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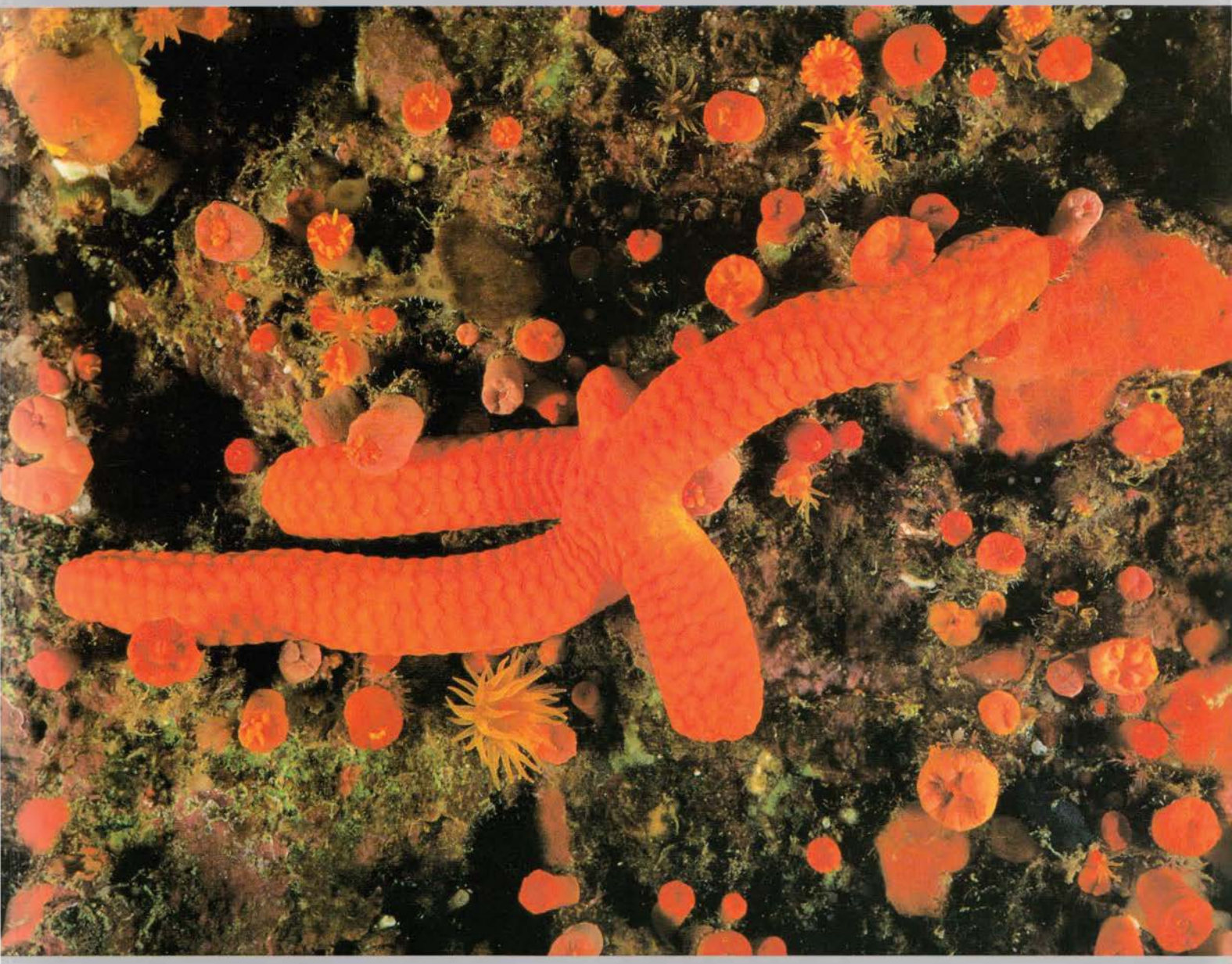

The Marine Fauna of New Zealand:

Echinodermata: Asteroidea (Sea-stars)
Order Valvatida

Helen E.S. Clark and Donald G. McKnight

NIWA Biodiversity Memoir 117

COVER PHOTO: *Ophidiaster kermadecensis* Benham, 1911 (Ophidiasteridae) from the Chanter Islands, near Raoul Island, Kermadec Ridge. Photo: Dr Roger V. Grace.

NATIONAL INSTITUTE OF
WATER AND ATMOSPHERIC RESEARCH (NIWA)

The Marine Fauna of New Zealand: Echinodermata: Asteroidea (Sea-stars)

Order Valvatida

by

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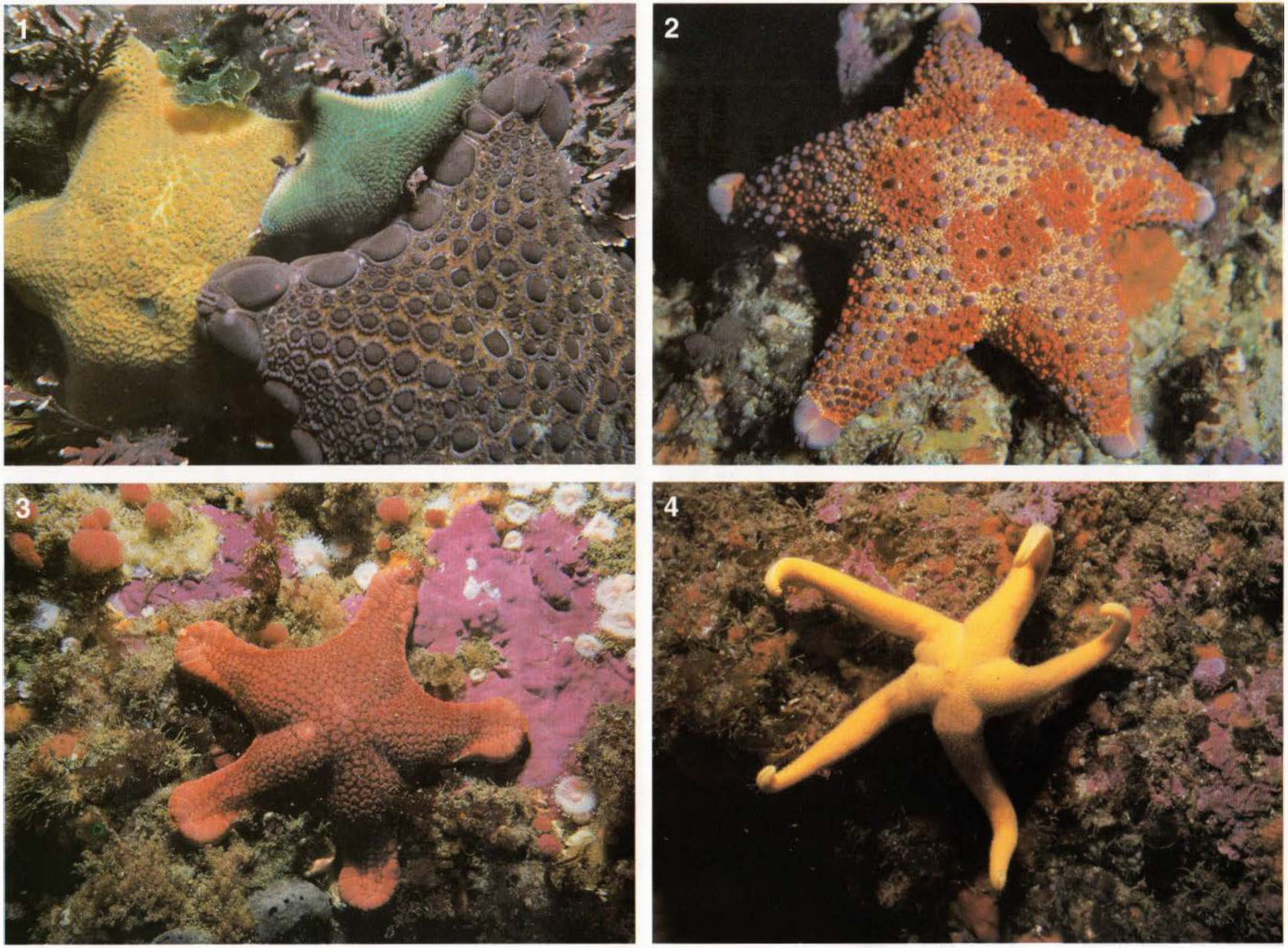

Frontispiece: 1. ***Pentagonaster pulchellus*** Gray, 1840 (Goniasteridae) (right) and yellow and green specimens of ***Patiriella regularis*** (Verrill, 1867) (Asterinidae) (left), from Breaker Bay, Wellington. Photo: Dr Malcolm P. Francis. **2.** ***Asterodiscides truncatus*** (Coleman, 1911) (Asterodiscididae), Poor Knights Islands. Photo: Dr Malcolm P. Francis. **3.** ***Diplodontias dilatatus*** (Perrier, 1875) (Odontasteridae), Breaker Bay, Wellington. Photo: Dr Malcolm P. Francis. **4.** ***Knightaster bakeri*** H.E.S. Clark, 1972 (Ganeriidae), 36 m, Castle Rock, off Mercury Bay. Photo: Dr Roger V. Grace.

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ABSTRACT

Sea-stars in the order Valvatida have been described for the New Zealand biogeographic region (24° to 57° S, 157° E to 167° W), including the Exclusive Economic Zone (EEZ), Lord Howe Island, and Norfolk, Kermadec, and Macquarie Ridges. Five superfamilies, 12 families, 54 genera, and 96 species-rank taxa are represented throughout the region (this includes 5 unidentified species): Goniasteroidea (Goniasteridae, 35 species and subspecies; Asterodiscididae, 2 species), Odontasteroidea (Odontasteridae, 9 species; Chaetasteridae, 1 species), Ganerioidea (Ganeriidae, 4 species; Asterinidae, 16 species; Poraniidae, 2 species), Ophidiasteroidea (Ophidiasteridae, 21 species; Mithrodiidae, 1 species), and Oreasteroidea (Oreasteridae, 1 species; Asteropseidae, 2 species; Acanthasteridae, 2 species). Two new goniasterid genera (*Eknomiaster, Kermitaster*) are described. Nine new species and one new subspecies are described in the genera *Calliaster, Ceramaster, Eknomiaster, Kermitaster, Mediaster, Sphaeriodiscus* (Goniasteridae), *Odontaster* (Odontasteridae), *Nepanthia* (Asterinidae), and *Tamaria* (Ophidiasteridae). Of the 95 species recorded in the wider region, 64 species are found within the boundaries of the EEZ, of which 30 are endemic. Five genera are endemic to the EEZ: *Eknomiaster, Enigmaster, Kermitaster* (Goniasteridae), *Knightaster* (Ganeriidae), and *Acheronaster* (Oreasteridae). Four other genera are newly recorded for the EEZ: *Dissogenes* (Ophidiasteridae), *Philonaster, Plinthaster* (Goniasteridae), and *Tremaster* (Asterinidae).

The family Goniasteridae dominates the Valvatida in the region, both in terms of the numbers of species (c. 38%) and of specimens (c. 2580 specimens out of c. 3630 for all species, i.e., 71%); in a 1970 survey of New Zealand echinoderms, only 8 taxa of Goniasteridae were recorded compared to the present 36. All 12 families of Valvatida recorded here are present on the continental shelf and six appear confined to depths of 200 m or less, viz. Acanthasteridae, Asperopseidae, Chaetasteridae, Mithrodiidae, Oreasteridae, and Poraniidae. Only four species extend to depths exceeding 1000 m. The deepest record is that of *Plinthaster dentatus* from 2910 m. Of the 95 species, some 72 have a known latitudinal range of six degrees or less within the region. Dissections were made of many of the goniasterid species. No internal parasites were encountered.

Keywords: Goniasteridae, Asterodiscididae, Odontasteridae, Chaetasteridae, Ganeriidae, Asterinidae, Ophidiasteridae, Poraniidae, Mithrodiidae, Oreasteridae, Asteropseidae, Acanthasteridae, New Zealand, sea-stars, taxonomy, distribution, new species

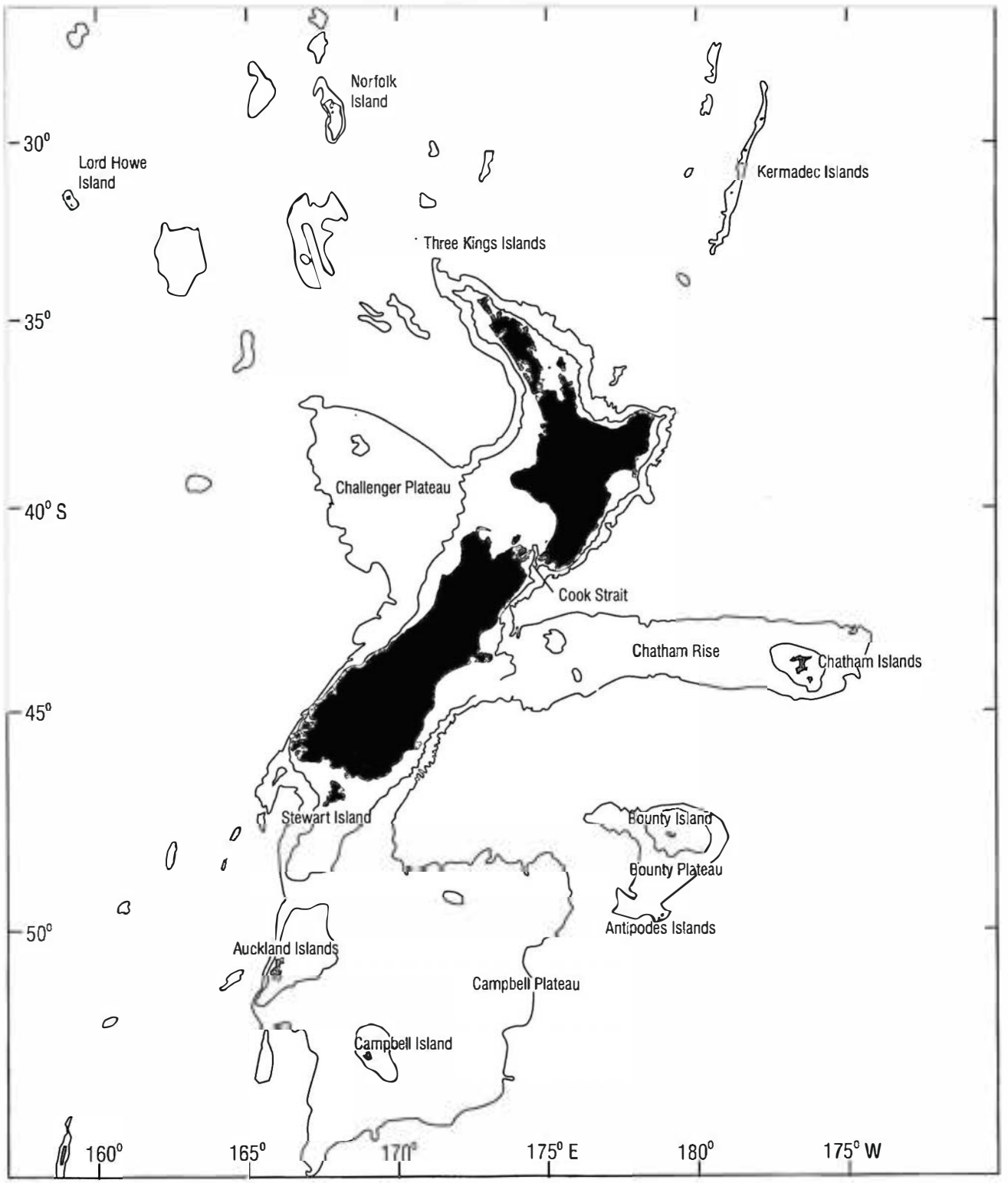


Fig. 1. Map of the New Zealand region which covers the study area.

INTRODUCTION

Probably the first sea-star to be reported from New Zealand waters was *Astrogonium pulchellum* (now *Pentagonaster pulchellus*) which was described briefly by Müller and Troschel (1842: 55); it is simply recorded as from "Neu-Seeland". Ayres, later in 1851, also described *Pentagonaster pulchellus* but called it *Stephanaster elegans*. Since then the recorded asteroid fauna of New Zealand has grown very considerably, and in 1970 six genera and seven species of goniasterid sea-stars (H.E.S. Clark 1970: 3) were known. By 2001, 21 genera and 32 species of goniasterid sea-stars are recorded from New Zealand waters.

The Goniasteridae is a large and very diverse family with a worldwide distribution; the family is especially well represented in the Indo-West Pacific. The family includes both shallow- and deep-water species.

In a series of papers and monographs (1911–1930) W.K. Fisher described and illustrated many sea-stars from the North Pacific, of which the goniasterid species are of special importance and interest to the present work.

Halpern (1970a, b) also contributed much to our knowledge of the family Goniasteridae; his papers dealt with Atlantic goniasterids, especially those from the Straits of Florida and surrounding waters.

A.M. Clark and Rowe (1971) included a number of goniasterids in their monograph of shallow-water Indo-West Pacific echinoderms, and A.M. Clark and Downey (1992: 226) recorded 24 genera and 35 species from the Atlantic. They remarked (p. 228) on how little was known, biologically, about members of the family.

A.M. Clark (1993: 240) recorded 59 genera in the family Goniasteridae and 262 species; this is on a world-wide scale. The family Goniasteridae is one of the largest, most diverse, and most interesting of all the asteroid families.

Finally, Rowe and Gates (1995) recorded 19 genera and 32 species of goniasterid sea-stars from Australian waters; 11 of these genera and seven species are known also from New Zealand.

Relatively few fossil Asteroidea are recorded from New Zealand deposits. Two fossil goniasterid genera from Upper Cretaceous deposits in North Canterbury were recorded and described by Fell (1952, 1956); these are, respectively, *Ophryaster novaezelandiae* and *Hippasteria antiqua*. Spencer and Wright (1966: U58) recorded *Hippasteria, Pseudarchaster, Paragonaster, Calliaster, Nymphaster,* and *Mediaster*. Fell also remarked on, but did not describe, a fossil New Zealand *Pseudarchaster*. Eagle (1999: 552) discussed Fell's identification and described *Pseudarchaster motutaraensis* from Miocene rocks at Motutara, West Auckland. Interestingly, in "The Great New Zealand Fossil Book" (Brazier *et al.* 1990: 10, fig. 3) there is a photograph of a fossil sea-star from early Cretaceous rocks in inland Gisborne which may well belong in the family Goniasteridae.

The classification adopted herein follows that of Blake (1987).

This memoir is the second of a series of three describing the entire New Zealand asteroid fauna.

AREA OF STUDY

Asteroid specimens in the present monograph are from collections made by the then New Zealand Oceanographic Institute (now incorporated into NIWA) and the National Museum of New Zealand Te Papa Tongarewa. The area covered is from 24° to 57°30'S and 157°E to 167°W (CANZ 1997; Fig. 1). This is essentially the area covered by most New Zealand scientific charts. It extends from the Lord Howe Rise, South Fiji Basin, and northern edge of the Louisville Seamount Chain in the north to the Hjort Trench, Southwest Pacific Basin, and Subantarctic Slope in the south. Depths range from 0 to nearly 5000 m (4868 m, *Eltanin* Stn 1837). The area includes Norfolk, Lord Howe, and Kermadec Islands in the north and Snares, Auckland, Campbell, Antipodes, and Bounty Islands to the south of New Zealand.

ABBREVIATIONS OF INSTITUTIONS

NMNZ: Museum of New Zealand Te Papa Tongarewa (formerly National Museum of New Zealand)

NIWA: National Institute of Water and Atmospheric Research, Greta Point, Wellingto

NZOI: New Zealand Oceanographic Institute, Wellington (now part of NIWA)

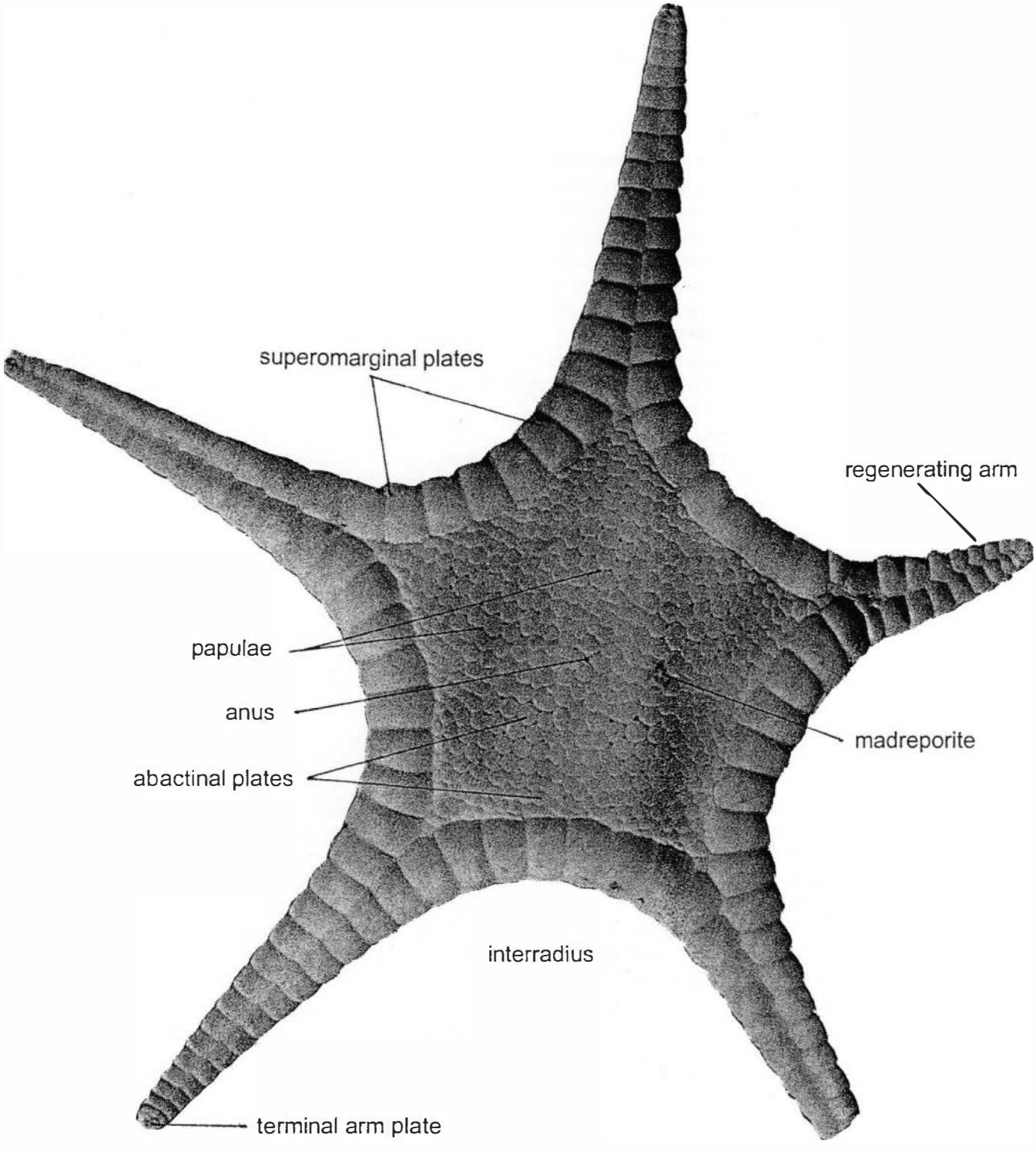
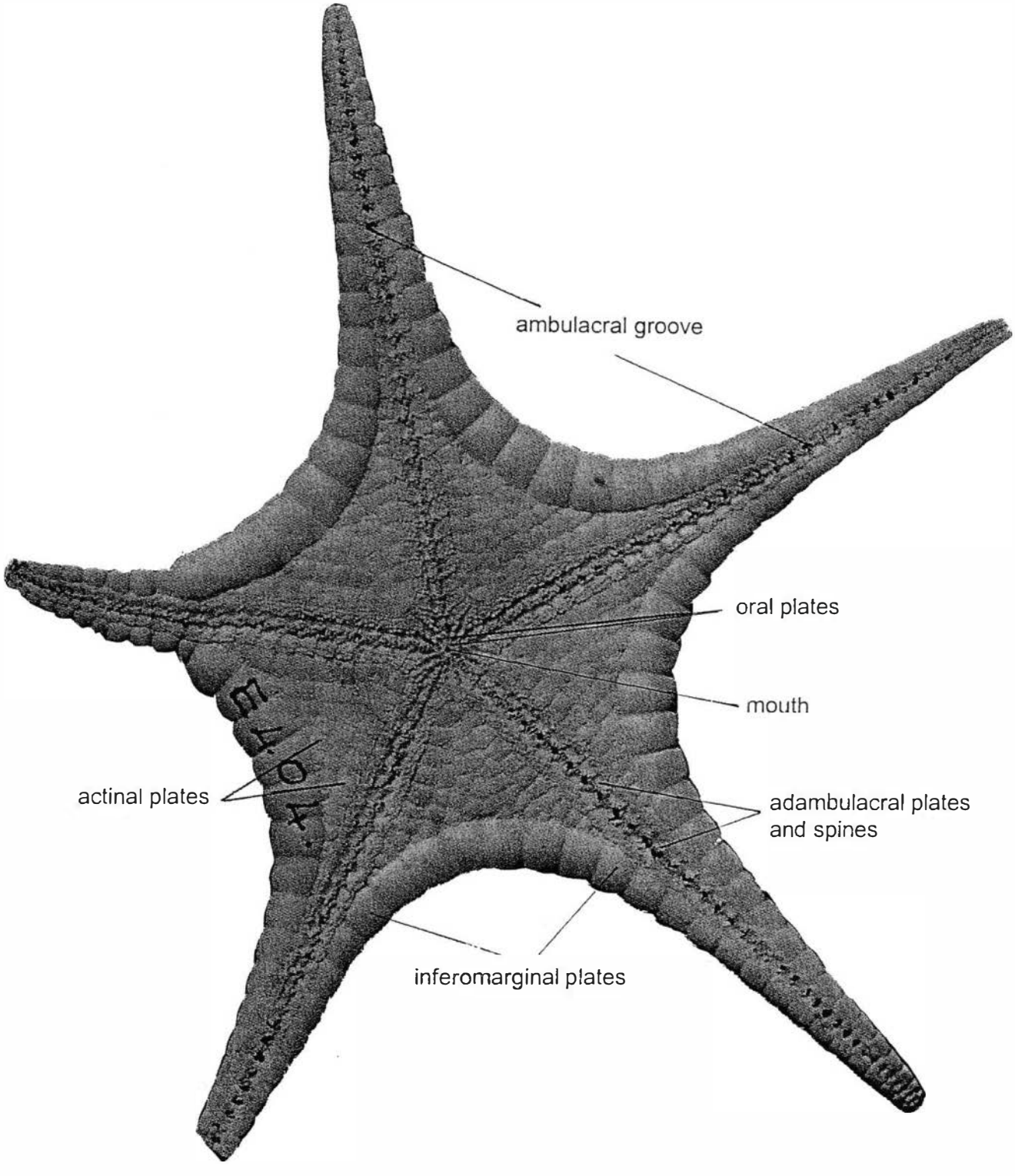


Fig. 2. Diagnostic features of a goniasterid sea-star. Example is *Lithosoma novaezelandiae* McKnight. Specimen taken from NZOI Stn E404. Abactinal (upper) and actinal (lower) surfaces.



CHECKLIST OF SPECIES

(* New species and records described in this memoir)

Superfamily **GONIASTEROIDEA**
Family **GONIASTERIDAE** Forbes, 1841

Anthenoides cristatus (Sladen)
Anthenoides epixanthus (Fisher)
Anthenoides granulosus Fisher
**Calliaster thompsonae* n.sp.
Ceramaster glasbyi McKnight
**Ceramaster patagonicus australis* n.ssp.
Ceramaster patagonicus patagonicus (Sladen)
**Eknomiaster macauleyensis* n. gen., n. sp.
Enigmaster scalaris McKnight & H.E.S. Clark
Gilbertaster anacanthus Fisher
Glyphodiscus mcknighti Rowe
Hippasteria phrygiana (Parelius)
**Kermitaster pacificus* n. gen., n. sp.
Lithosoma novaezelandiae McKnight
Mediaster arcuatus (Sladen)
**Mediaster gartrelli* n.sp.
Mediaster sladeni Benham
Milteliphaster wanganellensis H.E.S. Clark
Paragonaster ridgwayi McKnight
Paragonaster stenostichus Fisher
Paragonaster sp.
Pentagonaster pulchellus Gray
Philonaster sp.
Pillsburiaster aoteanus McKnight
Pillsburiaster maini McKnight
Pillsburiaster sp.
Plinthaster dentatus (Perrier)
Pseudarchaster garricki Fell
Pseudarchaster macdougalli McKnight
Pseudarchaster sp.
Pseudoceramaster hunti McKnight
Rosaster endilius McKnight
Rosaster mimicus Fisher
**Sphaeriodiscus irritatus* n.sp.
Sphaeriodiscus maui McKnight

Family **ASTERODISCIDIDAE**

Asterodiscides grayi Rowe
Asterodiscides truncatus (Coleman)

Superfamily **ODONTASTEROIDEA**
Family **ODONTASTERIDAE**

Diplodontias dilatatus (Perrier)
Diplodontias miliaris (Gray)
Diplodontias robustus Fell
Eurygonias hyalacanthus Farquhar
Hoplaster kupe McKnight
Odontaster aucklandensis McKnight
Odontaster benhami (Mortensen)
Odontaster penicillatus (Philippi)
**Odontaster rosagemmae* n.sp.

Family **CHAETASTERIDAE**

Chaetaster moorei Bell

Superfamily **GANERIOIDEA**
Family **GANERIIDAE**

Cycethra frigida (Koehler)
**Hyalinothrix millespina* Fisher
Knightaster bakeri H.E.S. Clark
Tarachaster australis McKnight

Family **ASTERINIDAE**

Anseropoda aotearoa McKnight
Asterina alba H.L. Clark
Asterina anomala H.L. Clark
Asterina heteractis H.L. Clark
Asterina inopinata Livingstone
Nepanthia belcheri (Perrier)
**Nepanthia grangei* n.sp.
**Nepanthia reinga* n.sp.
Paranepanthia aucklandensis (Koehler)
Patiriella exigua (Lamarck)
Patiriella gunni (Gray)
Patiriella oliveri Benham
Patiriella pseudoexigua Dartnall
Patiriella regularis Verrill
Stegnaster inflatus (Hutton)
**Tremaster mirabilis novaecaledoniae* Jangoux

Family **PORANIIDAE**

Marginaster sp.
Porania antarctica antarctica Smith

Superfamily **OPHIDIASTEROIDEA**
Family **OPHIDIASTERIDAE**

Dactylosaster cylindricus (Lamarck)
Dissogenes petersi Jangoux
Fromia milleporella (Lamarck)
Fromia monilis Perrier
Fromia polypora H.L. Clark
Gomophia watsoni (Livingstone)
Heteronardoa carinata (Koehler)
Leiaster leachii (Gray)
Leiaster speciosus von Martens
Linckia guildingi Gray
Linckia laevigata (Linnaeus)
Linckia multifora (Linnaeus)
**Nardoa* cf. *tumulosa* Fisher
Neoferdina cumingi (Gray)
Oneria tasmanensis Rowe
Ophidiaster confertus H.L. Clark
Ophidiaster hemprichi Müller & Troschel
Ophidiaster kermadecensis Benham
Ophidiaster macknighti H.E.S. Clark
Tamaria tenellus (Fisher)
**Tamaria giffordensis* n.sp.

Family **MITHRODIIDAE**
Mithrodia clavigera (Lamarck)

Superfamily **OREASTEROIDEA**
Family **OREASTERIDAE**

Acheronaster tumidus H.E.S. Clark

Family **ASTEROPSEIDAE**

Asteropsis carinifera (Lamarck)
Pectricia vernicina (Lamarck)

Family **ACANTHASTERIDAE**

Acanthaster brevispinus Fisher
Acanthaster planci (Linnaeus)

SUPERFAMILY GONIASTERACEA
Family GONIASTERIDAE

by

Helen E.S. Clark

Superfamily **GONIASTERACEA**
Family **GONIASTERIDAE** Forbes, 1841

Goniasteriae Forbes, 1841: 77.

Goniasteridae Perrier 1875: 185; 1876: 1; Verrill 1899: 145; Fisher 1911a: 158; H.L. Clark 1916: 33; Fisher 1919: 220; H.L. Clark 1923b: 252; Mortensen 1927: 78; Macan 1938: 355; Fisher 1940: 117; H.L. Clark 1946: 81; D'yakonov 1950: 35; Fell 1958: 8; 1959: 135; 1960: 61; A.M. Clark 1962: 22; Bernasconi 1963: 1; 1964: 252; Tortonese 1965: 155; Spencer & Wright 1966: U56; H.E.S. Clark 1970: 3, 19; Halpern 1970a: 193; Tommasi 1970: 11; Downey 1973: 46; McKnight 1973a: 171; Carrera-Rodriguez & Tommasi 1977: 91; Blake 1987: 519; Imaoka *et al.* 1990: 46; 1991: 52; A.M. Clark & Downey 1992: 226; A.M. Clark 1993: 240; Rowe & Gates 1995: 63.

Pentagonasteridae Perrier 1884: 231; Sladen 1889: 260; Perrier 1894: 332.

Antheneidae Perrier 1884: 231.

Pentopliidae H.E.S. Clark 1971: 545.

Disc generally large, pentagonal, arms 5, occasionally 4; interbrachial arcs well-rounded. Arms usually short, blunt; exceptionally arms long, slender, even pointed. Marginal plates forming an even and conspicuous edge to disc and arms, particularly interradially where edge of disc is high. Marginal plates often with a granular covering; sometimes plates naked, ringed with granules. Abactinal plates also sometimes naked or ringed with granules, or there may be a cover of granules and even short, sturdy spines. Abactinal plates often tesselate (plates form a close mosaic) or there may be secondary plates or slender connecting ossicles; the last 2 most obvious from the coelomic side. Pedicellariae often present, generally conspicuous, valvate. Papulae generally single, sometimes restricted to well-defined radial areas; papularia on abactinal surface. Tubefeet with distinct sucking discs.

H.L. Clark (1946: 81) stated of the family Goniasteridae, they "show extraordinary diversity in form

TABULAR CHECKLIST FOR GENERA (partly after A.M. Clark & Downey 1992).

Genus	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Anthenoides	l	f	c	s	a	w	a	n	s	+4	a	a	a/p	a	p	i	a
**Calliaster*	p/l	c/f	f	a/s	a	w	a	n	s	+4	a						
Ceramaster	p/l	p/t	c	s	a	w	a	n	s	+4	a	a	a	a	a	i	a
Ekonomiaster	p	f	n	s	a	w	p	n	s	+4	a	a	a	?a	?a	?i	a
Enigmaster	p	c/f	c	s	a	c	a	n	s	-4/+4	p	a	a	a	a	i	a
Gilbertaster	l	f	c	s	a	w	a	n	s	-4	a	a	a	a	a	i	a
+*Glyphodiscus*	l	f	f	a	a	w	a	n	s	+4	a	+					
Hippasteria	p	f	f	s	a	w	a	n	s	-4	a	a	?p	a	p	i	a
Kermitaster	l	f	c	s	a	w	a	n	a/s	+4	a	a	a	a	a	r	a
Lithosoma	l	f	l	a	a	w	a	n	s	+4	a	a	a	a	a	r	p
Mediaster	l	t	c	s	a	w	a	n	s	+4	a	a	p	p	a	r	a
**Milteliphaster*	l	c/f	n	s	a	w	a	n	s	+4	a	a					
Paragonaster	l	t	c	s	a	w	a	n	a/s	+4	a	p	a	a	a	a/i	a
Pentagonaster	p	c/f	f/n	s	a	w	a	y	s	-4	a	a	a	a	a	i	a
Philonaster	P	t	c	s	p	w	a	n	s	-4	a	a	a	a	a	i	a
Pillsburiaster	p/l	t	c	s	a	w	a	n	s	+4	a	a	a	a	p	i	a
Plinthaster	p	c/f	c	s	a	w	a	n	s	+4	a	a	a	a	a	i	a
Pseudarchaster	l	p/t	c	s	a	w	a	n	a	+4	a	p	a	p	a	i	a
**Pseudoceramaster*	l	f	c	s	a	w	a	n	s	+4	a	a					
Rosaster	l	t	c	a	a	w	a	n	s	+4	a	a	p	a	a	i	a
Sphaerodiscus	p	f/t	c	s	a	w	a	n	s	+4	a	a	a	a	a	a	a

This tabular checklist is based on New Zealand specimens.

1 Form:
p - pentagonal
l - arms well developed, distinct from disc, long, often slender

2 Abactinal plates:
c - convex (tumid)
f - flat
p - paxilliform
t - tabulate

3 Abactinal plates:
c - covered by (generally) granules
f - fringed by granules or short spines; more or less naked centrally
n - naked; occasional small glassy bosses present

4 Abactinal plates on arms:
a - not obvious, because marginal plates meet in midline
l - larger than disc plates
s - similar to, or smaller than, disc plates

5 Unpaired distinct, naked, abactinal plates present near arm tips:
a - absent
p - present

6 Marginal plates form:
c - confused, disordered edge to disc and arms
w - well-ordered, distinct edge to disc and arms

7 Interradially, an odd pair of marginal plates is:
a - absent
p - present

8 Inferomarginal plates continue beyond terminal superomarginal plate:
n - no
y - yes

9 Adambulacral plates with furrow margin:
a - angular, with apophyses distally
s - straight or gently curved, no apophyses

10 Adambulacral furrow spines:
- 4
+ 4

11 Distinct rungs (bars) present at bottom of ambulacral grooves:
a - absent
p - present

12 Unpaired oral furrow spine:
a - absent
p - present

13 Connecting bars (ossicles) present between abactinal plates (generally most obvious from coelomic side):
a - absent
p - present

14 Superambulacral plates (visible after dissection):
a - absent
p - present

15 Partial interradial septa, obvious only after dissection:
a - absent
p - present

16 Gonads
a - not seen
i - interradial, a single tuft on either side of the interradial septum
r - rows of individual gonads present interradially, at angle to septum

17 Calcareous plates, small, in interradial septa:
a - absent
p - present

* - generally a single specimen, no dissection
+ - specimen not seen

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and size, but most of them are relatively large and conspicuous. The most brilliantly coloured and beautiful sea-stars of Australia are with a few exceptions goniasterids." This is also true for the New Zealand goniasterids.

Anthenoides Perrier, 1881

Disc broad, arms 5, narrow; body covered, both abactinally and actinally, by a skin of varying thickness. Interradial arcs wide, well rounded. Marginal plates well developed, inferomarginals projecting beyond superomarginals.

TYPE SPECIES: *Anthenoides peircei* Perrier, 1881

TYPE LOCALITY: Windward Islands, West Indies.

REMARKS: Hyman (1955: 287) remarked that, in some genera of the Goniasteridae, *Anthenoides* included, "the gonads are numerous, occurring in a row along the side of each arm, each with a separate gonopore." However, in specimens of *Anthenoides cristatus* (Sladen) and *A. granulosus* Fisher, dissected in the course of the present work, the gonads are inter-radial, not serial, and present as a distinct cluster on either side of the interradial septum.

DISTRIBUTION: A.M. Clark and Downey (1992: 228) recorded only one species of *Anthenoides, A. peircei* from the Atlantic (*A. brasiliensis* Bernasconi is included as a

synonym). In the Pacific the genus is recorded from southern South America, Australia (Rowe & Gates (1995) recorded two species from Australian waters), and New Zealand. Yulin and A.M. Clark (1989) described two new species of *Anthenoides*, *A. laevigatus* and *A. tenuis* from Hainan Island in the South China Sea, in 107–270 m. *Anthenoides tenuis* is similar to *A. cristatus* and *A. laevigatus* seems close to *A. lithosorus* Fisher (1913, 1919) which is recorded from near Hong Kong in 380 m.

KEY TO NEW ZEALAND SPECIES OF *ANTHENOIDES*

1 (2) Distinct, short inferomarginal spines present, at least interradially ..... *cristatus*

2 (1) No distinct short inferomarginal spines present; although inferomarginal granules may be larger interradially

3 (4) Straight pedicellariae present, conspicuous, numerous, especially on abactinal and adambulacral plates .... *granulosus*

4 (3) Pedicellariae rare; if present, restricted to adambulacral plates ..... *epixanthus*

Anthenoides cristatus (Sladen, 1889) (Pl. 1, Fig. 4)

Leptogonaster cristatus Sladen, 1889: 327, pl. 54(1–7).
Anthenoides cristatus: Fisher 1919: 329, pls 78(1, 2), 88(1), 89(1); Macan 1938: 403, pls 3(5), 5(1); McKnight 1973a: 192; Yulin & A.M. Clark 1989: 41; A.M. Clark 1993: 241.

MATERIAL EXAMINED:

NZOI Stns: F915(2), I5(1), I6(1), I345(1), I346(6), Z2364(1), Z8263(1), Z8568(1), Z8985(1), Z8993(1), Z9009(3), Z9019(1), Z9604(1).

NMNZ: Bay of Plenty: Ech. 7390(1).

SIZE: R varies between 115 and 24 mm, r varies between 43 and 9 mm. Average R/r (12 specimens) 63/26 mm, R/r = 2/4.

DISTRIBUTION: Philippine Islands, Gulf of Aden, and this report, northern New Zealand (North Cape to Bay of Plenty).

DEPTH: 117–510 m.

DESCRIPTION: Description is of specimen from NZOI Stn I5, R/r = 66/27 mm.

Disc large, more or less flat, disc centre irregularly inflated; interbrachial arcs large, well rounded. A thin membrane, abactinally and actinally, tending to obscure plate outlines. Arms 5, rather short, broad basally, tapering evenly and quickly to pointed tips.

Terminal arm plates pentagonal, plates studded by many tiny glassy bosses arranged almost regularly; bosses, most obvious near free tip of plate, enveloped in a very fine wrinkled membrane; probably 2 terminal arm spines.

Abactinal plates forming close, regular cover on disc and arms; most obvious radially where there is a conspicuous carinal series; continuing almost to arm tips, last 2 or 3 pairs of superomarginals from opposite sides

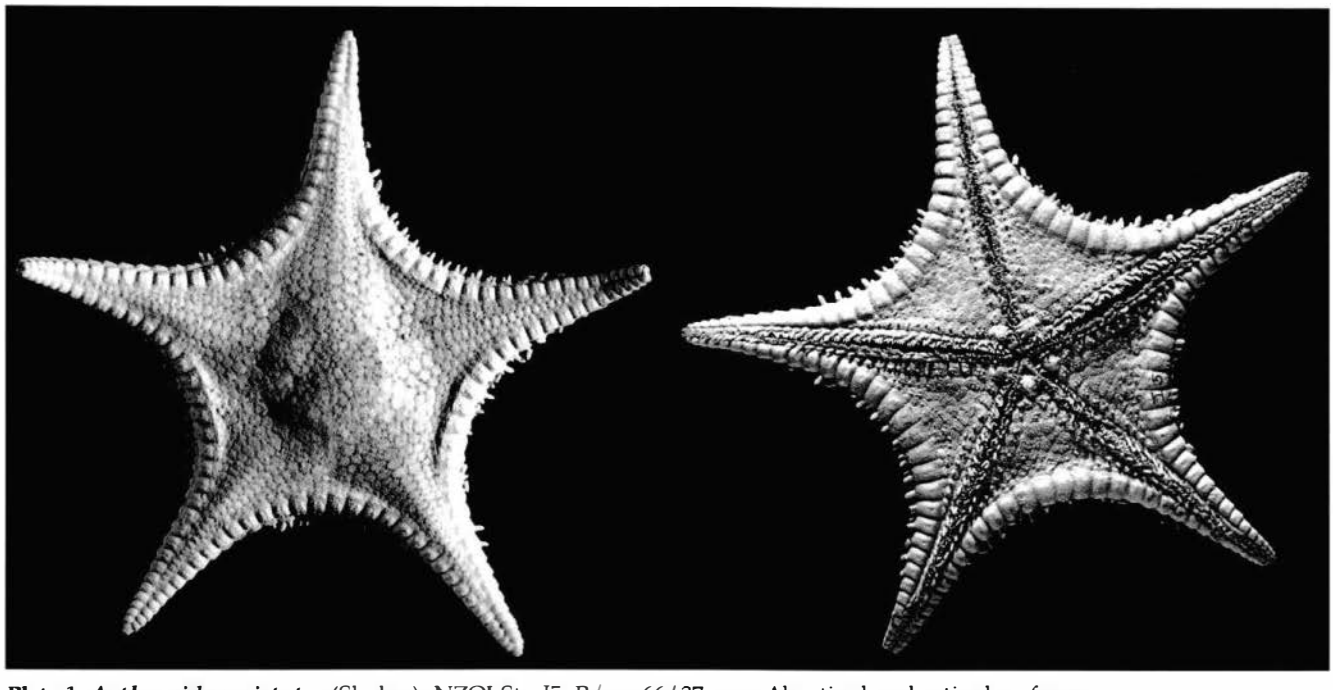


Plate 1. ***Anthenoides cristatus*** (Sladen). NZOI Stn I5. R/r = 66/27 mm. Abactinal and actinal surfaces.

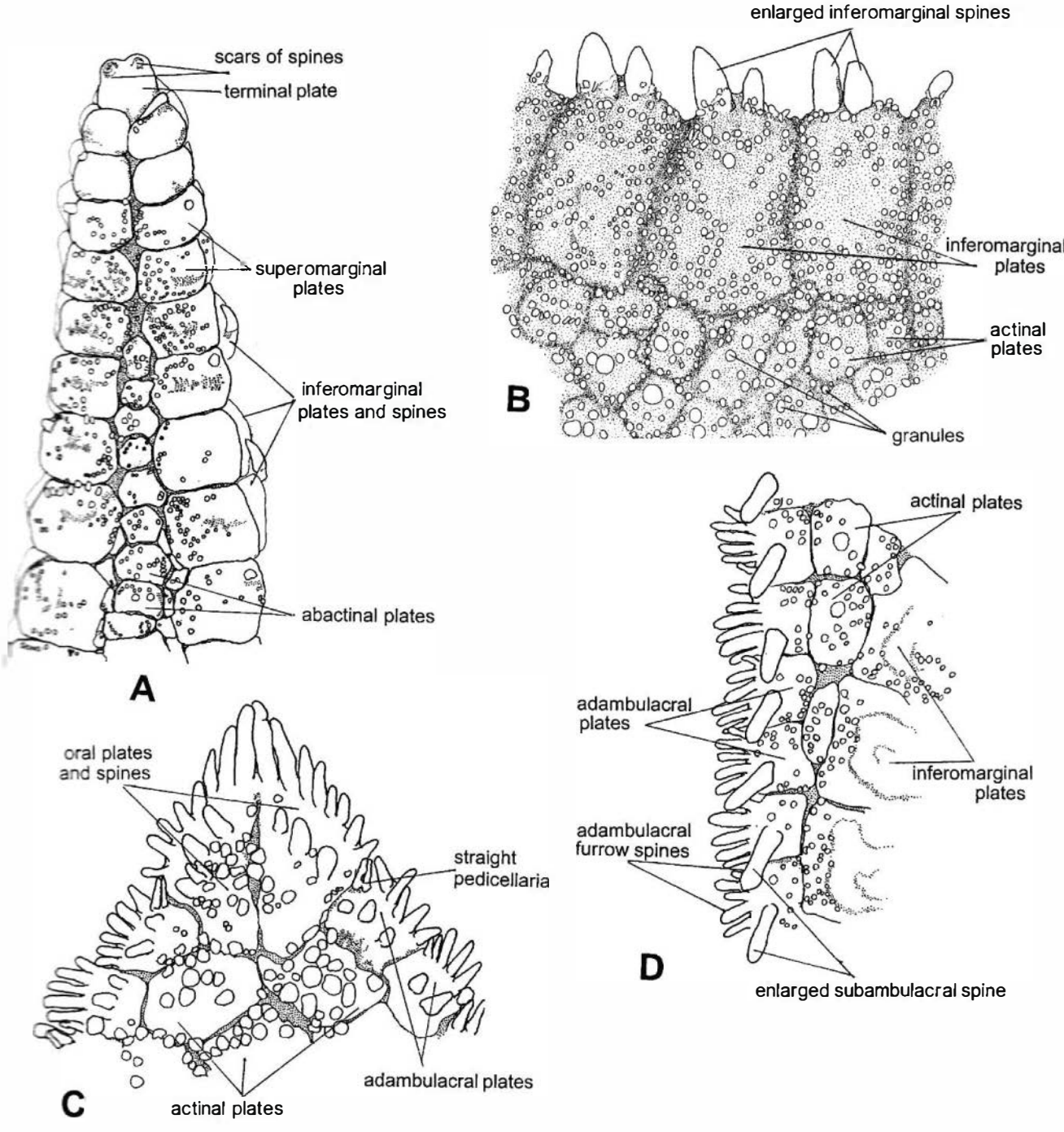


Fig. 4. *Anthenoides cristatus* (Sladen). A. Abactinal view of arm and terminal plate. B. Inferomarginal plates and adjacent actinals. C. Oral plates and adjacent adambulacral and actinal plates. Note the small, straight pedicellaria on first adambulacral plate. D. Adambulacral plates with enlarged subambulacral spine, near arm tip.

of arm in contact medially. A very short ill-defined row of 4 or 5 small, irregularly shaped ?secondary plates border anteriormost carinal plates. On disc and along arms, plates broadly rectangular, almost oval, extending in fairly regular rows on either side of carinal series; near superomarginals plates almost square, smaller, more regularly arranged. Distally, small plates, on either side of carinal series, few, less regularly arranged. Plates bear well-spaced, round, similar-sized finely thorny granules; centrally on plate occasionally 1 or 2 granules enlarged; interradially, plates smaller, rather irregular in shape, forming a very close cover. No en-

larged spines or pedicellariae on abactinal plates.

Papulae most conspicuous radially with generally 6 or 7 around each plate, long, slender, tapering, dark brown, emerging from a distinct round pore guarded by membranous fold or collar. No interradial papulae.

Madreporite small, irregularly round (about 3 mm), interradial, near disc centre; it is finely and deeply dissected with ridges converging centrally.

Anus, interradial very near disc centre, small, inconspicuous, slightly sunken and guarded by 8 or 9 enlarged, thickened, rather tongue-like granules.

Superomarginal plates 17 or 18, present from interradial angle to arm tip; plates rectangular, narrow edge to abactinal surface. Plates tumid centrally, with well-defined edge bordering abactinal surface; plates with spaced round granules similar to, but often larger than, those of abactinal plates. Surface of plates irregular, distinct, circular depressions remain if granules removed. On margin of plate, near inferomarginals, interradially generally 1, sometimes 2, enlarged rounded granules or very short spines, distally only 1 small inconspicuous granule.

Inferomarginal plates corresponding almost exactly to superomarginals, projecting slightly beyond them and visible from above. Inferomarginals with small, spaced, rounded granules similar to those of superomarginals; bearing, at least interradially, 1 or 2, sometimes 3, even 4, conspicuous, almost "tusk-like" spines, forming a well-defined fringe. Inferomarginal plates extending well onto actinal surface; border clear-cut between actinal and marginal plates. Inferomarginal plates tumid; in 1 interradius, on third inferomarginal plate from radial midline, a distinct small bivalved *pedicellaria*; it is very near actinal plates.

Actinal areas triangular, well developed; plates irregular in outline and size except for well-ordered row of rectangular plates bordering adambulacrals. These rectangular plates with scattered, well-spaced, small, round granules similar to those of marginal and abactinal plates; generally 1, sometimes 2, enlarged, well-rounded raised granules (short spines); 1 or 2 of these enlarged granules, especially on more proximal plates adjacent to oral plates, may be modified as a 2-valved rather indistinct pedicellaria. Actinal plates extending along arms to level of 5th inferomarginal plate (from interradial angle), 12th or 13th adambulacral plate. Other actinal plates also with spaced round granules; 1–5 granules may be enlarged, conspicuous.

Adambulacral plates forming regular edge along furrow, with straight or gently rounded furrow margin. Adambulacral furrow spines 6, sometimes 5, slender, tapering, round tipped, spaced; spines, webbed basally, forming even edge to furrow. On some plates posterior furrow spine distinctly shorter. Subambulacral spines short, conspicuous, round headed, in a row parallel to, and well spaced from, furrow spines, occuring on first 2 or 3 proximal most adambulacral plates; posterior granule or spine becoming greatly lengthened and conspicuous, as long as or longer than adambulacral furrow spines, to arm tip. Anteriorly, most adambulacral plates with a single, straight, slender bivalved pedicellaria, usually lying near or against furrow spines; pedicellariae becoming progressively smaller and generally absent altogether from last half of arms. Adambulacral plates separated, at least proximally, by distinct membranous areas, often with small granules.

Oral plates tumid, large, 2 oral plates in an angle well separated medianly by broad membranous area; membranous areas often with small, distinct, separate, rounded granules. Furrow spines 8 (on one plate 9), slender, tapering, well spaced, united basally by distinct membrane; anteriormost 2 spines large, thick, sturdy. Behind furrow spines, on raised area of plate, 2 or 3 large, sturdy, suboral spines and sometimes a single bivalved pedicellaria. Small, spaced, rounded granules, similar to those of actinal plates also present; armature of oral plates not crowded.

Ambulacral grooves deep, narrow; *tubefeet* biserial with well-developed sucking discs.

COLOUR: No colour notes of living material; dried (ex ethanol) both surfaces are light brownish-gold, or almost white.

REMARKS: In the present material small specimens lack abactinal pedicellariae, larger specimens (Stns F915, I6, R more than 70 mm) have occasional small, upright, 2-valved abactinal pedicellariae. Macan (1938: 405) recorded that in many of his specimens of *A. cristatus*, irrespective of size, there were no abactinal pedicellariae. Fisher (1919: 329) used the absence of abactinal pedicellariae to separate *Anthenoides sarissa* Alcock from *Anthenoides cristatus* Sladen. Macan (1938: 405) also noted that the number of subambulacral spines or granules was not a reliable character. Certainly, in this material the subambulacral armature is very variable, with generally two or three conspicuous granules or short spines; towards arm tips there is only one subambulacral spine; this is very large, often almost flat, broad tipped and very considerably larger than the furrow spines. The presence or absence of actinal pedicellariae is also very variable; they are found in only two of the present specimens.

However, in the present material the number of adambulacral furrow spines, five, six, occasionally seven, and the number of oral furrow spines, eight, nine, very occasionally 10, is fairly constant. In only one of the present specimens, the specimen described (NZO I Stn I5), are there obvious interradial enlarged

superomarginal granules. There is also variation in the abactinal granulation which may be very sparse or form a close covering as in large specimens (NZOI Stns F915, I6); in larger specimens, abactinal granules very finely thorny.

Two specimens (NZOI Stn I346 : R / r = 63/24; 54/23 mm) were dissected. In both the stomach was full of fine sandy mud with many foraminiferans. There are no obvious *superambulacral plates*; there is, however, distinct thickening and convexity of actinal plates near ambulacral plates. The specimens may be described as follows—

Ambulacral plates very steep, separated medianly by well-developed upper transverse ambulacral muscles. Also a well-developed *median membranous interradial septum*; these septa double, almost tent-like near disc centre, this particularly obvious in the interradius with the stone canal. On either side of the median interradial septum are 5 or 6 small *partial septa* extending from between the 2 series of marginal plates to the actinal plates; the first 1 or 2 of these partial septa correspond to the junctions between two marginal plates, thereafter septa are intermittent and closer together. Two series of holes or *pores*, the most conspicuous between the supero- and inferomarginal plates at plate corners; pores more or less round, distinct, and probably narrow very rapidly between the plates; no obvious external opening between plates (when specimens are examined externally). Other pores, less conspicuous and fewer, present near inferomarginals between actinal plates; these few, smaller, less regular. Possibly these are *gonopores* although again there is no obvious opening to the exterior.

Gonads interradial, lying in dark clusters on either side of the interradial septum, most obvious in larger specimens.

Abactinal plates, viewed from coelomic side, similar in general outline to plates seen from the outside; plates are distinctly lobed, meeting with similar lobes from neighbouring plates, no connecting ossicles between plates along arms; however, near disc centre, occasional oval, oblong, or triangular plates overlap and connect disc plates. Interradial plates forming a close network in a narrow strip; no obvious papulae.

The smallest specimen in the present collection is described: NZOI Stn I346, R / r = 25/10 mm.

Disc well defined, more or less flat, slightly raised centrally; arms 5, tapering rapidly to sharp tips. *Interbrachial arcs* evenly rounded, wide.

Arm tips protected by pentagonal plates studded with very fine glassy bosses; 2 terminal arm spines, 1 on either side, between them are 2 (in 1 arm 3) short, thorny spines.

Abactinal plates very regular, conspicuous; carinal series of 6-sided plates extending from near disc centre almost to arm tips; last 2 or 3 superomarginal plates in partial contact. On either side of carinal series are 2 or 3 rows of smaller but well-defined plates. Interradially, plates regularly arranged, almost brick-shaped and forming a close pavement. A conspicuous mid-interradial suture (shallow gutter, perhaps), running from marginal plates to edge of disc, where it forks becoming broadly Y-shaped; in 1 interradius branches of the Y encompass the madreporite, in the other 4 interradii, sutures terminate in a conspicuous primary plate. All abactinal plates with dusting of fine, well-spaced, rounded granules.

Papulae conspicuous radially, 1 at each corner of carinal plates and present between plates bordering carinals; papulae absent from disc centre and interradially.

Only 1 *pedicellaria* on an inferomarginal plate interradially; small, straight, bivalved, and near actinal surface.

Madreporite, slightly nearer disc centre, small, round, deeply and evenly dissected. It lies at "head" of mid-interradial suture or gutter, as described above.

Anus, almost central on disc, between 4 gently tumid plates, surrounded by enlarged granules or small plates.

Superomarginal plates conspicuous, forming well-defined edge to disc and arms; tumid with scattered round granules and no enlarged spines.

Inferomarginals not projecting beyond superomarginals, with scattered granules and generally at least 1, often 2, enlarged granules on free edge of plate, at least 1 enlarged granule on distal free edge of inferomarginals, almost to arm tips.

Actinal areas well defined, plates rather irregular in shape but forming almost transverse rows, largest adjacent to adambulacrals. Plates with 1–4 enlarged central granules, otherwise naked apart from very occasional tiny infrequent granules.

Adambulacral plates distinct, forming well-ordered edge to furrow, rectangular, long edge to furrow. Plates separated laterally by distinct membranous areas; 5, sometimes 6, furrow spines, anteriormost and posterior spines often very small; spines united in membrane for about one-quarter their length. Generally 2, sometimes 3, round-headed granules (very short spines) on outer actinal edge of plate. Towards arm tip, 1 conspicuous subambulacral spine, as long as or longer than furrow spines.

Oral plates tumid, very regular with 7 or 8 conspicuous well-separated furrow spines, anteriormost 2 spines overhanging mouth, largest; all spines united basally by membrane; 2 or 3 enlarged granules actinally, small granules also, generally parallel to furrow.

Adambulacral grooves deep, narrow; *tubefeet* obscured by adambulacral furrow spines.

Anthenoides epixanthus (Fisher, 1906) (Pl. 2, Fig. 5)

Antheniaster epixanthus Fisher, 1906: 1067, pls 20(3), 26(1, 1a-c), 29(1, 2), 49(1).
Anthenoides epixanthus: Fisher 1919: 328; Hayashi 1952: 152, pl. 8(10, 11); Yulin & A.M. Clark 1989: 39; A.M. Clark 1993: 242.

MATERIAL EXAMINED: NZOI Stn Z2369 (1).

SIZE: R/r = 56/24 mm.

DISTRIBUTION: In New Zealand known only from the Bay of Plenty, North Island; elsewhere from Hawaii, Japan, and recently New South Wales, Australia.

DEPTH: 100-488 m.

DESCRIPTION: The only specimen recorded from New Zealand waters (Stn Z2369) is described, R/r = 56/24 mm.

Disc more or less flat, gently raised along midline of arms; arms upturned, flattened dorsoventrally, only 1 arm tip intact; interbrachial arcs widely and evenly rounded; single remaining arm tip protected by more or less pentagonal apical (terminal) plate studded by minute glassy bosses, with possibly 2 apical spines.

Abactinal plates distinct, despite enveloping membrane, until near arm tips; last 3 or 4 superomarginal plates more or less in contact although with occasional small abactinal plates sandwiched between them. Carinal plates large, regular, rectangular to hexagonal, particularly obvious and maximum size at beginning of arms. On disc, plates irregular in shape and distribution, often almost round or oval, separated by similarly shaped, smaller plates. Interradially, plates close-fitting, often rectangular, distinctive; near superomarginals plates smaller, rather brick-like; no papulae. All abactinal plates with dusting of small, well-spaced round granules, few towards arm tips, indistinct, possibly due to wear and handling of specimen. Radial midrow of plates, *carinals*, conspicuous; plates flanked by rows of smaller round or oval secondary plates; generally 2 small plates correspond to 1 radial plate, these secondary plates obvious from near disc centre to where arm narrows. Outside small secondary plates, 3 or 4 rows of rectangular or hexagonal plates; near superomarginals, plates narrow, rectangular, crowded. No abactinal paxillae.

Papulae especially obvious along midline of arms, few, scattered, tiny, at disc centre; outer disc plates with very small papulae, generally 2 to a plate. Further along arms, papulae distinct, at beginning of carinal series 6, even 7, at plate corners, towards arm tips, only 4.

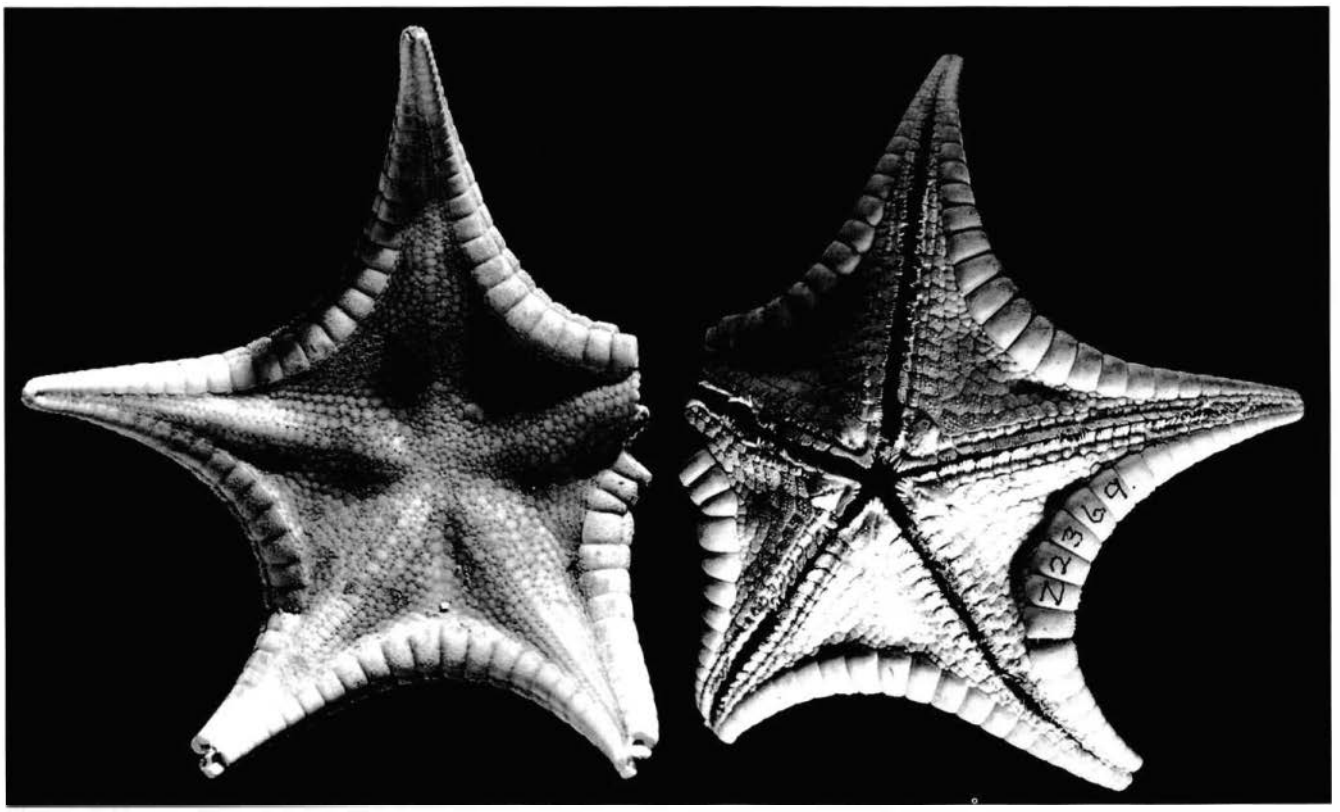


Plate 2. ***Anthenoides expianthus*** (Fisher). NZOI Stn Z2369. R/r - 56/24 mm. Abactinal and actinal surfaces.

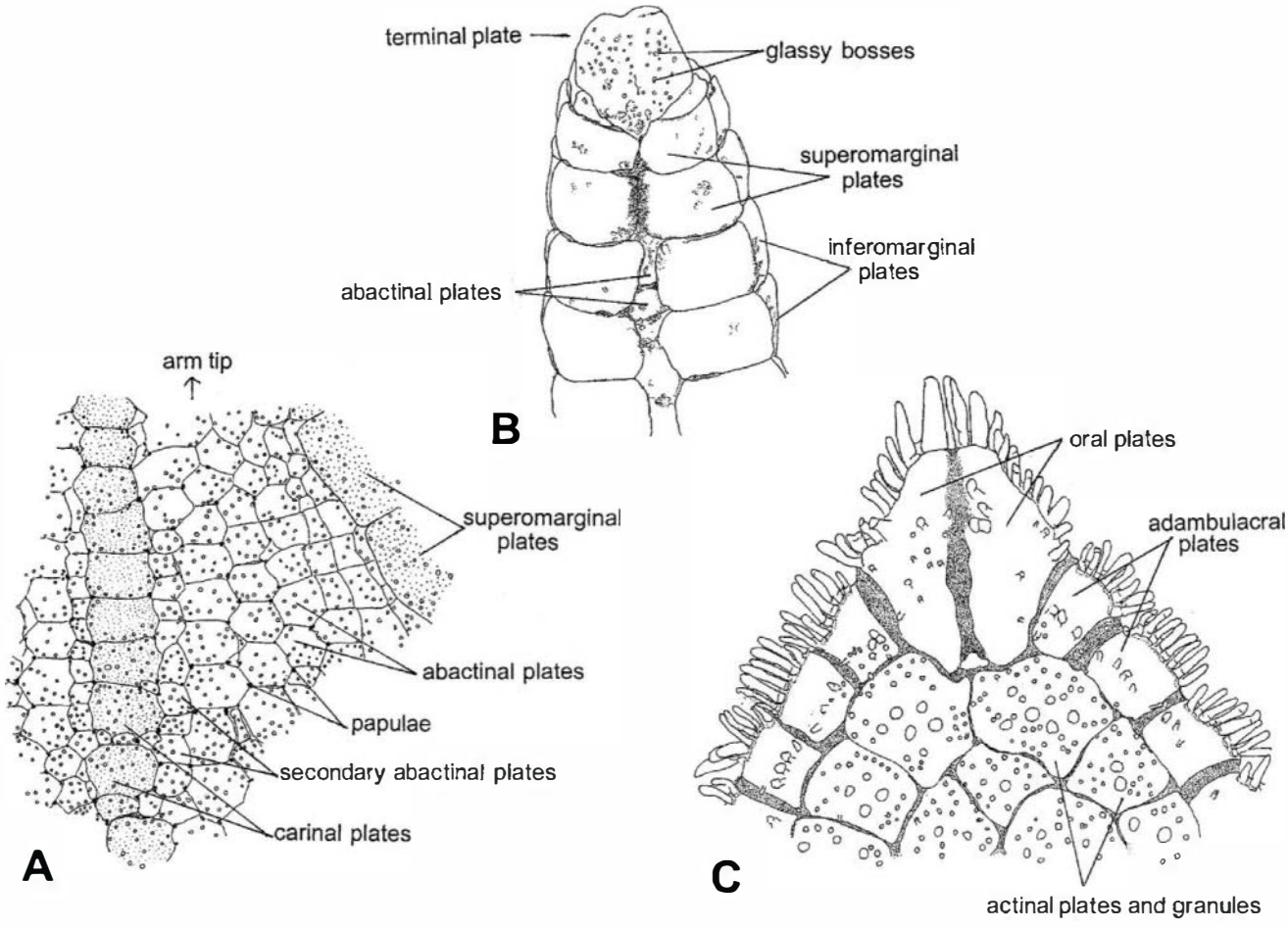


Fig. 5. ***Anthenoides epixanthus*** (Fisher). A. Abactinal plates near entrance to arm, both carinal and superomarginal plates are stippled. **B**. Arm tip. Note small glassy bosses on terminal plate. **C**. Oral plates and adjacent adambulacral and actinal plates. Note the absence of pedicellariae.

Papulae distinct for about half arm length; absent from triangular interradial area.

Pedicellariae not seen.

Madreporite interradial near disc centre, raised, tumid, almost circular, well defined, with narrow, very regular striations meeting centrally. Madreporite bordered by 6 or 7 crescent-shaped plates. Granules on plates immediately adjacent to madreporite slightly larger, more conspicuous, forming a distinct edge to madreporite.

Anus distinct, almost central on disc, guarded by 8 or 9 short, round-tipped, sturdy, conspicuous, flattened spines.

Superomarginal plates, 20 from midinterradial angle to arm tip; superomarginals distinct, regular, rectangular, narrow edge to disc; plates well defined; edge adjacent to abactinal plates rounded, distinct. Plates with well-spaced tiny round granules similar to those of abactinal plates; absent or very few on last 5 or 6 superomarginal plates; near inferomarginals however granules more obvious, distinctly larger, rounded. Distinct, shallow circular depressions remain when granules removed. No spines.

Inferomarginals larger, corresponding with superomarginals, forming a very regular raised edge to actinal surface; plates distinctly wedge-shaped with broad edge to actinal plates. Plates with fine dusting of tiny well-spaced granules; on outer edge near superomarginals, granules larger, round-headed (almost short spines), closer together; these enlarged granules most obvious on first 5, sometimes 6, inferomarginal plates on either side of midinterradius.

Actinal areas triangular, distinct, extending to 5th or 6th inferomarginal plate on either side of midline, forming a close, rather irregular cover; plates adjacent to adambulacrals conspicuous, likewise 2 plates immediately adjacent to oral plates large, almost fan-shaped; other plates rectangular to almost square, becoming smaller, almost oval at level of 5th inferomarginal (10th adambulacral) plate. Plates with small,

rounded granules, well spaced, occasionally 1 or several central granules larger. Plates bordering adambulacrals with as many as 5 enlarged central granules. No pedicellariae.

Adambulacral plates well defined, regularly rectangular; well separated laterally from one another by a conspicuous membranous area or path. Each plate has a weakly convex furrow margin with 8, or distally 9, conspicuous furrow spines, united basally (for less than half their length) by a membrane; anteriormost and posterior spines distinctly shorter. Subambulacral armature well separated from furrow spines, sparse, generally a single row of 2-4 small, raised, rounded granules, very small, irregular, and just visible, or further out along arms distinctly spine-like with only 1 or 2 spines or granules; remainder of plate naked. Small granules often on membranous areas between plates.

Oral plates well defined, tumid, bordered by 12 or 13 furrow spines, webbed basally, compressed laterally and standing narrow edge to plate and furrow; anteriormost 2 spines large, flat, leaf-like, well spaced; 2 plates in an angle separated medianly and anteriorly by a distinct membranous area; suboral granules sparse, well separated, of varying sizes; on 1 oral plate 3 distinct, short, round-headed spines bordering membranous area between 2 plates. Where plates are rounded, 2 plates in an angle well separated actinally. Smallest furrow spine, near first adambulacral plates often inset from margin.

Ambulacral grooves deep, narrow, *tubefeet* biserial with distinct sucking discs.

COLOUR: No colour notes of living material, dried (ex ethanol) colour is light to darker brown; midradially, actinal plates and some marginals white. Actinal surface white or pale brown.

REMARKS: The present single specimen agrees reasonably well with Fisher's (1906) type description of a specimen from Hawaiian waters. Fisher (1906: 1068) recorded more numerous (six to eight) subambulacral granules; there are seldom more than three or four in the present specimen but they are, obviously, easily lost. In the present specimen distally (last quarter or less) of arm subambulacral granules become enlarged to form distinct and obvious spines; Fisher recorded this also. The present specimen has no subambulacral pedicellariae; Fisher illustrated pedicellariae but remarked (1906: 1069) that it is a very variable character; he also recorded six to eight adambulacral furrow spines; in the present specimen there are eight or nine. Fisher noted 11 oral furrow spines in his material; in the present and smaller specimen there are 12 and 13. Hayashi (1952) described two small sea-stars from near Seto, Japan; he considered these to be young slender-rayed forms of *A. epixanthus*. Yulin and A.M. Clark (1989: 39) compared *A. epixanthus* with their new species *A. laevigatus*; they described the carinal series in *A. epixanthus* as not being "clearly distinguishable" (1989: 39). Carinal plates are certainly very obvious in the present specimen; Yulin and A.M. Clark also questioned (1989: 41) whether Hayashi's specimens of *A. epixanthus* are correctly identified, suggesting that they may belong to their second new species, *Anthenoides tenuis*.

Anthenoides granulosus and *A. epixanthus* are very similar, especially in the number of adambulacral and oral furrow spines; whether the presence or absence of abactinal pedicellariae (and this is a very variable character anyway) and differences in the armature of the abactinal plates is sufficient to warrant two species, is debatable. Unfortunately, there is only a single specimen of *A. epixanthus* in the present collections; it was not dissected. Examination of more material suggests that there is a strong possibility that both *A. epixanthus* and *A. granulosus* may eventually be recognised as synonyms of *A. cristatus*.

Anthenoides granulosus Fisher, 1913 (Pl. 3, Fig. 6)

Anthenoides granulosus Fisher, 1913: 647; 1919: 333, pls 88(2, 3), 94(4, 4a, b); Fell 1958: 12, pl. 1(B); 1959: 135; Baker & H.E.S. Clark 1970: 4; A.M. Clark 1993: 242.

Anthenoides rugulosus Fisher, 1913: 648; 1919: 338, pls 85(4), 88(4), 90(1), 94(5, 5a,b); Rowe 1989: 289; Rowe & Gates 1995: 63; A.M. Clark 1993: 242 [new synonymy].

MATERIAL EXAMINED:

NZOI Stns F914(1), I24(1), I351(3), K804(5), P40(3), Z1926 (1), Z2363(1), Z2366(1), Z8994(1), Z9001(1), Z9003(9), Z9005 (1), Z9011(1), Z9020(1), Z9022(1), KAH9401/2(1).

NMNZ: Bay of Islands: Ech. 851(2), 1680(1); Bay of Plenty: Ech. 727(1), 738(3), 1598(2), 1603(2), 5318(3), 6492(1), 7381 (3), 7391(1), 7392(1), 7393(3); near Great Barrier Island: Ech. 1014(1); Mernoo Bank, Chatham Rise: Ech. 7422(1).

SIZE: R varies between 150 and 16 mm; r from 65 to 5 mm; average R/r for 16 specimens, 83/39 mm (measurements are often very difficult as specimens are dried with upturned arms, or, as in the case of the largest specimens, with a contorted disc).

DISTRIBUTION: Philippine Islands, Moluccas, New South Wales, Australia, Norfolk Island, near Raoul Island, Kermadecs, and northern New Zealand.

DEPTH: 143–731 m.

DESCRIPTION: Description is of specimen from NZOI Stn F914, R/r = 95/44 mm.

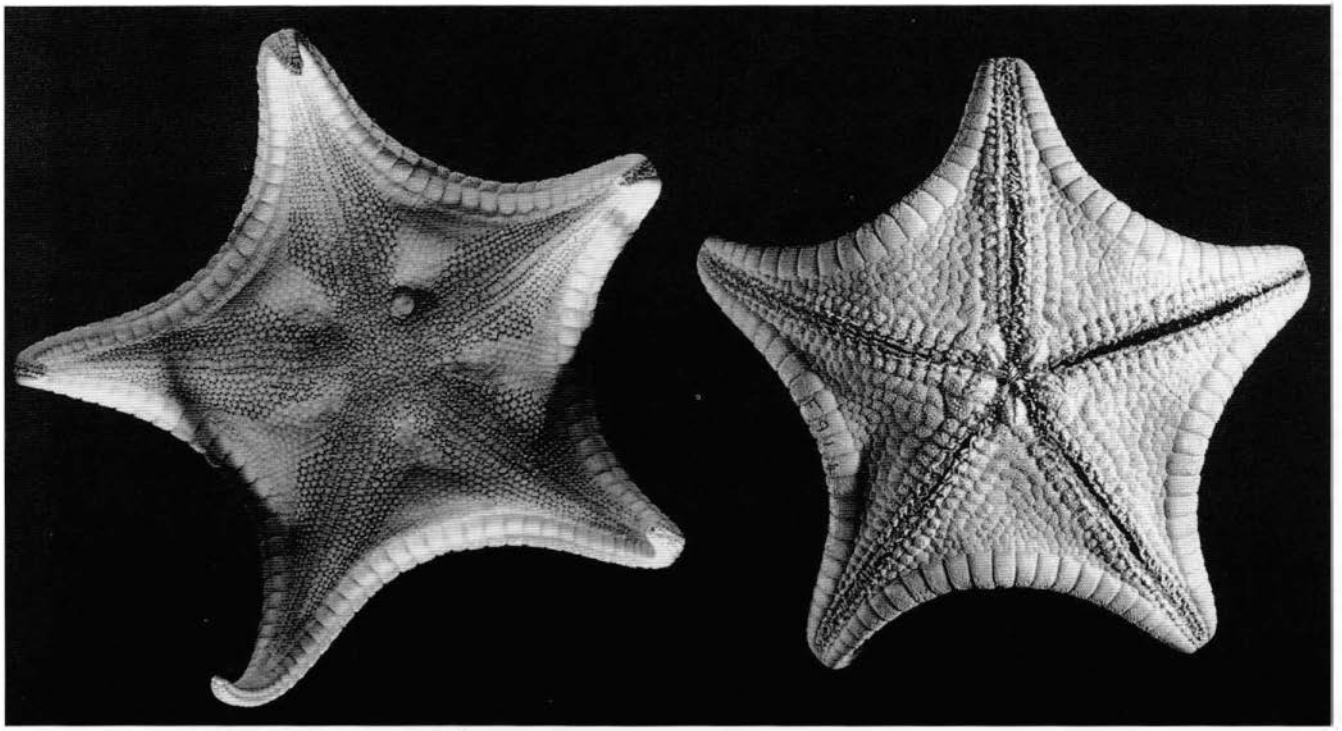


Plate 3. *Anthenoides granulosus* Fisher. NZOI Stn F914. R/r = 95/44 mm. Abactinal and actinal surfaces.

Disc large, very distinct, more or less flat except for gently inflated carinal areas. Arms short in relation to broad disc; interbrachial arcs wide, well rounded. Arm tips protected by small, almost pentagonal plates, with generally 2 (in one case 3) small, short, blunt-tipped spines; 3 arm tips broken.

Abactinal surface covered by membrane; plate outlines rather indistinct, arrangement of plates best seen with naked eye. Carinal series of rectangular plates conspicuous from near centre of disc to last quarter of arms; last 5–7 superomarginal plates, from opposite sides of arm, in contact; series flanked by small, rather inconspicuous square, oval, round, secondary plates, present for about two-thirds R. Plates on either side of secondary series extend in regular rows to superomarginals, and more or less hexagonal. Plates with an even covering of spaced, finely thorny, short spines or granules, with short, scattered, upright, straight, white *pedicellariae*, most conspicuous near disc margins and on papular areas; towards arm tips pedicellariae few, seldom more than 1 to a plate. Interradial areas conspicuous, almost mitre-shaped with narrow strip bordering superomarginal plates for almost half arm length; these plates square to rectangular, very compact, with an occasional pedicellaria; no papulae. Plates very regularly arranged in longitudinal rows with granules similar to those already described. Distinct conspicuous channels (shallow, naked, membranous gutters), run from edge of each superomarginal plate towards disc; most conspicuous near marginal plates.

Papulae conspicuous; papular areas form hastate area on arms and disc, with sharp point obvious near arm tips. Carinal and other radial plates with generally 6 (occasionally 7 or 8) conspicuous lateral papulae; small secondary plates with seldom more than 2 or 3 papulae; papulae present on disc, but absent from circular area surrounding anus at disc centre, and absent interradially.

Pedicellariae, already described, most obvious along arm edges; conspicuously white against dark brown or gold-brown plates. At the base of each pedicellaria often a shallow membranous rectangular pit or trough.

Madreporite interradial and near disc centre, more or less oval, pit or trough present, not particularly raised, slightly angular, well defined, finely dissected, with ridges meeting centrally. A distinct hole at 1 edge, opening to a short channel at a steep angle under madreporite; plates immediately surrounding madrep-orite not particularly conspicuous.

Anus central on disc, conspicuous, surrounded by a number of blunt-tipped spines; the 7 or 8 surrounding plates round, gently raised.

Superomarginal plates forming a well-defined and very regular edge to disc and arms; 50 superomarginal plates in an interbrachial arc; plates rectangular, narrow edge to abactinal plates. Plates with small, regularly spaced granules, finely thorny, largest centrally, and

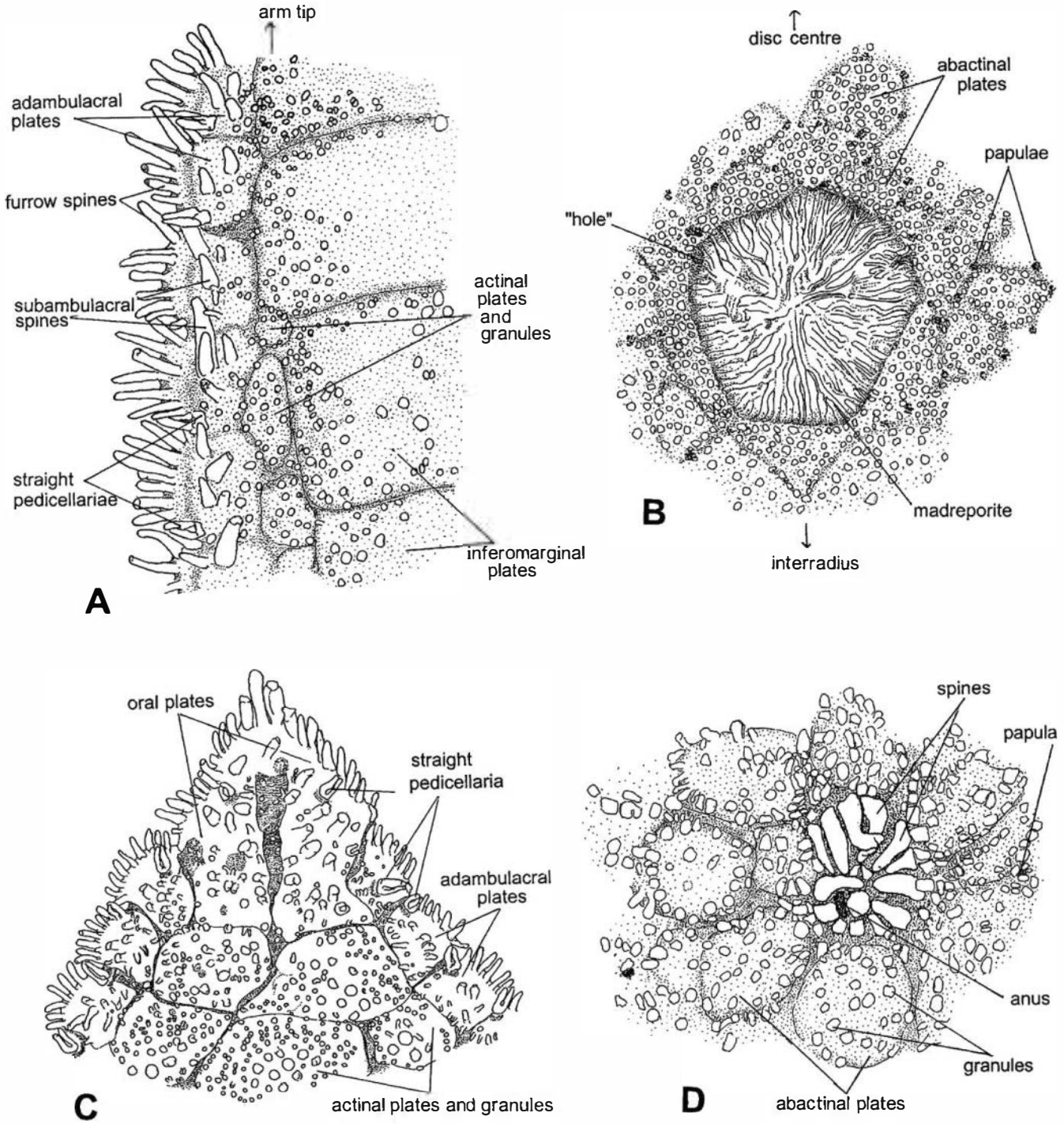


Fig. 6. *Anthenoides granulosus* Fisher. **A**. Ambulacrals and associated plates towards arm tip. **B**. Madreporite near disc centre. Note the curious "hole" in madreporite, and absence of papulae interradially. **C**. Oral angle with adambulacral and actinal plates. Note the straight pedicellariae. **D**. Abactinal plates and anus near disc centre. Note the spines surrounding the anus.

enveloped in membrane; no enlarged spines, no pedicellariae.

Inferomarginal plates corresponding with superomarginals, projecting beyond them to form a definite edge to disc and arms, longer than superomarginals and forming a conspicuously wide border actinally. Inferomarginals with spaced granules similar to those of superomarginal plates; however, on free edge of plate (ventrolaterally) granules or short spines are conspicuously enlarged forming almost straight rows.

On actinal surface of plates granules abruptly smaller, well spaced, more or less irregular in distribution and similar to granules of actinal plates. Distinct narrow channels or gutters separate plates actinally.

Actinal areas triangular, a well-defined row of more or less pentagonal or rectangular plates bordering adambulacral plates; elsewhere plates irregular in shape and size, forming a close mosaic, covered by a thin membrane; actinal plates present for about half arm length. Plates slightly tumid, with a number of small, well-spaced granules surrounding 2–10 spaced larger granules. Marginally on plates a narrow area free of granules, enhancing plate outline. No pedicellariae or enlarged spines on these central plates; occasional small, upright, bivalved straight pedicellariae on actinal plates near oral plates.

Adambulacral plates forming very regular edge to furrow, rectangular, edge bordering furrow gently convex; plates well separated laterally from one another by distinct muscular areas. Furrow spines 6, 7, 8, occasionally 9; a large (as long as a furrow spine) conspicuous straight pedicellaria proximally on plate, sometimes in a small indentation on lateral edge of plate; occasionally pedicellariae seem to occupy membranous space between plates. A distinct channel or space between furrow and subambulacral spines; subambulacral spines 3, 4, sometimes 5, broken here but probably distinctly longer than furrow spines; several small granules on actinal surface of plate. Furrow spines webbed for first quarter of length; towards arm tips at least 1 conspicuous enlarged subambulacral spine.

Oral plates large, tumid, well separated by membranous areas from adjacent adambulacral and actinal plates; 2 plates in an angle also well separated by membranous area. Furrow spines 12 or 13, webbed for first quarter of length, almost petal-like with narrow edge to furrow, and well spaced. Suboral armature of short granules or spines, and, also, well separated from furrow spines, 2 or 3 tall, straight conspicuous pedicellariae. Membranous areas between plates with scattered small granules.

Ambulacral grooves narrow proximally, broadening centrally, narrow distally; *tubefeet* biserial with small sucking discs.

COLOUR: Dried specimens (ex ethanol) generally golden or light brown with papulae dark and conspicuous. In some specimens, papulae were not conspicuously darker.

REMARKS: Fisher (1919: 338) noted the differences between *Anthenoides granulosus* and *Anthenoides rugulosus*. In the present material the ray length differs considerably; in smaller specimens the rays appear longer and more slender; likewise, although in most of the present specimens the abactinal granulation is fairly uniform, there are, nevertheless, enlarged granules, generally central, here and there. The form of the straight pedicellariae also varies as does the frequency; it seems likely therefore that *A. rugulosus* is a synonym of *A. granulosus*. The armature of the adambulacral and oral plates is very similar in both species; also the presence of secondary abactinal plates, which occur on either side of the carinal series for some distance along the arms. The presence of conspicuous straight bivalved pedicellariae on oral plates behind furrow spines is variable, pedicellariae are present in some specimens and not in others from the same station.

