaster Koehler, 1920, 89-91. (Type *P. mawsoni* Koehler, 1920).

Kalyptasterias Koehler, 1923, 43. (Type *K. conferta* Koehler, 1923).

Eremasterias Fisher, 1930, 232. (Type *Pisaster antarcticus* Koehler, 1917).

This synonymy is largely attributable to Fisher (1940). Ten years earlier he maintained *Sporasterias* and *Kalyptasterias* as distinct from *Anasterias* but merged *Parastichaster* with *Sporasterias*; at the same time he erected a new genus, *Eremasterias* for the apparently anomalous species *Pisaster antarcticus*, which was clearly not a *Pisaster* since it lacks the very distinctive pedicellariae of that genus. If the three species of *Parastichaster* are included in *Anasterias* then the status of *Calvasterias* Perrier is also disputable, since its species have the skeleton only a little more stoutly calcified and regular than those of *Parastichaster*. *Calvasterias* is vulnerable in another way since the identity of its type species, *C. asterinoides* Perrier 1875, is uncertain. Most of the type specimens of *asterinoides* had no localities but one was labelled as from Torres Strait, collected by Hombron and Jacquinot and received in 1841 by the Paris Museum. These gentlemen were on the voyage of the 'Astrolabe' to try and reach the South Pole. Besides collecting in various tropical Pacific and Australasian localities, this ship traversed the Magellan Strait as well as calling at the Auckland Islands from which both *Calvasterias suteri* and *C. laevigata* are known. This expedition also procured the type specimen of *Anasterias*

minuta Perrier, of which the locality was similarly unknown but which Perrier guessed to be Port Famine, Magellan Strait, from its likeness to specimens taken by the Cape Horn Expedition. If the types of *Calvasterias asterinoides* were from the Magellan area, then, like the apparently similar, well-calcified holotype of *Calvasterias stolidota* Sladen from the Messier Channel, southern Chile, (referred to *Anasterias* by Fisher, 1940) they are probably congeneric with *Anasterias antarctica* (Lütken), of which I suspect the holotype of *A. minuta* may prove to be a juvenile as mentioned on p. 77. On the other hand, if they were from the Auckland Islands or New Zealand, then *C. asterinoides* is probably synonymous with *Calvasterias laevigata* (Hutton) 1879.

In 1889 Sladen noted that *C. asterinoides* is known from the Falkland Islands and from Torres Strait. This Falkland record depends on four specimens from Ross's Antarctic Expedition with the 'Erebus' and 'Terror' labelled 'Falkland Is., Dr. J. Robertson' (surgeon of the 'Terror') with an incomplete registration number consisting only of the date 44 (i.e. 1844).5.29 and lacking an appended serial number. Since Perrier (1875) made no mention of specimens of *Calvasterias asterinoides* in the British Museum it is probable that they were named by Smith or Bell. Unfortunately, although a number of specimens from Robertson were registered under this date including some from the Falkland Islands, the only starfishes among them were noted as being from the Auckland Islands! I have compared the 'Falkland' specimens with some of *Calvasterias laevigata* undoubtedly from the Auckland Islands, taken by Scott's expedition with the 'Discovery' and clearly labelled as from 'Laurie Harbour, Auckland Is.' The single abactinal granuliform spinelets forming regular longitudinal series on the carinal and on the distal dorso-lateral plates as well as the solid skeleton with a well-marked ventro-lateral angle are very like those of *C. laevigata*. Of the many examples of *Anasterias* from the Falkland-Magellan area in the British Museum none has quite the same asterinid-like form as these and the dorso-lateral plates usually have a more irregular and reticular arrangement. Nearest to it are the holotype of *Calvasterias stolidota* Sladen (R 44 mm. as opposed to 22 mm. in the largest specimen of *C. asterinoides*) and the two smaller of four specimens also collected by Ross's Antarctic Expedition labelled as from St. Martin's Cove (near Cape Horn). The latter unfortunately were unregistered so no confirmation of the locality can be obtained. *C. stolidota* is considered by Madsen to be a synonym of *Anasterias varium* (Philippi) but I am not certain that this is correct. The four St. Martin's Cove specimens were identified as *Asterias* (i.e. *Anasterias*) *antarctica* either by Smith or Bell, probably the latter since he made two other specimens from the same locality the types of a new species *A. verrilli*, which Madsen has also referred to the synonymy of *A. varium*.

As commented on in the key, the Falkland-Magellan species of *Anasterias* need a thorough revision based on re-examination of the types together with a huge quantity of material to try and ascertain just how many species or formae are valid. To date thirteen specific names have been applied to specimens from this area, of which Fisher includes as many as five as synonyms of *A. antarctica* Lütken, the oldest name. Adding to the confusion is the fact that the unique holotype of *A. minuta*—the type species of the genus—is juvenile and it is by no means certain which of the other nominal species represents its adult form.

Anasterias perrieri (Smith)

text fig. 17a.

Asterias perrieri Smith, 1876, 106; 1879, 273, pl. xvi, fig. 2; Studer, 1884, 6-7; Sladen, 1889, 569; Koehler, 1911, 26, pl. i, figs. 1, 2.

Othilia sexradiata Studer, 1876, 458.

Sporasterias perrieri, Verrill, 1914, 356; Koehler, 1917, 14-20, pl. ii, figs. 1-3, 6-11, 13, pl. iv, fig. 14, pl. ix, fig. 3; Döderlein, 1928, 294; Fisher, 1930, 241.

Pisaster antarcticus Koehler, 1917, 30-33, pl. ix, figs. 5-8, 10, 17.

Eremasterias antarctica, Fisher, 1930, 232.

Anasterias perrieri (inferred), Fisher, 1940, 234.

Anasterias perrieri, Madsen, 1955, 15. Non *Anasterias perrieri* Studer, 1885, since referred to *Lysasterias*.

Banzare localities: Stations 6 (8 specimens), 7 (11 specimens), 8 (3 specimens), 12 (2 specimens), 13 (1 specimen), 47 (12 specimens), 49 (9 specimens), 50 (7 specimens), 52 and 53 (2 specimens), 55A (9 specimens), 55B (1 specimen), 59 (3 specimens), 62 (1 specimen), 64 (4 specimens), Colls. 282 (2 specimens), 705 (1 specimen), 712 (6 specimens), 759 (4 specimens), 783 and 784 (2 specimens).

Colour note. The specimens from coll. 712 were recorded as 'deepish brown dorsally' in life.

Nomenclature. This specific name is liable to confusion with *Anasterias perrieri* Studer 1885 which was referred to *Lysasterias* by Fisher in 1908. The fault is really Perrier's since he changed his concept of *Anasterias*, using *Sporasterias* instead for some of the species with stronger skeletons, as Fisher has pointed out.