The specimen described (NZOI Stn F914) was dissected: superambulacral plates absent, and ampullae of *tubefeet* double; interradial septa membranous, tough, partial septa are similar to those already described for *A. cristatus*; these partial septa, in *A. granulosus*, are long and reach to the row of plates bordering ambulacrals. *Oral plates*, seen from the coelomic side, are interesting; they are strong and long (in *A. cristatus* the oral plates seen from the coelomic side are small and not particularly conspicuous). *Gonads* interradial, as long clumps of fine, bluntly branching material on either side of interradial septum, extending from near disc centre almost to superomarginal plates; no sign of gonads along arms. Pyloric caecae are present for half arm length; papulae very obvious in clusters around plates, distinctly fewer near arm tips. *Abactinal plates* covered by thick, heavy membrane making outlines difficult to see, but there is certainly a single, conspicuous carinal series of plates, less obvious near arm tip; carinal plates flanked by a row of small round, oval, irregularly shaped secondary plates for about half arm length. *Abactinal plates*, round to oval, close-fitting, and papulae distinct between them. Actinally, from the coelomic side, plates irregular in shape and size except for a conspicuous row of rectangular brick-like plates bordering the ambulacral plates.

Two small specimens (NZOI Stn P40) R/r = 24/9, 22/8 mm are described briefly —

Arms flat, *disc* inflated centrally; interbrachial arcs wide, regularly rounded; marginal plates forming conspicuous edge to disc and arms, inferomarginals not obviously projecting interradially beyond superomarginals; 22–24 superomarginal plates between arm tip and arm tip in an interbrachial angle. *Arm tips* protected by pentagonal plates, at least 2 enlarged terminal spines, although mostly broken in these specimens; last 5 or 6 marginal plates in contact midradially.

Abactinal plates regularly arranged, enveloping membrane thin, inconspicuous, with distinct plate outlines. Carinal series of hexagonal plates obvious from near disc centre along arms to meet superomarginals from opposite sides of arm. No obvious secondary plates on either side of carinals; generally a row of 2 or 3 large plates, as large as, or slightly larger than, carinal plates, on either side of series. Plates immediately adjacent to superomarginals generally small, rectangular, regular.

Abactinal plates with small, fine, widely spaced granules, none obviously enlarged. In both specimens, in most interradii, a distinct line (gutter) running from midinterradius to disc centre.

Papulae very distinct, especially near carinal plates and for short distance into arm. No papulae on disc centre. Interradial areas without papulae, plates very regularly and closely arranged.

No obvious *pedicellariae.*

Madreporite small, oval, interradial, rather coarsely dissected.

Anus more or less central on disc and protected by short spines or enlarged granules, surrounding 5 plates, distinct.

Superomarginal plates smooth, with occasional tiny granules, no enlarged spines.

Inferomarginal plates corresponding with superomarginals forming a distinctly bevelled edge to actinal surface; plates with tiny granules, especially obvious near margins.

Actinal areas triangular, a conspicuous row of rectangular plates bordering adambulacrals; fine scattered granules on plates and occasionally, centrally, 1 enlarged granule.

Adambulacral plates forming regular edge to furrow; conspicuously convex at base of furrow spines; 5 or 6 furrow spines, webbed for half or less than half their length, anteriormost spine often distinctly shorter. Often 1 or 2 enlarged subambulacral granules, not conspicuous, on actinal edge of plate.

Oral plates large, conspicuous, tumid; widely separated near actinal plates and from centre of plates to anterior furrow spines; 7 (on one plate, 8) oral furrow spines, anteriormost 2 spines longer, spines webbed basally. Occasional suboral enlarged granules, generally at apex of plate on either side.

Tubefeet biserial, with suckers; narrow grooves.

Both these young specimens are white with distinctly darker papular pores.

Calliaster Gray, 1840

Arms 5, tapering evenly to blunt tips. Disc large, interradii well rounded, sweeping. Abactinal surface slightly raised, actinal surface flat. Abactinal plates round, rectangular, oval, with fringe of small, generally rectangular, flat-topped granules; a distinct carinal series of plates present, these often tumid, with large spines. Secondary small abactinal plates most obvious at disc centre, generally lacking spines. Marginal plates large, massive, smooth, often with spines or tubercles and fringed by small, generally rectangular granules. Actinal plates, often slightly raised, rectangular or irregular in shape, often with a large central spine or a small straight upright pedicellaria, the latter having a distinct pit scar. Adambulacral plates with regular fringe of furrow spines; subambulacral spines 1, 2, occasionally 3, in row at right angles to furrow spines. Oral plates elongate-triangular, almost diamond-shaped, with 4–7 furrow spines, suboral spines generally 1 or 2. Papulae restricted to abactinal surface, absent near arm tips and interradially; no marginal or actinal papulae. Pedicellariae often on abactinal and actinal plates and occasionally marginal plates.

TYPE SPECIES: *Calliaster childreni* Gray, 1840.

TYPE LOCALITY: Japan.

REMARKS: Aziz and Jangoux (1985: 585) cited *Calliaster* as a "well defined genus, whose validity was never questioned by subsequent authors". They remarked on the close affinity of *Calliaster* to *Hippasteria* and discussed the differences, remarking also on similarities with *Milteliphaster* Alcock, *Astrothauma* Fisher, and *Mabahissaster* Macan. A.M. Clark (1993: 246) listed 11 species of *Calliaster*, four from the Indian Ocean and the others from the Pacific, between 23 and 494 m.

Rowe and Gates (1995: 64) recorded *Calliaster childreni* Gray from Western Australia and the tropical western Pacific (China and Japan) in 121–292 m, and *Calliaster erucaradiatus* Livingstone from the type locality, the southeast coast of New South Wales, in 90 m. Two further specimens of *C. erucaradiatus*, also from the coast of New South Wales, are described here. They were identified by Dr F.W.E. Rowe in 1986. Although they come just outside the geographical range of the present paper they are included for comparison. A new species, *C. thompsonae* from the Bay of Plenty area, is also described; it is the first record of *Calliaster* from New Zealand waters. Rowe and Gates (1995) included *Mabahissaster* Macan (1938) as a synonym of *Calliaster* and both *C. spinosus* H.L. Clark and *C. regenerator* Döderlein were referred to *Milteliphaster* (Alcock (1893). The genus is also known from South Africa, with *C. acanthodes* H.L. Clark and *C. baccatus* Sladen.

KEY TO AUSTRALASIAN SPECIES OF *CALLIASTER*

1(2) Arms long, slender; superomarginal plates from opposite sides of arms separate for at least half arm length . . . . . *thompsonae* n.sp.

2(1) Arms short, stout; superomarginal plates from opposite sides of arms meeting near arm base . . *erucaradiatus*

Calliaster thompsonae n.sp. (Pl. 4, Fig. 7)

MATERIAL EXAMINED:

NZOI Stn Z10578(1). Label: "Bay of Plenty per Dave, Seamount Explorer". There are no coordinates as to where the specimen came from; however, it is from New Zealand waters.

SIZE: All arm tips broken. R/r = approx. 82, 83/24, 25 mm.

DISTRIBUTION: Bay of Plenty, New Zealand.

DEPTH: No depth recorded.

DESCRIPTION:

Disc large, distinct, more or less flat; *arms* 5, sturdy, rapidly and evenly tapering, all arm tips broken, no terminal plates or spines. *Interbrachial arcs* wide, sweeping, gently and evenly rounded. *Disc* well covered with long, slender, tapering, conspicuous, white spines; tumid *superomarginal plates* forming very definite edge to disc and arms.

Abactinal plates comprising large, tumid primary plates and small, distinctly more flattened secondary plates as a close cover on disc and proximally on arms. Abactinal plates round, oval, sometimes rectangular (especially along arms), naked and fringed by at least 1 row of small, generally rectangular granules. Large primary plates very tumid, each with single, generally central, large, sturdy, white, gradually tapering, round-tipped spine, each very finely thorny. Enlarged spines with slight constriction at distinctly rounded base, usually breaking at this point; these spines forming a very conspicuous cover centrally on disc, not present on arms and absent interradially from plates near superomarginals. Interradially, abactinal plates very much smaller, flatter, oval, rounded, often rectangular, with a ring of granules similar to those of larger plates, forming a very close cover, and are more or less of similar size. Most interradial plates with shorter, more slender, white, tapering spine; on some interradial plates, however, especially near superomarginals a single, white, well-rounded granule present; very occasionally 2 such granules well separated, on 1 plate. superomarginal plates (from midpoint, interradially) meet in midline. A quite well defined row of carinal plates along arms, distinctly tumid, oval, rectangular, bearing enlarged central spine, becoming smaller, shorter, distinctly rounded and granule-like along arms; enlarged granules and spines may be absent from distal most carinal plates in series; plates flanking carinal series distinctly flatter, enlarged spines very reduced or absent. A distinct, raised, circular scar remaining when spines removed from plates. The last 1 or 2 plates before superomarginals meeting in midline, slender, tapering, almost pointed; only 1 plate between superomarginals.

Papulae obvious, membranous, often extruded, 4–6 or 7 around each abactinal plate; perhaps less conspicuous interradially where plates tending to form closer cover, but may be absent from row of plates, immediately adjacent to superomarginals; often 4 of them found along arms, to point where superomarginal plates from opposite sides meet.

Pedicellariae small, straight, white, spatulate, especially abactinally on some interradial plates, generally shallow depression left when pedicellariae removed; no obvious holes abactinally. Pedicellariae with short broad-based trunk expanding into rounded, shell-like valve or blade, the valves very thin. Actinal pedicellariae more numerous, especially on proximal plates bordering adambulacrals and on proximal adambulacral plates. Actinal pedicellariae leaving very distinct, generally rectangular or sometimes square pit when lost. No pedicellariae seen on marginal plates.

Madreporite interradial, very near disc centre; small, almost triangular, well raised with worn edges, deeply, finely, and irregularly dissected; bordered by 4 well-defined round or oval, tumid abactinal plates, 3 bearing remains of long spines, 4th plate with single, shorter, more slender spine and, near madreporite, a small, straight, spatulate pedicellaria. Plate with pedicellaria slightly separated from madreporite, a distinct continuous fringe of rectangular granules at base. Other 3 plates with longer spines and no pedicellariae, a rigid and steep boundary with madreporite, no fringing granules.

Anus not obvious.

Superomarginal plates conspicuous, large, tumid, forming a very definite edge to disc and arms; plates rectangular with narrow edge to disc centre and inferomarginals, fringed by single row of very even rectangular, flat-topped granules. Each plate with 2, proximally on first 2 or 3 plates, interradially 3, enlarged spines similar to, but thicker and longer than, enlarged spines of adjoining abactinal plates; enlarged spines well separated on plate, 1 spine near abactinal plates, other near inferomarginals. Where 2 spines present interradially, a third spine, smaller, less robust, dis-

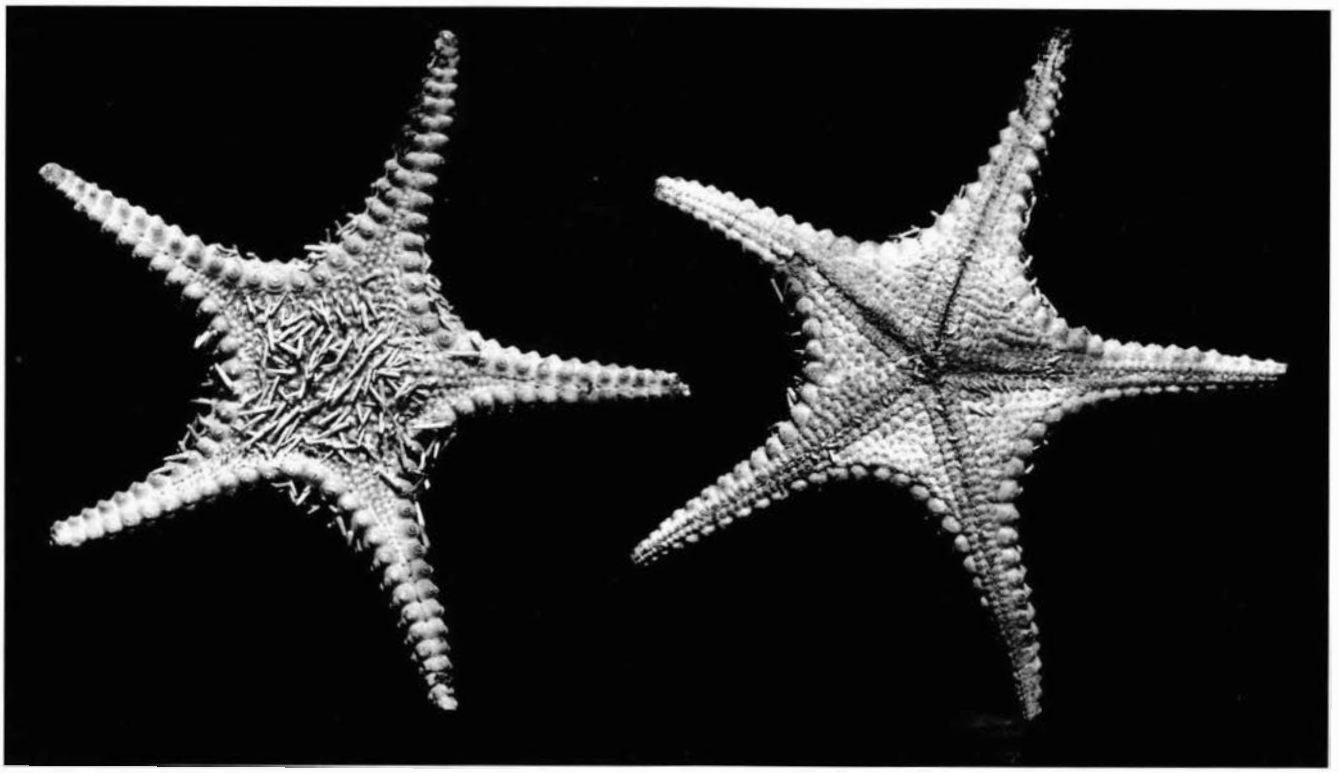


Plate 4. *Calliaster thompsonae* n.sp. Holotype. NZOI Stn Z10578. R/r = approx. 82, 83/24, 25 mm. Abactinal and actinal surfaces.

tinctly shorter, just above lower of 2 big spines. Small, round granules very short; thick spinelets (1 or 2) on plates near base of lower enlarged spines, most obvious interradially. Distally along arms, occasional superomarginal plates with 1 spine only near inferomarginals. Upper edge of superomarginal plates adjacent to abactinal plates fringed by granules, evenly rounded; likewise along arms, with slight irregularities.

Inferomarginal plates corresponding with superomarginals, not very obvious from abactinal surface, slightly less tumid than superomarginals; plates bordered by regular rectangular granules similar to those of superomarginals, and gently rounded on actinal edge. About half of each plate on actinal surface, other half on arm edge. Interradially, inferomarginal plates with 5 (sometimes 6) enlarged spines along plate centre in longitudinal row; many spines lacking, conspicuous scars remaining. Inferomarginal spines very similar to superomarginals, perhaps slightly longer, forming somewhat zig-zag vertical row on plates; a distinct clear area between enlarged spines and actinal surface. Spines adjacent to superomarginal plates probably largest, with very tumid base, resulting in curiously scalloped edge to lower surface of arms. Most enlarged inferomarginal spines missing from this specimen; further out along arm, spines fewer, seldom more than 2 or 3 per plate. Plates naked except for enlarged spines and fringing granules. Most spine scars on plates of similar size, occasionally 1 may be considerably smaller. No pedicellariae on either supero- or inferomarginal plates; a distinct clear area between enlarged spines on inferomarginal plates and actinal plates.

Actinal areas conspicuous, triangular, actinal plates extending to 4th or 5th inferomarginal plates (from interradial angle); from there, inferomarginal plates and adambulacrals in contact. *Actinal plates* regularly arranged, gently tumid, with 1, occasionally 2, enlarged spines near lower (inferomarginal) edge of plate; in most cases spines lost, a raised, round, irregular stump remaining. In only 1 interradius, 2 enlarged spines attached to plates, sturdy, round, tapering, very similar to abactinal and superomarginal enlarged spines. Sometimes, especially near oral plates, a single small, very short spine or rounded granule, generally only 1, occasionally 2 or 3, even 4 in cluster at spine base. A conspicuous, single, almost heart-shaped actinal plate at base of oral plates, with single large spine and several small granules; on at least 1 plate, a small, distinct, rectangular pit, suggesting presence of pedicellaria. Similar pits on some actinal plates bordering adambulacrals. Near inferomarginals, actinal plates small, less regular in shape, most plates with 1 large spine

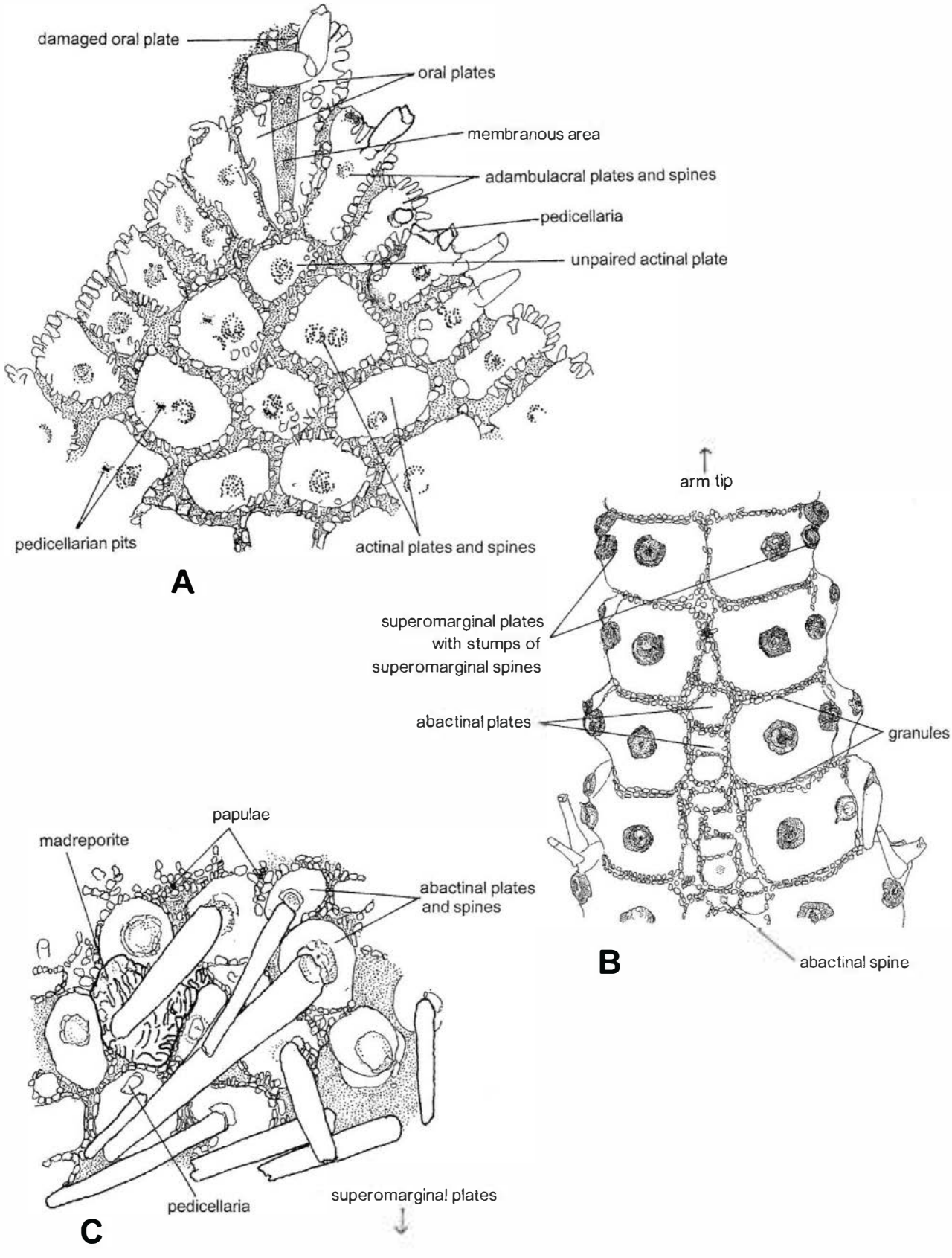


Fig. 7. *Calliaster thompsonae* n.sp. Holotype. A. Actinal, adambulacral, and oral plates with unpaired actinal plates. B. Abactinal view of arm. C. Madreporite and surrounding abactinal plates, spines, and pedicellariae.

spine at one time, obvious scars remaining. On some actinal plates several rows or partial rows of fringing granules. Triangular shape of actinal areas very distinct, well bordered by conspicuous adambulacral and inferomarginal plates.

Adambulacral plates distinct, well ordered, rectangular, with narrow edge to furrow and actinal plates, forming distinctly raised edge to furrow. Adambulacral plates fringed by small granules similar to those fringing actinal plates; on some plates, adjacent to actinals 2, even 3, often well-spaced rows of small granules. Each adambulacral plate with furrow series of generally 6 or 7 (occasionally 8) slender, round-tipped spines, these somewhat compressed, with narrow edge bordering ambulacral grooves and adambulacral plates; distalmost and proximal furrow spines often very small. Most furrow spines with broad base, lining well-rounded free edge of adambulacral plates. Plates often meeting with neighbouring plates from across furrow, obscuring ambulacral grooves. On several proximal adambulacral plates, a distinct, rectangular, deep pedicellarian pit near furrow spines, no actual pedicellariae seen. Most subambulacral spines broken, but 1 or 2 spines still entire, surprisingly long, stretching across about 2 adjacent actinal plates. Distally along arms, scars of 2 enlarged subambulacral spines still present, on most plates forming a slanting row, the upper spine very close to furrow spines. Very occasionally, 3 subambulacral spine scars per plate. Actinal plates between adambulacral and inferomarginal plates to level of 4th or 5th inferomarginal plate from mid-interradial angle. Distally along arms, only 5 or 6 adambulacral furrow spines, small, free edge of adambulacral plates quite conspicuously rounded. Towards arm tips, adambulacral plates meeting with neighbouring plates from across furrow.

Oral plates damaged, almost obscured by protruding stomach; attempts to free oral plates not successful. Oral plates near actinal and adambulacral plates, rather small, almost triangular, 2 plates in an angle well separated by regular, rather narrow, sunken membranous area. Oral furrow spines short, untapering, almost flat-tipped, similar to adambulacral furrow spines, distinct granules along plate edges and on plates where oral plates bordering adambulacral and actinal plates. Overhanging mouth oral plates appearing expanded and distinctly rounded, oral furrow spines longer, sturdier. Granules (or short spines) anteriorly, where plate more rounded and overhanging mouth. Each oral plate with at least 1 large, sturdy, tapering spine; all spines broken here but were obviously large and conspicuous; possibly 2 enlarged spines per plate. In 1 angle only, at tip of plates overhanging mouth, a very large, apparently single spine almost emerging between 2 plates in an angle — possibly represents an unpaired oral spine.

Ambulacral grooves tightly closed in 2 arms, in other arms grooves more or less open for short distance behind oral plates; owing to damage, *tubefeet* difficult to see; some emerging near tips of several arms between adambulacral plates, long, slender, probably in 2 rows, with distinct, narrow-edged conspicuous sucker.

COLOUR: No colour notes are recorded for living specimens. In preservative and dried, the specimen is light brown, with darker scars; all enlarged spines are white.

ETYMOLOGY: This new species is named for Rose-Marie Thompson of NIWA. Without her help and encouragement much would be left undone.

TYPE LOCALITY: No coordinates can be given to identify the station positon; the specimen was taken in the Bay of Plenty area.

TYPES: Holotype H-752 in the NIWA collection at Wellington.

REMARKS: *Calliaster thompsonae* is very similar to *C. acanthodes* H.L. Clark from southern Africa in 130–411 m. Probably the most obvious and striking difference between the two species is in the junction of the superomarginal plates; in *C. acanthodes* abactinal plates are present between superomarginals for most of the arm length; in *C. thompsonae* the eighth superomarginal plates (from interradial angle) meet in the midline. In *C. acanthodes*, inferomarginal plates have two to five spines and pedicellariae; in *C. thompsonae* there are sometimes six enlarged inferomarginal spines but no inferomarginal pedicellariae were seen. *Calliaster acanthodes* also has superomarginal pedicellariae, not seen in *C. thompsonae*. The armature of adambulacral plates in both species is similar; in *C. acanthodes* big pedicellariae are present on adambulacral plates, whereas in *C. thompsonae* no pedicellariae were actually seen, but distinct pits similar to those left by pedicellariae were present on anterior adambulacral plates. There are also differences in the oral plates and their armature, although it is difficult to be sure because of damage to the oral plates in *C. thompsonae*.

The holotype of *C. acanthodes* from Cape St Francis, South Africa in 137 m, is large, R/r = 79/27 mm; in the present specimen of *C. thompsonae* (arm tips broken), R/r is approximately 82, 83/25, 25 mm. This is the first record of the genus from New Zealand waters, although *C. erucaradiatus* occurs just outside the geographical range of the present paper. It is described here for comparison, based on specimens in the NIWA (NZOI) collection. Essential differences are given in the

key. Rowe and Gates (1995) included in the genus *Calliaster childreni* Gray from Western Australia; *C. spinosus* from southeastern Australia and the Philippine Islands is moved to *Milteliphaster* Alcock.

Calliaster erucaradiatus Livingstone, 1936
(Pl. 5, Fig. 8)

Calliastererucaradiatus Livingstone, 1936: 383, pl. 27, 1–5; H.L. Clark 1946: 87; A.M. Clark 1993: 246; Rowe & Gates 1995: 64.

MATERIAL EXAMINED:
NZOI Stns: P845(1), Q45(1) (both specimens identified by Dr F.W.E. Rowe in 1986).

SIZE: Q45: R/r = 235/9 mm; P845: R/r = 42/16 mm.

DISTRIBUTION: Rowe and Gates (1995: 64) recorded this species in 90 m off Crowdy Head, New South Wales, the type locality. The two present specimens are also from near the coast of New South Wales from the Taupo Seamount.

DEPTH: 90–153 m.

DESCRIPTION: The larger of the two specimens (NZOI P845) from the summit of Taupo Seamount, 140 m, is described.

Disc sharply pentagonal, bordered by well-defined, large, tumid, very regular superomarginal plates. *Interbrachial arcs* well and regularly rounded sweepingly. *Arms* 5, bordered by conspicuous, very regular superomarginal plates; third superomarginal plates from interradial midline meeting laterally with no obvious abactinal plates between for remainder of arm length. Initially, several small granules in small areas where plates meet with one another. Arms tapering evenly to large, distinct terminal plates.

Terminal plates large, sturdy, rectangular to almost square, each with a short, very sturdy, round, flat-tipped spine. On 1 terminal plate, 1 enlarged spine, slightly to one side, and scar; rough area beside it suggests 2 spines.

Abactinal disc plates oval, almost round or, at base of large spines, often rectangular; plates either more or less flat without enlarged central spine, or very distinctly tumid with enlarged spine; fringed by small, very regularly rectangular flat-topped granules; plates otherwise naked. Occasionally 1, sometimes 2 or 3, small central, round granules per plate, no enlarged spine; granules generally central, spaced or very close together. Central, carinal row of plates slightly larger, more conspicuous along each arm; each distinct, oval, the proximalmost conspicuous near disc centre, extraordinarily tumid, with tall sturdy spine. The next and following plates with short, round spine; the following 4th plate, before entry to arms, with round, rather small, flat-topped granule centrally. Generally 3 or 4 small, slender, rather oval plates in single row before superomarginals from opposites sides meet in midline. Irregularly rectangular plate central on disc with 1 upright spine and marginal fringe of small, rectangular granules; plate surrounded by 8 slightly irregular rectangular plates, 2 conspicuously smaller,

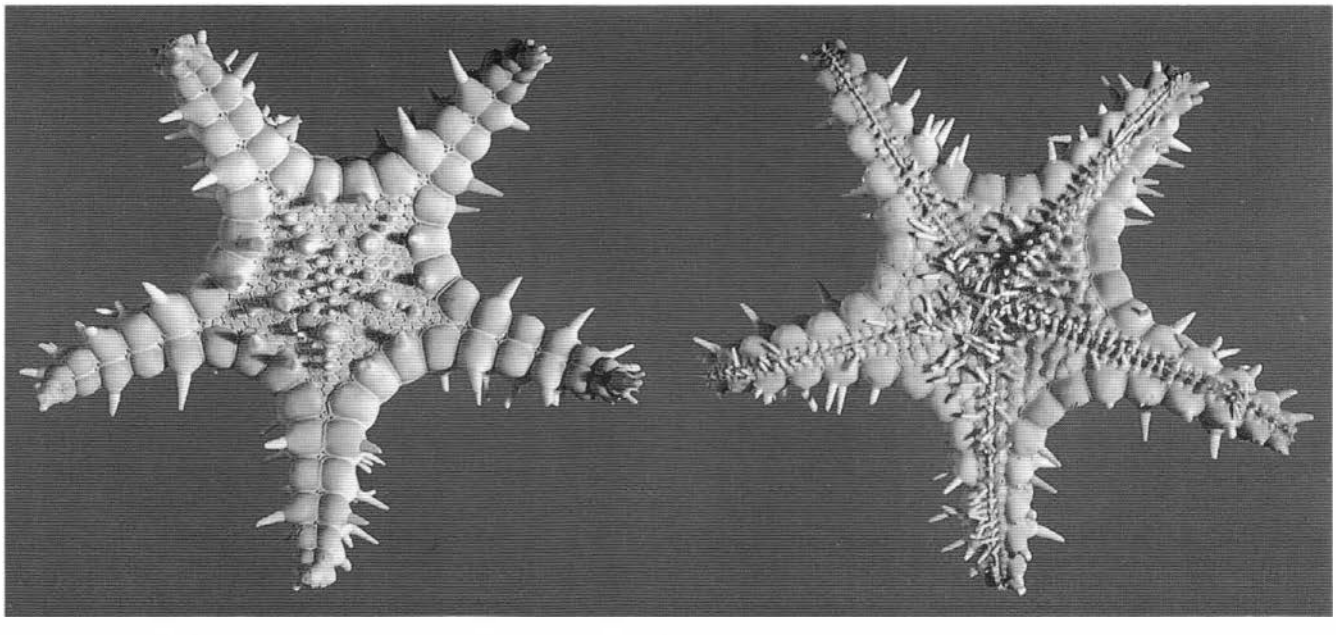


Plate 5. ***Calliaster erucaradiatus*** Livingstone. NZOI Stn P845. R/r = 42/16 mm. Abactinal and actinal surfaces.

triangular, no central spine; 6 larger plates with conspicuous, sturdy, round, flat-tipped spine centrally. Interradially no obviously large spines on plates, some plates with very short, round spine protruding just above plate surface, flat-tipped, sturdy. Other plates interradially with 1–3 flat, round, granules, either well spaced or touching each other. In 4 interradii a single, small, upright, straight pedicellaria, generally on a larger plate, often one with a spine. *Pedicellariae* small, straight, upright, with short trunk, the 2 blades round-tipped, very thin. *Abactinal plates* paved (under high magnification) by very regular rows of tiny hyaline granules, giving plates very regular, slightly brown or gold, finely shiny appearance.

Papulae present abactinally as small pores at plate corners, generally 4–6 or 7 around each plate. No obvious papulae between actinal plates or marginally.

Madreporite small, distinct, well raised, irregularly round, nearer centre than edge of disc; finely and deeply striated.

Anus not obvious.

Superomarginal plates large, tumid, smooth, very obvious, edged by single row of small, rectangular, very regular flat-topped granules; these sometimes corre-sponding with those from neighbouring plates; 8 superomarginal plates from interradial angle to arm tip; distalmost 8th plate very small, almost crescentic; adjacent to terminal plate. First 2 superomarginal plates in an angle with single conspicuous upright spine rising very close to abactinal plates; adjacent plates generally naked (no spines) although 1 plate with very short spine; small round scar on another plate suggests spine was present. Third superomarginal plate from interradial angle with conspicuous spine on outer edge, projecting horizontally outwards, large, round, rapidly and evenly tapering to rounded tip; 4th superomarginal plate without enlarged spine; 5th plate with conspicuous, long slender spine projecting horizontally on outer edge; distal superomarginal plates to terminal plate without enlarged spines.

Inferomarginal plates corresponding with superomarginals but smaller and not easily seen from above; fringed by regular row of small, rectangular granules similar to those of superomarginals. Most of inferomarginal plate on actinal surface, slightly smaller than superomarginal plates. First 2 inferomarginal plates interradially without spines, tumid, very regular, precise in outline, distal inferomarginal plates likewise. Second inferomarginal plate in series with 1 or 2 spines on outer free edge of plate, following plates often with only 1 spine. Spines slender, tapering, shorter than those of superomarginal plates. On last 2 or 3 plates only 1 enlarged spine; a shallow, round depression remaining when spine removed. Inferomarginal plates and spines smaller than superomarginals.

Actinal areas obvious, with regular plate arrangement. A distinct row of regular rectangular plates bordering adambulacral plates; initially, adjacent to oral plates and first 1 or 2 adambulacral plates, an unpaired roundly triangular plate; next plates, bordering adambulacrals, rectangular and large. Each plate with single, tall, slender spine, tapering slightly to flat, often grooved and worn tip. *Actinal plates* tumid, smooth with single enlarged spine and sometimes small, straight pedicellaria similar to abactinal plate pedicellariae. Distinct pit or groove left when pedicellaria removed. All actinal plates edged by rows of small, rectangular, regular granules similar to those of other plates. Actinal plates gently raised and regular, forming distinct V-shaped area actinally.

Adambulacral plates forming close regular edge along grooves, plates rectangular with tidy fringe of small, regular, rectangular granules. Furrow spines 7–9, small, slender, tapering, round-tipped; first and last spines on plate smaller and shorter. Proximally on plate, 2 sturdy, upright, large subambulacral spines; 1 near furrow spines and second near actinal plates. In last half or quarter of arms, only 1 enlarged subambulacral spine, lying immediately behind furrow spines; small, round, often isolated granule sometimes beneath large spine. Near arm tips fringing granules of adambulacral plates very small and in distal corner of plate forming several rows; resulting buildup almost triangular and obvious. Near arm tip small, single enlarged subambulacral spine on distalmost and uppermost edge of plate; occasional small bivalved pedicellaria, similar to those described, near anteriormost furrow spine.

Oral plates difficult to see as plates meeting centrally and outlines obscured. Plates gently raised, sharply diamond-shaped, a narrow, regular membranous area separating 2 plates in angle. Plates trimmed centrally on edge bordering adambulacrals by irregular row of large and small granules similar to those trimming adambulacral plates, but often conspicuously larger. Oral furrow spines 5–7, small, round-tipped, rather flattened, with narrow edge to plate and furrow, 2 or 3 larger spines overhanging mouth. Suboral spines 2, conspicuous, large, of similar length and size to neighbouring adambulacral and actinal spines, standing one behind the other and very obvious; proximalmost oral furrow spines deep in mouth, appearing larger, longer, sturdier than other oral furrow spines.

Ambulacral grooves tightly closed, not obvious owing to adambulacral furrow spines meeting with neighbouring spines from opposite side; impossible to see *tubefeet* which are are totally obscured.

COLOUR: Station register notes, presumably referring to this specimen (NZOI Stn P845; only one asteroid recorded) note "one spiny asteroid, grey-purple". The

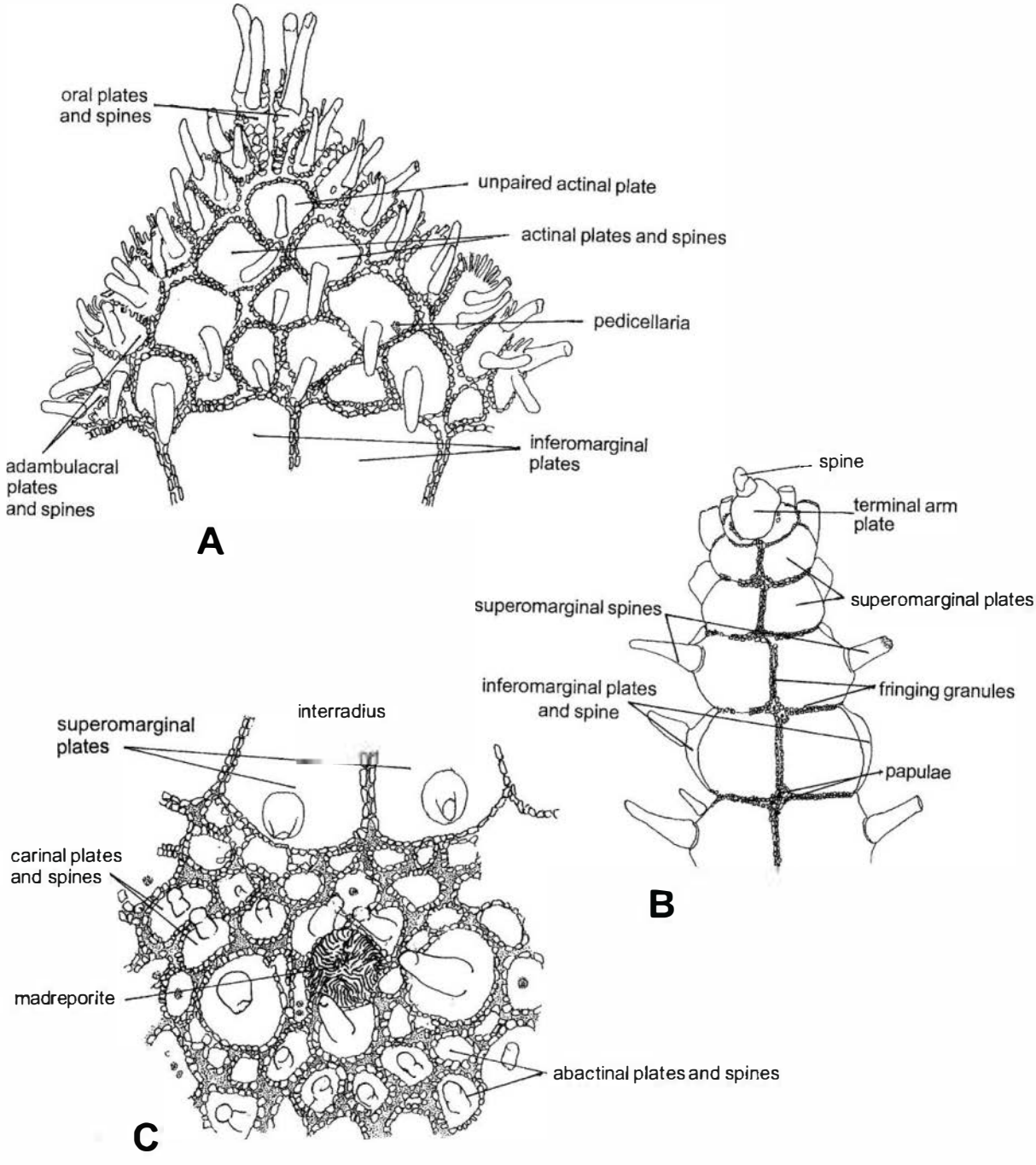


Fig. 8. ***Calliaster eucaradiatus*** Livingstone. **A**. Oral, adambulacral, and actinal plates. Note the unpaired actinal plates. **B**. Abactinal view of arm with fringing granules. C. Madreporite surrounded by carinal plates and spines, and abactinal plates and spines.

specimen, now dried, is largely white or cream, with just a hint of brown on small central disc plates.

REMARKS: The type specimen is from off Crowdy Head, New South Wales, Australia in 90 m and it seems that no other specimens have been collected there. The new NZOI specimens are from Taupo Seamount in 140–153 m. H.L. Clark (1946: 87) referred only to the type material; the present two specimens have added considerably to our knowledge of the species.

The variation between the two specimens is tabulated on the next page. In both specimens the armature of oral plates and their outline is difficult to determine, and ambulacral grooves are hidden by close-meeting adambulacral plates.

NZOI Stn	Q45 R/r = 25/9 mm	P985 R/r = 42/16 mm
Enlarged abactinal spines	present, small	most obvious, regular
Small straight pedicellariae	yes	yes, most obvious
Spines on interradial superomarginals	2	1
Spines on terminal arm plate	2	1
Spines on outer edge of inferomarginals	1, large	2 (3)
Enlarged actinal spines	no	yes
Actinal pedicellariae	no	yes
Madreporite	tumid, nearer disc edge	tumid

It is interesting that Livingstone (1936: 383) recorded actinal papulae — there are none in the present specimens. In a recent diagnosis of the genus *Calliaster*, Aziz and Jangoux (1985: 585) stated "no marginal or actinal papulae". There are similarities between *C. erucaradiatus* and *C. elegans* Döderlein from Flores, Indonesia, and the Marshall Islands. Livingstone (1936: 384) noted *C. elegans* as having pedicellariae and low, wide inferomarginals and there are differences in the armature of supero- and inferomarginal plates. In the present specimens pedicellariae are present and there are differences, probably most obvious, in inferomarginal plates. Possibly, *C. erucaradiatus* is a synonym of *C. elegans*, especially as *C. elegans* is now known from the Marshall Islands (A.H. Clark 1952: 284). Unfortunately, there are no specimens of *C. elegans* available to the author for comparison.

Ceramaster Verrill, 1899

Disc large, arms generally short. Abactinal plates either tabulate, especially radially, where plates are covered with granules (peripheral granules distinct from central ones) or plates are paxillate. Marginal plates, granulose, form distinct edge to disc and arms; smallest plates at arm tip; superomarginal plates generally separate (i.e., superomarginal plates, from opposite sides of ray, do not meet in midline) throughout all or most of ray. Marginal plates often with a central naked area. Generally, no secondary abactinal plates; if present, confined to disc. No superambulacral or internal radiating ossicles. Actinal interradial areas well developed, plates with granules. Pedicellariae, 2- or sometimes 3-valved, on abactinal, marginal, and actinal plates.

TYPE SPECIES: *Asterias granularis* Retzius, 1783.

TYPE LOCALITY: "St Croix" (? New Brunswick, Canada) (see A.M. Clark & Downey 1992: 234).

REMARKS: A.M. Clark (1993) recorded 17 species of *Ceramaster*.

DISTRIBUTION: The genus is well represented in the North Pacific and North Atlantic Oceans. Koehler (1909: 74, pl. 4[5, 6], pl. 9[7], 960 "brasses") described *Pentagonaster (Philonaster) mortenseni* from deep water in the Bay of Bengal and he remarked on its similarity to *Ceramaster*. A.M. Clark and Downey (1992: 231), A.M. Clark (1993: 247), and Rowe and Gates (1995: 64) included *Philonaster* as a synonym of *Ceramaster*. The present author, however, believes that the presence of the large, distinctive, unpaired, abactinal plate near the arm tip (this is possibly unique among asteroids) is grounds for re-establishing Koehler's subgenus *Philonaster* but at generic level (see p. 97). *Ceramaster* is not known from Antarctic waters but is well represented in New Zealand (3 species) and Rowe and Gates (1995: 65) recorded *Ceramaster patagonicus* (Sladen) from Port Macdonnell, South Australia. A.M. Clark and Downey (1992: 236) regarded *Ceramaster patagonicus* as a subspecies of *C. grenadensis*, *C. grenadensis patagonicus*. O'Hara (1998: 179), however, recorded and described *C. patagonicus* (Sladen) from Macquarie Island and included both *C. grenadensis patagonicus* and *C. lenmoxkingi* as synonyms of *C. patagonicus*. I agree with this and add a new subspecies *C. patagonicus australis*.

KEY TO NEW ZEALAND SPECIES OF *CERAMASTER*

1 (4) Outline pentagonal, arms very short.

2 (3) From 1 to 3, occasionally 4, small spatulate, straight pedicellariae present on superomarginal plates; oral furrow spines 5–8 (occasionally as many as 9, even 10) ..... *patagonicus patagonicus*

3 (2) No pedicellariae on superomarginal plates; oral furrow spines 10 or 11 ..... *patagonicus australis* subsp. n.

4 (1) Outline not pentagonal, arms long, slender, distinct from disc ..... *glasbyi*

Ceramaster patagonicus patagonicus (Sladen, 1889)
(Pl. 6, Fig. 9)

Pentagonaster patagonicus Sladen, 1889: 269, pl. 46, figs 3, 4, pl. 49, figs 3, 4.
Astrogonium granulare Müller & Troschel, 1842: 57; ?Whiteaves 1886: 117; Fisher 1911a: 214.
Pentagonaster austro-granularis Perrier, 1891: K127, pl. 12, 3a, 3b.
Mediaster patagonicus: Verrill 1899: 184.
Pseudarchaster patagonicus: Verrill 1899: 195.
Ceramaster patagonicus: Fisher 1911: 214, pl. 37, fig. 4, pl. 38, figs 1, 2, pl. 60, fig. 3; Verrill 1914: 291; Koehler 1923: 94; Fisher 1940: 118; D'yakonov 1949: 19; 1950: 40, fig. 27 (English translation 1968); Baranova 1957: 161; Bernasconi 1963a: 8, pl. 1, figs 1, 2, pl. 2, fig. 3; Baranova & Belyaev 1968: pl. 17, fig. 2; Tommasi 1970: 12, fig. 36; Lambert 1978: 62; Anderson *et al.* 1993: 502; Branch *et al.* 1993: 44 (illustr.); A.M. Clark 1993: 249; Rowe & Gates 1995: 65; O'Hara 1998: 179, pl. 1d.
Ceramaster lennoxkingi McKnight, 1973a: 178, fig. 4; 1984: 142; A.M. Clark 1993: 249.
Ceramaster grenadensis patagonicus: A.M. Clark & Downey 1992: 236, figs 39e, f, pl. 56 E, F.

MATERIAL EXAMINED:

NZOI Stns: D85(33), D134(1), D136(1), D137(3)*, D138(4), D207(1), D211(14), D870(1)*, E401(1), E404(1), E757(1), F90 (1), F95(1), F102(1)*, F104(8), F107(39), F109(3), F120(1), F122 (2), F124(6)*, F135(1), F151(12), G665(1), G666(1), G667(1)*, G886(2), G887(1), G888(3), G893(1), G894(2), G900(5), G901 (7), G902 (1), G903(5)*, G904(5)*, G905(2), G907(1), G908(1)*, G913(3)*, G914(1), G916(2), G917(1)*, I667(2), I678(2), I679(2)*, I680(1)*, I683(9), I686(1)*, I690(1), I698(1), I699(10), I704(1), J481(1), J483(1), J484(4), J550(14), S14(1), S16(2), S43(1), S61 (3), S65(1), S68(2), S70(?)*, S72(?)*, S140(1), S142(1), S147(1), S161(1), S166(1), S215(1), T32(?)*, T52(3)*, T53(1), T65(1), T71(2), T72 (4)*, T73(3), V375(1), Z8679(1), Z9188(1), Z9194(1), Z9302(1), Z9380(1), Z9576(1), Z9611(1).

NMNZ: Auckland Islands: Ech. 1497(1), 2700(3); Bay of Plenty: Ech. 6507(4); Bounty Plateau and Islands: Ech. 2418 (2), 3437(2), 6885(2); Campbell Island: Ech. 2026(1), 2699(4); Cape Turnagain: Ech. 4197(1); north of Chatham Islands: Ech. 4634(1), 4635(6); Foveaux Strait: Ech. 2386(1), 3100(1), 5296(1); Otago: Ech. 5294(1), 5295(1); Pukaki Rise: Ech. 3434(1), 6568 (2); Snares Islands area: Ech. 2030(1); Stewart Island: Ech. 6516(1).

Aktuba, 4/12/79: Ech. 4633(1).
Eltanin Stns: 1974(1), 2215(8).

SIZE: R varies between 98 mm and 8 mm, r varies between 60 mm and 6 mm, R/r averages 52/39 mm.

DISTRIBUTION: *Ceramaster p. patagonicus* is widely distributed. In the Pacific Ocean it ranges from the Bering Sea and southern Alaska to British Columbia, the Gulf of California south to southern Australia and New Zealand and its outlying islands, including the Bounty Islands and Macquarie Island. It is also known from the South Atlantic, from near Cape Horn, the Straits of Magellan, Falklands Islands, Falkland Plateau, and Burdwood Bank, the latter just south of the Falkland Islands.

Other records are from subantarctic Marion and Prince Edward Islands in the southern Indian Ocean. Branch *et al.* (1993: 44) illustrated a specimen R/r = 68/43 mm from these islands with four large oral furrow spines. O'Hara (1998: 180) remarked on this; in all the New Zealand material examined the oral plates bear 5–7 or 8, exceptionally in large specimens 10, oral furrow spines.

In New Zealand waters *Ceramaster p. patagonicus* is commonest south of Christchurch; there is one record from near the Chatham Islands and the most northerly specimen is from the Bay of Plenty. There are also records from Cape Turnagain and Cook Strait. One large specimen (NZOI Stn Z8370) with R/r = 98/70 mm was collected from 45°34' S, 156°40' W in 870–900 m, outside the range of this study.

DEPTH: 18–1125 m. Lambert (1978: 62) recorded 18 m for a specimen from Barnard Harbour, British Columbia.

DESCRIPTION: A specimen from NZOI Stn F107, R/r = 52/39 mm, is described.

Form pentagonal, thin dorsoventrally, arms very short, tips gently upturned. *Terminal plate* conspicuous, slightly tumid, smooth; plate round, oval or heart-shaped.

Abactinal surface with spaced, regularly arranged hexagonal paxillae; interradially shorter, less regularly arranged, mostly square. Near marginal plates paxillae rectangular or hexagonal, forming more or less regular rows. Radial paxillae have a short, thick trunk with a lobate base, expanding into a more or less round or slightly angular, sometimes almost hexagonal, head. Small, quadrate, flat, well-separated granules with precise, clean-cut margins forming a definite edge to paxilla; these surround 10–20 flat to gently rounded, closely adpressed granules. Interradially, paxillae smaller, shorter, less regularly arranged, peripheral granules less obvious.

Papulae single, at plate angles, restricted to radial areas.

Pedicellariae few, small, 2-jawed, spatulate, scattered, both interradially and radially, commonest interradially. Generally only 1 pedicellaria on a plate; pedicellarian valves fit in shallow depressions on plates.

Madreporite 5-sided, gently raised, finely and deeply dissected, lying near disc centre; adjacent plates enlarged.

Anus small, interradial, slightly sunken, near disc centre, surrounded by a number of enlarged granules; surrounding paxillae also slightly enlarged.

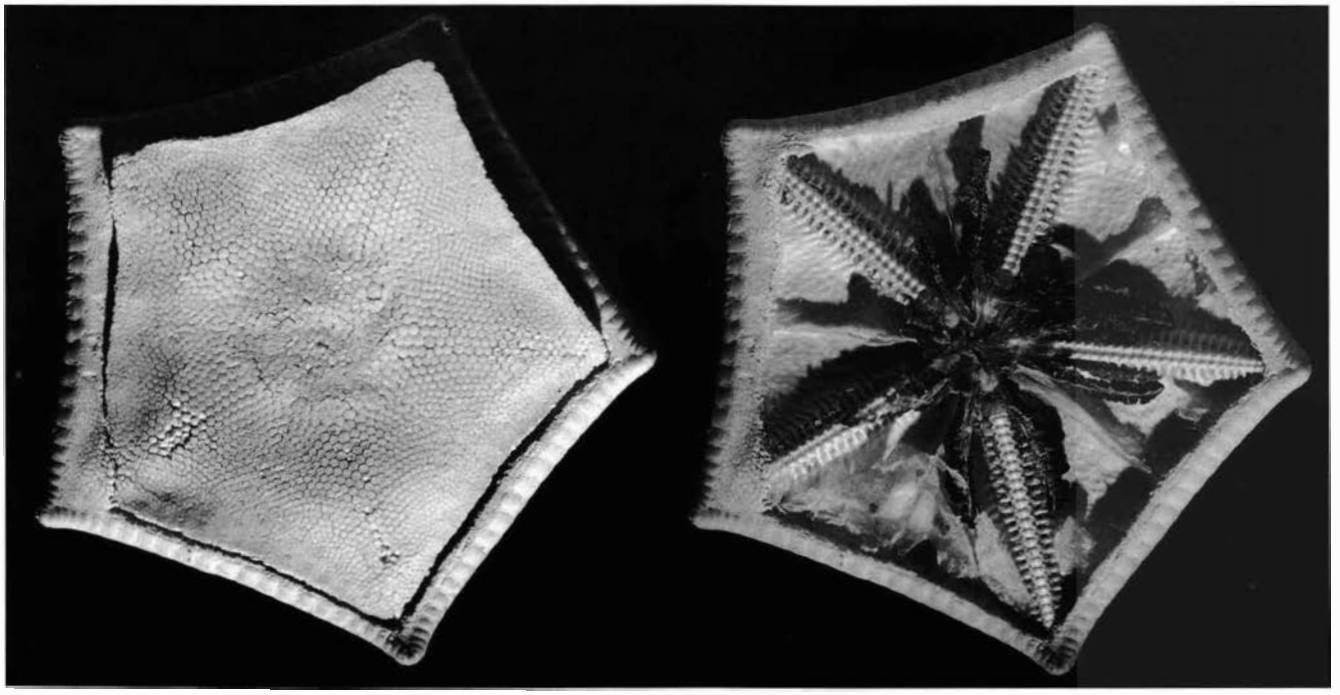


Plate 6. ***Ceramaster patagonicus patagonicus*** (Sladen). NZOI Stn F107. R/r = 52/39 mm. Abactinal and interior (actinal surface) after removal of abactinal "skin".

Superomarginal plates forming a definite bevelled edge to disc and arms. Twenty-six superomarginal plates from arm tip to arm tip, distalmost 1 or 2 plates from opposite sides of arm meeting in midline. Plates close-fitting, regular, rather flat; distinct bare rectangular area near abactinal plates; naked area bordered by single row of small, regularly arranged granules; lower part of plate, below bare area, with close covering of granules; peripheral granules larger. Pedicellariae, 1–3 occasionally 4 on a plate, small, similar to those already described, confined to edges of bare patches and granules laterally between plates.

Inferomarginals lying directly opposite superomarginals, plates in both series similar in size, forming very distinct edge to actinal surface. Bare patches considerably smaller than those of superomarginals, rather irregular in shape, bordered by several rows of granules. Pedicellariae 1 or 2, near bare areas, similar to those of superomarginal plates. Naked areas, on both series of marginal plates, rather flat.

Actinal areas large, triangular, with close paving of plates, rectangular, distinctly larger adjacent to adambulacrals; central plates smaller, more square. Small, scattered pedicellariae, especially on plates bordering adambulacrals; pedicellariae 2-jawed, similar to those already described. Actinal plates covered with granules, less regularly arranged and peripheral granules forming a less distinct margin than on abactinal plates.

Adambulacral plates rectangular to almost square, with a straight or gently rounded free margin, well separated laterally from one another. Furrow spines 3, 4, proximally and distally sometimes 5; spines short, sturdy, round-tipped, untapering, proximalmost spine sometimes shorter, set back from plate margin; subambulacral granules well separated from furrow spines, close-packed, forming 2 or 3 rows. In last part of arms, at least 1 subambulacral spine or granule becoming greatly enlarged and conspicuous. Outline of plates near actinals, rather indistinct.

Oral plates triangular, distinctive; furrow spines 5-8, spaced, anteriormost spine on either side, slightly longer. Suboral spines regularly arranged, anteriormost longest, separated by distinct gap from regular row of 4 spines; edge of plate adjacent to adambulacral plates with 2 or 3 short spines or granules.

Ambulacral grooves narrow near mouth, broad medianly, narrow near arm tip.

Tubefeet biserial, regularly arranged with distinct sucking discs.

COLOUR IN LIFE: Abactinally bright red or reddish-orange, actinal surface cream. Dried and in preservative specimens are light brown, pink, grey, or white.

In a large deep-frozen specimen from well east of New Zealand (NZOI Stn Z8370, 45°34′ S, 156°40′ W, 870–900 m) colour is recorded as "abactinal and superomarginal plates almost pink: actinal surface and inferomarginals white or pale cream, or fawn perhaps."

REMARKS: In total, 330 specimens are listed; 34 of these

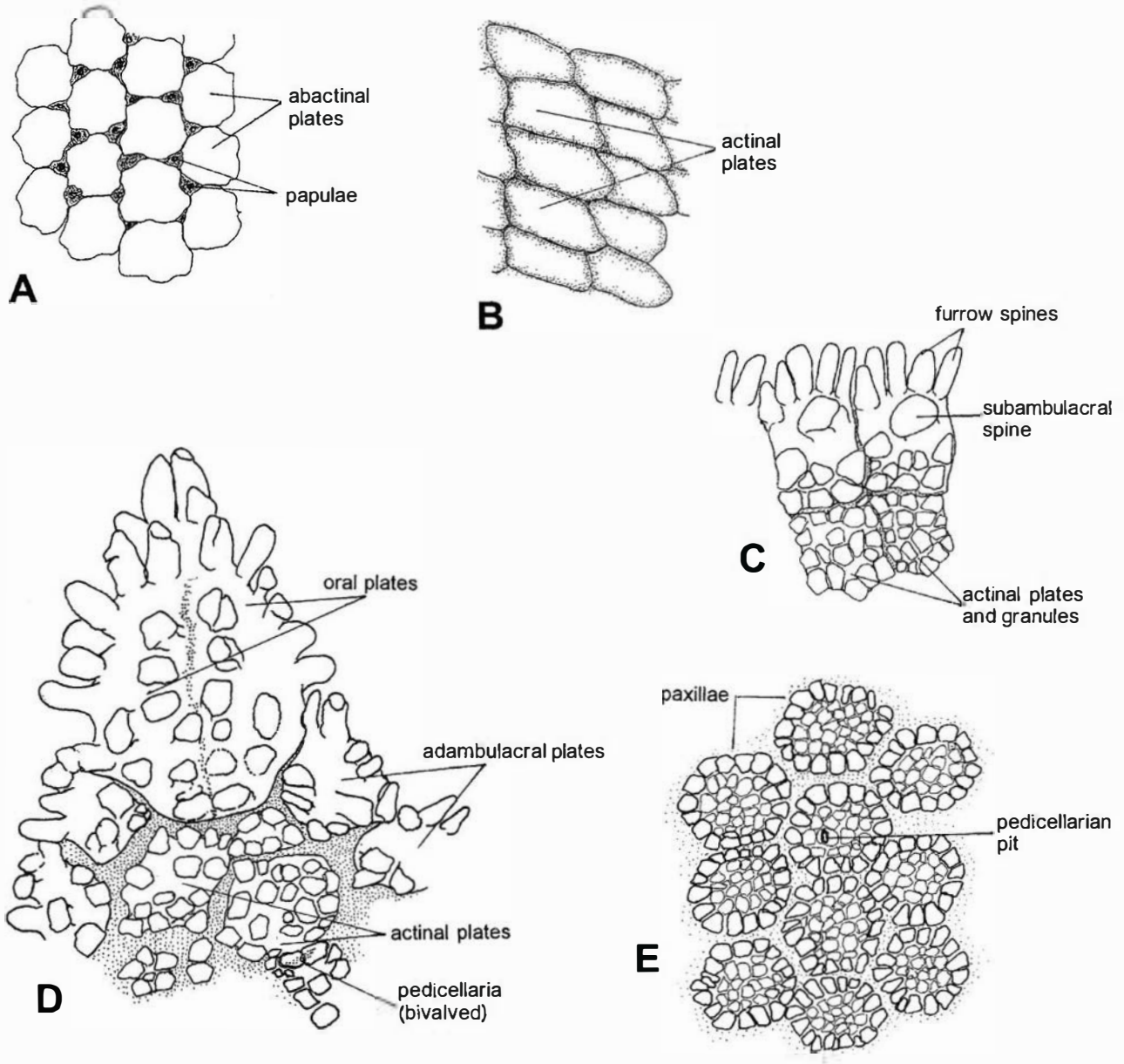


Fig. 9. *Ceramaster patagonicus patagonicus* (Sladen). **A**. Abactinal plates and papulae interradially, from coelomic side. **B**. Actinal plates seen from coelomic side. **C**. Adambulacral plates adjacent to actinals from near arm tip. Note the enlarged subambulacral spine. **D**. Oral, adambulacral, and actinal plates. **E**. Abactinal radial paxillae from near disc. Note the enlarged peripheral granules on the plates and pit left by pedicellaria.

from the NZOI collections are not present, thus 296 specimens were examined; the extent of variations and differences within the species was well appreciated.

One specimen R/ r = 40/33 mm (NZOI Stn F151, 12 specimens, 48°32′ S, 174°05′ E, 814 m) had four arms and four ambulacral grooves; in other respects the specimen was normal. Other four-armed specimens have been reported from near the Auckland Islands.

Variation occurs in the number of pedicellariae present; these may be extremely numerous as in a specimen from 200 m near Puysegur Point, western Foveaux Strait (NMNZ Ech. 5296, R/ r = 60/49 mm); in this specimen almost every abactinal plate carried at least one pedicellaria, in other respects the specimen is normal, although marginal bare patches are large and there are nine oral furrow spines. In most specimens pedicellariae are confined to margins of superomarginal plates, especially near bare patches, and they are also present between bordering granules. Actinally, pedicellariae may be very few; they are generally obvious on larger

plates which border the adambulacrals.

The extent of bare patches on marginal plates varies; in general, naked areas are larger and more conspicuous in younger, smaller specimens; in very large specimens they are often extremely small or absent altogether (NMNZ Ech. 3437, R/r = 92/65 mm). Bare patches, especially on the superomarginals, may be flat or slightly rounded, or they may rise steeply from the plate and have an irregular eroded outline and surface.

Adambulacral furrow spines vary in number, but seldom exceed 5; the most proximal furrow spine is often displaced towards the subambulacral spines or granules, thus the furrow spines form a slightly curved series. In larger specimens furrow spines are often sturdy and thick-set and subambulacral spines crowded and very obvious.

Generally oral plates are narrow and triangular with 7 or 8 furrow spines; sometimes, however, the plates may be broad and compact, and exceptionally there may be 10 furrow spines. In several specimens both oral and adambulacral furrow spines are well worn down and virtually only stumps remain, as seen in one specimen (NZOI Stn F107), other specimens from this station are normal.

Dissection of the specimen described showed no secondary abactinal plates, no interconnecting ossicles, no superambulacral plates, and ampullae of tubefeet are double. Gonads occurring as small, grape-like bunches, attached to abactinal plates on either side of interradial septum; interradial septa membranous and strong. Abactinal plates forming very regular rows, more or less oval or square with short lobes. Radially papulae distinct at plate corners; interradially very small, indistinct, or absent altogether.

Anderson and Shimek (1993: 502) found that *Ceramaster p. patagonicus* did not thrive in captivity and the captive specimens showed no interest in the very varied food which was given to them. The food supplied (p. 501) included chopped fish, squid, scallops, mussels, clams, live hydroids, sea-anemones, cup corals, tunicates, ascidians, and sponges. Anderson and Shimek came to the conclusion that *C. p. patagonicus* (from British Columbia) feeds on micro-organisms or the general surface film on rocks etc. of the seafloor.

Specimens of *C. p. patagonicus* with stomachs extended over the substratum were captured, killed, and dissected; there were no stomach contents. In dissected New Zealand specimens there were no gut contents either.

In his paper on Macquarie Island echinoderms, O'Hara (1998: 179) listed *Ceramaster lennoxkingi* McKnight as a synonym of *Ceramaster patagonicus* (Sladen), thus *C. p. patagonicus* is very widely distributed, from the Arctic to subantarctic waters. O'Hara argued that differences are probably size related. Unfortunately, there are no Sladen specimens of *C. patagonicus* for comparison; *C. lennoxkingi* is included here in *C. p. patagonicus.*

Ceramaster patagonicus australis subsp. n.
(Pl. 7, Fig. 10)

MATERIAL EXAMINED:

NZOI Stn E228(3) (holotype H-757, and paratypes (2) P-1226 in NIWA collection, Wellington). *Eltanin* Stn 1411(1).

SIZE: R varies between 91 and 42 mm, r varies between 67 and 29 mm.

DISTRIBUTION: Known only from Macquarie Ridge area.

DEPTH: 148–415 m.

DESCRIPTION: Description is of specimen from *Eltanin* Stn 1411, R/r = 42/29 mm.

Disc flat, thick, bordered by conspicuous superomarginal plates, last 4 or 5 superomarginals from opposite sides of arm meeting in midline. Arms short, tapering rapidly, interradial arcs shallow. Arm tips protected by distinct, heart-shaped, naked plates.

Abactinal plates tabulate; radially on disc and at beginning of arms plates distinctly pentagonal or hexagonal, well separated from one another and forming very regular rows; further along arms, near junction of superomarginals, plates irregular in arrangement, size and shape (plates may be oval, rhomboid, almost triangular). Near disc centre abactinal plates less angular, often round, oval, forming a close cover. Plate trunk short, thick, expanding into a flat, generally angular head with 11–16 spaced angular, clearly defined marginal granules; central granules smaller, spaced, almost round, arranged in more or less concentric circles. Plates distinct, well separated, gently tumid, especially radially. Interradially plates irregular in size and shape, outlines not clear cut; no distinction between central and peripheral granules on these plates.

Papulae radial in position, generally 6 surrounding each plate; papular arrangement and number most obvious from coelomic side.

Pedicellariae straight, few, but depressions and pits (1 to a paxillae) suggest these were more frequent. Pedicellariae with slender valves, little expanded at tips.

Madreporite small, distinct, hexagonal, interradial, more or less midway between marginal plates and disc centre, gently tumid, deeply and finely dissected with grooves meeting centrally.

Anus not obvious.

Superomarginal plates forming distinct, conspicuous edge to disc and arms, 18 or 19 plates present from arm

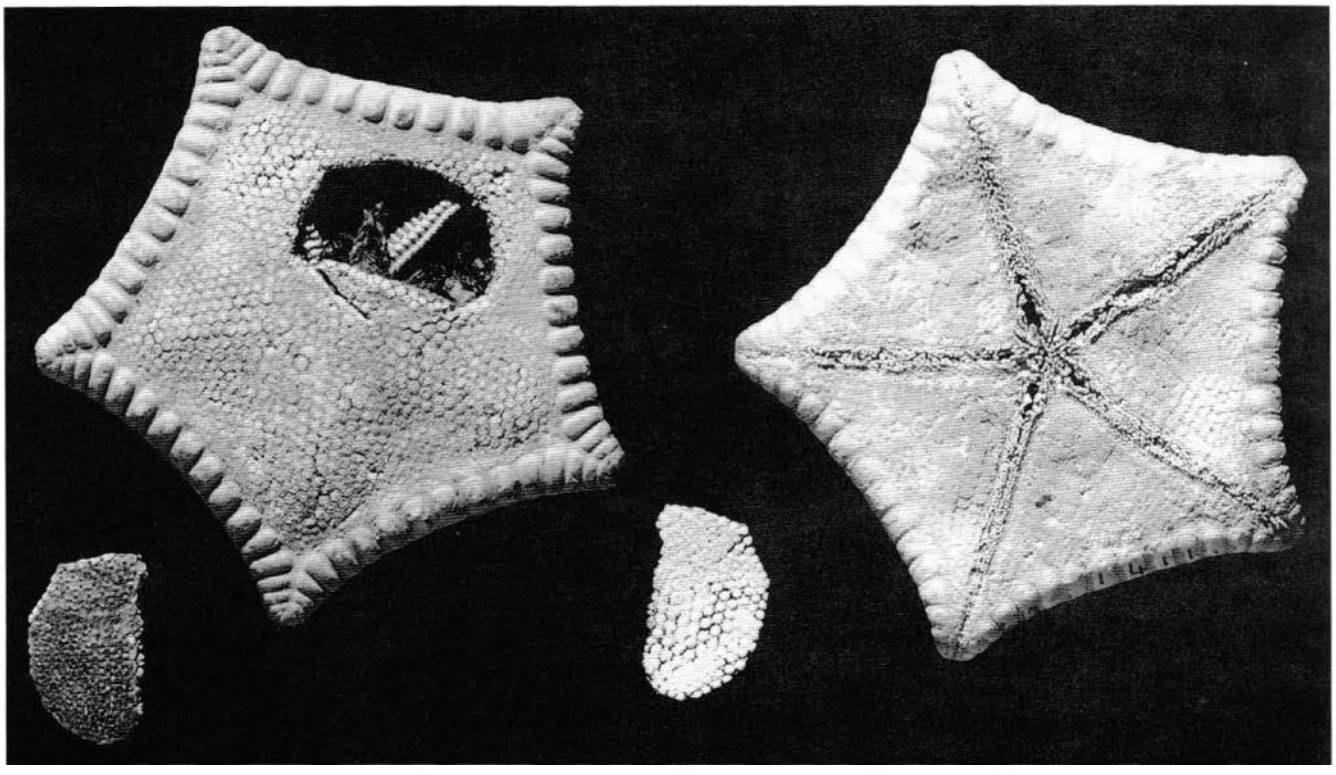


Plate 7. *Ceramaster patagonicus australis* n.subsp. *Eltanin* Stn 1411. R/r = 42/29 mm. Abactinal and actinal surfaces.

tip to arm tip. Plates rectangular, tumid, especially centrally, with a conspicuous, raised area. Regular rows of small, conspicuous rectangular or rounded, spaced granules surrounding raised area; plates bordered by distinct row of slightly larger and more conspicuous granules; larger granules also along abactinal edge of plate. Raised naked central area of plate irregular, with distinct depressions, each with sometimes 1 to several rounded granules; no pedicellariae. These plates may have originally been covered with granules.

Inferomarginals smaller, flatter, corresponding exactly to superomarginals. Inferomarginals probably covered with regular rows of small granules, as pitted appearance suggests, although a small irregular oval area on actinal surface may have been naked. No enlarged spines on any marginal plates.

Actinal areas well developed, triangular, with distinct rows of plates, rectangular near adambulacrals; interradially adjacent to inferomarginals, plates smaller, round, oval, irregular, with close covering of small, spaced granules, bordering granules slightly larger, triangular, rectangular (similar to abactinal paxillae); central granules spaced, round, irregular in arrangement. Plates bordering adambulacrals generally carrying 1 distinct pedicellaria, immediately adjacent to adambulacrals. Pedicellariae similar to those described above; a distinct rectangular pit or hole between 2 pedicellaria blades is conspicuously rimmed.

Adambulacral plates rectangular to almost square. Proximal plates with 4-6 (even 7), furrow spines; spines sturdy, blunt tipped, of similar height, almost triangular in cross-section, forming a very regular edge to furrow; behind these, generally 3 (occasionally 4) similar-sized, but less triangular, subambulacral spines; outer part of plate adjacent to actinals with generally 2 rows of short, squat, spaced angular granules; no adambulacral pedicellariae. Occasional accessory subambulacral granules may be on outer edge of plates; near arm tips 1 subambulacral spine may be greatly enlarged, sturdy, conspicuous.

Oral plates broadly triangular, flat, 2 plates in an angle separated by broad muscular area; 10 or 11 furrow spines; spines short, sturdy, more or less triangular in cross-section; flat tipped, very similar to adambulacral furrow spines. Spines of similar height throughout series, separated from suboral spines by distinct gap. Suboral spines thick-set, short, angular, slightly shorter than furrow spines almost granule-like, bordering suture between 2 plates; other small granules may also be near actinal plates.

Ambulacral grooves narrow, deep, more or less obscured by furrow spines.

Tubefeet biserial; sucking discs distinct.

REMARKS: A.M. Clark and Downey (1992: 236) discussed and illustrated the subspecies of *Ceramaster grenadensis;*

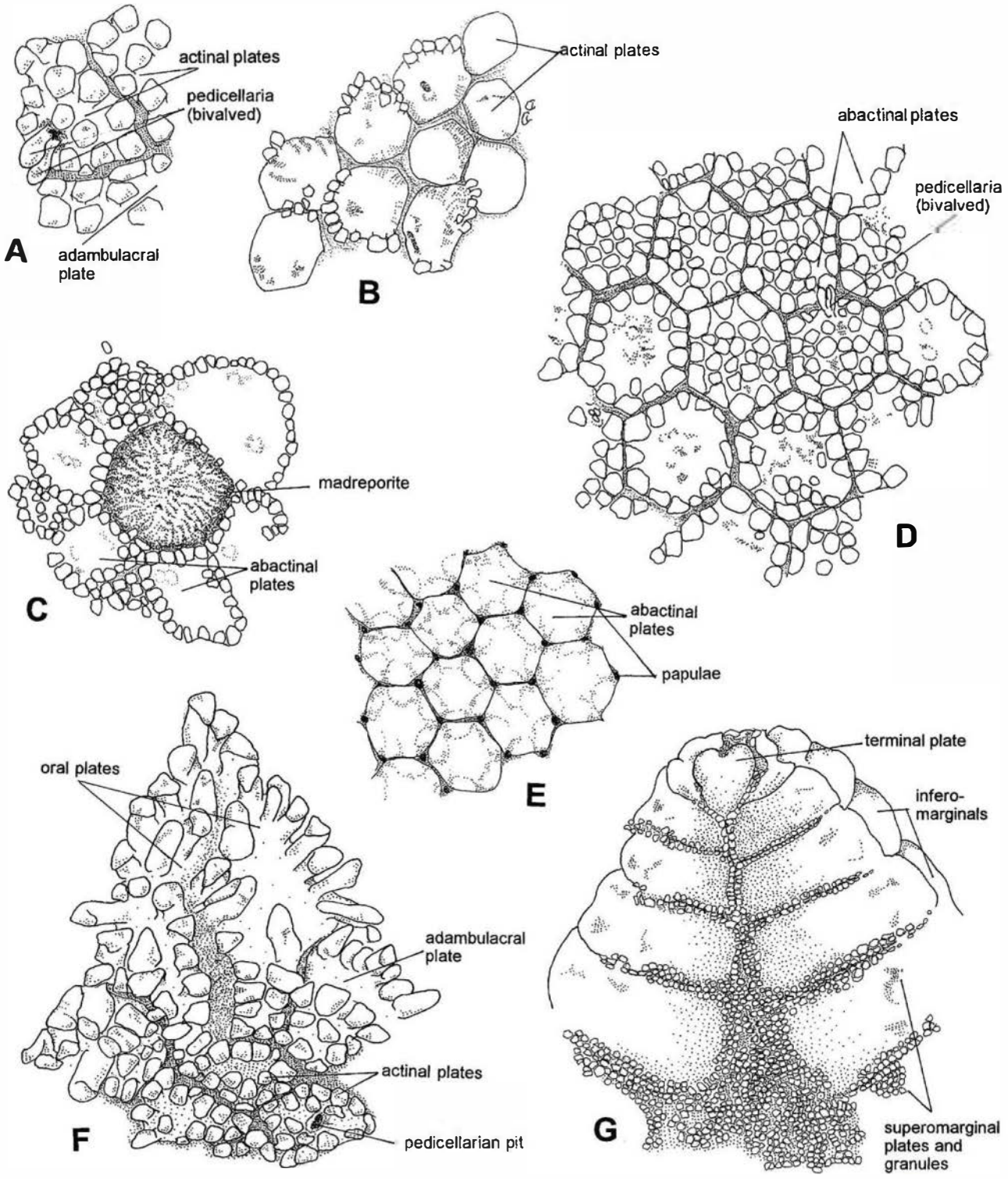


Fig. 10. ***Ceramaster patagonicus australis*** n.subsp. **A**. Actinal and adambulacral plates. Note the bivalved pedicellaria. **B**. Actinal plates near margin and arm tip. C. Madreporite and surrounding plates. **D**. Abactinal surface near midline of arms. **E**. Abactinal plates seen from coelomic side. F. Oral plates and adjacent ambulacrals and actinal plates. Note the pit left by pedicellaria. **G**. Arm tip.

they included *Ceramaster grenadensis patagonicus*. O'Hara (1998) treated it as *Ceramaster patagonicus*, with *Ceramaster lennoxkingi* McKnight as a synonym. The three Macquarie Island specimens described by McKnight (1984) and a specimen from the *Eltanin* collections (Stn 1411) are included here as *Ceramaster patagonicus australis*.

A.M. Clark and Downey (1992: 235 included *C. euryplax* H.L. Clark and *C. patagonicus* (Sladen) as subspecies of *C. grenadensis* (Perrier). A.M. Clark (1993: 249) included both *C. euryplax* and *C. patagonicus* as sub-species of *C. patagonicus*, and *C. patagonicus fisheri* is also included.

The present subspecies has affinities with *C. patagonicus fisheri* Bernasconi from the Gulf of California, from which it can be distinguished by fewer and larger marginal plates; in *C. patagonicus fisheri* R/r = 48/29 mm and there are 25 or 26 marginal plates in an interradius; in the present specimen (R/r = 42/29 mm) there are only 17 or 18 plates from arm tip to arm tip). The marginal plates of these recent specimens are very prominent and tumid and bordered by very regular rows of granules. Also, in the present specimens, the edges of the abactinal paxillae are precise and definite, not undulating and wavy as in *C. patagonicus fisheri*.

Ceramaster glasbyi McKnight, 1993 (Pl. 8, Fig. 11)

Ceramaster glasbyi McKnight 1993a: 169, figs 1, 2.

MATERIAL EXAMINED:
NZOI Stn U594 (1) (holotype H-614 in NIWA collection).

SIZE: R/r = 41/19.5 mm.

DISTRIBUTION: Known only from Tui Guyot, Three Kings Rise.

DEPTH: 486 m.

DESCRIPTION: Description is of the holotype, the only known specimen, U594 (H-614).

Disc large, flat; arms slender, fast-tapering to oval or heart-shaped naked terminal plates. Four or 5 pairs of superomarginal plates meet in radial midline at arm tip; 27 or 28 superomarginal plates from arm tip to arm tip.

Abactinal plates rectangular to hexagonal, low-tabulate, close-set, forming fairly regular rows along midline of arms and disc edges; plates gently tumid covered with granules; granules similar in size, but may be oblong, rectangular to almost round or square, little distinction between central and peripheral granules. Near arm base, 15–18 peripheral granules form a clear-cut edge to plate, and surround from 10 to 19 small, similar, often rounded, separated granules. Near disc centre, plates less regular in outline, granules less clearly defined; 5 interradial primary plates most obvious, especially when specimen is wet.

Papulae most obvious from coelomic side where generally 6 surround each plate; absent (or very small) near arm tips and interradially.

Pedicellariae not seen on abactinal surface of disc, arms, or marginal plates.

Madreporite small, rectangular, interradial, near disc centre, coarsely dissected; surrounding plates slightly swollen.

Anus possibly a small, circular hole, lying near madreporite and surrounded by slightly enlarged granules.

Supero- and *inferomarginal plates* forming a well-defined edge to disc and arms. Superomarginal plates large, rectangular, corresponding almost exactly to inferomarginals; plates covered with regular rows of small, spaced, round, distinct granules; bordering granules slightly larger, more obvious. Distalmost 4–6 marginal plates naked centrally.

Inferomarginals corresponding with superomarginal plates, forming a conspicuous margin to disc and arms.

Actinal surface well defined; plates small, rectangular, close fitting, arranged in fairly regular rows. Granules on these plates spaced, less rounded than those of abactinal plates, slightly larger, marginal granules more upright, angular. Plates adjacent to adambulacrals larger, many carry at least 1, sometimes 2, distinct pedicellariae; pedicellariae scattered on other actinal plates. Pedicellariae small, inconspicuous; each with a slender stalk that supports a broad, fan-shaped, flattened head with a slightly crenulate margin, with blades on either side of small, oblong or oval, pit or hole. Pedicellaria blades not occupying distinct depression or pit on plate, when lying flat; they are surrounded (?protected) by 4 enlarged granules or stocky spines, which flank slender shafts of pedicellariae.

Adambulacral plates rectangular, well separated laterally from one another by distinct grooves or channels. Furrow spines 7 or 8, spines compressed, thin, hastate, narrow edge facing margin; spines round-tipped, of similar size, proximalmost spine, however, shorter and inset slightly from furrow margin. Subambulacral spines (or large granules) well separated from margin by broad, naked channel; 3 subambulacral spines in first row; these are rather angular and round-tipped. Behind these, 3 (distally 4) rows of subambulacral granules forming more or less regular rows.

Oral plates triangular, distinct, with furrow series of 10–12 (in one angle, 13) round-tipped, flattened spines;

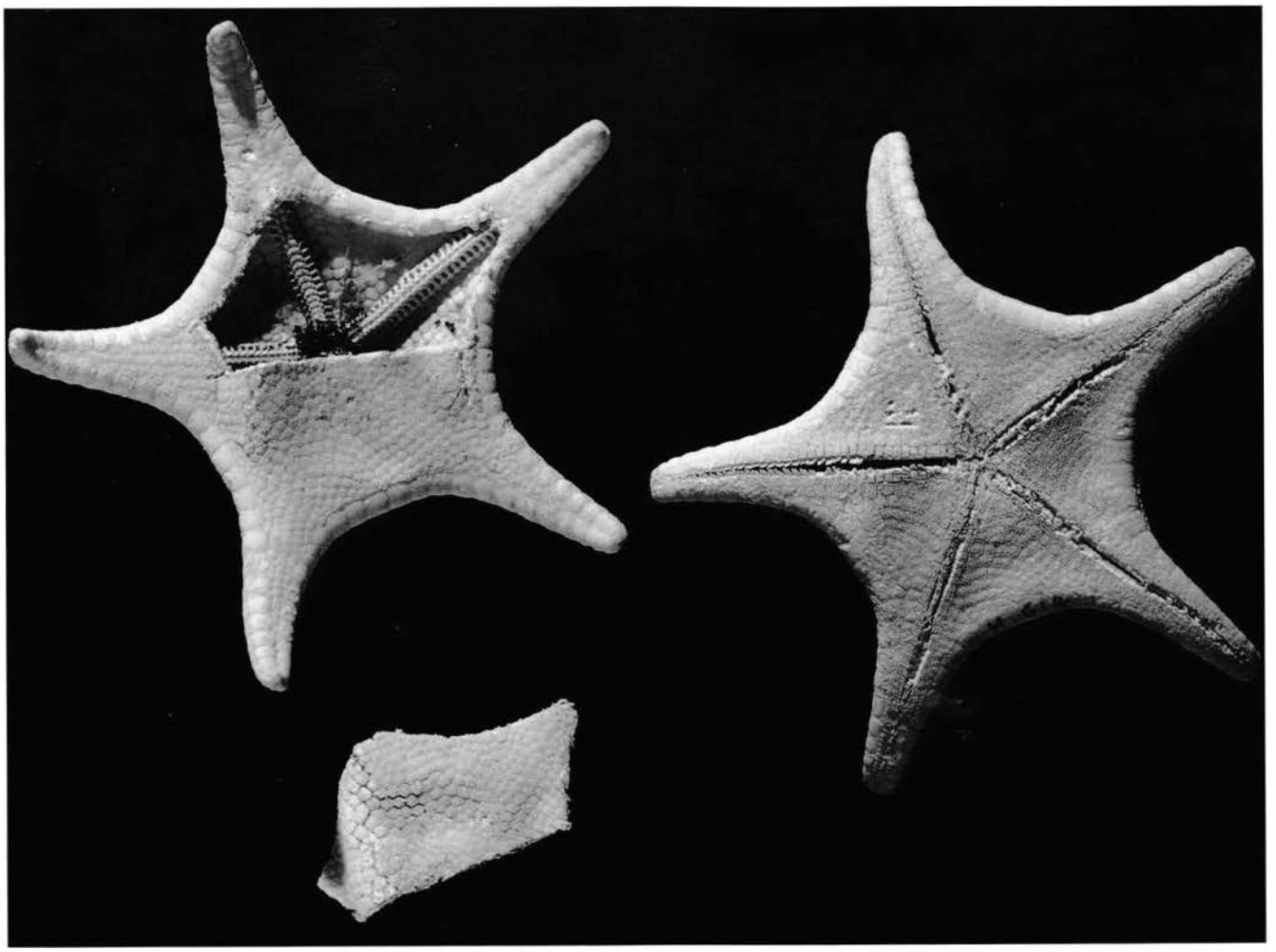


Plate 8. *Ceramaster glasbyi* McKnight. Holotype. NZOI Stn U594. R/r = 41/19/5 mm. Abactinal and actinal surfaces.

standing side on to one another and of similar size; those overhanging mouth sturdier. Suboral granules or short spines, 6–8, forming a regular row along plate suture; there may be other smaller granules also. Suture between oral plates and between oral and actinal plates, clear-cut, distinct.

Ambulacral grooves narrow, often obscured by furrow spines, these sometimes standing vertically in groove.

Dissection showed no superambulacral or secondary abactinal plates; *tubefeet* with double ampullae; an interradial membranous septum and interradial gonads open abactinally.

REMARKS: *Ceramaster glasbyi* with its rather small, well-defined disc and long, slender arms is distinct from *C. patagonicus patagonicus*, has a large disc and short, rather indistinct arms, and is commonest in southern New Zealand waters, although there is one record from the Bay of Plenty, North Island.

Ceramaster glasbyi has affinities with *C. bowersi* (Fisher, 1906) from near Kauai Island, Hawaii, 411–592 m; both species have distinct subambulacral spines (as opposed to granules); spines are present also, at least proximally, on the adambulacral plates; there are also differences in these two species in the arrangement and number of granules of the abactinal plates. Pedicellariae, present in both *C. bowersi* and *C. glasbyi*, also differ in form and abundance. In *C. bowersi*, pedicellariae are widespread on both surfaces and have narrow, spatulate blades; in *C. glasbyi* pedicellariae are most obvious and abundant on actinal plates and have an expanded and broad head with a crenulate margin.

Eknomiaster n.gen.

Disc large, pentagonal, well-defined by marginal plates; arms short, squat, last pair of superomarginals meet midradially. Odd pair of marginal plates interradially

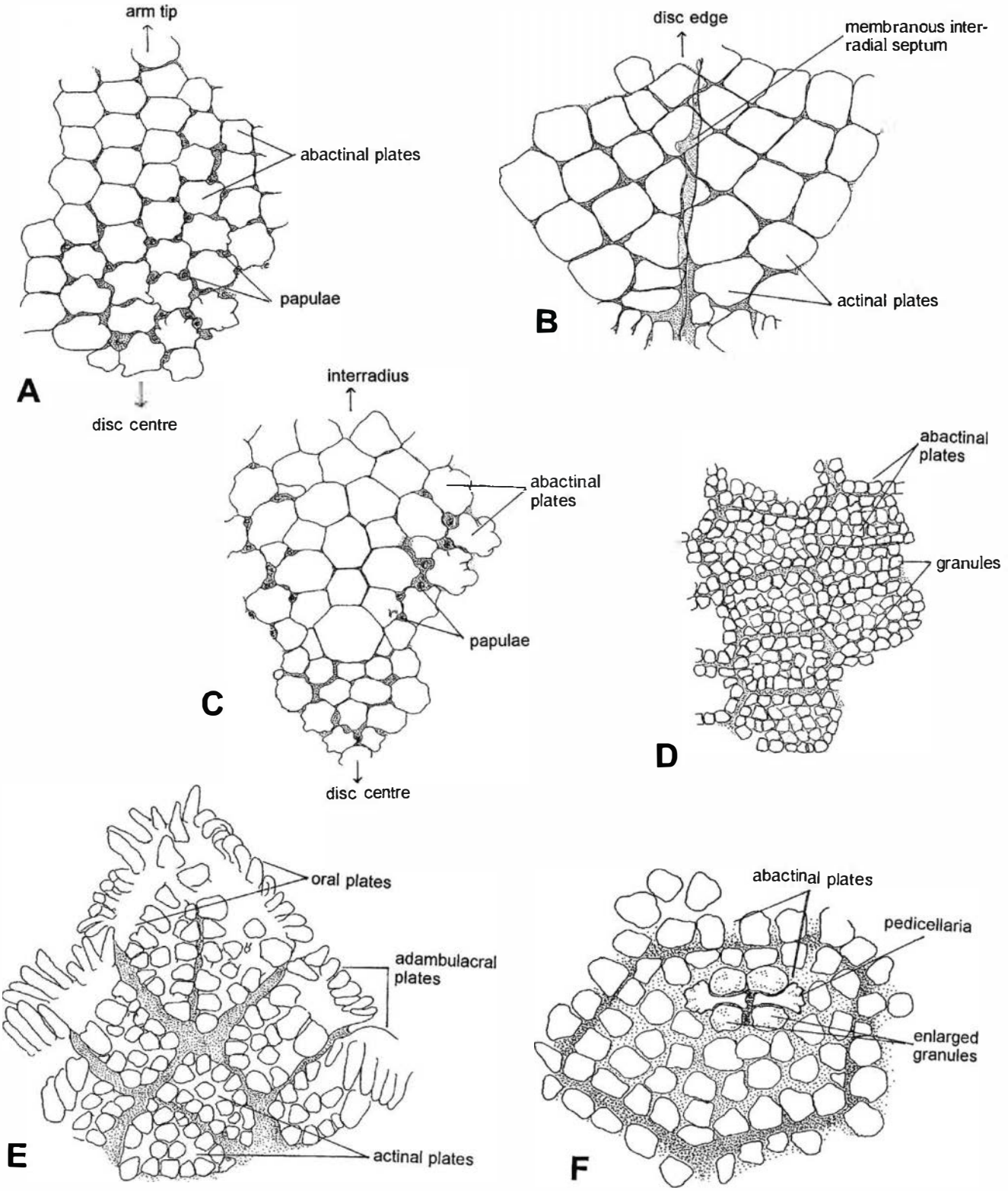


Fig. 11. *Ceramaster glasbyi* McKnight. **A**. Arrangement of abactinal plates, radially along centre of arm and disc. Plates viewed from coelomic side. B. Actinal plates seen from coelomic side. **C**. Interradial abactinal area from coelomic side to show plate arrangement. **D**. Abactinal plates near arm base. **E**. Oral, adambulacral, and actinal plates. **F**. Actinal plate with pedicellaria. Note the four enlarged surrounding granules.

in both series. Marginal plates large, distinct, tumid, no spines, bordered by small, regular rectangular granules, larger at corners; occasional bivalved pedicellariae may have been present—faint, indecisive scars remain. Distal superomarginal plates largest; inferomarginal plates more numerous, 2 distalmost inferomarginal plates indistinct — proximal large, distalmost very small; both extra inferomarginal plates at arm tips visible from abactinal surface. Abactinal plates, generally hexagonal, forming a close regular paving, except near superomarginals where plates more or less rectangular and form regular rows especially evident near unpaired superomarginal. Occasional small, bivalved, sugartong-like pedicellariae present abactinally. Actinal surface well paved with plates, many plates with distinct 2-valved, fan-like pedicellariae; valves, when flat, fit closely to gently depressed area on plates. Actinal plates variously shaped, bordered by small, regular, angular, closely fitting granules which enclose spaced, rounded granules. Adambulacral plates with fringe of long, slender, rather flattened, furrow spines edge-on to furrow; subambulacral armature with up to 3 enlarged conspicuous spines and pedicellariae. Near arm tip 1 subambulacral spine conspicuously enlarged. Oral plates large, narrow, with well-developed sturdy furrow spines.