Remarks. The close resemblance between the unique large type specimen (R 70 mm.) of *Eremasterias antarctica* (Koehler) 1917 and larger specimens of *A. perrieri* led me to denude partially a number of the latter, including three of the types of *A. perrieri*. This revealed the fact that all the specimens of *A. perrieri* with R 30 mm. or over have a more or less extensive series of actinal plates, which are, in the smaller ones, very narrow and sandwiched between the adambulacral and infero-marginal plates, while specimens with R about 45 mm. or more, have some of the proximal plates enlarged and often bearing a single spine in transverse series with the infero-marginal spines. However, the development of actinal spines is variable and the largest type specimen (R 80 mm.) has none, though a series of actinal plates is present. Several of the larger specimens even have an incipient second row of actinal plates (fig. 17a) and one from B.A.N.Z.A.R.E. station 64 with R 75 mm. has an actinal spine on the first one or two plates of this second series as well as a more extensive series of spines on the longer, outer row of actinal plates. According to Koehler, the type of *Pisaster antarcticus* has two rows of actinal plates at the base of the ray, those of the outer row being linked to the adjacent infero-marginal plates by bar-like supplementary plates leaving papular spaces between them. There are apparently no papulae between the two actinal series (such as one would expect to be present if papulae do occur between the outer actinal series and the infero-marginals). Koehler goes on to say that each plate of the outer actinal (ventro-lateral) series has two or three spines, which are the largest on the whole body, while the plates of the inner series have one or two spines. Fisher (1930) has pointed out that Koehler is almost certainly mistaken in his interpretation of these plates and that Koehler's outer ventro-lateral series is, in fact, the infero-marginal row and his infero-marginals are really the supero-marginals. This is in accord with the fact that the number of 'ventro-lateral' spines is not reduced on the distal plates and that they are the largest spines found. A reduction in the spines is invariably found on the distal actinal plates but not necessarily on the infero-marginals. Thus, it seems that the type of *P. antarcticus*, after all, probably has only a single series of actinal plates.

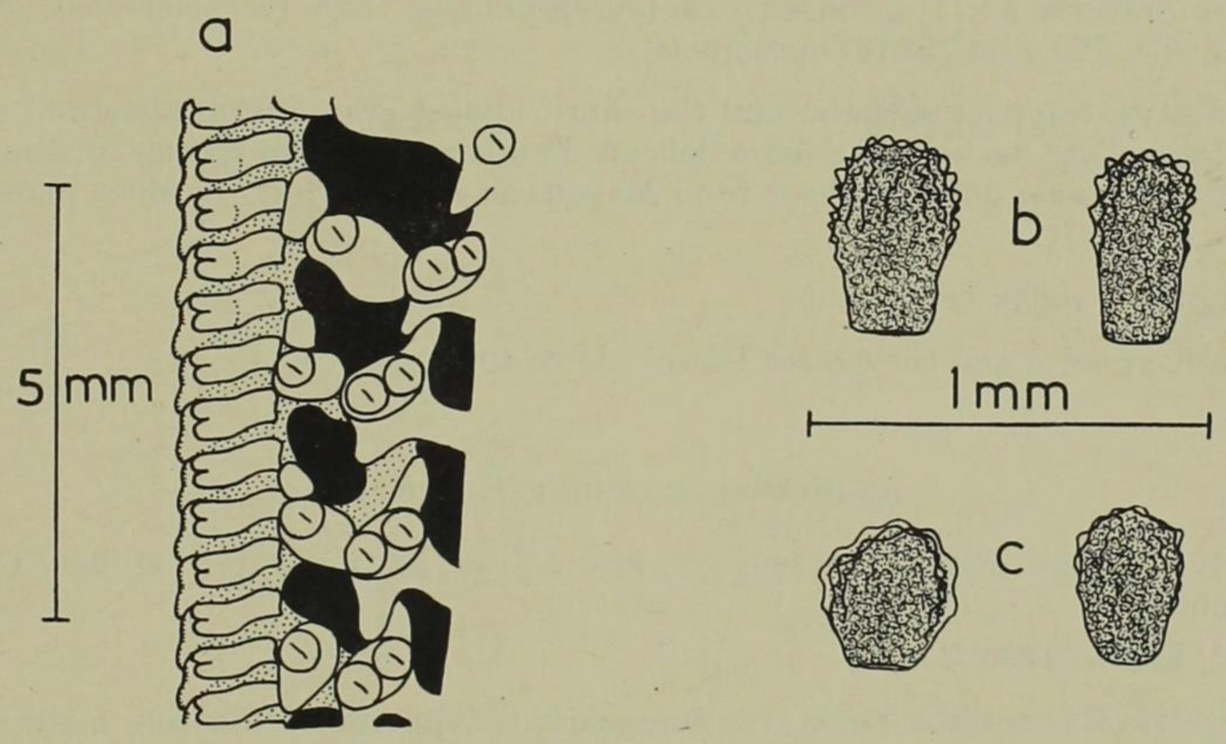


Fig. 17. *Anasterias* spp. a, *A. perrieri*, R 48 mm. from Banzare station 55B, denuded proximal plates of one side of a ray in ventral view from the adambulacral to the infero-marginal series with four spine-bearing plates of the first actinal series and three rudimentary ones forming a second series; the proximal-most entire adambulacral plate (top, left) is the thirteenth one; b, and c, proximal abactinal spinelets or granules of: b, *A. rupicola*, R 16 mm. from Banzare station 56A, and c, *A. directa*, R 13 mm. from station 81.

Koehler himself noted a resemblance between *Pisaster antarcticus* and *Sporasterias* (i.e. *Anasterias*) *perrieri*, but he believed his new species to be distinguished by the more numerous, shorter, more capitate and rugose-tipped abactinal spinelets and the more delicate reticulations of the skeleton, as well as particularly by the supposed differences in the ventro-lateral plates and their spines.

In the B.A.N.Z.A.R.E. specimens of *A. perrieri* the spinelets are very variable, both in number and shape; they may be sparse or clustered and up to four times as long as their median width with a barely expanded head, or distinctly capitate and only twice as long as the median width (or half again as long as the width of the expanded head, as in the type of *P. antarcticus*). The tip is always more or less rugose. The strength of the skeleton is also variable, as in the Magellanic species of *Anasterias*.

If Fisher is correct in his assumption about Koehler's mis-interpretation of the plates, as I am sure he is, then there is no distinction left between *Pisaster* (or *Eremasterias*) *antarcticus* and *Anasterias perrieri* and the former name becomes a synonym.

The occurrence of pedicellariae is very variable in the B.A.N.Z.A.R.E. specimens; there may be none outside the furrow, or only straight pedicellariae, or both straight and crossed together, though the crossed ones are less frequent. In shape the latter resemble the crossed pedicellariae of *Anasterias rupicola* (and the other species

of the genus), as those of *P. antarcticus* were also said to do; also the straight pedicellariae are similar to those of *P. antarcticus* figured by Koehler, sometimes with one valve overlapping the other at the tip.

Finally the proportions of the rays vary considerably. In twenty specimens with R 30 mm. or more, the ratio R/r ranges from 2·5/1 to 5·0/1, averaging 3·8/1. Br is approximately equal to r and so its relation with R exhibits a similar range.

TYPE LOCALITY. Observatory Bay, Kerguelen, shallow water.

RANGE. Known only from Kerguelen from the shore down to about 200 metres.

ANASTERIAS RUPICOLA (Verrill)

text fig. 17b.

Asterias rupicola Verrill, 1876, 71-72; Studer, 1884, 7. Non *A. rupicola* (?), Bell, 1881, 93-94 (Magellan Strait), which is probably *A. antarctica*.

Asterias antarctica var. *rupicola*, Koehler, 1912, 222, 252 (part). Non pp. 237, 239, nec Meissner 1896, Ludwig, 1903, which are *Anasterias varium* according to Madsen, 1956.

Sporasterias rupicola, Verrill, 1914, 356; Koehler, 1917, 9-13, pl. iv, figs. 1, 2, 8, 11, 18, 20-24; Döderlein, 1928, 294.

Anasterias rupicola, Fisher, 1940, 234 (implied); Madsen, 1955, 15.

BANZARE LOCALITIES: Stations 52 (1 specimen), 54 (30 specimens), 56A (8 specimens), 56B (6 specimens). Colls. 750, 783, 784, 790, and 792 (87 specimens).

The broad-based rays, compact skeleton and the short, almost granuliform abactinal spinelets (fig. 17b) of this species are intermediate between the more delicate Falkland-Magellan species of *Anasterias* such as the one Fisher has called *A. minuta* and the three from Macquarie Island which Koehler placed in the separate genus *Parastichaster*.

TYPE LOCALITY. Kerguelen, rocky beach.

RANGE. Known from Kerguelen and the Crozet Islands down to 11 metres.

ANASTERIAS MAWSONI (Koehler)

Parastichaster mawsoni Koehler, 1920, 91-97, pl. xix, figs. 1-8, pl. xx, fig. 1, pl. xxi, figs. 1-6, pl. xxiii, fig. 4, pl. xxiv, fig. 5, pl. lxiii, fig. 2.

Sporasterias mawsoni, Fisher, 1930, 241.

AUSTRALASIAN ANTARCTIC EXPEDITION LOCALITY: Macquarie I. 'Apparently low tide material, scrapings from rocks'. (One small specimen).

R is only 7 mm. but the six rays indicate that this specimen is referable to *A. mawsoni* rather than to *A. directa* and the spaced abactinal spinelets (or granules according to interpretation) and possibly also the fairly open skeleton distinguish it from *A. sphoerulata*, all three species being known from Macquarie Island. These differences are particularly noticeable in comparison with a similarly small specimen from Heard Island which I have referred to *A. sphoerulata*.

TYPE LOCALITY. Garden Bay, Macquarie Island, shore.

RANGE. Only known from the shore of Macquarie Island.

ANASTERIAS SPHOERULATA (Koehler)

Parastichaster sphoerulatus Koehler, 1920, 101-105, pl. xxi, fig. 7, pl. xxiii, figs. 5-10, pl. xxiv., figs. 1-4, pl. lxiii, fig. 3, pl. lxiv, figs. 1, 2.

Sporasterias sphaerulata, Fisher, 1930, 241.

BANZARE LOCALITIES: Stations 19 (3 specimens), 81 (1 specimen).

All these specimens have six rays.

The squat, often polygonal granules and close reticulation are similar in these specimens but the largest one from Heard Island (R 27 mm.) has only single partial series of actinal plates, whereas that from Macquarie Island, which is only a little larger (R 33 mm.), has two much better developed series, many of the plates with spines.

The occurrence of this species at Heard Island instead of *A. perrieri*, known from nearby Kerguelen, is very remarkable. It is to be hoped that more collecting will be done at Heard Island since there may also be a five-rayed species of *Anasterias* occurring there. Both five- and six-rayed species are found at Kerguelen and at Macquarie Island.

TYPE LOCALITY. Probably Garden Bay, Macquarie Island.

RANGE. Known from the shores of Macquarie and Heard Islands.

ANASTERIAS DIRECTA (Koehler)

text fig. 17c.

Parastichaster directus Koehler, 1920, 97-101, pl. xx, figs. 8-11, pl. xxi, figs. 8-12, pl. xxiii, figs. 1, 2, pl. lxii, fig. 2.
Sporasterias directa, Fisher, 1930, 241.

BANZARE LOCALITY: Station 81 (1 specimen).

The arrangement of the carinal granules in arcs of three is quite distinct and very regular, especially distally, where the arcs are close together.

TYPE LOCALITY. Macquarie Island, shore.

RANGE. Only known from the shore of Macquarie Island.

APPENDIX

Asteroids from southern Australian waters

Astropecten pectinatus Sladen

Astropecten pectinatus Sladen, 1883, 251; 1889, 202-203, pl. xxxiii, figs. 3, 4, pl. xxxvii, figs. 4-6; H. L. Clark, 1928, 371-372; Cotton and Godfrey, 1942, 194; H. L. Clark, 1946, 74; John, 1948, 497-498, pl ii, fig. 5.

Banzare locality: Station 112 (1 specimen).

Since John has demonstrated that in the type specimens of *A. pectinatus* there is more than one series of actinal plates like *A. schayeri* Döderlein, 1917, it only remains for a re-examination of the holotype of *A. schayeri* to ascertain whether its adambulacral plates agree with those of *A. pectinatus* despite Döderlein's odd description of their armature. It is most probable that the two are synonymous.

The B.A.N.Z.A.R.E. specimen has R/r 53 mm./14 mm. and is therefore similar in size to the largest 'Challenger' type of *A. pectinatus* from near Port Phillip, which has R 48-50 mm. and another specimen in the British Museum from the same region, with R 56 mm. It differs from these in having usually two, rather than three, flattened adambulacral spines in the second row from the furrow on each plate and in having fewer actinal plates, only nine in the innermost series, while the third series is represented by a single interradial plate. This compares with 16 and 27 plates respectively in the innermost series in the other two specimens, and one or three in the third, the largest specimen even having a fourth series of two plates.

Type locality. Off the entrance to Port Phillip, Victoria, 70 metres.

Range. Known from Spencer and St. Vincent Gulfs, South Australia and from Victoria, Tasmania and New South Wales in about 10 to 85 metres. The exact range is uncertain since H. L. Clark's records of 1909 and 1916 were partly of *A. vappa*, just which ones not being specified in Dr. Clark's later papers.

Nectria ocellata Perrier

Nectria ocellata Perrier 1876, 4-6 (188-190 of separate, 1875); H. L. Clark, 1916, 34-35; 1928, 378; 1938, 78; Cotton and Godfrey, 1942, 197; H. L. Clark, 1946, 85.

Banzare locality: Station 113 (1 specimen).

Type locality. 'Southern Seas'.

Range. Tasmania to the western end of the Great Australian Bight, in 55 to 220 metres.

Austrofromia polypora (H. L. Clark)

Fromia polypora H. L. Clark, 1916, 51-53, pl. xiv, figs. 1, 2.
Austrofromia polypora, H. L. Clark, 1928, 387-388; 1938, 132; 1946, 114.

Banzare locality: Station 113 (3 specimens).

All three have R about 80 mm. There are up to five rows of actinal plates proximally.

Type locality. Off Maria I., Tasmania, 143 metres.

Range. Known from Tasmania to Rottnest I., Western Australia, the only depth records being the present one and that of the types.

Pseudophidiaster rhysus (H. L. Clark)

Pseudophidiaster rhysus H. L. Clark, 1916, 55-56, pl. xvi, figs. 1, 2; 1938, 142; Cotton and Godfrey, 1942, 200; H. L. Clark, 1946, 125.