ETYMOLOGY: Eknomios, Greek unusual, marvellous: *Eknomiaster* — unusual, marvellous star.

TYPE SPECIES: *Eknomiaster macauleyensis* n.sp.

TYPE LOCALITY: Known only from near Macauley Island, Kermadec group, 510 m.

REMARKS: This new genus is distinct in having:

1, an unpaired marginal plate in both series;
2, inferomarginal plates continue beyond terminal superomarginal plates;
3, unusual high, fan-like, conspicuous actinal pedicellariae; these are quite distinct from abactinal pedicellariae, and
4, the armature of actinal plates, with close fringing marginal granules and isolated round central granules.

One other genus in the family Goniasteridae has an unpaired marginal plate in both series, this is *Perissogonaster* Fisher, 1913—*P. insignis* the type, from the Philippine Islands and a new species from Australia (to be described by the author)— both species have very long slender arms and superomarginal plates are separate to arm tips.

Pentagonaster (in the same family) has inferomarginal plates which continue beyond the last superomarginal, but in *Pentagonaster* the actinal plates are bare centrally and there is no conspicuous unpaired marginal plate in both series; it also lacks large fan-like actinal pedicellariae.

No other genus in the family Gonasteridae has the curious high fan-like actinal pedicellariae, neither are there actinal plates similar to those in the present genus.

Eknomiaster macauleyensis n.sp. (Pl. 9, Fig. 12)

MATERIAL EXAMINED: NZOI Stn T235(1).

SIZE: R/r = 28/19 mm.

DISTRIBUTION: Known only from near Macauley Island, Kermadec group.

DEPTH: 448–510 m.

DESCRIPTION: The only specimen (T235) and holotype, with one arm missing, is described.

Disc pentagonal, arms very short. Terminal plate large, oval, tumid, fringed by small regular granules; a spine may have been present at tip.

Abactinal plates generally hexagonal, sometimes septangular; 6 or 7 plates bordering superomarginals (interradially) rectangular, either with long axes at right angles to marginal plates or lying parallel to plates. Occasional small oval or triangular plates, sandwiched between superomarginal and rectangular plates. Abactinal plates under high magnification appear naked; however, there is suggestion of a fine dusting of tiny, mostly isolated, flattened granules. Plates bordering madreporite have definite glassy bosses (small granules) generally near plate edge. Occasional small bivalved, rather flattened sugartong-like pedicellariae present, valves flat on plate, little or no depression; between valves a small, conspicuous, rectangular pit. Abactinal plates ringed by rectangular granules, meeting with granules from neighbouring plates and forming a very regular edge to plates. Marginal granules larger, tumid, and most distinctive at plate corners where, generally 3 (sometimes 4) granules meet.

Papulae at plate corners, conspicuous radially, absent interradially, forming a particularly close-knit network; papulae probably also absent from between most central plates on disc, and from first 3 or 4 radial plates.

Madreporite more or less pentagonal, interradial, close to disc centre, somewhat damaged, narrowly and deeply dissected. Madreporite ringed by granules, some damaged.

Anus not obvious.

Superomarginal plates forming conspicuous edge to disc and arms; plates 7, 3 on either side of unpaired plate, smooth, tumid, large, bordered by regularly rect-

Plate 9. ***Eknomiaster macauleyensis*** n. gen., n.sp. NZOI Stn T235. R/r = 28/10 mm. Abactinal and actinal surfaces.

angular granules similar to those of abactinal plates, slightly larger; 2 terminal superomarginal arm plates meeting medianly.

Inferomarginal plates 11, central 7 of similar size to superomarginals and corresponding almost exactly. Two most terminal plates interesting, distinctive; second to last plate large, curving up and round last superomarginal plate, not quite reaching abactinal surface. Distalmost inferomarginal plate dramatically smaller, almost oval, flanking terminal arm plate and adambulacral groove.

Actinal surface with close pavement of irregularly shaped plates — rectangular, almost square, round, pentagonal, diamond-like. Plates with clear border of angular, close-fitting granules; centrally either a large conspicuous fan-like, upright pedicellaria or, if no pedicellaria, isolated rounded granules in almost regular rows. Pedicellariae very distinctive, blades fan-like, flattened, round tipped, fitting in distinct depressions on plates. At base of pedicellariae, at either side of blades, generally 2 round prominent granules; between blades a rectangular, conspicuous well-defined pit. An unpaired row of diamond-shaped actinal plates runs from oral plate to unpaired inferomarginal, very obvious in 1 interradius; in another interradius the sequence is confused and hidden by a jumble of plates near inferomarginals; possibly an enveloping membrane was present actinally, still persisting in 1 interradius.

Adambulacral plates rectangular with gently curved furrow margin. Furrow spines generally 7, occasionally 8; spines flattened, quite broad, more or less untapering, truncated, spines generally edge-on to furrow; most proximal and distal spines distinctly shorter. Behind furrow spines a distinct clear space, then a row of 1, sometimes 2, conspicuous, large pedicellariae. If only 1 pedicellaria, generally 1 or 2 heavy, round-tipped spines also forming a straight row. Near arm tips generally 1 very conspicuous heavy, almost oval, round-tipped spine occupying most of plate; other spines apart from furrow, few. On proximal adambulacral plates, 2 or 3 rows of conspicuous, spaced, short, angular granules; these difficult to distinguish near arm tips. Actinal plates between adambulacral and inferomarginals to last large inferomarginal plate of arms; near arm tip adambulacral and inferomarginal plates in contact.

Oral plates narrow, shortly acute; furrow spines 11 or 12, very similar to adambulacral furrow spines, possibly somewhat more flattened but of similar length, narrow edge to plate centre. An occasional suboral spine replaced by a large bivalved pedicellaria. Tip of furrow spines very irregular in shape, some almost triangular. Suboral spines 5–7, forming a definite, well separated row adjacent to furrow spines. Boundary between 2 plates in angle bordered by row of regularly arranged more or less rectangular short, broad-headed granules.

Ambulacral grooves narrow, deep, *tubefeet* biserial with indistinct sucking discs.

COLOUR: No colour notes of living animal; dried, brown-grey.

ETYMOLOGY: The holotype is from near Macauley Island, in the Kermadec group.

TYPE: NZOI holotype H-747, in NIWA collection Wellington.

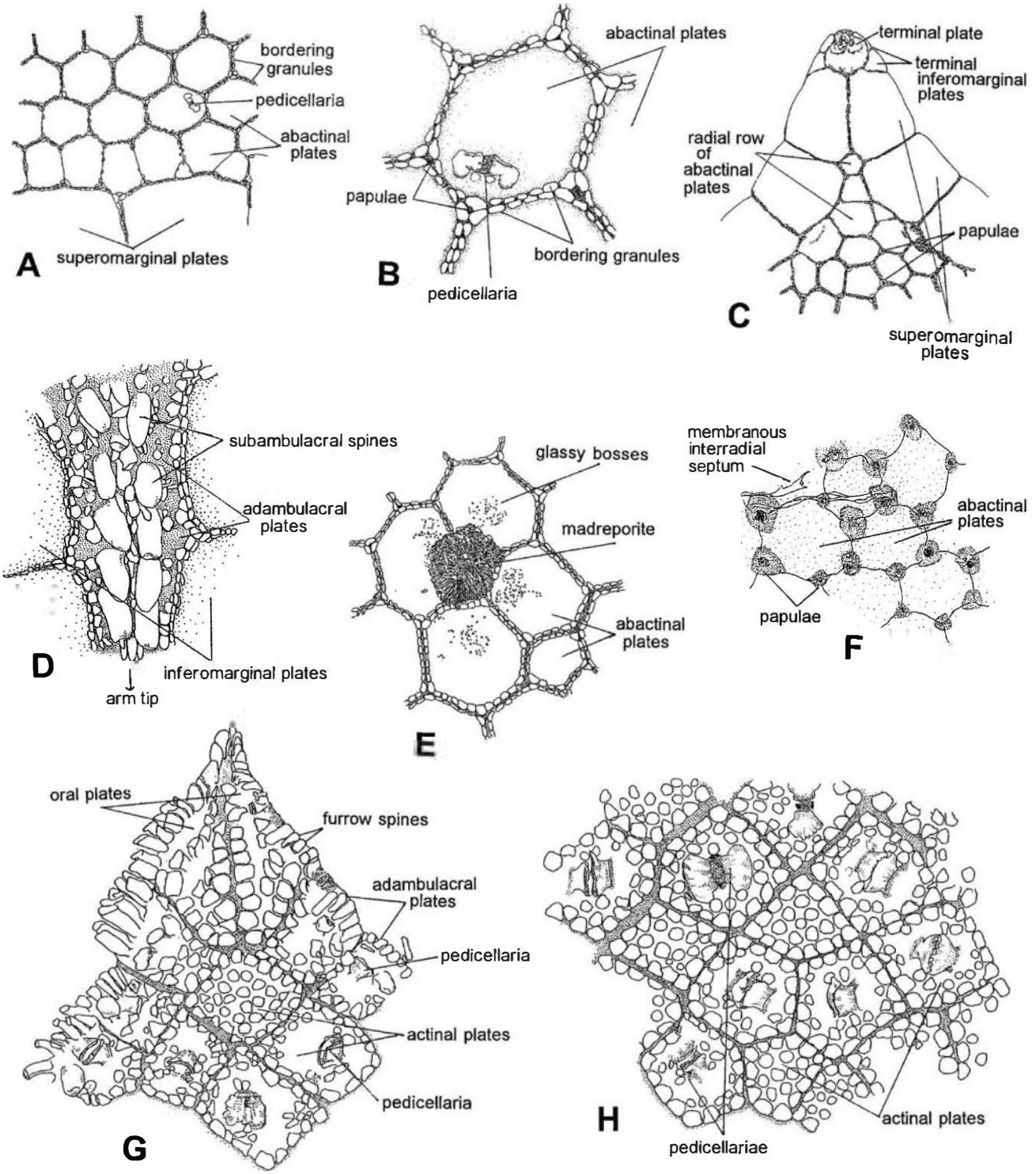


Fig. 12. *Eknomiaster macauleyensis* n. gen., n.sp. **A.** Superomarginal plates, adjacent abactinal plates, and pedicellaria. **B.** Abactinal plate near disc margin showing abactinal pedicellaria. **C.** Abactinal view of arm tip. Note the two terminal inferomarginal plates and the conspicuous radial row of abactinal plates. **D.** Actinal view of small area near arm tip. Note large well-developed subambulacral spines. **E.** Madreporite and adjacent abactinal plates with glassy bosses. **F.** Abactinal plates seen from coelomic side. **G.** Oral, adambulacral, and actinal plates. Note the large distinctive actinal pedicellariae. **H.** Actinal area showing pedicellariae and plates.

REMARKS: See remarks under genus. This complex speci-men is interesting; possibly it has close affinities with *Pentagonaster* which also shows an extension of the inferomarginal series of plates.

The specimen was not dissected but some anatomy is visible where the 5th arm has been removed. The abactinal plates form a very regular close-knit skeleton of hexagonal plates, with sharply truncated lobes; this is especially obvious interradially. Interradial septa (a small part remains) membranous; papulae, widespread, are conspicuous as well-defined pores. Interradially, probably near interradial septum, but close to disc centre there are two stalked broad-headed organs attached to an irregular, rather rounded mass on abactinal plates; perhaps these are gonads.

Enigmaster McKnight & H.E.S. Clark, 1996

Disc large, almost pentagonal; arms hastate with marginals large and regular near arm tip; elsewhere, interradially, marginal plates small, jumbled. Abactinal plates with granules, peripheral series smaller. Actinal areas extensive, plates covered by granules. Along furrow, adambulacral plates with short, regular furrow and subambulacral spines. Abactinally and interradially some plates with definite pores continuing to coelomic side; actinally, a few small pores between actinal plates. Upper transverse ambulacral muscle occupies distal part of ambulacral head only. Bars or rungs in the ambulacral grooves, passing from 1 ambulacral ossicle across furrow to opposite ossicle external (apparently) to epidermis. Tubefeet lacking obvious sucking discs, possibly very small ones are present.

TYPE SPECIES: *Enigmaster scalaris* McKnight & H.E.S. Clark, 1996.

TYPE LOCALITY: Auckland Islands.

REMARKS: *Enigmaster scalaris* McKnight & H.E.S. Clark is described from the single large specimen taken near the Auckland Islands. It is unusual in having:

1, muscular bars across the ambulacral furrows;
2, no suckers on tubefeet (if present, very small and hard to see);
3, irregular and curious arrangement of interradial marginal plates;
4, pores through some abactinal plates and pores between some actinal plates.

DISTRIBUTION: Known only from the type locality at the Auckland Islands.

Enigmaster scalaris McKnight & H.E.S. Clark, 1996
(Pl. 10, Figs 13, 14)

Enigmaster scalaris McKnight & H.E.S. Clark, 1996: 205–214, 1 pl., 10 figs.

MATERIAL EXAMINED: Auckland Museum: AK 79700(1).

SIZE: R / r = (approx.) 67 / 42 mm.

DISTRIBUTION: From near Auckland Islands, south of New Zealand.

DEPTH: 520 m.

DESCRIPTION: The holotype, the only specimen, is described.

Disc generally large, thin, although radially disc steep, rising sharply. Marginal plates really only obvious at arm tips; interradially plates small, inconspicuous, globose, distorted; unusual interradial marginal plates give curious body form with hastate arm tips. *Terminal arm plates* oval, halfmoon-shaped, small, inconspicuous, without spines.

Abactinally, plates solid, angular, forming very regular rows radially and interradially; midradially, a conspicuous carinal row of plates for at least half arm length. Proximally, plates flat, sharply defined, near arm tips plates irregularly arranged, often conspicuously tumid. On most abactinal plates, granules missing; however, on some plates on either side of steep radial ridge and near superomarginals, granules are present. Near disc centre plates square, oblong, oval, or irregular in shape with close mosaic of very finely thorny granules; on plate margins granules thick, rectangular, spaced, forming upright or angled fringe along plate edge; central granules round, oval, or hexagonal.

Papulae 6 or 7, surrounding each plate, most obvious radially and present to arm tips; interradially, sparse or absent, probably also absent from disc centre.

Pedicellariae straight, two types — one with slender, tapering blades, the other with conspicuous, broad, fan-like blades. When pedicellariae removed, distinct oval or oblong pits remaining; these with small distinct lip, numerous, widespread abactinally, 1–4 on a plate; especially obvious near disc centre; interradially, pits small, inconspicuous. Other plates with larger ovoid or rounded pits, lacking lip; no traces of pedicellaria blades with these "unlipped" pits. In some interradii pits continuing through plate, becoming visible on underside.

Madreporite near disc centre, large, irregular in shape, coarsely dissected, surrounding plates slightly raised.

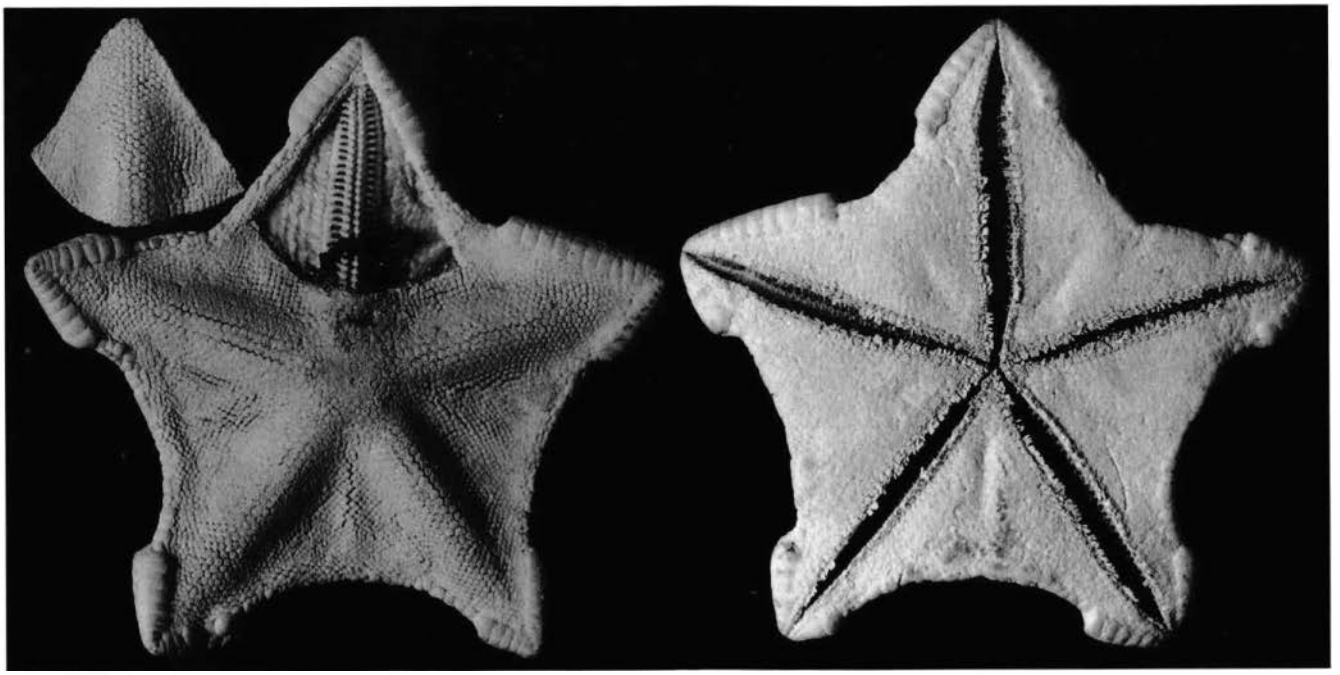


Plate 10. ***Enigmaster scalaris*** McKnight & H.E.S. Clark. Auckland Museum Stn AK79700. R/r = 67/42 mm. Abactinal and actinal surfaces.

Anus not obvious.

Superomarginal plates only really obvious at arm tips where plates rectangular, regularly arranged and forming distinct bevelled edge to disc. Plates now generally naked but surface texture indicates original granulation; granules still present on some edges, occasionally also on plates. Pedicellaria pits present, distinct, generally near plate margins. Most distal 2 or 3 pairs of superomarginals from opposite sides of arms meeting in midline. Interradially, both supero- and inferomarginal plates small, irregular in shape, oval, globose, distorted, confused. Unusual interradial marginal plates imparting curious body form, with hastate arm tips.

Inferomarginal plates distally similar to and corresponding with superomarginals but no pedicellaria pits.

Actinal areas extensive, well developed, triangular, plates more or less regularly arranged, especially near adambulacrals. Actinal plates square, rectangular, irregular; plates bordering adambulacrals well defined, rectangular, large. Plates with small granules, peripheral series with slightly spaced, clear-cut outer margins, surrounding angular or round granules. One to 3 pedicellaria pits on plates, pits mainly marginal, fewer centrally.

Adambulacral plates forming distinct edge to furrow; rectangular, well separated laterally; furrow edge straight or very gently rounded; no pedicellariae. Furrow spines generally 4, although proximally only 3 and occasionally, 5 distally; spines short, non-tapering, round-tipped, sturdy, proximalmost adambulacral furrow spine often distinctly shorter, sturdier and inset on plate, away from margin. Subambulacral spines 2 or 3, short, thickset, generally forming a gently curved series; subambulacral granules angular, well spaced, forming 2 or 3 rows; near arm tips subambulacral granules enlarged, flattened, typically forming a rosette-like arrangement, with a central flattened granule and other granules surrounding it.

Oral plates triangular, very obvious, with 7 or 8 furrow spines, short, thickset, non-tapering, round-tipped, large; sturdiest at plate tip. Suboral spines 3–5, short, with thick tips; suture between plates very distinct, bordered by 5 or 6 small spines or granules.

Ambulacral grooves broad centrally, narrow proximally and distally; *tubefeet* regularly biserial, all retracted. Tubefeet, when retracted, forming large, oval, amorphous, sac-like mass; sucking discs apparently absent. At bottom of furrow, between pairs of tubefeet, distinct and regular bars spanning grooves, passing from 1 ambulacral ossicle to opposite, rather like rungs of a ladder; bars like these not reported in other goniasterids.

COLOUR: No colour notes of fresh material; dried, ex-preservative, white to light-brown or fawn.

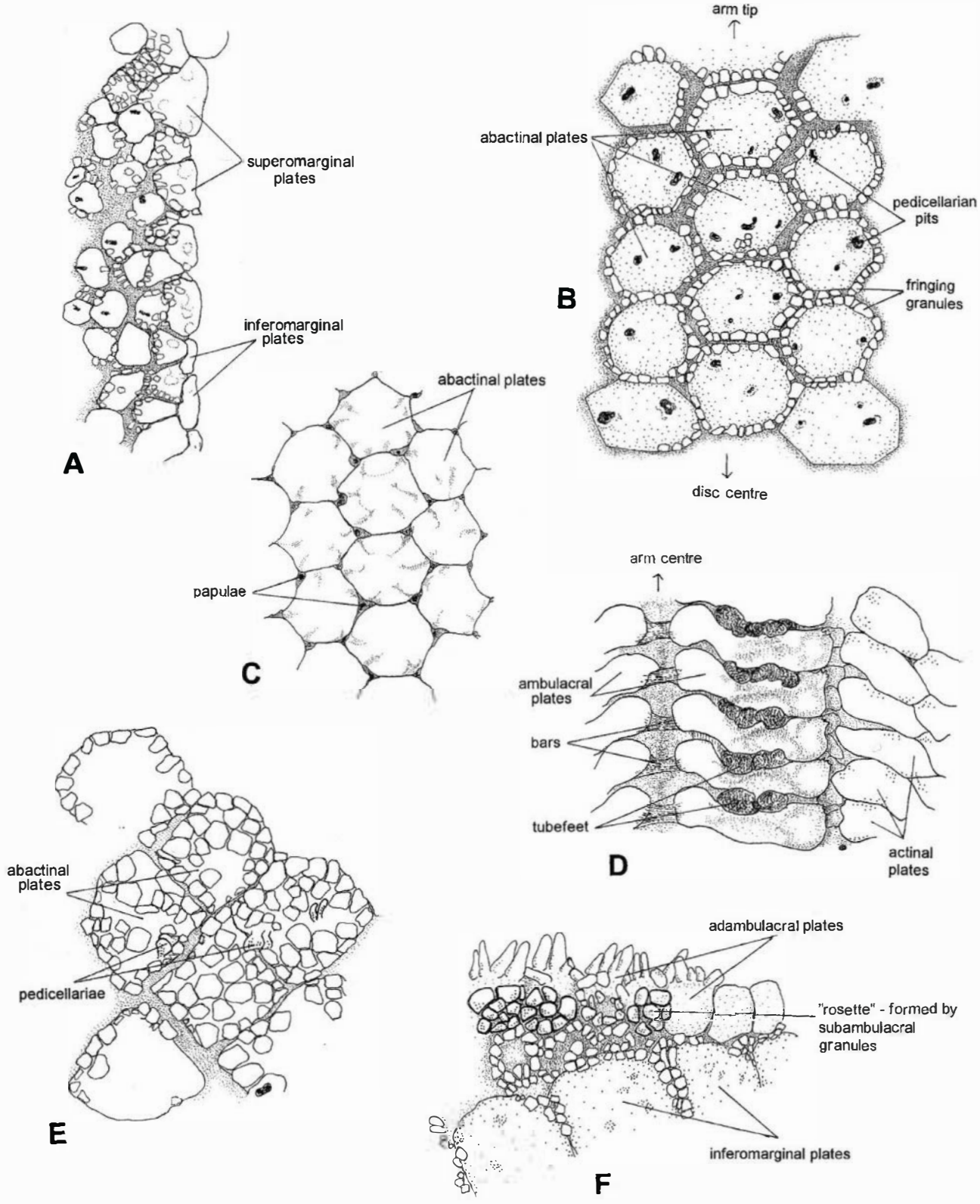


Fig. 13. *Enigmaster scalaris* McKnight & H.E.S. Clark. **A**. Superomarginal plates midway along arms. Note the uneven size and arrangement. **B**. Abactinal plates showing pits left by pedicellariae, and also some granules. **C**. Group of abactinal plates from coelomic side, midline of arms. **D**. Ambulacral and actinal plates from coelomic side. **E**. Group of abactinal plates interradially near margin. Note pedicellariae and some smaller fringing granules. **F**. Adambulacral and inferomarginal plates near arm tip, showing curious rosette form of subambulacral granules.

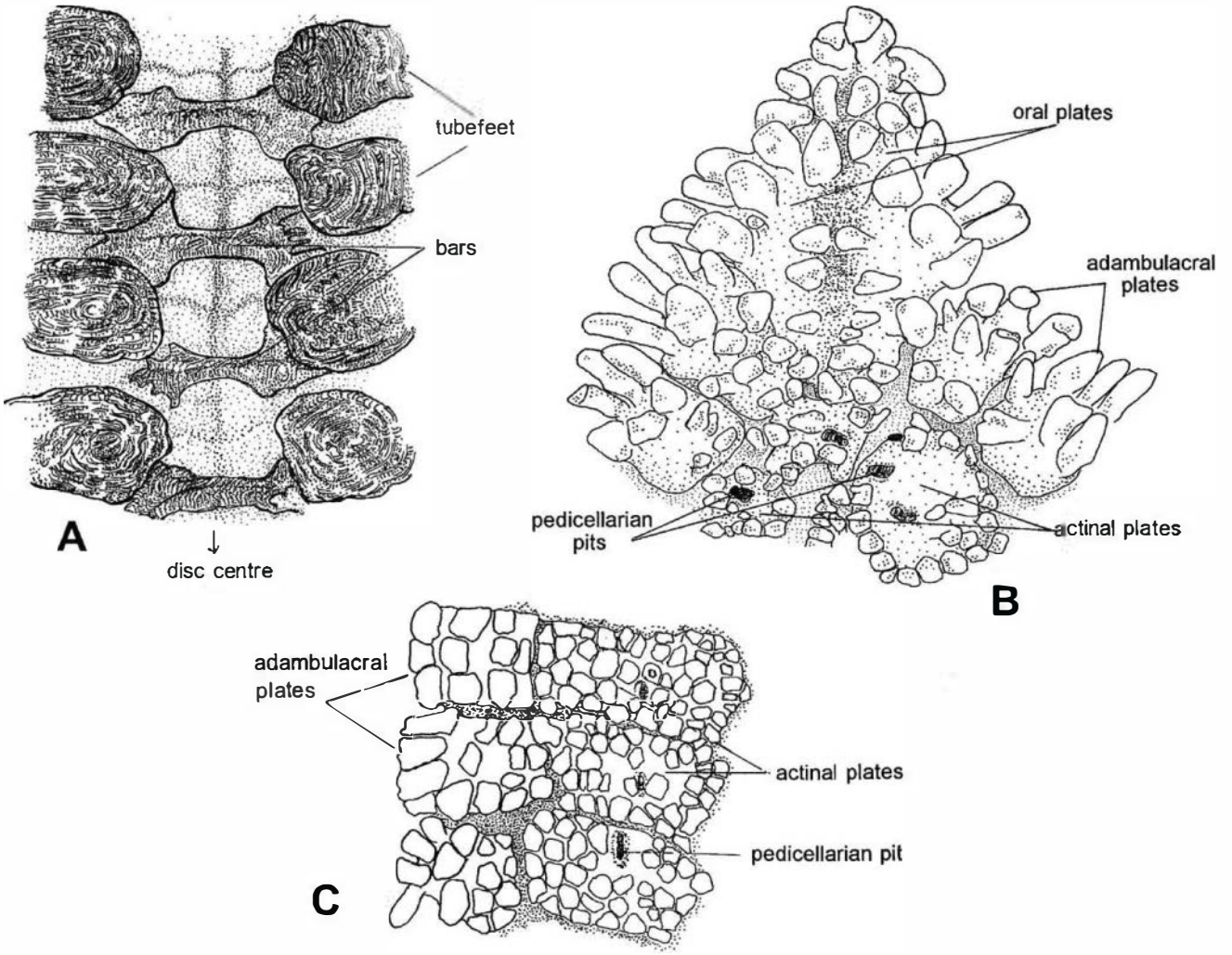


Fig. 14. ***Enigmaster scalaris*** McKnight & H.E.S. Clark. **A.** Ambulacral groove, showing bars and sac-like tubefeet. **B**. Oral, proximal adambulacrals, and actinal plates. **C**. Three adambulacral plates and adjacent actinals. Note there is a tendency for smaller granules to be aggregated near plate edges.

REMARKS: There are five important points to be considered:

1. The strong rungs or bars (apparently fibrous, not calcareous) that extend across the furrow between the ambulacral ossicles are unique. They are not skin-covered and are outside the general body coelom.
2. The curious appearance of the marginal plates is puzzling. Possibly the uneven arrangement may allow greater flexibility and perhaps there is a parallel here with the common shallow-water New Zealand sea-star *Stegnaster inflatus* (Hutton). It is known to catch prey by arching part of the interradial region to make an inviting dark cave or entrance, and when an unwary fish or small crustacean enters the sea-star flattens immediately, trapping the prey (Grace 1974). Another suggestion (F.W.E. Rowe, pers. comm.) is that marginal plate irregularities may allow a streamlining; perhaps an attribute for sinking or burrowing into a soft substrate. *Enigmaster scalaris* resembles *Stegnaster inflatus* in general body form.
3. Distinct small pores are present abactinally, passing through some plates, but not between plates as papulae do. Possibly they are pedicellarian pores, as in *Hippasteria trojana*, in which they do pierce the plates, but there is also a lip, not present in *Enigmaster*.
4. Pores between some actinal plates resemble those seen in members of the Asteriidae, Echinasteridae, Ophidiasteridae, and Zoroasteridae.
5. Absence of definite suckers on the tubefeet suggest this species belongs in the order Paxillosida. The body form is goniasterid, however. (A similar anomalous combination of characters has been noted for *Pseudarchaster boardmani* Livingstone (1934) by Rowe and Gates (1995: 68)).

One arm was dissected: ambulacral ossicles broad, sturdy, from centre of arm to arm tip, no superambulacral ossicles; near disc several actinal plates are very thick, almost arched, with rounded ends nearly meeting ambulacral plates — almost forming superambulacrals. Actinal plates thick, close-fitting; plates near ambulacral ossicles regularly arranged, others less so. Between actinal plates sometimes distinct small pits or holes are shrouded in membrane and run at an angle between plates; they are not continuations of pedicellarian pores or simply gaps due to imperfect fitting of plates. Ampullae of tubefeet double; interradial septa membranous; small grape-like clusters on either side of septa are probably gonads. Membrane lining abactinal plates thick, heavy; arrangement of abactinal plates seen from coelomic side similar to that in *Ceramaster patagonicus*. In *Enigmaster* the arrangement of the ambulacral muscles is of interest; it differs from that found in other goniasterids such as *Ceramaster* and *Pillsburiaster*.

DISTRIBUTION: Known from Hawaii and New Zealand, near Gisborne and Mahia Peninsula, east coast, North Island.

Gilbertaster Fisher, 1906

Disc large, arms distinct, narrow, tapering; interbrachial arcs rounded. Straight pedicellariae conspicuous, bivalved, present abactinally and actinally but not marginally; no abactinal, marginal, or actinal spines. Abactinal plates large, well defined, generally carinal row of plates conspicuous; plates with close covering of granules; marginal granules slightly smaller. Marginal plates also with close covering of granules. Adambulacral plates well defined with 2 or 3 short, sturdy, truncate, rather flattened furrow spines and 2, sometimes 3, ill-defined rows of subambulacral granules; bivalved pedicellariae often present on furrow edge of plate. Actinal areas well paved, conspicuous large bivalved pedicellariae present near adambulacrals. Madreporite with striae and central pores, or with pores only.

TYPE SPECIES: *Gilbertaster anacanthus* Fisher, 1906.

TYPE LOCALITY: West coast of Hawaii Island, 463–699 m.

REMARKS: Fisher (1906) recorded one species from Hawaii. McKnight (1973a: 192) described a new species, *G. brodiei* from a single specimen taken from near Gisborne, North Island (southeast of East Cape) in 740–913 m. A third specimen, NMNZ Ech. 6476, also from near Gisborne, is described here. Examination of many specimens of species included in the family Goniasteridae has shown how very variable species can be — we now recognise *G. brodiei* as being synonymous with *G. anacanthus* Fisher. In *G. brodiei* (NZOI Stn E719) there is a carinal series of abactinal plates (not especially conspicuous), there are small abactinal secondary plates; there is variation in development and presence of adambulacral furrow spines and the madreporite, although striate, also has fine pores. In the NMNZ specimen there is a conspicuous and well-developed carinal series of plates (at least for three-quarters of arm length), there are distinct, small, secondary plates present, and the madreporite, besides being conspicuously striate, also has small pores or holes centrally. Both New Zealand specimens differ in having 3 more or less equally developed adambulacral furrow spines, the central spine is seldom shorter. *Gilbertaster brodiei* (NZOI Stn E719) is the largest specimen recorded, R / r 94 / 42 mm, and differences in the arrangement of granules on abactinal plates and differences in the adambulacral plates are regarded as variations only. How important the appearance of the madreporite is — whether there are striae, pores, or both, is not really known; possibly Fisher's specimen was damaged in some way, or well worn.

Gilbertaster anacanthus Fisher, 1906 (Pl. 11, Fig. 15)

Gilbertaster anacanthus Fisher, 1906: 1063, pl. 27(2a–2c).
Gilbertaster brodiei McKnight, 1973a: 192, fig. 10; A.M. Clark 1993: 223.

MATERIAL EXAMINED:
NZOI Stn E719(1).
NMNZ: near Mahia Peninsula: Ech. 6476(1).

SIZE: R = 95, approx. 67 mm, r = 42, 25 mm.

DISTRIBUTION: Known from Hawaii and New Zealand, near Gisborne and Mahia Peninsula, east coast, North Island.

DEPTH: 463-913 m.

DESCRIPTION: Specimen NMNZ Ech. 6476 is described, R / r = approx. 67 / 25 mm (3 arm tips are damaged).

Disc large, unevenly inflated, arms of slightly different lengths, narrow, upturned, tapering evenly to sharp tips. *Terminal plate* large, rounded with (on 1 arm) an unpaired, almost square, central granule; terminal plates scarred with numerous, spaced, shallow pits, occupied by small, round, rather flattened gran-ules, a few remain. Interbrachial arcs rounded.

Abactinal surface with intricate paving of plates, shaped from oval to almost square, oblong, pentagonal, hexagonal. Conspicuous carinal series of well-defined plates for at least half arm length, flanked by rows of

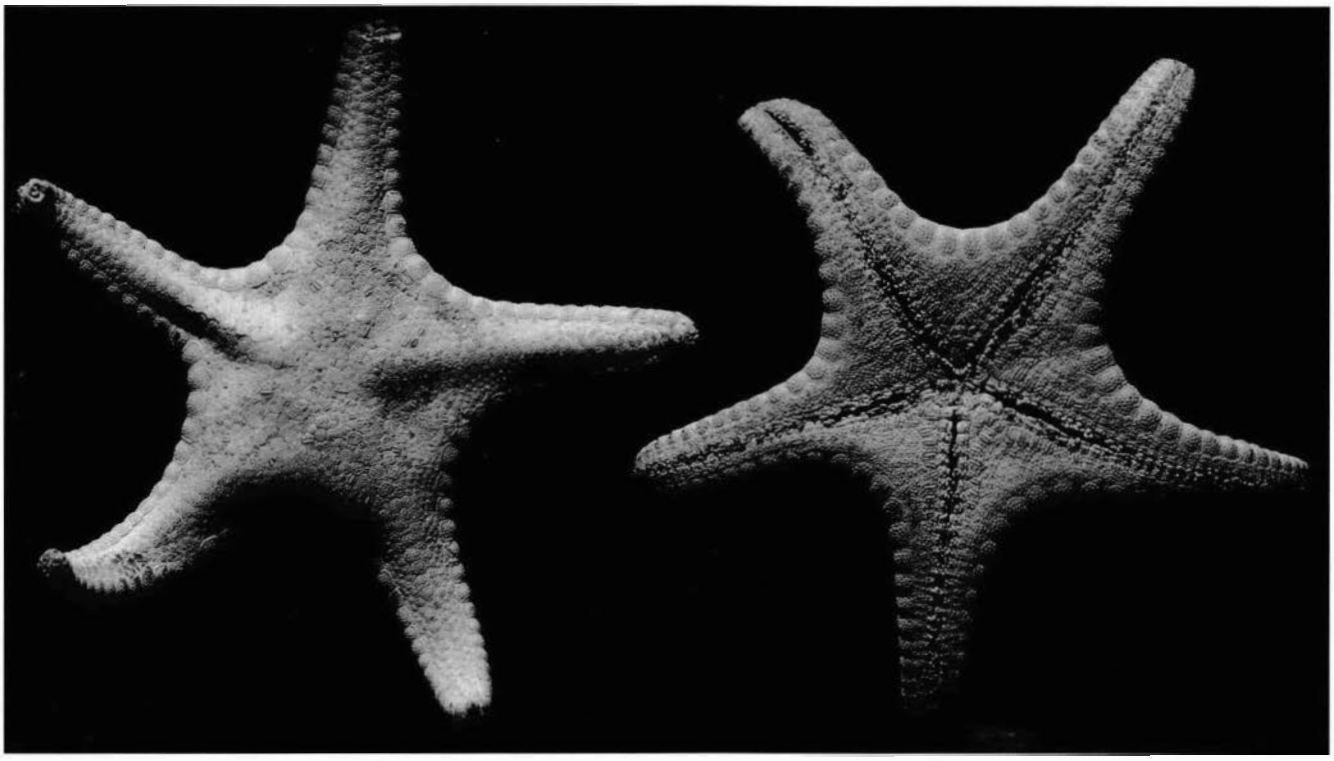


Plate 11. *Gilbertaster anacanthus* Fisher. NMNZ 6476. R = 95, 67, r = 42, 25 mm. Abactinal and actinal surfaces.

similar but smaller and less well-defined plates. In first half of arms large radial (carinal) plates separated from one another by either conspicuous, small, bivalved straight pedicellariae, or by a row or rows of close-fitting plates. Further out on arms, carinal plates often touching. Abactinal plates large, slightly raised; plates bordered by regular, close-fitting rectangular or pentagonal granules, enclosing a pavement of angular granules, 1, sometimes 2 or 3, may be central. Central granules generally flat but some raised, with a tiny central swelling or pimple. On disc centre plates often confluent or separated by smaller plates, often with a central, conspicuous, tumid pedicellaria, or plates may be considerably smaller (secondary plates) with one enlarged central, often angular, granule. Towards arm tips plates irregular in size and shape, often paved with rows of similar granules, these slightly more tumid than those of disc. Interradially, plates smaller, irregular in size and shape, often with a single central granule or long, narrow bivalved pedicellaria.

Papulae generally at plate corners, most obvious for first half of arms; few or absent from disc centre and absent interradially near marginal plates.

Pedicellariae long, bivalved, conspicuous, smooth, occasional hint of teeth or irregularities along free edges, blades appearing hollow and generally tightly shut. Pedicellariae, generally central on plate, surrounded by granules; largest on disc but few and small near disc centre and last quarter or half of arms.

Madreporite interradial, hexagonal, nearer disc centre surrounded by 6 larger, more conspicuous plates; madreporite finely, conspicuously striate, somewhat worn centrally, but with conspicuous pores.

Anus small, depressed, interradial, guarded by jumble of small oblong and some larger granules and plates.

Marginal plates large, gently tumid, forming well-defined edge to disc and arms, 18 or 19 marginal plates from interradial angle to arm tips. Superomarginal plates very regularly rectangular with curved (almost rounded) and conspicuous abactinal margin. Regular rectangular marginal granules surrounding close mosaic of central granules, these often with small, conspicuous pimples. No pedicellariae or spines. Edges of plates bordering inferomarginals straight; inferomarginals corresponding almost exactly with superomarginals.

Inferomarginals similar to superomarginals with well-rounded edge adjacent to actinal plates; central granules often with slight pimples or swellings.

Actinal areas well defined, with close covering of plates, adjacent to adambulacrals most conspicuous with large, slender, straight pedicellariae lying at right angles to furrow. Occasional shorter pedicellariae may also be present; surrounding granules often with small central pimple (swelling). Pedicellariae often isolated on plates, with granules well spaced from them.

Adambulacral plates rectangular, distinct. First and/

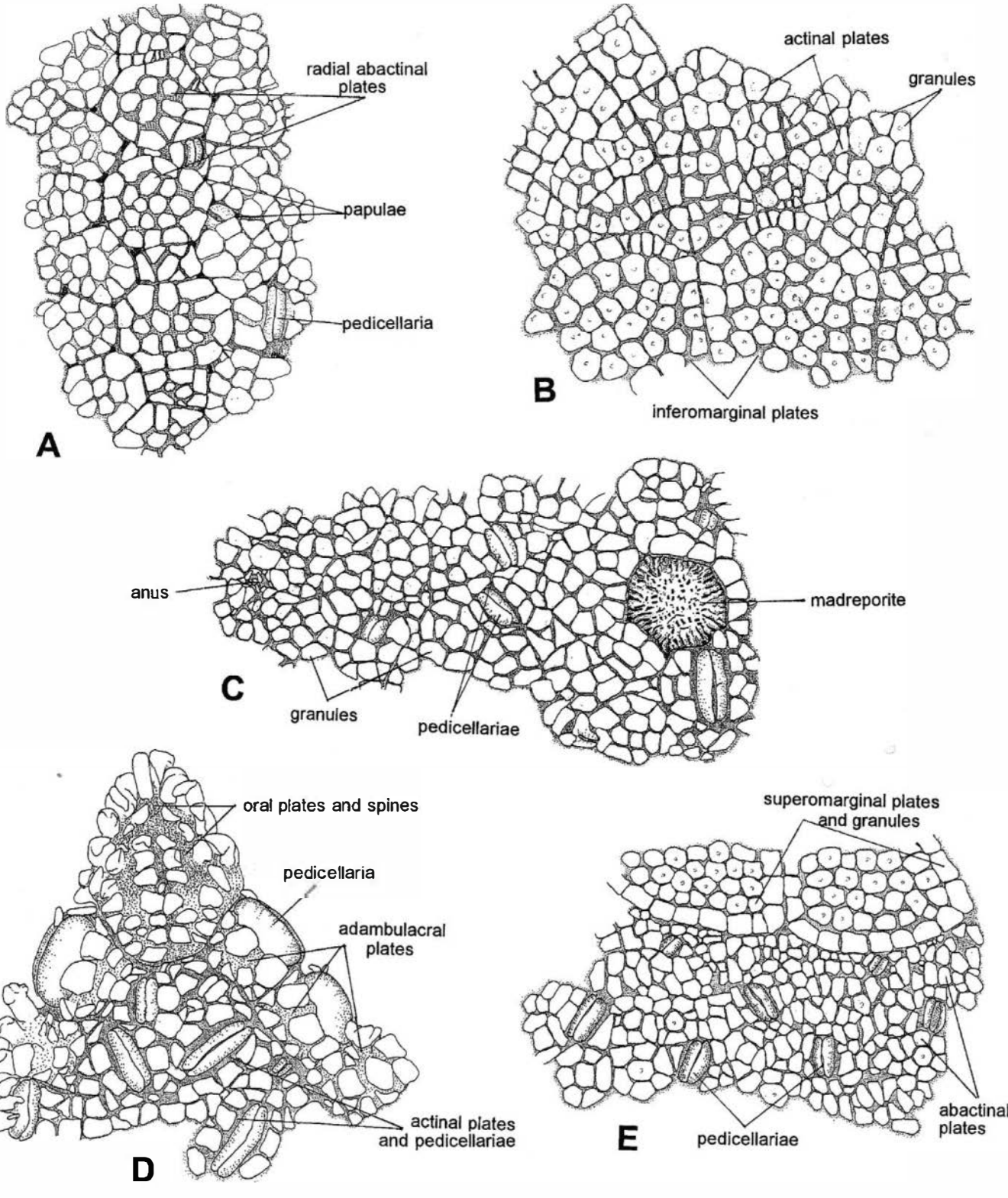


Fig. 15. *Gilbertaster anacanthus* Fisher. A. Radial abactinal plates near disc. B. Inferomarginals and adjacent actinal plates. Note the granules on plates, often with a small central "pimple". C. Abactinal plates showing madreporite, anus, and pedicellariae. D. Oral plates, adjacent ambulacral plates, and actinal plates. Note the large bivalved pedicellariae. E. Superomarginal plates and granules, abactinal plates, and pedicellariae.

or second and sometimes third adambulacral plate, adjacent to oral plates, often with conspicuous, large, straight, bivalved smooth pedicellariae; 2 valves open over furrow and generally lying parallel with it. Valves generally fitting together smoothly, without teeth, although sometimes slight marginal irregularities. Where pedicellariae present along ambulacral groove, these generally overhanging groove on free edge of plate; below pedicellariae, actually in groove, sometimes 1–4 small slender spines or scales, generally upturned, inconspicuous. If no pedicellariae, generally 3 (occasionally 2) conspicuous, sturdy, thick, non-tapering, furrow spines; these often compressed and tip may be angular or irregular in shape. Behind furrow spines generally 1, sometimes 2, conspicuous, enlarged flat-topped, central subambulacral granules, these flanked by 1 or 2 angular granules. Between these and actinal granules a row of 3 or 4 small rectangular granules which border actinal plates. Near arm tips, actinal and adambulacral granules difficult to distinguish.

Oral plates conspicuous, quite large, with furrow series of 5 or 6 sturdy triangular spines, anteriormost largest. Suboral armature of granules or, proximally, short spines; adjacent to first adambulacral, 2 or 3 rows of irregularly shaped granules or short spines. Oral plates "dip" into mouth.

Ambulacral grooves narrow, deep; *tubefeet* suckered, biserial.

COLOUR: No colour notes of living animal; dried, white to very pale brown.

REMARKS: The other larger specimen (NZOI Stn E719) *Gilbertaster brodiei* (McKnight, 1973a), R/r = 95/42 mm, has five intact but worn arms, arm tips similar to those already described. In this larger animal, the carinal series of abactinal plates is present but less conspicuous; the *madreporite* is obvious and striate and there are fine pores present between the ridges centrally. *Papulae* are most conspicuous radially; they are not present near marginal plates and are inconspicuous, very small, or absent from disc centre. *Marginal plates* are similar to those already described, 22 or 23 present from interradial angle to arm tip; plates generally opposite interradially, slightly alternating distally, less well defined compared with those of smaller specimen. *Inferomarginal plates* similar to those described. *Adambulacral* and *inferomarginal plates* separate for at least half to three-quarters length of each arm; intervening actinal plates generally with a bivalved pedicellaria.

In a smaller specimen (NMNZ 6476), actinal plates also present for part of arm length but they seldom carry pedicellariae. Very few marginal or other plates in this larger specimen have small pimples or swellings on plate centre. First *adambulacral plates*, adjacent to orals, with conspicuous large pedicellariae; elsewhere in adambulacral series pedicellariae rare, occasionally replacing furrow spines. At arm tips there are often only two, sometimes one (obvious) furrow spines. There may be one enlarged distal subambulacral spine immediately behind the furrow spines but it is not as conspicuous as in the smaller specimen. Actinal pedicellariae adjacent to adambulacral plates conspicuous. *Tubefeet*, with small suckers, in two regular rows.

The specimen described was dissected: a thick, enveloping membrane is present, especially abactinally, often obscuring plate outlines. Abactinal plates are round or oval, there are no connecting ossicles and no secondary plates, but there is a fairly conspicuous row of carinal plates. Papulae are obvious, leaving long, slender, finger-like processes in the thick abactinal membrane; 4–6 or 7 papulae are present around each abactinal plate; towards the arm tips they are fewer, smaller, and less conspicuous. Papulae are also absent from a narrow strip interradially, on either side of the septum. These interradial septa are membranous but very strong and upright; there are no partial septa present. Gonads are present as a single organ, on either side of the interradial septa; they presumably open very near the superomarginal plates. Proximally, there are no superambulacral plates; midway along the arms there are conspicuous folds or ridges of tissue running from the actinal plates to the ambulacral plates — these do not seem to hide or include plates. Pyloric caecae are obvious along the arms for at least half their length; dorsal to these is a series of connecting, branching, round tipped slender sacs, the ?intestinal caecae per-haps. The sacs are held in place by distinct, narrow folds of tissue which attach to the abactinal plates. The actinal plates are regularly arranged, especially near the ambu-lacral ossicles; they are rectangular and form regular rows.

Glyphodiscus Fisher, 1917b

Disc large, flat; arms short, composed entirely of superomarginal plates which meet in radial midline. Abactinal plates flat, smooth, ringed by single series of granules; no crystalline bodies (hyaline granules). Marginal plates more or less opposite, equal in size. Papular areas radial, restricted. Actinal areas extensive; plates with single, peripheral series of granules. Adambulacral plates with short row of furrow spines, subambulacral armature granuliform, forming 3 rows. Pedicellariae small, spatulate, sometimes present on marginal, actinal and adambulacral plates.

TYPE SPECIES: *Iconaster pierctus* Fisher, 1913.

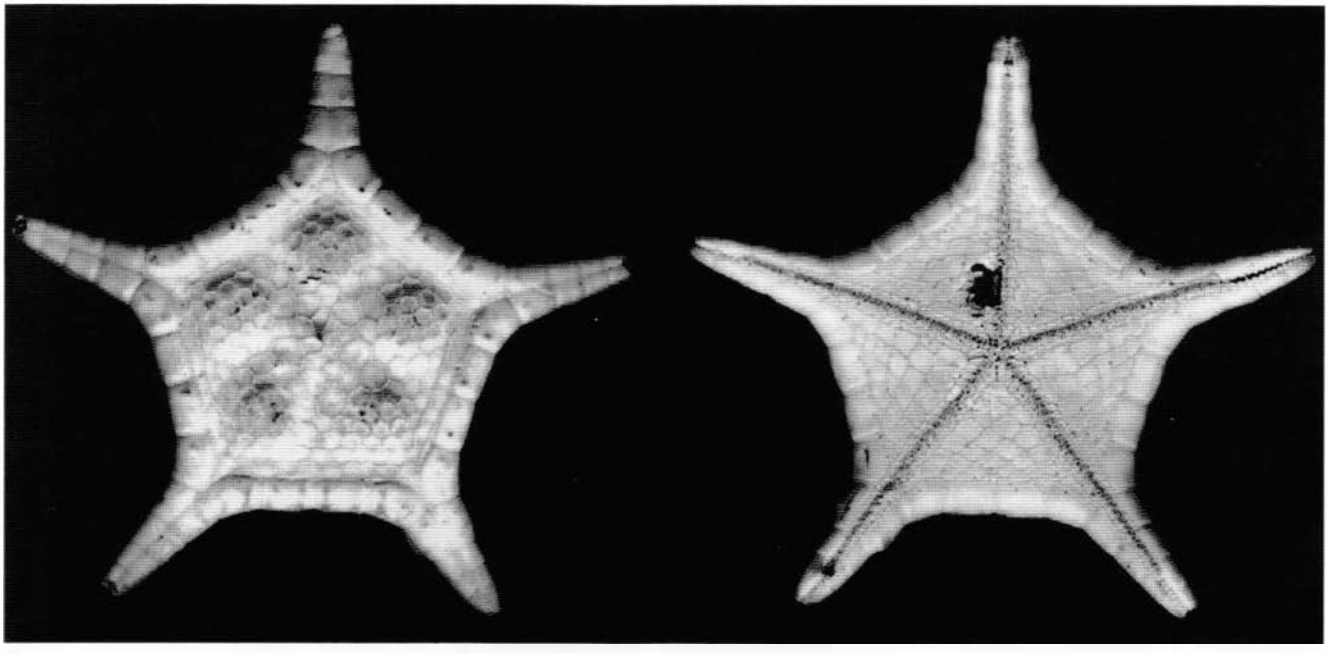


Plate 12. ***Glyphodiscus mcknighti*** Rowe. Holotype. AM J21702. R/r = 23/11.5 mm. Abactinal and actinal surfaces.

TYPE LOCALITY: Near Observation Island, Tawi Tawi group, Philippine Islands, 177 m.

REMARKS: Rowe (1989: 273, figs 8a, b, 9a, b) recorded a new species, *Glyphodiscus mcknighti* from near Norfolk Island, 450–475 m.

Glyphodiscus mcknighti Rowe, 1989 (Pl. 12)

Glyphodiscus mcknighti Rowe, 1989: 273, figs 8A, B, 9A, B; A.M. Clark 1993: 254; Rowe & Gates 1995: 65.

MATERIAL EXAMINED: No material examined, description from Rowe (1989); one specimen, holotype, AM J21702.

SIZE: R/r - 23/11.5 mm.

DISTRIBUTION: Known only from near Norfolk Island, 28°42.30′ S, 167°56.70′ E (NZOI Stn P46).

DEPTH: 450–475 m.

DESCRIPTION: Description of holotype, AM J21702, with R/r = 23/11.5 mm, 6 marginal plates between interradial angle and arm tip.

Disc large, pentagonal; arms 5, short, tapering to blunt tips, only 2 arms with terminal plates. Superomarginal plates, from opposite sides of arm, join in midline, from third superomarginal plate. Abactinal and actinal surfaces flat; superomarginals projecting slightly above abactinal plates; margins vertical.

Abactinal plates smooth, flat, no glassy bosses; plates rounded-polygonal; radial plates slightly smaller than those interradially. Narrow transversely rectangular plates form rows adjacent to superomarginals. Plates bordered by single row of peripheral granules.

Papular areas rounded, convex, abactinal, involving about 10 plates; the areas are radial and restricted.

Pedicellariae small, spatulate; 1, or occasionally 2, present at edge of some actinal plates; also sometimes on actinal edge of inferomarginal plates. No pedicellariae on superomarginal or abactinal plates.

Madreporite small, triangular, interradial; very near disc centre.

Anus central on disc.

Supero- and *inferomarginal plates* similar in shape, size, number; plates block-like, smooth, longer than wide, upper and lower margins rounded, plates opposite each other. From interradial angle to arm tip, in each series, 6 plates, last 4 plates joining along radial midline. All marginals with single, peripheral row of small granules.

Actinal plates flat, smooth, more or less diamond-shaped, forming a regular pavement; plates edged with single row of granules.

Adambulacral furrow spines 5, laterally compressed, behind these a row of 3 enlarged subambulacral granules, and 2 or 3 rows each with 3 or 4 smaller wedge-shaped granules similar to those of neighbouring actinal plates.

Oral plates with 7, 8 furrow spines; 4 or 5 enlarged suboral granules and a further 8–10 wedge-shaped granules on actinal surface of plate.

COLOUR: No colour notes of living or dead material.

REMARKS: *Glyphodiscus mcknighti* differs from the only other known species, *G. perierctus* which has rough superomarginal plates, tumid peripheral abactinal disc plates and widespread papulae. *Glyphodiscus perierctus* is known only from the Philippine Islands, in 177 m.

Hippasteria Gray, 1840

Disc large, arms 5, short to moderate in length; interbrachial arcs rounded. Abactinal plates irregularly arranged, round, of 2 sizes; larger plates usually bare, sometimes convex, with peripheral granules and 1 or more spines, tubercles or pedicellariae ; smaller plates often with granules only. Marginal plates distinctive, large, naked, except for peripheral granules; spines and often pedicellariae. Actinal plates with granules, pedicellariae and often short spines. Adambulacral plates with 1–3 furrow spines; subambulacral spines, pedicellariae or granules. Pedicellariae broad, bi- or tri-valved, standing above plate surface.

TYPE SPECIES: *Hippasteria europaea* Gray, 1840 [= *Asterias phrygiana* Parelius, 1768].

TYPE LOCALITY: "European Ocean" (Gray 1840: 279).

REMARKS: Dons (1938) recognised two subgenera — *Euhippasteria*, with large, subquadrate or rectangular regularly arranged marginal plates; and *Nehippasteria*, with smaller oblong, rhomboid or oval plates which show no regular arrangement.

DISTRIBUTION: Three species are recorded from the Atlantic; in the Pacific the genus is known from the Bering Sea south to Japan, Australia, and New Zealand and southern islands; in the Indian Ocean it is reported from southern South Africa.

Hippasteria phrygiana (Parelius, 1768)

(Pl. 13, Fig. 16)

NOTE: The references and synonymy given here for *Hippasteria phrygiana* are from A.M. Clark and Downey, (1992: 247). References which have not been checked are marked with an asterisk; some references have been omitted as there was no mention of *Hippasteria phrygiana*. This is by no means a complete list as *Hippasteria phrygiana* and its synonyms are mentioned in many publications, some of them extremely obscure and difficult to find.

Pentaceros planus Linck, 1733: 21, pl. 12, no. 21, pl. 22, no. 53.*
Asterias phrygiana Parelius, 1768: 425 [1770: 349], pl. 14, figs 1, 2.*
Asterias equestris Lamarck, 1816: 555. [non *A. equestris* Retzius, 1805]
Asterias johnstoni Gray *in* Johnston, 1835: 146, fig. 21.
Hippasteria europaea Gray, 1840: 279; 1866: 9.
Hippasteria johnstoni: Gray 1840: 279; 1866: 9.
Hippasteria cornuta Gray, 1840: 279; 1866: 9.
Hippasteria plana Gray, 1840: 279; 1866: 9; Perrier 1876: 86; Sladen 1883: 159; Danielssen & Koren 1884: 59; Sladen 1889: 341; Koehler 1909: 88, pl. 2, fig. 5; 1924: 179, pl. 5, figs 6, 7, pl. 7, fig. 6.
Goniaster equestris: Forbes 1841: 125, figs on p. 125, 127, 129.
Astrogonium phrygianum: Müller & Troschel 1842: 52.
Astrogonium aculeatum Barrett, 1857: 47, pl. 4, figs 4a, b.
Goniaster phrygianus: Norman 1865: 123.
Hippasteria phrygiana: Verrill 1885: 542, pl. 17, fig. 47; 1895: 137; 1899: 148; Döderlein 1900: 218; Hartlaub 1900: 191; Ludwig 1900: 457; Whiteaves 1901: 50; Grieg 1902: 21; H.L. Clark 1905: 1; Nordgaard 1905: 160, 235; Grieg 1907: 28, 32; Süssbach & Breckner 1911: 215; Grieg 1912: 6; 1913: 115; 1917: 5; H.L. Clark 1923b: 270; Mortensen 1927: 88, fig. 50; 1933: 245, pl. 11, figs 1, 2; A.H. Clark 1949: 373; Djakonov 1950: 53; Blacker 1957: 18, 45, fig. 27c, appendix 2 (tables 1, 2), appendix 3 (tables 8, 9, 10, 11, 12, 19, 20); Buchanan 1966: 25; Wolff 1968: 82; Walker 1978: 361, figs, pls; O'Connor & Tyndall 1986: 96; A.M. Clark & Downey 1992: 247, fig. 41c, d, pl. 58, A, B; A.M. Clark 1993: 258; Hamel & Mercier 1994: 419.
Hippasteria phrygiania [sic]: Ganong 1893: 56.
Hippasterias phrygiana: Greig 1895: 6; Simpson 1903: 40; Haubold 1933: 199, figs 1, 5–7.
?*Hippasteria pacifica* Ludwig, 1905: 138, pl. 12 (56, 57), pl. 23 (132).
Hippasteria (Euhippasteria) phrygiana: Dons, 1938: 17, figs 3, 7b.
Hippasteria (Nehippasteria) insignis Dons, 1938: 16, figs 1, 2, 4-7a.
Hippasteria trojana Fell, 1958: 11, pl. 1, figs A, G; 1959: 136, fig. 21; 1960: 61, pls 2, 3; 1962: 33 (illust.); McKnight 1967: 300; H.E.S. Clark 1970: 3; A.M. Clark 1993: 259; Rowe & Gates 1995: 65 [new synonymy].

MATERIAL EXAMINED:

NZOI Stns D85(1)*, D211(2), E121(1), E411(1), G697(1), G887(1), G893(1), G904(1), G911(2)*, G912(3), G927(2), I664 (1), I680(1)*, J482(1), P927(1), S65(1), S167(2), T36(1), T37(1)*, T50(1), T65(3), V387(2)*, Z9792(1), Z10138(1).

NMNZ: near Auckland Islands: Ech. 1262(1), 1263(1), 1264(1), 2419(3), 7382(9), 7394(3), 7395(1); Bay of Plenty: Ech. 7377 (1); Bounty Islands and Plateau: Ech. 3460(1); Campbell Island and Campbell Island Rise: Ech. 2698 (2); Canterbury Bight and Banks Peninsula: Ech. 2384(2), 4166(1), 4167(1), 4168(1), 4653(2), 4655(2), 7344(1), 7355(1), 7356(3); off Castlepoint: Ech. 3901(1); Chatham Rise: Ech. 3904(1), 3911(2), 4169 (3), 4170(1), 5320(1), 6432(2), 6433(1); near Dunedin: Ech. 7375 (1); off Hawke Bay: Ech. 6593(1); Pegasus Bay: Ech. 1261(2); Pukaki Rise: Ech. 3461(1), 5687(1), 6567(1), 6891(2), 7378(1); Puysegur Trench: Ech. 7372(1); Stewart Island: Ech. 6514(1).

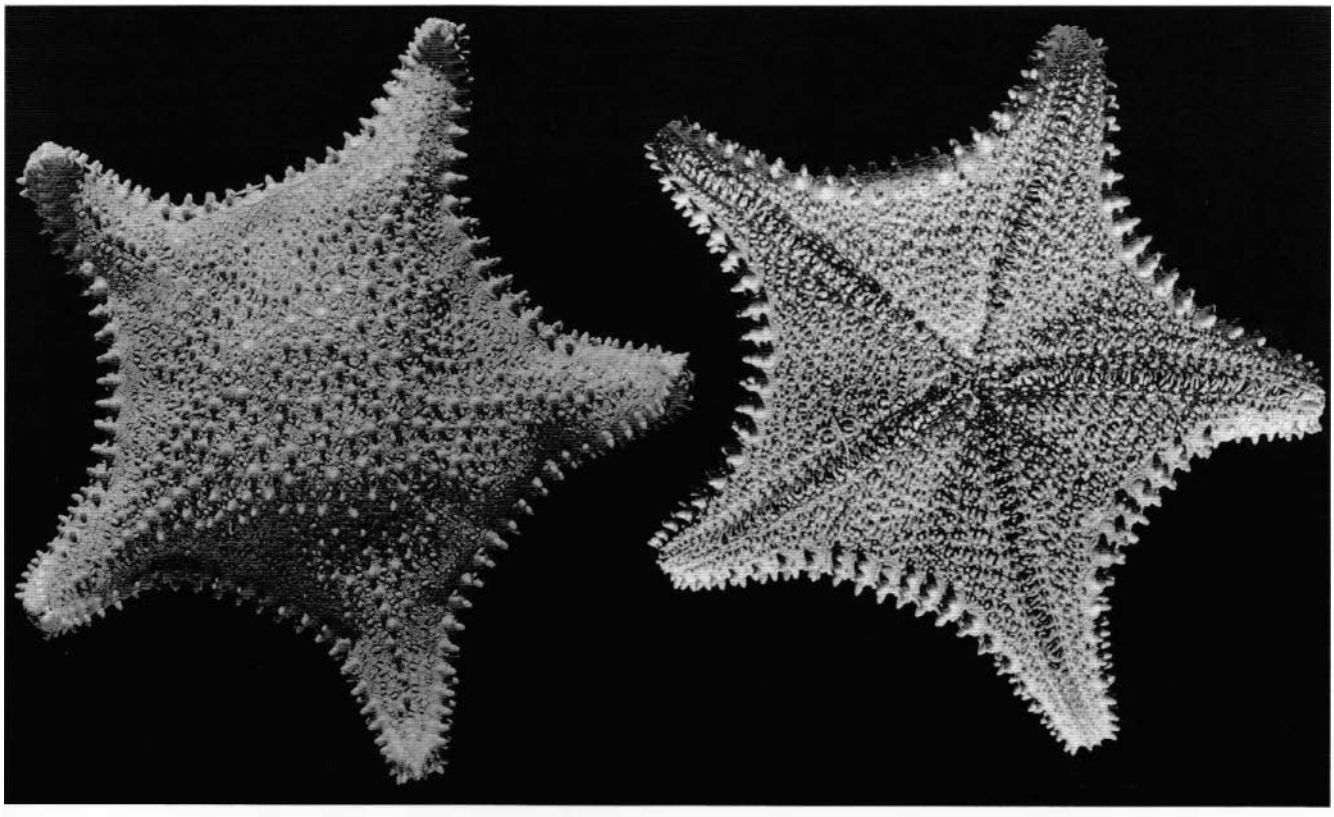


Plate 13. ***Hippasteria phrygiana*** (Parelius). NZOI Stn G697. R/r = 86/44 mm. Abactinal and actinal surfaces.

SIZE: R varies from 157 to 38 mm, r = 94–23 mm (average R/r for 33 specimens = 95/54 mm).

DISTRIBUTION: *Hippasteria phrygiana* is widely distributed in the Northern Hemisphere; in the south it is known from New South Wales and Victoria, Australia; from New Zealand waters it is recorded from 37°S (one record, Bay of Plenty, North Island) to 51°S, and east to Chatham Islands; it is commonest to the east of New Zealand south of 40°S.

DEPTH: 20–1275 m (most records are from over 500 m). Mortensen (1927: 89) recorded the depth for *Hippasteria phrygiana* as about 20–800 m.

DESCRIPTION: Specimen described, NZOI Stn G697, R/r = 86/44, 45 mm.

Disc large, tumid; arms short, rather flat, tapering rapidly to sharp tips; terminal plate not particularly conspicuous, rounded, almost heart-shaped with generally 2 sturdy spines, or on 1 arm tip a single central spine flanked by 2 smaller spines.

Abactinally, plates round, tumid, conspicuous, with a well-defined row of carinal plates reaching almost to arm tips and similar conspicuous plates on disc centre. Interradially, large plates and spines absent from broad band adjacent to superomarginals. Larger plates tumid, naked centrally, with a single, sturdy, rounded, squat, central spine; plates fringed by oval or rectangular well-spaced granules, granules flat-topped, often with a distinct depression centrally. Larger plates separated from each other by smaller secondary plates; secondary plates distinctly less tumid, considerably smaller, also ringed by similar spaced granules, on some plates granules almost meeting centrally; these plates often bear a single large conspicuous bi- (sometimes tri-) valved pedicellaria. Pedicellariae breadroll-like, 2 valves, sometimes meeting centrally, or sometimes arm meeting on side of blade of pedicellariae; blades of pedicellariae hollow. Interradially, and near arm tips pedicellariae small, few, and abactinal plates almost flat, naked apart from fringing granules. Occasional tri-valved straight pedicellariae also, generally 1 valve is considerably larger; most obvious on disc centre where large primary plates are often almost surrounded by a row of these very conspicuous pedicellariae.

Papulae not particularly obvious; however, at arm base and for short distance along arms, distinct small round pores present between plates; very indistinct or absent in last quarter of arms. Papulae best seen from coelomic side —see later.

Pedicellariae generally bivalved, occasionally tri-

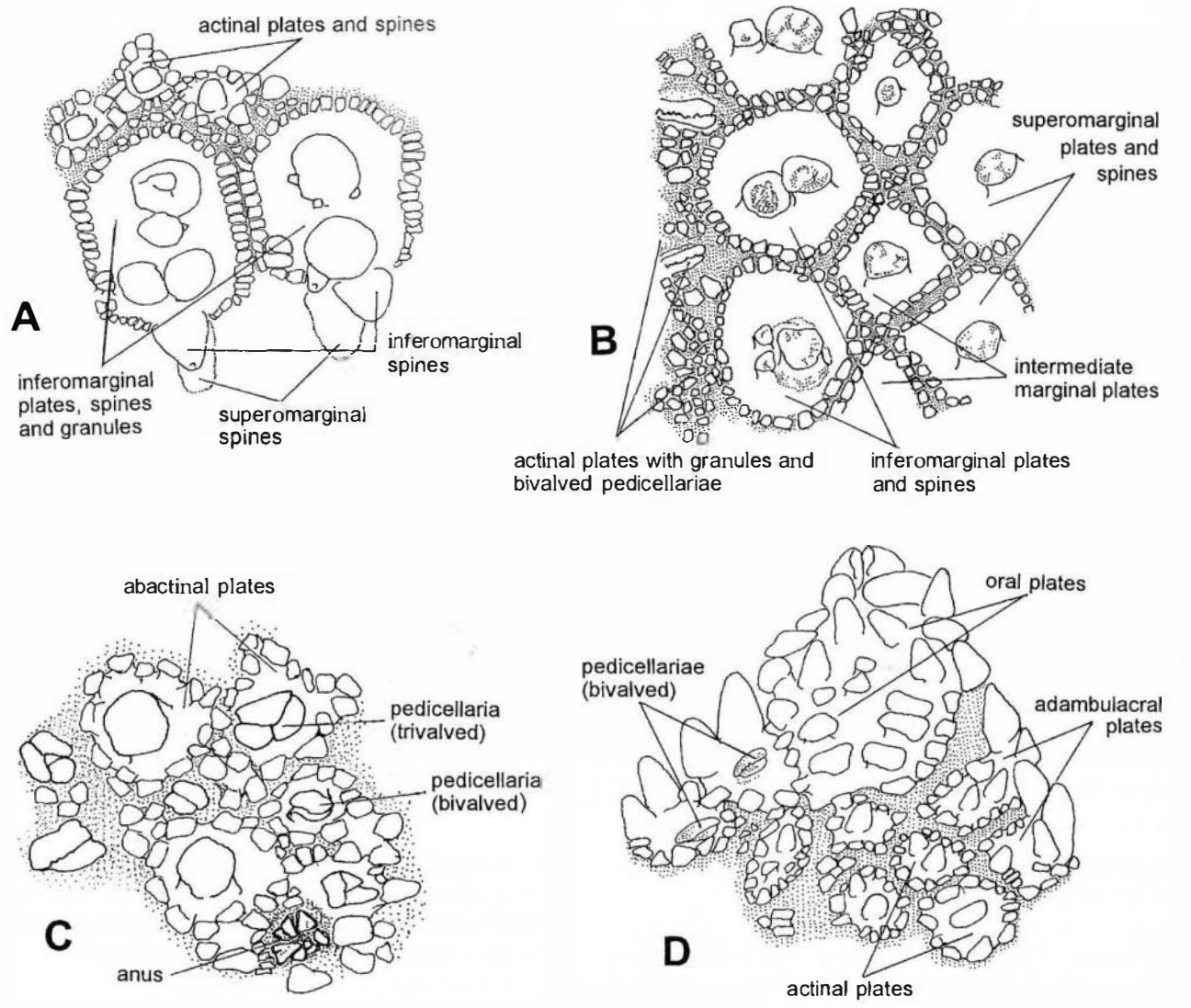


Fig. 16. *Hippasteria phrygiana* (Parelius). A. Two inferomarginal plates near interradial angle. **B.** Margin of arm, showing three rows of marginal plates. Note the even edging of granules around the plates. C. Area near anus showing abactinal plates, spines, pedicellariae, and granules. **D.** Oral plates and adjacent adambulacral and actinal plates.

valved, numerous, conspicuous, small, few interradially and in last quarter of arms.

Madreporite small, interradial and distinctly nearer disc centre; more or less square, well-defined, finely and deeply dissected; surrounding plates and pedicellariae not particularly conspicuous.

Anus almost central on disc, surrounded by short, rather flattened granules or very short spines.

Superomarginal plates forming a very distinct edge to disc and arms, corresponding with inferomarginal plates, 26 or 27 from arm tip to arm tip. Supero- and inferomarginal plates of similar size. Superomarginals large, distinct, almost oval with well-rounded edge abactinally; plates bordered by single row of small, distinct, oblong granules, often with a central distinct depression. Each plate bears at least 1, sometimes interradially as many as 3, rounded, very sturdy central spines forming a vertical row; flanking these spines, 3, 4, even 5 small, bivalved pedicellariae, generally near marginal granules. Towards arm tips enlarged spines fewer, seldom more than 1, and pedicellariae, if present, very small and often indistinct.

Inferomarginals of similar size to superomarginals most obvious actinally, forming a conspicuous border. Inferomarginals also fringed by very regular rows of granules; more regularly rectangular, forming if anything, a more definite edge to plates. Interradially 3, 4, or even 5 spines along plate centre, these large, sturdy, rounded spines similar to those of superomarginal plates; towards arm tips only 1 short spine; pedicel-

lariae similar to those of superomarginal plates and occasional small, round, scattered granules.

Actinal areas large, triangular; plates oval, round, almost square, forming a regular pavement; plates also naked but distinctly less tumid than abactinal plates. Actinal plates fringed by small, rather irregularly shaped granules; centrally, 1-4, even 5, short, round, tapering, spines, or spines absent and a conspicuous central bivalved straight pedicellaria (similar to those of abactinal plates) may occur. Occasional pedicellariae with distinctly serrated or toothed margins to valves; teeth interlock with similar teeth from opposite valve. Pedicellariae generally most obvious on plates bordering adambulacrals.

Adambulacral plates regularly rectangular, forming a well-defined regular edge to furrow. Furrow spines 2 or 3; distally, occasionally 4; furrow spines large, sturdy, upright, round tipped, often proximalmost spine smallest. Subambulacral spine generally 1, conspicu-ous, almost triangular, round-tipped or may be re-placed by a straight pedicellaria; plates fringed by rather irregular, angular, spaced, thickset granules.

Oral plates tumid, with furrow spines similar to adambulacral spines, 5, occasionally 6, furrow spines. Suboral spines or central granules in 1 or 2 rows; plates edged, adjacent to first adambulacrals, by 4 or 5 short, thick, irregular granules. Membranous area, between 2 oral plates in an ill defined angle, indistinct.

Ambulacral grooves deep, narrow; *tubefeet* biserial with well-developed suckers.

COLOUR: Colour notes of living material (NMNZ Ech. 6891, R/r = approx. 150/84 mm): "abactinally – orange; marginal spines– light orange; actinally – fawn, yellow, ivory; tubefeet white, sometimes yellow." Blacker (1957: 45) recorded "a beautiful scarlet colour" in life. Colour (ex-alcohol): fairly uniform fawn to light brown.

REMARKS: This is certainly a very variable species, the one constant feature being the presence, in the majority of specimens examined, of 5 arms and the lack of crossed pedicellariae; an exception to this is nine specimens (NMNZ: Ech. 7382) from near the Auckland Islands in 490–510 m; three specimens had 4 arms.

Fell (1956) described a large (R/r = 116/49 mm) fossil sea-star from Upper Cretaceous limestone in the bed of the Motunau River, North Canterbury, South Island, New Zealand. He named it *Hippasteria antiqua* and remarked (1956: 12) that "perhaps [the genus] awaits discovery off New Zealand". Two years later he described the first living *Hippasteria* from New Zealand waters, *H. trojana*; he discussed the similarities and differences of living and fossil forms.

In his description of *H. trojana*, Fell (1958: 11) remarked on its close similarity to Atlantic *H. phrygiana*, especially in the armature of the marginal plates and in the number, 2–3 of adambulacral furrow spines. After examination of more than 80 specimens of "*H. trojana*" it seems that the marginal plates often have more than one spine, and two or even three are not exceptional. The form of the adambulacral furrow spines is highly variable and many specimens lack marginal pedicellariae. I was fortunate to be able to compare our animals with Atlantic specimens of *H. phrygiana* sent to us by the Museum of Zoology, Lund University, Sweden, the University of Bergen, Norway, and with a specimen from the Smithsonian Institution, Washington DC, USA. I agree with A.M. Clark and Downey (1992: 248) when they say of *H. phrygiana* "this extremely variable species has caused considerable confusion."

Hippasteria pacifica described and figured by Ludwig (1905: 138) certainly seems similar to *H. phrygiana*. Fisher (1911a: 237) suggested that, as the secondary abactinal plates are independent and do not join with other plates, *H. pacifica* is more likely to be related to *Cryptopeltaster* in which the abactinal plates are covered with numerous flat, circular, quadrate granules and very often a large, straight, pedicellaria replaces the adambulacral furrow spines. Attention is drawn, in the present work, to two large specimens from the Chatham and Pukaki Rises in which the abactinal plates have a covering of spaced granules; in these specimens, however, there is no enlarged adambulacral pedicellariae replacing furrow spines.

Imaoka *et al.* (1990) described *Hippasteria imperialis* Goto from Japanese waters; it is also similar to *H. phrygiana*. A.M. Clark (1993 : 257) listed *H. imperialis* as a valid species.

There is variation in the granulation of the *abactinal plates*: in most specimens the plates are conspicuously naked apart from a central spine or spines and the tumid plates are fringed by small, regular, spaced granules. However, in several large specimens (NMNZ, Ech. 5320 from the Chatham Rise area, 220 m, R/r = 127/70 mm; Ech. 6891 from north of Pukaki Rise, 685–729 m, R/r = 150/84 mm) the abactinal plates have no naked central area; instead there is a covering of spaced granules similar to those that fringe the plates. In other respects these specimens are normal. Similarly, the number of *pedicellariae* (both bivalved and trivalved) varies considerably; they are generally fewer in smaller specimens where they are most obvious radially, at the beginning of the arms; likewise, some blades, particularly in bivalved pedicellariae, are toothed, interlocking with similar teeth from the opposite valve. The armament of the *marginal* and *adambulacral plates* is also variable; marginal plates may bear one spine only, or, more commonly, from 2 to 3 (exceptionally as many as

5); spines may be flanked by small, short-stalked, generally bivalved pedicellariae, or by granules. Sometimes plates, apart from spines, are completely smooth; there are no pedicellariae. There are generally 3 *adambulacral furrow spines* near oral plates, and then 2, but sometimes 3 persist almost to arm tips. There is also variation in the *subambulacral armature*, either 2 short, blunt-tipped spines, or these may be replaced by a pedicellaria, or a single spine and a pedicellaria may be present.

In two large specimens (R/r = 131/76 mm, NMNZ Ech. 4166, 44°49′ S, 172°49′ E, 1166–1179 m, and R/r = 145/90 mm, NMNZ Ech. 6891, 48°02′ S, 173° 26′ E, 685–729 m) there are three distinct rows of *marginal plates*; the third and middle row of small, diamond-shaped plates is sandwiched between supero- and inferomarginal plates, and is most conspicuous interradially, these plates bear distinct spines or stumps of spines.

In the smallest specimen in the present collections (NZOI Stn D211, R/r = 37/20 mm) abactinal spines are restricted to the radial areas at the arm bases. There is generally only one spine to a plate; the spines are short, squat, round tipped; marginal granules of plates are round, often raised, well spaced from each other; if no enlarged central spine is present there may be a large or small central granule. *Pedicellariae* bivalved, bread-roll-shaped, commonest radially at arm base; interradially, they are small and generally on plates near superomarginals. *Superomarginal plates* from opposite sides of the arm are separated by at least one row of plates, there are no enlarged spines, but scattered, small, compact, straight bivalved pedicellariae are present. *Madreporite* nearer centre than disc edge, conspicuously pentagonal and deeply and uniformly dissected. *Superomarginal plates*, 22 from arm tip to arm tip form a very obvious and well-ordered edge to disc and arms; plates are very tumid, naked except for fringing granules and they bear a single sturdy, rather squat, round-tipped spine; there are no pedicellariae and no distinct granules. *Papulae* are surprisingly distinct radially, at arm bases and also centrally on disc; from 5 to 7 surround each plate. *Actinally*, plates are well developed and very regularly arranged; there may be one or 2 central enlarged granules present or a small, straight-stalked pedicellaria. *Inferomarginal plates* are very regularly arranged also; there may be 1 or 2 central enlarged granules, or a small, straight, stalked pedicellaria. Proximally there are 3 (in one case 4) *adambulacral furrow spines*; near the arm tips there are generally 2, sometimes 3 spines present; the subambulacral spine is well developed, conspicuous. There are 5 *oral furrow spines*, sturdy, the anteriormost largest. *Tubefeet* are biserial with distinct sucking discs.

One large (R/r = 123/69 mm) specimen, NMNZ no collection data and thus unregistered, was dissected. In this specimen the ambulacral ossicles form a high, steep and very regular skeleton along the arms; they are well separated dorsally by distinct muscles. There are no *superambulacral plates* present. There are strong, *interradial membranous septa* and both abactinal and actinal plates are sheathed in heavy membrane; this is particularly conspicuous and thick abactinally where it obscures plate outlines. Outline of *actinal plates* is visible through the membrane; the hexagonal actinal plates form fairly regular rows, centrally on the plates there is a very shallow indentation or trough which occupies much of the plate and which corresponds with a pedicellaria on the outer surface. Investigations with a probe suggest that this shallow area is membrane covered only, as the plate is easily pierced here. Near the marginal plates the membrane is thicker and plates appear regularly rectangular and brick-like, especially interradially; they are, in fact probably the actinal surface of the marginal plates. Interradially, the *actinal plates* are smaller, less regularly arranged, and irregular in outline. The *pyloric caeca* are small, short, and are restricted to the first half of the arm. The *stone canal* is very obvious. Secondary *abactinal plates* are apparent when the specimen is viewed from the coelomic side; these form rows, of 2--4 small, bar-like, round, flattened ossicles or plates; they are especially obvious at the arm centre. *Papulae* viewed from the coelomic side are very widespread, and present from near arm tips, interradially and centrally. *Gonads* appear as individual, finely branching tufts, close to and on either side of the interradial septum; they are nearer the edge of the disc.

A smaller (R/r = 83/44 mm) specimen (NZOI Stn D211) was also dissected; arrangement of both *abactinal* and *actinal plates*, seen from the coelomic side, in this smaller specimen was more distinct. In this specimen the *interradial septa* are membranous, well developed, and strong; the *pyloric caecae* extend for less than half the arm length and *intestinal caecae* are obvious as distinct, fine, very slender, long tubules; the *gonads* are a compact mass of branching tubules interradially, nearer the disc edge and attached very close to the interradial septum. Walker (1976: 361) described the gonads in European specimens of *H. phrygiana* as being "some distance from the interradial septum". In the present specimens they are extremely close to the septum, one on either side; neither are the gonads "2 in each ray" as Walker (1976: 361) also stated.

The arrangement of the *abactinal plates* viewed from the coelomic side, is complex. However, in the small specimen dissected (NZOI Stn D211) there is a distinct but not particularly obvious carinal series of plates running from near the disc centre to the arm tip; these plates are lobed, oval, oblong, rather irregular in shape, joined lengthwise by small, oval, almost round or gently triangular plates. On either side of this rather ill-defined

carinal series of plates, there is a row of smaller, oval, gently lobed, slightly tumid, conspicuous plates, again connected by distinct, generally oval secondary plates or ossicles; between this intricate network of ossicles and plates, small, oval depressions or holes are present, they are often paired and are presumably papulae. Besides the conspicuous and strong interradial septa are 2 mesenteries (?pyloric) which run as distinct strands of tissue on either side of the carinal series of plates. Near the interradial septa, plates are more uniform in size and form a close pavement, papulae between these plates are not obvious. In the large specimen (NMNZ, no data) there is a similar arrangement of plates although the larger plates, flanking the carinal series, are less conspicuous. Actinally (NZOI Stn D211), there is an intricate and quite uniform network of oval to rectangular or almost square, gently lobed plates, between which are distinctly smaller and rather irregularly-shaped plates; plates flanking the ambulacral ossicles are larger, more prominent and more uniform in shape, forming a conspicuous row, and are irregularly rectangular with a distinctly rounded margin adjacent to the other actinal plates. Near the marginal plates actinal plates are somewhat smaller, more compact; interstitial plates are absent.

Kermitaster n.gen.

Disc large, arms 5, long, narrow, evenly tapering to sharp tip, superomarginal plates from opposite sides of arm separate to arm tip. Carinal series of abactinal plates distinct, no secondary plates. Two jawed small, conspicuous straight pedicellariae present, especially abactinally. Marginal plates conspicuous, inferomarginals not projecting beyond superomarginals; plates with uniform covering of granules, these becoming longer near free edges of plates. Actinal areas well developed; distinct grooves or fascioles present between inferomarginals and adambulacral plates. Oral plates conspicuous with fringe of fine furrow spines; adambulacral plates with straight margin and furrow spines similar to those of oral plates. Internally, no superambulacral plates and no abactinal connecting ossicles; tubefeet biserial, with suckers.

TYPE SPECIES: *Kermitaster pacificus* n. gen., n. sp.

TYPE LOCALITY: From near Raoul Island, Kermadec Islands, 610 m.

REMARKS: The new genus shows similarities to several other genera; these similarities are discussed in more detail in Remarks at the end of the description.

DISTRIBUTION: Known only from near Raoul Island, in the Kermadec Group, north of New Zealand.

Kermitaster pacificus n. sp. (Pl. 14, Fig. 17)

MATERIAL EXAMINED: NZOI Stn K829(2).

SIZE: R/r = 40/13 mm; R/r ~= 22, 23/10 mm.

DISTRIBUTION: Known only from near Raoul Island, Kermadec Islands.

DEPTH: 610 m.

DESCRIPTION: The larger specimen described here is damaged; 5 arms, only 2 remain attached to disc and 1 is broken with disruptions and damage to disc; no obvious thick or thin enveloping membrane abactinally.

Disc large, arms slender, rapidly and evenly tapering to sharp tip; arm tip protected by irregularly oval plate; no terminal spines. Interbrachial arcs widely and regularly rounded; disc and arms radially inflated; interradially depressed. Superomarginal plates from either side of arms separate to arm tips.

Abactinally, a carinal series of hexagonal, sometimes oval, or almost round, plates from near disc centre to last quarter of arm, at least as far as 4th or 5th superomarginal from arm tip. Carinal plates flanked by fairly regular rows of more or less oval plates; no small secondary plates. Abactinal plates with spaced, round, finely thorny, fairly regularly arranged granules, plate margins with fringe of small, spaced, almost triangular pointed spines, these sometimes terminating in 2 distinct glassy points. Disc plates and plates on proximal most raised part of arms irregular in size and shape.

Papulae 4–6, distinct abactinally at plate corners, most conspicuous around carinal plates. Absent or very few at disc centre and interradially.

Pedicellariae many, especially on disc, raised proximal part of arms, and interradially; generally only 1 pedicellaria to a plate, occasionally 2. Pedicellariae straight, bivalved, small, conspicuous with broad base and ill-defined trunk, blades sometimes broad, shell-like with 5, 6 or more fine teeth on free edge; when blades are flat they fit in shallow depressions on plate. Some pedicellariae longer, thinner, strap-like with blades a continuation of trunk, not noticeably broadening, teeth in these pedicellariae more conspicuous, coarser. Pedicellariae border a distinct rectangular pit, edges of pit raised.

Madreporite rather small, interradial, almost hexagonal nearer disc centre. It is finely and regularly dissected with ridges converging centrally; surrounding abactinal plates slightly enlarged.