Banzare locality: Station 113 (10 specimens).

The size ranges from R 115 mm. to 165 mm., the latter corresponding to a minor radius (r) of about 32 mm. In the largest, the radial diameter of the madreporite is 16 mm.

Type locality. Not specified by H. L. Clark but Cotton and Godfrey give 'Great Australian Bight, 80-120 fathoms.'

Range. Known from Tasmania to the Great Australian Bight in 110 to 366 metres.

Marginaster sp. (cf. M. paucispinus Fisher)

Banzare locality: Station 113 (1 specimen).

Description. R/r is 9 mm./6·5 mm.

The dorsal side is very convex and the surface irregular, with small tubercles, single or grouped, arising from the elevations made by the skeletal plates. These form an open reticulum only visible after partial denuding or drying. The tubercles, or almost granuliform spinelets, are about 0·25 mm. long, mostly about twice as high as wide and taper very slightly from the base to a rounded, more or less blunt, finely rugose tip. On the carinal plates they form elongate groups of up to eight aligned transversely but on the other plates there are rarely more than four. The papulae are spaced singly in the skeletal meshes.

The supero-marginal plates are not distinct.

The infero-marginals form a prominent flange to the body and each bears on its dorsal side a line of two to four small tubercles like the abactinal ones and on the margin a webbed fan of three to five spinelets up to 0·5 mm. long, the first infero-marginal plate always having five spinelets. The tips of these are rounded and very rugose.

The actinal surface is quite flat and the plates are spineless. The skin covering each area is marked with furrows extending from between the marginals to the adambulacral plates, as in some specimens of *Marginaster capreensis*.

The adambulacral plates each have one cylindrical or slightly tapering furrow spine and usually two subambulacral spines arranged almost parallel to the furrow though the distal one is a little closer to it than the proximal. These subambulacral spines are about 0·75 mm. long and are expanded and flattened in their distal halves. Sometimes the two spines are replaced by one which is larger and more flattened, almost paddle-shaped.

The oral plates each have four furrow spines, the apical one very stout, and two suboral spines.

Affinities. This specimen is most closely related to *Marginaster paucispinus* Fisher, 1913 and 1919, from the vicinity of Hongkong. Both of them differ from the European *M. capreensis* in lacking spinelets on the actinal plates and in having the subambulacral spines flattened in shape and arranged in a line parallel to the furrow, not transversely. However, the B.A.N.Z.A.R.E. specimen appears to differ from the unique holotype of *M. paucispinus* in lacking a web between the subambulacral spines and in having more numerous abactinal tubercles, which are not clavate unlike the few carinal ones of *M. paucispinus*. Fisher does not mention any furrowing of the actinal skin in his specimen, but this may be indistinct in some specimens of *M. capreensis* though conspicuous in others and its absence is not significant.

It remains to be seen from further material how great is the range of variation in these minor characters in the forms of *Marginaster* found in the China Sea and in Australian waters.

This record is of interest in adding another genus of starfishes to the Australian fauna list.

Stylasterias reticulata (H. L. Clark)

text fig. 18, pl. vi, figs. 5, 6.

Pedicellaster reticulatus H. L. Clark, 1916, 69-70, pl. xxvii, figs. 3, 4; 1946, 155.

Banzare localities: Stations 113 (2 specimens), 115 (1 specimen).

Description. These specimens are all somewhat damaged, the very long, slender rays being easily detachable at the base. Even so they are in better condition than the holotype and I am accordingly giving here a supplementary description and some figures. All three specimens probably had six rays when entire.

The largest has the longest rays 40 mm. long; one is in process of regeneration and another is lost. In the two other specimens the longest rays are about 30 mm. and 35 mm. The smallest is the one from station 115. It has four, approximately equal, rays remaining and two lost while the other has two adjacent small rays with a larger one on each side opposite each other and the two other rays lost. The type specimen had three adjacent rays regenerating.

The madreporite is single in all three specimens and relatively large, measuring 1·7 mm. in diameter in a specimen with disc diameter only 6 mm. Probably the species is not naturally fissiparous but often breaks accidentally.

The abactinal skeleton forms an open, wide-meshed, delicate reticulum. However, the specimen from station 115 differs from the other two in having many fewer supplementary abactinal plates linking the carinal and supero-marginal plates, which instead have very long lobes. Some of the carinal plates are very asymmetrical in shape, with a short lobe on one side and a large one on the other. Distally the supplementary plates are even fewer and the primary plates may be isolated from each other. The two other specimens both have more numerous and much smaller plates forming chains to link together the primary plates, which are themselves small.

In all three specimens the spines occur singly on the carinal, some dorso-lateral and both series of marginal plates. The length augments from the carinal to the infero-marginal spines, the latter being up to about 1·75 mm. long in the largest specimen. In shape the spines are very slender, slightly tapering, ridged for most of their length and terminating in a blunt tip often with a crown of six or seven slightly flared, hyaline points.

Around each spine is a conspicuous wreath of crossed pedicellariae. These lie mostly around the bases of the abactinal spines but around the shafts of most of the marginal spines in the preserved specimens. The pedicellariae themselves are of a very modified form with the tip of each valve abruptly widened into a broad, almost straight lip with a very large tooth at each end and fine teeth between, like the canines and incisors of a cat. In side view the intermediate teeth are hidden and the big teeth appear to be terminal. This contrasts with the curved lip of the usual form of crossed pedicellaria, where, if the lateral-most teeth are enlarged, they appear in side view to be subterminal, the smaller teeth extending beyond them. In these specimens the shaft of each valve bears a few large recurved spines spaced from the terminal lip (fig. 18b).

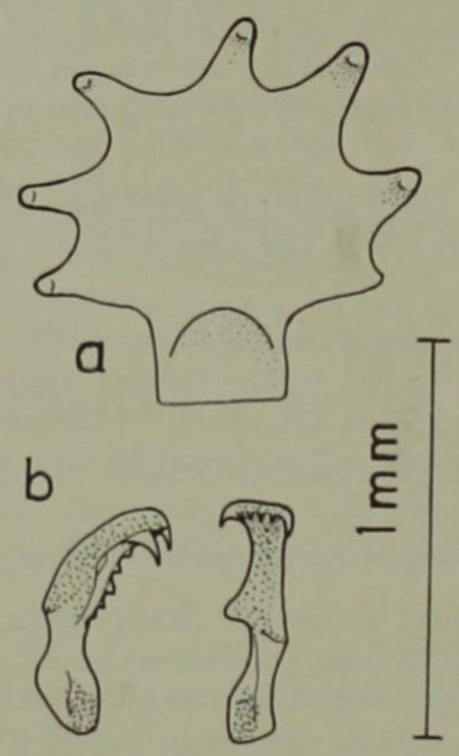


Fig 18. *Stylasterias reticulata*, R 40 mm. from Banzare station 113, a, valve of felipedal pedicellaria and b, two valves of crossed pedicellariae.