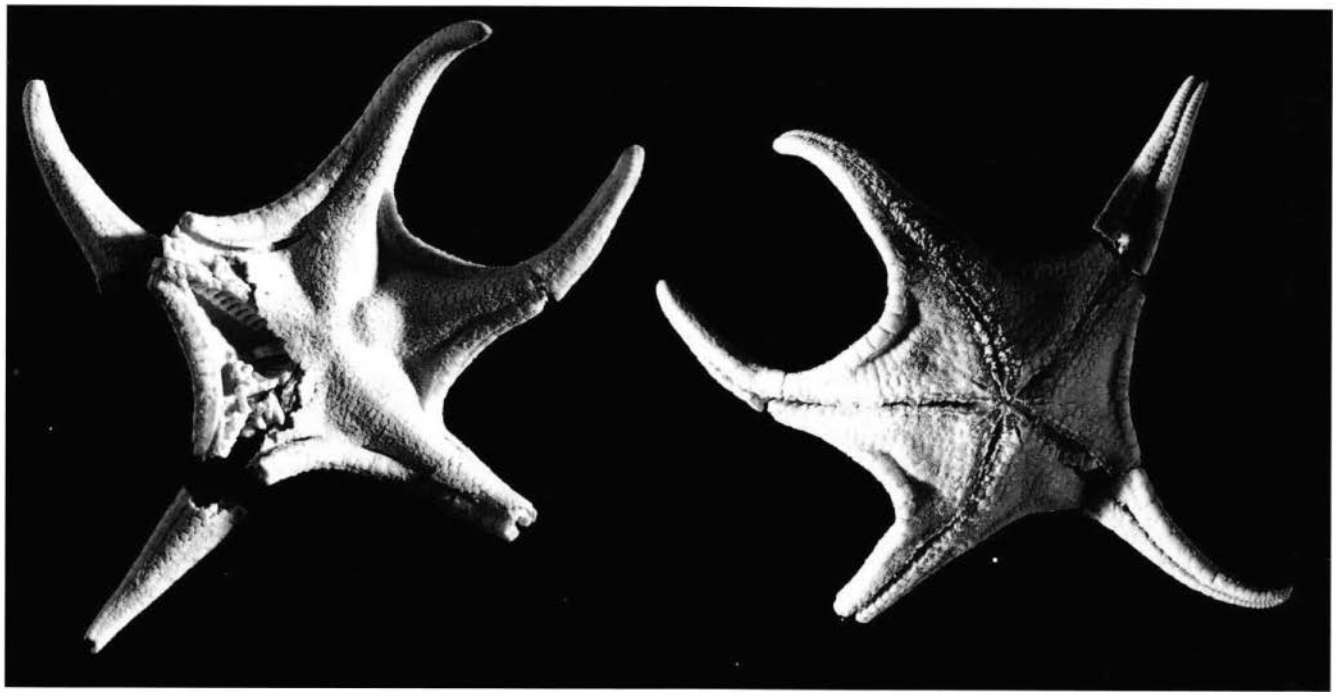


Plate 14. *Kermitaster pacificus* n. gen., n.sp. NZOI Stn K829. R/r = 40/13 mm. Abactinal and actinal surfaces.

Anus not obvious, however near disc centre there is a small opening guarded by 6 or 7 rather irregularly shaped granules of different sizes.

Superomarginal plates, 24 from interradial angle to arm tip forming a well-ordered edge to disc and arms; plates rectangular, narrow edge to abactinal plates with finely thorny, round, spaced granules similar to those already described. Granules forming a more or less close cover and distinctly longer near inferomarginals. Occasional pedicellariae, never more than 1 to a plate, present interradially; pedicellariae strap-like, toothed along length when blades are flat; pedicellariae fitting in shallow depressions.

Inferomarginals of similar size and more or less corresponding to superomarginals; plates forming raised edge to actinal surface, with regular rows of spaced granules similar to those of superomarginals; granules elongated to short almost triangular spines, especially on actinal edge of plate. Inferomarginal plates, especially interradially, separated laterally by distinct membranous furrows or grooves, more obvious than those between superomarginal plates. A faint pit or scar present on 1 inferomarginal suggests occasional pedicellariae may have been present.

Actinal areas large, plates extending between marginal and adambulacral plates for more than half arm length. First 2 (sometimes 3) actinal plates immediately adjacent to oral plates, enlarged, flat-topped, conspicuous, fringed, and covered by spaced granules (short spines) similar to those of neighbouring actinal plates. Actinal plates irregular in shape and size; from level of 4th or 5th proximal adambulacral plate, plates more regularly arranged, forming definite rows from adambulacral plates to inferomarginals; in general, 2 rows of plates more or less correspond to 1 inferomarginal. Actinal plates along arms rectangular to almost square with distinct round or slightly angular spaced granules; plates bordered by well-spaced almost triangular short spines or granules; towards arm tips, outlines of plates less distinct. On 1 midinterradial plate a distinct pedicellarian pit, pedicellariae also present intermittently on actinal plates bordering adambu-lacrals. Distinct grooves or furrows run from infero-marginal plates almost to adambulacral plates; grooves guarded by slightly longer marginal spines of neigh-bouring actinal plates, almost fasciole-like, less obvious towards arm tips.

Adambulacral plates forming a very regular edge to furrows; rectangular, well separated laterally from each other by distinct membranous areas or gutters. Adambulacral plates with gently rounded free edge; deep in furrow, plates taper to point. Furrow spines 11–13, petal-shaped; free thin edge to furrow and actinal plates rounded; spines forming a graded series with anterior and posterior spines distinctly shorter; furrow spines not webbed. A distinct membranous area or gap between furrow and subambulacral spines, these 4, 5, even 6, central 3 or 4 spines very tall, as tall as or taller than furrow spines; these spines also petal-like, sturdier, thicker, standing broad face to plate and furrow forming

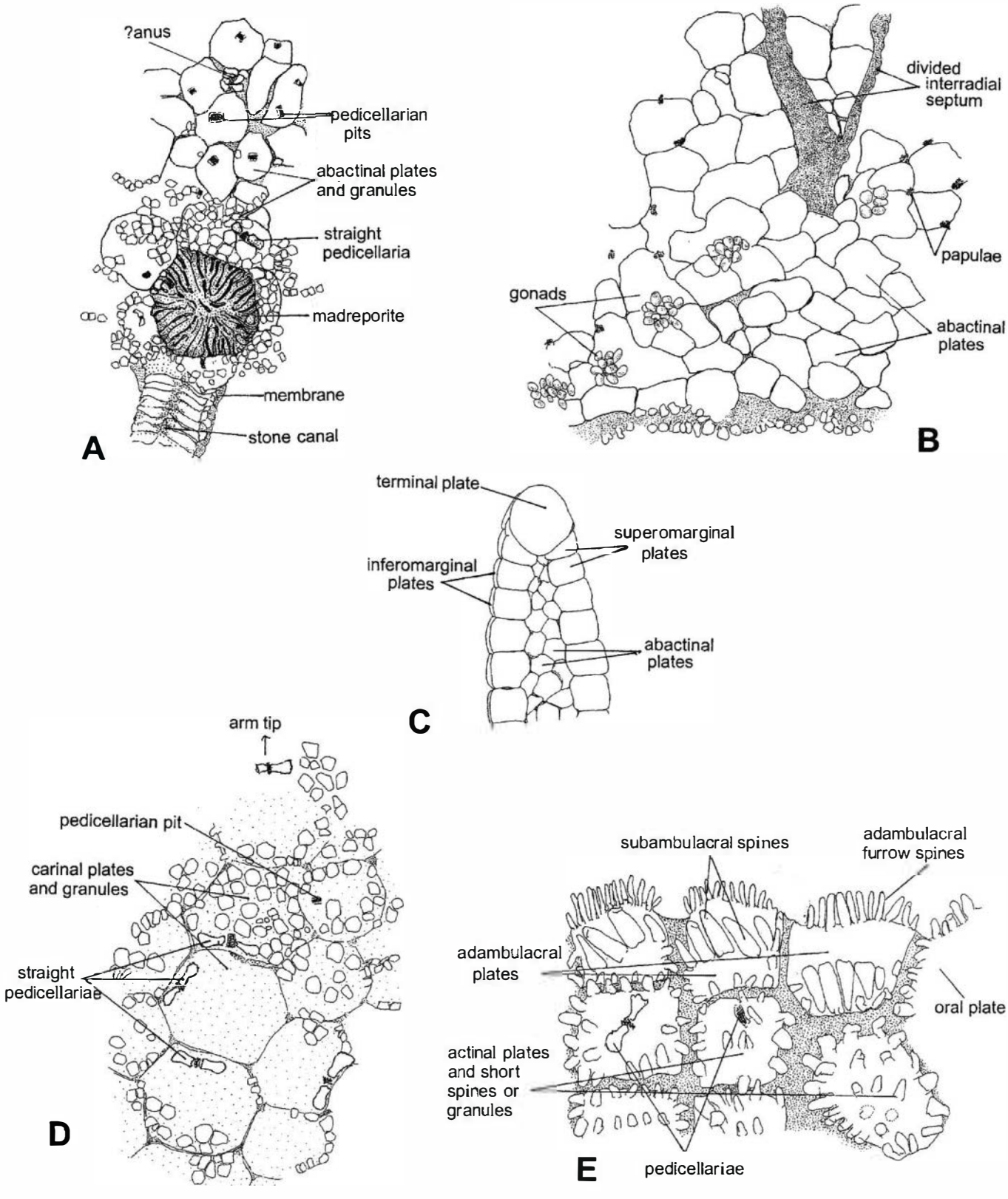


Fig. 17. *Kermitaster pacificus* n. gen., n.sp. (damaged specimen) **A**. Abactinal surface near disc centre showing madreporite, stone canal, ?anus, abactinal plates and pedicellariae. **B**. Interradial and radial plates seen from coelomic side. Note the clusters of gonads and double interradial septum. **C**. Arm tip with plates devoid of spines etc. because of damage. **D**. Abactinal surface, showing carinal and associated plates and pedicellariae. **E**. Adambulacral plates and adjacent oral and actinal plates.

a very effective palisade behind furrow spines. Most anterior and posterior subambulacral spines very small, pointed, slender. Enlarged subambulacral spines blunt-tipped, often appearing grooved centrally. Actinal and lateral plate edges fringed with small, often sharp, spaced rather flattened spines or granules similar to those of neighbouring actinal plates; no obvious adam-bulacral pedicellariae. Towards arm tips subambu-lacral spines not conspicuously enlarged, armature very similar to that of more proximal plates, although only 3 larger spines; angular edge of plate deep in furrow, becoming very obvious.

Oral plates prominent, 2 plates in an angle forming an almost flat triangle anteriorly; raised posteriorly; plates separated near actinal plates by a broad membranous area. Oral plates with regular and distinct 20–24, even 25 furrow spines; petal-like (as adambulacrals) with narrow edge to furrow and plate. Oral furrow spines "bent" (or hooked) over plate edge, straight along outer edge of plate. Suborally, fine spines or sturdy granules forming 2 rows parallel to furrow spines. Near first adambulacral plate suboral spines thick, enlarged, heavy, grooved, irregular in shape, similar to subambulacral spines already described. A few small blunt-headed granules fringing actinal edges of oral plates, these spaced, rather irregular in shape and size.

Ambulacral grooves narrow, deep, *tubefeet* biserial, with small sucking discs, very small near arm tips.

COLOUR: No colour notes of living material; dried, ex-alcohol: pale brown, plates white where granules have rubbed off; actinally, adambulacral and oral spines slightly darker golden brown. Pedicellariae conspicuously white.

Etymology: Kermit, the wayward frog of Muppet fame; and *pacificus*, in reference to the encircling waters.

REMARKS: As the specimen is damaged it is possible to see some of the internal anatomy; no superambulacral plates; actinal plates (seen from the coelomic side) are hidden by a thick membrane; stone canal is very massive, almost double, with very regular ring-like plates. No partial septa present as (in at least some) species of *Anthenoides*, septa here which are visible appear double, the two folds well separated interradially. Gonads serial, visible as small distinct bunches in an angled row on either side of interradial septum. Papulae distinct, from coelomic side, 4 or 5 around plates; abactinal plates gently lobed, no connecting ossicles. Interradially, areas small, triangular, with close pavement of rather irregularly shaped petal-like plates; no papulae were seen.

The smaller and battered specimen, with all arms broken, is very similar to the specimen described. Abactinal plates, however, seem to lack the fringe of small pointed spines which are present in the larger specimen. In this small specimen granules of abactinal plates are obvious and very regularly arranged, forming very distinct rows on plates, especially interradially. Many plates are damaged and no granules remain. There are few pedicellariae but there are many rectangular edged pits and papulae are also obvious. No pedicellariae or pits were seen on either infero- or superomarginal plates. Adambulacral plates are similar to those described although there may be only 10 furrow spines, and many subambulacral spines are damaged, or missing. An interesting feature, near the free, anterior tip of the oral plates, is the large, sturdy, upright, round-headed spines — they are very similar to (perhaps they are) large straight bivalved pedicellariae. Similar spines are recorded in the larger specimen described, although these spines are closer to the first adambulacral plates.

In many respects this new species is similar to species of *Anthenoides*, especially in the form of the abactinal carinal plates, arrangement of disc plates, and armature of adambulacral plates — with a distinct furrow series, a gap, and then subambulacral armature. The presence of fasciole-like structures actinally however, recalls *Pseudarchaster*, and the pedicellariae with the finely-toothed blade edge is similar to that seen in *Mediaster gartrelli* n.sp. The presence of abactinal plates to the arm tips (i.e., superomarginals from opposite sides of arm, separate) is also characteristic of many species of *Mediaster*; also the arrangement of the gonads, in individual clumps, at an angle to the inter-radial septum is very similar to that seen in *Mediaster*. However, it differs from *Mediaster* as it lacks the bar-like connecting ossicles of the abactinal plates which are visible only from the coelomic side. This specimen also bears some resemblance to *Litonotaster* **V**errill, 1899 (a genus not yet reported from New Zealand waters) in the abactinal form of the plates and in the absence of secondary abactinal plates; however, there do not seem to be naturally bare areas on the abactinal plates or on the marginal plates.

Lithosoma Fisher, 1911c

Disc large, conspicuous; arms long, slender, distinct with superomarginal plates from either side of arm in contact from base of arm to arm tip. Radial abactinal plates completely surrounded by granules, both abactinal and actinal plates smooth, plates with border of small, regular granules; papular areas radial, slightly elevated. Subambulacral granules well spaced from furrow spines. Pedicellariae small, spatulate, excavate, often on abactinal, marginal, and actinal surfaces.

TYPE SPECIES: *Lithosoma actinometra* Fisher, 1911c.

TYPE LOCALITY: Western Luzon, Philippine Islands; 216 m.

REMARKS: *Lithosoma* is closely allied to *Iconaster* from which it can be distinguished as the abactinal radial plates are completely surrounded by granules; in *Iconaster* (not yet reported from New Zealand waters) granules are present only on lateral edges of abactinal plates.

DISTRIBUTION: The genus is widespread, with at least six species: *L. actinometra* is known from the Philippines, Indonesia (Timor Sea and possibly Borneo), and the Andaman Islands, Bay of Bengal; *L. ochlerotatus* Macan (1938) is from Zanzibar, East Africa; *L. novaezelandiae* McKnight (1973a) from New Zealand and outlying islands; and *L. penichra* Fisher (1917a) from the Philippines and New South Wales, Australia. *Lithosoma japonica* Hayashi (1952) is restricted to Japanese waters, and *L. pentaphylla* Alcock (1893) to the Andaman Sea and Timor, Indonesia; possibly *L. actinometra* is a synonym of *L. pentaphylla*, according to A.M. Clark (1993 : 260).

Lithosoma novaezelandiae McKnight, 1973a

(Pls 15–17, Figs 18–21)

Lithosoma novaezelandiae McKnight, 1973a: 189, fig. 9; A.M. Clark 1993: 260.

MATERIAL EXAMINED:

NZOI: D85(2), D134(2), D136(3), D137(4), D138(3), D226 (1), D243(1), E404(1), E409(1), E734(1), E826(3), E841(1), F90 (1), F91(2), F99(1), F100(2), F753(1), F909(1), G823(1), G927 (1), I24(1), I381(1), J31(1), J482(1), J711(7), S14(10), S14B(2), S43(1), S140(6), S141(1)*, S142(1), S147(4), S160(1)*, S379(3), S386(1), Z2375(1).

NMNZ: between Auckland and Campbell Islands: Ech. 2025(1); Bay of Plenty: Ech. 7376(1); Canterbury Bight and Banks Peninsula: Ech. 7343(1), 7348(1), 5589(1); off Cape Maria van Diemen: Ech. 4689(1); Challenger Plateau: Ech. 2039(1), 2044(2), 2048(1), 3881(2), 6618(1); Norfolk Ridge: Ech. 4690(3); Pukaki Rise: Ech. 6874(1); Snares Island area: Ech. 2017(2), 2020(1), 2023(1), 6466(1); Stewart Island and southern South Island: Ech. 2383(1), 2388(1), 3102(1), 6515(1); Taiaroa Trench, Otago: Ech. 2049(3); off Westland, South Island: Ech. 2038(1), 2042(4)*, 2045(1), 2046(4), 2047(1), 4691(1), 4692(1).

Eltanin Cr. 32, Stn 1989(1).

SIZE: R varies between 153 and 10 mm, and r between 43 and 4 mm; in most specimens one or more of the arms are broken making accurate measurements difficult. Of the many specimens examined only five had complete arms; for these five, R averaged 62 mm, r averaged 21 mm.

DISTRIBUTION: Widespread around New Zealand from 32°39′ S (NMNZ, Ech. 4690) to 53°32′ S (NZOI Stn G927) and from 162°59′ E (NZOI Stn G823) to 176°50′ E (NZOI Stn J711). The species has not been found on the east coasts of North and South Islands, from East Cape (North Island) to Christchurch (South Island); neither is it known on the western New Zealand coast from North Cape to Cape Farewell. It is most common from Christchurch south to the Snares Islands.

DEPTH: 120–1190 m, most commonly from 600 to 800 m.

DESCRIPTION: Description of specimen NZOI Stn I24, R / r = 63 / 22 mm; all arms intact.

Disc pentagonal, bordered by conspicuous superomarginals; arms 5, long, slender, rapidly tapering to sharp tips. Terminal arm plate oval to almost triangular or heart-shaped; no spines; however, on 4 terminal plates a faint horseshoe-shaped swelling at plate apex possibly once bore spines. Superomarginal plates forming complete casing to arms from base of arm to tip; 4th or 5th superomarginal plate (from midinterradial angle) joining with opposite plate, in midline.

Abactinal surface more or less planar, gently raised at arm bases. Abactinal plates close-fitting, quadrangular, hexagonal, pentagonal, forming very regular rows from near disc centre to beginning of arms; interradially, plates less regularly arranged. Plates flat or slightly tumid, all bordered by very regular, very neat, rectangular granules, these often almost triangular at plate corners. Plates with conspicuous small hyaline (glassy) bosses, occupying entire surface of plate but less obvious near plate edges; bosses tending to form more or less concentric circles.

Papularia radial, petal-like, not very distinct; papulae at plate corners, 5 or 6 surrounding each plate. Papulae generally most obvious around 7th (occasionally 8th) radial plate, near junction of superomarginals.

Pedicellariae few, especially obvious on central row of radial plates where they are generally marginal. Pedicellariae small, bivalved; spatulate valves when flat occupying shallow depressions; valves thin, compressed, tapering gently, round-tipped.

Madreporite distinct, pentagonal, coarsely dissected, interradial, and nearer centre than edge of disc; bordered by 5 distinct plates.

Anus slit-like between plates, more or less central on disc, surrounded by a number of enlarged, conspicuous granules.

Superomarginal plates forming very definite edge to disc and arms; 20 plates from interradial angle to arm tip. Plates rectangular, smooth, centrally naked, gently tumid and completely bordered by rows of narrow, rather ill-defined granules. Pedicellariae, similar to those of abactinal plates, along plate sides, seldom more

than 2 per plate. No pedicellariae on superomarginals of arms. In 2 arms, opposite superomarginals corresponding exactly with 1 another; for first 5 anteriormost pairs of plates, at middorsal junction, a single small, flat plate enclosed. On 3 remaining arms supero-marginal plates more or less alternate; no enclosed plates.

Inferomarginals very slightly larger than superomarginals, corresponding with them. Inferomarginals bordered by very regular rectangular granules, better defined than those of superomarginals. Inferomarginal plates meeting adambulacral plates near arm base; no actinal plates present beyond 4th or 5th inferomarginal plate (from midinterradial angle).

Actinal areas triangular with regular pavement of plates, quadrangular to almost square, those bordering adambulacrals conspicuously larger. Plates gently tumid, completely edged by single row of small, rectangular granules. Pedicellariae especially obvious and numerous, 2 or 3, on plates bordering adambulacrals; these pedicellariae are small, distinct, similar to those of abactinal plates.

Adambulacral plates rectangular, regular, with straight or gently curved furrow margin; margin bordering actinal plates also gently convex, edged with conspicuous granules. Furrow spines 6 or 7 proximally, medially, and distally 10 or 11, exceptionally 12. Furrow spines slender, laterally compressed, standing edge-on to furrow; most anterior and posterior spines broader, shorter, almost triangular, and standing broad-side to plates and furrow. Subambulacral granules or short spines well spaced from furrow spines; anterior-most row (adjacent to furrow spines) with short, flat, round edged upright granules, 2nd and 3rd rows comprising short, thick, spaced granules. No adambu-lacral pedicellariae .

Oral plates almost triangular, large, well defined with 9 or 10 furrow spines. Furrow spines sturdy, untaper-ing, round-tipped, very regularly arranged; anterior-most spines conspicuously larger, angular. Subambu-lacral granules or short spines distinct, anteriormost spines largest, forming a single row along central furrow; generally 2 or 3 accessory rows of granules. A distinct naked central membranous furrow between plates and a distinct gap between furrow and suboral spines.

Ambulacral grooves narrow, deep; *tubefeet* obscured.

COLOUR: One specimen (NMNZ, Ech. 6874) from Pukaki Rise, south of New Zealand, has colour notes of fresh material: "biscuit coloured, pale brown-cream abactinally, light fawn actinally". In preservative and dried: light fawn, cream, or white.

REMARKS: This species is very variable as examination of 116 specimens showed. Two specimens (NMNZ Ech. 7376, 2023) from, respectively, the Bay of Plenty and the Snares Island Shelf, have 4 arms only; there is no trace of a 5th. In the first (Ech. 7376) the disc is square — 27 mm x 27 mm, in the second, 51 mm x 52 mm.

Probably most variation occurs in the presence or absence of *straight pedicellariae*. These may be present on abactinal, superomarginal, inferomarginal, actinal, and adambulacral plates — pedicellariae from the first four areas small, spatulate, and, when flattened, valves occupy a distinct depression on the plate, with a small central pore; generally, these are 2-valved pedicellariae but sometimes three valves are present, especially on actinal plates. Adambulacral pedicellariae often present, 2-, 3-, and sometimes 4-valved and distinctly similar to subambulacral spines or granules; when the blades are lying flat, they rest in a clearing rather than a depression. These adambulacral pedicellariae may form a constant series along arms, or only one or two may be present; occasionally two pedicellariae are present on one plate. If superomarginal pedicellariae are present they are generally confined to either lateral edges of plates adjacent to granules or they may be present near the abactinal plates; pedicellariae are not spread across the superomarginal plates. In most specimens abactinal pedicellariae are restricted to radial areas but in some specimens scattered pedicellariae are also found interradially.

Papulae are generally most obvious in small specimens where papularia are often markedly petaloid. In some large specimens this condition persists; in others it is difficult to distinguish any papulae.

In all specimens but one, a *madreporite* is present, obvious and generally pentagonal; in one 4-armed specimen (NMNZ Ech. 7376) there is no obvious madreporite although a disruption of disc plates may be responsible for this. Generally, superomarginal plates meet with opposite plates at 4th-6th supero-marginal; in smaller specimens occasionally the 3rd plates meet.

Variation also occurs in adambulacral plates and their armature; in larger specimens (R 100 mm and more) there may be as many as 12, even occasionally 13, furrow spines; in small specimens there are seldom more than 8. Generally, the most anterior and posterior spines are enlarged, conspicuous and distinctly shorter; sometimes, however, furrow spines are uniformly slender.

In general the *oral plates* are almost triangular, straight-sided and tapering posteriorly; in other specimens the plates are short and distinctly rounded laterally. In a large, rather damaged specimen (R/r = 154/43 mm) the oral plates are curious in having enormously enlarged suboral spines. In yet another specimen (NMNZ Ech. 3881, R/r approx. 64/20 mm) all five

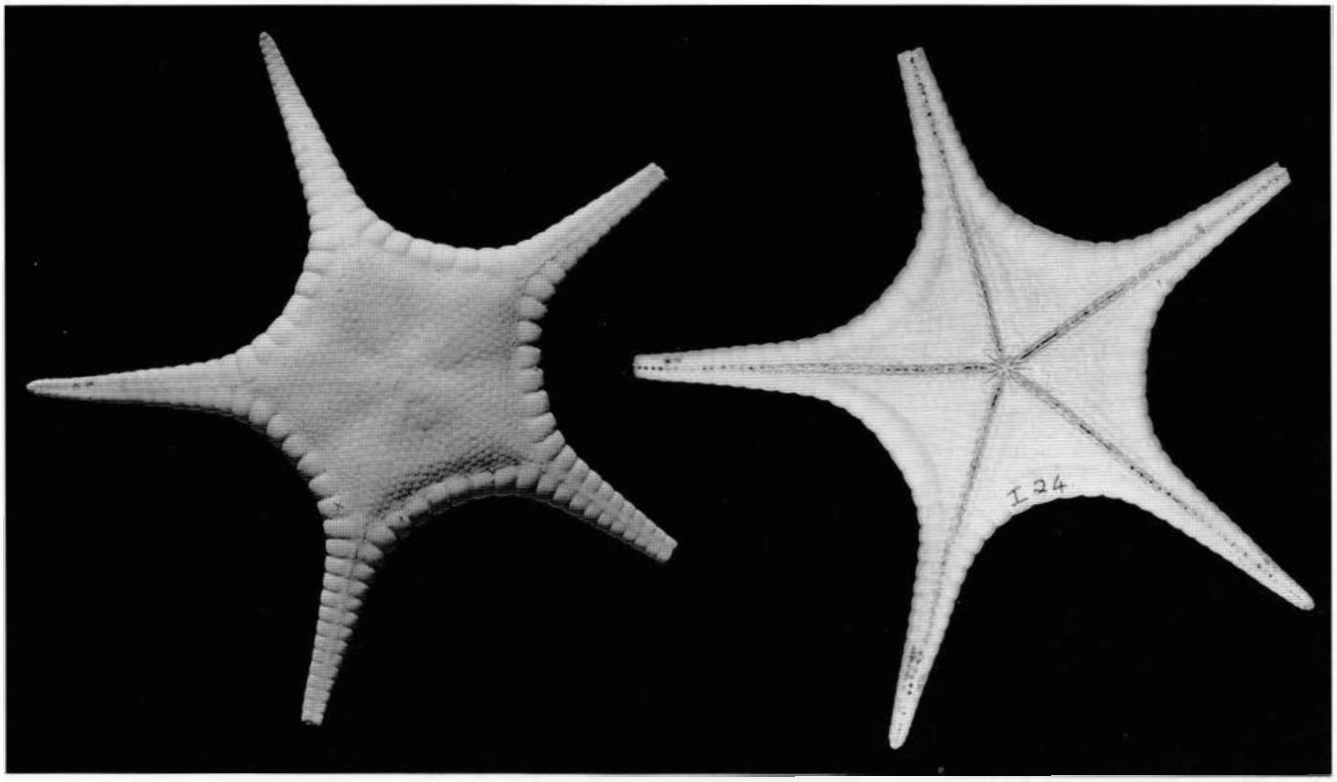


Plate 15. ***Lithosoma novaezelandiae*** McKnight. NZOI Stn I24. R/r = 63/22 mm. Abactinal and actinal surfaces.

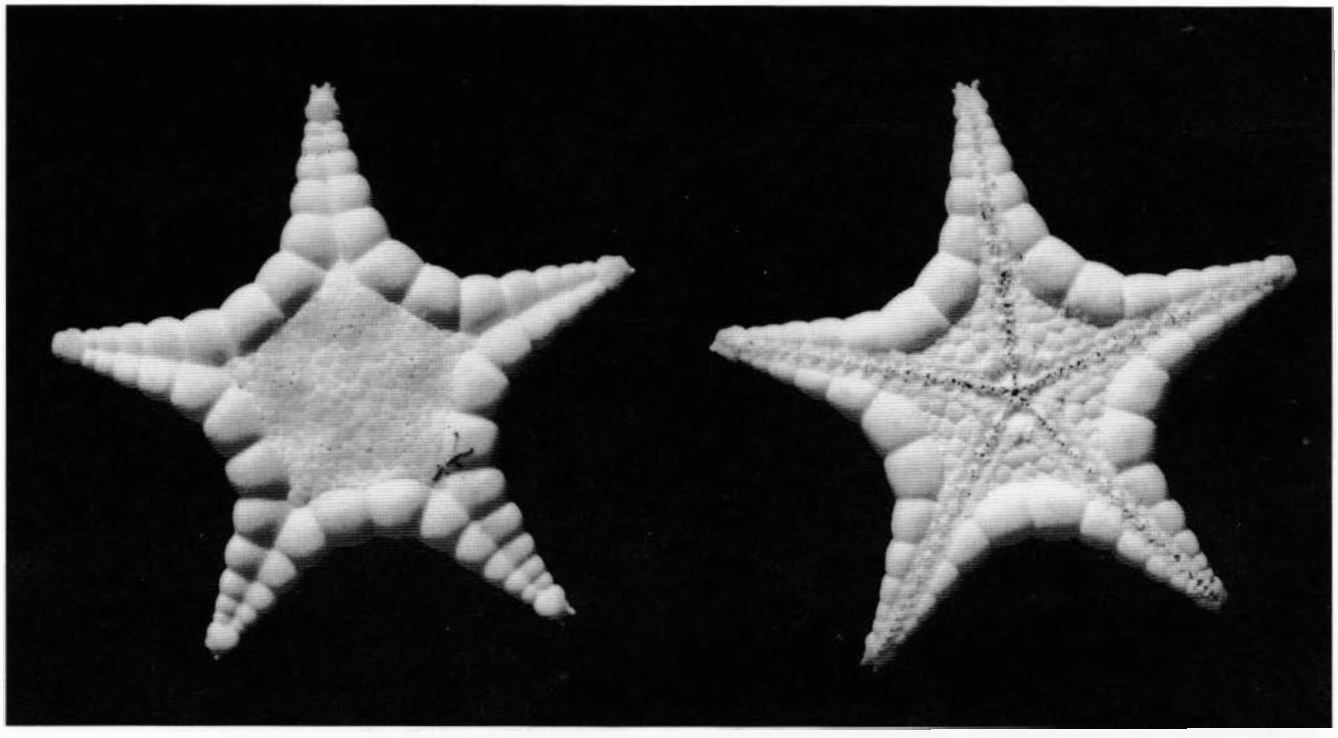


Plate 16. ***Lithosoma novaezelandiae*** McKnight. NZOI Stn I381. R/r = 12/6 mm. Abactinal and actinal surfaces of a juvenile specimen.

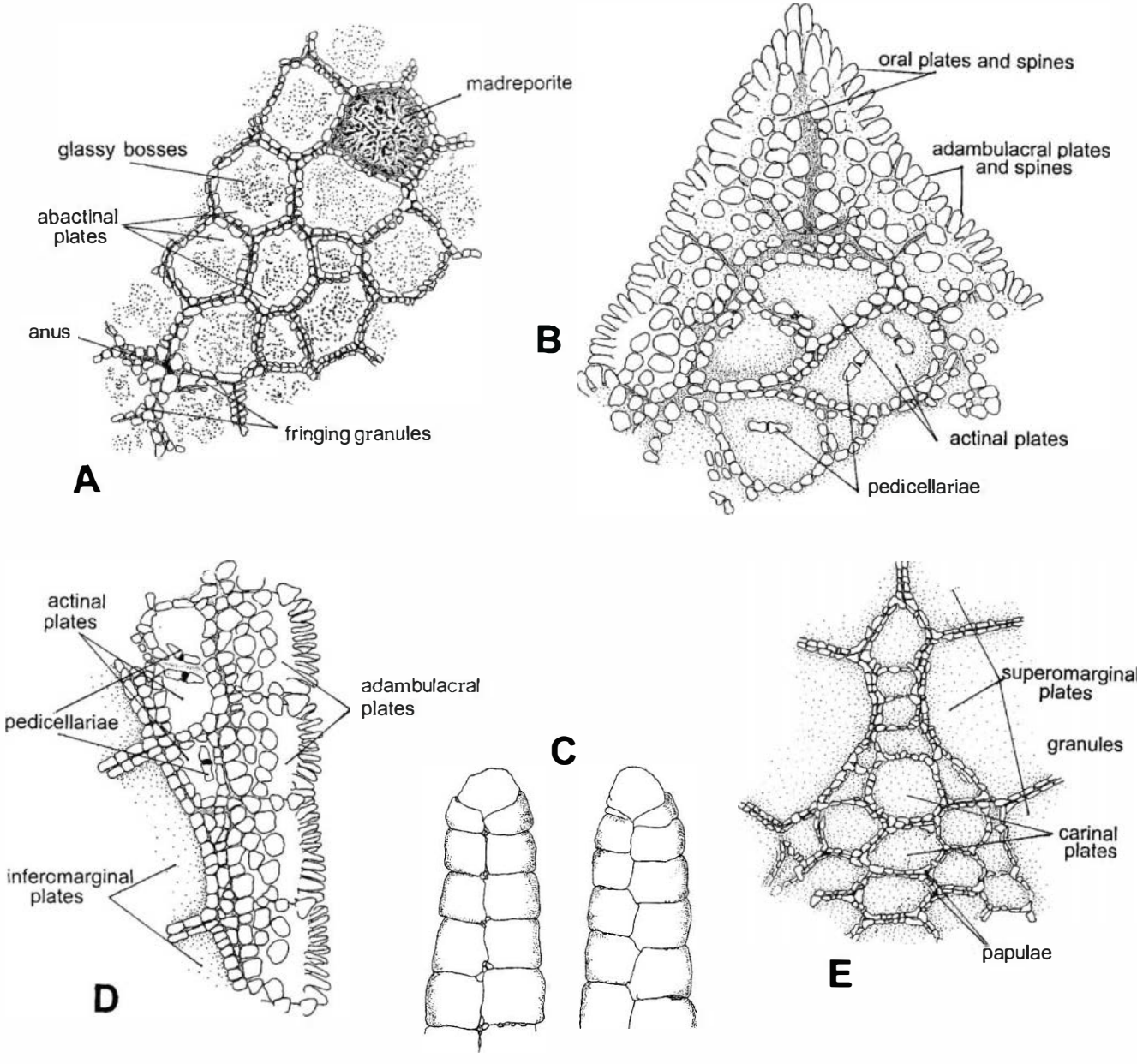


Fig. 18. ***Lithosoma novaezelandiae*** McKnight. NZOI Stn I24. **A**. Abactinal plates near disc centre. Note the madreporite, anus and glassy bosses. **B**. Oral, adambulacral and actinal plates, and pedicellariae. **C**. Arm tips. Left, superomarginal plates lie almost opposite each other; right, confusion of superomarginal plates. **D**. Adambulacral plates and adjacent actinal and inferomarginal plates. E. Abactinal plates near arm tip. Note the conspicuous carinal plates.

oral plates are long, slender, pinched and crooked with nine or ten furrow spines and very crowded suboral granules; this, possibly is a result of injury.

Probably *Lithosoma novaezelandiae* is close to (if not synonymous with) *Lithosoma penichra* Fisher 1917a; unfortu-nately few specimens of *L. penichra* are available for comparison, so the two species remain separate.

DESCRIPTION OF SMALL SPECIMEN:

A small specimen, NZOI Stn I381, from south of Cape Maria van Diemen, west coast, North Island, 492 m; R/r = 12/6 mm is described.

Disc pentagonal, superomarginal plates forming conspicuous tumid edge to disc and arms; 12 superomarginal plates present in all angles from arm tip to arm tip. Terminal arm plates conspicuous, swollen, with 3 terminal spines forming a transverse row, central spine small, triangular; one arm tip with 4th spine outside larger lateral spine.

Abactinal plates forming a close-knit rather irregular pavement; plates irregular in shape — rectangular, pen-

tagonal, hexagonal, octagonal, naked except for small glassy bosses or spots. The bosses generally central on plate thus leaving an unencumbered edge but indistinct on plates at disc centre and near superomarginals. Plates not bordered by regular granules; however, small, rather indistinct oblong granules sometimes present at plate corners especially on enlarged radial plates.

Papulariae radial, papulae especially conspicuous around 6th (in some cases 5th) midradial hexagonal plates; plates lateral to this, 2 on either side and 1 plate below and nearest superomarginals have 4 papulae, 2 of which are shared with larger, central plate.

Madreporite interradial near disc centre, separated from central anus by width of 1 plate, very indistinct, small, irregular in shape, occupying 1 more or less pentagonal plate; 2 barely discernible rather coarse ridges (striae) present. Of interest, abactinally, is a small almost rectangular interradial plate, separated from superomarginals by 3 or 4 plates, with a curious ill-defined almost pentagonal central swelling; on lower (superomarginal) side a distinct widely horseshoe-shaped groove, with 2 very indistinct small holes or pits, on upper (disc) side 2 small depressions, one at least houses 3 or 4 very tiny granules.

Anus slit-like, central on disc, conspicuous between 4 large distinct plates, surrounded by 5 enlarged granules.

Superomarginal plates (12 in each interradius) tumid, conspicuous, regular, naked (no marginal granules); arms encased in superomarginals; second superomarginal plates (from interradial angle) from opposite sides of arm meeting in midline. *Inferomarginal plates* also tumid, corresponding almost exactly with superomarginals, naked except for tiny triangular granules present basally on 1 midinterradial inferomarginal plate near actinal plates.

Actinal areas more or less triangular with close pavement of irregularly shaped plates; those bordering adambulacral plates larger, distinct, 4 or occasionally 5 present from oral angle to inferomarginals. *Actinal plates* slightly tumid, generally naked although occasional small isolated granules are present marginally.

Adambulacral plates distinct, forming regular edge to furrow; plates large, with well-separated distinctly curved, angular posterior (almost question-mark-like) furrow margins; edge adjacent to actinal plates very gently convex, this edge with 4–6 small, distinctly round, separated granules; 5–7 exceptionally 8, furrow spines present, generally slender, round-tipped, of similar length, with short basal webbing. Most posterior 1, sometimes 2, spines often slightly longer, distinctly triangular, inset slightly on plate.

Oral plates distinct, large, rectangular, with gently curved furrow margin, plates fairly steep, sloping down towards mouth. Furrow spines generally 7, but 6 and 8 also present, distinct, sturdy, mostly rounded or with slightly angular tip, appearing finely thorny, especially most anterior and largest ones. Most anterior spines (overhanging mouth) longer, sturdier, almost wedge-shaped, very slightly tapering to rounded tip. Furrow spines webbed basally, especially evident between most anterior spines; posterior edge of oral plate fringed with 3–5 spaced, rounded granules. Oral plates separated medianly by straight, even, shallow furrow adjacent to actinal plates, in angle of 2 oral plates a small oval or round unpaired plate present.

Ambulacral grooves and *tubefeet* obscured by furrow spines.

Other specimens are of interest. One specimen (NZOI S386, off Cape Foulwind, west coast, South Island, 513 m) has all 5 arm tips regenerating. These arm tips have either regular, rather tumid superomarginal plates or there is a jumble of plates present; the extreme thickness of the plates is obvious. Actinal plates forming a close network, adambulacral plates with furrow series of 10 or 11 spines and 2 or 3 rows of subambulacral granules. At regenerating arm tips plates small, with angular margin and fewer furrow spines. Oral plates with 7–9 furrow spines and well developed suboral granules. Tubefeet, just visible, biserial, suckered.

Two further interesting small specimens (NZOI Stn S14) from southeast of Snares Islands.

Larger specimen (R/r = 14/6 mm) has longer and more slender arms than specimen (NZOI Stn I381) already described, both having a disc diameter of about 10.5 mm. In the larger of the two, *superomarginal plates* are distinctly less tumid, with 18 superomarginal plates from arm tip to arm tip (compared with 12 superomarginal plates in specimen from Stn I381). Also in this specimen superomarginal plates join in midline of arms at 3rd plate (2nd plate in I381). In other respects the specimen is similar to that already described, with *papulae* most obvious around the 7th radial plate. *Anus* more or less central on disc, obvious, surrounded by 6 enlarged granules. No obvious *madreporite* but interradially, slightly nearer disc centre, a small roughly triangular plate, with no glassy bosses; instead, there is a deep, uniform narrow curved trench with 2 or 3 spaced pores, possibly the beginning of the madreporite. Two intact arm tips present, each with 2 small spines and indication of a possible very tiny spine between the two. *Adambulacral plates* angular with 5 or 6 furrow spines (5–7, exceptionally 8, furrow spines in specimen from I381); in both specimens the posterior-most adambulacral furrow spine often distinctly triangular. *Oral plates* regular, distinct, with 8, 7, or even

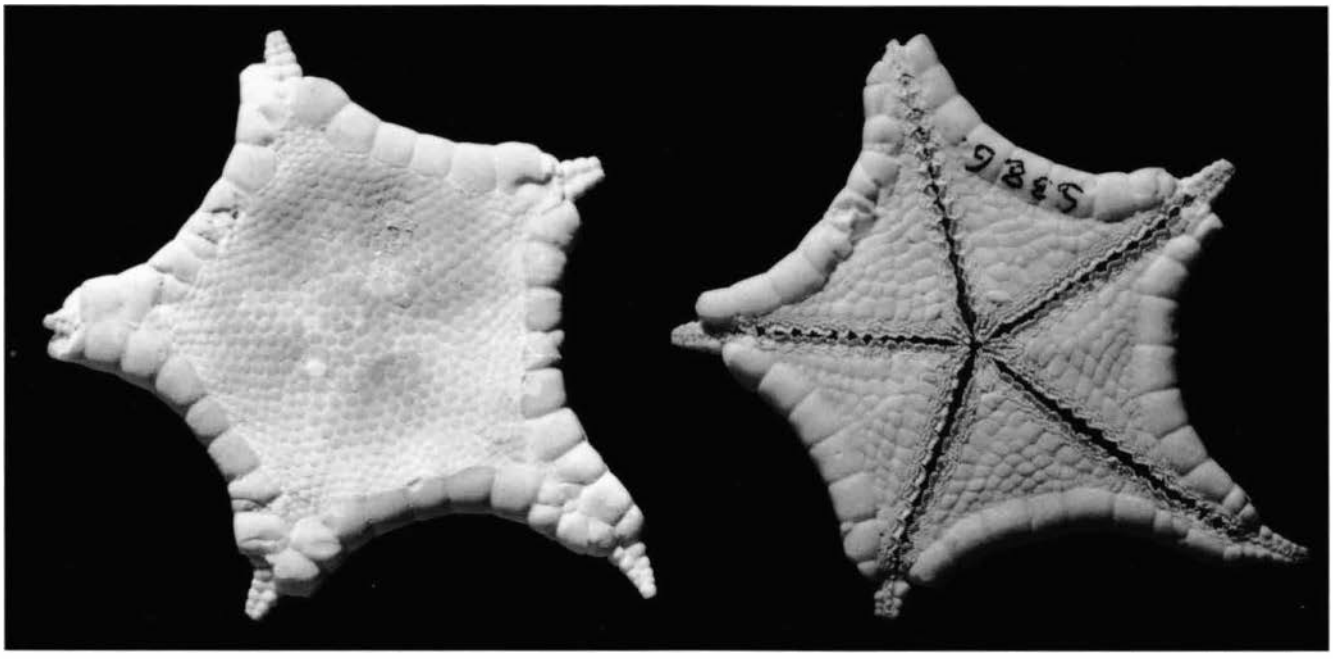


Plate 17. *Lithosoma novaezelandiae* McKnight. NZOI Stn S386. Abactinal and actinal surfaces.

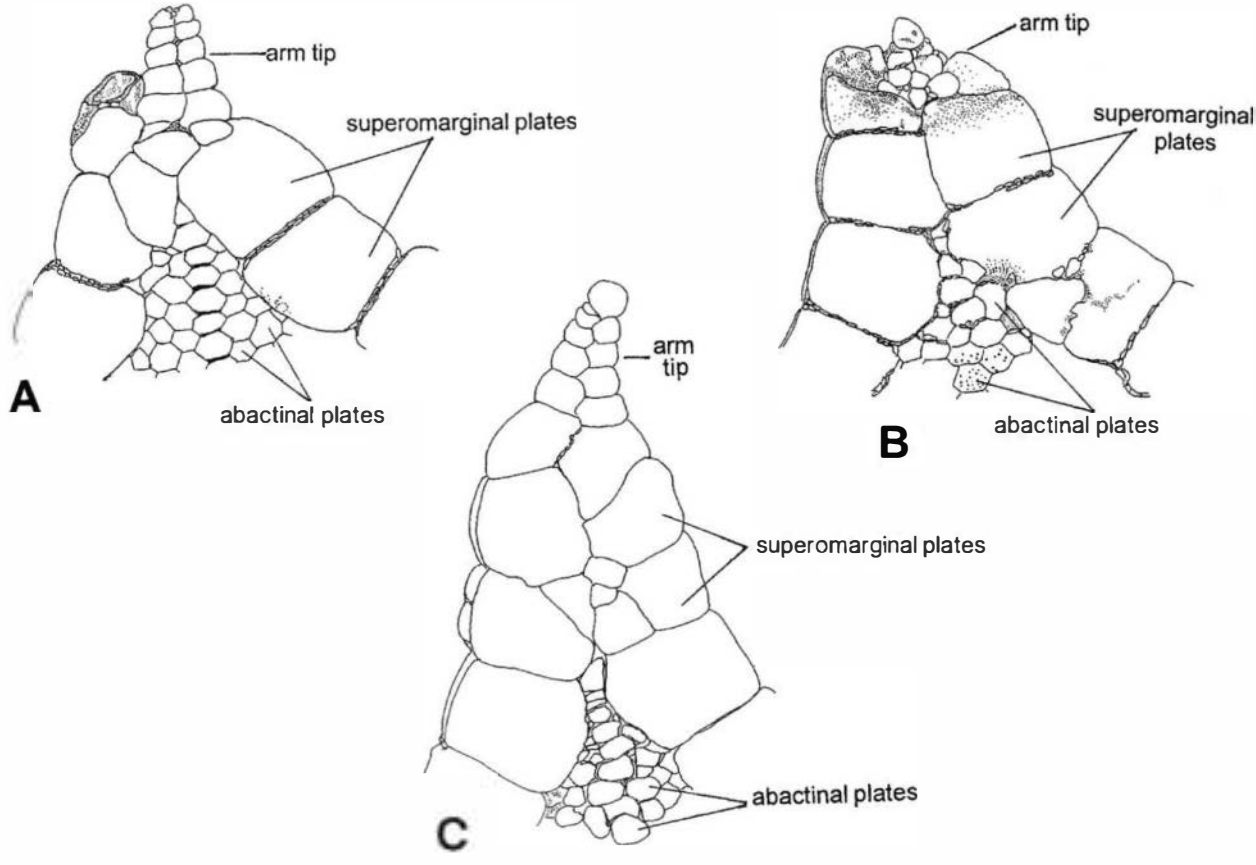


Fig. 19. *Lithosoma novaezelandiae* McKnight. **A-C**. Regenerating arm tips in specimen from NZOI Stn S386.

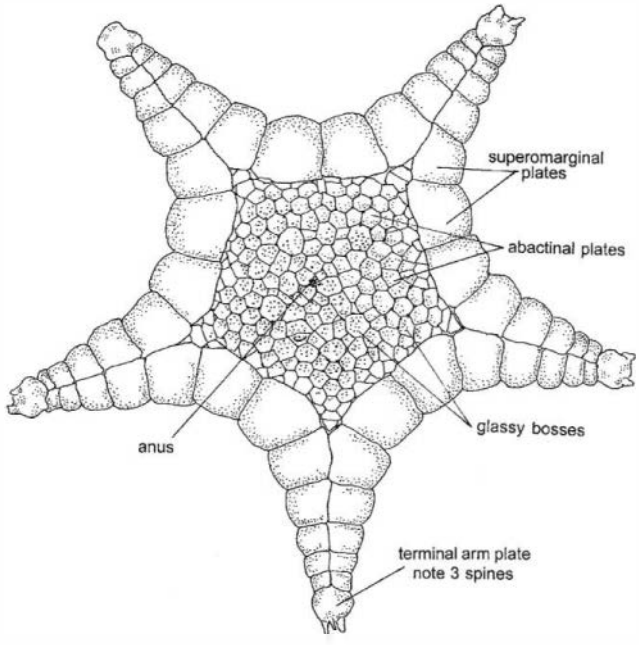


Fig. 20. ***Lithosoma novaezelandiae*** McKnight. NZOI Stn I381. Abactinal view of small specimen from Stn I381.

6 furrow spines; near actinal plates a row of 3 or 4 spaced, rather indistinct granules; it is difficult to decide whether oral furrow spines are webbed or not. *Ambulacral grooves* deep, narrow and more or less obscured by adambulacral plates and furrow spines.

The smaller specimen (Stn S14) with R/r = 11/4 mm, has 2 intact arm tips, each with 2 short, squat, round-tipped spines. Six or 7 *superomarginal plates* present from interradial angle to arm tip; superomarginal plates meeting in radial midline at 2nd plate (counting from interradial angle). There is a central conspicuous abactinal plate surrounded by a distinct ring of 9 rather irregularly shaped plates. *Anus*, obvious on margin of central plate surrounded by 6 or 7 distinctly enlarged granules. Glassy bosses present, but not very obvious, on many abactinal plates. *Papulae* 2-6, most conspicuous around 4th or 5th radial plate. Midway between central disc plate and margin a roughly hexagonal rather tumid plate, etched by curved deep trenches — the *madreporite?* No fringing granules present on most abactinal plates; sometimes especially near papulae occasional plates with 1 or 2 very tiny oblong granules. *Adambulacral plates* conspicuous, angular with 6 (occasionally 7) furrow spines, most posterior largest, almost triangular; towards arm tips adambulacral plates meet across furrow enclosing distinct oval areas with tubefeet present. *Tubefeet* obvious, paired, with small sucking disc. Large distinct *oral plates* present, sloping towards mouth; furrow spines 6 (possibly 7 on 1 plate), most anterior spine conspicuous, larger. On margin adjacent to first adambulacral plate, oral plates with 2 or 3 spaced granules, otherwise plates bare; distinct furrow be-tween 2 plates in an angle. *Actinal plates* close-fitting, largest adjacent to adambulacral plates, occasional marginal granules present.

One specimen (NZOI S386, off Cape Foulwind, west coast, South Island, 513 m) has all 5 arm tips regenerating. These arm tips have either regular, rather tumid superomarginal plates or there is a jumble of plates present; the extreme thickness of the plates is obvious. Actinal plates forming a close network, adambulacral plates with furrow series of 10 or 11 spines and 2 or 3 rows of subambulacral granules. At regenerating arm tips plates small, with angular margin and fewer furrow spines. Oral plates with 7–9 furrow spines and well developed suboral granules. Tubefeet, just visible, biserial, suckered.

In one further specimen (*Eltanin* Stn 1989) from south of Campbell Island there are 5 regenerating arms but the transition is less obvious and arm tips are not as obviously different as in S386. This *Eltanin* specimen has very angular, almost V-shaped adambulacral plates with 6–8 or 9 (exceptionally 11) furrow spines; oral plates are quite rounded laterally, with 8–10 furrow spines.

One specimen from the Snares Island Shelf (NMNZ Ech. 2020, R/r = 88/30 mm), was dissected. There are no superambulacral plates and no connecting ossicles between abactinal plates. Papulae, single, between plates are most obvious radially; they are absent from a triangular area interradially where plates are very close together and they are sparse between plates at disc centre. Abactinal plates are quite tumid, round, oval, gently lobed and very regularly arranged though there is no really distinct carinal series present. There are conspicuous primary radial and interradial plates near the disc centre. Gonads are interradial, and are present as conspicuous single tufts on either side of the interradial septa. There is a thick enveloping membrane, both abactinally and actinally, obscuring plate outlines; the abactinal membrane is perforated by papulae; there are also small circular to irregular calcareous plates present, very scattered and actually embedded in the membrane. Ampulae of tubefeet are double. Actinal plates rectangular, square, oblong, forming fairly regular rows; no actinal papulae present.

Mediaster Stimpson, 1857

Arms 5; superomarginal plates on either side of arms generally separate to arm tips; abactinal plates tabulate with close covering of granules. Internally, abactinal plates connected by distinct bar-like ossicles; no internal actinal connecting ossicles. No unpaired median mouth

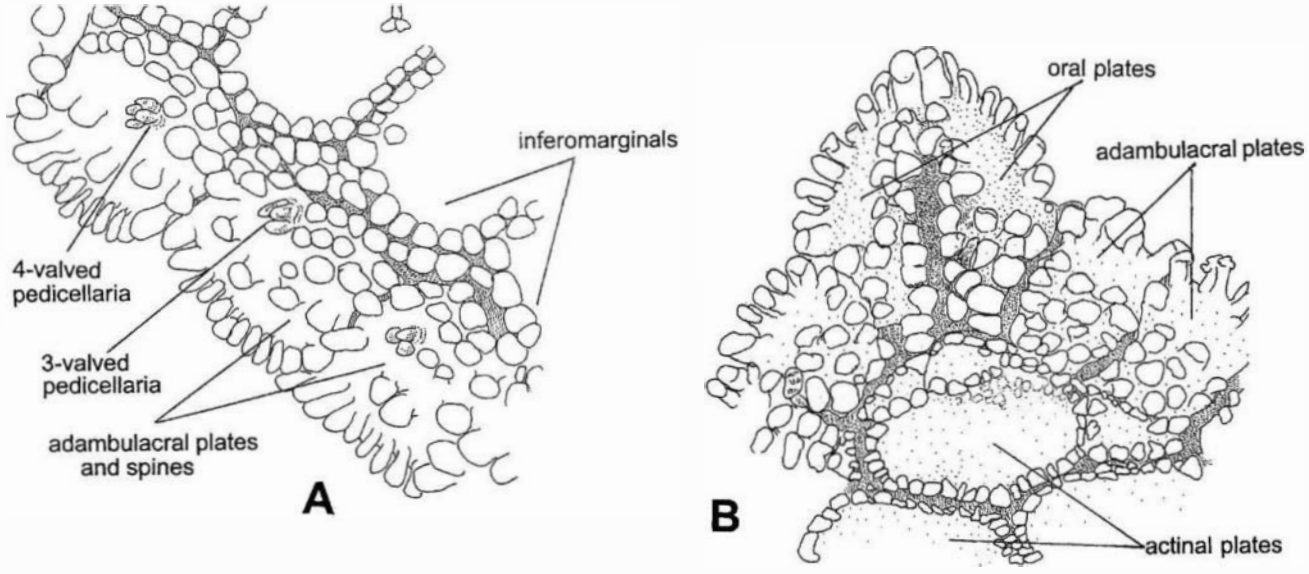


Fig. 21. ***Lithosoma novaezelandiae*** McKnight. **A**. Large specimen from NZOI Stn F91. Adambulacral plates showing 3- and 4-valved pedicellariae. **B**. NZOI Stn D136. Oral and adjacent plates. Note the "rounded" oral plates and curiously large actinal plates.

spine. Furrow margins of adambulacral plates straight or very gently curved, not angular. Superam-bulacral ossicles present, often rudimentary, sometimes only distinct in last half of arms. Interbrachial septa membranous, gonads in distinct tufts (or clumps) in a line on either side of interbrachial septum.

TYPE SPECIES: *Mediaster aequalis* Stimpson, 1857.

TYPE LOCALITY: Puget Sound, western USA.

REMARKS: In the New Zealand species of *Mediaster* the superomarginal plates from opposite sides of the arm are separate to the arm tip. Fisher (1911a: 196) recorded abactinal plates as present to arm tips; Halpern (1970a: 202) in his diagnosis of *Mediaster* stated "superomarginal plates not contiguous throughout arm" and yet in his description of *M. pedicellaris* (p. 207) he remarked that the "number of superomarginals in contact varies from zero to 7 and is usually five."

Similarly, in all our three New Zealand species the gonads are interradial and form distinct tufts in a row, the row running at an angle to the interbrachial septum. Halpern (1970a: 204) in his description of *M. pedicellaris* recorded the gonads as arranged "in a series extending along the arm".

Mediaster sladeni Benham, 1909a and *M. arcuatus* (Sladen, 1889) are sometimes separated on their body form and depth of collection; large disc, short rapidly tapering arms and from depths greater than 600 m (often over 1000 m) in *M. arcuatus* and long, slender often upturned arms and smaller disc and from shallow water for *M. sladeni*. There are exceptions, however, as a single specimen (NZOI Stn R439, R/r approx. 50/19 mm, from near Mahia Peninsula, 1000 m) shows. In this specimen the arms are long, slender, upturned and thus *sladeni*-like but there are no obvious abactinal pedicellariae or pits (many abactinal plates are bare of granules and the single specimen is somewhat battered), adambulacral furrow spines are 5 or 6, and oral furrows spines 9 or 10; it seems to share the features of both species; it is included here as *M. arcuatus* (Sladen).

Another specimen (NZOI Stn D902, from 420 m, near the Chatham Islands) is included in *M. sladeni*. The arms are certainly long and reasonably slender but pedicellariae are small, especially on the disc, and distinctly *arcuatus*-like; further out on the arms the pedicellariae are distinctly more valvate and *sladeni*-like, although still small. Adambulacral furrow spines are 4 or 5 and oral furrow spines 8 or 9. There are other specimens in the collections which also seem to share features of both species. Probably the most reliable difference between these two species is in the form of the pedicellariae themselves. In *M. sladeni* straight pedicellariae are large, conspicuous, and broadly valvate (2, 3 even occasionally 4, valves) and in *M. arcuatus* pedicellariae are very small, few, and inconspicuous. The third species, *M. gartrelli* n. sp., apart from more numerous adambulacral and oral furrow spines, has distinctive broad valvate pedicellariae with edges of blades toothed.

DISTRIBUTION: A.M. Clark (1993: 262) recorded 16 species

of *Mediaster*; *M. gartrelli* n.sp. from New Zealand brings the total to 17. *Mediaster arcuatus* (Sladen) is also reported from Australia and Japan. Depth range for the genus is from 11 to 1790 m.

KEY TO NEW ZEALAND SPECIES OF *MEDIASTER*

1 (4) Adambulacral and oral furrow spines not especially numerous, spines not united basally by membrane; blades of pedicellariae smooth, without teeth

2 (3) Abactinal pedicellariae generally numerous, conspicuous, valvate, broad, with 2 or 3 smooth blades *sladeni*

3 (2) Abactinal pedicellariae inconspicuous, small, few, 2 small slender smooth blades only ..... *arcuatus*

4 (1) Adambulacral and oral furrow spines numerous, conspicuous, and united basally by a distinct membrane, blades of pedicellariae with fine teeth .... *gartrelli*

Mediaster arcuatus (Sladen, 1889) (Pl. 18, Fig. 22)

Pentagonaster arcuatus Sladen, 1889: 277, pl. 18(5, 6), pl. 52 (1, 2); Alcock 1893: 89; Goto 1914: 326, pl. 11, figs 171–177.
Mediaster arcuatus: Verrill 1899: 183; Macan 1938: 369; A.M. Clark 1993 : 262; Rowe & Gates 1995: 65.
Mediaster dawsoni McKnight, 1973a: 175, fig. 3; A.M. Clark 1993 : 263 [new synonymy].

MATERIAL EXAMINED:

NZOI Stns: D468(1), E401(2), E414(1)*, E426(1)*, E719(2), E732(1), E776(1), E783(2), E903(1), F90(1), F104(2), G666(1)*, G690(3)*, P119(1), P120(8), P927(1), Q83(1)*, ?R439(1), T31 (1)*, T36(1), T38(7), T48(1), U197(5).

NMNZ: Canterbury Bight and Banks Peninsula: Ech. 4196 (2), 4701(6); near Challenger Plateau: Ech. 5334(1), 5335(6); Hawke Bay-Mahia Peninsula: Ech. 4200(3), 5526(1), 6419(1), 6552(1); Lord Howe Rise: Ech. 5525(1); Otago: Ech. ?5524 (1) (no depth recorded); Tasman Basin: Ech. 4700(1).

SIZE: R varies between 67 and 4 mm, r varies between 34 and 2 mm; average R/r for 18 specimens = 37/19 mm.

DISTRIBUTION: From 33°00′ S, 163°01′ E (NZOI Stn Q83, specimen not seen) to 49°30′ S (NZOI Stn F90) to 179°39′ W (NZOI Stn T31, specimen not seen), near the Antipodes Islands. This species is also recorded from Japan, from the Andaman Sea (Alcock 1893: 89, is doubtful about this identification), from New South Wales, and from near Gabo Island, Victoria, Australia.

DEPTH: 601–1280 m.

Description: Specimen described, NZOI Stn P119, R/r = 47/28 mm.

Disc large, arms 5, short, broad basally, tapering rapidly and evenly to sharp tips; 3 arm tips damaged, on other 2 apical plate more or less oval; with small spines similar to those of superomarginal plates. Mid-radially and centrally disc gently inflated; interradial areas distinct, broadly triangular, slightly depressed.

Abactinal plates very regularly arranged radially and interradially; radial plates slightly larger, more conspicuous, series continuing to arm tips, plates lobed basally, tabulate, tabulae circular to almost oval. Each plate with an outer circle of 12–16, occasionally more, rather angular, very finely thorny, short, well-spaced granules or short spines enclosing 3, 4, occasionally 8 or 9, similar well-spaced often round-headed spines or granules. Small 2-valved *pedicellariae*, short, thickset, often marginal and formed by 2 spinelets or granules, with tips meeting; where abactinal pedicellariae are marginal generally a distinct gap in fringe of spines. Interradially, plates square, rectangular, near superomarginals plates somewhat irregularly shaped, often round; occasional pedicellariae present on these plates, similar to but smaller than those already described.

Papulae, distinct between plate lobes, present for at least half arm length; distally fewer and less easily recognised; near arm tips abactinal plates forming a very close and regular cover. Along arms papulae distinct as round holes or pores between plate lobes; radial plates with 6 papulae. On disc centre plate arrangement less regular, papulae smaller and sometimes only 2 papulae between plate lobes.

Pedicellariae (already described) often difficult to see.

Madreporite small, almost square; interradially and near disc centre deeply and finely dissected, with plates immediately above and below larger than adjacent plates.

Anus not obvious.

Supermarginal plates forming a regular edge to disc and arms; plates encroaching slightly on abactinal surface, especially interradially. Plates rectangular, tumid, with generally round granules, these distinctly spaced, short, forming almost regular rows; marginal granules more or less truncate, not particularly distinct; distinct circular scars remain when granules removed, however. No pedicellariae.

Inferomarginals encroaching on actinal surfaces, similar in size and shape to superomarginals with which they correspond; granules less regularly arranged, more angular, closer together. Bordering granules regular, a distinct trough or gutter laterally between plates and a distinct naked area between marginal and actinal plates; no pedicellariae seen.

Actinal areas large, triangular, paved by small irregularly shaped plates, present for at least three-quarters length of each arm; plates adjacent to adambulacrals more regularly arranged, rectangular, or

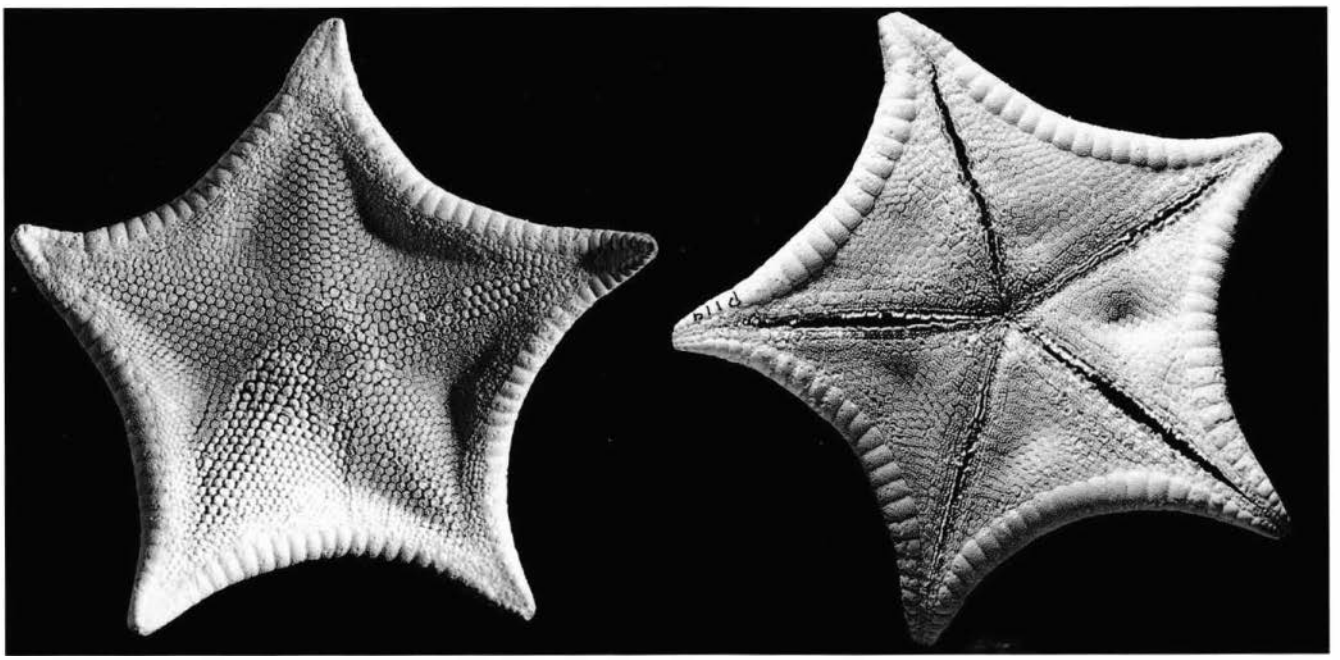


Plate 18. *Mediaster arcuatus* (Sladen). NZOI Stn P119. R/r = 47/28 mm. Abactinal and actinal surfaces.

almost square, distinct. Occasional small 2-valved upright pedicellariae, generally marginal on plates; these formed by tips of 2 spines bending over and coming in contact, similar to abactinal pedicellariae. Actinal plates embedded in thick obscuring membrane, projecting just above it, with small, short, spaced, generally angular granules; the outer row distinct, with 9–13 or more granules enclosing 2-4 similar, spaced granules.

Adambulacral plates rectangular, long edge to furrow, furrow edge gently rounded. Furrow spines 7 or 8, long, quite slender, upright, most anterior spine (i.e., adoral) often very much smaller. Spines compressed laterally, thin margin borders furrow as a distinctive edge; a wide uncluttered area separates subambulacral armature from furrow spines. Subambulacral armature of distinct, angular, well-separated granules in generally 2 rows, occasionally 3- or even 4-bladed pedicellariae proximally, generally near the naked area separating furrow and subambulacaral spines. A distinct naked channel or furrow, empty of spines and granules generally obvious between adambulacral and actinal spines.

Oral plates rather narrow, v-shaped, with 10 or 11 furrow spines, similar to those of adambulacral plates, compressed laterally, narrow edge to furrow; anterior-most spine larger, broader, more thickset. *Suboral* armature of thick, rather angular round-headed granules (or short spines); a regular row of 6–8 granules bordering membranous area between 2 plates in an angle, and between these and furrow spines 2-4 similar granules forming almost another row. Actinal edge of plate also bordered by similar granules.

Ambulacral grooves deep, narrow; *tubefeet* biserial with obvious suckers.

COLOUR: No colour notes of fresh material for this specimen; dried, ex-alcohol, largely white, faintly yellow radially. Colour notes of fresh material (field notes NZOI Stn E732) record "pale orange above, pale creamy-orange below" (McKnight 1973a: 177).

REMARKS: McKnight (1973a: 175, fig. 3) described *Mediaster dawsoni* from south of New Zealand; with more material available, including NMNZ collections, it seems that *M. dawsoni* is synonymous with *M. arcuatus*. Sladen (1889) described *Pentagonaster arcuatus* from *Challenger* material collected south of Yeddo, Japan in 631 m.

Seventy-seven specimens of *Mediaster arcuatus* were examined; all but one had five arms. The four-armed specimen, which is almost square, is from near East Cape, North Island (NZOI Stn D468, R/r approx. 55/30 mm); this specimen has four ambulacral grooves, with no sign of a fifth groove or arm.

In this species abactinal pedicellariae, when present, are few, generally inconspicuous, easily overlooked; in many specimens, despite careful examination, no abac-

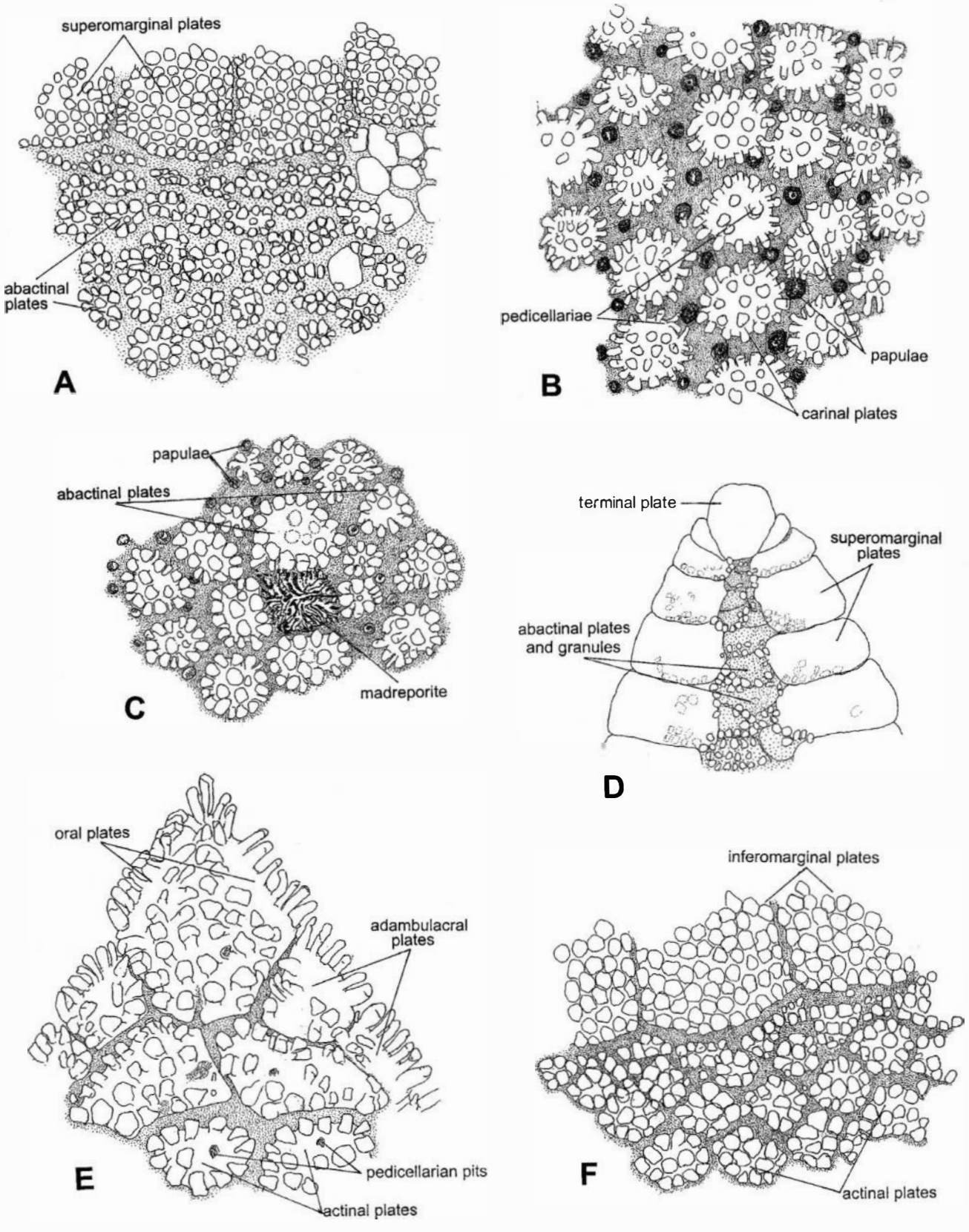


Fig. 22. ***Mediaster arcuatus*** (Sladen). **A.** Superomarginal and adjacent abactinal plates. Note the naked abactinal plates, right hand side. **B.** Abactinal paxillae, mid-arm. Note the very large, distinct, regular papulae. **C.** Madreporite, abactinal plates and papulae. Note the absence of pedicellariae. **D.** Arm tip. **E.** Oral, adambulacral and actinal plates. **F.** Inferomarginal and adjacent actinal plates. Note the absence of pedicellariae.

tinal pedicellariae were seen. There are generally no pedicellariae on the marginal plates; in one specimen only (NZOI Stn D468, with four arms) small pedicellariae, scattered, inconspicuous, are present occasionally on superomarginal plates; they are formed of often three, sometimes two, slightly longer spines (or granules). In this specimen also, occasional inferomarginal pedicellariae were present, similar to those described. In one further specimen (NZOI Stn E401, R/r = 62/33 mm), although no inferomarginal pedicellariae were seen, occasional plates have rectangular pits similar to those left by pedicellariae.

Adambulacral furrow spines vary between five and eight, occasionally nine; in small specimens (R less than 20 mm) only four, five, sometimes six spines are present. *Oral furrow spines* vary between four (NMNZ Ech. 5335, R/r approx. 4/2 mm, specimen from near Challenger Plateau, 1028–1029 m) to six (in other small specimens R was less than 20 mm) to 12 and 13; generally 10 or 11 spines are present in larger material. Generally, in small specimens *papulae* are well developed and conspicuous, especially midradially; the *marginal plates*, particularly *inferomarginals*, are tumid.

In small specimens (R - 20 mm and less) there is no sign of a *madreporite;* in larger specimens, generally the madreporite is small, often almost square, and lies close to the disc centre. A specimen from the Hawke Bay area (NMNZ Ech. 4200, R/r = 51/24 mm, 1010–1035 m) has a very heavily calcified madreporite; there is little indication of characteristic grooves and ridges.

The *internal anatomy* is interesting, with *gonads* present as "tufts" interradially; these are attached to abactinal plates and presumably open abactinally; they are present in a straight line, which runs at an angle to the interradial septum. As many as seven or eight tufts of gonads may be present in a row. *Abactinal plates*, seen from the coelomic side, are round or oval, connected to each other by distinct, separate *bar-like ossicles* which are round-tipped and most conspicuous and largest along the midline of arms; *papulae* are present between these lobes. Interradially, on either side of interradial membrane, there is a distinct triangular area where abactinal plates are oval or almost square and form a very close mosaic; there are no papulae. *Actinal plates* form an overlapping pavement, are rather irregular in shape, and sometimes rectangular with rounded corners; often, at least in larger specimens there is a distinct rounded projection of the plate on the side facing the interradial septum; plates are largest and distinctly lobed adjacent to ambulacral plates. In smaller specimens actinal plates are rather more regular, almost scale-like, overlapping. *Superambulacral ossicles* are present, and are most obvious distally. *Ampullae* of *tubefeet* are double and distinct.

Mediaster gartrelli n. sp. (Pl. 19, Fig. 23)

MATERIAL EXAMINED:

NZOI Stns: K800(1), K804(2), K826(4), K829(11), K860(1)*, P68(3).

SIZE: R varies between 56 and 8 mm, r varies between 27 and 4 mm, average R/r = 31/15 mm.

DISTRIBUTION: From north of Raoul Island, Kermadec Islands, 28°48′ S, 177°48′ W (Stn K826) to Aotea Seamount, off Taranaki coast, 38°39′ S, 172°38′ E (Stn P68).

DEPTH: 142–720 m.

DESCRIPTION: Description is of holotype (NZOI Stn K826) with R/r = 31/16 mm.

Disc more or less flat, abactinal surfaces very slightly raised along midline of arms where plate outlines are visible. *Interbrachial arcs* evenly and widely rounded; *arms* short, narrow, tapering to large, heart-shaped, smooth, *apical plates;* no spines or granules on apical plates but very faint depressions suggest plates may once have had short spines or granules similar to those of superomarginals.

Abactinal plates forming close covering on disc and arms; single midradial series of larger hexagonal (carinal) plates runs from near disc centre almost to arm tip; distally less conspicuous; superomarginal plates from opposite sides of arm separate to arm tips; generally, at least proximally, 4 or 5 rows of similar but smaller plates on either side of midradial carinal series. Interradially, plates form a close covering; interradial plates oval, rectangular, round; most regularly arranged adjacent to superomarginals where generally 2 brick-shaped plates correspond to 1 superomarginal plate. All abactinal plates with outer fringe of spaced, very finely thorny, round granules (very short spines), tending to stand at slight angle to plate, enclosing fairly regular rows of similar but shorter, spaced granules; there may be 3 or 4 central rows on midradial plates, where fringing granules vary from 18 to 24; other plates with fewer granules.

Papulae most conspicuous along midline of arms, 6 regularly around each plate; absent from last half of arms and interradially. On disc centre, abactinal plates irregular in shape, size and arrangement, papulae very small, inconspicuous.

Pedicellariae of two types: most obvious and frequent are bivalved straight pedicellariae with a short, wide trunk and rounded blades, free edge of blade often with 5 or 6 tiny, spaced, sharp teeth along trunk edges; when flat, blades fit in shallow, rounded depression on either side of a central pit. If pedicellariae present near plate margins, adjacent marginal spines often missing.

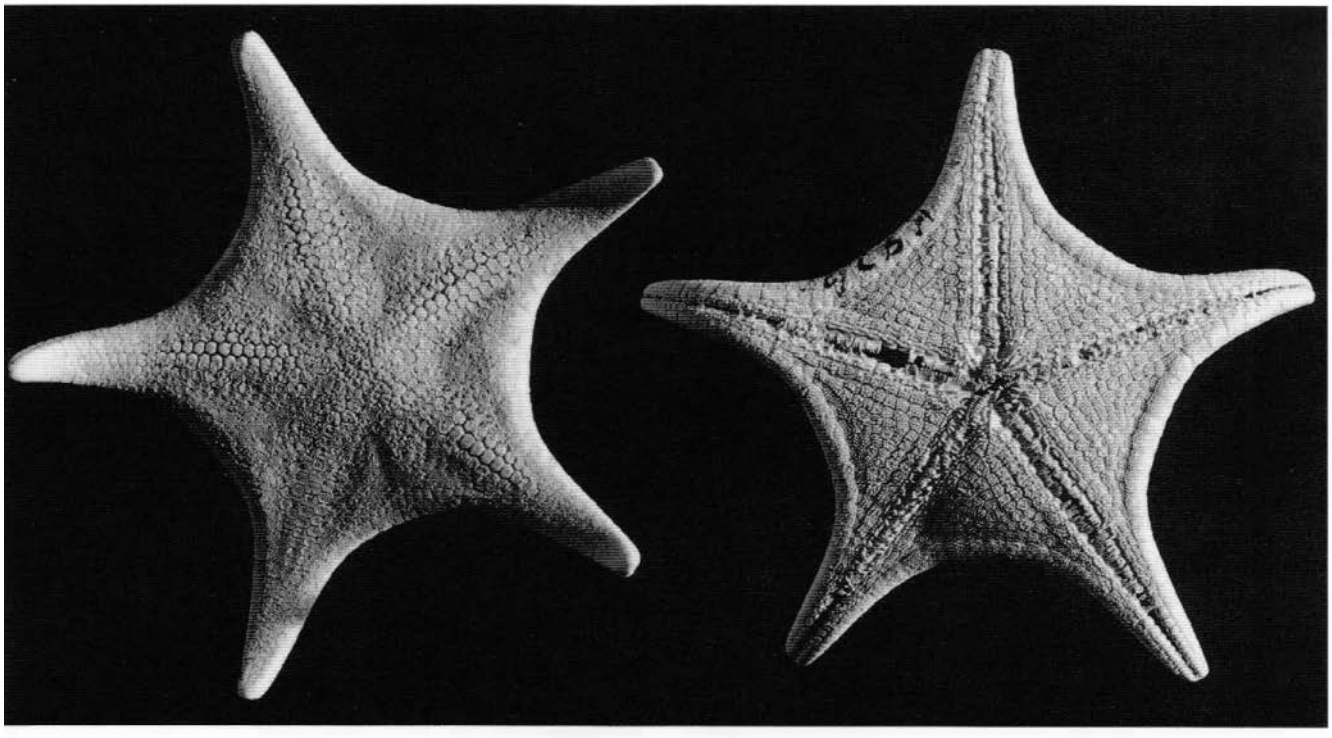


Plate 19. ***Mediaster gartrelli*** n.sp. Holotype. NZOI Stn K826. R/r = 31/16 mm. Abactinal and actinal surfaces.

Occasionally, 2 straight bivalved pedicellariae on 1 plate; if lying close together, often separated by a straight, finely thorny bridge-like horizontal spine or 2 granules may meet forming a barrier. Trivalved straight pedicellariae also occasionally at arm bases, interradially near disc centre, and on plates bordering madreporite. Blades of trivalved pedicellariae longer, flatter, more slender, no obvious teeth; blades surround a distinctly triangular pit.

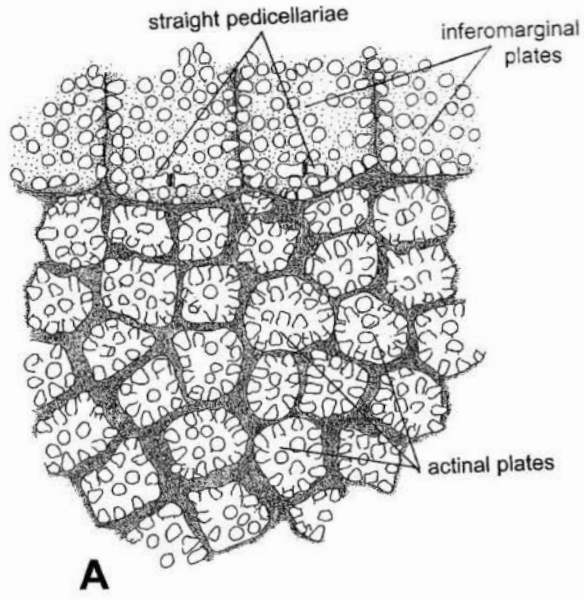
Madreporite interradial, near disc centre, slightly depressed, more or less oval, deeply and regularly dissected. Surrounding plates not conspicuously enlarged.

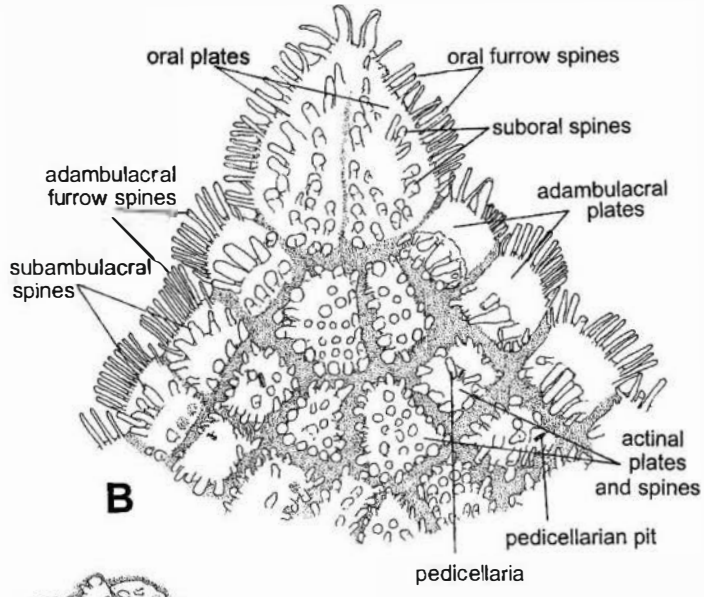
Anus not distinct; however near disc centre there isa jumble of very small spines guarded by 4 distinctly larger plates; possibly this is the anal opening.

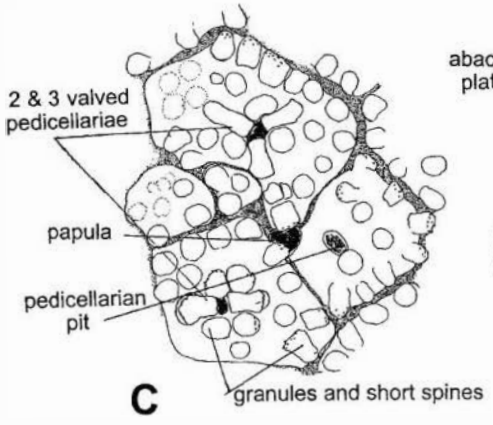
Marginal plates forming a very regular, well-ordered edge to disc and arms. *Superomarginal plates* rectangular, with narrow straight edge to disc. Plates with marginal series of regular, well-spaced round granules (very short spines), similar to those of abactinal plates, enclosing rows of similar (slightly smaller) spaced granules. Occasional pedicellariae, similar to those already described, with broad base, short trunk, and rounded blades with short, sharp delicate teeth; 1 or 2 pedicellariae in each interradius on superomarginals near abactinal plates. Also on these plates very close to inferomarginals, often actually replacing some marginal granules, a small, inconspicuous bivalved pedicellaria; in 1 interradius, 1 to a plate, almost to arm tip; these pedicellariae not obvious when specimen is viewed abactinally; 30 superomarginal plates in 1 inter-radius, from arm tip to arm tip.

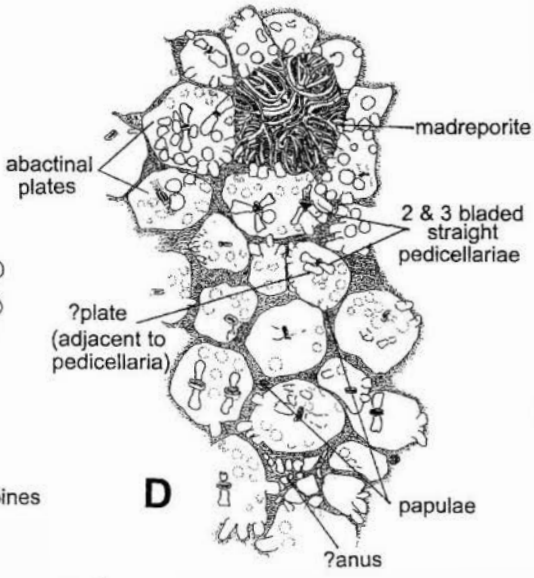
Inferomarginals similar in shape to superomarginals, possibly slightly longer; interradially more or less corresponding with superomarginals; towards arm tips inferomarginal plates wider, almost alternating with superomarginals. Armature of inferomarginal plates very similar to that of superomarginals; occasional straight pedicellariae, especially near actinal plates. A distinct narrow naked membranous gutter or channel separating infero- and superomarginal plates, especially obvious interradially.

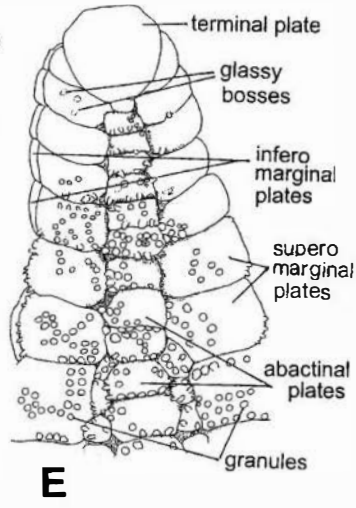
Actinal areas triangular, conspicuous; actinal plates between adambulacrals and inferomarginals for about half arm length. Actinal plates distinct, oval, rectangular, almost square and well separated from neighbouring plates. Boundaries between plates hidden by enveloping membrane; plates similar to those of abactinal surface with border of well-spaced granules or short spines, enclosing a few, often only 2 or 3 central granules. Pedicellariae on row of regular rectangular plates bordering adambulacrals similar to but slightly longer than those already described, occupying almost entire width of plate; on side facing adambulacrals 2 enlarged granules around which blades of pedicellaria fit, in a rather "hooked" way. Pedicellariae on plates bordering adambulacrals very regular; central pit between blades often membrane covered, for about half

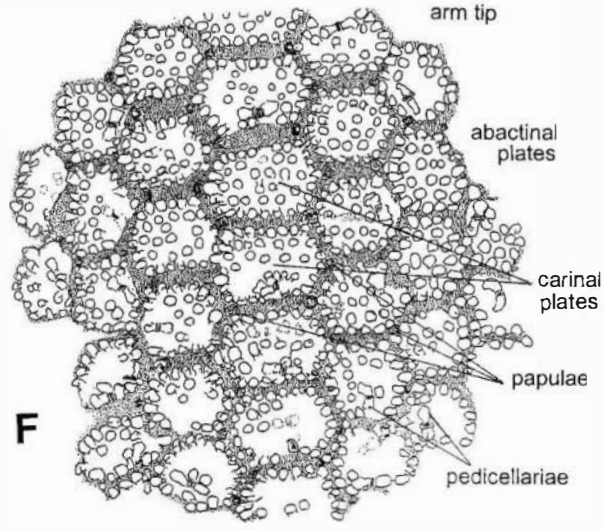


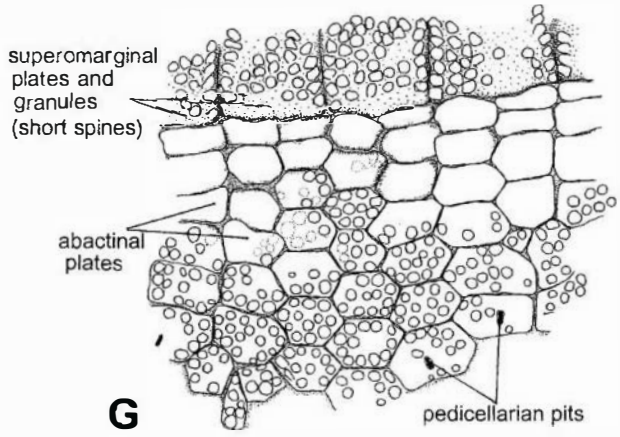












arm length.