Besides these crossed pedicellariae, all three specimens possess some relatively large felipedal straight pedicellariae, each valve of which is markedly expanded laterally from a narrow base, rather like a very broad hand but with six to eight long curved fingers interlocking with and crossing those of the corresponding valve (fig. 18a). The width just exceeds the length which is up to 0·9 mm. These pedicellariae are most numerous on the ventral side but some occur dorsally.

H. L. Clark did not make a close examination of the pedicellariae of the holotype and so failed to see the peculiarities of both kinds.

There are no actinal plates, the infero-marginals and their supplementary linking plates (when present) adjoining the adambulacrals directly. The latter have two simple spines. The first, post-oral, pair of adambulacral plates do not quite meet interradially even in the largest specimen, so there is no oral carina. Also the tube feet, though crowded and apparently multiserial, are in fact biserial. Both these characters suggests inclusion in the subfamily Pedicellasterinae but they may be attributable to the relatively small size. The arrangement of the crossed pedicellariae in wreaths around the spines does not occur in that subfamily.

The single infero-marginal spines and the absence of actinal plates cause this species to run down to the Labidiasterinae in Fisher's key to the Asteriidae (1928); also the two-fanged crossed pedicellariae are not unlike those of *Labidiaster*. However, that subfamily is also characterized by the multiplicity of the rays, their number increasing with growth. A closer examination of the genera which Fisher included in the Coscinasteriinae shows that, in fact, one or two of them have the actinal plates reduced or rudimentary, notably the monotypic genus *Stylasterias*, of which the type species, *S. forreri* (de Loriol) ranges from California to Alaska. Fisher (1928) has illustrated the pedicellariae of this species and it is evident that the crossed ones are almost identical with those of *Pedicellaster reticulatus*. The only other species which has pedicellariae approaching this form is *Distolasterias nipon* (Döderlein) from the vicinity of Japan, but this has only lanceolate straight pedicellariae, though *D. stichantha* Sladen does have some relatively smaller felipedal pedicellariae. The crossed pedicellariae of *D. stichantha* are less modified even than those of *D. nipon* and have the terminal lip curved with only a moderate-sized tooth at each end.

According to H. L. Clark, the rays of the holotype of *P. reticulatus* are wider than in most species of *Pedicellaster*. The B.A.N.Z.A.R.E. specimens, however, all have very slender rays. Fisher has shown that in *Stylasterias forreri* there is considerable variation in this character. His slender-rayed specimen (1928, pl. xlviii) is very similar in appearance to these Tasmanian ones.

There are a number of differences between *Stylasterias forreri* and *Pedicellaster reticulatus*, which may necessitate a separate genus for the latter; notably the presence of six rays, the retarded adoral carina and the occurrence of single infero-marginal spines, not two on each plate. However, *S. forreri* grows to a size of R nearly 300 mm. Possibly larger Australian specimens, if they exist, will prove to have an adoral carina, though it is notable that an example of *S. forreri* with R only 16 mm. figured by Fisher already has the first pair of postoral adambulacral plates partly in contact. Nevertheless, I believe that the species *reticulatus* should be referred to the genus *Stylasterias*.

Since these specimens were taken at the same stations as *Australiaster dubius* (H. L. Clark), I suspected at first that they might represent a six-rayed, fissiparous, young form of that species, as reputed to occur in *Sclerasterias*. However, the very different pedicellariae, both crossed and straight, as well as the actinal spines of *A. dubius* easily distinguish them. Also a relatively small specimen of *A. dubius* from this collection with R 43 mm., has five rays like the adults and H. L. Clark has recorded one with R 22 mm., presumably with five rays since he made no statement to the contrary.

TYPE LOCALITY. Off Maria Island, Tasmania, 143 metres.

RANGE. Only known from around Tasmania in 128 to 174 metres.

AUSTRALIASTER DUBIUS (H. L. Clark)

Coscinasterias dubia H. L. Clark, 1909, 532-534, pl. xlix, figs. 3, 4, pl. l; 1916, 73-74, text fig. 11, pl. xxx, figs. 1, 2; Cotton and Godfrey, 1942, 206.

Australiaster dubia, Fisher, 1923, 253; 1928, 131, pl. xlii, fig. 5; H. L. Clark, 1946, 156.

BANZARE LOCALITIES: Stations 113 (1 disc and 3 rays), 115 (8 specimens).

In only two of these specimens, one of which has R 82 mm., are the infero-marginal spines chisel-shaped; the rest have them more or less tapered. In the 'Endeavour' material, studied by H. L. Clark in 1916, it was only the largest of the series of specimens, (R 138 mm.) which had chisel-shaped infero-marginal spines like the type (R 83 mm.) taken by the 'Thetis'. The size of the B.A.N.Z.A.R.E. specimens ranges from R 43 mm. to 105 mm. In the smallest, one pair of postoral adambulacral plates is already in contact.

TYPE LOCALITY. New South Wales, Botany Bay, 37 to 42 metres, designated by Cotton and Godfrey.

RANGE. Known from South Australia to New South Wales in 27 to 366 metres.

COSCINASTERIAS CALAMARIA (Gray)

Asterias calamaria Gray, 1840, 179.

Coscinasterias calamaria, H. L. Clark, 1909, 531-532; 1916, 72-73; 1928, 399; 1938, 189-190; Cotton and Godfrey, 1942, 206; H. L. Clark, 1946, 156.

Coscinasterias gemmifera, H. L. Clark, 1916, 74. Non *Asteracanthion gemmifera* Perrier, 1869, from Chile, which is probably a synonym of *C. echinata*.

BANZARE LOCALITY: Station 76 (1 specimen).

TYPE LOCALITY. 'Australia'.

RANGE. Known from Rottnest I., Western Australia, south and east to New South Wales and Lord Howe Island down to about 75 metres.

ALLOSTICHASTER POLYPLAX (Müller and Troschel)

Asteracanthion polyplax Müller and Troschel, 1844, 178.

Allostichaster polyplax, Verrill, 1914, 363; H. L. Clark, 1916, 70-71; Koehler, 1920, 85, 86, pl. xviii, figs. 7-11, pl. lxi, fig. 2; H. L. Clark, 1928, 399; 1938, 193-195; Cotton and Godfrey, 1942, 205; H. L. Clark, 1946, 157.

BANZARE LOCALITY: Station 115 (1 specimen).

This specimen has the four remaining rays each a different length, the largest having R 32 mm. and the smallest 12 mm. Two rays only appear to have been lost, one from each side of the largest ray.

In comparison with *Allostichaster regularis*, apart from the rays being irregular in size and number, this species tends to have fewer infero-marginal spines, usually two on most plates, three on some of the distal plates and one on the proximal-most one or two plates. Most specimens of *A. regularis* have three spines on the majority of plates; four on some and two on the proximal-most. Also there may be a similar spine, occasionally two, on each proximal actinal plate and this tends to be in series with the corresponding infero-marginal spines. In other specimens the actinal plates and spines may be undeveloped. The abactinal spinelets are variable in

both species but they are usually more numerous, even crowded, in *A. regularis*, where they may form linear series, mostly transverse or oblique, along the skeletal plates. In *A. polyplax* the spinelets, which are often more or less granuliform or even capitate, are usually single and spaced, though the carinal plates may bear several close together in a V-shaped arrangement.