Adambulacral plates conspicuous, square to almost rectangular, well separated laterally by naked membranous area. Furrow spines, 9–12 or 13, long, petal-like, with narrow edge to furrow, generally most anterior and posterior spines slightly shorter, inset on plate. Basally, both adambulacral and oral furrow spines united in a very regular web of membrane; this distinct as is the slight curve of marginal furrow spines. Distinct from furrow series and well separated by a flat, naked membranous area, subambulacral spines distinctly angular, often sharp tipped, 4 or 5 in a row parallel to furrow. In present specimen many spines missing, scars remaining. Actinal edge of plate and sometimes plate edges guarded by small, rather pointed well-separated granules. Adambulacral plates forming a very regular edge to furrow.

Oral plates conspicuous, large; oral furrow spines 14–17 or 18, forming very definite edge to plate, petal-like with thin edge to furrow; anteriormost spines broader, taller; furrow spines united basally in very even membrane, similar to that of adambulacral plates. Suboral spines 4–6, occasionally 7; short, angular, sturdy, united basally by a very shallow membrane. Central posterior part of oral plates distinctly raised and rounded, suboral spines defining edge; membranous area between 2 oral plates fringed by small, well-spaced granules, similar granules edging plate poseriorly. A well-defined clear area between furrow and suboral spines on oral plates; a similar area, perhaps more obvious, on adambulacral plates.

Ambulacral grooves deep, narrow; *tubefeet* in 2 rows with well-developed suckers.

COLOUR: There are no colour notes for living material; dry specimens (ex-preservative) are white to pale yellow-brown.

ETYMOLOGY: This new species is named for Mr B.M. Gartrell, B.V.Sc., M.R.C.V.S., also a zoologist, but in another sense of the word.

REMARKS: All specimens have 5 arms. Variation occurs in the number of adambulacral furrow spines (from 8 to 15 or 16) and oral furrow spines (10–18 or 19, exceptionally 30 or more). In some specimens, regardless of size, carinal plates are present almost to arm tips, in other specimens this series of plates is indistinct in last part of arms.

The smallest specimen (K826: R/r = 8/4 mm) has an obvious and well-developed raised *carinal* series of abactinal plates with 6 distinct *papulae* present at plate corners. *Superomarginal plates* from opposite sides of arms separate to terminal plate; this quite large and with a few scattered spinelets similar to those of superomarginal plates. A small, rectangular bordered pit at the base of each arm near the unpaired carinal series of plates; these similar to the pedicellarian pits seen in other specimens; one interradial superomarginal plate also with a similar pit; in all cases, pedicellarian blades are lost. The *madreporite*, inter-radial, midway between disc centre and margin, consists of a few coarse ridges which meet centrally; it is easily overlooked. There are 12 *superomarginal plates*, from arm tip to arm tip; small, spaced, spiny granules are still present on some plates. *Inferomarginal plates* correspond with superomarginals, a distinct, broad, naked membranous channel separating the two series of plates. Inferomarginal plates tumid, rising steeply from actinal plates; inferomarginals with covering of small, short, spaced spines, similar to those of superomarginals. *Actinal areas* well developed also, with small well-separated rather tumid plates; these with spaced, thorny-headed spinelets. *Adambulacral plates* with 5, occasionally proximally 6, spaced slender furrow spines; there are 3 or 4 stout, angular subambulacral spines and the plate is fringed by 3 or 4 small indistinct spines. *Oral plates* with 10–12 slender, well-spaced, tapering, round-tipped furrow spines. Suboral spines mostly lost, but some angular and larger spines remain, well separated from oral furrow spines. *Tubefeet* biserial with suckers; *grooves* deep.

The three larger specimens (NZOI Stn P68 from off Taranaki, R = 50-56 mm, r = 26, 27 mm) are similar to those already described. Abactinally, the *carinal* series is obvious and regular for at least three-quarters length of each arm; plates larger with a fringe of 35–37 spinelets; these are similar to those of smaller specimens. These spinelets (or granules) are very finely thorny with tiny spinelets arranged in very regular rows. The outer spinelets, on the carinal plates, enclose 4 or 5 rows of round-headed granules (or short spines). There are 2–

Fig. 23. (opposite) ***Mediaster gartrelli*** n.sp. **A**. Inferomarginal plates and adjacent actinal plates. Note the straight pedicellariae on inferomarginals. **B**. Oral, adambulacral and actinal plates. **C**. Abactinal plates near disc centre. Note the 2- and 3-valved straight pedicellariae, abactinal granules and short spines, papula, and pedicellarian pit. **D**. Abactinal plates near disc centre. Note the madreporite, ?anus, 2- and 3-bladed pedicellariae, papulae and granules, and short spines. **E**. Arm tip. Note that the superomarginal plates are separate to the arm tip and glassy bosses are indistinct, but present. **F**. Carinal plates, midline of arms, and adjacent plates, abactinal surface. **G**. Superomarginal and abactinal plates interradially. Note the dark pits left by pedicellariae.

4 distinct rows of plates on either side of the carinal series. *Carinal* plates are surrounded by 5 or 6 papulae, but these are less obvious than in small specimens. Near disc centre the *madreporite* is quite large, almost square and deeply, finely, and regularly dissected. The *anus* is very near the disc centre, surrounded by 5 rather enlarged conspicuous plates.

Both series of *marginal plates* are similar to those described for smaller specimens, but pedicellariae are fewer.

A very obvious difference is the presence of *pedicellariae* on adambulacral plates; these are tall, slender and present in the first row of subambulacral spines; occasionally, on proximal plates, 2 pedicellariae are present. In the largest specimen adambulacral furrow spines vary from 12 to 16; oral plates are large and furrow spines very numerous, up to 29 and 30; most anterior spines are broadly petal-like and conspicuous, and 1 or 2 pedicellariae similar to those already described are generally present near the suboral spines.

Two specimens (Stn K826, R/r = 36/16 mm; Stn K829, R/r = 38/19 mm) from the Kermadec region, were dissected. *Oral plates*, viewed from the coelomic side are remarkable; they are simple, strong, bar-like structures, the two plates in an angle form a simple V and the oral furrow spines interlock with one another very regularly. *Polian vesicles* are conspicuous, long, slender; one only is present in each interradius. *Gonads* form small, distinct clumps or bunches, well separated from each other; each clump is united in a membrane which, however, does not seem to connect individual clumps; gonadial clumps, 7 or 8, are present in a straight row which runs at an angle to the strong, membranous interradial septum. *Carinal* rows of plates, seen from coelomic side, large, gently lobed, lobes overlapping and connected to neighbouring abactinal plates by characteristic bar-like, round tipped plates. Inter-radially, plates rather irregular in shape, long, narrow, forming a very close network; there are no interradial papulae present. *Actinal plates* overlapping, enveloped in thick, obscuring membrane. In last half of arms there is a conspicuous membranous vertical fold or bar at base of ambulacral plates, possibly hiding a rudimen-tary subambulacral plate.

A large specimen (Stn P68, R/r = 50/27) was also dissected. The *oral plates*, seen from the coelomic side are interesting, also V-shaped, sturdy; each plate, at the tip, has a recurved, tapering, sharp-pointed tooth. These 'fang-like' teeth, born at the very tip of the plate, curve down into the gut of the animal, and are not obvious externally. *Polian vesicles* in this larger specimen are very conspicuous, large, extending almost half way, from midcentre of disc to margin; one polian vesicle has 2 lobes, dividing into 2 about half way along its length. Distinct swellings (knobs, almost) are present at the base of 4 of the polian vesicles, these are probably the Tiedemann's bodies. A number of small, isolated, slender bar-like ossicles or plates are also present in the ?cardiac stomach, near disc centre. Arrangement of abactinal plates shows the connecting bar-like plates between carinal series and lateral plates are large and strong; they are often strengthened by small, oval, overlapping bars. Interradially, plates are also lobed and form a very close-knit skeleton; there are no connecting ossicles or papulae interradially.

This new species, from near the Kermadec Islands and off the Taranaki coast in 142-610 m, is distinct from either of the two known New Zealand species, as the key shows. The large number of adambulacral and oral furrow spines makes the species almost unique. There are, however, affinities with *M. murrayi* Macan (1938) from Zanzibar, east Africa, as both species have similar pedicellariae, and basal webbing between (at least) the adambulacral plates and probably also the oral furrow spines. Macan (1938: 372, text-fig. 5c) showed a distinct membrane between the adambulacral furrow spines; he did not, however, mention it in the text. There is also a rather small and restricted actinal area in both species. *Mediaster gartrelli* however, has more numerous adambulacral and oral furrow spines and the carinal abactinal plates are also distinct; there is no fusion present between carinal and lateral abactinal plates as in *M. murrayi*. The Australian species, including *M. arcuatus* (Sladen) and *M. australiensis* H.L. Clark (1916), lack the numerous adambulacral and oral furrow spines.

Mediaster sladeni Benham, 1909a (Pl. 20, Fig. 24)

Mediaster sladeni Benham, 1909a: 94, pl. 7(1-5) in separate publication p. 12, pl. 7(1–5); Fell 1958: 10; 1959: 136, fig. 19; 1960: 61, pl. 3; McKnight 1967: 300; H.E.S. Clark 1970: 3; Baker & Clark 1970: 4; A.M. Clark 1993: 263; McKnight 1993b: 192.

MATERIAL EXAMINED:

NZOI Stns B658(4), D245(1)*, D870(1)*, D872(3), D876(4), D895(1), D900(1)*, D901(4)*, D902(1), E76(1)*, E79(1), E158 (1)*, E164(1), E820(1), E828(1), F916(1), G15(1)*, G155(1)*, I2 (2)*, I6(2), I31(3), I46(1), I356(5), I359(1), P65(7), P66(1), P67 (1)*, P68(2), P655(1)*, Q30(1), Q34(12), Q343(1)*, S122(5), S123 (1), S126(1), S127(2), S130(1), S398(3), V388(1), Z2363(1), Z2367(2), Z2371(1), Z2372(1), Z2373(1), Z2374(2), Z2375(1).

NMNZ: Ahipara Bay: Ech. 4698 (1); off Banks Peninsula: Ech. 6284(2); Bay of Islands: Ech. 4695(1); Bay of Plenty: Ech. 1605(22), 1606(15), 1608(3), 1609(1), 1610(1), 6506(1); off Cape Campbell: Ech. 571(1), 4699(1), 4710(1), 4711(7); Challenger Plateau: Ech. 4703(1), 4706(3), 5693(2); Chatham Rise (including Mernoo Bank and slope) and islands: Ech. 647(1), 1268 (3), 1607(1), 1611(1), 4696(2), 4697(2), 6472(9), 6489(1), 7418 (3); off East Cape: Ech. 4702(1); Cape Farewell area: Ech. 1265 (1), 4704(1); off Greymouth: Ech. 1266(1); off Heaphy River,

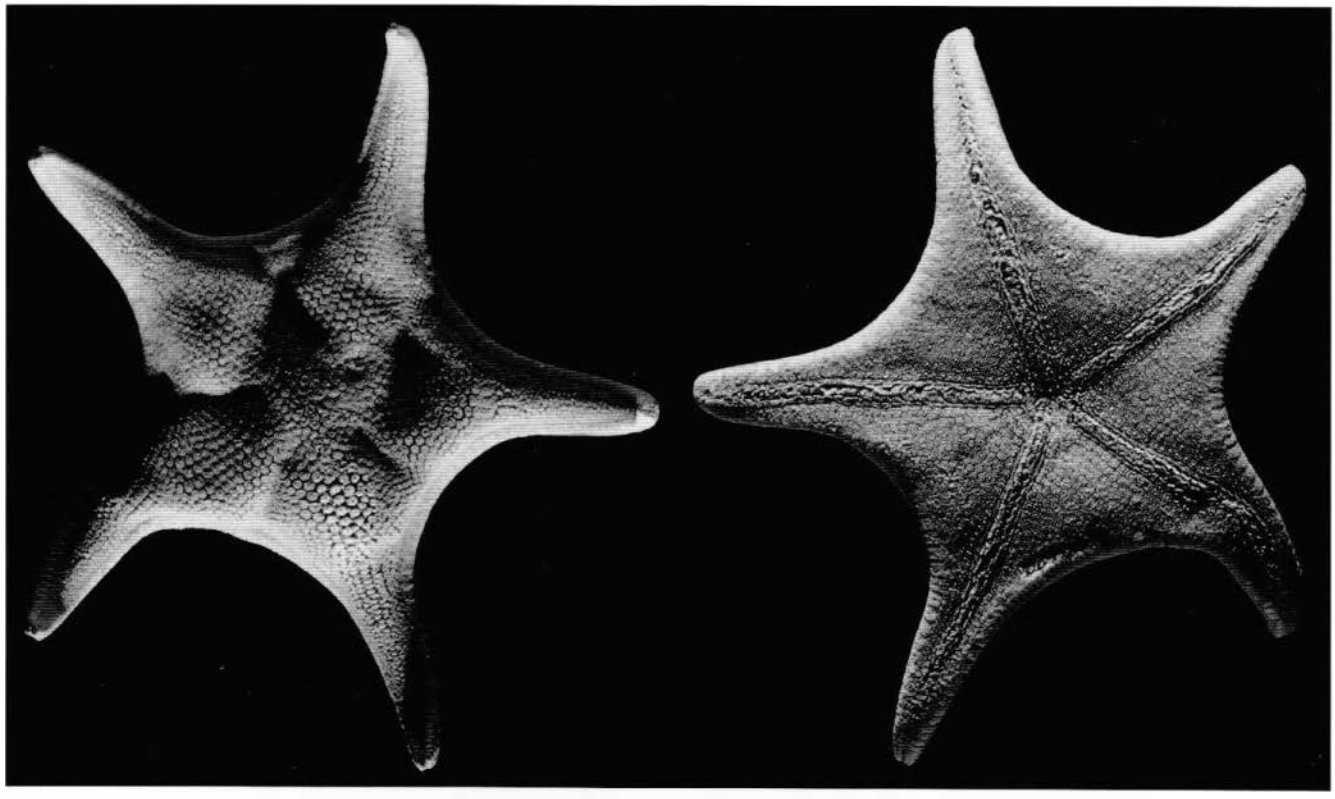


Plate 20. ***Mediaster sladeni*** Benham. NZOI Stn D895. R / r = 85 / 38 mm. Abactinal and actinal surfaces.

Westland: Ech. 4708(4), 5692(3); Hokianga Harbour: Ech. 1270 (4); Otago: Ech. 654(2), 5332(5), 6505(2); Puysegur Point, southern South Island: Ech. 2389(2); south of Snares Islands: Ech. 2672(2); Solander Trough: Ech. 1271(2); off Stewart Island: Ech. 1269(3), 4709(1), 6519(1); Three Kings Islands: Ech. 4093(2), 5695(2); near Whangarei: Ech. 1679(1).

SIZE: R varies between 115 and 12 mm, r varies between 50 and 7 mm; average for 24 specimens: R = 62 mm and r = 26 mm.

DISTRIBUTION: From near Three Kings Islands in the north, 34°04′ S (NMNZ Ech. 4093) to south of Snares Islands, 48°20′ S (NMNZ Ech. 2672) and to 165° E and to 175° W.

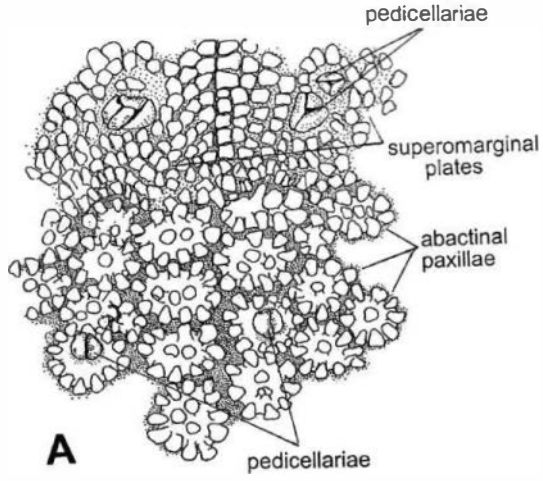
DEPTH: 41 m (off Otago Peninsula, South Island, NMNZ 6504) to 600 m near Snares Islands, NMNZ 2672). A specimen from 821 m (NZOI Stn E76, 44° S, 178° E) was not seen; perhaps it belongs in *Mediaster arcuatus* as the depth is exceptional.

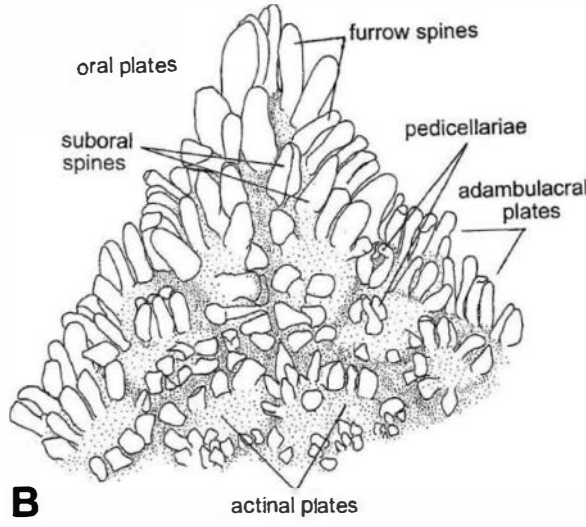
DESCRIPTION: Specimen described, NZOI Stn D895 from near the Chatham Islands, R / r = 85/38 mm.

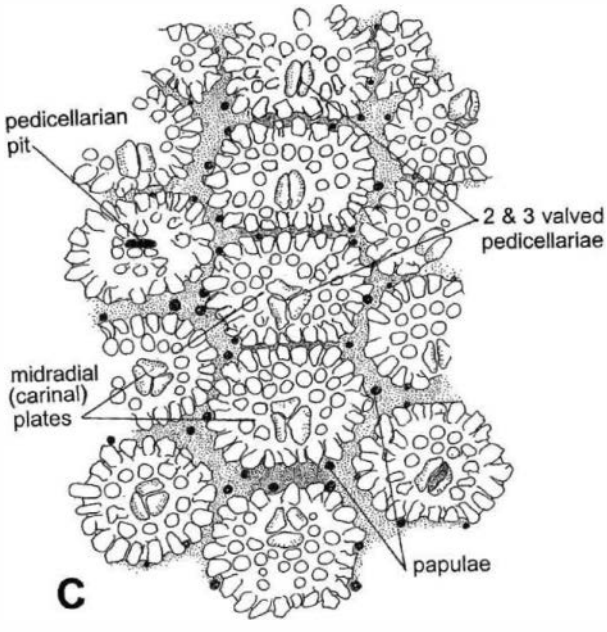
Disc large, irregularly inflated centrally and at arm bases; interbrachial angles wide, rounded. Arms slender, evenly tapering to oval, gently tumid apical plates; no enlarged apical spines; apical plates covered with spaced, short, blunt-tipped granules or short spines, similar to those of superomarginal plates; in present specimen most granules have rubbed off; faint scars remain.

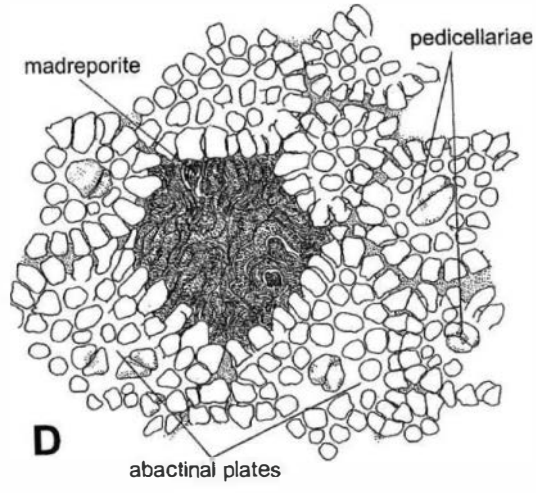
Abactinal plates form close covering over disc and arms; plates lobed basally, tabulate, with generally an oval, enlarged, flattened head; midradially, plates oblong (lozenge)-shaped. Midradial plates with fringe of 17–24 small, well separated, thick, sturdy, blunt-headed granules or short spines; often a small pimple (tiny spine) restricted to top edge of spines. Outer granules enclose 1, occasionally 2, circles of smaller granules; if a second circle, it is often incomplete. A pedicellaria (see below) with 2 or 3 valves centrally on most abactinal plates. Small developing plates also present between larger plates; these smaller plates have 5–12 or 13 outer spines enclosing 1, but sometimes 2 or 3 smaller granules or short spines; no pedicellariae. Plates forming regular rows on either side of midradial row; midradial plates larger, distinct, regular. Interradial plates small, close together; spinelets of these plates generally with triangular heads; these spines generally more angular.

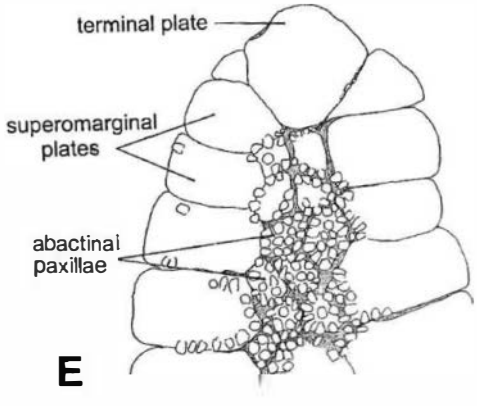
Papulae at arm base and near disc centre present in groups of 3 (occasionally 4) at 6 points between plate lobes; papulae small, generally forming a triangle. Along arms, papulae fewer, 6 separate papulae surrounding central plates; no papulae adjacent to inter-

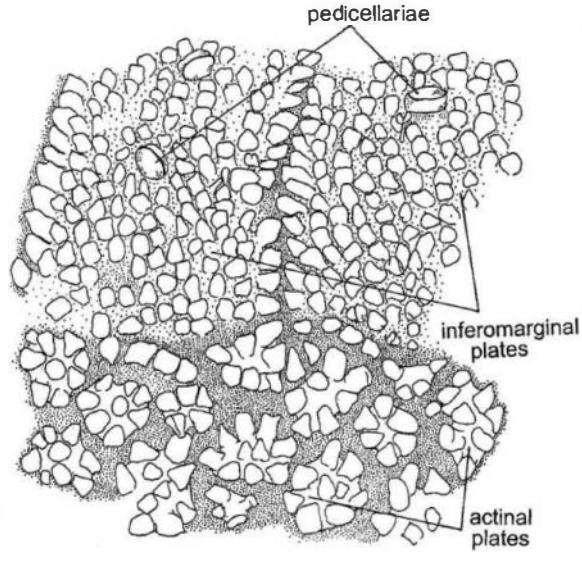












radial marginal plates or in last part of arms where plates form a close network.

Pedicellariae numerous, widespread, distinct, large, generally marginal, sometimes more central on plates; where pedicellariae are marginal a distinct gap with several marginal spines missing. Pedicellariae raised above level of surrounding granules, generally with 2 valves, sometimes 3; near arm tips pedicellariae small, round, button-like, generally 2-valved only and division between 2 valves often difficult to see. Pedicellariae triangular if 3 valves present and often a small gap centrally between 3 blades. All pedicellariae surrounding a distinct rectangular pit or hole.

Madreporite interradial, pentagonal, and nearer to disc centre than to marginal plates, finely and deeply dissected. Enlarged granules (short spines) from surrounding plates forming a protective fringe along margins.

Anus, midcentre of disc, small, rather inconspicuous, and guarded by a number of slender, tapering spines.

Marginal plates forming a distinct and even edge to disc and arms. *Superomarginal* plates rectangular, covered with small, spaced, flat or round-topped granules or short spines arranged in regular rows; plates bordered by distinctly larger more angular but still regular spines; enlarged marginal spines absent from edge between abactinal and marginal surfaces and between supero- and inferomarginal plates. Pedicel-lariae very conspicuous, 2–4, on interradial plates, conspicuous for at least half arm length, fewer towards arm tips. Superomarginal pedicellariae conspicuous, standing well out from plate; pedicellariae often with 3 blades, sometimes even 4.

Inferomarginals of similar size and shape to superomarginals with which they more or less correspond, especially towards arms tips. Pedicellariae, however, fewer, distinctly longer, more slender, often with 2 blades, sometimes 3, occasionally 4. Marginal spines of plates sometimes modified to form 2-bladed pedicellaria for at least half length of each arm.

Actinal areas well-developed, triangular, plates fairly regularly arranged especially near adambulacrals. Actinal plates raised, oval, round, oblong, flat-topped, with small spaced angular granules or short spines surrounding the plate, enclosing 1–4 similar well-spaced granules. *Pedicellariae* 2–4-valved, numerous, especially on plates bordering adambulacrals; pedicellariae formed by modified spines generally taller and certainly more conspicuous than surrounding spines.

Adambulacral plates narrowly rectangular, long edge to furrow, furrow spines 5 or 6; furrow edge of plate straight or gently curved. Furrow spines blade-like, slender, round-tipped, forming a very regular edge to furrow, compressed from side to side, narrow edge to furrow; subambulacral spines generally 5, sometimes 4 or 6, most anterior spine distinctly shorter. Subambulacral spines sturdier, shorter, more angular, forming a distinct row parallel to and well separated from furrow spines. Actinal edge of plate edged by a row of similar, shorter, well-separated angular spines or granules. Towards arm tips subambulacral armature difficult to determine.

Oral plates long, narrow; furrow spines 9 or 10, standing edge on to furrow, and well spaced. Most anterior spines longer, sturdier. Suboral spines shorter, tapering, flattened and forming 2 fairly regular rows.

Ambulacral grooves narrow, deep; *tubefeet* obscured by spines.

COLOUR: No colour notes of living material; dried, ex-alcohol, yellow-brown, pedicellariae white.

REMARKS: In general, arms in this species are long and slender and generally upturned. Several medium-sized specimens, however, have short, evenly tapering arms, especially the most southerly ones (NMNZ Ech. 2672 from south of the Snares Islands, 600 m). In other respects, with four or five adambulacral furrow spines, seven or eight oral furrow spines, and numerous abactinal and marginal pedicellariae, the specimen is normal. More than 200 specimens were examined; only one specimen (NMNZ 6472, from the Chatham Rise, R/r = 75/32 mm) had four arms, there being no sign of a fifth. Another large specimen (NMNZ Ech. 4696, R/r = 71/30 mm) from the northern Mernoo Slope has only four arms, with the fifth present as a short stump covered by an irregular mass of finely granu-lated and spined plates; the ambulacral groove is also closed by an irregular mass of folded plates and small rounded granules.

The position and arrangement of the papulae is interesting as neither Benham in his type description nor other workers discuss or describe them. A group of six conspicuous papulae is present in the arms, between the lobes of the plates, midradially. On the disc

Fig. 24. (opposite) ***Mediaster sladeni*** Benham. **A**. Abactinal surface, interradially, showing abactinal paxillae, superomarginal plates and pedicellariae. **B**. Oral, adambulacral and actinal plates. **C**. Abactinal plates midradially. Note the prominent 2- and 3-valved pedicellariae. D. Madreporite and surrounding plates. Note the fine sculpturing of madreporite and surrounding fringe of granules. E. Arm tip. Note that superomarginal plates are separate to arm tip. F. Inferomarginal and actinal plates. Note the inferomarginal pedicellariae.

and at the base of the arms each plate has six groups of papulae, each of which has three (very occasionally four) papulae. Papulae, at least in larger specimens, are present on disc and arms but are absent from a narrow mid-interradial strip running from superomarginals to near the disc centre; they are also absent from the last quarter of arms; here the abactinal plates form a close network. The mid-interradial strip, devoid of papulae, is very obvious on dissection.

Variation also occurs in the number, shape, and arrangement of pedicellariae. They are mostly 2-4-valved, generally round, but sometimes elongate–breadroll or sausage-shaped; they may protrude above the level of surrounding granules or granules may be higher. Pedicellariae are often present on both series of marginal plates or may be restricted to superomarginals. Actinal pedicellariae are generally most obvious on plates adjacent to adambulacrals and they are sometimes present on proximal adambulacral plates themselves; these pedicellariae are taller, more con-spicuous and formed from two or three more upright spines. Most abactinal pedicellariae occur on or near plate margins, but some occur centrally on a plate; there is generally only one pedicellaria but two or three may be present.

In all specimens examined the madreporite lies near the disc centre; two specimens are of interest. In a large specimen (NZOI Stn E79, R/r = 83/36 mm) from the Chatham Rise, the madreporite is large, swollen, smooth, seven-sided and totally unsculptured apart from a few, very faint striations along one margin. In another specimen (NZOI Stn I356, R/r approx. 55/23 mm) from near North Cape, the specimen seems normal but has two very distinct madreporites, one below the other. The upper madreporite is small and square; the lower is larger, more distinct, and almost divided into two.

In most of the present specimens the oral plates are long, narrow, and lie close together in an angle; in a specimen (NMNZ Ech. 6472, R/r = 86/36 mm) from the Chatham Rise, the oral plates are very long and slender, furrow spines are few, and the two plates in an angle are separated by a very broad, naked, membranous area. A similar condition is present in another specimen from near Cape Campbell (NMNZ Ech. 571, 110–128 m, R/r = 85/36 mm). A third specimen (NMNZ Ech. 4704, 208–264 m) from near Kahurangi Point, Cape Farewell, has very short, wide oral plates.

A single specimen (NZOI Stn S127, R/r = 85/33 mm) was dissected. The ambulacral ossicles form a steep, straight ridge along the arms, separated abactinally by broadly heart-shaped transverse muscles; superambulacral plates are present but difficult to see, being tucked right under the ambulacral ossicles and standing almost vertically; they are most obvious in the last half of the arms. Actinal plates, seen from the coelomic side, are rather irregularly oval or round, over-lapping and distinctly rectangular bordering the ambu-lacral ossicles, where they form a regular row. The marginal plates are distinct and form a very regular series, especially interradially; they are flat to tumid, with the inferomarginals larger. Ampullae of tubefeet are double and interradial septa membranous and strong; the intestinal caecae, restricted to near the disc centre, are a series of smooth, unbranching, tapering round-tipped sacs. The gonads are very conspicuous and form a row at an angle on either side of the interradial septum; the rows from either side of the septum almost meet near the centre of the disc; six or seven clumps of individual gonads are present in a row. Abactinally, plates viewed from the coelomic side form a beautiful network of slender ossicles which connect the ill-defined, oval or round abactinal plates. Generally there are six ossicles and two or three papulae present in each area between the plate lobes.

Milteliphaster Alcock, 1893

Disc rather small, tumid; arms 5, rounded, long, slender. Abactinal plates of various shapes and sizes, fringed by small granules and generally naked apart from 1, 2, very occasionally 3 large, sturdy, tapering spines. Abactinal plates present to arm tips; superomarginal plates not meeting in radial midline. Supero- and inferomarginal plates of similar size, each plate with at least 1, sometimes 2 or even 3 enlarged spines, small rough granules, and occasional pedicellariae. Adambulacral plates with "close comb" of furrow spines and generally 2 large subambulacral spines often with bifid or multifid tips; some enlarged spines ?hollow. Straight pedicellariae scattered on abactinal, marginal and actinal plates. Actinal interradial areas large, plates often rectangular and bearing 1 or 2 large spines; surface of actinal plates rather rough and small granules and pedicellariae often present.

TYPE SPECIES: *Milteliphaster woodmasoni* Alcock, 1893.

TYPE LOCALITY: Andaman Sea, Bay of Bengal.

REMARKS: Rowe and Gates (1995) list three species of *Milteliphaster* from Australia — *M. regenerator* (Döderlein, 1922), *M. spinosus* (H.L. Clark, 1916), and *M. wanganellensis* H.E.S. Clark, 1982; the first two were originally included in the genus *Calliaster;* A.M. Clark (1993: 247) included *regenerator* and *spinosus* with *Calliaster. Milteliphaster wanganellensis* is very similar to Alcock's *M. woodmasoni* from the Bay of Bengal.

Milteliphaster wanganellensis H.E.S. Clark, 1982
(Pl. 21, Fig. 25)

Milteliphaster wanganellensis H.E.S. Clark, 1982: 35, figs 1-7; Rowe 1989: 289; A.M. Clark 1993: 264; Rowe & Gates 1995: 66.

MATERIAL EXAMINED:
NMNZ: Wanganella Bank: Ech. 3780(1).

SIZE: R / r = 87/27 mm.

DISTRIBUTION: Known only from the Wanganella Bank area, Tasman Sea, 32°35.3′ S, 167°41.8′ E to 32°34′ S, 167°39′ E.

DEPTH: 422-437 m.

DESCRIPTION: The holotype, the only specimen, is described.

Disc irregularly tumid; arms 5, long, slender, tapering to blunt upturned tips protected by distinct rounded plates; tips of plates swollen, forming conspicuous knobs; faint scars suggest 1–4 spines may have been present.

Abactinal plates of all shapes and sizes; a single series of rectangular plates between superomarginals to arm tips. Abactinal plates gently tumid or flat, naked, more or less smooth, no conspicuous hyaline granules; plates of 2 sizes, especially on disc where small oval plates, each with a complete fringe of granules, generally surround larger plates. All plates fringed by small, rectangular, oval to almost square granules; occasionally granules conspicuously larger, leaflike. Large disc plates generally with 1, sometimes 2, central spines; these long, slender, tapering to an almost blunt tip, borne on distinct, raised membranous bosses. A distinct *carinal* series of plates extending to arm tip; for at least three-quarters length of arm, carinals with a single enlarged spine similar to those of disc, these spines becoming progressively shorter near arm tips, absent from last 5 or 6 plates; occasional pedicellariae, similar to those described.

Papulae single, 3–6 or 7 present between fringing granules at plate edges on disc, and for short distance into arms, few and indistinct in last quarter of arm and in narrow interradial areas near superomarginal plates.

Pedicellariae occasional, straight; these bivalved, shell-like, delicate, round-bladed and supported by a short broad stalk; presumably blades must sometimes lie flat on plate although there is no obvious depression.

Madreporite large, interradial, very near disc centre, rounded-pentagonal, dark brown, regularly and finely dissected, bordered by 3 large plates; 2 lateral plates each with a single enlarged spine; third plate, nearest disc centre, with 3 spines and a deep, wide, almost triangular indentation; a delicate, shell-like pedicellaria similar to those already described but blades, when at rest, fitting in shallow depressions on either side.

Anus not obvious, unless it lies in the curious indentation on the large plate near the disc centre bordering the madreporite.

Superomarginal plates 19–22 from interradial angle to arm tip, forming obvious edge to disc and arms; each plate rectangular, tumid, ringed by small granules similar to those of abactinal plates and with 1, to occasionally 3 or even 5, large tapering spines similar to those decribed, tending to form an almost vertical row; 1 or 2 plates with a scattering of small, rounded, isolated granules and occasional round-bladed pedicellariae similar to those described. Surface of plates very slightly roughened by, perhaps, tiny hyaline granules.

Inferomarginal plates more or less corresponding to superomarginals, the surface finely pitted, rough; marginal granules larger, more distinct, in 2 rows, and small, independent, isolated round granules may also occur; enlarged spines more numerous, up to 7 (on 1 plate, interradially), and pedicellariae, especially distally, more obvious, their edges often flanked by distinct, small, rectangular, swollen granules.

Actinal areas distinct, triangular, actinal plates present for about one-quarter arm length; extending to level of about 12–14 (counting from oral plates), adambulacral plates. Actinal plates more or less rectangular, bordered by small, rather irregularly shaped and sized granules; sometimes forming 2 rows. Actinal plates with 1, proximally sometimes 2, short, sturdy, almost bottle-shaped spines, scattered granules and often 3-bladed pedicellariae.

Adambulacral plates regularly rectangular, forming a well-ordered and straight or gently rounded edge to narrow furrow. Plates with 2, occasionally 3, large, sturdy spines at right angles to furrow, somewhat flattened (flat edge to furrow), blunt-tipped, possibly hollow. Surface of plates rough with scattered different-sized granules, especially on proximal plates often forming a distinct fringe at base of spines. Occasional pedicellariae at base of spines, these fan-shaped, similar to those described, or blades may be longer, almost leaflike, tapering to sharp tip; blades in these latter pedicellariae hollow, pedicellariae most obvious anteriorly. Furrow spines 5–7, occasionally 8, on proximal plates, small, slender, blunt-tipped, often flattened, narrow edge to furrow. Furrow spines forming graded series, most anterior and posterior spines smallest.

Oral plates large, almost triangular, with covering of scattered granules; suboral spines 2 or 3, forming a distinct row, similar to but slightly longer than adjacent subambulacral spines. Oral furrow spines 8–10. Pedicellariae on most oral plates.

Ambulacral grooves narrow; *tubefeet* not visible.

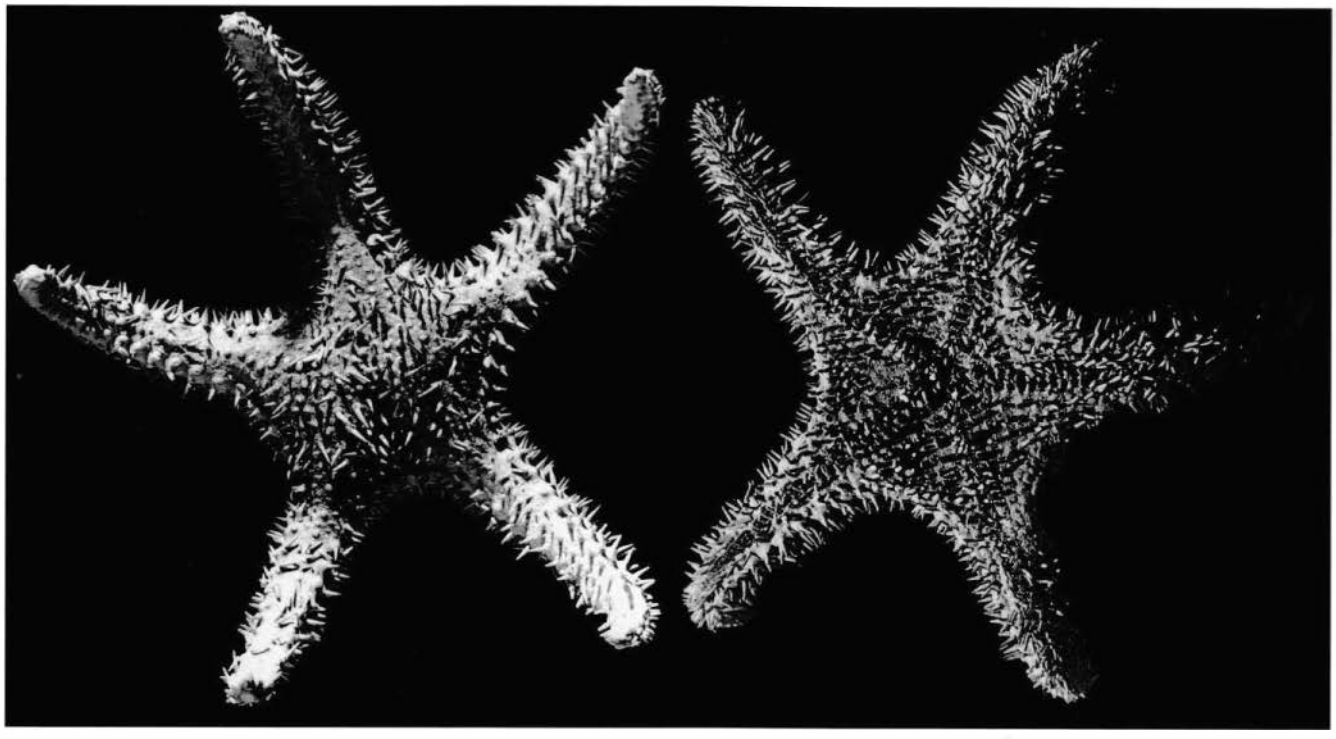


Plate 21. ***Milteliphaster wanganellensis*** H.E.S. Clark. Holotype. NMNZ Ech. 3780. R/ r = 87 /27 mm. Abactinal and actinal surfaces.

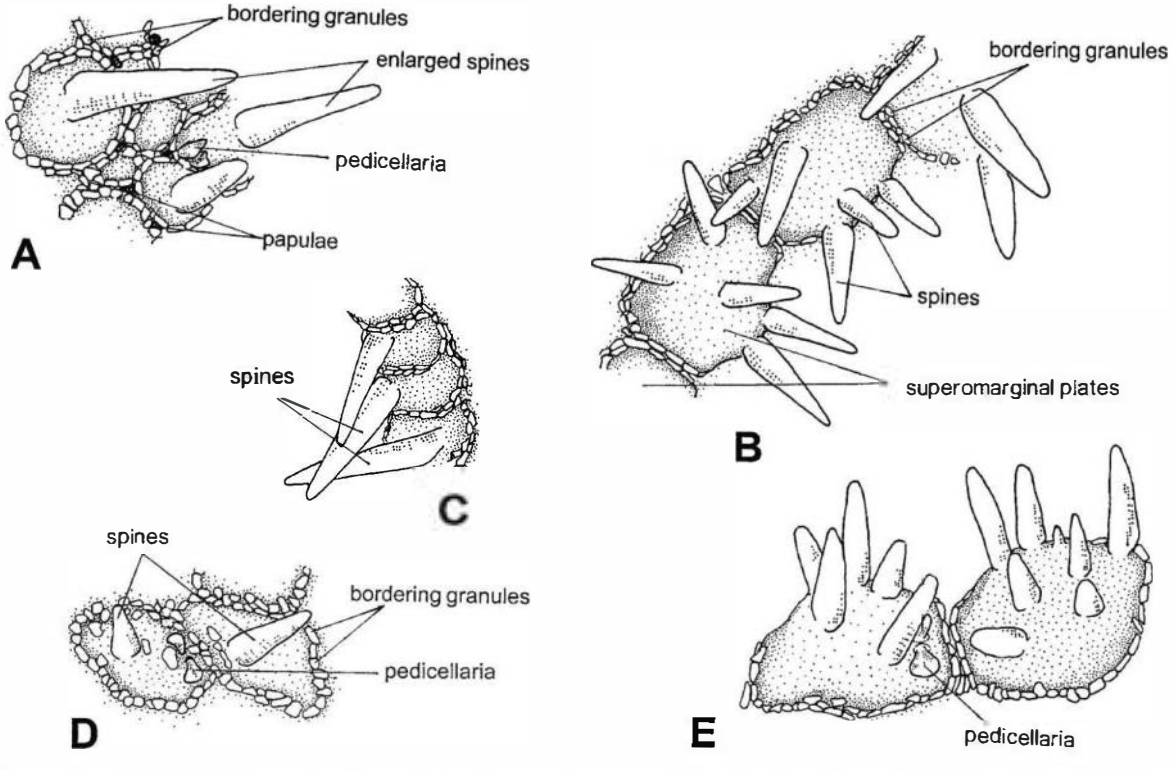


Fig. 25. ***Milteliphaster wanganellensis*** H.E.S. Clark. **A**. Abactinal plates showing bordering granules, spines, papulae and pedicellariae. **B**. Superomarginal plates near interradial angle showing number and arrangement of spines. **C**. Superomarginal plates near arm tip showing reduction to one spine. **D**. Actinal plates showing arrangement of spines and pedicellariae. **E**. Inferomarginal plates near interradial angle, showing number and arrangement of spines and pedicellariae.

COLOUR: Colour notes of living material: "brick red". Alcock (1893: 93) recorded colour "in life" for the closely allied *Milteliphaster woodmasoni* as "a network of cinnabar-red on a yellow ground abactinally". Dried, ex-preservative, the present specimen is grey-brown in colour.

REMARKS: The present single specimen is very similar in size to *Milteliphaster woodmasoni* Alcock; whether differences in spine number and form are simply variations or rank as specific differences is hard to decide. Specimens of *Milteliphaster woodmasoni* were not available for comparison. Actinally, in this specimen, in three interradii and along one arm, a parasitic gastropod mollusc (*Stilifer* sp.) is present.

Paragonaster Sladen, 1889

An unpaired but not recurved oral furrow spine present, common to 2 oral plates in an angle; superomarginal plates separated along arm length by a single series of often rectangular, sometimes rounded, non-paxilliform plates. Remaining abactinal plates paxilliform with spaced granules. Marginal and actinal plates with granules and sometimes enlarged spines also. Adambulacral furrow margin sometimes rounded, sometimes angular; fasciolate pedicellariae may be present betweeen adjacent adambulacral plates.

TYPE SPECIES: *Paragonaster ctenipes* Sladen, 1889.

TYPE LOCALITY: Arafura Sea between Kei and Banda Islands, Indo-Malay Archipelago, 217–256 m.

REMARKS: Sladen listed *Paragonaster* in Thomson and Murray (1885: 617) but it is a nomen nudum as no species was named (A.M. Clark 1993: 267). This is a small but well-defined genus; the unpaired oral furrow spine, common to two oral plates in an angle, is very distinctive.

DISTRIBUTION: A.M. Clark and Downey (1992: 255) recorded two Atlantic species of *Paragonaster*. *Paragonaster ctenipes* Sladen is known from the Arafura Sea and more recently Rowe and Gates (1995: 67) recorded it from Western Australia in 115–398 m; Imaoka *et al.* (1990: 47) reported one specimen from Tosa Bay, Japan. *Paragonaster ridgwayi* McKnight (1973a) is restricted to northern New Zealand waters and *P. stenostichus* Fisher (1913) previously recorded from the Philippine Islands, is now known from the Three Kings Rise north of New Zealand. Recently, Blake and Aronson (1998) described a new Eocene species of *Paragonaster*, *P. clarkae*, from Seymour Island in the Antarctic Peninsula.

KEY TO THE NEW ZEALAND SPECIES OF *PARAGONASTER*

1 (2) Arms long and very slender; adambulacral plates with distinct sharp (triangular) edge in furrow; conspicuous "trunk" present on either side of oral plates in an angle ..... *ridgwayi*

2 (1) Arms not particularly long and slender; no sharp, conspicuous edge to adambulacral plates and no "trunk" on oral plates ..... *stenostichus*

Paragonaster ridgwayi McKnight, 1973a

(Pl. 22, Fig. 26)

Paragonaster ridgwayi McKnight, 1973a: 172, fig. 2a, b; 1993a: 168, 184; A.M. Clark 1993: 268.

MATERIAL EXAMINED:

NZOI Stns: J40(1) (paratype P-221)), J48(1) (holotype H-160), U195(1).

SIZE: R/r = 103/21 mm (holotype); Rr = 54/12 mm (paratype).

DISTRIBUTION: Fairway Trough, New Caledonian Basin to the west of northern New Zealand.

DEPTH: 2113–2930 m.

DESCRIPTION: The holotype, NZOI J48 (H-160), R/r = 103/21 mm, is described.

Disc large, flat, slightly and evenly raised centrally, arms 5, 1 remaining arm very long, slender, flattened, arm tip (and plate) missing; other arms broken, though 2 arms actually regenerating, no tips. Marginal plates on 2 regenerating arms distinctly smaller, rather tumid, a single row of abactinal plates present to arm end; on 1 regenerating arm, probably as a result of further injury, superomarginal plates are particularly tumid, confused, often divided.

Abactinal plates radially well ordered, gently tumid, regularly hexagonal (at least until arms narrow) with distinct carinal series continuing to arm tip. Near disc centre carinal plates with 9–18 or 19 central, generally flat-topped, rather angular, slightly spaced granules; plates edged by more numerous (up to 27) small, separate, wedge-shaped, truncated granules (very short spines). Paxillae on either side of carinal series becoming progressively smaller, oval or rectangular, with distinctly fewer central granules; near superomarginal plates, interradially, plates small, regularly rectangular and often lacking central granules; paxillae sometimes reduced to 3 or 4 granules only. Generally along arms 2 abactinal plates corresponding to 1 superomarginal plate.

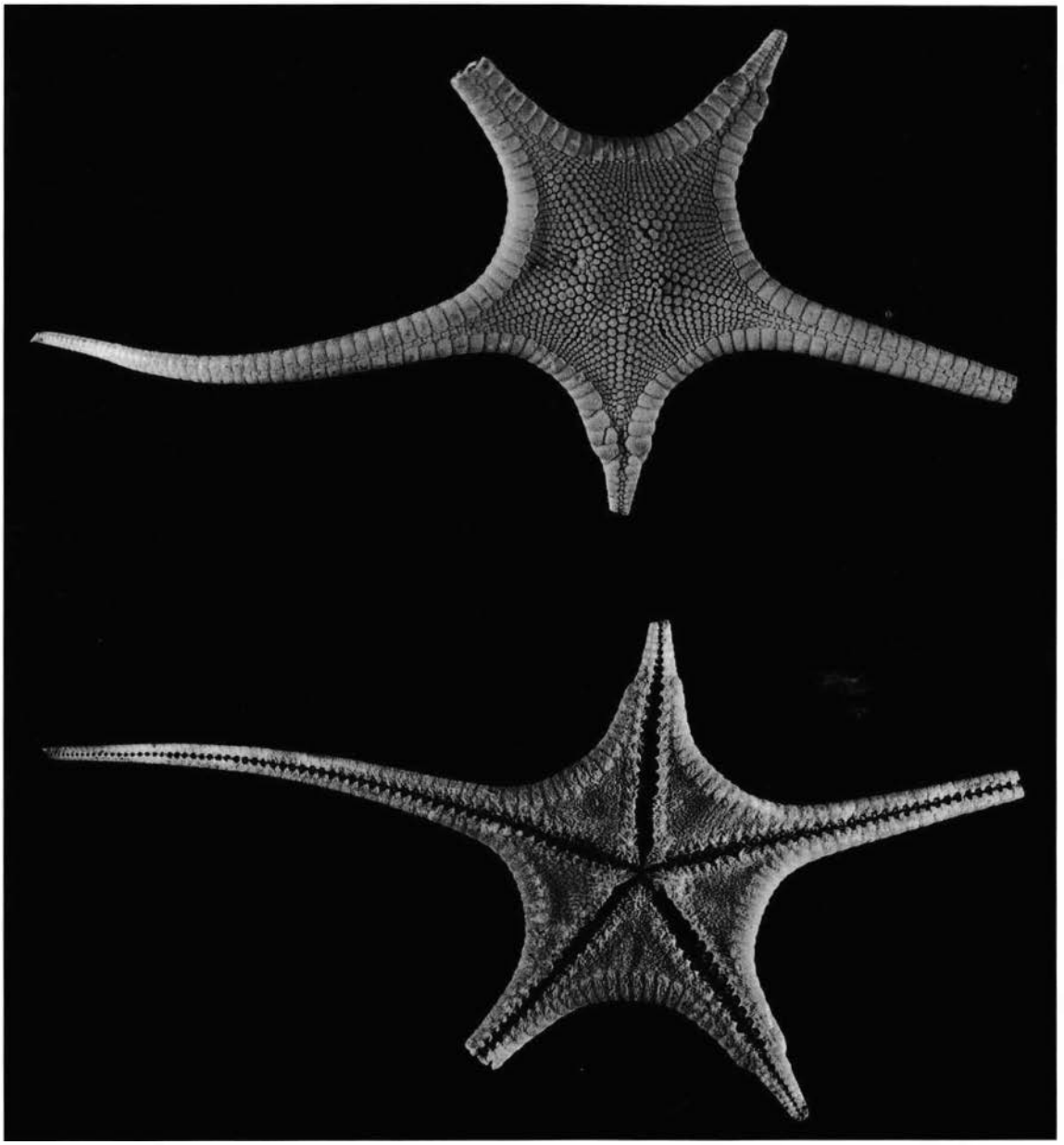


Plate 22. ***Paragonaster ridgwayi*** McKnight. Holotype. NZOI Stn J48. R/r = 103/21. Abactinal and actinal surfaces.

Papulae distinct radially between conspicuous plate lobes, 4–6 surrounding each plate; interradially, a distinct triangular area without papulae. Papulae becoming small, indistinct, near arm entrance and absent from single series of abactinal plates reaching arm tips; also smaller, less obvious or missing near disc centre.

Pedicellariae not seen on abactinal or superomarginal plates.

Madreporite small, sunken, bluntly triangular, almost midway between centre and edge of disc, coarsely and deeply dissected. Neighbouring abactinal plates between centre and edge of disc somewhat enlarged, tumid.

Anus not obvious.

Superomarginal plates all wider than long, gently tumid, forming distinct, conspicuous edge to disc and arms. Plates projecting slightly above level of adjacent abactinal plates, with covering of spaced, flat-topped, round to gently angular, mostly similar-sized granules, and edged by single row of distinctly smaller but conspicuous wedge-shaped granules, often corresponding to and even meeting with granules from neighbouring plates. Superomarginal plates separated laterally from one another by distinct deep gutters.

Inferomarginal plates barely visible from abactinal surface, corresponding with superomarginals, most obvious actinally forming a conspicuous raised edge

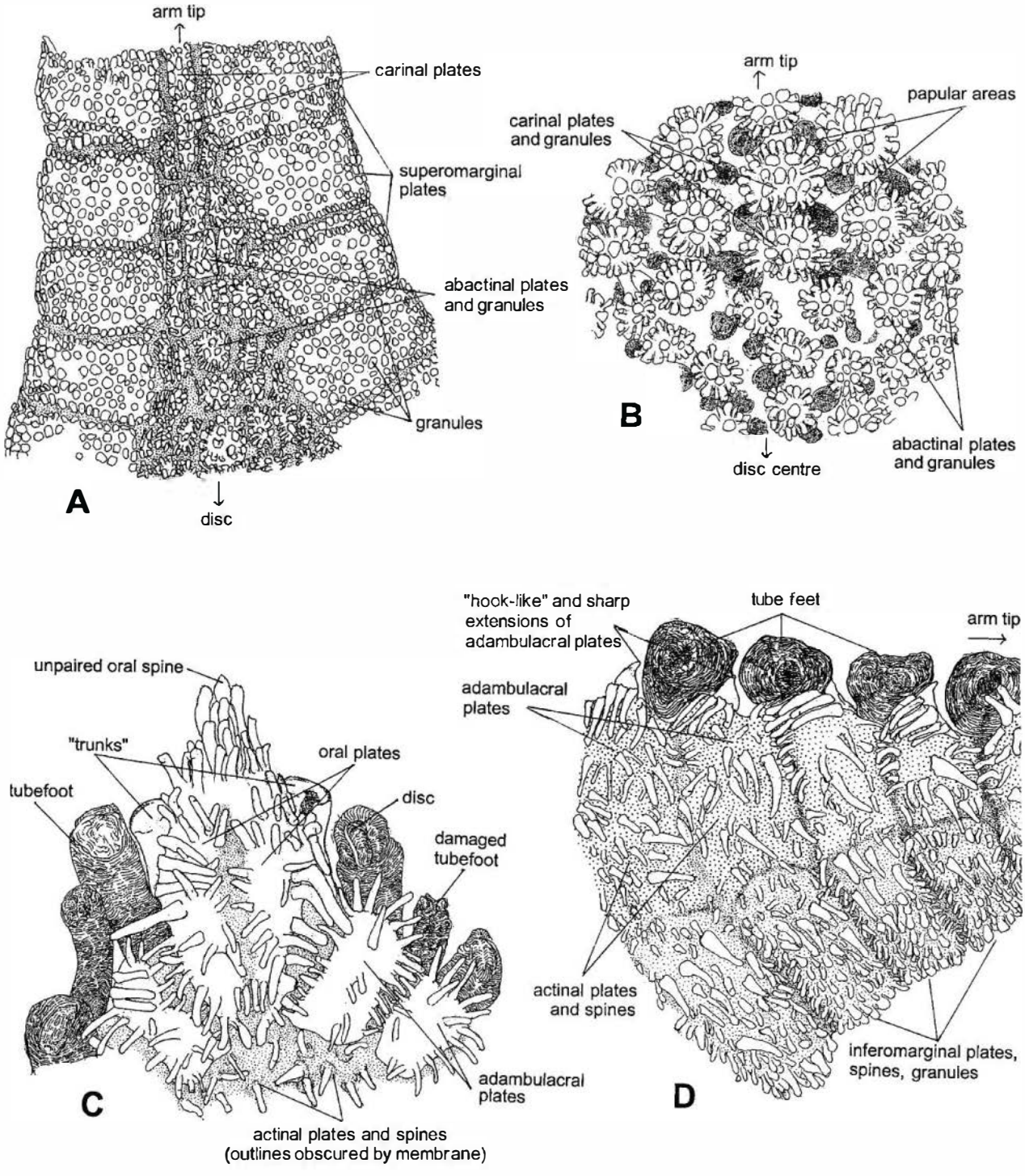


Fig. 26. *Paragonaster ridgwayi* McKnight. Holotype. **A**. Abactinal view of arm base. **B**. Abactinal plates and paxillae, membranous areas, finely stippled, with papulae. Note the carinal series of larger plates. **C**. Oral angle: note the curious "trunk"-like extensions of oral plates. **D**. Adambulacral, actinal, and inferomarginal plates. Note the angular (almost hook-like) extensions of adambulacral plates, and outlines of adambulacral and actinal plates are obscured by membrane.

to actinal areas. Plates shaggy with small, spaced spines of several sizes; on actinal surface of plates interradially, spines slender, upturned, especially along plate edges where, although spines are smaller, they form a distinct fringe. Near junction with superomarginals, spinelets small, more thick-set, blunt-tipped. As well as small, spaced spines, longer, more distinct, lanceolate, tapering spines are present; these becoming fewer, smaller along arms and completely absent from last half of existing arm.

Actinal areas triangular, plates present to level of 9th or 10th adambulacral plate (counting from oral plates) and 6th or 7th inferomarginal plate (from midinterradial angle). Actinal plates irregular in size and shape, outlines difficult to distinguish because of enveloping membrane, square, rectangular, ovoid, with 5–7 or 8 distinct spines; these finely thorny along most of length and generally of similar size; sometimes 1, very occasionally 2 spines distinctly longer and generally central on plate.

Adambulacral plates rectangular, narrow edge to furrow, first 3 or 4 plates with rounded furrow margin, plate margin becoming progressively more angular until, near arm tip, tubefeet in "pockets" formed by angular extensions of adambulacral plates. Proximally, 6, 7, occasionally 8 adambulacral furrow spines; these slender, round-tipped, slightly flattened with narrow edge to furrow, well separated from each other; subambulacral spines 1-4, forming row at right angles to furrow; lateral edges of adambulacral plates with 3–5 or 6 small, spaced, slender, thorny spines, some meeting spines from neighbouring plates, forming more or less fasciolate pedicellariae. Near arm tips adambulacral plates rectangular, separated by slender membranous areas; furrow spines 5, 6, several subambulacral granules or short spines.

Oral plates narrow, long, conspicuous; unpaired oral spine similar to other oral furrow spines but projecting further into mouth; unpaired spine finely thorny, untapering. On either side furrow spines 7-10, well spaced, slender, untapering, round-tipped; suboral spines in 2 fairly regular rows, 5–8 similar spines in a row. Membranous area between plates in an angle narrow, rather indistinct.

On either side of the oral plates in an angle, deep in the mouth, is a conspicuous thick blunt trunk (an extension) which projects at an angle. It is unusual and obvious and does not seem to have been reported for *Paragonaster* before. It is shown in the drawing of the oral plates. These curious extensions are present in both specimens of *P. ridgwayi*, but they are, perhaps, most obvious in the larger holotype.

Ambulacral grooves distinct, quite wide; *tubefeet* biserial, with small sucking discs.

COLOUR: No colour notes of living animal; dried ex-ethanol – light yellow-brown.

REMARKS: The paratype (Stn J40, R / r = 54/ 12 mm) has one intact arm; the *terminal plate* is large, solid, oval, upturned and largely naked apart from three small granules near abactinal plates; possibly the plate was fringed by granules (short spines) or they may have been present over entire surface. In most other respects the specimen is similar to that already described. The *madreporite*, however, is very small, barely visible as just two ridges midway between disc edge and centre. *Anus* is present, midcentrally, on disc, between close mosaic of disc plates. *Abactinal plates* which are present, between superomarginals, to arm tips are interesting; plate edges, adjacent to superomarginals are guarded by distinctly larger and more conspicuous granules, from three to five or six in a row, these are generally round, may touch each other or be more spaced. Centrally, on these abactinal plates there may be three to five (even six) enlarged, often rectangular granules; nearer arm tips these may alternate with broader, almost triangular granules; generally two plates correspond to one superomarginal. *Actinal surface* is similar to that already described, most proximal *adambulacral plates* with generally five, sometimes six, well-spaced furrow spines, the most proximal three or four adambulacral plates with a distinctly round furrow margin distally. "Pockets" are formed by extensions of adambulacral plates, and there are stumps of five or six furrow spines; tubefeet are conspicuous in the "pockets". In this smaller specimen *actinal plates* are more distinct; plates are raised, somewhat irregular in shape and size with spines similar to those already described; *oral plates* are also similar. All spines are finely thorny.

The paratype (NZOI Stn J40) was dissected. *Intestinal caecae* are obvious with short, strong lobes; *pyloric caecae* large, very folded. No *gonads* were seen; Fisher (1919: 235) recorded gonads in the closely allied *P. stenostichus* as single tufts on either side of the interradial septum. *Interradial septa* membranous, well developed, "double"; near abactinal plates septa part (split) into two membranes; each expands and lines one-half of the interradial area. *Superambulacral plates* hard to determine, possibly present distally. *Ampullae* of tubefeet double. *Ambulacral ossicles* separated dorsally by broad muscular areas. *Abactinal plates* seen from the coelomic side are regularly hexagonal, forming a very close network. They are evenly lobed, there are no connecting ossicles, and single papulae are present between lobes; generally six papulae around each plate. *Papulae* are fewer and less obvious at beginning of arms and were not seen towards arm tips. Interradially, plates oval, oblong, less distinctly lobed, forming a close cover and papulae are absent near the margins. The

disc centre is well demarcated by five distinct shallow gutters; abactinal plates here are smaller, oval or round, generally lacking lobes and forming a close network; papulae are few or absent. A conspicuous central opening on the disc is probably the *anus*.

Paragonaster ridgwayi is most similar to *P. stenostichus* Fisher from the Philippines and near the Three Kings Rise north of New Zealand; however, *P. ridgwayi* has longer and more slender arms; in *P. stenostichus* there is one enlarged subambulacral spine; in *P. ridgwayi* one to four, often two, are present. Also in *P. stenostichus* superomarginal plates appear much wider—the radial series of abactinal plates in *stenostichus* is recorded from the 3rd to 5th superomarginal plate; in *ridgwayi* from the 8th superomarginal on. The superomarginal plates are distinctly more narrow. *Paragonaster stenostichus* also has fewer inferomarginal spinules and more granules on proximal radial abactinal plates. In both *P. ctenipes* Sladen and *P. subtilis* (Perrier, 1881), plates of the single abactinal series of the ray are as wide as long.

The curious blunt trunk or extension of the oral plates is very obvious in both specimens of *P. ridgwayi* in the NZOI collections. There seems to be no mention in descriptions of other *Paragonaster* species of these extensions. The other interesting feature is the sharp angular edge of the adambulacral plates in *P. ridgwayi*. Sladen (1889: 312) recorded similar adambulacral extensions in *P. ctenipes*. In the one specimen of *P. stenostichus* in the present collections there are no "oral" trunks and no angular extensions of the adambulacral plates.

Paragonaster stenostichus Fisher, 1913

(Pl. 23, Fig. 27)

Paragonaster stenostichus Fisher, 1913: 627; 1919: 232, pls 60(2), 70(2), 71(1), 91(10, 10a); McKnight 1993a: 168, 184; A.M. Clark 1993: 268.

MATERIAL EXAMINED: NZOI Stn S568(1), near the Three Kings Rise, north of New Zealand.

SIZE: R = approx. 50-55, 56 mm, r = 19.5 mm (all arm tips broken).

DISTRIBUTION: Known from the Philippines and a seamount near the Three Kings Rise, north of New Zealand.

DEPTH: 315-900 m.

DESCRIPTION: Description is of the single specimen.

Disc thick, more or less flat, slightly sunken interradially; carinal series of plates obvious. Arms sturdy, rather short; arm tips and terminal plates missing on all 5 arms. Superomarginal plates forming a conspicuous thick-set edge to disc and arms.

Abactinal plates tabulate (at least on disc), closely packed, oval, round, outlines indistinct interradially; radially, carinal series and adjacent plates are obvious. Carinal plates pentagonal to round with 24–30 large, central, angular granules; these square, rectangular, sometimes rounded; plates edged by small, slender, spaced, short, blunt-tipped spines. Carinal series of plates continuing to arm tip as a single series between superomarginals; in this series, plates longer than wide, bearing well-spaced, similar-sized granules, in rather uneven rows, especially distally; generally 2 abactinal plates correspond to 1 superomarginal.

Papular area difficult to define as plates are closely packed; papulae 5 or 6 between lobed radial plates, absent between single series of abactinal plates in arms. Papulae probably absent interradially; absent or very few and scattered at disc centre.

Pedicellariae not seen abactinally.

Madreporite interradial, small, pentagonal, eroded, very near disc centre; it was probably finely and deeply dissected; 2 adjacent plates enlarged.

Anus almost central on disc, a small opening edged by granules.

Superomarginal plates tumid, forming conspicuous raised heavy edge to disc and arms; plates mainly denuded now, but occasionally with a few granules. These small, rectangular, square, finely spaced, forming regular rows; faint scars remaining when granules removed. Plates edged laterally by close row of small, slender, upright spines; no enlarged superomarginal spines.

Inferomarginal plates corresponding almost exactly with superomarginals, generally wider than long but inferomarginal plates somewhat shorter distally, rectangular to almost square; inferomarginal plates almost denuded in this specimen; however, occasional remaining granules and spines suggest that distinct large-headed short spines (or granules) were present, and also longer, very slender spines; plates margined by small, upright spines, some remaining.

Actinal plates rather irregular in shape and size; actinal area extending to level of 11th or 12th adambulacral plate, 5th or 6th inferomarginal (from interradial angle). Plates rectangular near inferomarginals, adjacent to adambulacrals solid, rectangular, large; short spines forming a spaced fringe around plates; generally at least 1 (sometimes 2) enlarged, long, slender spines, generally central on plate.

Adambulacral plates large, raised, rectangular, well separated laterally by membranous areas. Furrow spines 5 or 6 proximally, distally 8 or even 9, slender, rather flattened, narrow edge to furrow; blunt-tipped spines of similar length. Subambulacral spines slightly shorter, broader than furrow spines, in 2 or 3 rows; at

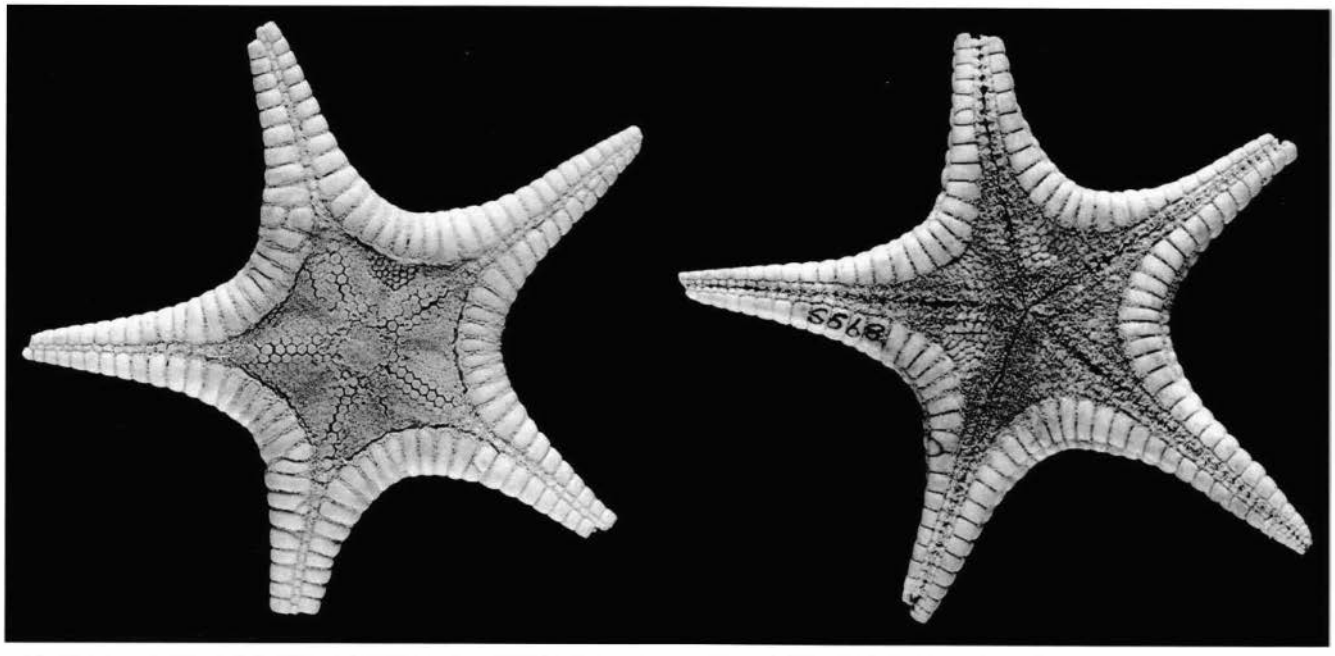


Plate 23. *Paragonaster stenostichus* Fisher. NZOI Stn S568. All arms broken. Abactinal and actinal surfaces.

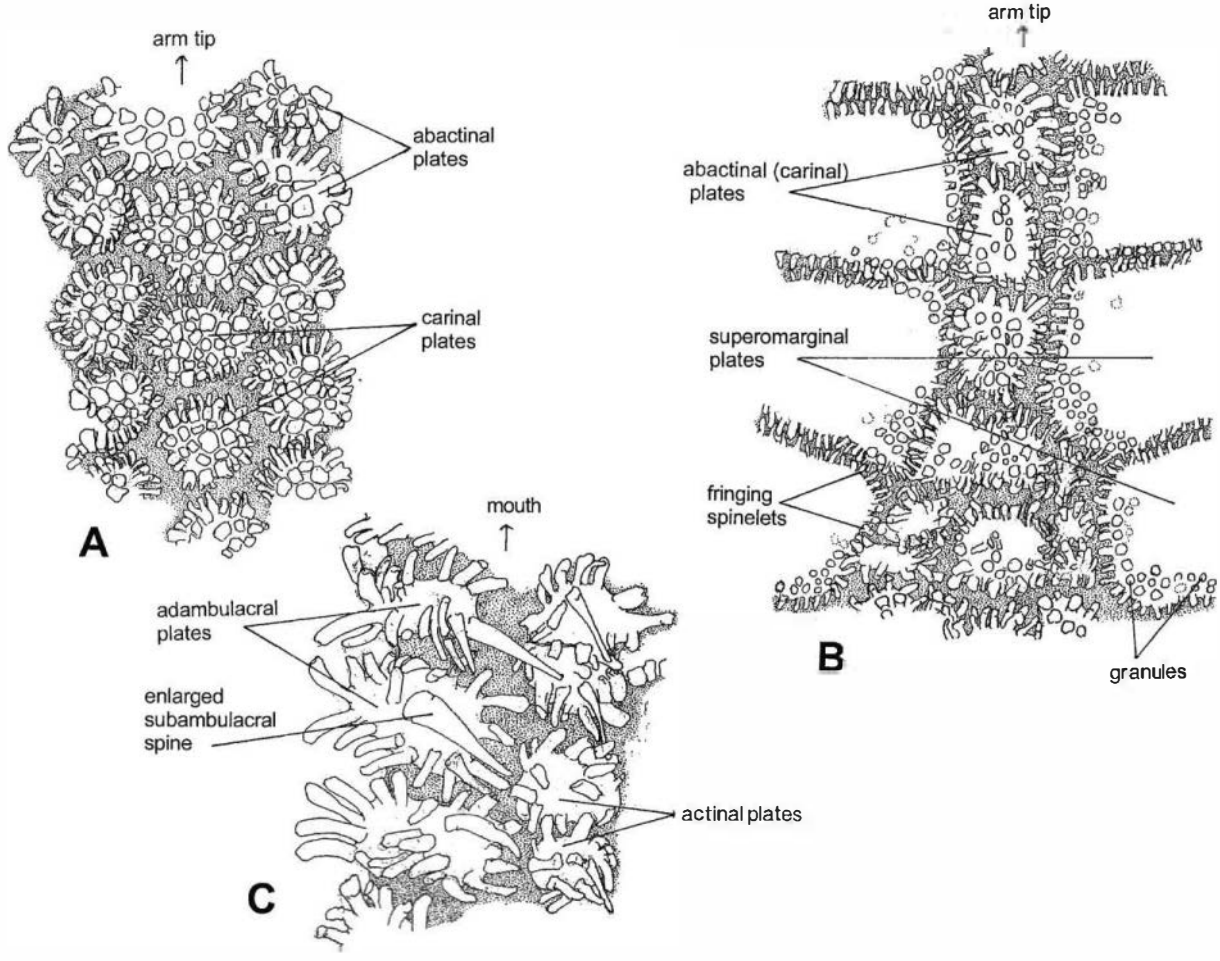


Fig. 27. *Paragonaster stenostichus* Fisher. NZOI Stn S568. All arms broken. **A**. Abactinal plates near arm base. Note the carinal series of plates. **B**. Superomarginal and abactinal (carinal) plates, near arm base. **C**. Adambulacral and actinal plates near oral plates. Note the enlarged and long, slender spines on both series of plates.

least 1 enlarged subambulacral spine, with a sturdy base, long, slender, tapering, and generally present on actinal surface of plate. Spines along lateral plate edges often corresponding with and sometimes meeting spines from opposite plates, barely constituting pedicellariae.

Oral plates rather damaged; central unpaired spine longer, quite broad, round-tipped; furrow spines 6 or 7, possibly 8; subambulacral spines in 2 or 3 rows larger, round-tipped, sturdier than furrow spines. Membranous area between 2 plates in an angle most obvious near actinal plates.

Ambulacral grooves narrow, almost obscured; *tubefeet* in 2 rows.

COLOUR: No colour notes of living material; dried, ex-ethanol, light brown.

REMARKS: Differences between *Paragonaster ridgwayi* and *P. stenostichus* are discussed under *P. ridgwayi*. Both the present species are similar in having the single series of median abactinal plates that separate the superomarginal plates wider than long.

The present specimen of *P. stenostichus* differs from that described by Fisher (1919: 235) in lacking the fasciolate pedicellariae near the base of the oral plates and more numerous and possibly smaller granules on the marginal plates.

? ***Paragonaster*** sp. (Pl. 24)

MATERIAL EXAMINED: NZOI Stn U195(1).

SIZE: R / r = 12 / 5 mm.

DISTRIBUTION: New Caledonian Basin, northwest of New Zealand.

DEPTH: 2930 m.

DESCRIPTION: In this single small specimen, R / r = 12 / 5 mm, the 5 *arms* are very distinct from disc; disc large in relation to arms, well defined by raised, regularly arranged superomarginal plates. Arms tapering rapidly, smoothly, to tip; 2 arm tips broken; in other 3, terminal plates large, almost heart-shaped, faint round scars at free edge suggesting presence, originally, of 2 enlarged spines. Small granules, similar to those of adjacent superomarginals, in regular rows on all 3 existing terminal plates and small, faint circular scars, suggesting terminal plates were once covered in regular rows of small granules.

Abactinal plate outlines difficult to determine, as specimen more or less caked in fine mud, not removed by soaking. Abactinal plates bearing small, oval to round, sometimes almost square, similar-sized granules; these narrowly separated from each other, probably finely thorny and forming fairly regular rows on plates. There are 5 groups of large, bare *radial plates* on disc, near entrance to arms. Each group of plates consists of 1–3, or 4, conspicuous, tumid, naked plates; a fringe of granules, at plate base suggests plates once covered in small granules similar to those of neighbouring plates; plates lobed basally. Abactinal plates as a single series of probably almost square plates along arms to terminal plate; these small plates have granules similar to those of larger plates.

Papulae 4-6, between lobes at base of conspicuous naked radial plates; elsewhere, papulae hidden; exact extent of papulae difficult to determine.

Pedicellariae, madreporite, and *anus* not seen.

Superomarginal plates rectangular, gently tumid, forming a distinct very regular edge to disc and arms. Plates distinctly edged with round, spaced granules (very short spines) similar to those already described; many granules lost, faint regular scars remain. There were probably no enlarged granules or spines. Eight or 9 plates present from interradial angle to arm tip.

Inferomarginals corresponding with superomarginals, forrning conspicuous edge to actinal surface. Inferomarginal plates not visible from abactinal surface, with spaced granules (many fallen) or, perhaps, very short spines in regular rows; none of these granules enlarged; however, granules often larger than those of superomarginal plates. Inferomarginal plates separated laterally, at least interradially, by distinct naked channels.

Actinal areas small, extending along arm to level of second inferomarginal plate (4th or 5th adambulacral plate). Outlines of actinal plates obscured by small spines or granules similar to those of inferomarginals. No conspicuously enlarged spines present, no pedcellariae.

Adambulacral plates with rounded furrow margin proximally, distally margin less rounded, sometimes almost straight, adambulacral plates from opposite sides almost meeting across furrow. Proximally furrow spines 4, often 5, distally 6 spines not uncommon. Spines of similar size well separated; each plate with a fringe, laterally of 3 or 4 short, blunt-tipped spines or granules, 1 or 2 similar-sized spines may be central on plate and actinal plate edges may also be fringed by granules.

Oral plates raised, conspicuous, furrow spines damaged, exact number and arrangement of spines difficult to determine; an unpaired central spine, common to 2 plates in an angle, appears to be present, and there were probably 6 or 7 small lateral furrow spines. Although actinal surface of plates is largely bare, occasional small spines are present.

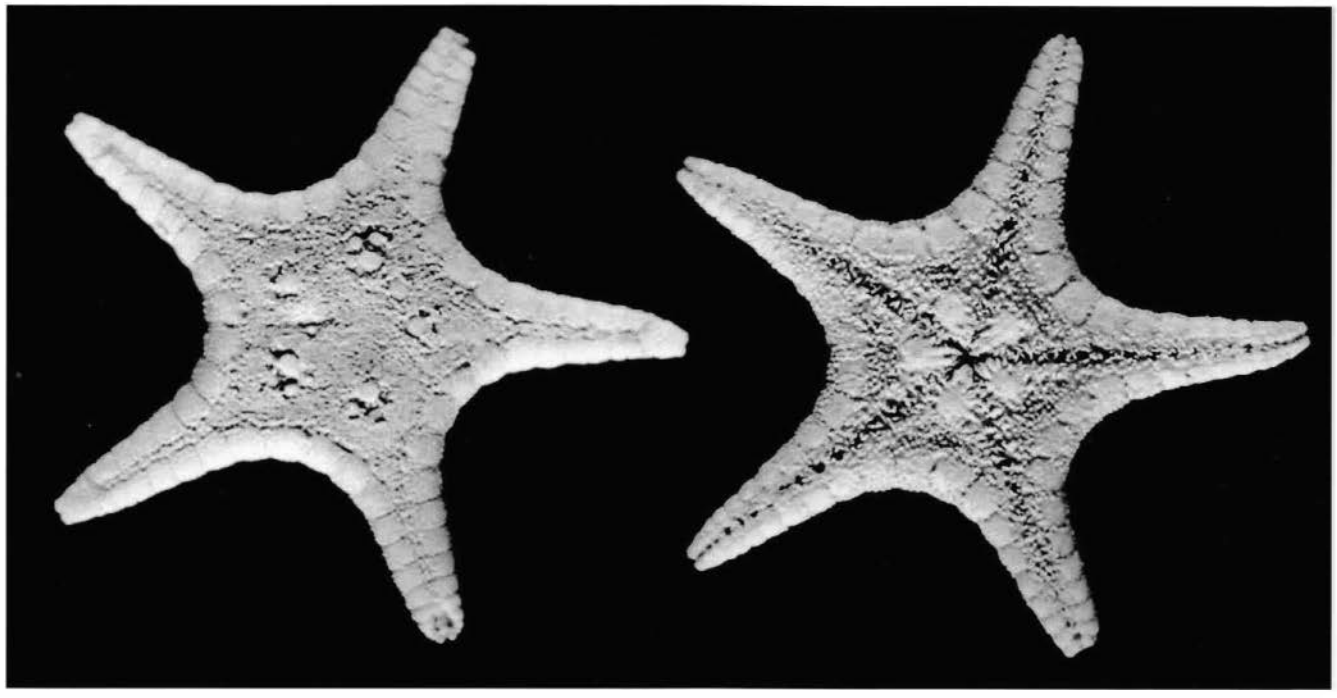


Plate 24. ***Paragonaster*** sp. NZOI Stn U195. R/r = 12/5 mm. Abactinal and actinal surfaces.

Ambulacral grooves narrow; *tubefeet* more or less obscured by furrow spines.

COLOUR: No colour notes of living specimen; dried, from preservative, fawn to light brown.

REMARKS: The presence of a row of abactinal plates to arm tips, separating superomarginals from opposite sides of the arm, is characteristic of *Paragonaster*, as is the probable unpaired oral spine.

This is possibly a small specimen of *Paragonaster ridgwayi* McKnight in which the enlarged spines of inferomarginal and actinal plates have not yet differentiated.

Pentagonaster Gray, 1840

Arms generally 5, short, well defined. Abactinal, marginal, and actinal plates flat or sometimes distinctly tumid, bordered by a single series of granules or very small plates. Marginal plates prominent, generally in pairs, often enlarged at arm tips. Actinal plates numerous, more or less regularly arranged, and may bear 1–4 jawed pedicellariae; jaws generally long and slender with 1, 2 or 3 small terminal teeth. Pedicellariae alveolate and housed in shallow pits; rarely present abactinally. Adambulacral plates distinct; furrow and subambulacral spines few (1-3), these short, thick and generally crowded. Oral plates small with short, thick, blunt spines.

TYPE SPECIES: *Pentagonaster pulchellus* Gray, 1840.

TYPE LOCALITY: "China" (Gray 1840: 280).

REMARKS: There are no other records of this species from Chinese waters; Mortensen (1925: 285) suggested that the type material was from New Zealand.

DISTRIBUTION: The species is probably restricted to New Zealand waters although Tenison-Woods (1879: 91) recorded it in his "List of Australian Starfishes" from the "New South Wales coast, Tasmania, and New Zealand"; perhaps he was mistaken. H.L. Clark (1946: 88) recorded two species of *Pentagonaster* from Australian waters, *P. dubeni* Gray, 1847 and *P. crassimanus* (Möbius, 1859); Rowe and Gates (1995: 67) included only *P. dubeni* (with *P. crassimanum* and *P. stibarus* H.L. Clark, 1914 as synonyms); there is no mention of *P. pulchellus* from Australian waters.

Pentagonaster pulchellus Gray, 1840

(Frontis, Pl. 25, Fig. 28)

Pentagonaster pulchellus Gray, 1840: 280; 1866: 11, pl. 8(3); Hutton 1872: 8; Perrier 1875: 18; Benham 1909a: 93; Mortensen 1925: 281, pl. 12 (6-10); Farquhar 1927: 237; Young 1929: 159; Fell 1947: 21; 1952: 8; 1958: 12; 1959: 136, fig. 20; 1960: 56; 1962: 31, fig.; A.M. Clark 1953: 396, text-fig. 13a, pl. 42; Powell 1959: 9, fig. 20; McKnight 1967: 300; H.E.S. Clark 1970: 3; Fenwick & Horning 1980: 439; A.M. Clark 1993: 274.

Astrogonium pulchellum: Muller & Troschel 1842: 55; Sladen 1889: 748; Farquhar 1895: 200; 1898a: 310.
Stephanaster elegans Ayres, 1851: 118.
Pentagonaster abnormalis Gray, 1866: 11, pl. 8(1, 2); Benham 1909a: 93, pl. 8(5).
Pentagonaster (Dorigona) pulchellus: Tenison-Woods 1879: 91, (28).
Astrogonium abnormale: Farquhar 1898a: 310.

MATERIAL EXAMINED:

NZOI Stns: B197(1), B218(1), B220(4), B224(1), B225(1), B230(1), B233(1), B241(1), B260(1), B264(2), B267(2)*, B270(2), B272(1), B568(1), D273(1), D595(1)*, E833(3), G161(3), G672 (1), G673(2), G684(1), G685(9), G691(5), G695(11), G707(5), H917(1)*, J122(13), Q41(3), Q91(1), Q93B(3), Q99(1), Q102(1)*, Q107(2), Q118(2), S247(1), S251(1), T459(2), T754(4).

NMNZ: Chatham Islands: Ech. 3872(1), 4646(1), 5305(1), 6545(1), 6638(2), 6642(1), 6651(3), 6654(2), 6659(2); Cook Strait (including Wellington, Kapiti Island, Cape Palliser, etc.): Ech. 29(1), 30(1), 37(4), 87(1), 180(2), 181(1), 185(1), 621(1), 769(1), 1051(3), 1614(1), 1615(1), 1618(1), 1619(1), 1620(1), 1622(1), 1623(1), 1624(1), 3439(1), 4642(1), 4645(1), 7342(1); near Dunedin: Ech. 7323(4); Fiordland: Ech. 1188(1), 7379(1); Foveaux Strait: Ech. 183(2), 184(4), 545(1), 917(6), 918(11), 5312(14); Hawke Bay: Ech. 653(2); Kaipara Harbour: Ech. 1272(1); Marlborough Sounds (Tasman Bay, Durville Island, etc.): Ech. 179(1), 858(2), 957(2), 4638(3), 4639(8), 4640(3), "New Zealand": Ech. 91(2); Otago: Ech. 511(6), 580(1), 760(3), 1612(7), 2406(4), 4646(1), 4647(4), 4648(3), 4649(1), 5297(2), 5298(2), 5299(14), 5300(2), 5301(1), 5302(1), 5303(1), 5304(1), 5306(2), 5307(3), 5308(1), 5309(13), 5310(1), 5522(1), 6504(4), 7305(3), 7318(1), 7324(4); Snares Islands: Ech. 643(1), 4644(1), 6883(1); Stewart Island: Ech. 182(1), 1273(1), 1274(2), 1613(3), 1705 (1), 4636(1), 4637(2), 5311(15), 6440(1), 6447(2), 6881(2), 6882 (1), 7148(2); Auckland Is: Ech. 161(1).

SIZE: R varies between 67 and 8 mm, r varies between 44 and 5 mm, (average for 104 specimens R/r = 33/19 mm).

DISTRIBUTION: Known from north of Auckland (one record) to about 48°S, (Snares Islands); common in Cook Strait and the east coast of South Island, from Otago south to Foveaux Strait and Stewart Island; it is also recorded from the Chatham Islands.

DEPTH: 0–215 m (especially 0 to 50 m).

DESCRIPTION: Specimen from west coast of South Island, New Zealand (NZOI Stn 247), is described: R/r = 43/25 mm.

Arms 5, distinct, tapering to rounded, well-defined tips. *Disc* and arms more or less flat, arm tips protected by a pair of rounded, conspicuous superomarginal plates; actual apical plate very small, oval to almost triangular, strongly tumid, naked, sandwiched between conspicuous superomarginal plates, bordered by granules. *Abactinal surface* paved by flat, round, oval, slightly angular or irregularly shaped plates; there is a marked carinal series of more conspicuous plates, and a circle of similar plates at disc centre. Latter plates surrounding a central oval plate. Plates completely naked apart from a fine freckling of tiny hyaline bosses and a distinct collar of small, more or less upright, spaced, oval to square or rectangular granules or small plates; several of these may be enlarged.

Papulae widespread abactinally between plates; 4–6 or 7 surrounding each plate; most conspicuous radially.

No abactinal *pedicellariae*.

Madreporite almost square, interradial, slightly nearer centre than disc edge; finely, deeply dissected, fringed by a very regular border of slightly larger granules.

Marginal plates conspicuous; inferomarginals corresponding to superomarginals, but not very obvious from upper (abactinal) surface. Superomarginal plates distinctly tumid, naked, fringed by small granules similar to those of abactinal plates; granules slightly larger laterally.

Inferomarginals of similar size, naked, corresponding exactly with superomarginals; inferomarginals most obvious from actinal surface. Enlarged terminal inferomarginal plate corresponding exactly with similarly enlarged superomarginal plate; beyond these 2 plates the inferomarginal series continues with 3 small plates; the first is dramatically small, and 2nd and 3rd very small indeed; these 2 additional inferomarginal plates curve sharply upwards; no corresponding superomarginal plates.

Actinal interradial areas closely paved with oblong, oval or irregularly shaped plates; these fairly regularly arranged, especially near margins, fringed by granules. No spines present, however some plates may bear a single small bivalved (occasionally trivalved) *pedicellaria* with long, slender blades and often 2 large, distinct teeth; when not upright, blades fit in slender depressions on plate surface.

Adambulacral plates forming a very regular straight edge to groove; plates rectangular or wedge-shaped, well separated laterally from each other. Furrow spines 2, (3 on first 1 or 2 most proximal plates), sturdy, round-tipped, set at slight angle to each other; subambulacral spines in pairs, conspicuous, wedge-shaped, smaller near actinal plates; near arm tips distalmost row of subambulacral granules (nearest actinal plates) may bear 1 very enlarged round or slightly angular granule or short, squat spine; distalmost furrow spine similarly enlarged.

Oral plates small, with sturdy wedge- or triangle-shaped spines. Limits of oral plates difficult to determine; at least 2, probably 4 oral furrow spines and generally 2 pairs of suboral spines.

Ambulacral grooves deep, narrow, often almost

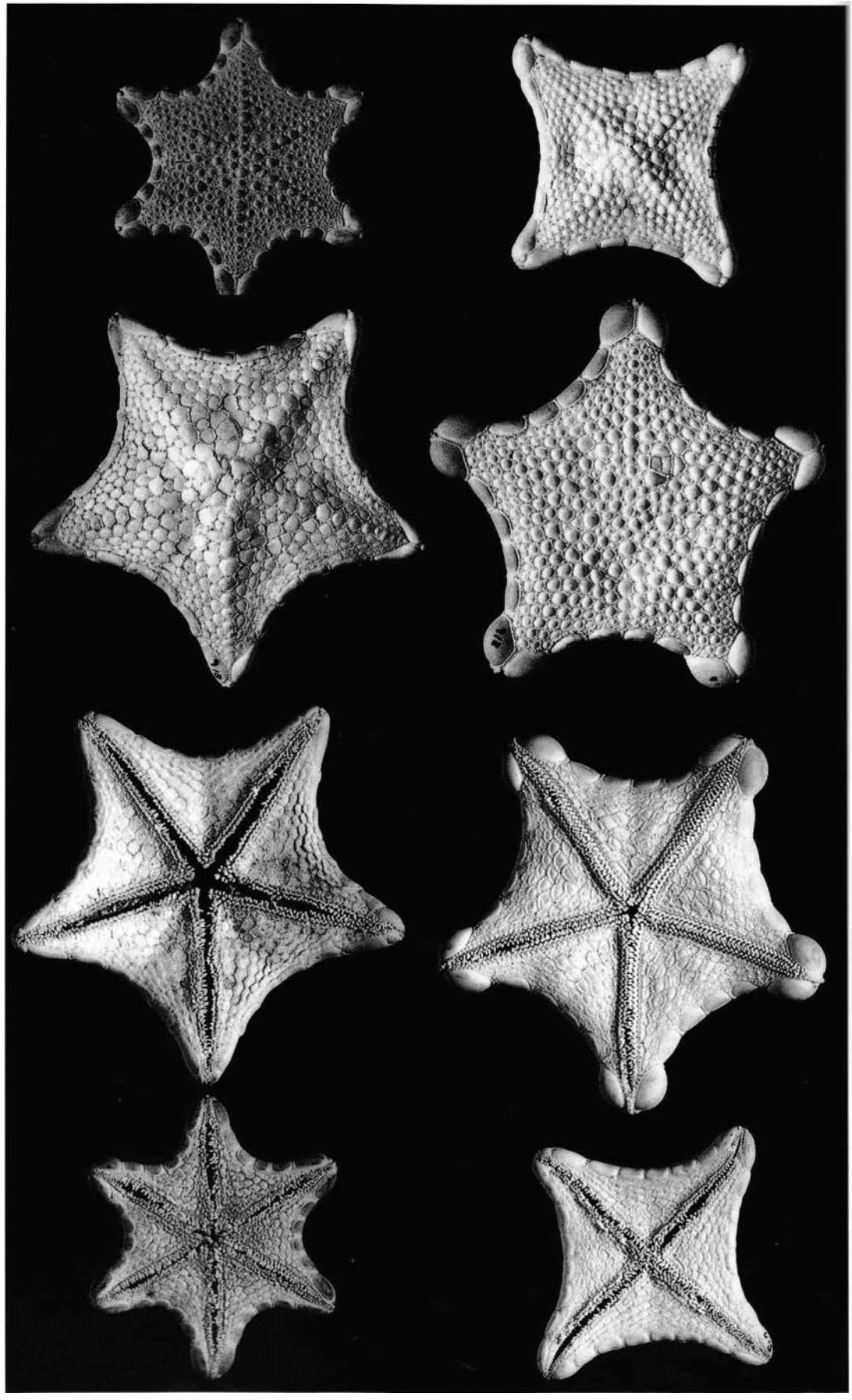


Plate 25.
Pentagonaster pulchellus Gray.
4-, 5-, and 6-armed specimens from New Zealand waters. Note in 5-armed specimens, the difference in size and shape of terminal arm plates. Abactinal and actinal surfaces.

obscured by adambulacral furrow spines; *tubefeet* regularly biserial with distinct sucking discs.

COLOUR: In life, often brown, sometimes red, orange, yellow, even grey or purple; in a dried state, brown, fawn, or yellow.

REMARKS: This species is very variable. Earlier workers recognised two species, *P. pulchellus* and *P. abnormalis*, based on the appearance of the enlarged marginal plates at the arm tips. Perrier (1876) and Mortensen (1925) however, regarded *P. abnormalis* as a synonym of *P. pulchellus*; subsequent workers, including the present author, accepts this. The enlarged superomarginal plates at the arm tip may be squat and tumid, or slender, long, and not especially noticeable; all degrees are present in a large series, such as the 300 or more specimens examined here. However, if terminal plates are swollen, large, and distinct, this condition is present in all five arms; there is no change in plate size in any one animal.

Most specimens have five *arms*, however, four- and six-armed animals are recorded especially from the Foveaux Strait area; these have, respectively, four or six ambulacral grooves.

Generally, there are four pairs of *marginal plates* in an interradial angle; in larger specimens, however, small accessory plates may be present, especially near the large plates at arm tips. Additional plates are most obvious between and above superomarginal plates. Where injuries and breakage have occurred, a jumble of small plates may result, and sometimes six or seven pairs of marginal plates are present in an interradius. Most marginal plates are naked (apart from bordering granules), smooth, often tumid; in only one specimen (from Foveaux Strait) is there a distinct pedicellaria present on a superomarginal plate immediately adjacent to the enlarged plates. The *madreporite* is generally triangular; less commonly it is oblong or almost square; often perforated, especially marginally, by one or two small, circular, very regular holes of unknown etiology.

In many specimens the small hyaline (glassy) *spots* or *bosses* of the abactinal plates are conspicuous (they may even be present on marginal plates), in others they are very few or may be absent altogether.

The continuation, with three further small plates, of the *inferomarginal series*, after the enlarged plate is of interest; it is present, although difficult to see, in all specimens. There are no corresponding superomarginal plates; Mortensen (1925: 284) commented on this, saying "on the point of the arms are found a very small terminal plate and one or two pairs of very small plates, evidently representing an outer pair of marginal plates."

The *adambulacral* armature is fairly constant with, on the first one or two plates, three furrow spines; after this there are regularly two spines and the plates (when denuded) are seen to be separated laterally from one another by a distinct gap. Similarly, there are generally four oral furrow spines, occasionally three, or exceptionally two. Pedicellariae generally with two jaws, sometimes three are found actinally near oral and inferomarginal plates but they may be scattered over the entire actinal area; abactinal pedicellariae are rare but sometimes occur near and even on marginal plates as recorded earlier.

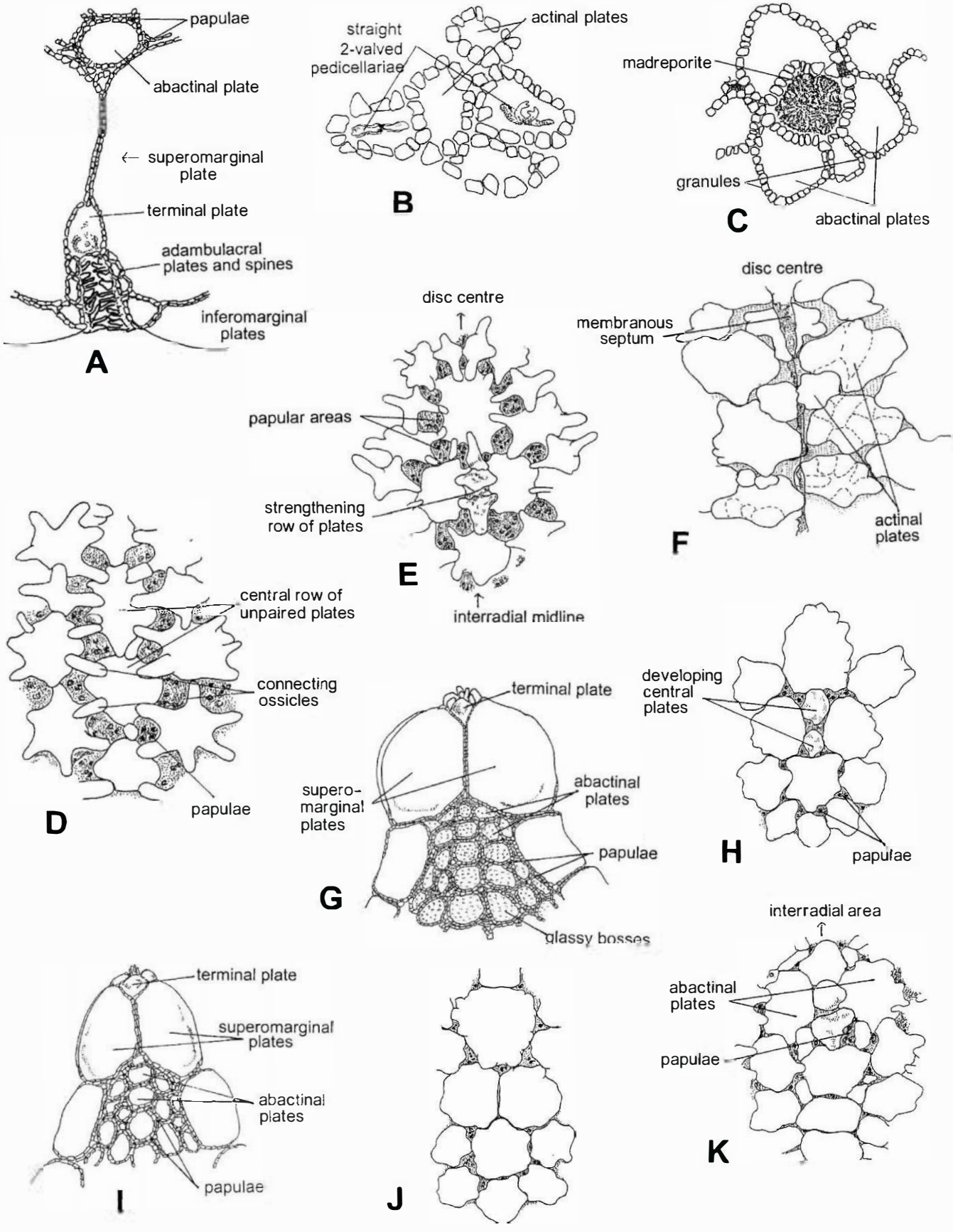
Ayres (1851 : 119) recorded his specimen (undoubtedly *Pentagonaster*) from "Patangaroa, New Zealand", an untraceable place name. Ayres remarked that his specimen "displays much beauty of form and structure, and probably also during life of colour" which was why he proposed *elegans* as a specific name.

A.M. Clark (1953: 398) had some interesting remarks to make; she suggested that some of the specimens of *Pentagonaster pulchellus* in the British Museum recorded from "India" and "China" were so labelled by vendors who hoped that an exotic locality would hasten their sale. A.M. Clark (ibid.) also remarked on the continuation, as very small plates, of the inferomarginal series.

Dissection of a large specimen (R/r = 48/29 mm, NZOI Q93B: 46°03′ S, 166°47′ E, south of Puysegur Point, southern South Island) was of interest; there are no superambulacral plates, ampullae of tubefeet are double; and gonads are small and attached on either side of the interradial septum; it is not possible to see where they open.

Arrangement of abactinal plates as seen from the coelomic side shows an unpaired radial (carinal) row of tumid, round or oval gently lobed plates flanked by similar plates that differ in having distinct finger-like lobes, generally six, sometimes four; often the tips of these lobes appear fractured; there may be a distinct break. Plates form a strong skeleton; papulae are present in interstices. Interradially, in the midline, there is a single row of plates; midway between the edge and centre of the disc is a pair of lobed plates; superimposed on these is a curious collection of plates. The lower unpaired plate is almost cross-like, it is capped by an oval, sometimes gently lobed plate that in turn supports a hastate plate — the interradial septum is attached along this midline.

Dissection of other specimens confirmed this collection of plates. In a small (R/r = 28/15 mm) specimen from north of Dunedin, South Island (NZOI Stn G672, 45°20′ S, 170°57′ E), two more or less oval plates are present between a pair of plates, very similar to those already described. A similar-sized specimen (R/r = 27/17 mm, NZOI Stn G685,45°53′ S, 170°48′ E, south of Dunedin) showed no development of this central group of interradial plates. However, a larger specimen (R/r



= 46/25 mm, NZOI Stn G161 42°48′ S, 173°28′ E, from north of Christchurch, South Island) shows these central plates well, and in addition there are also small, rect-angular or almost rod-like vertical plates, between adjacent plates.

Actinal plates from the coelomic side are irregularly oval or rectangular and often lobed; when dried, many of these plates are apparently divided by slender lines, giving a sort of crazy paving effect.

Philonaster Koehler, 1909

Disc flat, rather thin dorsoventrally; arms short, broad, not very distinct. Abactinally near terminal plate an unpaired oval or round, tumid, naked conspicuous plate edged by several rows of granules. Marginal plates distinct with conspicuous naked areas, bordered by granules; actinal areas large, conspicuous. Abactinal paxillae bordered by well-defined, separate granules enclosing a number of similar, separate, gently tumid granules.

TYPE SPECIES: *Pentagonaster (Philonaster) mortenseni* Koehler, 1909.

TYPE LOCALITY: Andaman Sea, Bay of Bengal, 1756 m.

REMARKS: Koehler (1909: 74, pl. 4, (5, 6), pl. 9 (7)), described and illustrated *Pentagonaster (Philonaster) mortenseni* in detail; Fisher (1919: 260) remarked on its similarity to *Ceramaster arcticus* (Verrill, 1909), and (p. 257) to *C. smithi* Fisher (1913). A.M. Clark and Downey (1992: 231), A.M. Clark (1993: 249) and Rowe and Gates (1995: 64) regarded *Philonaster* as a synonym of *Ceramaster*.

DISTRIBUTION: Bay of Bengal, Indian Ocean, southern Australia and (this report), southeast of Christchurch, South Island, New Zealand.

Philonaster sp. (Pl. 26, Fig. 29)

MATERIAL EXAMINED: NZOI Stn Q343(1).

DISTRIBUTION: In New Zealand known only from south-east of Christchurch, South Island.

DEPTH: 500 m.

DESCRIPTION: Description is of the single, somewhat battered specimen, R/r = 54/30 mm, 24–26 superomarginal plates present from arm tip to arm tip.

Form more or less pentagonal, with short, broad, rapidly tapering arms; arm tips with hemispherical, tumid, naked terminal plates, fringed by small, square or rectangular, regularly arranged granules. At least 1, often 2 pairs of superomarginal plates from opposite sides of arms in contact before terminal plate; also in radial midline, a tumid, triangular or oval unpaired naked plate; obvious even to the naked eye, and ringed basally by a row of small, regularly arranged rect-angular to square plates or granules.

Abactinally, plates form fairly regular rows except interadially near marginal plates, where arrangement and shape of plates is somewhat confused. Plates tabulate, hexagonal, clearly defined, with 9–15 or 16 peripheral granules, and 2–4, sometimes 6 or 7, central granules. Central granules often rounded, sometimes angular, quadrate or triangular, well separated and generally projecting above peripheral granules; peripheral granules wedge-shaped, clearly defined, separate from one another, and forming very distinct edges to plates.

Papulae not obvious abactinally; however, seen from coelomic side, they show a regular arrangement at plate corners, 5 or 6 around each plate; papulae most obvious radially, few and indistinct interradially. No actinal papulae.

Pedicellariae present, 1, sometimes 2, either centrally on abactinal plate or at edge; leaving a distinctive round, oval, or rectangular pit when removed; the pit or hole often marked by a conspicuous small fold, or

Fig. 28 (opposite) ***Pentagonaster pulchellus*** Gray. **A-C**, NZOI Stn S247, R/r = 43/25 mm. **A.** Arm tip showing continuation of inferomarginal plates. **B.** Actinal plates near oral plates, two 2-jawed pedicellariae, one with blades upright. **C.** Madreporite and surrounding abactinal plates. **D-F**, NZOI Stn Q93B, R/r = 48/29 mm. **D.** Abactinal plates, radially, from coelomic side. Note the terminal arm plates, in this specimen large and swollen. **E.** Arrangement of abactinal plates, interradially, from coelomic side. Note that this specimen has very swollen superomarginal plates at arm tips. **F.** Actinal plates seen from coelomic side, interradially. Note the curious division of some actinal plates by faint lines. **G, H.** NZOI Stn G672, R/r = 28/15 mm. **G.** Arm tip. Note the large, swollen fused superomarginal plates and small tumid terminal plate. Papulae are not very obvious. **H.** Abactinal plates from coelomic side, interradially. Note the developing central plates. The specimen had swollen arm tips. **I, J.** NZOI Stn G685, R/r R/r = 27/17 mm. **I.** Arm tip; note the slender fused superomarginal plates and small tumid terminal plate. **J.** Abactinal plates from coelomic side. This specimen had slender terminal arm plates with no developing central plates. **K.** NZOI Stn G161, R/r = 46/25 mm. Arrangement of abactinal plates, interradially, from coelomic side. The specimen had long, slender superomarginal plates at arm tips.

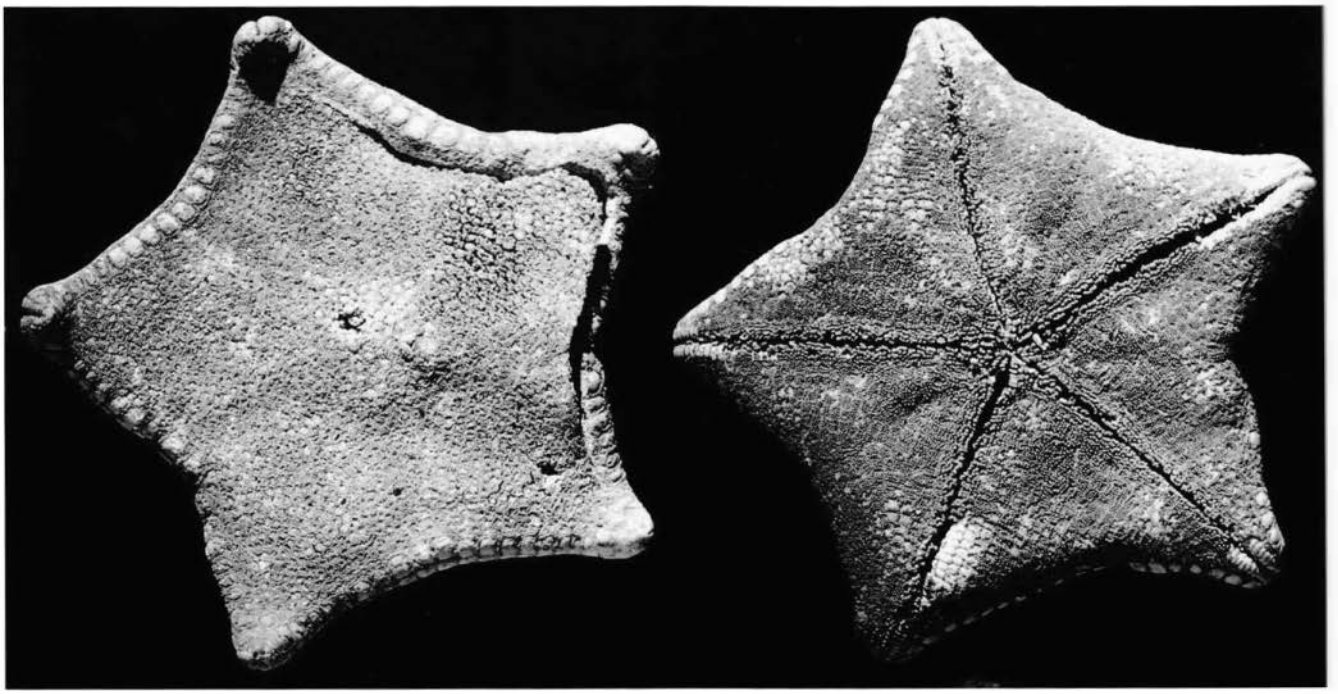


Plate 26. ***Philonaster*** sp. NZOI Stn Q343. R/ r = 54/30 mm. Abactinal and actinal surfaces.

collar, of membrane. Pedicellariae short, 2-valved, with an expanded base, a slight "waist" and broad, expanded, shell-like blades; these very finely thorny.

Madreporite conspicuous, close to disc centre, oval to hexagonal, intricately dissected; surrounding plates enlarged, conspicuous.

Anus not obvious.

Superomarginal plates 24–26, from arm tip to arm tip; plates rectangular, forming a definite if rather uneven edge to disc and arms, towards arm tips plates irregular in shape, rather distorted. Plates bordered, at least abactinally and laterally, by distinct, oblong, sometimes almost triangular or wedge-shaped granules; centrally on disc, plates edged by a single row of granules; towards arm tips, naked central bare area smaller, narrower, and bordering granules more conspicuous. These latter plates generally tumid with surface often eroded and scarred and occasional isolated granules; superomarginal plates largest interradially.

Inferomarginal plates corresponding with superomarginals, larger, more obvious; naked now, but possibly originally with a close covering of granules probably similar to those of superomarginal plates.

Actinal areas extensive, plates regularly arranged, especially near adambulacral and oral plates. Plates generally rectangular, with well defined margins; marginal granules rectangular or wedge-shaped. Centrally on plates, granules spaced, less regularly arranged, contours angular or rounded, often slightly tumid. Pedicellariae most obvious on plates bordering adambulacrals, generally only 1 to a plate; elsewhere actinal pedicellariae small, few.

Adambulacral plates regularly rectangular, outline distinct when clear of granules, forming a very definite border to grooves. Each plate with 3, sometimes 4 (especially proximally), short, sturdy, sometimes triangular, round-tipped, upright furrow spines. Furrow series separated from subambulacral armature by a distinct channel. Subambulacral armature with generally 2 rows of 3 short, thick-set, large-headed granules or short spines. Behind these are 2, or sometimes 3 rows of short, thick granules very similar to actinal granules.

Oral plates rather damaged but distinct, large, triangular, slightly irregular in outline, with a furrow series of 8 or 9 spines; spines slender, long, upright, almost wedge-shaped, especially distally; proximalmost spines more slender, slightly shorter. Suboral spines 6 or 7 in a row, spines rather heavier, longer, round-tipped, and grading distally to granules, similiar to those of neighbouring plates.

Ambulacral grooves narrow, deep, especially proximally and distally. *Tubefeet* regularly biserial, with distinct sucking discs.

COLOUR: No colour notes of the living animal; dried, ex alcohol, specimens are grey or white.

REMARKS: Koehler (1909) described *Pentagonaster (Philo-*

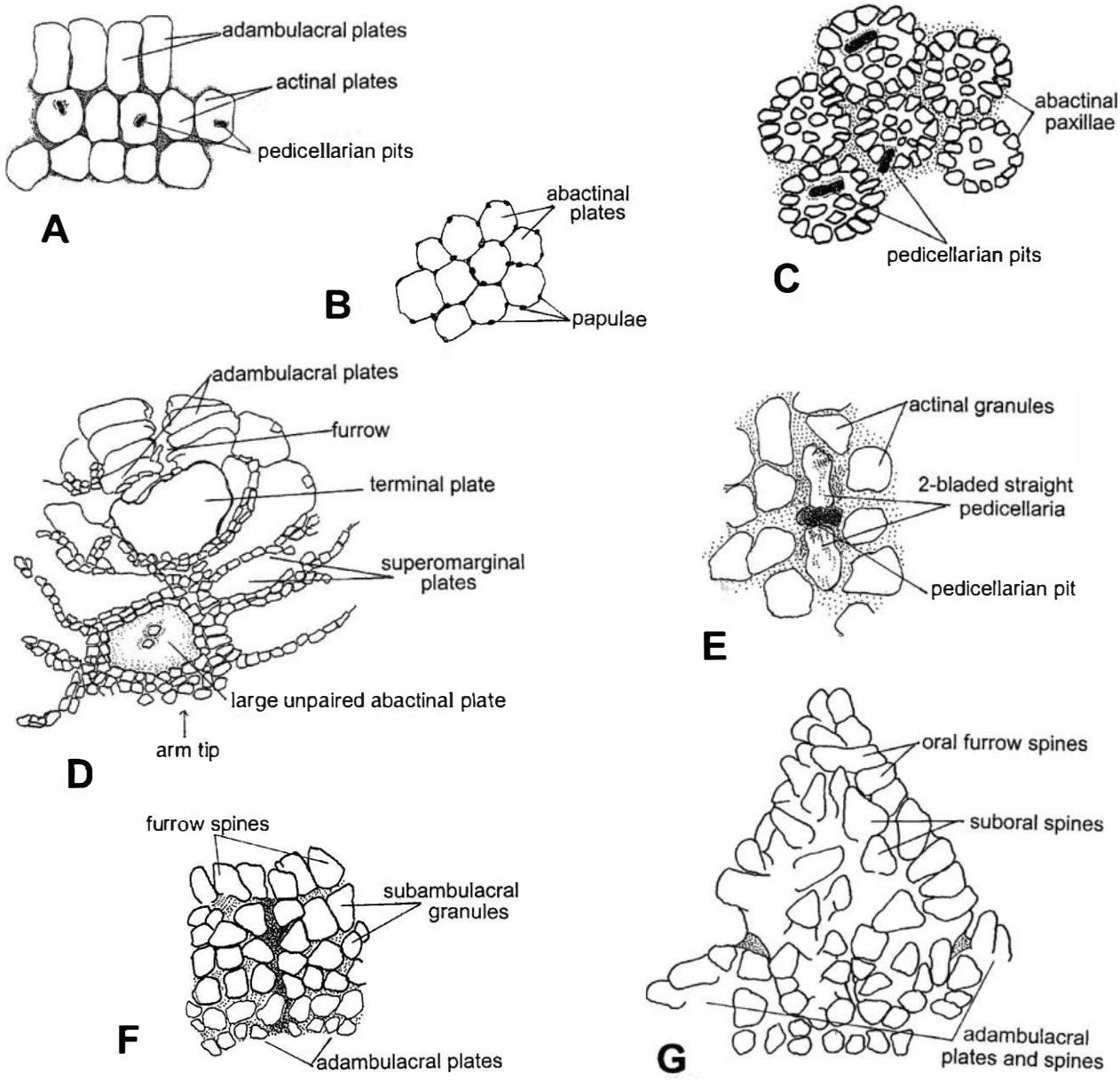


Fig. 29. ***Philonaster*** sp. **A**. Denuded adambulacral and actinal plates showing their arrangement. Note the pedicellarian pits. **B**. A group of abactinal plates with widespread papulae, centrally along arms, seen from coelomic side. C. Abactinal paxillae with pedicellarian pits. **D**. Arm tip. Note the terminal plate, superomarginal plates meeting centrally, and the solitary large tumid unpaired abactinal plate. E. Actinal surface showing straight two-bladed pedicellaria and surrounding actinal granules. **F**. Two adambulacral plates, outer half of arms. **G**. Oral plates and adambulacral plates.

naster) mortenseni from two specimens. The presence, at the arm tips, of a single, distinct plate is, in the author's opinion, unique, and it certainly warrants a new genus. Koehler (1909: 75) stated that in at least three arms in his larger specimen the terminal plates are misplaced and appear as the large (unpaired) oval and convex plate; in the present specimen there is both a terminal and a distinct bare plate present in all arms. It differs from Koehler's specimen of *Pentagonaster (Philonaster) mortenseni* in several respects. The smaller of Koehler's specimens is very similiar in size to the present specimen, although the R/ r ratio differs, and his animal seems to have had longer arms. Koehler's larger specimen shows a clearly defined centrodorsal and five interradial primary plates, not visible in the present specimen; this is a very variable characteristic anyway (as examination of a large number of the closely allied *Ceramaster patagonicus* shows). All specimens agree in having distinctly hexagonal abactinal plates. However, in the present material, the abactinal paxillae

have 3–5 central granules and 12–15 peripheral ones; Koehler recorded 1 or 2 central granules, and 6–8 marginals. Actinally, in the present specimen, granules are large, distinct, well separated; in Koehler's specimen granules were apparently fine and closely packed. In *Philonaster* sp., the marginal plates, and supero- and inferomarginals lie one above the other; in Koehler's specimen they tend to alternate. Likewise, the present specimen has three (occasionally four) adambulacral furrow spines of similiar size; Koehler recorded four, the first being considerably longer. Finally, the presence of numerous conspicuous pedicellariae is in direct contrast to Koehler's finding of very few.

Dissection showed no superambulacral plates, no secondary abactinal plates, and no slender connecting ossicles between actinal plates. Interradial septa are membranous and gonads occur in a single tuft interradially and probably open near superomarginal plates. Ampullae of tubefeet are double.

Pillsburiaster Halpern, 1970b

Abactinal plates tabulate, both primaries and secondaries covered with spaced, spherical granules. Subambulacral granules well separated from furrow spines, subambulacral armature not crowded. Papulae between primary and secondary plates especially distinct in young (small) specimens where papular areas are petaloid and very obvious.

TYPE SPECIES : *Pillsburiaster geographicus* Halpern.

TYPE LOCALITY: Northern Gulf of Guinea, West Africa, 1464-1986 m.

REMARKS: This is a widespread genus with at least five, possibly six, species; two are recorded from New Zealand waters.

DISTRIBUTION: The genus is known in the Atlantic Ocean from the Gulf of Guinea, in the Pacific from Hawaii and New Zealand, and in the Indian Ocean from near Ceylon and the Cocos Islands. It does not seem to have been recorded in Australian waters.

KEY TO NEW ZEALAND SPECIES OF *PILLSBURIASTER*

1 (4) No enlarged central granules on abactinal plates

2 (3) Outline pentagonal, 10-20 granules on primary abactinal plates ..... *aoteanus*

3 (2) Outline substellate, 9-13 granules on primary abactinal plates ..... *maini*

4 (1) One or more enlarged central granules on abactinal plates ..... *Pillsburiaster* sp.

Pillsburiaster aoteanus McKnight, 1973a

(Pl. 27, Fig. 30)

Pillsburiaster aoteanus McKnight, 1973a: 180, fig. 5; A.M. Clark 1993: 276.

Plinthaster singletoni McKnight, 1973a: 185, fig. 7; 1993a: 169, 185; A.M. Clark 1993: 277 [new synonymy].

MATERIAL EXAMINED:

NZOI Stns: D137(1), D211(2), E401(2), E404(1), F100(1)*, F104(8)*, F107(5), F135(1), F150(1)*, F151(1)*, F75(1), F763(1),G665(1), G666(2), G667(1), G700(1)*, G901(3), G904(1)*, G912 (2)*, G913(1)*, G916(1), G922(2)*, G923(4), H528(1), J481(1), J550(2), P120(2), R439(1), S14B(2), S16(2), S44(3), S148(3), S161 (1)*, S378(1), U197(6)*, U198(1), U569(1), U595(1), V375(1)*, Z8371(1), Z9793(1).

NMNZ: Campbell Island Rise: Ech. 7380(3); Cape Turnagain: Ech. 3900(1); Chatham Rise: Ech. 4179(1), 4650(1); near Christchurch: Ech. 4199(2); Clarence River mouth: Ech. 4651 (1), 4714(1); near Dunedin: Ech. 7373(1); Foveaux Strait: Ech. 2387(1), 3103(4); off Hawkes Bay: Ech. 6426(1), 6551(2), 6589 (1), 6590(1); Hikurangi Trench: Ech. 4180(1), 4181(1), 4188 (1), 4189(1), 4650(1), 4713(2), 5341(2); Pukaki Rise: Ech. 4715 (1); Taiaroa Trench: Ech. 2027(3), 2029(2); no station data, *Oyang* '86 trip 375: Ech. 5346(3), 6595(1), 6622(1), 6627(1), 7368 (1).

Eltanin Stn : near Cape Palliser: Stn 1403(1).

Auckland Museum: North Cape: AK 79702(1).

SIZE: R varies between 124 and 14 mm, r varies between 82 and 8 mm. Average R/r for 68 larger specimens 62/40 mm.

DISTRIBUTION: Most northerly record NZOI Stn U595 (30°S, 173°E), near the Three Kings Rise, north of North Cape, New Zealand, and from the Hawkes Bay area to south of Campbell Island, east to near Chatham Islands and west (NZOI Stn U198) to 162°E.

DEPTH: 120–1573 m (commonest between 400 and 800 m).

DESCRIPTION: Description of specimen from near Campbell Island Rise, 440 m, NZOI Stn G923, R/r = 60/41 mm.

Disc thick, more or less flat, well defined by superomarginal plates, gently raised radially and at arm tips. Abactinal plates, to arm tips, of 2 sizes, smaller (secondary) plates often surrounding larger (primary) ones. Plates raised, round, oval, or slightly angular, with distinct round granules, spaced, seldom in contact; when granules removed concave scars often present. Larger, more conspicuous radial (carinal) plates along midline of arms, forming intermittent, irregular, disrupted rows. *Arm tips* gently raised, adjacent abactinal plates forming a close mosaic. *Terminal plate* conspicuous, tumid, almost round, naked except for a stump of a single, probably large spine; in 1 arm tip, remains of 3

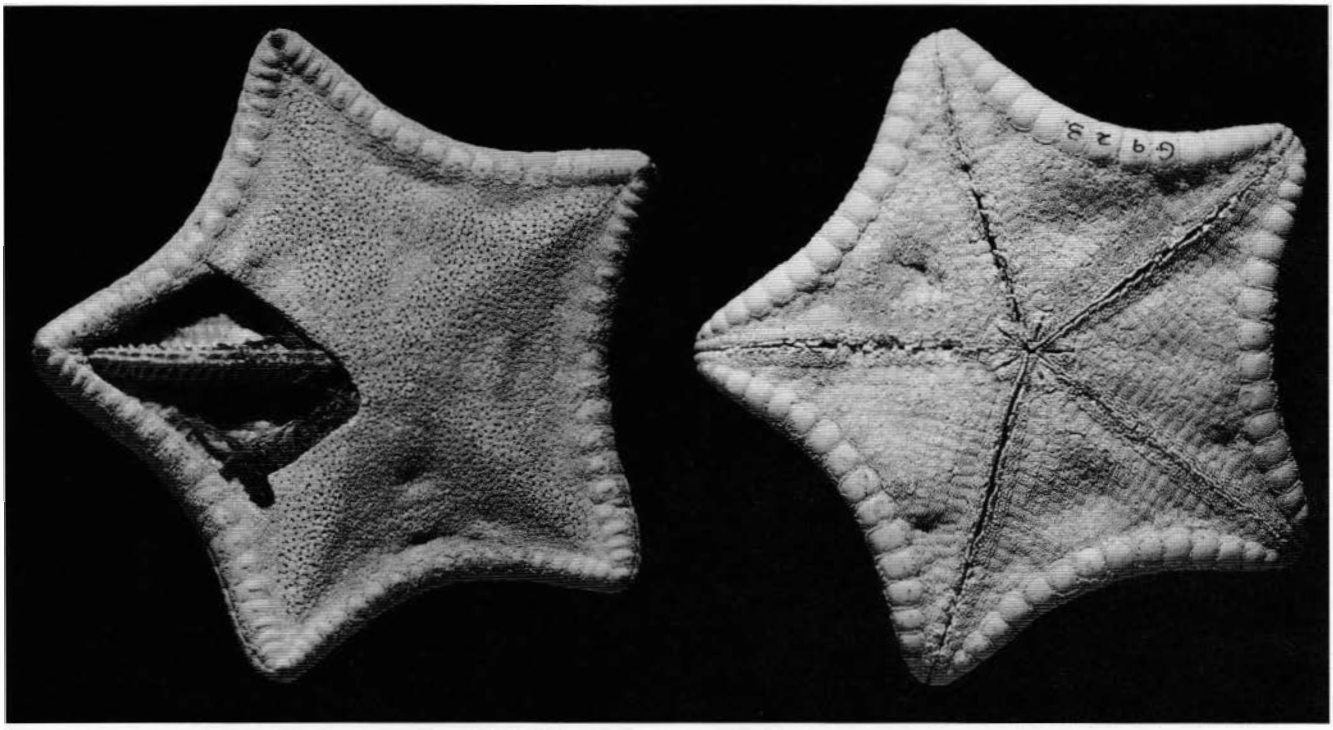


Plate 27. ***Pillsburiaster aoteanus*** McKnight. NZOI G923. R/r = 60/41 mm. Abactinal and actinal surfaces.

spines. Interradially, plates closer together, more compact, outlines indistinct, occasional pedicellariae, small, bivalved (in 1 case trivalved), generally on plate edge.

Papulae distinct, obvious, forming a petal-like area along each arm, generally 3 or 4 around each larger plate; papulae emerge from a distinct membrane-lined hole or pore, few or absent from small area at disc centre, a midinterradial strip, and from plates bordering superomarginals.

Pedicellariae few, small with slender, distinct stalkand smoothly rounded blades; most obvious interradially, pedicellariae generally bivalved, occasionally trivalved; on removal a distinct pit remains.

Madreporite small, pentagonal, interradial, nearer disc centre, finely and deeply dissected. Plates and granules at lower edge larger, tumid, more distinct. *Anus* not obvious.

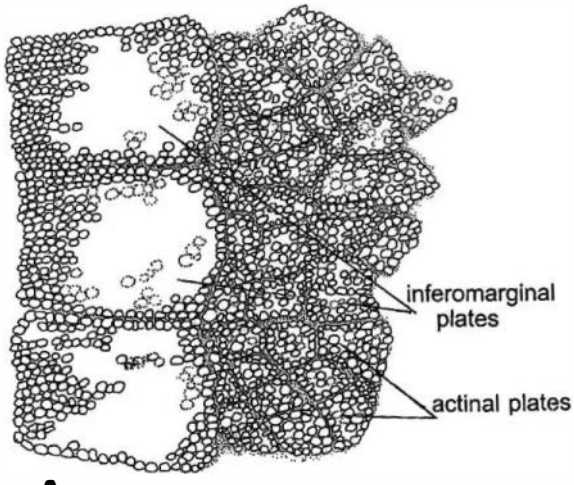
Superomarginal plates, 18 in each interradius, forming a conspicuous and slightly raised edge to disc and arms; plates with raised oval or oblong, naked central area; this most conspicuous on distal plates where it occupies most of plate; midradially, area small, poorly defined. Plates with small, often round, sometimes angular, isolated granules, most regularly arranged along plate edges as distinct rows.

Inferomarginals corresponding almost exactly to superomarginals. Plates well defined, especially obvious actinally, largely bare of granules, although pits suggest granules almost covered plates, and if a bare patch, probably small and actinal. Granules more regularly arranged, often slightly larger than on supero-marginal plates.

Actinal areas distinct, large, triangular, plates adjacent to adambulacrals rectangular, other plates square, irregular in shape and arrangement. Plates with distinct, round, isolated granules, along plate edges granules slightly smaller, very regularly arranged. No pedicellariae seen. Inferomarginal and adambulacral plates i contact for last quarter of arm.

Ambulacral plates rectangular, regularly arranged, quite conspicuous; furrow edge of plate, especially medianly and distally, curved, actinal edge straight. Furrow spines 5, sometimes 6 or 7, short, sturdy, untapering, flat-tipped, forming a conspicuous edge to furrow; proximal spines (nearest oral plate) sometimes distinctly shorter, often inset on plate. Anteriormost plates often with a single, small, bivalved pedicellaria. Actinal surface of plates with rounded or slightly angular spaced granules. A distinct, conspicuous gap between furrow spines and subambulacral armature.

Oral plates conspicuous, evenly raised, flat, triangular, with 8–10 furrow spines, these flattened, sturdy, untapering laterally, sometimes with distinct, almost angular upper edge. Two oral plates in an angle well separated medianly by broadly oval membranous area. Suboral granules in 2 well-defined rows, plate edges adjacent to actinal plates bordered by small granules. Anteriormost furrow spine slightly larger,



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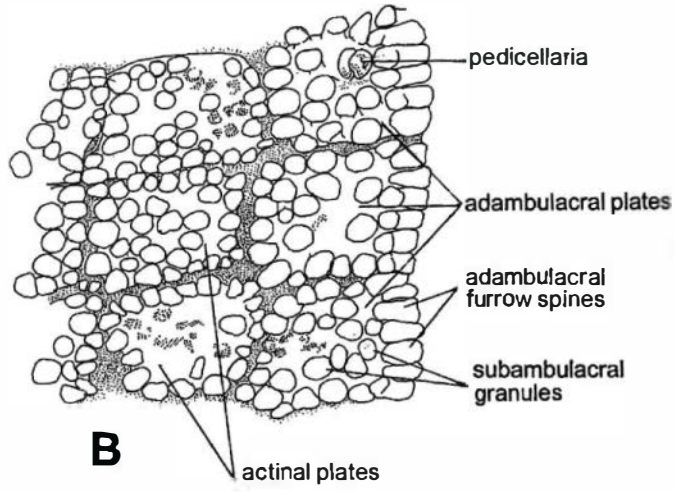

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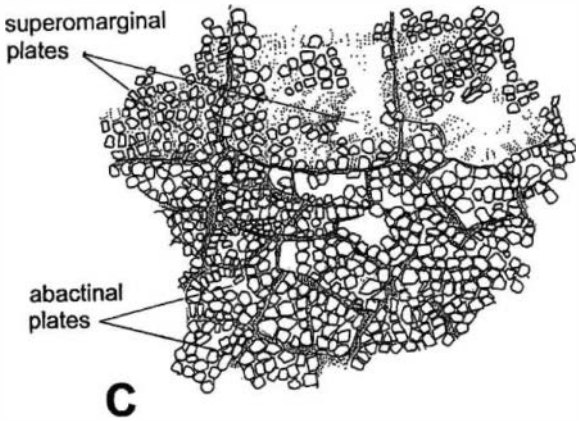

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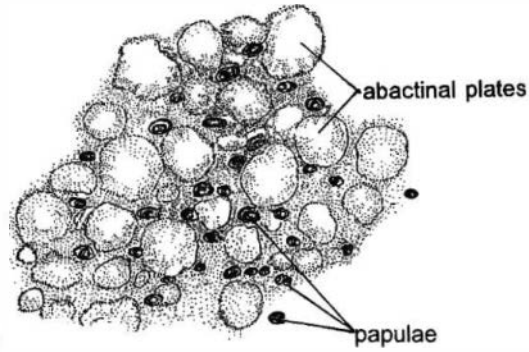

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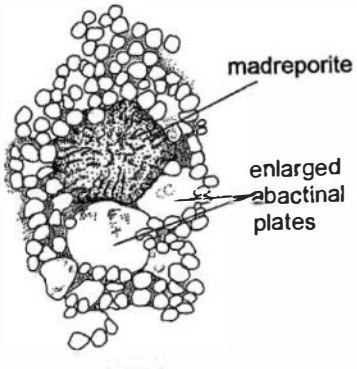

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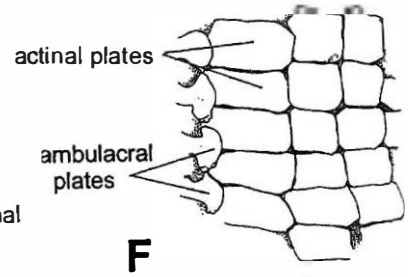

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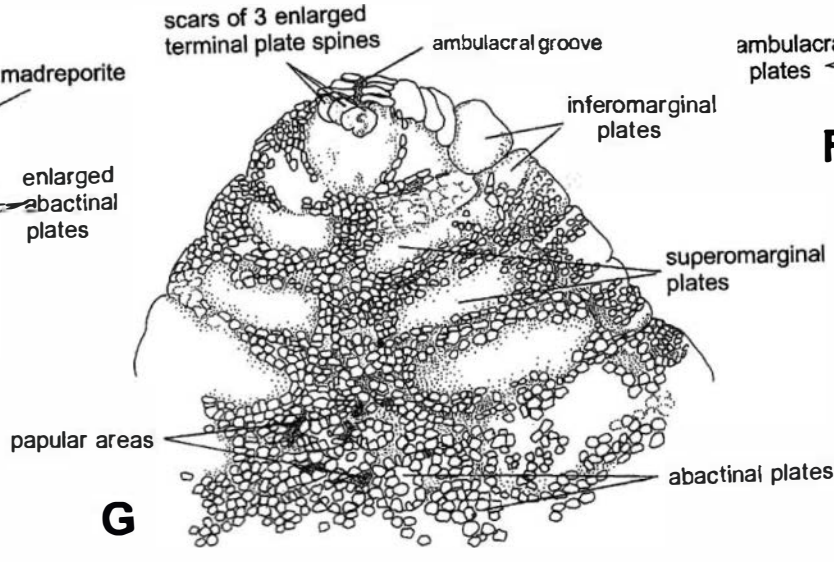

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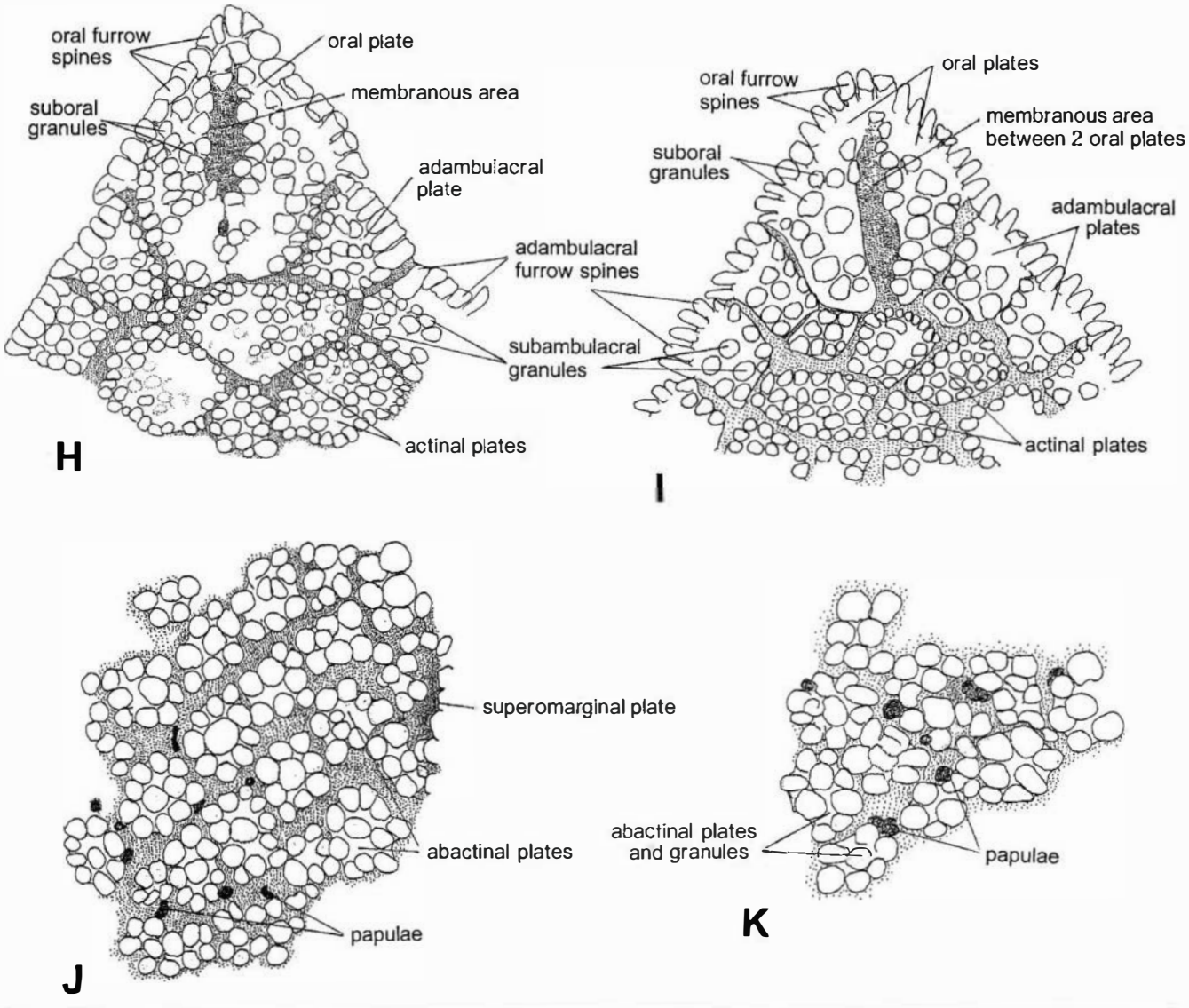


more angular than adjacent spines, likewise anterior-most subambulacral spine.

Ambulacral grooves narrow; *tubefeet* biserial with rather indistinct sucking discs.

COLOUR IN LIFE: No colour notes with this or other specimens. However, colour recorded for a deep-frozen specimen from 1100 m near Mahia Peninsula, North Island is "abactinally, orange, marginal plates also orange, slightly lighter; actinally, orange, with a few bleached patches near oral plates." Dried, ex-alcohol, uniform fawn or light brown, papulae distinctly darker.

Fig. 30 (opposite and above). ***Pillsburiaster aoteanus*** McKnight. **A**. Three inferomarginal plates and adjacent actinals at interradial angle. **B**. Three adambulacral plates and adjacent actinals from halfway along arm. Note the small straight pedicellaria. **C**. Superomarginal and adjacent abactinal plates near interradius. Note the distinct lines between plates but little actual space. Also there are no obvious papulae and the marginal granules on the plates are often larger than central granules. **D**. Abactinal plates and papulae from coelomic side. Note that there is a heavy enveloping membrane, hence no very definite plate outlines. **E**. Madreporite with enlarged abactinal plates. **F**. Actinal plates, midway along arm, from coelomic side. **G**. Arm tip with scars of three enlarged spines on terminal arm plate. Note the large papular areas between abactinal plates. [Page84] **H**. Oral plates and adjacent adambulacral and actinal plates. **I**. *Eltanin* Stn 1403, R/ r = 21 / 12 mm. Oral, adambulacral, and actinal plates. **J, K.** Auckland Museum Stn AK79702. **J**. Abactinal plates, interradially and near superomarginal plates. Note the regular arrangement of plates. **K**. Abactinal plates and papulae, radially, near arm base.

REMARKS: This species is extremely variable as examination of 99 specimens showed.

The extent of the *papular areas* and nature of the *papulae* is interesting. In large specimens papulae are widespread, although they are absent from a small interradial strip near the superomarginals. In the very large (R/r = 124/73 mm,) North Auckland specimen, papulae are especially conspicuous, stocking-like, slender, pointed, and very numerous; this condition is also noticeable in another large specimen (R/r about 100/80 mm, NMNZ Ech. 4189) from the Hikurangi Trench. The number of *pedicellariae* also varies, from none to very numerous, confined to interradial areas or most obvious and well developed on adambulacral plates. Generally pedicellariae have two blades, but three are not uncommon. One specimen only (NMNZ Ech. 2029, from the Taiaroa Trench, R/r = 57/34 mm) has pedicellariae on interradial superomarginal plates. The number of *marginal plates* in relation to the size of the animal, the density of granules, and the extent and tumidity of bare patches or their absence vary considerably. Smaller specimens have distinct bare patches on marginal plates, rare in large animals, and if granules have been lost, distinct scars are generally present. Large granules may or may not be conspicuous anteriorly on plates but this feature varies within and between specimens, regardless of size. Likewise, on the *adambu-lacral plates,* the smallest, most proximal furrow spine may be absent, and all spines of similiar size.

In small specimens there is often a well-defined and quite conspicuous terminal arm spine, generally worn and broken in large specimens. In very large specimens (e.g., the one from North Auckland) there is no clear-cut channel or area between adambulacral furrow spines and subambulacral spines; rather, the subambulacral granules are spread out across the plate. Similarly, not all specimens have enlarged subambulacral granules on plates near the arm tips.

There is also a difference in *disc* thickness, which in most specimens is relatively thin but may also be thick, heavy, and conspicuous.

In the specimen described (NZOI Stn G923), one arm and part of the disc was dissected; a thick, heavy membrane covers the abactinal plates but is less obvious over the actinal plates. These are very regularly arranged; ambulacral ossicles are steep, almost vertical, and there are no superambulacral ossicles. The interradial septa are thick and heavy, and gonads are not obvious. Partial (Fisher 1919: 297 called them accessory in *Pontioceramus*) curved septa are present, passing from the marginal plates to the actinal plates and are present at intervals from the large interradial septum to the arm tips. Abactinal plates and papulae are very distinct despite the heavy enveloping membrane; plates are tumid, primary plates are distinctly larger and more conspicuous, and papulae very obvious.

Notes on large specimen: AK 79702, Northland, North Cape, offshore, 446–471 m. R/r = 124/73 mm:

Disc distinctly raised radially, interradial areas flat, slightly sunken. Marginal plates very distinct, 2 arm tips broken. *Abactinal plates* similiar to those already described for specimen from Stn G923; no pedicellariae. *Papulae* (already discussed) very obvious, absent from a narrow strip adjacent to superomarginals; in each interradius, midway between disc centre and disc edge, a round ca. 10 mm patch without papulae; these also absent from small circular area at disc centre. *Madreporite* conspicuous, more or less pentagonal, situated almost midway between disc centre and marginal plates and raised above general plate level; surrounding plates, especially at lower edge, enlarged. *Anus* central on disc, slit-like, surrounded by a large number of disarranged granules. *Superomarginal plates* large, forming a conspicuous border to disc and arms, with a covering of fairly regularly arranged granules; small circular scars remaining after granules have fallen or been rubbed off; naturally bare patches probably not present. Injury near base of one arm has resulted in a jumble of irregularly sized and shaped plates, with 28–32 plates from arm tip to arm tip. *Inferomarginals* similar in size to superomarginals, corresponding with them; bare patches probably absent from these plates also. Covering of small, round regularly arranged granules similar to that of superomarginal plates. *Actinal areas* large, triangular, with close covering of plates; those bordering adambulacrals large, rectangular, regularly arranged. All plates with covering of spaced granules; no pedicellariae. *Adambulacral plates* large, rectangular, furrow edge straight, actinal edge angular. Furrow spines 5–8, very sturdy, thick, untapering, almost wedge-shaped, free end blunt, forming well-defined edge to groove, the anteriormost spine often distinctly smaller; subambulacral granules of similar size, in more or less regularly spaced rows, distinct gap or space between furrow series and subambulacral granules not obvious. No pedicellariae. *Oral plates* large, distinct, flat or gently tumid, with 12 or 13 thick, heavy, solid furrow spines, these blunt-tipped — either triangular, wedge-shaped or rectangular. Anteriormost spine largest. Suboral granules numerous, more or less regularly arranged, especially bordering membranous area between 2 plates in an angle. *Ambulacral grooves* narrow, deep; *tubefeet* biserial with small suckers.

Dissection of one arm and part of disc (AK 79702) showed an immensely thick enveloping membrane which hides contours of actinal and abactinal plates; partial (accessory) septa are present; interradially, septum is membranous but small and really only obvious near disc centre. Gonads are interradial in position, large, and attached by a mesentery to abactinal

plates; they possibly open dorsally nearer disc centre. Pyloric caeca short, occupying less than half arm length, gastric ligaments distinct, obvious, centrally fading from view at level of 5th or 6th (from centre of disc) ambulacral plate. Ampullae of tubefeet double, no superambulacral plates. Ambulacral plates steep, separated abactinally by distinct, broad, conspicuous muscles. Between some ambulacral plates laterally and near the conspicuous muscular areas are small pear or heart-shaped muscular (soft) areas not apparent in other dissected specimens.

Dissection of another large specimen (NZOI Stn Z8371: R/r = 106/70 mm, from near Hawke Bay), showed the arrangement of the *abactinal plates* (after treatment with NaOH solution), seen from the coelomic side to be particularly spectacular. *Abactinal plates* are really tumid and round, oval, almost heart-shaped; slightly larger plates especially along arm midline are surrounded by smaller plates. *Papulae* are also very conspicuous and are present as distinct pores between the abactinal plates; they are smaller and less conspicuous in a narrow band interradially near superomarginal plates.

Notes on small specimen: *Eltanin* Stn 1403, north of Cape Palliser, lower North Island, 946–1006 m. R/r = 21/12 mm.

Disc well defined by conspicuous marginals, rather flat, slightly raised radially and at disc centre. *Abactinal plates* round, oval or irregular in shape; small, secondary plates present between large plates. Plates with small round granules, central granules sometimes slightly larger, generally one or several, spaced or, more often, touching. Abactinal plates present to arm tips, outlines of distal plates not always clearly defined. *Papulae* very conspicuous, papularia well defined, petaloid, radial, on either side of conspicuous median row of plates, emerging from very distinct pores, long, slender, blunt tipped, absent from last half of arms. *Madreporite* 6-sided, coarsely dissected, interradial, midway between disc centre and arm edge; surrounding plates conspicuous. *Anus* central on disc, surrounded by 4 large plates and a number of small granules. *Marginal plates* forming conspicuous edge to disc and arms, 17 plates present from arm tip to arm tip. *Superomarginal plates* rectangular, tumid, plates with large central bare patch, bordered by a single row of granules. *Inferomarginal plates* corresponding with superomarginals, conspicuously naked on lower (actinal) surface, bordered laterally by a single row of granules. Granules of marginal plates similar to those of abactinal plates, in more or less ordered rows. Small gap laterally between granules of adjacent plates. *Actinal areas* well developed, more or less triangular. Plates square, rectangular, well defined especially near adambulacral plates, granules and their arrangement very similar to those of abactinal plates. *Adambulacral plates* almost square, forming very regular edge to furrow, well separated laterally from one another. Furrow spines 5 or 6, most anterior and sometimes most distal spines conspicuously smaller and sometimes inset on plate. Spines sturdy, spaced, non-tapering, blunt-tipped. Subambulacral granules very regularly arranged in generally 2 rows, with 2–4 granules, towards arm tips considerably fewer subambulacral granules and furrow spines, sometimes furrow spines well separated from subambulacral granules. *Oral plates* large, gently tumid, with 9 or 10 sturdy, well-spaced, blunt-tipped furrow spines, the anteriormost (overhanging mouth) distinctly larger, often broken, distalmost spine (adjacent to first adambulacral plate) smallest. Suboral granules in 2 or 3 fairly regular rows, small, round, separate and regularly arranged, well separated from furrow spines. Wide membranous (muscular) area separates 2 oral plates in an angle. Ambulacral grooves deep, narrow; *tubefeet* with small suckers, in 2 rows.

There are other young specimens in the collections, with R = 25–14 mm, r = 16–7 or 8 mm, collected in depths ranging from 593 to 999 m. In these, *superomarginal plates* from opposite sides of arm are generally separate to arm tips, there is a very definite, restricted petaloid area with conspicuous papulae, and there are 8–10, exceptionally 13, or more oral furrow spines; the number of adambulacral furrow spines (4, 5, occasionally 6) is very constant.

McKnight (1973a:185) described a number of small specimens as a new species of *Plinthaster*, *P. singletoni*, from New Zealand waters. The large number of specimens now in the collection suggests that the specimens described as *Plinthaster singletoni* are, in fact young specimens of *Pillsburiaster aoteanus*. In these young specimens the most conspicuous feature is the well marked and distinctly petaloid papular areas; in larger specimens although papular areas are less obvious, they show great variation in their extent. *Plinthaster* is distinguished particularly in having distinct glassy bosses on the plate centres, absent in the present specimens.

Pillsburiaster maini McKnight, 1973a (Pl. 28, Fig. 31)

Pillsburiaster maini McKnight, 1973a: 183, fig. 6; A.M. Clark 1993: 276.

MATERIAL EXAMINED: NZOI Stn J42 (1) (holotype H-164).

Size: R/r = 41/18 mm.

DISTRIBUTION: Known only from off the west coast of the North Island, New Zealand, near the Challenger Plateau.

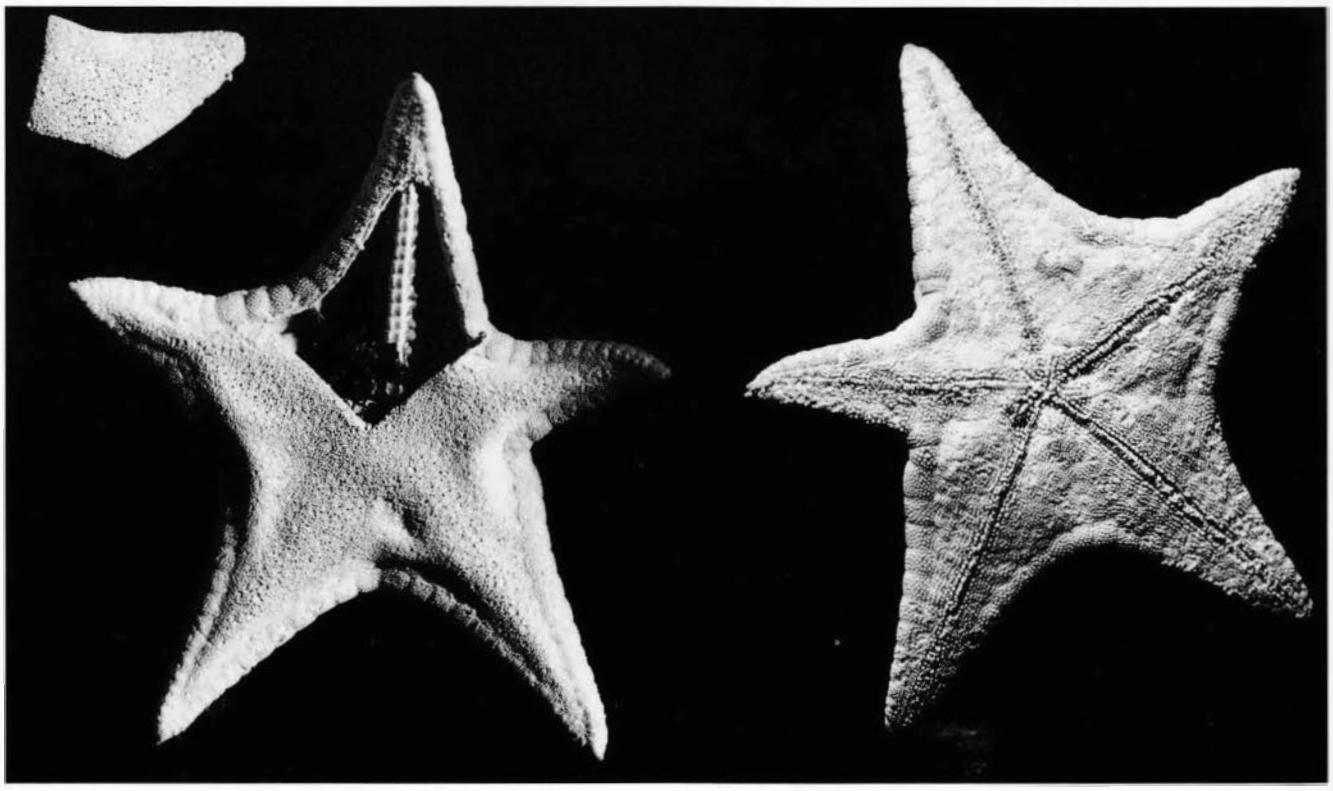


Plate 28. ***Pillsburiaster maini*** McKnight. Holotype. NZOI Stn J42. R/r = 41/18 mm. Abactinal and actinal surfaces.

DEPTH: 1996-2008 m.

DESCRIPTION: The holotype, the only specimen, R/r = 41/18 mm, is described.

Three (of the 5) arms long, broad basally, rapidly and evenly tapering to sharp tips, 2 arms also tapering, considerably shorter, regenerating, with confusion of superomarginal plates near arm base.

Disc large, abactinal plates rising steeply from margin, levelling out to flat surface. Arm tips with well-developed pyramidal or conical apical plates, bearing 1 (on one arm tip 2) very sturdy, round, apical spine; spines broken on all plates.

Abactinal plates flat or gently rounded, in outline round, oval, almost triangular, of 2 sizes. Smaller, secondary plates with 2–5 small, round granules; on larger plates 1 granule, sometimes 2 or 3, central and ringed by other granules. Some plates with small, generally marginal 2-valved pedicellariae; pedicellariae with short, rather thick stalks, and slender, sometimes slightly expanded blades; these generally as long as or longer than stalk of pedicellaria; no obvious pit on plate into which valves fit.

Pedicellariae well defined, sparse, present on disc and arms.

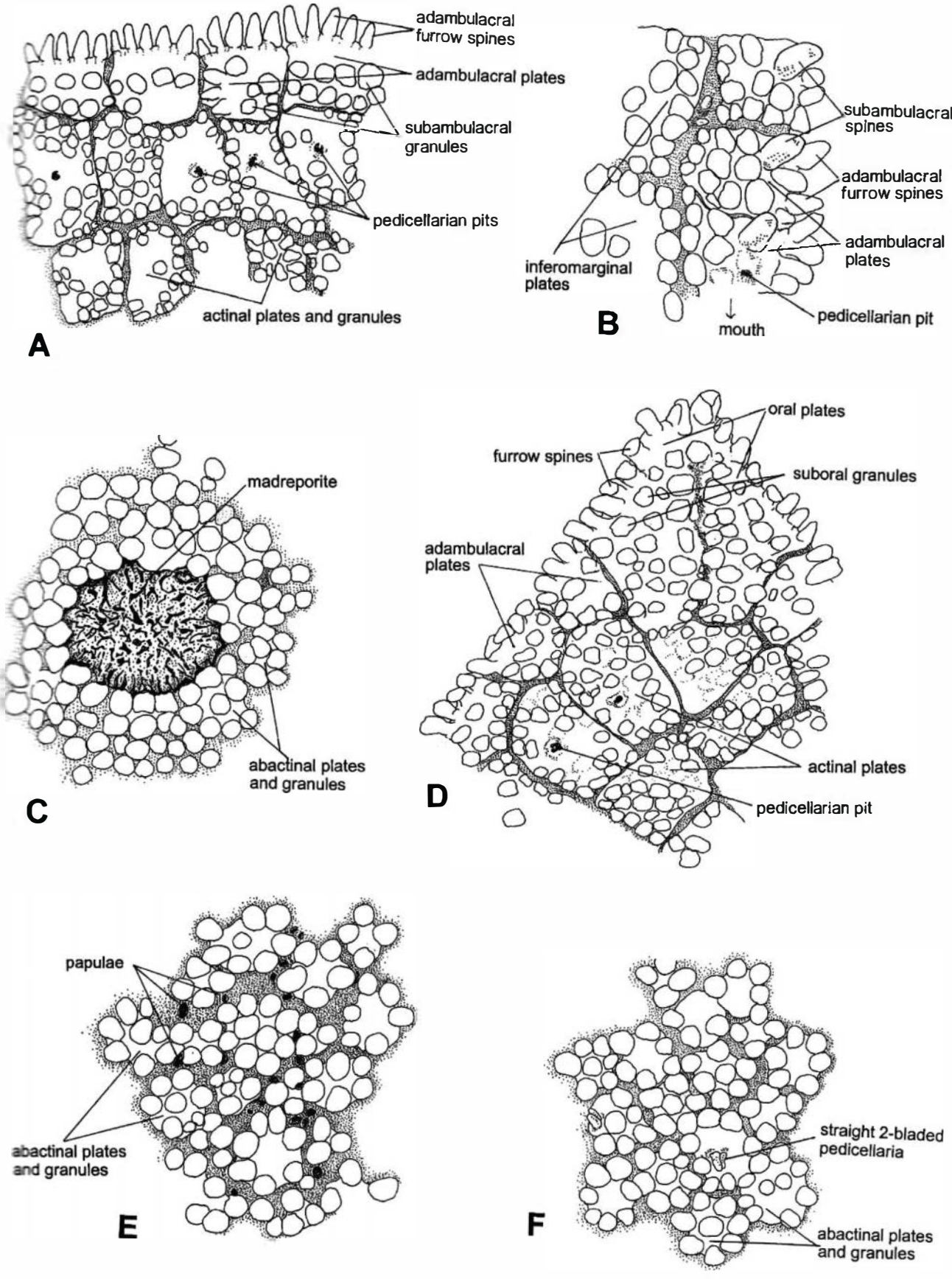
Papulae distinct, 3–5 surrounding each plate, on disc and for half arm length, absent or very few and small, near disc centre, arm tips, interradially, and near marginal plates.

Madreporite finely dissected, oval, small, lying almost midway between marginal plates and disc centre, surrounding plates not especially conspicuous.

Anus not obvious.

Marginal plates 27, 28 from arm tip to arm tip, 25, 26 on small arms, rectangular, regular, with close covering of small, even, distinct, well-separated, generally round granules; those bordering plates very slightly larger, very regularly arranged. Near abactinal plates, superomarginals have a small, irregularly shaped bare patch, becoming larger, distinctly tumid, near arm tips. Interradially, immediately adjacent to abactinal plates, occasional small bivalved pedicellariae on plate edges,

Fig. 31 (opposite). ***Pillsburiaster maini*** McKnight. **A**. Adambulacral plates and adjacent actinals. Note the distinct space or gap between adambulacral furrow spines and subambulacral granules. **B**. Three adambulacral plates near arm tip, with enlarged subambulacral spines. **C**. Madreporite and surrounding plates. **D**. Oral plates, and adjacent adambulacral and actinal plates. **E**. Abactinal (radial) plates at base of one arm, with papulae. **F**. Abactinal interradial plates and granules. Note the slender rayed straight 2-bladed pediellariae and the absence of papulae.



similar to abactinal pedicellariae.

Inferomarginal plates corresponding with superomarginals, with spaced, fairly regularly arranged granules; plates edged by distinct rows of granules, occasional interradial pedicellariae similar to those described above; no bare patches.

Actinal interradial areas large, triangular; actinal plates bordering adambulacrals more or less rectangular, sometimes irregular, large, with occasional pedicellariae, especially on proximal plates. Remaining plates irregular in shape, with spaced, rounded granules. Actinal plates for at least three-quarters length of each arm, in last quarter adambulacral and infero-marginal plates meeting.

Adambulacral plates with generally 5, occasionally 6, furrow spines, sometimes 4 near oral plates; furrow spines very regular, short, sturdy, round-tipped, of similar height. Subambulacral granules in more or less regular 2 or 3 well-spaced rows, well separated from furrow spines. In 1 (long) arm, second proximalmost adambulacral plates on either side of furrow, each bearing a single pedicellaria. Towards arm tips 1 subambulacral granule, either central, or distal on plate, is conspicuously enlarged (as in some specimens of *Pillsburiaster aoteanus*).

Oral plates conspicuous, slightly tumid, with 8 or 10 furrow spines, blunt, round-tipped, sturdy, anteriormost slightly longer, posteriormost (adjacent to adambulacrals) often very small. Suboral spines in fairly regular rows, especially along membranous central area, these spines or granules very similar to those of adjacent actinal plates.

Ambulacral grooves narrow; *tubefeet*, with suckers, in 2 rows.

COLOUR: No colour notes of living animals; dried (ex-alcohol) white or faintly fawn.

REMARKS: *Pillsburiaster maini* McKnight is described from one specimen collected from deep water off the west coast of the North Island, New Zealand; no further specimens have been taken. It is readily distinguished from *P. aoteanus* by its longer and more definite arms, more compact and better defined abactinal paxillae, and by (on the whole) fewer oral furrow spines; this last character is highly variable.

Dissection of one arm and a small part of disc showed a thick, enveloping membrane, especially actinally where plate outlines are totally obscured. *Ambulacral plates* steep, very regular; *ampullae* of tubefeet double; no superambulacral ossicles. *Interradial septa* membranous, not especially conspicuous, *gonads* present as small, ?single, grape-like masses on either side of interradial septum, apparently attached to a membranous stolon. Abactinal plates from coelomic side small, lobed, tumid, of several sizes; no secondary or connecting plates. Near midline of arm, plates show no special arrangement; along arm edges, plates distinctly smaller, oval to round, largely unlobed, forming a very close network; almost forming regular longitudinal rows along arm sides. *Papulae* distinct, 4–6 around abactinal plates in midline of arms, distinctly fewer near arm tips, smaller, less conspicuous.

Pillsburiaster sp. (Pl. 29, Fig. 32)

MATERIAL EXAMINED: *Eltanin* Stn 1712 (1).

SIZE: R / r = 65 / 32 mm.

DISTRIBUTION: From off east coast of North Island, New Zealand.

DEPTH: 1354–1995 m.

DESCRIPTION:

Arms distinct from disc, broad basally, narrowing rapidly to sharp tip; this protected by small, conspicuous, tumid, collar-like plate bearing the stump of a single, large, sturdy spine. Superomarginal plates from opposite sides of arms separate to arm tips. Specimen bent, contorted, broken across 3 arms on actinal surface.

Abactinal plates rising steeply from superomarginal plates then levelling out to plane surface with slightly depressed interradial areas. Plates flat to gently tabulate, small, oval to almost square or irregular in shape; near superomarginals forming a fairly close-knit skeleton. Elsewhere plates irregular in shape and size, often quite tumid, interradially bearing round, well-separated granules, central granule higher, distinctly larger; enlarged granules less conspicuous on plates adjacent to superomarginals. Enlarged granules and prominent papulae giving a distinctive appearance to disc and arms. Interradially and in last half of arms, enlarged central granule is generally surrounded by 6–8 small, round granules. Near disc centre, larger granules more conspicuous, sometimes forming quite prominent rows or bars. Occasional straight, bivalved *pedicellariae*, especially interradially near superomarginals; sugar-tong-like, blunt tipped.

Papulae very obvious, distinct, most with a membranous basal collar. Papulae on arms, except near tips, also absent or very few in disc centre and in a broad, conspicuous midinterradial tract running from disc edge almost to disc centre; 3–5 or 6 papular surrounding each plate.

Madreporite interradial, slightly nearer disc centre; irregular in shape more or less flat, worn, with only

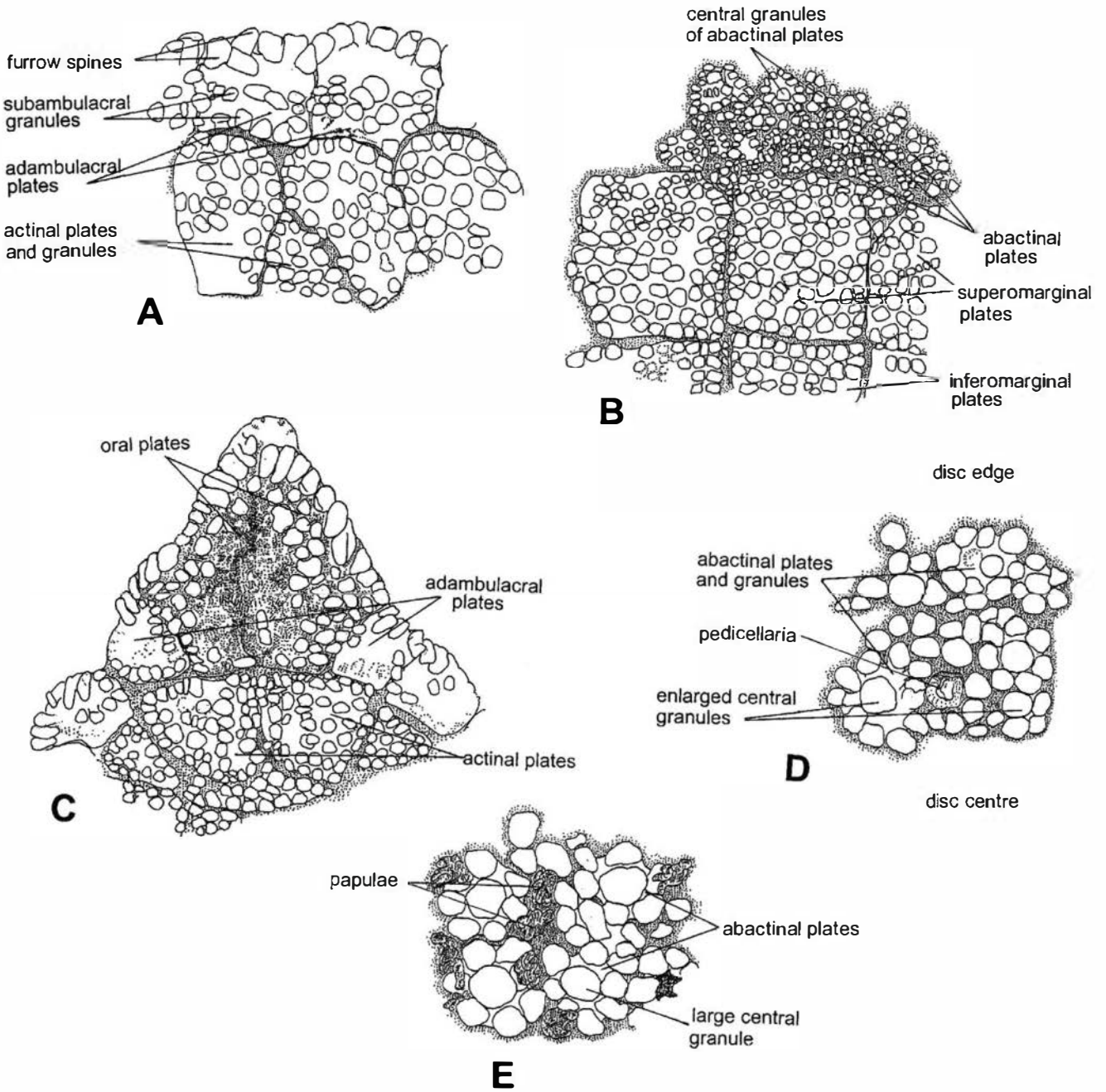


Fig. 32. ***Pillsburiaster*** sp. *Eltanin* Stn 1712. R/r = 65/32 mm. **A.** Adambulacral plates and adjacent actinal plates. **B.** Interradial abactinal and marginal plates. **C.** Oral, adambulacral, and actinal plates of damaged specimen. **D.** Paxillae, plates, pedicellaria, interradially between two intact arms. Note the absence of papulae, and the enlarged centred granules of plates. **E.** Abactinal plates radially near disc centre. Note the large central granules in abactinal paxillae.

traces of sculpture near edge. Surrounding plates not especially conspicuous.

Anus central on disc, small, depressed, inconspicuous.

Superomarginal plates 28, 29 from arm tip to arm tip, rectangular near abactinal plates with a distinctly rounded margin, bearing fairly regular rows of spaced, round granules similar to those of abactinal plates; marginally smaller, gently angular. Bare patches on superomarginals, few, scattered; where bare patches are present faint scars remain, suggesting granules have been lost.

Inferomarginals corresponding with superomarginals and with a similar covering of granules. No naturally bare patches, spines, or pedicellariae on either series of marginals.

Actinal areas extensive, *actinal plates* present between adambulacral and inferomarginal plates

almost to arm tips. Plates bordering adambulacrals large, conspicuous, rectangular or almost pentagonal; elsewhere irregular in size and shape, forming a close mosaic, with round or gently angular spaced granules that show no definite arrangement; plate edges with smaller granules forming a fairly regular border. Occasional single pedicellarian pits present on actinal plates bordering adambulacrals.

Adambulacral plates forming regular edge to furrow, first plate almost triangular, fitting very closely at distal tip of oral plate; furrow spines 5 or 6, very similar to oral furrow spines. Subambulacral granules small, round, well spaced; a distinct fringe of granules on free edge of plate; plates rectangular, furrow spines long, slender. A conspicuous furrow or channel between furrow spines and subambulacral granules. Sometimes a small, bivalved straight pedicellaria (similar to those described) among adambulacral granules. Near arm tip, last 3 or 4 inferomarginal plates in direct contact with adambulacrals; no actinal plates.

Oral plates large, conspicuous, damaged, 2 plates in an angle widely separated. Oral furrow spines 10–12, short, thick, non-tapering, round tipped. Immediately inside furrow spines is a row of very short, round-tipped spines or granules; between these and the median edge of plates, a number of rounded or gently angular granules forming a fairly close covering. Faint scars along edges of sutures between plates in an angle, suggesting a row of larger granules.

Tubefeet with suckers in 2 rows, furrow not especially deep.

REMARKS: This specimen has four distinguishing features:
1, long, distinct, rapidly tapering arms;
2, the presence in paxillae of a conspicuously enlarged central granule;
3, the numerous, large, collared papulae; and
4, the small, irregular, close-packed and generally angular abactinal interradial plates. The absence of bare patches on the marginal plates is a very variable characteristic, as examination of a large number of specimens of *Pillsburiaster aoteanus* shows.

The specimen was not dissected.

Plinthaster Verrill, 1899

Tosia (section B, *Plinthaster*) Verrill, 1899: 161; Fisher 1906: 1052.
Pyrenaster Verrill, 1899: 166; Fisher 1911a: 165.
Eugoniaster Verrill, 1899: 172; Macan 1938: 382.
Plinthaster Fisher, 1910: 172; 1911a: 165; Halpern 1970a: 244; 1970b: 2; A.M. Clark & Downey 1992: 259; A.M. Clark 1993: 276.

Pentagonal to stellate sea-stars with short arms. Abactinal plates with a single row of marginal granules and bare centres; bare area not smooth but roughened by hyaline (glass-like) bosses or granules; these may be very tiny.

TYPE SPECIES: *Pentagonaster perrieri* Sladen, 1889 (a synonym of *Pentagonaster dentatus* Perrier, see Fisher 1910: 172).

TYPE LOCALITY: Coast of Morocco, northwest Africa, 830–1435 m.

REMARKS: This is the first report of the genus from New Zealand waters.

DISTRIBUTION: Widespread in the North Atlantic; in the Pacific it is recorded from Australia (unpublished data) and from the Kermadec Islands, north of New Zealand.

Plinthaster dentatus (Perrier, 1884) (Pl. 29, Fig. 33)

Pentagonaster dentatus Perrier, 1884: 168, 170, 179, 180, 183, 185, 186, 242, 243, pl. 8, fig. 3; 1894: 36, 39, 40; Sladen 1889: 265, 267, 744; Farran 1913: 10; Grieg 1932: 21.
Pentagonaster grandis Perrier, 1885a: 886; 1885b: 35; 1894: 32.
Pentagonaster perrieri Sladen, 1889: 265, 267, 746; Perrier 1894: 31, pl. 25, figs 1a–1b; Koehler 1895: 451; 1896: 60; 1909: 85, pl. 2, fig. 7.
Pentagonaster concinnus Sladen, 1891: 690, pl. 26, figs 1-5.
Tosia (Plinthaster) perrieri: Verrill 1899: 161; Fisher 1906: 1054.
Tosia (Plinthaster) compta Verrill, 1899: 163, pl. 27, fig. 2; Fisher 1906: 1054.
Tosia (Plinthaster) nitida Verrill, 1899: 165, pl. 27, figs 1–1b; Fisher, 1906: 1054.
Pyrenaster dentatus: Verrill 1899: 167, pl. 27, figs 3–3b; Fisher 1910: 172.
Plinthaster dentatus: Fisher 1910: 172, 1911a: 165; Verrill 1915: 107; H.L. Clark 1941: 42; Halpern 1970a: 244, figs 17–19; Downey 1973: 52, pl. 19, figs A, B; Gage *et al.* 1983: 280; A.M. Clark & Downey 1992: 260, pl. 61, D, E; A.M. Clark 1993: 276.
Plinthaster perrieri: Fisher 1910: 172; 1911a: 165; Koehler 1921: 2; 1924: 182; Mortensen 1927: 83, figs 46, 47.
Goniaster africanus: Koehler 1914: 169, pl. 7, figs 1–4.

MATERIAL EXAMINED:
NMNZ: NNE of Herald Island near Raoul Island, Kermadecs: Ech. 5315 (1).

SIZE: R / r = 29 / 17 mm.

DISTRIBUTION: Widespread, mainly in the north Atlantic Ocean; in the Pacific Ocean known from New South Wales, Australia and (this specimen) from the Kermadec Islands, north of New Zealand.

DEPTH: 229–2910 m.

DESCRIPTION: The single specimen, NMNZ Ech. 5315, in the present collections is described.

Disc large, arms 5, short, triangular, rapidly tapering to sharp tips. *Terminal plate* large, tumid, distinctive, free edge rounded with either 1 large central spine (broken here) or an enlarged and distinctly rounded short, squat, spine (or granule); in this specimen, on 1 arm tip, 1 distinct short (possibly broken) spine (or granule) remaining, on other 4 terminal plates a distinct scar only. Edge of terminal plate adjacent to abactinals angular, with point between superomarginals. Terminal plates probably naked apart from single enlarged anterior spine or granule; plate smooth, no depressions or hollows such as occur on neighbouring superomarginal plates when granules are removed. Terminal plates actually "fringed" by granules of anteriormost superomarginal plates.

Abactinal plates round, oval, hexagonal; conspicuous carinal series of plates for most of arm length to junction of last 2 superomarginal plates in midline. Centrally on disc abactinal plates irregular in shape and size; small, generally round or oval secondary plates between larger plates; secondary plates also on either side of carinal plates at beginning of series. Interradially, plates smaller, irregular in shape and arrangement, forming a close mosaic. All abactinal plates with a complete fringe of granules, small, round, mostly flat tipped, and generally narrowly spaced from each other forming very regular edges to plates. Abactinal plates slightly tumid, separated from one another by distinct, narrow, naked, shallow gutters, fringing granules almost meeting with neighbours across gutters. Hyaline (glassy) granules not obvious; however, on some central plates, interradially, especially near madreporite, very tiny hyaline granules, others may have been lost. Round granules occurring more or less centrally on some plates and distinct rounded depressions (pits, hollows) obvi-ous on most plates, suggesting a number of granules, depressions making plate surfaces very rough, 1 (gene-rally central) to 9 depressions. Distally along arms between superomarginal plates, abactinal plates ir-regular, oblong, rectangular, distalmost plates often tri-angular, large, with distinct, spaced, marginal granules. In all arms in this specimen, last 2 superomarginal plates in contact medially.

Papulae distinct, obvious, single, round, or oval at abactinal plate corners, 4–6 around most plates; papulae absent, however, from between last 5 marginal plates (from arm tips); also absent, indistinct or very small in rosette of plates at disc centre and interradial areas.

Madreporite worn, almost square, tumid, interradial and very near disc centre; the few remaining marginal striations suggest it was coarsely ridged and grooved.

Anus small, interradial, near disc centre and guarded by 5 distinct round or wedge-shaped granules.

Superomarginal plates forming distinct edge to disc and arms, 14 plates from arm tip to arm tip. Plates large, gently swollen, rectangular, narrow edge to abactinal plates, bordered by small, spaced granules similar to those of abactinal plates; granules along lateral edges of plate slightly larger, often meeting with similar granules from adjacent plates, thus obscuring distinct channels between plates. Plate surfaces very rough with numerous depressions and a number of well-spaced granules, similar to those already described; granules or hollows often in regular rows. Plates smaller, nar-rower near arm tips on either side of terminal plate, often flanked by lateral rows of superomarginal granules.

Inferomarginal plates corresponding with superomarginals; three-quarters of an inferomarginal plate on actinal surface. Plates very regularly rectangular with well-defined edge to actinal surface, edged by slightly larger, more conspicuous granules projecting at an angle from plate and closer together than those of superomarginal plates; with more or less regular rows of rounded granules similar to those of abactinal and superomarginal plates; many granules lost, leaving behind a distinct, characteristic depression. Inferomarginal plates separated laterally by shallow gutters; marginal granules from neighbouring plates almost meeting. No *pedicellariae* on marginal or abactinal plates.

Actinal areas well defined, regularly triangular, extending to level of 3rd inferomarginal plate from mid-interradius or 11th adambulacral plate from oral plates. Near adambulacral plates, actinal plates almost square, raised, separated from neighbouring plates by distinct channels, with spaced granules sometimes more tapering, almost triangular, others round or flat-tipped. One large plate at actinal edge of 2 oral plates in an angle, extending from adambulacral plates on one side to those of opposite side. In one angle only, the large plate is divided by continuation of furrow which extends between 2 oral plates in angle; 2 of these large, unpaired actinal plates bearing a distinct, small straight *pedicel-laria*; these bivalved, sugar-tong-like, with a distinct stalk and broad base; these 2 pedicellariae are the only ones on actinal plates. Near inferomarginals, plates small, less regular in size and shape, often central granules slightly larger.