TYPE LOCALITY. 'Australia'. Port Willunga, South Australia, designated by Cotton and Godfrey.

RANGE. Known from South Australia to New South Wales and from New Zealand in 0 to 128 metres.

ALLOSTICHASTER REGULARIS H. L. Clark

Allostichaster regularis H. L. Clark, 1928, 400-401, fig. 115; Cotton and Godfrey, 1942, 205; H. L. Clark, 1946, 158.

BANZARE LOCALITIES: Stations 113 (1 specimen), 115 (8 specimens).

In contrast to specimens of *A. polyplax*, all these have, or have had, five regular rays. R in largest one is 33 mm.

H. L. Clark described the holotype of this species (R 30 mm.) as having no actinal plates but one of the four infero-marginal spines on the plates of the basal half of the ray 'distinctly by itself on the oral surface of the plate'. The largest B.A.N.Z.A.R.E. specimen answers to this description but, on denuding a ray, was found to have an extensive series of well-developed actinal plates, of which about the first twelve, extending to just over half the length of the ray, each bear one, sometimes two, actinal spines. These are similar to the infero-marginal spines and almost or quite in series with them. However, the presence of actinal plates and spines is not invariable, a slender-rayed specimen with R 28 mm. having only rudimentary plates although another with broader rays has a partial series of narrow plates, the proximal ones with spines. Since the largest specimen has relatively broad but pointed rays, the development of the actinal plates seems to be correlated with br (the arm breadth) rather than with R. The expansion of its rays is greatest just beyond the base, br being 8 mm. at a distance of 8 mm. from the centre of the disc. The broadening of the rays gives the specimen a resemblance to the much larger (R 67 mm.) holotype of *Cosmasterias dyscrita* H. L. Clark (1916). That species differs from *A. regularis* in having three series of actinal plates with papulae between them and in having felipedal pedicellariae. The type locality of *C. dyscrita* is 'South of Gabo I., Victoria, 200 fathoms', but Fell (1958, p. 20) records some fragments from east of New Zealand under this name.

H. L. Clark's smaller specimens of *A. regularis* from South Australia had the rays relatively shorter than in the type, but all the B.A.N.Z.A.R.E. specimens, except two of the larger ones mentioned above, have very slender, acute rays.

TYPE LOCALITY. Spencer and St. Vincent Gulfs, South Australia.

RANGE. Known from South Australia and Tasmania down to 174 metres.

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Laboratoire de ZOOLOGIE
Michel JANGOUX



PLATE I.

Figs. 1 and 3. *Cycethra verrucosa mawsoni* subsp. nov., holotype, dorsal and ventral views, x 1. (The missing plates were loosened by over-exposure to strong bleach).

Fig. 2. The same in ventro-lateral view, x 2, showing the very slight modification of the marginal plates, which on other rays may be even more indistinct than this.

Figs. 4 and 5. *Perknaster fuscus* Sladen, R 56 mm. from station 64, dorsal and ventral views x 1½, for comparison with Koehler's photographs of *Cribrellopsis rallieri* (1917, plate v, figs. 7, 10).

[Plate reduced to nine-tenths the stated size.]

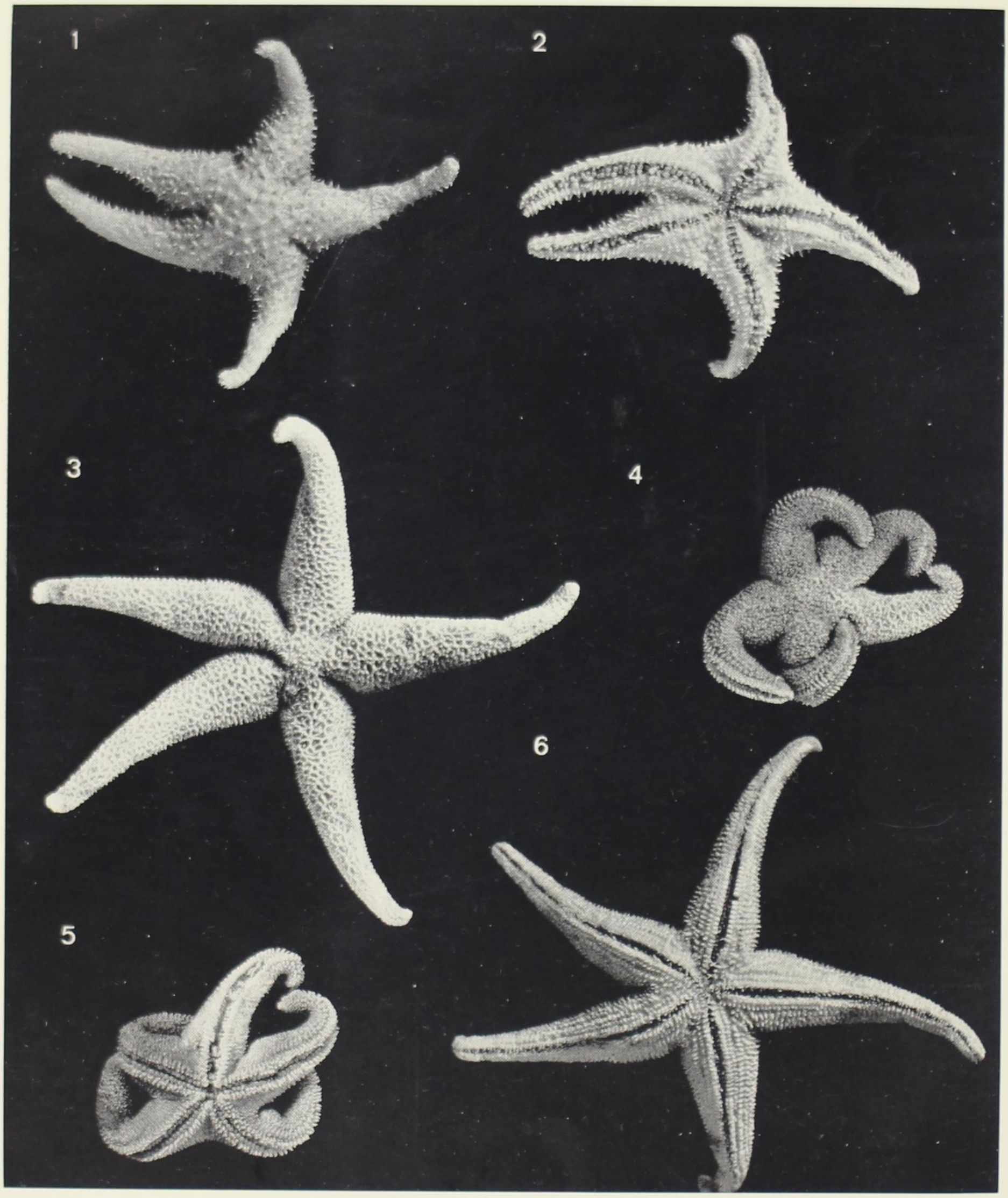


PLATE II.

Figs 1 and 2. *Rhopiella hirsuta kerguelenensis* subsp. nov., holotype, 'Challenger' station 149D, dorsal and ventral views, x 1½.