Adambulacral plates very regular, rectangular, long edge to furrow; furrow margin straight or gently rounded; plates well separated laterally by distinct, clear grooves. Furrow spines generally 5, sometimes proximally 6; anteriormost spines sometimes smaller. Anteriorly furrow spines large, flattened, narrow edge to plate and groove, round-tipped. Subambulacral

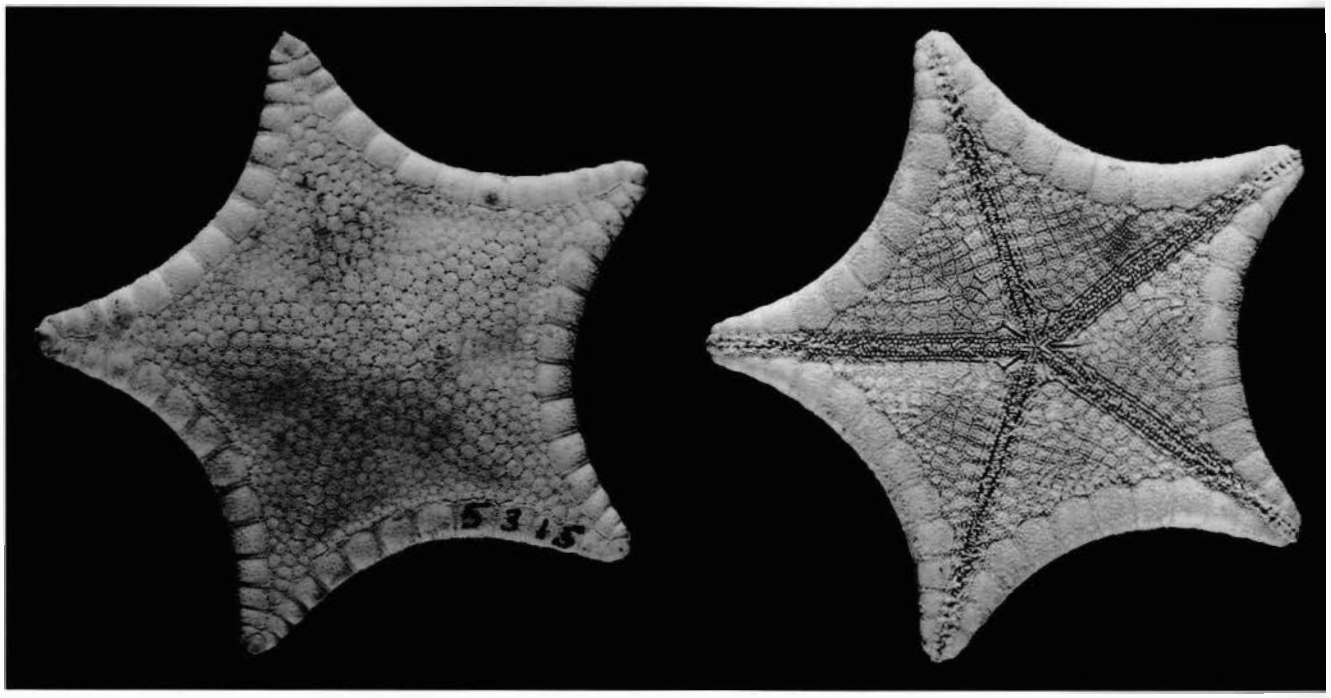


Plate 29. ***Plinthaster dentatus*** (Perrier). NMNZ Ech. 5315. R/r = 29/17 mm. Abactinal and actinal surfaces.

spines in 2 rows; row adjacent to, but well separated from, furrow spines, with generally 4, occasionally 5, spines, short, round tipped, thick-set, and well spaced from one another. Plates fringed actinally by a similar number of shorter, well-spaced spines. Near arm tips 1 subambulacral spine often enlarged, distinct, thick, 2 or 3 times as long as adjacent spines; very conspicuous. Adambulacral furrow spines also fewer with only 2 or 3 on a plate, short, thick and blunt-tipped; tipped adambulacral plates near arm tip are rounded, tumid. Adambulacral plates separated from neighbouring actinal plates by distinct clear gutter similar to those separating actinal plates. First 2, sometimes 3, adambulacral plates bearing single, proximal, straight pedicellaria; these upright, stalked, 2-bladed, the head expanded and soup-spoon-shaped.

Oral plates large, 2 plates in an angle separated by a distinct, very clearly defined muscular area. Furrow spines 10 or 11 similar to adambulacral furrow spines, thickset, almost triangular; anteriormost spine largest, projecting well forward. Actinally on plate a single, large but shorter anterior suboral spine; junction between 2 plates in an angle fringed by 6–9 spaced, short, round granules or very short spines; these granules (short spines) decreasing in size near actinal plates. A further series of short spines in 2 or 3 rows; well spaced, shorter, fewer than furrow spines.

Ambulacral grooves narrow, furrow spines from opposite plates almost meeting across furrow.

COLOUR: No colour notes of living material; dried, white to pale cream or yellow.

REMARKS: The present specimen is unusual in lacking distinct hyaline granules (possibly because of abrasion) and the presence of enlarged subambulacral spines on distal adambulacral plates is also noteworthy.

Halpern (1970a: 252) summed up the situation: "H.L. Clark (1941: 43) discussed the variations in the Cuban specimens of *Plinthaster dentatus*. He was astonished, as I am, by the great differences in appearance between the extremes of the different forms. However, he concluded that the intergradation seemed too complete to justify any separation."

McKnight (1973a: 185) described *Plinthaster singletoni* from New Zealand waters; re-examination of these specimens and examination of many specimens of *Pillsburiaster aoteanus* suggest that *P. singletoni* is a synonym of *P. aoteanus*.

The present specimen was dissected: the *ambulacral plates* are high, almost vertical and form a conspicuous ridge along arms; there are no *superambulacral plates* and *ampullae* of tubefeet are double. *Gonads* are large, well developed, conspicuous and present as individual clusters on either side, and well clear of the interradial septum, probably opening abactinally close to the superomarginal plates. There are no *connecting ossicles* between the abactinal plates, as seen from the coelomic side; secondary plates are not obvious. *Abactinal plates* along arms are oval and gently lobed and the *carinal*

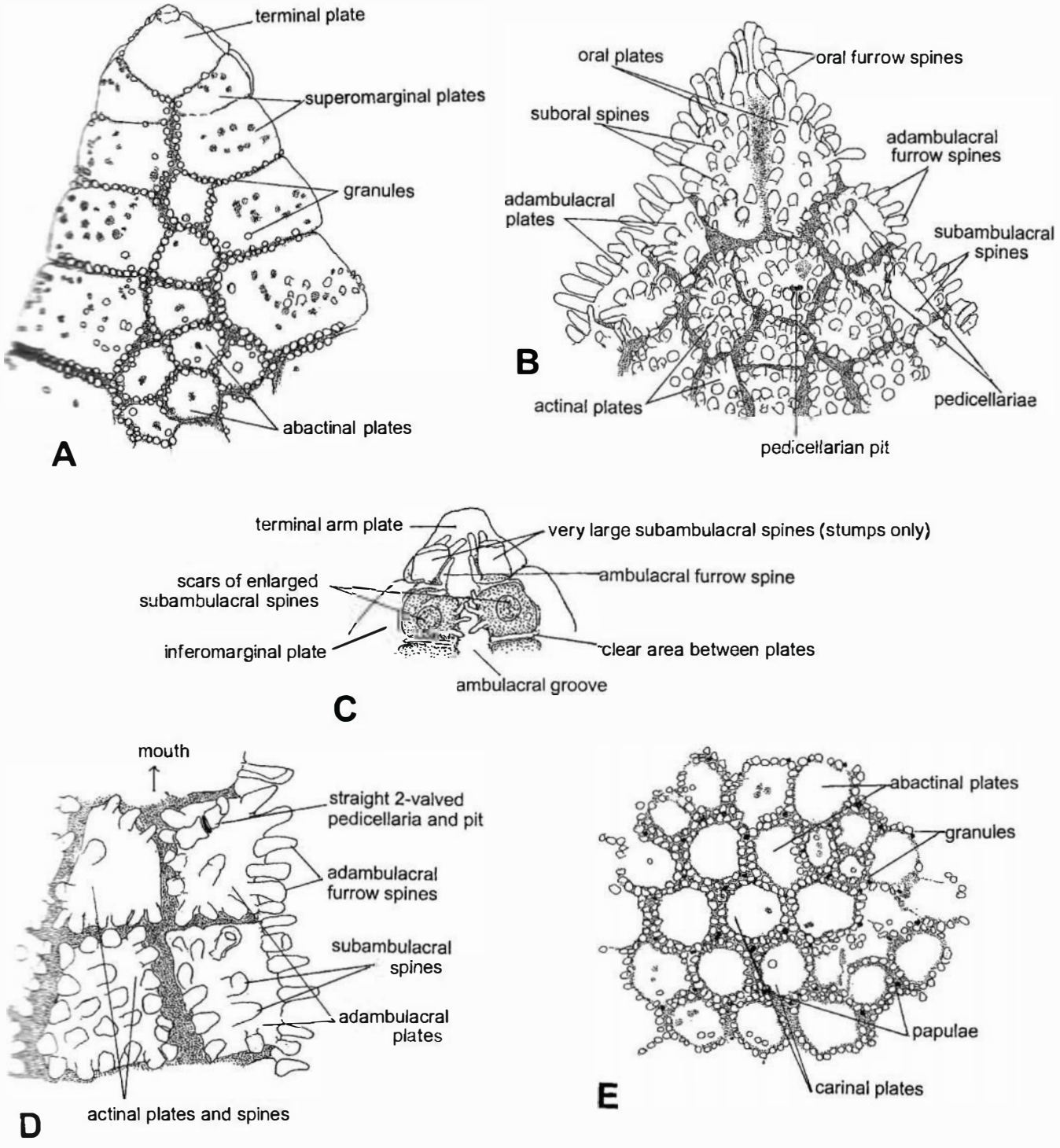


Fig. 33. ***Plinthaster dentatus*** (Perrier). **A**. Arm tip showing superomarginals, abactinals, and terminal arm plates. Note the depressions or pits, left when granules are removed (stippled areas). **B**. Oral angle, with oral, adambulacral, and actinal plates and associated spines, granules, and pedicellariae. Note the unpaired actinal plate and pedicellaria. **C**. Actinal view of arm tip. **D**. Adambulacral and adjacent actinal plates. **E**. Abactinal plates, along arm centre. Note the occasional granules or scars on plates.

series is particularly obvious. *Papulae* are conspicuous, six surround each plate, and they are also present but smaller, and less conspicuous on the disc centre; they are absent interradially where *abactinal plates* are smaller, oval to round, and form a close, regular network. Actinally, the plates are very regularly arranged, rectangular to almost round, and adjacent to regularly rectangular and large ambulacral ossicles. The *interradial septa* are membranous and well developed.

Pseudarchaster Sladen, 1889

Arms 5. Unpaired straight median oral spine common to 2 oral plates in an angle. Abactinal plates paxilliform or tabulate, at least 1 series reaching arm tip, thus separating superomarginals from opposite sides of arms. Marginal plates well developed, conspicuous; actinal plates present, well defined. Superomarginal plates with close covering of granules, inferomarginals (and actinals) with granules only, or granules and short spines. Adambulacral plates with convex or angular furrow margin, furrow spines palmate, subambulacral armature well developed. Gonads interradial, in single tuft on either side of interradial septum; superambulacral plates present, often small but can be conspicuous.

TYPE SPECIES: *Pseudarchaster discus* Sladen, 1889.

TYPE LOCALITY: Messier Channel off the west coast of Chile, South America, 256 m.

REMARKS: *Aphroditaster* Sladen, 1889 and *Astrogonium* Perrier, 1894 are regarded as synonyms of *Pseudarchaster*. More recently Halpern (1970b) listed and described a new genus, with type species *Fisheraster (Fisheraster) microceramus* (Fisher, 1913); Aziz and Jangoux (1984) regarded *Fisheraster* as a synonym of *Pseudarchaster*; I agree with them.

DISTRIBUTION: The genus is well-represented, particularly in deep water on both sides of the equator; it has not been reported from Arctic or Antarctic regions.

KEY TO NEW ZEALAND SPECIES OF *PSEUDARCHASTER*

1(2) Inferomarginal plates with close covering of distinct broad-headed granules; enlarged, generally lanceolate spines often present ..... *garricki*

2(1) Inferomarginal plates with variously shaped spines; plates conspicuously naked, no close covering of granules ..... *macdougalli*

Pseudarchaster garricki Fell, 1958 (Pl. 30, Fig. 34)

Pseudarchaster garricki Fell, 1958: 8, pl. 3 (G, K); McKnight 1967: 300; H.E.S. Clark 1970: 3; A.M. Clark 1993: 279; McKnight 1993a: 169, 184; 1993b: 192, 198.

Pseudarchaster abernethyi Fell, 1958: 10, pl. 3 (I, J); 1962: 29, fig.; Baker & H.E.S. Clark 1970: 5; H.E.S. Clark 1970: 3; A.M. Clark 1993: 278; Rowe & Gates, 1995: 68.

MATERIAL EXAMINED:

NZOI Stns: A823(2), ?B197(1), C605(1), D3 (?1)*, D85(2), D92(1), D117(1), D203(2)*, D211(9), D895(4), D908(1), E80(2), E106(13)*, E117(2)*, E118(4)*, E159(5)*, E401(2), E414(4)*, E433(3), E434(1), E719(1)*, E734(3), E757(4)*, E783(1)*, E819 (1)*, E827(1), E877(8), E886(1), F94(1), F102(1), F104(9)*, F106 (1), F107(3), F109(4), F135(1), F136(2), F150(1)*, F870(1)*, F906 (45), F915(24), F916 (3)*, G56(1), G163(1)*, G185(1)*, G259(1), G276A(5), G283(1)*, G283A(1), G329(2)*, G329A(1), G343(1), G403(1)*, G651(1)*, G665(4), G666(16), G667(3), G688(1)*, G881(2), G886(1)*, G898(4)*, G901(1), G904(1)*, G916(1)*, G929(1)*, G938(3), I2(2)*, I6(28), I7(1)*, I11(1)*, I31(52), I32 (1)*, I38(9), I39(1)*, 146(5), I48(1)*, I64(1), I345(2)*, I346(4), I356 (27), I359(26), I363(15), I364(1)*, I667(1)*, I672(1)*, I686(1)*, I690(3)*, I707(1)*, J481(4), J484(1), J550(10)*, P61(1), P65(79), P66(2), P67(4), P120(14), P655(1), Q12B(1), Q29(1), Q34(3), Q35(1)*, Q729(1), R435(1)*, S14(1)*, S43(9), S66(1), S121(2)*, S123(1), S126(1), S127(1), S140(2), S142(1), S168(1), S173(1), S378(1), S395(3), S398(28), T17(1)*, T29(3), T31(3), T56(1)*, T73 (?)*, T88(6), T574(1), U197(9), U227(3), U569(1)*, V381(1), V389(6), Z2363(5), Z2364(9), Z2365(8), Z2366(1), Z2367(1)*, Z2372(1).

NMNZ: near Auckland Islands: Ech. 2019(1), 4678(1); Bay of Islands: Ech. 4664(1); Bay of Plenty: Ech. 1009(1), 1626(10), 1627(18), 1628(24), 1629(9), 1630(3), 1631(5), 1632(98), 1633 (1), 1634(1), 1635(21), 1636(5), 1637(68), 1638(58), 1639(1), 4659 (3), 4671 (1), 4675(12), 4676(2), 4681(3), 4682(7), 4683(2), 4684 (46), 4685 (2), 4686(14), 4687(2), 5326(2), 5328(6), 5345(2), 6503 (1); Canterbury Bight: Ech. 4660(1); Cape Campbell: Ech. 4658 (1), 4670(1), 4673(1), 5523(1), 5578(3); west of Cape Farewell: Ech. 1276(2), 2024(2), 4672(3), 4680(1), 5324(1), 5689(1); north of Cavalli Islands: Ech. 5323(3); ?Challenger Plateau: Ech. 6266(1); Mernoo Bank, Chatham Islands: Ech. 4661(1), 4663 (1), Ech. 4668(1), 5327(1); off Clarence River: Ech. 4657(7), 4669(1); Hikurangi Trench (southeast of Cape Palliser): Ech. 4667(1); off Hokianga Harbour: Ech. 1275(9), 1496(1), 4679(9); off Ninety Mile Beach: Ech. 1277(4); near North Cape: Ech. 4665(1), 5325(7), 5690(1), 5691(1); off Oamaru: Ech. 1278(1); near Otago: Ech. 4662(1); Palliser Slope: Ech. 4656(1), 4666(2); northeast of Pegasus Bay: Ech. 1279(1); Pukaki Rise: Ech. 2016(1); near Whangarei: Ech. 1634(1), 1677(1), 4677(2).

Eltanin Stn 1709: NMNZ 4674(2).

SIZE: R= 115–4 mm, r = 27–3 mm, R/r averages (for 60 specimens, chosen at random) 36/9 mm.

DISTRIBUTION: From near North Cape, 34°04′ S, 172°12′ E, to south of Campbell Island, 53°29′ S, 170°04′ E, and from the Challenger Plateau and Norfolk Ridge (in the west) to east of Chatham Islands. It has not been recorded from Hawke Bay south to Cape Palliser or from much of the southern part of the west coast of

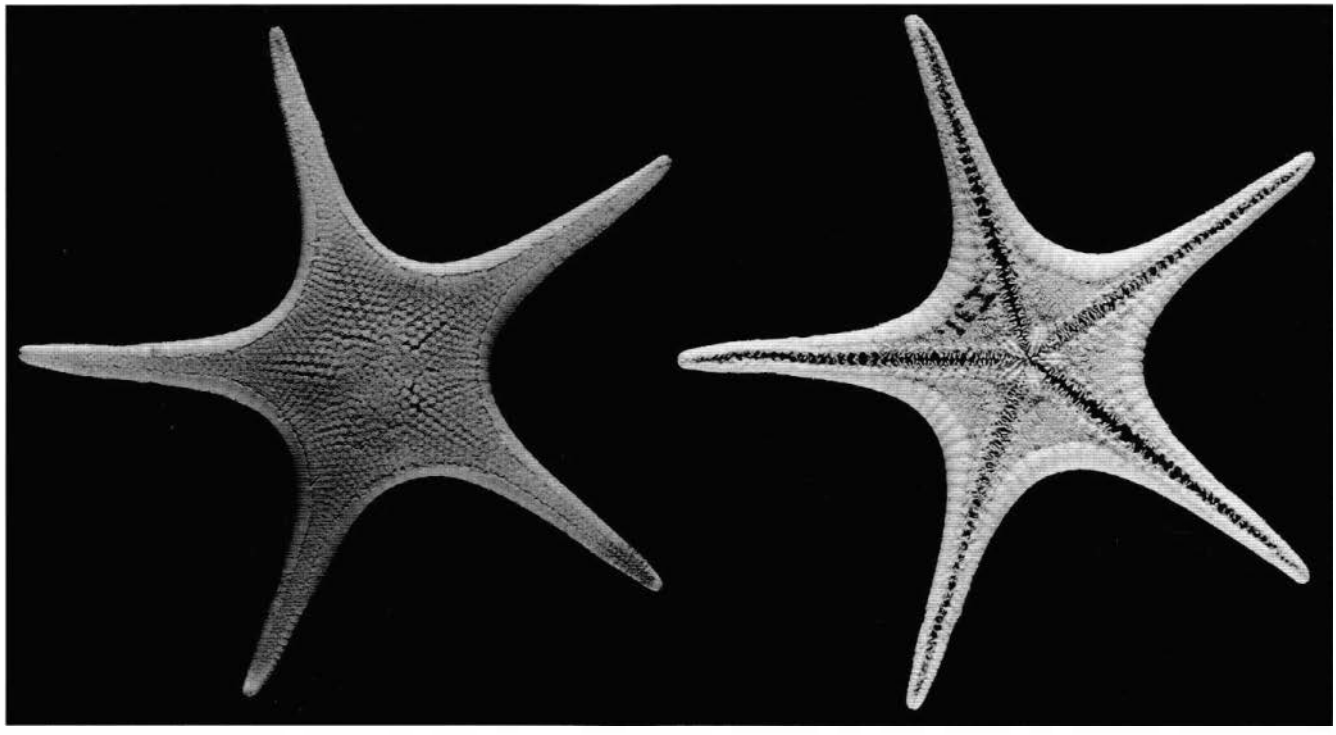


Plate 30. ***Pseudarchaster garricki*** Fell. NZOI Stn I31. R/r = 38/11 mm. Abactinal and actinal surfaces.

North Island; there are no records from Foveaux Strait or Stewart Island. This species (as *Pseudarchaster abernethyi*) is also recorded from New South Wales and Victoria, Australia (Rowe & Gates 1995: 68).

DEPTH: 56-2598 m.

DESCRIPTION: Specimen described is from NZOI Stn I31, Bay of Islands (35°11.70′ S, 174°39.80′ E), 245-249 m, R/r = 38/11 mm.

Disc large, flat; *arms* 5, also flat, long, slender, evenly tapering to distinct heart-shaped apical plates, these naked here but probably covered by small granules similar to those of adjacent abactinal and superomarginal plates; no obviously enlarged apical spines. Interbrachial arcs sweepingly and evenly rounded.

Abactinal plates and paxillae forming a close, even cover to arm tips, thus superomarginal plates from either side of arm separated to terminal plates. Abactinal paxillae, angular, oval, round, forming a close cover on disc centre, regularly arranged at arm base and for first half of arms. In last half of arms, outline of paxillae difficult to determine; at least 1 row of abactinal plates continuing to arm tip. Disc paxillae with 6–12 central, well-separated granules, small, distinct, either triangular, pentagonal, or square; marginal granules generally more slender, often distinctly flattened, more regularly arranged, sometimes alternating with larger granules, sometimes meeting with similar granules from neighbouring paxillae. Near disc edge and entrance to arms, paxillae less dense and at arm entrance regular longitudinal carinal rows of paxillae distinct; interradially, paxillar arrangement less regular. It is difficult, with close covering of granules, to decide whether plates paxilliform or tabulate; here interpreted as thick-set, stump-like tabulate plates, and paxillate plates with a definite, often flattened extension into a head which bears spinelets or granules. Probably both tabulate and paxillate plates present here; the margin between the 2 slender. Distally, in last half of arms granules borne on flat, unraised plates; true paxillae absent.

Papulae, difficult to see, widespread on disc, although fewer or absent near disc centre, absent in a narrow strip interradially and present for less than half arm length.

Pedicellariae not seen.

Madreporite interradial, slightly nearer disc margin; more or less flattened, rectangular, deeply, coarsely dissected; adjacent paxillae larger, more conspicuous.

Anus almost central on disc, star-shaped, guarded by 5 precise, rather small paxillae.

Superomarginal plates forming a conspicuous and very distinct edge to disc and arms; plates wider than long with a regular cover of small, angular, spaced, flat-topped granules forming an even mosaic. At lateral edges of plates granules larger, almost rectangular, forming a definite border; superomarginal plates the

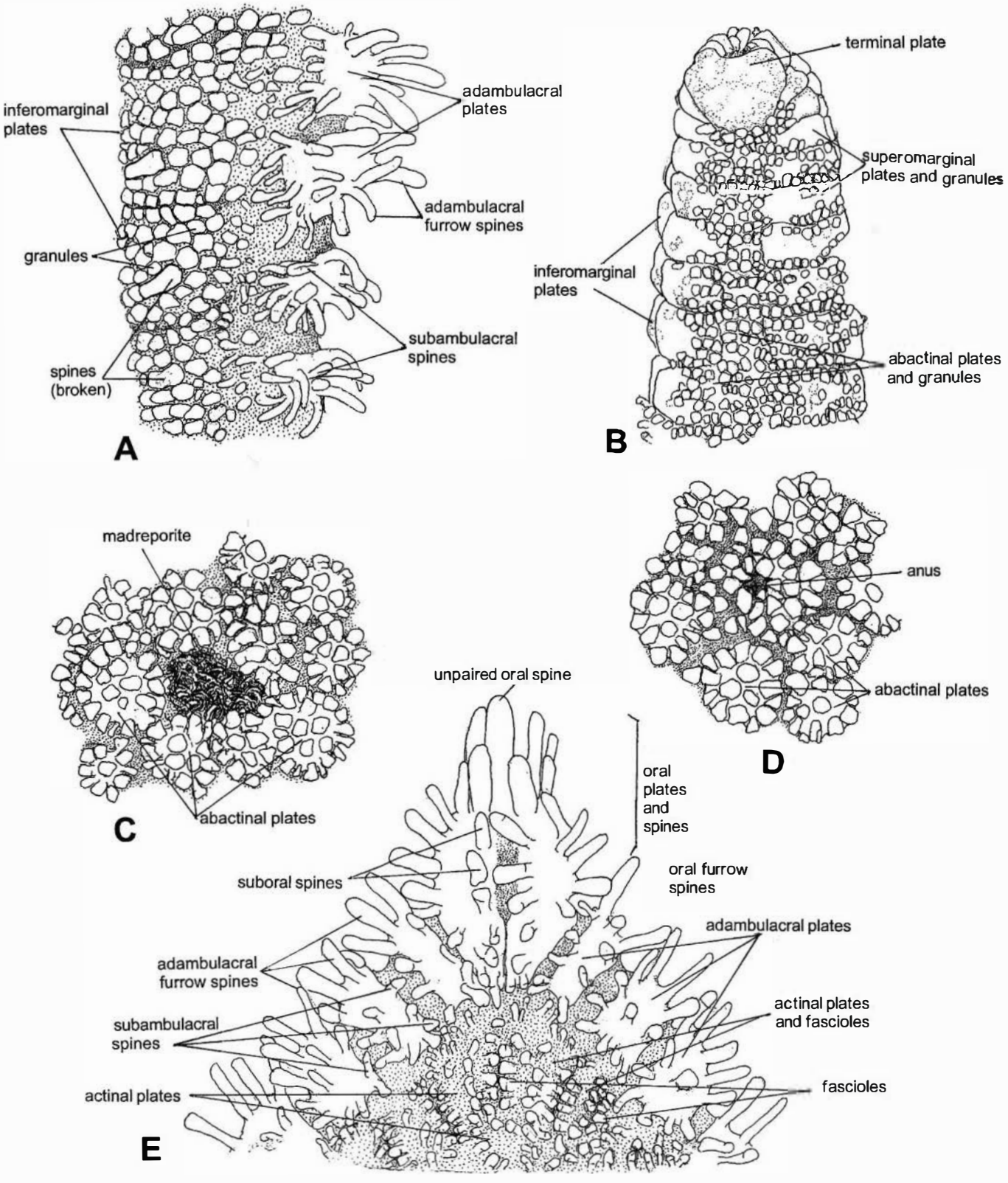


Fig. 34. ***Pseudarchaster garricki*** Fell. **A**. Inferomarginal and adambulacral plates near arm tip. Note absence of actinal plates. **B**. Arm tip with terminal plate and abactinal, supero- and inferomarginal plates. Outlines of abactinal plates obscured. **C**. Madreporite and surrounding abactinal plates. **D**. Anus and surrounding abactinal plates. **E**. Oral, adambulacral, and actinal plates. Note that actinal plate outlines hidden by membrane.

only marginal plates visible from above.

Inferomarginals corresponding exactly with superomarginals; plates slightly tumid, distinct from actinal plates. Plates with large, angular granules, some distinct with obvious but ill-defined stalks. Interradially, and for about half arm length, 1 or 2, occasionally 3, distinctly enlarged, rather flattened hastate, short-stalked granules; these often 2 or 3 in a vertical row, conspicuous, projecting over and above surrounding granules.

Actinal areas triangular, well-defined, plates to level of 8th or 9th adambulacral plate (4th or 5th inferomarginal, counting from interradial angle). Actinal plates rectangular to almost square, with covering of slender-stalked, large, angular-headed granules of generally similar size; near arm entrance 1 or 2 enlarged into almost diamond-shaped small spines similar to enlarged inferomarginal spines. Simple fascioles also on first 2 or 3 proximal plates near oral plates, consisting of enlarged marginal spines from 1 plate meeting with similar spines from a neighbouring plate. Fascioles most conspicuous on plates adjacent to adambulacrals, extending from oral plates to level of 3rd or 4th proximal almost adambulacral plate. Other actinal plates nearer inferomarginals showing a similar, but less conspicuous enlargement of spines along plate edges, arrangement not really fasciolate.

Adambulacral plates precise, clear-cut, almost rectangular, tumid, well separated from neighbouring plates by distinct membranous channels. Free edge of plate convex, projecting over ambulacral groove. Three to 6 adambulacral furrow spines, slender, non-tapering, rather flattened, finely spinulose, with a flat tip, well spaced laterally from one another and radiating across groove, almost meeting with spines from opposite side. Generally 2 spaced rows of 2–4 distinctly shorter, well-spaced subambulacral spines or large-headed granules; plates fringed actinally by 3–5 spaced, short, rather flattened spines. Near arm tips adambulacral plates with very distinct projection into furrow, plates from opposite side of furrow almost meeting, forming distinct conspicuous "pockets" enclosing a pair of tube-feet.

Oral plates conspicuous, raised, oral furrow spines similar to adjacent adambulacral furrow spines, well spaced, connected basally by shallow membrane. Unpaired median spine large, sturdy, round tipped, scarcely tapering. Oral furrow spines on 2 levels; proximal almost 2 or 3 spines dip steeply into mouth, remaining 6 or 7 furrow spines forming a conspicuous well-ordered edge to plate. Five or 6 suboral spines forming a single row along membranous junction between 2 oral plates in an angle. Both adambulacral and oral plates conspicuous by their well-ordered, uncrowded spines.

Ambulacral grooves narrow, deep; *tubefeet* with small suckers in two well-separated rows.

COLOUR: Fell (1958, pl. 10) recorded colour in life as "orange above, cream below". Colour, ex-ethanol, many shades of brown, grey, sometimes white, marginal plates generally lighter in colour, often white.

REMARKS: Fell (1958: 8) described two new species of *Pseudarchaster* from New Zealand waters: *Pseudarchaster garricki*, from one specimen taken in 1006 m in Cook Strait, and *P. abernethyi* from 14 specimens taken in 101–115 m near Cape Campbell. Fell certainly described the extremes within what is now regarded as the one species; he drew attention to the important features of *P. garricki* by saying (1958: 10) that there was a "complete absence of spines or spinules from the uniformly granulated margins and actinal intermediate plates." Baker and H.E.S. Clark (1970: 5) suggested that, with more material for comparison, the two species might be synonymous and, in fact, I now believe they are.

After examining the external features of more than 1000 specimens of this very variable species, there are only four constant features:

1, all specimens examined had 5 arms;

2, there are no enlarged spines or spinelets on any superomarginal plates;

3, abactinal plates present to arm tips in all specimens, i.e., superomarginal plates from opposite sides of arms separate;

4, tubefeet, with small suckers, present in 2 rows with a wide central space between.

In all other respects the species is very variable. In sorting through the present extensive collection, it seemed that two forms were present; one with long, slender arms, and the other with shorter arms and more conspicuous superomarginals, the latter apparently restricted to deeper water. The deepest recorded specimen, however (NMNZ Ech.4667, BS 645, 2598 m, from the Hikurangi Trench, southeast of Cape Palliser), has long and very slender arms.

Fell illustrated (1958, pl. 3, G, I) two different types of abactinal paxillae; examination of the present material shows that the form and arrangement of these paxillae is extremely variable — for example, the presence and extent or absence of the small, rather slender, marginal spines which may or may not alternate or meet with similar marginal spines from neighbouring plates. The madreporite (shape, size, location) is also very variable; in some specimens it is quite distinct, in others it is extremely difficult to find as it is hidden by paxillae; generally the madreporite lies midway between disc centre and edge, and sometimes very much nearer the margin. The position, size, and

shape of the madreporite is often reasonably constant in specimens from any one locality and depth. Superomarginal plates lack enlarged spines; in specimens with short arms they form an especially conspicuous edge to disc and arms and in most specimens they are slightly raised above the level of abactinal plates. The armature of the inferomarginal plates varies enormously; granules may form a uniform covering or some granules may be enlarged to form lanceolate spines or spinelets. Where enlarged spinelets are present, they may be very few or may be present in regular longitudinal rows especially interradially, and are occasionally found right at the arm tips. Adambulacral and oral armature is reasonably constant, although the form of the spines, especially the adambulacral furrow spines, varies; often one furrow spine is enlarged, sturdier, and more con-spicuous. Armature of the oral plates is also interest-ing — in many specimens oral furrow spines are on two distinctly different levels. Immediately adjacent to the unpaired spine on either side, two sometimes three small distinct spines drop steeply into the furrow, while other spines continue around plate edge, in the usual way.

Several specimens were dissected. The anatomy is similar in both short- and long-rayed forms. The abactinal plates, seen from the coelomic side, form a close and very regular cover; plates are distinctly six-lobed and very regularly arranged. There is a distinct single carinal series of slightly more prominent plates in each arm; adjoining plates form very regular transverse rows on either side of the carinal series. At disc centre, abactinal plates are slightly larger, more tumid, more conspicuous, and form a very close mosaic. Papulae are conspicuous on the disc and for the first part of the arms; six papulae occur between the lobes around most plates. Near the disc centre and for the last quarter or half of arms and mid-interradially, papulae are generally absent from a narrow and heavily calcified strip and they are also absent from a very narrow strip interradially near superomarginal plates. There is a distinct ridge of larger, more obvious, and heavier plates that runs from the midinterradius to near the disc centre, one or two plates in width. In the interradius with the stone canal the ridge is considerably more pronounced and the plates are larger. Superambulacral plates are present radially as small, distinct membrane-shrouded bars that pass from the ambulacral ossicles onto the actinal plates; they are absent, small, or very indistinct on the two most proximal ambulacral ossicles; they are also absent or very indistinct in the last narrow half of the arm. Actinal plates, viewed from the coelomic side, are almost scale-like, often irregularly arranged, and sometimes overlapping. Interradial septa are membranous; gonads are present on either side of the septum as distinct clusters, appearing to open interradially between abactinal plates and superomarginals. In similar-sized, short-rayed specimens examined, gonads appear small and compact on either side of the interradial septa; in long-rayed similar-sized specimens, gonads appear as branching, diffuse organs occupying much of the interradius. It is just possible that, as sexes are generally separate in sea-stars, one is looking at male and female individuals, the one with long arms and the other with short, rapidly tapering arms. Intermediate forms, in which it is not easy to decide whether arms rate as long and slender or short and squat, are probably not yet sexually mature. Gonads were not sectioned so there is no proof of this.

Undoubtedly, *Pseudarchaster garricki* bears a close resemblance to both *P. discus* Sladen, 1889 and *P. parelii* (Düben & Koren, 1846). *Pseudarchaster discus* is recorded from Magellanic and Falkland regions in 140–283 m, and *P. parelii* is a North Pacific and North Atlantic species; Imaoka *et al.* (1990: 46) recorded one specimen of *P. parelii* from the Sea of Japan, North Pacific, 292 m. A.M. Clark and Downey (1992) provided a key (table 42, p. 261) to the Atlantic taxa of *Pseudarchaster* and certainly *P. garricki* comes very close to both of these species, especially *P. discus*. Fell (1958) also remarked on similarities in these two species. Without material for comparison, however, *Pseudarchaster garricki* is retained.

Pseudarchaster macdougalli McKnight, 1973a

(Pls 31, 32)

Pseudarchaster macdougalli McKnight, 1973a: 172, fig. 1a, b; A.M. Clark 1993: 280.

MATERIAL EXAMINED:

NZOI: G953(1), J45(1) (holotype).

NMNZ: north of Chatham Is: Ech. 4177(2); north of Christchurch: Ech. 4688(2); unregistered specimen, no data (1).

SIZE: R varies from approximately 150–30 mm; r varies from 47 to 11 mm. (Measurements for large specimens are approximate only, as specimens are dry, folded, distorted.)

DISTRIBUTION: West coast of North Island, northeast of Christchurch, north of Chatham Islands.

Depth: 1140–2146 m.

DESCRIPTION: Specimen described, NMNZ Ech. 4177, from north of Chatham Is, R/r =145/46 mm.

Disc large, raised, flattened, arm centres also raised, almost table-like. Arms 5, somewhat irregular in length,

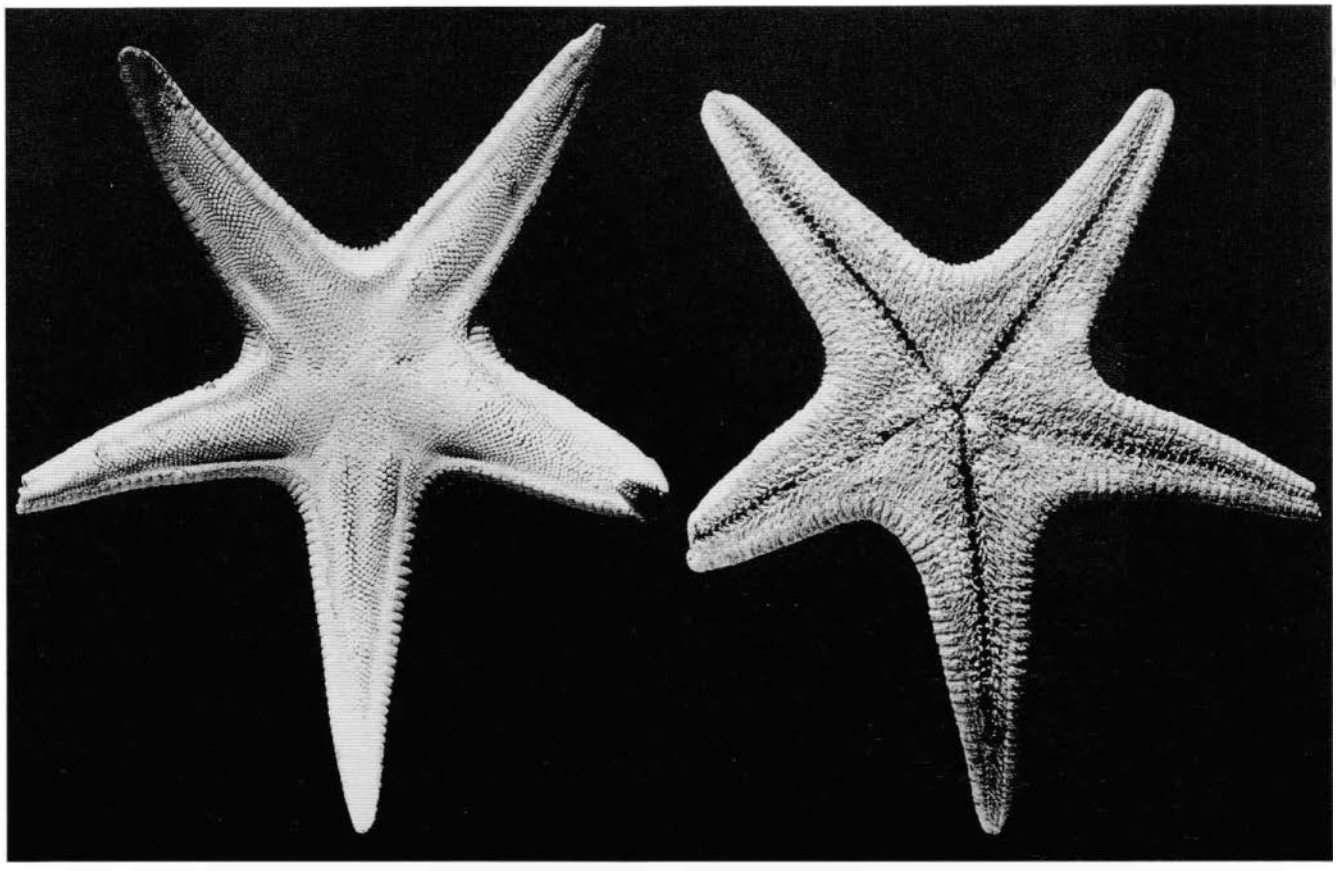


Plate 31. ***Pseudarchaster macdougalli*** McKnight. NMNZ Ech. 4177. R/r = 145/46 mm. Abactinal and actinal surfaces.

rapidly and evenly tapering to pointed tips, 2 arm tips missing, remaining terminal arm plates damaged. Interbrachial arcs wide.

Abactinal paxillae extending to arm tips; regular rows of paxillae particularly obvious along arm edges. On disc centre and entrance to arms paxillae forming a close raised covering, outlines of paxillae rather indistinct. Central disc paxillae with 1–7 gently tumid, well-separated central granules encircled by similar, spaced, large-headed granules. Alternating with these outer granules, sometimes replacing them, slender, short, blunt-tipped, thorny spines often meeting or alternating with similar spines from neighbouring plates. Thick, enveloping membrane, especially on disc, tending to obscure plate outlines; further out on arms abactinal paxillae more spaced, connected to neighbouring plates by distinct strands of tissue, these originating in shallow depressions near base of paxillar trunks, then proceeding down, across, and onto neighbouring plates; thus 6 sheets of tissue on each paxillar trunk. Centrally on arm, near base, paxillae larger, more isolated, with longer trunks; along arm edges paxillae smaller, oval, in very regular rows, with fewer fringing spines, sometimes only 1 central granule. Near arm tips central enlarged granules missing or very few, leaving a delicate fringe of conspicuous marginal spines. Paxillae, viewed from the coelomic side, interrradially show a short, stout trunk the head of which is fringed by slender spines (spinelets).

Papulae difficult to see because of close paxillar covering; dissection shows them to be widespread on disc, where 5 or 6 surround each plate; interradially absent or very few from a narrow strip near superomarginals; near arm tips papulae also few or absent from near marginals. A heavy enveloping membrane in last quarter of arm obscuring plate outlines.

Pedicellariae not seen.

Madreporite interradial, midway between disc centre and disc edge; sunken, almost round, deeply and finely dissected.

Anus central on disc, apparently as small, almost triangular hole.

Thirty-five to 42 or 43 marginal plates from interradial angle to arm tip. *Superomarginal plates* forming a very even series, plates wider than long, almost vertical, very evenly arranged, gently tumid, forming the visible, vertical edge of rays. Plates separated laterally from one another by even and distinct membranous gutters, fringed by short, round-tipped projecting spinelets that meet with similar spinelets from neighbouring plates;

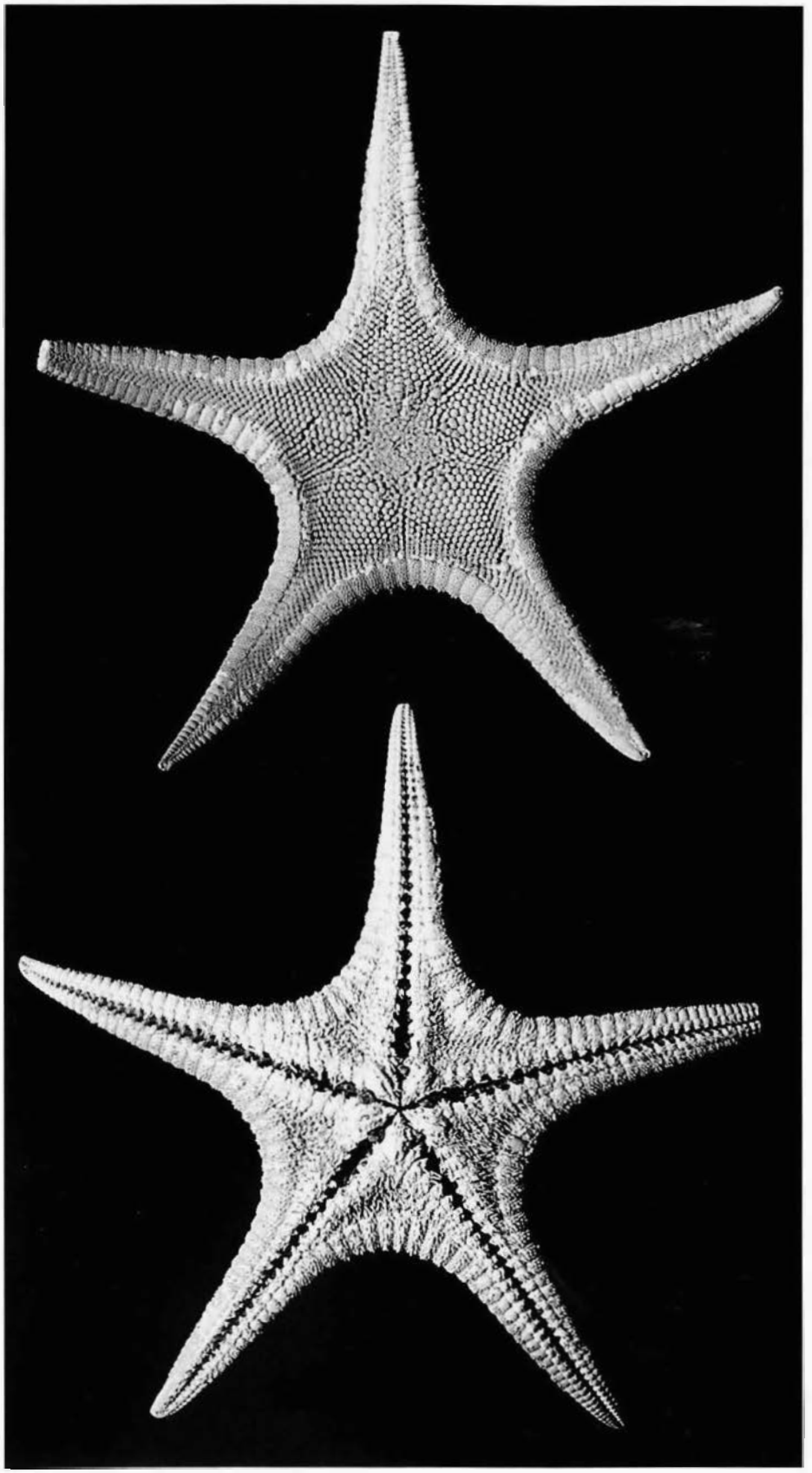


Plate 32. *Pseudarchaster macdougalli* McKnight. Holotype. NZOI Stn J45. R / r = 50/17 mm. Abactinal and actinal surfaces.

plates also with well-spaced granules of 2 sizes; largest granules round, sometimes angular, stalked, not forming very regular rows. Near inferomarginals granules longer, larger, often forming distinct spines; these may be long, slender, rounded, or almost lanceolate and slightly flattened. Enlarged superomarginal spines not numerous, most obvious on interradial plates with 3–5 or 6 spines per plate. Towards arm tips no enlarged spines, although granules distinctly larger near inferomarginals.

Inferomarginal plates confined to actinal surface, similar in size to corresponding superomarginals. Inferomarginals with enlarged, semi-lanceolate, rather flattened spines of 2 sizes; large spines near actinal and superomarginal plates; between them finely thorny, slender, gently tapering, round-tipped spines. Along plate edges spines shorter, more slender, thorny, well separated, almost hooked; these spines pointing downwards, forming a double or treble row along plate edges. Inferomarginal plates conspicuous in their nakedness; apart from enlarged spines there are no surface granules.

Actinal plates for at least three-quarters length of each arm, gently tumid, especially near inferomarginals; rectangular, or irregular in shape, generally 2 plates corresponding to 1 inferomarginal. Plates with shaggy spines of 2 sizes, similar to those of inferomarginals; larger spines, 2 or 3, generally central on plate, plates fringed by small curved spines similar to those already described; actinal surface of plate naked. Actinal plates flanking adambulacrals, generally with single enlarged spine only; small spines fringing plates.

Adambulacral plates raised, tumid, with more or less rectangular or gently rounded free edge, projecting well over groove; otherwise plates angular, with distinct projection deep in furrow. Furrow spines 5–7, long, slightly tapering, round-tipped, spinulose, of similar size, except for proximalmost spine which is distinctly shorter; furrow spines possibly with slight webbing basally. Subambulacral spines in 2 or 3 rows, sturdy, thicker than furrow spines; subambulacral spines very similar to enlarged actinal spines. Free edges of adam-bulacral plates and edges adjacent to actinal plates with slender, well-spaced spines or spinelets. Adambulacral plates well separated laterally by wide, distinct mem-branous areas.

Oral plates rather damaged, not especially conspicuous or large. Furrow spines 7 or 8 on either side of stout, angular, unpaired spine, finely spinulose, round-tipped, well spaced from each other, some posterior spines slightly flattened. Two plates in an angle well separated by broad membranous area. At least 1 conspicuous row of enlarged suboral spines similar to furrow spines, slender spines also along membranous edge of plate. A faint suspicion that furrow spines are webbed basally.

Ambulacral grooves narrow, deep; *tubefeet* biserial, with ill-defined sucking discs.

COLOUR: No colour notes of living specimens; dried specimens brown, varying from russet (reddish-brown) to pinkish-brown.

REMARKS: The other large specimen from the same station (NMNZEch. 4177) R / r = 134/43 mm is similar to the specimen just described, except that the *paxillae*, centrally on disc, form such a close covering that it is very difficult to see the slender fringing spines. However, near the beginning of the arms, paxillae are more spaced and fringing spines are obvious, often numerous, and very small. Actinally, the specimen is similar to that described, with eight or nine *oral furrow spines* and only four *adambulacral furrow spines* proximally, with at least five, sometimes six further along the arm. *Actinal plates*, with their enlarged central spine or spines, are distinctive, and enlarged spines point towards margin.

Two other larger specimens (NMNZ Ech. 4688) R / r = 120–125 mm, and R approximately 160–170 mm, are similar to specimens already described: *oral plates*, somewhat damaged, with 8 (possibly 9) spines per plate, *oral furrow spines* well spaced, long and sturdy. Oral plates separated from first adambulacral plates by broad muscular area. The second, smaller specimen (NMNZ Ech. 4688), R / r = 120–125 mm, r = 32, 33 mm, similar to larger specimen although *central disc paxillae* less crowded. Actinally, 8 or 9 *oral furrow spines* and junction between superomarginal and inferomarginal plates clearly visible. *Adambulacral furrow spines*, 4-6.

In smallest specimen (NZOI Stn G953, R / r = 30 / 11 mm), *disc* well defined by superomarginals; disc and arms flattened, abactinal plates present to arm tips. *Papular areas* conspicuous, large, triangular; base of triangle rather rounded, "point" projects into arms; *papulae* conspicuous, 5 or 6 around each plate. Adjacent *paxillae* with slender trunk and 3–5 (occasionally 6) enlarged, well-separated central granules, these surrounded by slender, spaced marginal spinelets. *Abactinal plates* forming conspicuous well-ordered rows near disc and arm edges. *Madreporite* small, round, interradial and nearer disc edge, finely, deeply, regularly dissected; several surrounding abactinal plates enlarged, conspicuous, encroaching on surface. *Superomarginal plates* conspicuous, regular, similar to those in specimens already described; conspicuous enlarged granules near inferomarginals, but no *actinal spines*. *Inferomarginals* corresponding with *superomarginals* and most obvious on actinal surface; enlarged spines present especially near superomarginals. *Actinal plates* restricted, extending short distance only into arm, to

level of 8th or 9th adambulacral plate; actinal plates with generally only 1 enlarged central spine; slender, spaced, small marginal spines are also present. *Adambulacral furrow spines* 4, 5, occasionally 6, well spaced, slender, thorny; plates edged by small, slender, spaced spinelets. *Oral plates* conspicuous, very tumid, unpaired spine large, sturdy, projecting over mouth. Furrow spines 7, 8 on either side of unpaired spine; suboral spines in 2 or 3 rather irregular rows, most anterior largest, most conspicuous, projecting over unpaired spine. *Ambulacral grooves* deep, *tubefeet* in 2 very regular rows, well separated. Only 1 arm tip intact — *terminal plate* large, oval, naked with a few small irregularities.

In the holotype (NZOI Stn J45, H-159; Pl. 32) paxillae in the papular areas are distinctly hexagonal; in all other specimens examined, including the smallest specimen (NZOI Stn G953), arm-base paxillae are round or oval. Also in the holotype and in the smallest specimen (G953) superomarginal granules are enlarged and more conspicuous near inferomarginals but there is no enlargement into distinct spines as in all larger specimens.

Another difference is the restriction of papulae. The two smaller specimens (holotype and G953) have papulae restricted to a large triangular area at the base of each arm; in all larger specimens papulae are present for at least three-quarters the length of each arm.

One specimen was dissected (NMNZ, no data, no registration number), R/r = 140/47 mm: *abactinal plates*, from coelomic side, amazingly regular, forming very even pavement. Plates regularly round to oval. In one area, near arm base, almost midradially, several small oval or irregularly shaped plates present, 2 bridging plates, the third, much larger, lying between 3 plates; accessory plates like these not seen elsewhere. The abactinal plates, internally, overlain by thin membrane. A distinct *midradial (carinal)* single series of slightly larger plates, only really obvious when specimen dry, from which rows of plates pass to margins. Near superomarginal plates outlines of abactinal plates becoming very distinct. *Papulae* obvious and very regular between abactinal plates, 6 papulae around each plate; towards arm tips papulae restricted to arm centre, absent or indistinct laterally along arms and interradially adjacent to superomarginals. *Abactinal plates* overlain by thin, almost transparent membrane, thick, almost hiding plate outlines, near superomarginals. *Interradial septa* large, membranous, conspicuous. *Gonads* irregularly shaped, compact, attached to abactinal plates on either side of septum and lying nearer superomarginals than disc centre. *Gonopores* possibly open between abactinal plates interradially, although no actual pores observed. Small *partial septa* also present interradially, irregular in size and shape, present near interradial septa only. *Superambulacral plates* large, conspicuous, on all but first 2 ambulacral ossicles in each series; ossicles distinct, bar-like, passing straight down from central flange of ambulacral ossicle then at angle to actinal plates; a thick enveloping membrane here. Near arm centre superambulacral plates stretching across actinal plates almost to infero-marginals.

Pseudarchaster sp. (Pl. 33

MATERIAL EXAMINED: NZOI Stn C734(1).

DESCRIPTION: A single small 5-armed specimen, R/r = 8/5 mm, from northwest of Macquarie Island (53°55′ S. 158°55′ E), 360 m.

Disc broad, flat; arms short, uneven in length, very broad basally, tapering especially in last half of arm to tumid, almost heart-shaped or oval, terminal plate; this naked but possibly once covered by granules similar to those of neighbouring abactinal and superomarginal plates; no obviously enlarged spines.

Abactinal plates to arm tips, thus separating superomarginals; outlines of plates difficult to determine: plates with small, angular, similar-sized, flat-topped, very short-stalked granules. At entrance to arms, granules in groups of 4–6; presumably corresponding to plates; generally no obviously central granules in a group, although occasionally smaller granules central on disc; these generally narrowly separated from one another and either square, triangular, or rectangular.

Madreporite, *anus*, *papulae*, and *pedicellariae* not seen.

Narrow, conspicuous, band-like *superomarginal plates* forming definite raised edge to disc and arms, separated from abactinal surface by distinctly naked gutter. Superomarginal plates separated laterally from one another by distinct, narrow, deep gutters. Plates with spaced, mostly square granules similar to those of abactinal plates, at lateral margins of plates forming particularly sharp, well-demarcated edge. At interradius, plates with 3 or 4 longitudinal rows of granules; near arm tips only 1 or 2 rows. Superomarginal plates, near arm tips, with small naked, oval area; slightly swollen, bare of granules, near to abactinal plates these areas less obvious or missing interradially.

Inferomarginal plates large, corresponding with superomarginals, forming very definite edge to actinal surface. Inferomarginal plates tumid, well separated laterally, with regular rows of elongate granules or short, broad-tipped spines, these curving upwards towards superomarginals. A few distinct small, more slender spines along plate edges; 12–18 marginal plates from arm tip to arm tip in each interradius.

Actinal areas small, triangular, plates close-fitting, gently tumid, rather irregular in shape and size, extending to level of 3rd or 4th adambulacral plate, 2nd

Plate 33. *Pseudarchaster* sp. NZOI Stn C734. R/r = 8/5 mm. Abactinal and actinal surfaces.

or 3rd from inferomarginal plates (midradius).

Adambulacral plates with angular projection into furrow, more or less rectangular, each well separated laterally by broad, distinct, regular membranous channel. Furrow spines generally 4, long, slender, blunt-tipped, untapered; subambulacral spines mostly missing, probably forming 2 or 3 rows and similar to actinal spines.

Oral plates quite tumid, with conspicuous short, sturdy, triangular, finely thorny spine. Oral furrow spines in 2 distinct series; first 2 or 3 small spines on either side of single spine markedly triangular, finely thorny, passing steeply into furrow; above these as regular edge to plate are 5 or 6 slender, spaced, blunt-tipped untapering spine, similar to adambulacral furrow spines; at least 1 row of suboral spines along junction of 2 plates in angle, these mostly damaged or missing.

Ambulacral grooves well-developed, quite deep; *tubefeet* in 2 rows separated by broad area, with well-defined sucking discs.

REMARKS: The very broad disc and short, rather ill-defined uneven arms are distinctive. The short, sturdy, large triangular, single oral spine is also conspicuous; however, it seems in young specimens in this genus, that this is often the case. The presence of enlarged granules or short spinelets on the inferomarginals is similar to the condition seen in *Pseudarchaster macdougalli* McKnight.

Notes on small (i.e., R = 20 mm or less) specimens of *Pseudarchaster*: In most small specimens *terminal arm plates* oval, heart-shaped, almost round with generally two enlarged spines, sometimes covered by small granules. Outline of *abactinal plates* and form of *abactinal paxillae* or granules often indistinct; occasionally, however (NMNZ Ech. 5328, 6 specimens from near Mayor Island, Bay of Plenty, R = 10-5 mm, r = 4, 3, 2 mm), plate outlines very distinct; often a gently raised *radial primary plate*, and sometimes 3 or 4 plates forming the beginning of carinal series along the arm. *Madreporite* obvious in only 2 of 23 young specimens examined. In one specimen (NZOI Q29, R/r = 10/4 mm) from near Chatham Islands, madreporite small, almost square, lying midway between disc edge and centre; in another specimen (NMNZ Ech. 5328, northwest of Mayor Island, Bay of Plenty, R/r = 9/4 mm) madreporite very tiny, very near superomarginal plates, comprising ca. three distinct ridges in small clearing.

In all small specimens, *superomarginal plates* conspicuous, forming well-defined and often slightly raised edge to disc and arms; superomarginals from opposite sides of arm separate to arm tips. No superomarginals with spines, but distinct *bare patches* variably present in all specimens with R 20 mm or less; these patches often oval, sometimes distinctly rounded, conspicuous on upper part of superomarginals and often separated from abactinals by row of granules. Two most distal superomarginals adjacent to single terminal plate mostly without bare patches; patches

absent or small interradially; the bare patch often distinctly tumid. *Inferomarginals* also with bare patches, these tumid or flat, either restricted to interradial regions or more obvious near arm tips.

Also in small specimens, single *oral spine* large, distinctive, finely thorny, often almost triangular; on either side of it 3 (sometimes only 2) small, similarly thorny, flattened, sharp-tipped spines dipping sharply towards mouth. Remaining oral furrow spines present behind these, but at higher level; in larger animals a fringe of oral furrow spines more usual. Generally *adambulacral furrow spines* constant; 4 or 5 small, well-separated distinct spines, angular projection of the adambulacral plate most obvious near arm tip.

Three very small specimens from deep water south-east of Cape Campbell (NMNZ: Ech. 5578 (BS670), 939-1019 m, mud, R/r approx. 5-4/2 mm) of particular interest, having enlarged, conspicuous inferomarginal spines; these rather flattened, round-tipped at distal end of bare patch of inferomarginals, overhanging free edge of animals. In best-present specimen 7, 7, 9 (or 10), 5 + 6 enlarged *inferomarginal spines* respectively. Abactinal surface with rather indeterminate *abactinal plates*, no obvious *madreporite* similar to that already described, likewise *superomarginals* with large conspicuous tumid bare patches on all plates, except perhaps most distal. *Terminal arm plates* interesting: tumid, broadly heart-shaped, conspicuous, fringed by small, round, spaced granules similar to those of adjacent superomarginals; at tip of plate between 2 conspicuous enlarged spines an indentation, almost divided; accompanying granules or short spines slightly larger, more obvious. The enlarged terminal spines broad-based, rapidly tapering, blunt-tipped, very finely thorny. In most other respects these three specimens similar to those already described, with 4 or 5 *adambulacral furrow spines*, large single *oral spine*, 4–6 *oral furrow spines*, and conspicuous row of short, spaced spines (granules) along junction of 2 oral plates in angle. Distally, however, in last half of arm, generally 2 subambulacral spines elongated, slightly flattened, tapering in last half; these conspicuous, giving arm tip a distinctly "shaggy" appearance; 2 most distal of these spines showing between enlarged terminal spines, obvious from abactinal surface.

Another slightly larger specimen (R/r = approx. 7/3 mm, also from near Cape Campbell, NMNZ: Ech. 5523 (BS 669)) also with enlarged inferomarginal spines; these smaller and less conspicuous than in the specimen just described. Likewise, subambulacral spines near arm tips slightly enlarged but much less conspicuous than in smaller specimens.

Pseudoceramaster Jangoux, 1981b

Disc pentagonal, arms relatively long. Abactinal plates forming a very close network, plates never tabulate. Abactinal, marginal, and actinal plates with close covering of granules; no enlarged spines. Adambulacral and actinal plates sometimes with straight pedicellariae. Adambulacral plates with well-ordered rows of spines; furrow spines long and slender, all adambulacral spines and granules in very regular rows.

TYPE SPECIES: *Pseudoceramaster regularis* Jangoux, 1981b

TYPE LOCALITY: Philippine Islands, 14°09′ N, 120°26′ E, 174–204 m.

REMARKS: This new genus described by Jangoux (1981b) is distinct from *Ceramaster* as the abactinal plates are not tabulate. The genus includes, besides the type species *Pseudoceramaster regularis* from the Philippines, *Pentagonaster pulvinus* Alcock (1893) from the Laccadive Sea, Indian Ocean, 2195 m, *Pentagonaster misakiensis* Goto (1914) from Misaki, Japan, 560 m, and *Pseudoceramaster hunti* McKnight (1993a) from the Three Kings Rise, north of New Zealand.

A.M. Clark (1993: 282) included only the type species *regularis* Jangoux, 1981b in *Pseudoceramaster*. She retained *P. pulvinus* in *Pentagonaster* and *P. misakiensis* as *Ceramaster*.

Pseudoceramaster hunti McKnight, 1993a (Pl. 34)

Pseudoceramaster hunti McKnight, 1993a: 171, 185, figs 3, 4.

MATERIAL EXAMINED:
NZOI Stn U591 (1) (Holotype H-613).

SIZE: R/r = 40/16 mm.

DISTRIBUTION: Known only from the Tui Guyot, Three Kings Rise, north of New Zealand.

DEPTH: 486 m.

DESCRIPTION: Holotype, H-613 (NZOI Stn U591), the only specimen.

Disc broad, large in relation to slender, rather short arms; disc gently raised, arms more or less flat, 1 arm broken. *Terminal plates* small, on 3 arms only; plates almost heart-shaped, naked, no spines or granules, probably lost.

Abactinal plates at disc centre smaller than radial plates of arms, irregular in shape and size, forming very close-knit skeleton; no obvious secondary plates. At arm

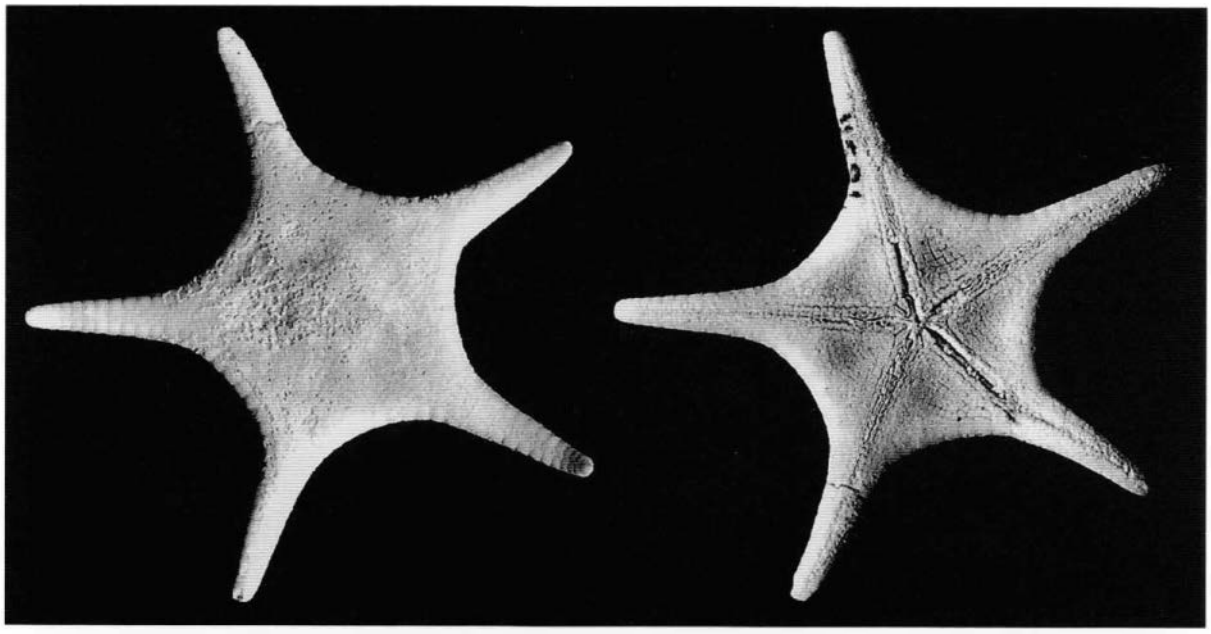


Plate 34. ***Pseudoceramaster hunti*** McKnight. Holotype. NZOI Stn U591. R / r = 40/16 mm. Abactinal and actinal surfaces.

entrance a distinct carinal series of plates; these initially hexagonal and regularly arranged; further along arms centre plates less regular in shape, varying from almost triangular, rectangular, irregularly oval, to more or less circular. One row of plates between superomarginals of opposite sides of arms with distal 6 or 7 superomarginal plates in contact medially. Abactinal plates more or less flat, not tabulate, occasionally slightly raised; granules forming uniform covering on plates, obscuring plate edges. Radially, near arm entrance, 15 or 16 granules around plates, enclosing 10 or 12 similar central granules. All granules similar, small, rounded, occasionally flat-tipped, equally spaced, forming very regular cover; plate outlines difficult to see without removing covering granules. Interradially, plates irregular in shape and size, but close-knit, with similar-sized granules.

Papulae not seen, but probably present between carinal plates; a faint indication of papulae midway along 1 arm.

Pedicellariae not obvious.

Madreporite very small, interradial, near disc centre; almost triangular with coarse, shallow sculpture.

Anus not seen.

Superomarginal plates forming definite, but not very obvious, margin to disc and arms; 35–37 plates from arm tip to arm tip. Interradially, superomarginal plates very regular, wider than long, shorter towards arm tips, almost square. Distal 9 or 10 superomarginal plates with distinct oval to round, often gently raised, naked areas near abactinal edge; in general, state of arms in only specimen poor, many plates devoid of granules, but with scars; in contrast, oval raised areas smooth, almost polished, suggesting granules were not present. Elsewhere, superomarginals with regular covering of granules, like those of abactinal plates, in regular longitudinal and transverse rows, especially conspicuous along lateral margins of plates.

Inferomarginal plates not obvious from abactinal surface, generally corresponding with superomarginals, especially interradially. Granules similar to those of superomarginals, but rows less regular, granules possibly slightly smaller; plates abraded near arm tips, granules missing; no obvious pedicellariae.

Actinal areas more or less triangular, generally inferomarginal plates meeting with adambulacrals at level of 5th or 6th inferomarginal plate from interradial angle. Actinal plates regularly arranged in chevrons; arrangement and size less regular near inferomarginals, with rows of regular, spaced, granules similar to those of abactinal and marginal plates, but more spaced. Row of plates adjacent to adambulacrals largest, each almost square, some especially proximally, with bivalved, sugartong-like straight *pedicellaria*; free edges of blades often roundly toothed; pedicellariae with slender stalks and often flanked by conspicuous rectangular granules. A small rectangular pit basally between blades. Actinal plates gently raised, well separated by conspicuous clear channels.

Adambulacral plates regularly rectangular, narrow edge to furrow, separated laterally by distinct membranous areas. Furrow spines generally 6, sometimes 7, occasionally 5 proximally; distally along arm, 7, sometimes 8. Furrow spines forming trim, very regular

edge to furrow, slender, not tapering, flattened, narrow edge to furrow and plate, round-tipped. Behind furrow spines 3 (occasionally 2) large, sturdy, round tipped, bat-like, rather flattened, subambulacral spines, broad face to furrow; these well separated from furrow spines. Between larger spines and actinal plates, 2 well-ordered rows of granules, each with 3, sometimes 4 granules (or short spines). Further out along arms 3, 4, or even 5, rows of very close granules, often rather angular. Adambulacral plates separated from neighbouring actinal plates by a wide membranous channel. Several adambulacral plates, especially proximally, with a distinct, straight, long-stemmed *pedicellaria* formed by spines of first subambulacral row.

Oral plates large, distinct, with generally 11, sometimes 10, furrow spines; these similar to adambulacral spines, flattened, almost leaf-like but not tapering, narrow edge to furrow, flat-tipped. On actinal surface of plate, furrow spines paralleled by row of 3 or 4 larger, flattened, spaced, spines similar to those of adambulacral plates, forming row close to furrow spines. Several small rows of short, truncated granules parallel to suture between 2 plates.

Ambulacral grooves narrow, deep; *tube feet* not seen.

COLOUR: No colour notes of living material; dried (ex-ethanol) cream-white.

REMARKS: *Pseudoceramaster hunti* McKnight, *P. regularis* Jangoux, and *P. pulvinus* (Alcock) all have bare areas on distal superomarginal plates and pedicellariae are present in all three species on the adambulacral plates. The number of adambulacral furrow spines is also more or less similar in all three species. *Pseudoceramaster regularis* Jangoux from the Philippines differs, however, in having two sorts of granules present on the abactinal plates — cuboid granules peripherally and round granules centrally. Although there are differences in the number and arrangement of subambulacral spines and granules, these may eventually be seen as variations if more material becomes available. *Pseudoceramaster misakiensis* (Goto) has many abactinal and superomarginal pedicellariae; these are not present on actinal plates however, and there are differences also in the subambulacral spines.

McKnight (1993a: 171) did not record either the bare patches on the distal superomarginal plates or the pedicellariae on adambulacral and actinal plates.

Rosaster Perrier, 1894

Disc well defined with arms long, slender, tapering, distinct. Superomarginal plates, from opposite sides, meeting in radial midline. Abactinal skeleton strong, with distinct bar-like ossicles connecting abactinal plates, most obvious from coelomic side. Abactinal plates tabulate, especially midradially where papulae also very conspicuous; a well-defined, occasionally raised, radial petaloid papular area. Hyaline granules (bodies) often present on marginal plates, sometimes elsewhere on body also. No superambulacral plates; gonads generally in tufts interradially.

Type Species: *Pentagonaster alexandri* Perrier, 1881.

TYPE LOCALITY: Off Sandy Bay, Barbados, Caribbean Sea, 183 m.

REMARKS: Two goniasterid genera, *Mediaster* and *Rosaster*, have internal skeletal connecting ossicles, but can be separated by the arrangement of the abactinal plates in the arms. In *Mediaster*, abactinal plates are present to the arm tip, i.e., superomarginal plates from opposite sides of the arm are separate; in *Rosaster* superomarginal plates from opposite sides of the arm meet in the midline, generally near the arm base.

DISTRIBUTION: The genus is known mainly from tropical waters in the Indian, Atlantic, and Pacific Oceans.

KEY TO THE NEW ZEALAND SPECIES OF *ROSASTER*

1 (2) Subambulacral spines in 3 well-defined rows; superomarginal plates with close covering of uniform, small, generally round granules, none enlarged. Hyaline granules few, inconspicuous or absent ..... *mimicus*

2 (1) Subambulacral spines in 2 well-defined rows; superomarginals with spaced granules, distinctly longer near free edge of plate. Hyaline granules obvious, numerous ..... *endilius*

Rosaster endilius McKnight, 1975 (Pl. 35, Fig. 35)

Rosaster endilius McKnight, 1975: 54, fig. 2; H.E.S. Clark 1982: 38; A.M. Clark 1993: 283; McKnight 1993a: 184.

MATERIAL EXAMINED:
NZOI Stns: J678(1), U591(1), Z2098(1) (holotype H-176).

SIZE: No arms intact, all measurements approximate only. J678: R/r = approx. 65/24 mm; U591: R/r = approx. 45/20 mm; Z2098 (holotype): R/r = approx. 50, 51/21 mm.

DISTRIBUTION: From north of New Zealand, Three Kings Rise, and from the Bay of Plenty.

DEPTH: 352--850 m.

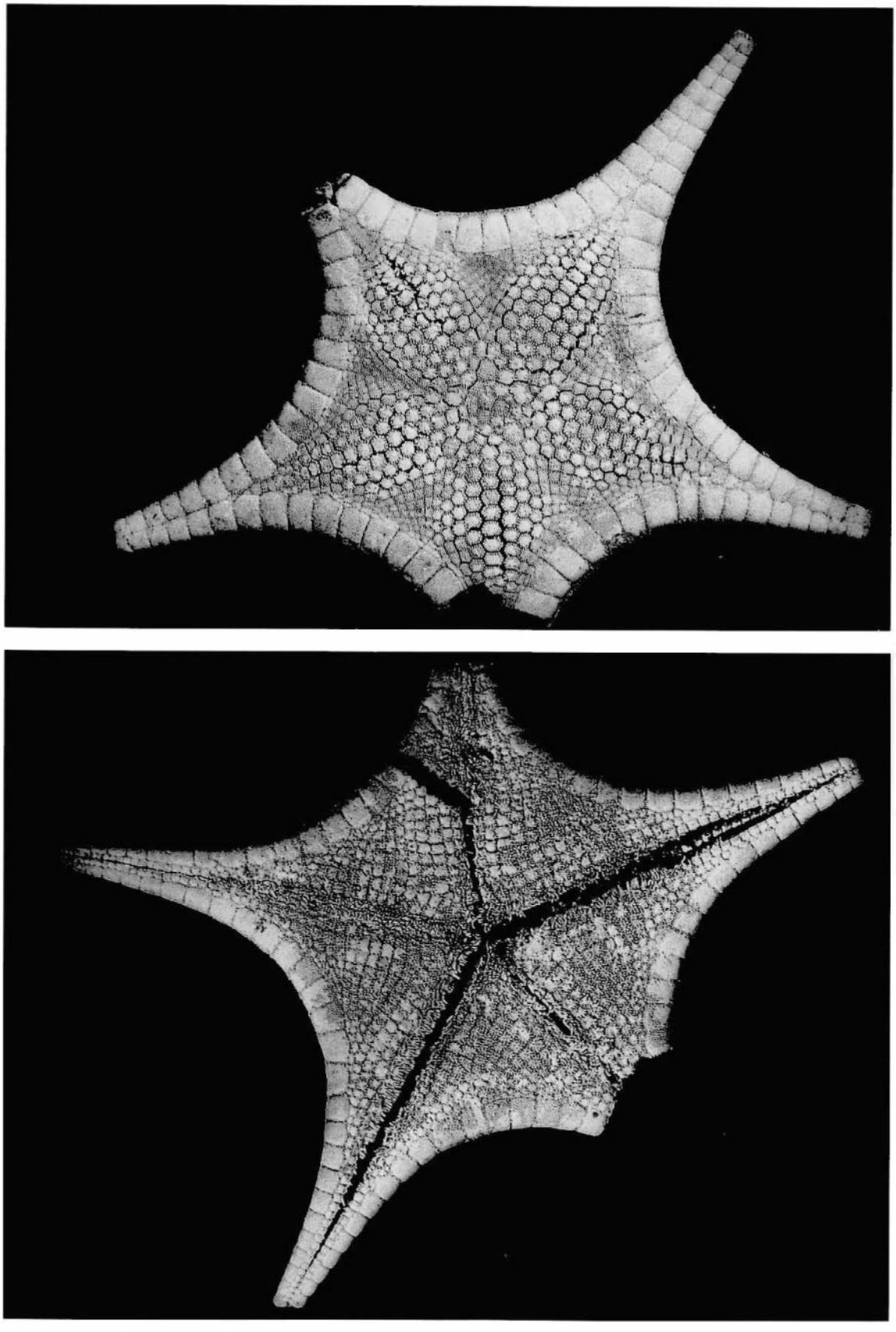


Plate 35. *Rosaster endilius* McKnight. Holotype. NZOI Stn Z2098. R/r = 50, 51/21 mm. Abactinal and actinal surfaces.

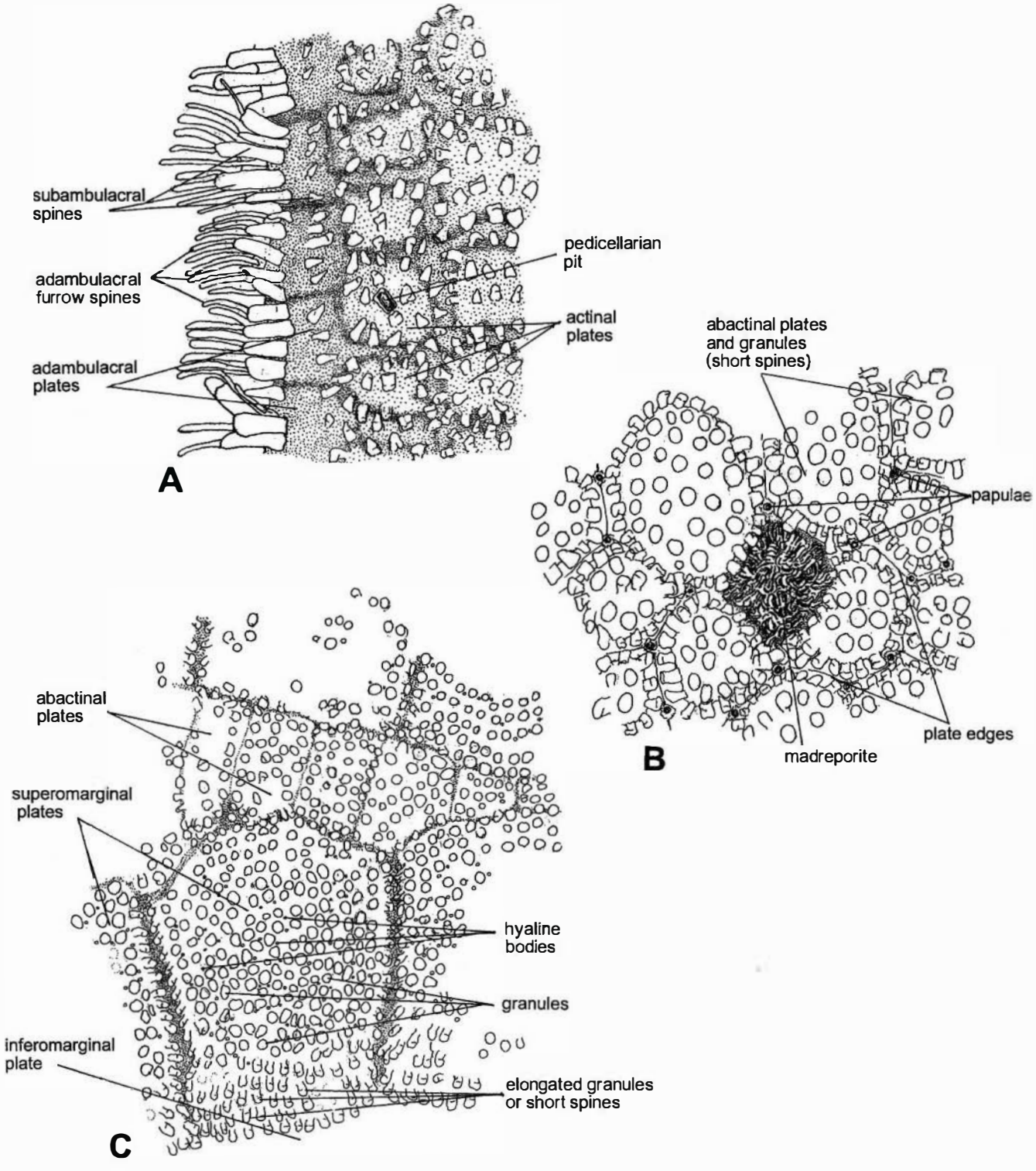


Fig. 35. ***Rosaster endilius*** McKnight. **A**. Adambulacral and actinal plates near beginning of arm. **B**. Abactinal plates near madreporite. **C**. Superomarginal and abactinal plates near arm-base. Note the hyaline bodies (granules) on superomarginal plates.

DESCRIPTION: Specimen described is from NZOI Stn J678, Bay of Plenty area, 37°24.70′ S, 177°12.00′ E, 352 m.

Disc large; arms 5, 4 broken, tip of 5th missing; arms distinct from disc, rather short, tapering evenly and rapidly. *Interbrachial arcs* widely, smoothly, rounded; margins more or less vertical and formed largely by superomarginal plates; abactinal and actinal surfaces almost flat. Along *arms* abactinal plates distinct, tabulate, regularly hexagonal; *carinal* row of plates also hexagonal, slightly enlarged, with 15–20 marginal granules (short spines), these truncated, almost triangular, well separated, forming very even, strong edge to plate; centrally 14–16 spaced distinct granules (very short spines). These carinal granules generally round, sometimes gently angular, of similar size, in distinct rows. Plates smaller bordering carinal series, but distinct, in 2 or 3 rows; bordering plates often almost pentagonal or rectangular. Along arms, near junction of superomarginals, carinal plates less obvious, granules small, and marginal series rather ill-defined. Interradially, abactinal plates almost square, very regularly arranged in precise, clearly separated rows, with 14 or 15 spaced marginal spinelets similar to those of carinal series; centrally, generally 6, sometimes 8, distinct, round well-separated granules or short spines, as tall as, possibly taller than, marginal granules of spines. Near disc centre 5 enlarged interradial plates, each with 27–36 peripheral spaced granules enclosing 30–36 spaced granules. Centrally, on disc, plates rather irregular in size and shape. No abactinal pedicellariae.

Papulae restricted to radial and central disc areas, 6 between plate lobes, small, round, most obvious when viewed from coelomic side, fewer in number and less distinct near superomarginal plates. Papulae absent from wide, interradial area.

Madreporite raised, coarsely, deeply, and irregularly dissected, almost diamond-shaped, lying very near disc centre; surrounding plates fitting very closely around it.

Anus not obvious.

Superomarginal plates forming conspicuous edge to disc and arms; probably 22 or 24 (arm tip missing) from interradial midline to arm tip. Superomarginal plates from either side of arm meeting at 5th or 6th plate from interradial midline, each with fairly regular rows of small, spaced, rather round granules or short spines similar to those of abactinal plates. Granules along lateral edges very regular in spacing and size; more or less corresponding to similar granules from neighbouring plates; plates laterally separated by distinct shallow membranous channels. Towards free edges of superomarginal plates granules (short spines) distinctly longer, forming definite, almost shaggy, edge to plates. Small, distinct, round hyaline granules on superomarginal plates between and at base of granules, in fairly regular rows, most obvious near abactinal plates, no conspicuously enlarged superomarginal spines or granules.

Inferomarginal plates corresponding to superomarginals, covering granules (short spines) very similar; *hyaline granules* few, indistinct; no conspicuously enlarged granules or spines but well-marked row of slightly taller granules and conspicuously narrow and naked channel between inferomarginal and actinal plates.

Actinal areas distinct, large; plates more or less square, similar to abactinal interradial plates, but slightly more tumid, with distinctly triangular granules. Occasional bivalved pedicellariae, 1 per plate; on plates bordering adambulacrals, pedicellariae similar to those of *Rosaster mimicus*; occasional rectangular pits also on these plates and faint depressions on either side probably indicating pedicellarian valves.

Adambulacral plates forming very regular, straight edge to furrow; distally along arms free edges definitely convex, plates meeting with neighbouring plates across furrow "pocketing" tubefeet pair. Adambulacral plates with 9 or 10 furrow spines proximally, 11 or 12 distally. Furrow spines long, slender, flattened, thin edge to furrow and plate; flat-tipped, of similar size except for proximal 1 or 2 spines which may be smaller. Distinct naked channel between these and subam-bulacral spines. Latter 4, occasionally 5, very regular, spaced, blade-like, flattened but with broad side to furrow and actinal plates, webbed basally for short distance and, while not as tall as furrow spines, in conspicuous row. Outside these, well separated, generally 4, occasionally 5, short, squat, granules fringing actinal edge of plate.

Oral plates long, narrow, separated medially in angle by wide, rather indistinct membranous area. Furrow spines 12 or 13, most anterior 1 or 2 distinctly larger, flattened, broad, round-tipped, narrow edge to furrow; immediately behind these similar but shorter spines adjacent to actinal plates and parallel to furrow; generally 2 rows of short angular granules or spines parallel to suture between two plates. A distinct 3-bladed, short, sturdy pedicellaria often present near narrow posterior part of oral plate; 2 may be present in angle, 1 on either side, or only 1 present. [These pedicellariae very similar to those in *Rosaster mimicus*; oral furrow spines in *Rosaster endilius* longer, more slender.]

Ambulacral grooves narrow, deep; *tubefeet* biserial, with sucking discs.

COLOUR: No colour notes of living material; dried or in alcohol, more or less white to faintly brown.

REMARKS: Similarities and differences between the two

New Zealand species of *Rosaster* are discussed in the description of *R. mimicus*.

Rosaster mimicus Fisher, 1913 (Pl. 36, Fig. 36)

Rosaster mimicus Fisher, 1913: 632; 1919: 250, pls 62(1), 65(1), 70(1), 91(4, 4a, 4b); H.E.S. Clark 1982: 38, figs 8, 9; Rowe 1989: 289; A.M. Clark 1993: 283; McKnight 1993a: 184; Rowe & Gates 1995: 69.

MATERIAL EXAMINED:

NZOI Stns: I7(1), I355(17), I368(1), K861(3)*, P66(1), P68 (2).

NMNZ: southeast of Alderman Islands: Ech. 3783(1); off Cape Reinga: Ech. 4094(1); Chatham Rise: Ech. 3782(1); Norfolk Ridge: Ech. 3781(1).

SIZE: R = 84-31 mm, r = 31-9 mm, R/r average for seven specimens (these specimens were the only ones in which there was at least one, generally only one) arm intact — average is 59/19 mm.

DISTRIBUTION: Norfolk Ridge and Wanganella Bank, Kermadec Islands, east coast of North Island from Cape Reinga to Bay of Plenty, and from Chatham Rise.

DEPTH: 178–1030 m (NZOI StnK861 specimens, 1030 m not seen).

DESCRIPTION:

Specimen described is from NZOI Stn I355, from near North Cape, North Island, New Zealand (34°50.10′ S, 174°06.20′ E, 330 m); R/r = 57/19 mm.

Disc more or less flat, broad, distinct, slightly raised radially where papular areas petaloid; interbrachial arcs well rounded. *Superomarginal plates* from opposite sides of arms meeting at beginning of arms, at 6th or 7th superomarginal from interradial angle. No abactinal plates for most of arm length, however in at least 2 arms a diamond-shaped abactinal plate at junction of following 2 superomarginal plates. One *terminal arm plate* intact, almost egg-shaped, bearing no granules or spines.

Abactinal plates, radially, most conspicuous; clear-cut, precise, well separated from one another, most plates distinctly hexagonal, gently convex. Carinal row of regular, slightly larger, hexagonal, well-separated tabular plates bordered by 20–26 small, distinct, separate, wedge-shaped granules (very short wedge-shaped spines), enclosing 20–34 often round-headed, sometimes almost angular, spaced granules. Proximally 3,

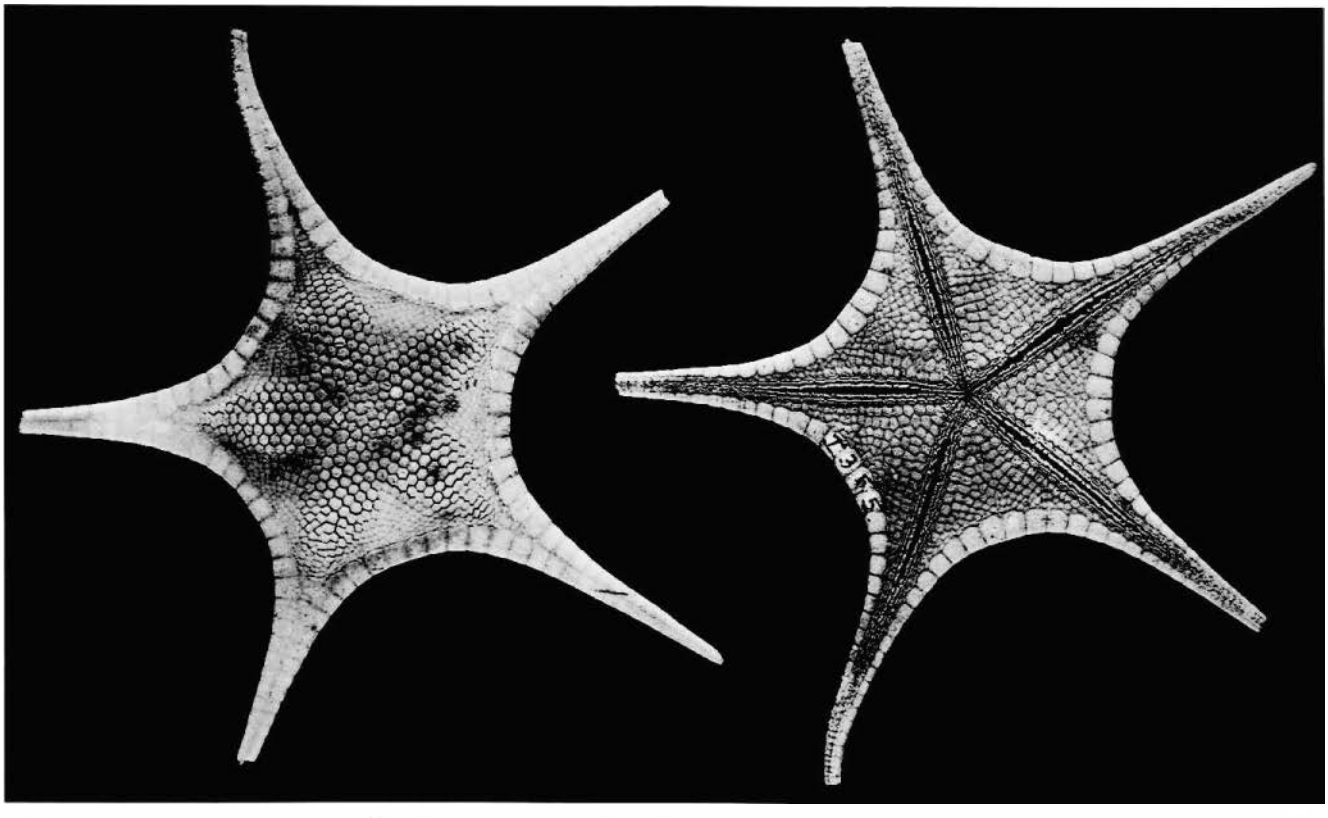


Plate 36. ***Rosaster mimicus*** Fisher. NZOI Stn I355. R/r = 57/19 mm. Abactinal and actinal surfaces.