Figs. 3 and 6. *Henricia fisheri* sp. nov., holotype, 'Discovery' station 1564, dorsal and ventral views, x 1½.

Figs. 4 and 5. *Henricia spinulifera* (Smith), station 55A, R 21 mm., dorsal and ventral views, x 1½.

[Plate reduced to nine-tenths the stated size.]



PLATE III.

Figs. 1 and 2. *Henricia smilax* (Koehler), station 107, R 38 mm. dorsal and ventral views, x 1½.
Figs. 3 and 4. *Henricia smilax* (Koehler), station 107, R 31 mm., dorsal and ventral views, x 1½.
Figs. 5 and 6. *Henricia smilax* forma *tenuis* forma nov., holotype, dorsal and ventral views, x 1½.
Figs. 7 and 8. *Henricia parva* (Koehler), station 107, R 27 mm., dorsal and ventral views, x 1½.

[Plate reduced to nine-tenths the stated size.]

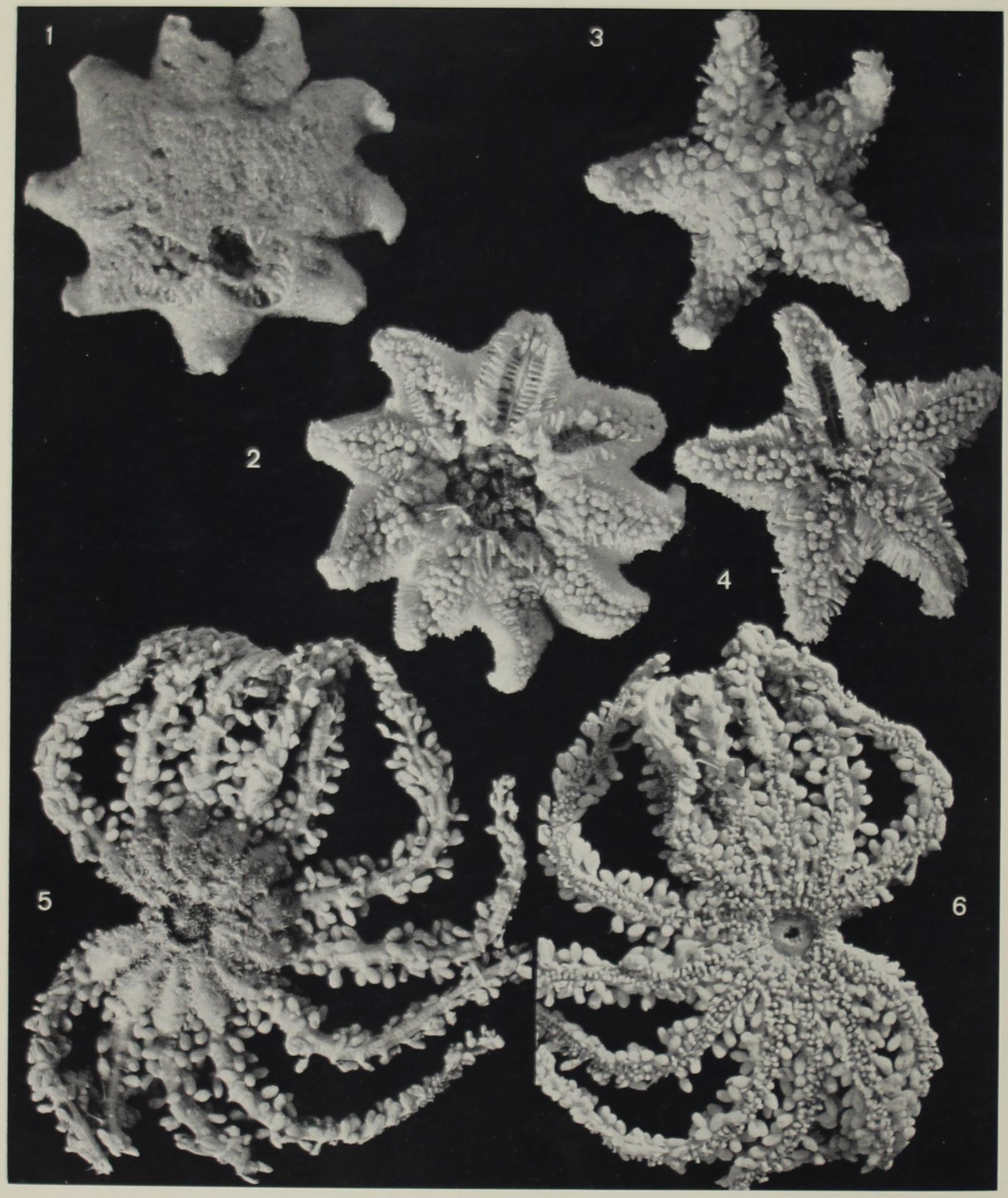


PLATE IV.

Figs. 1 and 2. *Pteraster koehleri* sp. nov., holotype, dorsal and ventral views, x 2.

Figs. 3 and 4. *Peribolaster macleani* Koehler, station 41, R 18 mm., dorsal and ventral views, x 2.

Figs. 5 and 6. *Odinella nutrix* Fisher, station 34, R 100 mm., dorsal and ventral views, x 1.

[Plate reduced to nine-tenths the stated size.]

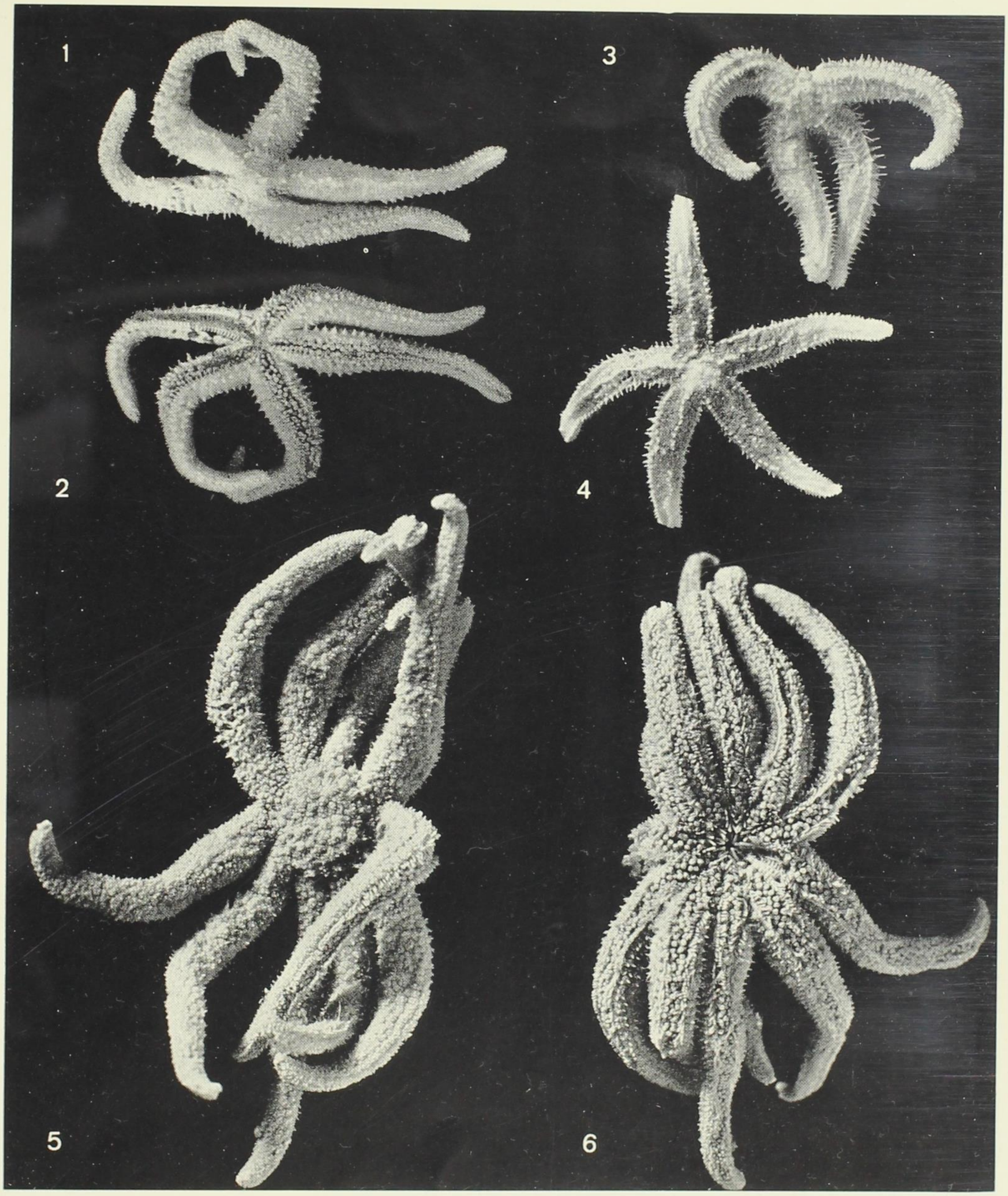


PLATE V.

Figs. 1 and 2. *Kenrickaster pedicellaris*, sp. nov., holotype, dorsal and ventral views, x 1½.
Fig. 3. *Diplasterias brucei* (Bell), station 40, R 44 mm., thin-spined specimen, dorsal view, x 1.
Fig. 4, *Diplasterias brucei* (Bell), station 90, R 40 mm., usual form, dorsal view, x 1.
Figs. 5 and 6. *Psalidaster mordax rigidus*, subsp. nov., holotype, dorsal and ventral views, x 1.
[Plate reduced to nine-tenths the stated size.]

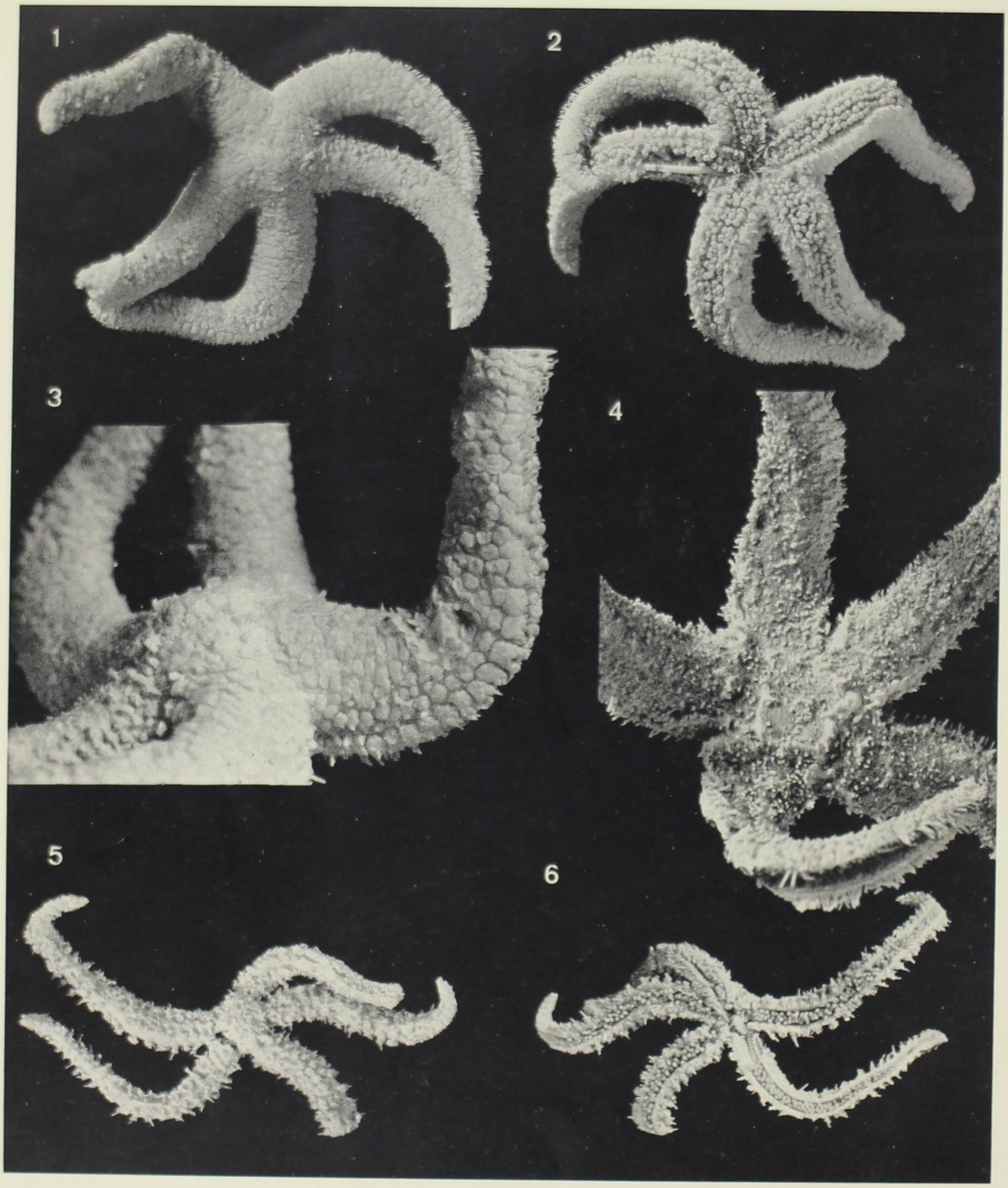


PLATE VI.

Figs. 1 and 2. *Lysasterias digitata*, sp. nov., holotype, dorsal and ventral views, x 1.
Fig. 3. The same, partial lateral view, showing proximal intermarginal felipedal pedicellariae, x 2.
Fig. 4. *Lysasterias digitata*, sp. nov., dried paratype, R 50 mm., dorsal view of disk and proximal parts of rays, x 2.
Figs. 5 and 6. *Stylasterias reticulata* (H. L. Clark), station 113, R 40 mm., dorsal and ventral views, x 1½.

[Plate reduced to nine-tenths the stated size.]

REPORTS OF B.A.N.Z. ANTARCTIC RESEARCH EXPEDITION, 1929-1931

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	Part 13.	Free-Living Nematodes Sect. 2, *by Patricia M. Mawson* (1958)	4	6
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