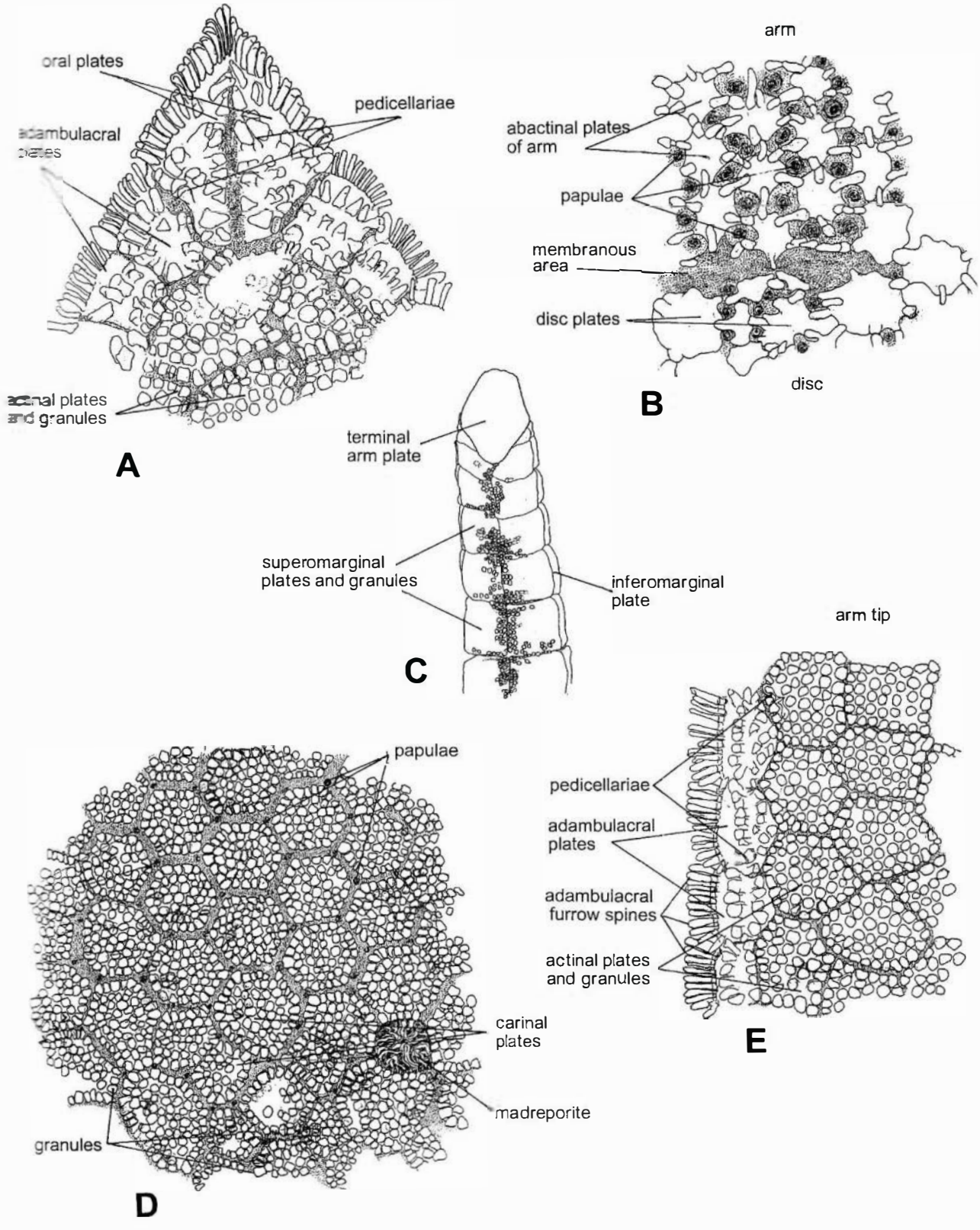


Fig. 36. *Rosaster mimicus* Fisher (dissected specimen). **A**. Oral, adambulacral, and actinal plates. **B**. Abactinal, arm, and disc plates, from coelomic side. **C**. Arm tip with terminal plate and supero- and inferomarginal plates. **D**. Madreporite and surrounding abactinal plates. **E**. Adambulacral and actinal plates

then 2 rows of plates on either side of carinal series. Distally along arms plates irregular in shape and size, marginal granules less distinct, carinal series of plates not obvious. Interradial abactinal plates small, often more or less square, rectangular, or pentagonal near radial series forming more or less regular rows, but arrangement somewhat confused near superomarginals. Interradially, plates flat, forming fairly close mosaic, marginal and central granules not particularly conspicuous. At centre of disc plates raised, rather irregular in arrangement and size. No hyaline granules (glassy plates).

Papulae radial, between plate lobes, generally 6 around each plate, especially conspicuous between carinal and neighbouring plates.

Straight *pedicellariae* on disc plates and superomarginals interradially and radially; not common.

Madreporite small, irregularly round, coarsely dissected, interradial very near disc centre.

Anus possibly a small rectangular opening between paxillae at disc centre.

Superomarginal plates forming well-defined edge to disc, meeting centrally in midline of arms. Plates rectangular with regular cover of small, round, or slightly angular separated granules, these bordering lateral edges of plates generally in 2 rows, slightly raised, more conspicuous, more regularly arranged. Some superomarginal plates, especially interradially, with small, straight, quite conspicuous 2-, occasionally 3-bladed *pedicellariae*, often only distinct rectangular pit remaining; 2 or 3 pedicellariae per plate, small, almost soup-spoon-shaped with slender stalk and rounded, toothed (2–5 small teeth) blade; when flat, blades conforming to slender, naked depressions on plate.

Inferomarginal plates not very obvious from abactinal surface, corresponding exactly to superomarginals and with similar granules; marginal series of granules less conspicuous. No obvious pedicellariae; three-quarters of inferomarginal plate on actinal surface.

Actinal interradial areas with close paving of rather irregular plates, similar to abactinal interradial areas. Plates adjacent to adambulacrals forming fairly regular row, often with 1, sometimes 2, straight pedicellariae similar to those described; an occasional 3-bladed pedicellaria, especially further along arms.

Adambulacral plates forming definite, well-ordered edge to furrow; plates rectangular, well separated from each other laterally; near oral plates, free edge of plate more or less straight, near arm tip, plate edges evenly rounded. *Adambulacral furrow* spines 9–14 proximally, up to 16 near arm tips, of similar size except for proximalmost which is generally distinctly shorter; furrow spines compressed laterally, narrow edge to plate and furrow, free edges often eroded centrally, resulting in cleft-free edge. Between furrow spines and thick-set subambulacral granules (short spines) a distinct, conspicuous, regular gap. Subambulacral granules generally in 3 rows; first row strong, with 5–7 granules parallel to furrow spines and distinctly shorter than them; anteriormost 2 or 3 forming distinct 2- or 3-valved pedicellaria. Distally along arm 8, even 9, subambulacral granules. Behind first subambulacral series 2 further rows of similar but fewer granules; these spaced, short, often angular. Occasional thick-set, strong, straight pedicellariae on some adambulacral plates, less common near arm tips; their pedicellariae gently curved at free edge.

Oral plates large, distinct; 2 plates in an angle distinctly arrow-shaped. Furrow spines 16 or 17, forming regular edge to furrow, similar to adambulacral furrow spines, narrow edge to furrow and plate; anteriormost spine narrow, longly triangular. One to 3 rows of shorter, very sturdy suboral, angular granules may form 2- or 3-jawed distinctive, short, sturdy pedicellariae especially in last half of plate. A broad membranous area between 2 oral plates in an angle.

Ambulacral grooves deep, narrow, proximally and distally, somewhat broader medially.

Tubefeet biserial with distinct sucking discs.

COLOUR: No colour notes of living material; dried, ex-ethanol, uniform light brown ranging to almost white.

REMARKS: The species is also known from the Philippine Islands, in 368-454 m. Some differences were noted by H.E.S. Clark (1982: 38). Fisher's (1919: 251) description of pedicellariae is perhaps somewhat misleading; his illustration (pl. 91, 4a), however, shows a slender pedicellaria with an enlarged spoon-like head similar to that seen in the present specimens. Probably the greatest variation occurs in the presence and number of pedi-cellariae. In one specimen of *Rosaster mimicus* (NZOI Stn I368; R/r = 57, 58/18 mm) there is a very constant row of upright straight pedicellariae on the row of actinal plates adjacent to the adambulacrals; there is one pedicellaria only, almost central, per plate and they are present along the arms almost to where the actinal plates cease. The blades of these pedicellariae end in 4 or 5 distinct teeth which interlock with teeth from neighbouring blades; the free edges of the pedicellaria bend inwards, making the pedicellaria appear very sturdy. This single specimen has one regenerating arm, and a parasitic mollusc interradially and marginally at the base of one arm.

Differences between *R. mimicus* and *R. endilius* include a rather larger and thicker disc and relatively shorter arms in *R. endilius* and closer, more even granulation of abactinal, marginal, and actinal plates in *R. mimicus*; in *R. endilius* the granules on these plates (almost short spines) are more spaced and distinctly

fewer. Other differences include a greater incidence of hyaline bodies (granules) in *R. endilius* where they are particularly obvious on the marginal plates; also in *R. endilius* there is a distinct tendency for the spaced granules (or short spines) to become longer and actually lean towards the free edge of the superomarginal plates. Pedicellariae and adambulacral and oral armature are similar in both species although there are small differences in the numbers of spines. Arrangement and form of abactinal plates, seen from the coelomic side, is also similar. In *R. mimicus* at least near the disc centre, however, two ossicles, one from each plate, meet and often overlap, connecting the lobes of the plates; in *R. endilius* the connecting ossicles are very conspicuous, thick, oblong, and round-ended, and only one ossicle is present. In both species there is a distinct mem-branous interradial septum, and gonads are present as tufts (and appear to open independently) on either side of the septum. There are no superambulacral ossicles in either species.

Sphaeriodiscus Fisher, 1910

Body pentagonal, marginal plates conspicuous, tumid, few. Marginal, abactinal, and actinal plates with spaced granules, marginally forming distinct rows, elsewhere scattered, generally isolated and if granules are removed, shallow depressions remaining. Abactinal radial plates distinctive, several series of plates present on either side of unpaired radial (carinal) row; radial plates generally tabulate, with conspicuous lateral enlargement of granules to form short, distinct, sturdy spines that more or less meet with neighbouring spines and have the "appearance of acting as opercula to protect the papulae beneath" (Fisher 1919: 288). No secondary abactinal plates. Subambulacral armature well developed, well separated from furrow spines. Pedicellariae 2-jawed, spatulate.

TYPE SPECIES: *Stephanaster (Pentagonaster) bourgeti* Perrier, 1885a.

TYPE LOCALITY: North of Cape Verde Islands and west of the Azores, 410–760 m.

REMARKS: The genus is distinct in having enlarged lateral granules (almost short thick spines) on the radial abactinal plates. *Sphaeriodiscus* seems close to *Ceramaster*; there are similarities in spine arrangements of oral, adambulacral, and actinal plates, and species in both genera have an enlarged conspicuous subambulacral spine in the last quarter of the arm.

DISTRIBUTION: Azores and Cape Verde Islands to South Africa (southern Indian Ocean), Hawaiian Islands, the Philippines, and two species from New Zealand waters.

KEY TO NEW ZEALAND SPECIES OF *SPHAERIODISCUS*

1(2) Radial areas restricted, with elongate "kite-shaped" radial plates; enlarged marginal granules (short spines) of these plates restricted to lateral margins . . *maui*

2(1) Radial areas wide with very regular, rectangular radial plates; enlarged marginal granules (short spines) surrounding plates, not restricted to lateral margins . . . . . *irritatus* n.sp.

Sphaeriodiscus irritatus n.sp. (Pl. 37, Fig. 37)

Sphaeriodiscus maui McKnight, 1993a: 169, 185 [non *S. maui* McKnight, 1973a].

MATERIAL EXAMINED: NZOI Stn S572(1) (holotype H-734).

SIZE: R / r = 22 / 17 mm.

DISTRIBUTION: Southeast of Norfolk Island, Norfolk Basin.

DEPTH: 530 m.

DESCRIPTION: Holotype and only specimen is described.

Disc large, pentagonal, largely flat, slightly raised radially, bordered by few large, regular, conspicuous superomarginal plates. *Arms* very short, not distinct. *Terminal arm plate* small, crescent, igloo- or beehive-shaped, no spines, no distinct granules.

Abactinal plates of various shapes: oval, pentagonal, hexagonal, almost square to nearly triangular near margin, with covering of spaced, mostly rounded granules, in more or less regular rows; those bordering plates spaced, slightly larger, more angular, very regular. Radial plates and central disc plates conspicuous, often naked centrally, naked areas with small depressions where granules lost. Occasional bivalved, soupspoon-shaped pedicellariae, sometimes interradially, often on radial plate edges; distinct rectangular, bordered pit between 2 blades. Radial areas broad, almost meeting across interradius, with mid-radial row of hexagonal plates, these flanked by 3 lateral rows of plates; plates bordered on all sides by spaced regular, rectangular or sometimes almost triangular, granules forming a precise, clean-cut edge to plate. Central granules of radial plates often missing, leaving faint round depressions; if present, granules well spaced, round, possibly finely spinous and projecting just above marginal granules. Larger, marginal, horizontally projecting granules sharply truncated, meeting with similar granules from neighbouring plates. En-

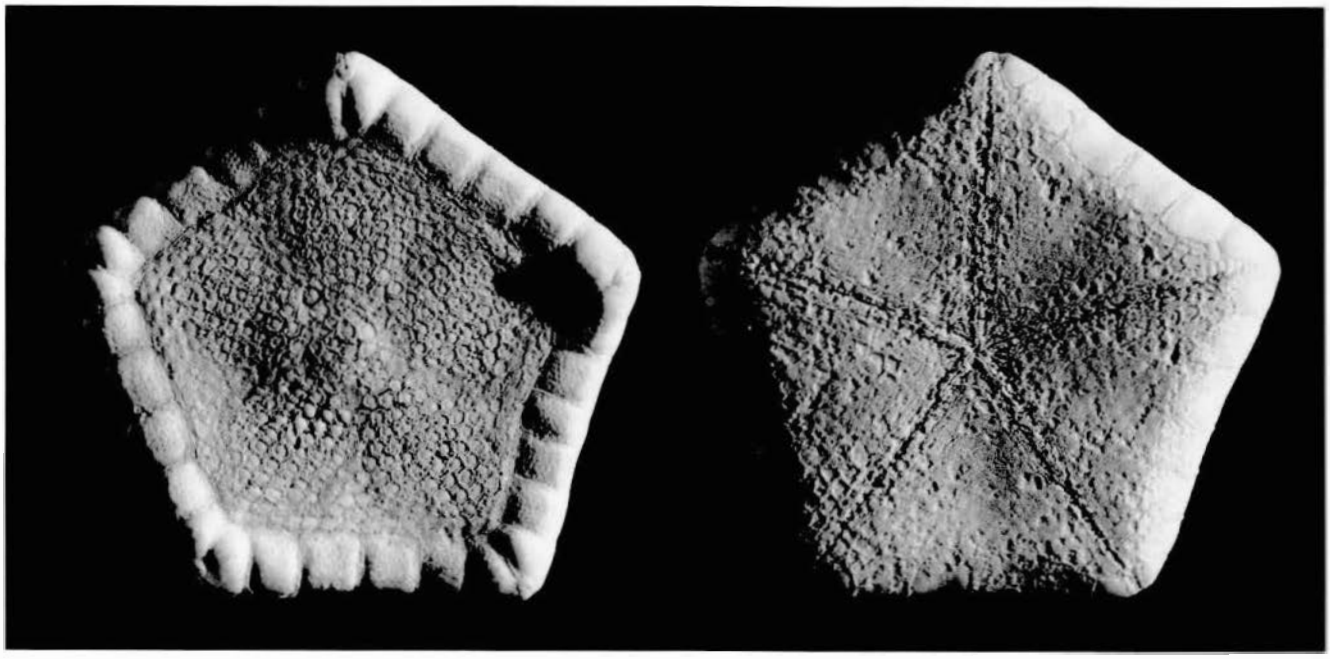


Plate 37. ***Sphaeriodiscus irritatus*** n.sp. Holotype. NZOI Stn S572. R/r = 22/17 mm. Abactinal and actinal surfaces.

larged radial plates not obvious near superomarginals. Centrally on disc, interradially, 2 (remains of 3 others) conspicuous, hexagonal plates with 6 or 7 regular rows of small, round, spaced granules; edging granules larger, angular, spaced, conspicuous.

Papulae radial, indistinct, single, occasionally visible at plate corners.

Pedicellariae few radially; rare, indistinct, interradially.

Madreporite occupying an enlarged, conspicuous interradiate plate slightly sunken, deeply and coarsely dissected, surrounded by 4 or 5 larger, hemispherical plates lying nearer disc centre than edge.

Small opening, possibly *anus*, central on disc, surrounded by 4 enlarged conspicuous oval plates with central granules missing, but scars (depressions) distinct, in regular rows.

Superomarginal plates 6, from arm tip to arm tip, most distal plates largest, tumid; 2 distalmost plates from opposite sides of arm meeting medianly along their length. Plates fringed by regular rows of granules; faint scars suggest small granules near plate edges although central tumid area may have been naked. Superomarginal plates rectangular, with narrow edge to abactinal surface; probably plates had scattering of isolated granules; scars remaining.

Inferomarginal plates of similar size (possibly slightly smaller), more numerous, with 8 or 9 plates from arm tip to arm tip. Last 1 or 2 inferomarginal plates in series distinctly smaller, often tapering, flanked by superomarginal and adambulacral plates. Inferomarginal plates with close covering of rounded granules (similar to those of superomarginal plates) but granules more regularly arranged in definite rows parallel to marginal granules; many granules lost.

Actinal areas large, triangular; plates more or less rectangular with close covering of spaced granules, these slightly larger, more angular at plate edges. Occasional straight pedicellariae, especially on plates bordering adambulacrals, similar to those described above.

Adambulacral plates large, rectangular, with narrow edge to furrow; edge bordering actinal plates and furrows more or less straight. Near mouth, furrow spines 7–9, distally 5 or 6. Spines of similar size (except for proximalmost one which may be shorter) and slightly inset on plate, flattened, round tipped, narrow edge to furrow. Behind furrow spines 3 or 4 rows of rather untidy enlarged granules or short spines, and definite fringe of granules on actinal surface of plate; occasional indistinct pedicellariae.

Oral plates triangular with close furrow series of 12 or 13 spines, these flattened, broad, with narrow edge to furrow; a conspicuous row of round-tipped suboral spines next to furrow spines; a further row of shorter spines or granules bordering membranous area between 2 plates in an angle, sometimes a second, less well-defined row between these and spines paralleling furrow spines.

Adambulacral grooves narrow, *tubefeet* hidden.

COLOUR: No colour notes of living specimen. Dried and

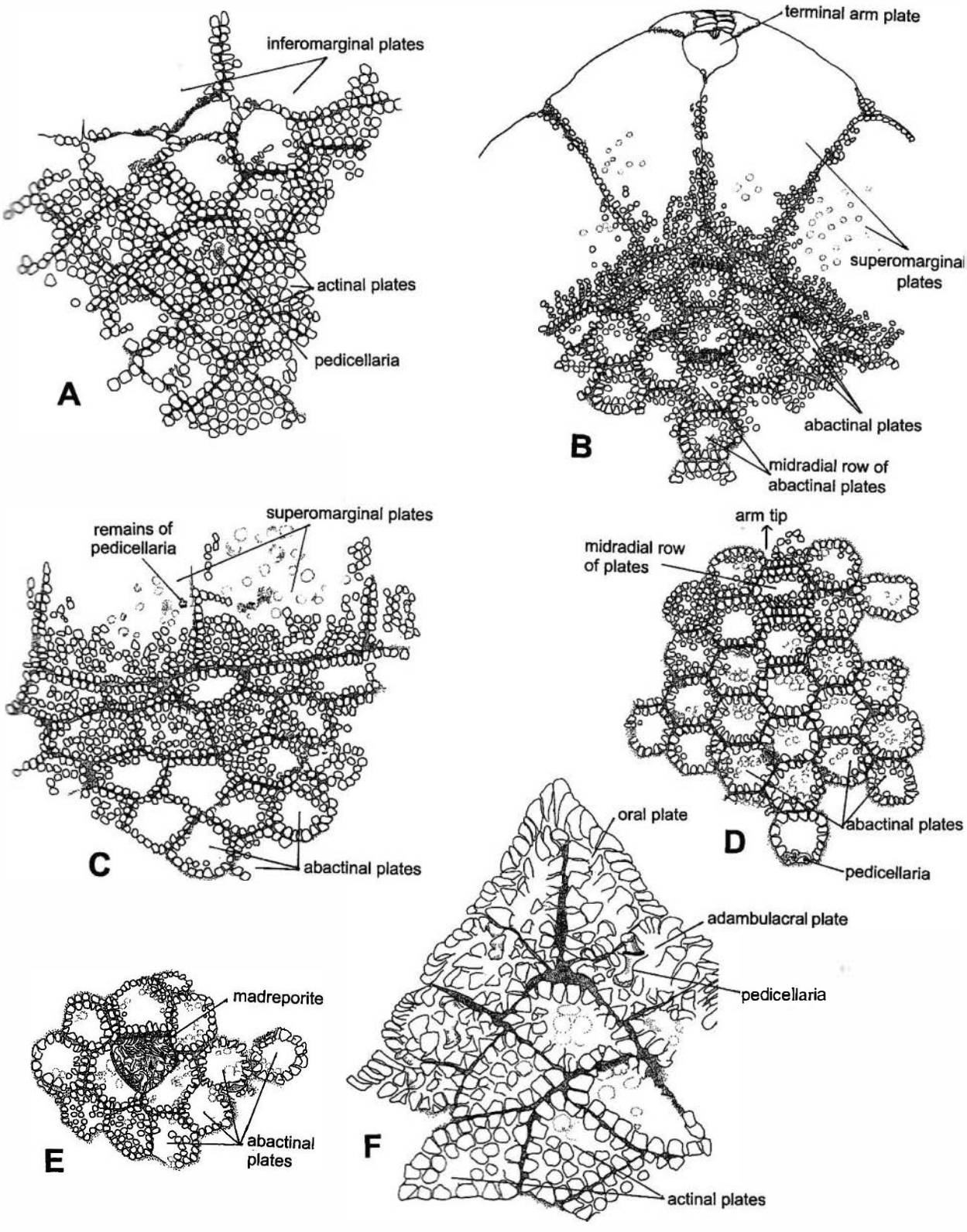


Fig. 37. ***Sphaeriodiscus irritatus*** n.sp. **A**. Inferomarginal and adjacent actinal plates. **B**. Arm tip and adjacent abactinal plates. **C**. Superomarginal and adjacent abactinal plates. **D**. Midradial row of plates and adjacent abactinal plates. **E**. Madreporite and surrounding abactinal plates. **F**. Oral, adambulacral, and actinal plates.

in preservative, very pale brown, almost white actinally.

ETYMOLOGY: The specific name *irritatus* refers to the nuisance of having to describe and illustrate a (probable) new species of such a little-known but widely distributed genus.

REMARKS: This new species differs from the only other known New Zealand species *S. maui* McKnight, in having very large, wide, abactinal radial areas with different shaped plates — in *S. irritatus* they are more or less rectangular and very regular; in *S. maui* plates are more elongate, kite-shaped, and the radial area is restricted. In *S. maui* also the enlarged marginal granules (short spines) are most conspicuous on lateral margins of the radial plates; in *S. irritatus* the marginal granules spines all stand out from the plate edges. Most noticeable of all in *S. irritatus* are the conspicuous, tumid, distalmost superomarginals on either side of the terminal plate (in *S. maui* the penultimate superomarginals are distinctly smaller). Fisher (1906: 1052) discussed *S. ammophilus* and suggested that "young specimens show more irregularity in the number of marginal plates, since the small distal plate may be absent." It is possible, if more material is collected, that *S. irritatus* may be shown to be a young stage of *S. maui*, especially recalling Fisher's remarks (above) concerning the small distal plate.

Sphaeriodiscus maui McKnight, 1973a (Pl. 38, Fig. 38)

Sphaeriodiscus maui McKnight, 1973a: 187, fig. 8; A.M. Clark 1993: 284.

MATERIAL EXAMINED:
NZOI Stns E902(1), K861(1), KAH0006/45(4A).

SIZE: R/r = 39/29 mm to smallest specimen from KAH0006/45, R/r = 19.14 mm.

DISTRIBUTION: Aotea Seamount, west of Auckland, New Zealand, and Macauley Island, Kermadec group.

DEPTH: 926–1180 m.

DESCRIPTION is of the holotype from NZOI Stn E902, R/r = 35/28 mm.

Disc pentagonal, arms poorly defined, *interbrachial arcs* gently concave. Ten *superomarginal plates* between 2 arm tips, distalmost superomarginals smallest in series, meeting with opposite superomarginal in dorsal midline. Penultimate and largest superomarginal also meeting entirely or for much of its length with opposite plate. Inferomarginal plates 14, an extra 2 at either end of series. *Terminal plate* small, distinct, heart-shaped or almost oval, no indication of spines.

Abactinal surface largely flat, slightly raised radially; *abactinal plates* gently tabulate, obvious midradial row of plates conspicuous, 7 or 8 plates (in a row) from near arm base to near disc centre. Central plates hexagonal, almost "kite-shaped" (Fisher 1919: 298), slightly larger than neighbouring plates; 2 or 3 similar plates especially near arms, on either side of distinct radial row. Radial plates with spaced, round granules, where granules are lost, a distinct shallow depression remains. On lateral edges of plates, marginal granules replaced by short, spaced, regular rows of thick, strong spines corresponding almost exactly with similar extensions from neighbouring plates; occasionally spines touching, sometimes alternating. Spaced granules elsewhere on plate margins similar to central granules. Occasional straight pedicellariae generally marginal, 2-jawed, with slender stalk, wide base, and expanded head; blades finely toothed; when blades flat, fitting in shallow depression on plate; centrally between blades a distinct well-bordered *rectangular pit*. Interradially, abactinal plates forming close network, especially near superomarginals and disc centre; variously shaped, almost quadrangular, pentagonal, round, oval, all distinctly fringed by generally round, sometimes slightly angular granules surrounding similar, spaced granules.

Pedicellariae also interradial, generally only rectangular pits remaining. Interradially, near margin a distinct area where plates separate and thus conspicuous, ca. 7–20 plates in total. No pedicellariae in disc centre.

Papulae conspicuous radially between spaced plates, generally 6 around each plate. Papular areas well protected by fringing spines of abactinal plates. Small, scattered isolated pores, presumably papulae at plate corners, particularly obvious dorsal to specialised radial plates.

Madreporite small, hexagonal, interradial, near disc centre, intricately and deeply dissected; surrounding plates, although gently raised, not especially conspicuous.

Anus not obvious.

Superomarginal plates large, rectangular, not especially tumid but forming obvious edge to disc and short arms, distalmost plate smallest in series. Ten superomarginal plates from arm tip to arm tip, close-fitting, edged by small, round or oval, very regular spaced granules, remainder of plate with scattered deciduous granules, distinct depressions remaining when granules removed.

Inferomarginal plates large, rectangular, similar to, but slightly larger than, superomarginal plates, 14 from arm tip to arm tip. Margin bordering actinal plates

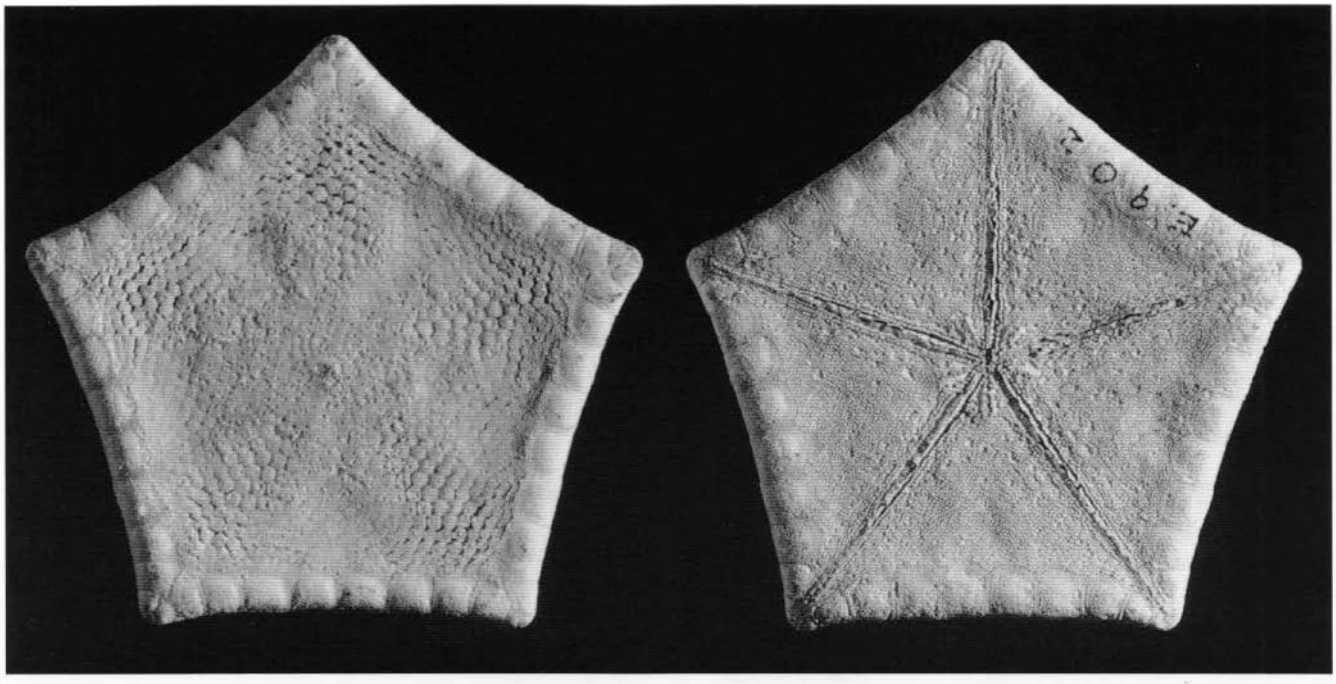


Plate 38. *Sphaeriodiscus maui* McKnight. NZOI Stn E902. R/ r = 35/28 mm. Abactinal and actinal surfaces.

rounded, small triangular actinal plates in angle between 2 inferomarginal plates. Two distalmost plates distinctly smaller, most distal small, long, slender, pointed. Plates with scattered round granules, near margin granules more regular, distinctly closer together. Occasional pedicellariae, similar to those of abactinal plates.

Actinal areas well paved with generally rectangular plates, those adjacent to adambulacrals larger, often with conspicuous pedicellaria, generally only a pit remaining. Plates with rounded or gently angular spaced granules, marginal granules distinct.

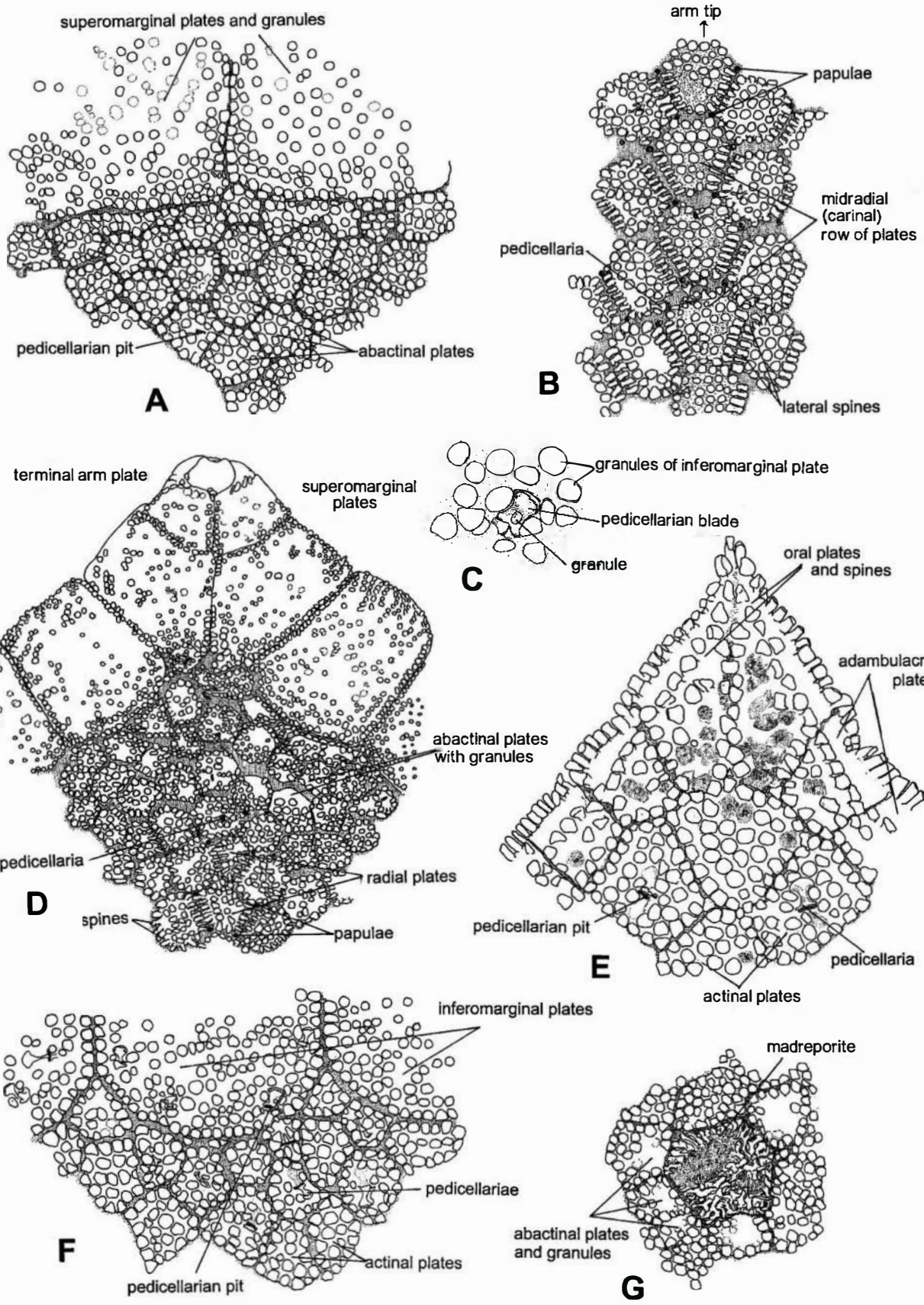
Adambulacral plates square or rectangular with either straight or gently curved furrow margin, and well-developed fringe of 8, sometimes 9, exceptionally 10, slender, regular furrow spines, anteriormost often distinctly shorter, more squat, slightly inset on plate; spines almost wedge-shaped, thin edge to furrow. Near arm tips, arrangement and number of spines difficult to determine but generally fewer; often a subambulacral spine enlarged and conspicuous. Subambulacral granules in 2–4 rows; distinct gap between furrow spines and first row of 4 or 5 subambulacral granules, a similar shorter row of often 3 granules behind this, and plate fringed actinally by 4 or 5 small, regular granules. Edge of plate bordering actinals straight, *slanted*, gently curved, or distally almost angular.

Oral plates large almost triangular, with regular fringe of 12 or 13, exceptionally 14, furrow spines, these short, regular, untapering, blunt-tipped, anteriormost spine slightly longer, often almost triangular. Spine adjacent to adambulacral plate often distinctly broader and conspicuous. Suboral armature of conspicuous, often angular, spaced granules; an obvious row parallel to, but well separated from, marginal spines; furrow between 2 plates bordered by angular granules tending to alternate with those from adjoining plate.

Ambulacral grooves narrow, almost obscured by furrow spines, *tube feet* deep in furrow.

COLOUR: No colour notes of living animal. Dried, and in preservative, uniform fawn or pale brown.

REMARKS: *Sphaeriodiscus maui* is most similar to *S. scotocryptus* Fisher, 1913 from the Sulu Sea, Philippines (905 m). It is especially similar in the armature of adambulacral and oral plates. The marginal plates in *S. scotocryptus*, however, are considerably narrower and the third superomarginal plates actually meet at the distal inner corner; in the present specimen, only the last two superomarginal arm plates are in contact. There is also a difference between the two species in the lateral extensions of the radial abactinal plates. In *S. maui* they are well spaced, strong, and sturdy; in *S. scotocryptus* they are small and little spaced laterally from one another (Fisher 1919: pl. 92, fig. 10a). If more New Zealand material is collected, it is possible that *S. maui* and *S. scotocryptus* will be regarded as synonymous. In *S. bourgeti*, the two interradial superomarginal plates are smallest in the series and Perrier recorded six oral furrow spines and five adambulacral furrow spines. In *S. ammophilus* (Fisher), adambulacral plates are long



and narrow and there are only four adambulacral furrow spines.

A second, smaller, specimen (NZOI Stn K861) is damaged, with one arm and side of the animal missing. The specimen is from near Macauley Island, in the Kermadec group, north of New Zealand, R/r approximately 26/27/18 mm: 8 *superomarginal plates* and 10 *inferomarginals* from arm tip to arm tip. Specimen similar to that described above, but no separation or distinction of *abactinal interradial plates* as in larger specimen. Five or 6 unpaired *median radial plates* per row, similar to those already described. *Madreporite* and *anus* lacking. *Adambulacral furrow spines* 7, sometimes 8, *oral furrow spines* 12, possibly 13. *Actinal plates* similar to those described for larger specimen.

Specimen dissected: *abactinal plates* seen from coelomic side round, oval, rectangular, almost pentagonal; a conspicuous *carinal* (midradial) series of plates closely flanked by rows of similar, perhaps slightly smaller, plates overlapping or meeting with central plates. *Papulae* very obvious midradially, generally 6 papulae around each cardinal plate restricted to carinal and flanking series of plates, absent or very few and indistinct near terminal plates and interradially. Interradially, abactinal plates forming very close, regular network. No *superambulacral plates*, ampullae of *tubefeet* double; ambulacral ossicles very steep, almost vertical; where ossicles meeting with opposite ossicles, abactinally, a distinct series of interlocking teeth present. Interradially, abactinal plates forming a close, regular meshwork of plates, no obvious papulae. No gonads or interradial septa seen.

Recently, four specimens of *Sphaeriodiscus maui* from the Aotea Seamount area were added to the collections (KAH0006/45). Measurements for these four are: R/r = 39/29 mm, 36/26 mm, 27/22 mm, and the smallest, R/r = 19/14 mm. One of the most interesting features is the very obvious, raised, irregularly shaped madreporite in the three larger specimens; difficult to see and not raised in smallest specimen. In largest specimen pedicellariae on superomarginal plates, 12 such plates from arm tip to arm tip, on 1 oral plate a short, broad-valved pedicellaria just behind furrow spines. On actinal plates, bordering adambulacral, 1, sometimes 2, straight pedicellariae present, visible without magnification.

In specimen R/r = 27/22 mm, adambulacral furrow spines only, 6 or 7 and granules on marginal plates scattered, well spaced. In smallest specimen, terminal arm plates small, heart-shaped; on 1 plate at free edge 2 sturdy, rounded, truncated spines, several small rounded granules basally on plate. No conspicuous spines on other 4 terminal plates but faint scars on 1 plate suggestive of presence originally. Occasional pedicellariae on actinal plates, especially those bordering adambulacrals, 7 or 8 (9 on 1 plate), adambulacral furrow spines; oral plates with 14 or 15 furrow spines. Enlarged, tapering subambulacral spines near arm tips, bending towards tips in all four specimens.

References: See pages 238–245.

ACKNOWLEDGMENTS

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Fig. 38. (opposite) ***Sphaeriodiscus maui*** McKnight. **A.** Superomarginal plates and adjacent abactinal plates. **B.** Radial plates with distinct spines on lateral edges. **C.** Straight pedicellaria, one blade only with granule, on inferomarginal plate near actinal plates. D. Arm tip with small strong spines on lateral edges of radial plates. **E.** Oral, adambulacral, and actinal plates. **F.** Superomarginal plates and adjacent abactinal plates. **G.** Madreporite, slightly damaged, and surrounding abactinal plates and granules.

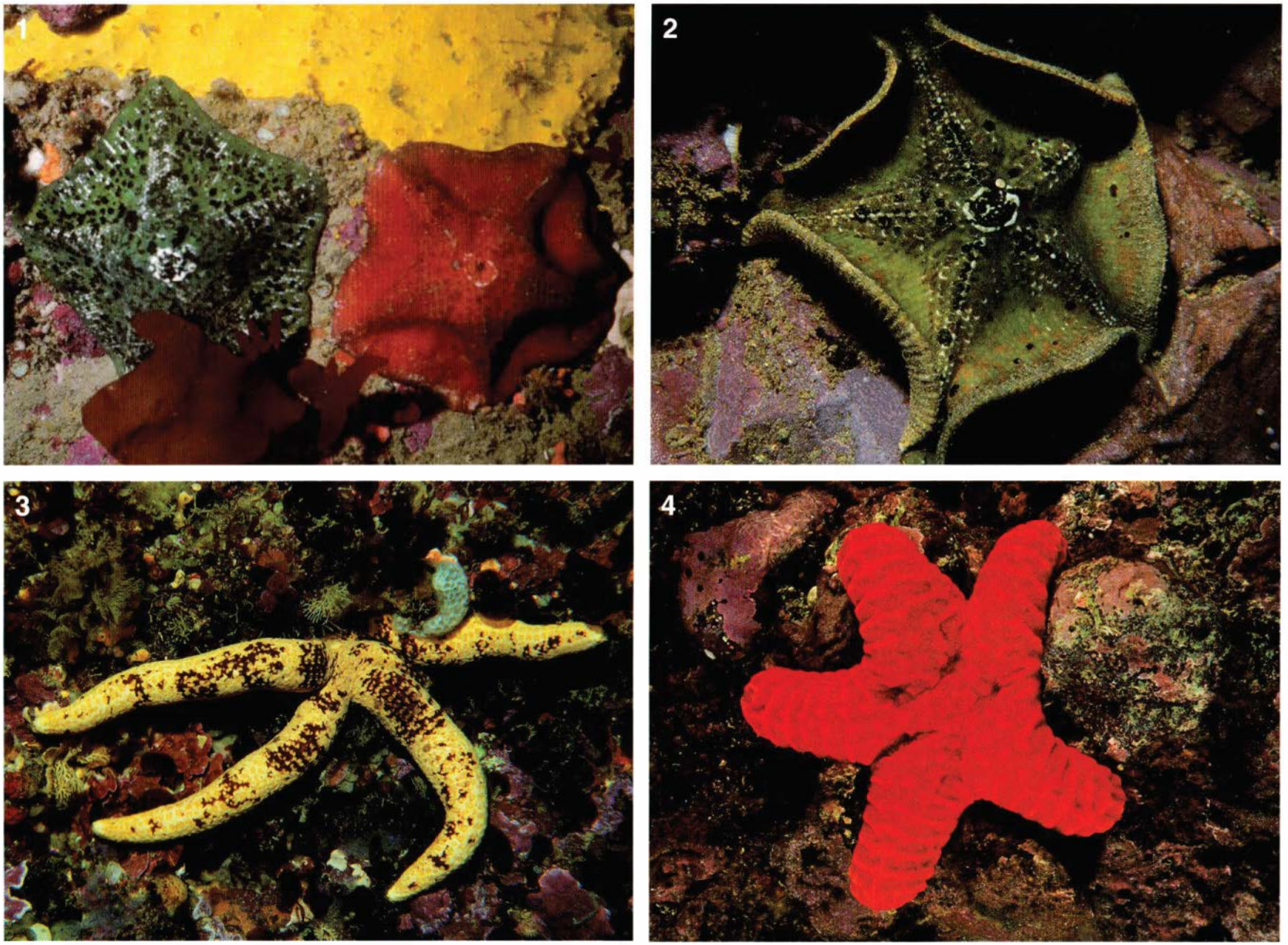

Plate 39: **1, 2.** ***Stegnaster inflatus*** (Hutton, 1872) (Asterinidae): two colour morphs from the Chetwode Islands, Marlborough Sounds, and a specimen from Matauri Bay, Northland, showing the characteristic predatory arching behaviour — when a small fish or crustacean enters the "inviting cave" under the animal it immediately flattens, trapping the prey. Photos: Dr Malcolm F. Francis. **3.** ***Ophidiaster macknighti*** H.E.S. Clark, 1962 (Ophidiasteridae), Ngaio Rock, Poor Knights Islands. Photo: Dr Malcolm P. Francis. **4.** ***Petricia vernicina*** (Lamarck, 1816) (Asteropseidae), Chanter Islands, near Raoul Island, Kermadec Ridge. Photo: Dr Roger V. Grace.

SUPERFAMILIES GONIASTEROIDEA (excluding Goniasteridae), ODONTASTEROIDEA, GANERIOIDEA, OPHIDIASTEROIDEA, OREASTEROIDEA

by

D.G. McKnight

Superfamily **GONIASTEROIDEA**

Family **ASTERODISCIDIDAE** Rowe, 1977

Pentagonal to stellate in form, with large disc; juvenile form goniasterid-like. Abactinal skeleton reticulate, invested with thick integument. Abactinal plates linked by internal radiating ossicles that may develop into a complex supporting network. Plates flat or slightly raised, each with an enlarged spine or tubercle, a peripheral ring or rings of granules, or granules only. Granules and small tubercles occurring on small plates that are supported in the investing integument covering the open meshes. Skeletal meshes contain discrete groups of papulae, but this not evident superficially. Superomarginal plates few, 3–5 on each side of arm, the distal one sometimes enlarged. Intercalated intermarginal and abactinal plates separating superomarginals with age. Inferomarginals 8–18, likewise separated. Marginal series separated by intermarginals. Papular areas may extend to inferomarginals but not to actinal surface. Adambulacral plates with 3–7 spines in furrow series; subambulacral spines usually present, truncate. Pedicellariae usually present, foraminate, vertically elongate (forceps-shaped). Interbrachial septum membranous. Tubefeet lacking spicules.

Asterodiscides A.M. Clark, 1974

Outline pentagonal to stellate; 3–4 superomarginal plates, the distalmost usually large, bare, prominent; abactinal tubercles low, no higher than 4 mm; varied actinal granulation and tuberculation; intermarginal papulae abundant; furrow spines 3–7, subambulacral spines in 1 or 2, rarely 3 series.

TYPE SPECIES: *Asterodiscus elegans* Gray, 1847.

KEY TO SPECIES OF *ASTERODISCIDES*

1 Actinal plates with prominent tubercle surrounded by unequal granules; 3 or 4 (rarely 5) adambulacral furrow spines; subambulacral spines in single series; 1 prominent tubercle on actinal plates ..... *truncatus*

2 Actinal plates with 1–4 prominent tubercles surrounded by granules; 5–7 adambulacral furrow spines; subambulacral spines in 2 series; 1–4 prominent tubercles on actinal plates ..... *grayi*

Asterodiscides grayi Rowe, 1977 (Pl. 40, Fig. 39)

Asterodiscides grayi Rowe, 1977: 208; 1989: 534; A.M. Clark 1993: 281.

MATERIAL EXAMINED: NZOI Stns I90(2), P18 (1).

Size: Study specimen from NZOI Stn I90, R/r = 77/43 mm (det. F.W.E. Rowe).

DISTRIBUTION: This species is recorded from north-eastern Australia, Norfolk Island, Raoul Island (Kermadec group), and Japan.

DEPTH: 20–108 m.

DESCRIPTION: Outline pentagonal-stellate, 5 arms tapering to blunt tip, interbrachial arcs rounded; Actinal surface flat, abactinal slightly inflated, margins rounded.

Abactinal and actinal surfaces covered with tubercles and granules, plates not visible. Abactinal surface with tubercles and granules in 3 distinct sizes. Large subspherical to elongate rounded-conical tubercles roughly arranged in alternating longiseries; between these are smaller tubercles, similar in shape, but less than half height, and also smaller, rounded, enlarged granules; neither of latter 2 groups arranged in any order.

Anus not evident.

Madreporite tumid, rounded, 3 mm diameter; the sculpture fine and radiate, the plate placed just less than half r from disc centre.

Papulae inconspicuous.

Small 2-jawed *pedicellariae* are scattered over disc and arms, usually at base of smaller tubercles.

Marginal plates not evident except near arm tip. One naked, slightly tumid, conspicuous superomarginal at arm tip, wider than long, with single peripheral series

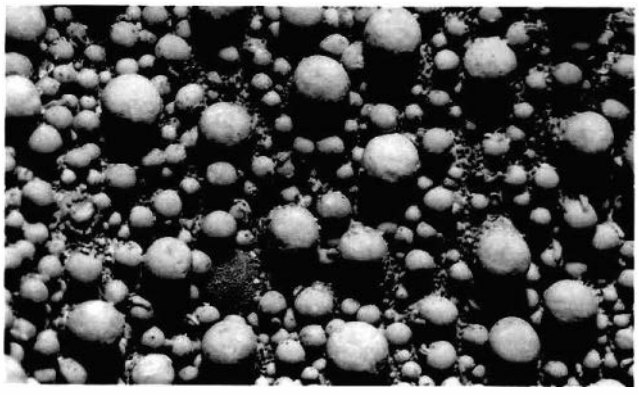

Fig. 39. *Asterodiscides grayi*. Close-up of abactinal surface showing madreporite.

of granules; below, 2–4 small inferomarginals, each with sparse covering of granules. Terminal plate small, naked, with 2 stubby spines on actinal surface.

Actinal areas extensive, outlines of plates not apparent. Plates with 1 or 2 larger tubercles, not as long as abactinal ones, and 4–6 smaller tubercles; granules rare, but pedicellariae common.

Adambulacral plates with 5 furrow spines proximally, 4 over most of arm; subambulacral spines repre-sented by 2 elongate tubercles, inner usually a little stronger.

Oral plates with 9 or 10 furrow spines, slightly larger proximally, 8 or 9 larger suboral spines scattered over plate.

Tubefeet biserial, with distinct sucking discs.

COLOUR: (ex-ethanol) dull brown. Other colours recorded (dried or in ethanol) uniform off-white, or uniform muddy-brown.

Asterodiscides truncatus (Coleman, 1911)
(Frontis, Pl. 41)

Asterodiscus truncatus Coleman, 1911: 699, pl. 83; H.L. Clark 1946: 108; Powell 1937: 78; Rowe 1977: 200, 1985: 534; A.M. Clark 1993: 292.

MATERIAL EXAMINED:
NZOI Stns E848(1), I357(2).

SIZE: Specimen from NZOI Stn I357, R/r = 117/54 mm.

DISTRIBUTION: This species is known from southern and southeastern Australia, northern New Zealand, and Raoul Island, Kermadec Group.

DEPTH: 14–792 m.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs rounded, 5 arms slowly tapering. Actinal surface flat, abactinal slightly inflated, margins rounded.

Abactinal and actinal plates not evident owing to granulation. Abactinal surface with granules and tubercles, the latter in 2 sizes. Larger, near-hemispherical tubercles in indistinct longiseries; scattered among them are smaller tubercles and granules, both tending to form circles around larger tubercles, but at some distance. Granules infrequent near arm tip.

Anus not evident.

Madreporite tumid, rounded, 4 mm diameter, with fine sculpture, placed at one-third r from disc centre.

Papulae inconspicuous.

A few small *pedicellariae*, with elongate jaws scattered over abactinal surface, not common.

Marginal plates not evident except at arm tip. Distal superomarginal tumid, wider than long, with a single peripheral series of granules, conspicuous. Below it, 3 or 4 similar, but smaller inferomarginals, some with conspicuous actinal tubercle. Terminal plate small, tumid, naked, with 1 or 2 small stubby spines on actinal surface.

Actinal areas large, plates with 1 or 2 tubercles, shorter than abactinal, and relatively close pave-ment of granules.

Adambulacral plates with 5 furrow spines proximally, 4 over most of arm. Spines elongate, with proximal shortest. A single stubby subambulacral spine to each plate.

Oral plates with 6 or 7 furrow spines, strongest proximally, 4 or 5 suboral spines and a few granules, scattered over plate.

Tubefeet biserial, with distinct sucking discs.

COLOUR: (ex ethanol) dull brown. In life recorded as "variegated usually with pastel colours, mauve, orange, and yellow appearing to predominate; purple or red; chrome, vermilion and purple" (Rowe 1977: 201).

REMARKS: In comparison with material of *A. grayi*, this species differs in having longer adambulacral furrow spines, and only a single row of subambulacral spines.

Superfamily ODONTASTEROIDEA

Family ODONTASTERIDAE

Arms 5, outline stellate, almost pentagonal in some juvenile specimens; interradial areas large, arcs rounded. Preserved specimens often flattened. Both series of marginal plates conspicuous, block-like, lacking large spines, an unpaired plate in each series. Abactinal plates

plates paxilliform, arranged in longitudinal and oblique transverse series, no enlarged carinal series of plates or enlarged primary plates. Oral plates usually with 1 or more large, median, glassy-tipped spines at apex, pointing away from mouth. Pedicellariae, if present, simple and fasciculate, valves spiniform or granu-liform.

KEY TO GENERA OF ODONTASTERIDAE

1 No recurved, usually hyaline spines at apex of jaws; abactinal plates flat, covered with short spines; papulae absent interradially and distally ..... *Hoplaster*
1 or 2 recurved and hyaline median teeth at apex of combined jaws 2

2 1 tooth at jaw apex 3
2 teeth at jaw apex ..... *Diplodontias*

3 Marginals largest interradially, closely united; abactinal plates simply tabulate ..... *Odontaster*
Marginals largest near arm tip, with distinct grooves between plates; abactinal plates with a tall, club-like paxillar shaft, topped by numerous minute spinelets .. .. *Eurygonias*

Odontaster Verrill, 1880a

A single recurved spine at apex of combined jaws. Outline pentagonal, to pentagonal stellate, interradial arcs variable. An unpaired marginal plate in both series. Marginal plates slightly larger proximally, plates of both series separated by shallow grooves. Abactinal plates lobed or stellate, somewhat tabulate, but lacking a tall spiniform pedicel. Actinal plates spiniform. Adambulacral armature spiniform in longiseries. Papulae on disc and in a separate area along arm.

TYPE SPECIES: *Odontaster hispidus* Verrill, 1880a.

KEY TO SPECIES OF *ODONTASTER*

1 Actinal spinelets blunt, tip slightly widened; abactinal spinelets truncate, those on marginals almost granular; papular areas separate; crystal bodies on abactinal and marginal plates ..... *aucklandicus*
Actinal spinelets pointed 2

2 Abactinal spinelets pointed, as are those on marginals; papular areas separate; crystal bodies present on abactinal and marginal plates ..... *benhami*
Abactinal spinelets truncate, like those on marginal . 3

3 Papular areas separate; crystal bodies absent; no pedicellariae ..... *penicillatus* (Philippi)
Papular areas confluent; crystal bodies present on marginals; actinal pedicellariae ..... *rosagemmae* n.sp.

Odontaster aucklandensis McKnight, 1973b (Pl. 42)

Odontaster aucklandensis McKnight, 1973b: 225 (non *Odontaster aucklandicus* McKnight 1984 = *Odontaster penicillatus* (Philippi, 1870).

MATERIAL EXAMINED:

NZOI Stns: B175(21), D104(1), D148(1), D176(1), D193 (1), D194(1), D200(4), D208(1), F138(1), G884(1), G919(1), I719 (1), J538(1), S30 (2), S41(3), S80(1).

SIZE: Study specimen from NZOI Stn G674, R / r = 35 / 24 mm; 19 superomarginals per interbrachial arc.

DISTRIBUTION: Southern slopes of Chatham Rise, Campbell Plateau, and Bounty Platform.

DEPTH: 55–353 m.

DESCRIPTION: Outline substellate, abactinal surface slightly inflated, more so radially, margin relatively high, vertical.

Abactinal plates tabulate, higher on papular areas, plates at disc centre rounded, becoming wider than long from about half R along ray, more irregular, smaller, and lower towards interradial margin. Larger plates with up to 21 peripheral and 17 central spinelets. Central paxillar spinelets usually truncate while peripheral similar or blunt-tipped, all truncate distally, very finely thorny, lacking terminal glassy points. Crystal bodies rare, absent from most paxillae.

Papular areas extensive, extending almost to arm tip, and only a narrow non-papulate interradial area; a similarly very narrow zone margining the central papular area.

Anus near-central, inconspicuous owing to overhanging flanking paxillae, opening surrounded by short, thick spinelets.

Madreporite placed just less than half r from disc centre, rounded, maximum 3.5 mm diameter, with coarse radiate sculpture.

The two series of *marginal plates* more or less opposite throughout arm, forming high vertical margin to body. All wider than long, separated by distinct grooves. Both series with complete cover of slightly spaced short spinelets, their tops flat or slightly convex, those on superomarginals almost granular, about as high as wide, those on inferomarginals somewhat longer; at plate margins spinelets not enlarged, but concealing intervening grooves. An almost bare distal superomarginal with 2 crystal bodies.

Actinal plates in about 6 six regular chevrons, plates subrectangular. The larger with up to 20 short spinelets, often with tip slightly widened. In 2 interradii, immediately behind oral plates, a small pedicellaria, composed

of 2-4 shorter, slightly curved spinelets in a compact erect group.

Adambulacral plates forming a regular series along ray, the proximal ones with 3 furrow spines and 6 subambulacral spines, the latter in 2 transverse rows across plate. All adambulacral spinelets blunt-tipped, distinctly thicker and longer than actinal spinelets.

Oral areas slightly sunken, *oral plates* small, with large smooth and glassy spine at apex of combined plates projecting backwards over distal edge of plate; 6 or 7 blunt furrow spines, and 3 or 4 similar suboral spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex ethanol): Dull uniform cream.

REMARKS: This species differs from *O. benhami* in having a higher margin with shorter arms, and the papular area is broader and extends to near the arm tip. Also, spinelets lack glassy terminal points. It differs from *O. penicillatus* in having almost granular marginal spinelets and those on the actinal plates are blunt.

Odontaster benhami (Mortensen, 1925) (Pl. 43)

Peridontaster benhami Mortensen, 1925: 288, pl. 12 (12, 13).
Odontaster benhami: Fell 1958: 7; H.E.S. Clark 1970: 18; Rowe & Gates 1995: 78.

MATERIAL EXAMINED:

NZOI Stns: A444E(1), A444K(1), A843(1), A887(1), A910 (4), B196(1), B197(3), B205(1), B488(1), B515(2), B560(3), B561 (1), B562(1), B581(1), B583(3), B587(4), B591(1), B592(2), C224(1), C601(5), C624(2), C683(1), C703(7), C706(3), C844 (11), C957(2), D100(4), D114(1), D131(36), D132(4), D133 (22), D144(1), D155(1), E159(1), E412(1), E424(1), E804(1), E817(1), E820(2), E832(8), F77(8), F78(16), F93(2), F97(30), F567(1), G156(3), G161(1), G162(5), G674(2), G680(5), G685 (2), G686(2), G689(6), G690(1), G691(1), G877(1), G878(1), G879(1), G881(2), G939(1), Q38(1), Q85(4), Q93A(1), Q99(1), S134(2), S155(3), S177(1), S180(3), S184(1), S186(1), S201(1), S217(2), T760(1), Z1842 (field notes), Z8635(1), KAH9704/ 123.

SIZE: Specimens from NZOI Stn F97, 30 specimens, range from R/r = 19/11mm, 17 superomarginals to interbrachial arc; to R/r = 11/6 mm, 13 superomarginals to interbrachial arc.

DISTRIBUTION: Hawke Bay southwards to southern New Zealand, also Chatham Islands. Aso known from New South Wales, Australia.

DEPTH: In the New Zealand region, 0–549 m, with 82% of the above records from less than 200 m. In the Australian region, 468–549 m.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs rounded, arms 5, tapering to a point; abactinal and actinal surfaces flat, margin vertical.

Abactinal plates tumid, more so on papular areas here, up to 8 short, low basal lobes connecting them to other plates. Elsewhere plates simply rounded or ovoid and abutting or almost so. At half r from centre, interradii with slightly enlarged basals. Plates at disc centre and carinal series also a little larger with up to 20 peripheral and 10 central spinelets. Latter very slightly thicker than peripheral, all finely thorny, with angular tips, terminating in 1–3 very fine, hyaline points. Almost all abactinal plates with 2–4 small glassy granules, usually retained when spinelets cleaned off.

Papulae found at centre of disc and in separate elongate area along arm. Up to 8 papulae around carinal plates. In smallest specimen, distal papular area a little longer than wide. In larger specimens clearly longer than wide.

Madreporite a small circular plate, 2 mm diameter, more attenuate arms, R/r = 29/15 mm. 19 marginals with coarse radiate sculpture, placed about one-quarter r from disc centre.

Anus small, inconspicuous, more or less centrally placed; may be guarded by short spinelets.

Marginal plates encroaching on both abactinal and actinal surfaces and both series more or less opposite along arm. All plates with small spinelets, like those on abactinal plates; also several small glassy granules. Both series wider than long throughout arm, distal superomarginals may be in contact or separate to arm tip.

Actinal plates in about 4 chevrons, with innermost extending into distal one-third of arm. Plates flat and rectangular to ovoid, with up to 20 spinelets, each a little longer than those on abactinal and marginal plates and arranged in rows, spinelets of each row increasing in size towards outer edge of plate. Each plate with a few glassy granules.

Adambulacral plates short, about as wide as long over most of arm; 3 subequal furrow spines, and 3 pairs of subambulacral spines, outermost the shortest. Occasionally 3 subambulacral spines instead of 2 in each series. Distally often only 2 furrow spines, and outer subambulacral spines very short.

At jaw apex a stout glassy tapering spine, extending backwards to distal end of oral plates or beyond. Each *oral plate* with 4 or 5 furrow spines like those on adambulacral plates.

COLOUR (ex ethanol): Dull uniform cream, with the papular areas sometimes darker.

REMARKS: The largest specimens examined are from: NZOI Stns Z8635, R/r = 42/24 mm, 22 superomarginal to the interbrachial arc; and KAH9704/123, R/r = 39/21 mm, with 27 superomarginals. In this latter specimen, from about one-third R along ray the abactinal paxillae become wider than long, with 20–22 peripheral spinelets, the same number centrally. Actinal plates have up to 28 spinelets. Both specimens have separate central and radial papulate areas.

In the specimen from Stn Z8635 the madreporite is concealed by paxillae; the central paxillar spinelets are somewhat blunter than usual, as are those on the superomarginal plates, although those at the margins are sharply pointed. In this specimen, on the actinal plate immediately behind the oral plates, are pedicellariae in three interradii. Each of these plates has an almost bare central patch with two or three short, slightly curved, erect spinelets in a central clump.

The smallest specimen has a central papular area developed, and in all specimens the distal papular area ends before the arm tip so that there are four or five carinal plates beyond. The specimen from NZOI Stn G161 has more attenuate arms, R/r = 29/15 mm, and 19 marginals to the interbrachial arc.

Odontaster penicillatus (Philippi, 1870) (Pl. 44)

Goniodiscus penicillatus Philippi, 1870: 268.
Odontaster penicillatus: Fisher 1940: 105; Clark & Downey 1992: 156, pl. 37B; O'Hara 1998: 176, pl. 1b.
Odontaster aucklandensis: McKnight 1984: 141 (non *O. aucklandensis* McKnight 1973b: 225).

MATERIAL EXAMINED:
NZOI Stns C732A(1), E228 (2), E233 (1).

DISTRIBUTION: Known only from Macquarie Island in the extreme south of the study area. Other records are from South America, the Falkland Islands, and Marion Island.

SIZE: Study specimen from NZOI Stn E228, R/r = 13/8 mm with 13 superomarginals to interbrachial arc.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs gently concave, flat above and below, margin high and vertical. Abactinal plates paxillate, paxillae rounded, top slightly expanded, usually very gently convex rather than flat. Paxillar spinelets tapering near tip which is usually pointed but occasionally blunt. Spinelets finely thorny over most of length. Midradial paxillae with about 12 peripheral and 12 central spinelets. Crystal bodies absent.

Papular areas relatively conspicuous, with small circular area at disc centre and separate petaloid area on each arm extending almost to arm tip. Interradial non-papulate area triangular, extending inwards to non-papulate ring around papulae at disc centre, so that non-papulate areas confluent.

Marginal plates forming high vertical border to disc, those of both series opposite each other. All plates wider than long, separated by distinct grooves. Spinelets on marginal plates clearly longer than wide, tapering near tip to sharp point, or tip truncate. Inferomarginal spinelets longer. Crystal bodies absent.

Actinal plates in 4 or 5 chevrons, plates regularly arranged, with up to 15 pointed spinelets on larger plates. In 3 interradii, just behind oral plates, a small pedicellaria, with 2–4 tapering, curving spinelets in erect compact group.

Adambulacral plates subrectangular, wider than long, with 3 blunt furrow spines and subambulacral spines arranged in 2 transverse series.

Oral plates small, those of each pair slightly as long, separated on midline. All major spines short, at most half length of oral plate, and lacking glassy tip, pos-sibly owing to fracture; 6 or 7 oral furrow spines, all rather delicate, and 1 thicker, longer, blunt-tipped suboral spine.

COLOUR (ex-ethanol): Dull light brown, abactinal surface a little darker.

REMARKS: To my chagrin I previously cited this species as *O. aucklandensis*. The recent paper by O'Hara (1998) has clarified the morphological features. These include the paxillar marginal and actinal spinelets and the absence of crystal bodies.

Odontaster rosagemmae n.sp. (Pl. 45)

MATERIAL EXAMINED:
NZOI Stns R435(1), Z9568(2), Z8978(1), Z9000(1).

SIZE: Holotype, R/r = 47/27 mm, 27 superomarginals to interbrachial arc, from NZOI Stn Z8978.

DISTRIBUTION: This species is known from east of the Chatham Islands and off the east coast of North Island.

DEPTH: 445 to 1190 m.

DESCRIPTION: Outline substellate, arms tapering to a point, interbrachial arcs rounded; more or less flat on upper and lower surfaces.

Abactinal plates lobate and paxillate. Paxillae with top slightly wider than base, regularly arranged, slightly spaced on papular areas, almost in contact interradially. Paxillae more or less rounded, becoming only

slightly wider than long on distal radial areas. Paxillar spinelets generally with tip truncate, a little wider than at base. Midradial paxillae with up to 24 peripheral spinelets, the same number centrally, all similar. Crystal bodies absent from paxillae.

Papular areas extensive, covering most of abactinal surface, continuous across centre of disc, and surrounding madreporite. Only a small triangular interradial area free from papulae

Anus subcentral, rounded, almost concealed by adjacent paxillae, surrounded by a few short blunt spinelets.

Madreporite situated just less than half r from disc centre, rounded, maximum diameter 4 mm with relatively coarse radiate sculpture.

Marginal plates forming low rounded edge to body, all wider than long, the 2 series opposing each other, individual plates separated by distinct grooves. Plates densely covered with short spinelets like those on abactinal paxillae, with tip truncate and slightly expanded. Marginal spinelets may be slightly longer, very occasionally a marginal spinelet with tip pointed. Inferomarginal spinelets longer than superomarginal ones. Last 2 or 3 superomarginals uniting on radial midline, terminal plate small, subtriangular. Crystal bodies on distal superomarginals.

Actinal plates in 7 chevrons, individual plates subrectangular, outline tending to be concealed by spinulation. Plates with up to 20 tapering, pointed, spinelets, marginals smallest.

Pedicellariae composed of 4–6 tapering, pointed, curving spinelets in erect compact group present in 3 interradii just behind oral plates and extending along 1 actinal plate row adjacent to adambulacrals for about half R.

Adambulacral plates wider than long, slightly separated throughout by membranous interspace; 3 blunt furrow spines and 6–8 subambulacral spines in 2 transverse series, becoming more pointed and shorter outwards, so that outermost a little longer than adjacent actinal spinelets.

Oral plates of each pair narrowly separated by membrane. Major spine extending backwards for about two-thirds length of plates, wide at base, tapering in distal third and becoming glassy near tip. One plate with 2 smaller spines. About 8 oral furrow spines, proximal 5 or 6 laterally compressed with truncate tip, the distal longer, more robust with tip bluntly rounded; 2 or 3 larger suboral spines towards distal end of plate rounded with tip slightly expanded, bluntly rounded.

Adambulacral furrows narrow, *tubefeet* biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull uniform light brown.

REMARKS: The specimen from NZOI Stn R435 differs in having somewhat higher and smaller abactinal paxillae, with 12 peripheral and 12 central spinelets. That from NZOI Stn Z9000, the northernmost record, has R/r = 45/23 mm, with 27 superomarginals to the interbrachial arc. It differs also in having some of the abactinal spinelets with pointed tips. Pedicellariae are abundant on the paxillae, with a few on the abactinal surface of the superomarginals, on the lateral face of a few interradial inferomarginals, and also on the actinal interradial plates. These pedicellariae are composed of two to six modified spinelets, slightly wider at the base, curved, and tapering to a sharp point. They replace most or all central spinelets on the paxillae and surround a distinct pit in the paxilla head. Those on the marginal plates are smaller, while the actinal pedicellariae are a litle longer than the abactinal ones.

ETYMOLOGY: *Rosa* + *gemma* (rose + bud) in appreciation, albeit flirtaceous, of the contribution of Mrs Rose-Marie Thompson to New Zealand marine sciences.

HOLOTYPE: H-753 in NIWA collection, Wellington (NZOI Stn Z8978, R/r = 47/27 mm, with 27 superomarginals to interbrachial arc).

PARATYPES: P-1222 deposited in the NIWA collection, Wellington (NZOI Stn Z9568, R/r = 39/21mm, 23 superomarginals; R/r = 40/22 mm, 25 superomarginals).

TYPE LOCALITY: 44°08.53′ S, 178°37.83′ W, on the southern edge of Chatham Rise, west of Chatham Islands.

REMARKS: This species is distinguished by the character of the spinelets on the abactinal and actinal plates, as well as those on the lateral face of the marginals; the presence of crystal bodies on the distal superomarginals; confluent papular areas; and the presence of actinal pedicellariae.

Diplodontias Fisher, 1908

Two recurved, hyaline spines at jaw apex, 1 on each plate. Outline pentagonal-stellate, with rounded interbrachial arcs. Abactinal plates lobate, and subtabulate or at least slightly raised. Papulae widely distributed on abactinal surface. Marginals decreasing or increasing in size distally. Actinal plates in several chevrons, covered with short spinelets. Adambulacral plates short, wider than long over most of arm, the spines in pairs or trios across plate.

TYPE SPECIES: *Pentagonaster dilatatus* Perrier, 1875.

KEY TO SPECIES OF *DIPLODONTIAS*

1 Distal superomarginals enlarged; 20 or fewer marginal plates with R > 40 mm; crystal bodies on abactinal and marginal plates ..... *dilatatus*
Distal superomarginals not enlarged 2

2 More than 20 marginals with R > 40 mm; crystal bodies present ..... *miliaris*
Less than 20 marginals with R > 40 mm; no crystal bodies ..... *robustus*

Diplodontias dilatatus (Perrier, 1875) (Frontis, Pl.46)

Astrogonium miliare: Hutton 1872: 7 (non Gray, 1847)
Pentagonaster dilatatus Perrier, 1875: 217.
Diplodontias dilatatus: Mortensen 1925: 286, pl. 12(11); Fell 1953: 77, pl. 2 (A, B); H.E.S. Clark 1970: 3, 6; A.M. Clark 1993: 192.

MATERIAL EXAMINED:
NZOI Stns: D140(1), E836 (field notes); Q41(1), T449(4), T459(1), T752(3), T754(1), T758(1), T760(1), Z3865(1), Z6173(3).

SIZE: Study specimen from NZOI Stn T752, R/r = 47/26 mm, 19 superomarginals to interbrachial arc.

DISTRIBUTION: Known from Cook Strait southwards to the Snares Islands.

DEPTH: 0–70 m.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs rounded, 5 arms widening from base to near tip; abactinal and actinal surfaces flat with margin vertical.

Abactinal plates with irregular outlines and vary-ing sizes. Base lobate and centre raised into a broad, slightly convex, tabulum. Larger plates at disc centre forming a distinct carinal series, composed of roughly transversely elliptical plates. On either side of carinal series progressively smaller plates forming oblique rows towards margins. Tabulum of plates covered with up to 40 angular, flat-topped, short, almost granule-like spinelets. Tips of spinelets forming com-plete cover over plate. Occasional plates, particularly larger, with 3 or 4 glassy granules amid longer spine-lets.

Papular areas extensive, covering almost all abac-tinal surface, only a small interradial area close to margin lacking papulae.

Anus not apparent.

Madreporite a conspicuous flat plate placed at about one-third r from disc centre, rounded-pentagonal, 6 mm diameter, with coarse radiate sculpture.

Plates of both *marginal series* opposite throughout arm, all separated by narrow grooves, though usually covered by spinelets and not apparent. All superomarginals wider than long, likewise almost all inferomarginals, with only distal 2 longer than wide. Superomarginals with rounded inner margin, lateral margins more or less parallel except for unpaired plate tapering from inner side. Superomarginals increasing in width on abactinal surface from interradius to near arm tip with distal 3 narrowing to terminal plate. Inferomarginals with rounded inner margin and nearly parallel side. Unpaired plate slightly tapering, distinctly narrower than others. Both series of marginals covered with slightly spaced, short, almost granuliform spinelets similar to those on abactinal plates. Marginal plates tumid, marginal spinelets, although not differentiated, distinct, with covering grooves between individual plates. Smally glassy granules between spinelets except on lateral faces of plates.

Actinal plates arranged in 5 chevrons, with inner-most row extending into distal quarter of arm, adja-cent series extending to about half R while others not extending beyond arm base. Plates smallest at margin, most transversely widened. Larger with 10–12 spinelets.

Adambulacral plates wider than long throughout rarely 3, furrow spines, and 3 pairs of subambulacral spines, decreasing in size from furrow, although outer spines longer than those on adjacent actinal plates. From about half R usually only 2 pairs of subambu-lacral spines.

Each *oral plate* with stout, rounded, tapering spine near tip on actinal surface; spine projecting backwards over distal end of plate, glassy in distal third. On actinal face 1–3 small spines near distal margin.

Furrow spines 5, stubby, proximal slightly enlarged.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol or dried): Dull, uniform cream or light brown. In life, "The marginals of the upper series are bright orange, the fasciolar divisions between them being buff. The paxillar region above is buff, while the granules of the paxillar plates are orange. The adoral surface is almost uniformly cream, only the outer borders of the lower marginals being tinted orange" (Fell 1953).

Diplodontias miliaris (Gray, 1847) (Pl. 47)

Astrogonium miliare Gray, 1847: 80.
Astrogonium rugosum Hutton, 1872: 7.
Asterodon miliaris: Mortensen 1925: 287, pl. 13 (7, 8); H.E.S. Clark 1970: 4, 6.
Diplodontias miliaris: A.M. Clark 1993: 193.

MATERIAL EXAMINED:
NZOI Stns: B554(1), C672(1), G162(3).

SIZE: Specimen from NZOI Stn B554, R/r = 64/32 mm, 25 superomarginals to interbrachial arc.

DISTRIBUTION: Known from the east coast of South Island, Kaikoura to Foveaux Strait.

DEPTH: 0–101 m.

DESCRIPTION: Outline pentagonal-stellate, with rounded interbrachial arcs; 5 arms gradually tapering to bluntly pointed tip; abactinal and actinal surfaces more or less flat, margin vertical.

Abactinal plates slightly tabulate, weakly lobate, of varying size and shape; a few larger plates at disc centre, others forming a slightly indicated radial series. At sides of radial series, plates smaller tending to form longiseries. Transverse series not apparent. Larger plates with up to about 50 slightly spaced, short, flat-topped granuliform spinelets, occasional plates with 3 or 4 smaller glassy granules. Up to 10 papulae around larger plates, almost whole abactinal surface with papulae.

Madreporite a flat conspicuous plate at about one-quarter r from disc centre, pentagonal, 7 mm across, with fine radiate sculpture.

Anus small, inconspicuous, near disc centre, surrounded by small granules.

Marginal plates of both series opposite throughout. Unpaired superomarginal tapering slightly, wider than long; paired superomarginals with more or less parallel margins, wider than long interradially, becoming about as wide as long distally. Distal plates encroaching onto abactinal surface only a little more than proximal. Unpaired inferomarginal tapering only slightly and scarcely narrower than adjacent plates; all inferomarginals wider than long. All plates slightly tumid, separated by shallow but distinct grooves. Plates covered with slightly spaced, flat-topped, granular spinelets similar to those on abactinal plates. Marginal spinelets covering over grooves between plates. Each plate also with a few small glassy granules.

Actinal plates in about 6 chevrons, with innermost extending into distal third of arm; 2 adjacent series extending to just beyond half R, remainder not extending beyond arm base. Plates of varying shapes and sizes, smallest near margin. Larger plates with up to 15 flat-topped granule-like spinelets. Occasional actinal plates adjacent to adambulacrals with a small spiniform or fasciculate pedicellaria, with 2-4 jaws of flattened and slightly curved spinelets, standing in erect group at plate centre in small, otherwise bare area.

Adambulacral plates short, wider than long over most of arm. Spines arranged in pairs, or rarely threes, across plate. Furrow spines 2, rarely 3, slightly flattened and expanded at blunt tip; up to 3 pairs of subambulacral spines, usually in pairs. Spines decreasing in size from furrow, but outermost larger than those on adjacent actinal plates. First 4 adambulacrals with 3 pairs of subambulacral spines, remainder with 2.

Each *oral plate* with large, tapering spine near proximal end and on actinal surface; spine projecting backwards over plate, glassy distally. One or 2 stubby distal suboral spines, and 5 angular furrow spines becoming larger proximally.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried specimen): Dull, uniform light brown.

Diplodontias robustus (Fell, 1953) (Pl. 48)

Asterodon robustus Fell, 1953: 80, pls 1(A–C); 2 (C, D); H.E.S. Clark 1970: 6.
Diplodontias robustus: A.M. Clark 1993: 193.

MATERIAL EXAMINED: Nil.

Size: Range from R/r = 67/44 mm, 19 superomar-ginals to interbrachial arc, to R/r = 35/26 mm, 13 superomarginals. R/r varies from 1.35/1 to 1.9/1, with smaller specimens tending to have the lower ratio.

DISTRIBUTION: Known only from the Auckland Islands, south of New Zealand, intertidal and in adjacent shallow water.

DESCRIPTION (taken from Fell 1953):

Outline pentagonal-stellate, interbrachial arcs broadly rounded, 5 arms tapering to a blunt tip, disc flat on abactinal and actinal surfaces, margin relatively high and vertical.

Abactinal plates polygonal, closely spaced, flat-topped and slightly tabulate. A few larger plates at disc centre and carinal series evident. On either side of carinals, plates smaller, tending to form longiseries. Plates smaller towards margins. Larger plates with up to 40 small, granuliform spinelets, apparently lacking glassy granules.

Papulae widely distributed over abactinal surface.

Madreporite about one-third r from disc centre, polygonal, diameter 8 mm.

Marginal plates more or less opposite throughout arm, forming relatively high margin to body. Both unpaired superomarginal and inferomarginal taper-ing outwards. All marginal plates wider than long, separated by distinct grooves. Distal superomarginals united on radial midline. Marginals covered by granuliform spinelets like those on abactinal plates, also covering intervening grooves.

Actinal plates in 3–5 chevrons; plates irregular in outline, smaller towards margin. Larger plates with

about 20 small, granule-like spinelets.

Adambulacral plates short, spines arranged in pairs across plate. Proximal plates with 4 pairs, more distal with 3. Spines decreasing in size from furrow.

Each *oral plate* with large backwards-directed smooth spine extending over distal end of plate.

Tubefeet biserial, with distinct sucking discs.

COLOUR (from field notes and sketch): "The whole aboral surface is a uniform, rich, chocolate-red, and this colour extends over the marginals to include, on the adoral side, the inferomarginals and the outer border of the adoral interradial areas. The peristomial region is a lighter orange-yellow tint, which becomes gradually darker as one passes distally towards the margin" (Fell 1953).

REMARKS: Although no further specimens have been collected, this species appears quite distinct from the other two known from the New Zealand region.

Eurygonias Farquhar, 1913

A single recurved spine at apex of combined jaws. Outline almost pentagonal, interradial arcs little or not indented. Disc inflated at centre and along radial midline. A single marginal plate in both series. Marginal plates slightly larger distally, plates of both series separated by relatively deep grooves. Abactinal plates lobed, each with a tall club-shaped paxillar crown. Actinal plates with elongate spinelets. Adambulacral armature of elongate spinelets, in 3 series. Papular area extensive, with only a narrow interradial line free from papulae.

TYPE SPECIES: *Eurygonias hyalacanthus* Farquhar, 1913.

Eurygonias hyalacanthus Farquhar, 1913 (Pl. 49)

Eurygonias hyalacanthus Farquhar, 1913: 213, pl. 3; H.E.S. Clark 1970: 3; A.M. Clark 1993: 194; Ryan & Paulin 1998: 98–99.

MATERIAL EXAMINED:

NZOI Stns: G836(1), T752(1) + 1 unregistered specimen, Kaikoura.

SIZE: Study specimen from Stn T752, R/r = 39/28 mm, 17 marginals to the interbrachial arc.

DISTRIBUTION: Known only from the east coast of New Zealand from Cook Strait southwards to the Snares Islands.

DEPTH: 0–7 m (Ryan & Paulin 1998: 98).

DESCRIPTION: Outline pentagonal with interradial arcs only slightly indented, 5 arms scarcely produced. *Disc* slightly inflated, margins vertical, actinal surface flat.

Abactinal plates tumid and low, with lobate base, giving stellate outline. At raised centre of plate a small boss, on this a tall, club-shaped paxillar crown up to 1 mm long.

Paxillae rounded, widening distally to rounded head capped by numerous short, finely thorny spinelets, rounded or slightly flattened and often glassy in distal half, terminating in 1 or more very fine points.

Plates of varying sizes, smallest at margins. Larger plates forming a weakly marked carinal series, other plates forming distinct longitudinal and transverse series on either side. Plates at disc centre also slightly enlarged, and in interradii a double series of plates.

Papulae widespread over abactinal surface, with only a narrow interradial streak free from papulae; 4–6 papulae around most of plates.

Anus small, inconspicuous, subcentral, sur-rounded by small spines.

Madreporite not apparent in specimen; possibly marked in 1 interradius by a cluster of paxillae. Visible in type.

Marginal plates prominent, both series opposite throughout arm. Individual plates separated by distinct grooves with longitudinal groove separating both series. All plates wider than long, with outer margin rounded. Unpaired marginals tapering toward narrower outer plates with fairly dense covering of small spinelets like those on abactinal paxillae, and with several small glassy granules interspersed between spinelets. Naked grooves between plates.

Actinal plates slightly tumid, subrectangular, smaller towards margin, arranged in 8 chevrons, with a cluster of 6–10 flattened, often curved, spinelets up to 1 mm long near centre and several smaller spinelets around margin. Plates adjacent to adambulacrals with longest spinelets.

Adambulacral plates short and broad throughout, 2 or 3 to each of adjacent actinals. Spines a little longer than on adjacent actinals, arranged singly or in pairs across plate; 2 furrow spines, 1 distally, and 3 or 4 pairs of subambulacral spines, 3 or sometimes 2, distally.

At tip of each pair of *oral plates* a large rounded, tapering spine projecting backwards over distal end. Spine smooth and distinctly glassy in distal half. On each oral plate a short, blunt, suboral spine near distal margin, and on 1 plate a second similar proximal spine.

Furrow margin of plate with 5 or 6 small spines, proximal slightly enlarged.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull reddish-brown.

REMARKS: This monotypic genus is endemic to New Zealand.

Hoplaster Perrier, 1882

Outline pentagonal-stellate; an unpaired marginal plate in both series. Actinal surface of oral plates lacking any enlarged recurved teeth. Abactinal plates subtabulate and lobate, with small spinelets; marginals and actinals similarly covered. Adambulacral plates with spines in 3 longiseries, subambulacrals often in pairs across plate. Fasciculate pedicellariae often on adambulacral, actinal, and oral plates. Superambulacral plates absent; interradial septum membranous; first ambulacrals enlarged, higher than others, stomach appears attached to sides of inner wall of first ambulacral, crest with no retractors. Ampullae double, small; gonads not apparent.

TYPE SPECIES: *Hoplaster spinosus* Perrier, 1882.

Hoplaster kupe McKnight, 1973b (Pl. 50)

Hoplaster kupe McKnight, 1973b: 227, fig. 6; A.M. Clark 1993: 195.

MATERIAL EXAMINED:
NIWA Stns: J42(2), J44(2), J51(1), U226 (numerous).

SIZE: Study specimen from NZOI Stn U226, R/r = 19/11 mm. In addition, numerous other specimens from this station.

DISTRIBUTION: Known only from west of North Island, New Zealand, Fairway Trough, Bellona Gap, and Lord Howe Rise.

DEPTH: 2000–2417 m.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs broadly rounded; arms 5, short, tapering rapidly; abactinal and actinal surfaces flat, margin vertical.

Abactinal plates ovoid to rounded, convex to low-tabulate; closely spaced in interradii, but further apart on radial plates, connected by 5 or 6 short lobes. Primary plates not apparent, carinal series not enlarged though plates smaller towards margin. On either side of carinal series, plates in longitudinal and oblique transverse series. Plates with 1–5 central, and 8–11 outer spinlets in a flaring cluster. Spinelets short, up to 1 mm long, with tips very slightly expanded and blunt. Peripheral spinelets slightly shorter.

Papular area extensive, with only a narrow subtriangular interradial area free from papulae. Up to 6 papulae around larger plates.

Madreporite placed at about half r from disc centre, small, slightly tumid and rounded, 1.5 mm diameter, with coarse, radiate sculpture.

Anus not apparent in larger specimens, but visible in one small specimen; small, inconspicuous, nearly centrally placed, surrounded by a few granules.

Marginal plates conspicuous, the 2 series opposite throughout; an unpaired marginal in both series, wedge-shaped, with superomarginal widest towards disc while inferomarginal varies, and may be similar or widest at margin. Paired marginals squarish to rectangular, becoming wider than long distally. Narrow shallow grooves separating all marginals. Plates covered with spinelets like those on abactinal plates, but slightly shorter on abactinal and actinal surfaces and slightly longer on lateral faces. Terminal plate small and subtriangular, truncate proximally, covered with spinelets.

Actinal plates in 4 or 5 chevrons in interradius; innermost series extending to about three-quarters R along arm, and adjacent series nearly so; outer series more or less restricted to interradius. One large plate just distal to orals. Plates rectangular to ovoid in outline, with 15–20 slightly thorny spinelets.

Small fasciculate *pedicellariae* often on plates adjacent to adambulacrals, sometimes elsewhere, but not occurring near margin. These pedicellariae with 3–6 spinelets in an erect group; spinelets flattened and slightly curved, tapering to a sharp point.

Adambulacral plates squarish with a weakly convex furrow margin, as wide as long throughout the ray; 3 or 4 tapering furrow spines, and 6–8 slightly shorter subambulacral spines, in 2 longiseries. Occasional plates with most of subambulacral spines replaced by fasciculate pedicellaria. On distal plates 1 subambulacral spine may be slightly enlarged.

Oral plates relatively large and long, with distinct median space between plates of each jaw. Furrow spines 6 or 7, pointed, longest proximally; 10–15 suboral spines forming 2 longiseries, also largest proximally. Rarely, distal suboral spines replaced by fasciculate pedicellaria.

Tubefeet biserial, with distinct sucking discs.

Interradial septum membranous, superambulacral plates absent.

COLOUR (ex ethanol): Creamy white to dull brown, with no marked pattern.

REMARKS: The only other known species in the genus is from the Atlantic Ocean.

Family **CHAETASTERIDAE** Sladen, 1889

Chaetaster Müller & Troschel, 1840

Arms 5, slender, cylindrical. Marginals small, with an odd interradial marginal in each series. Spinelets of paxillae slender and glassy. Superambulacral plates present; interbrachial septa calcareous; ampullae single.

TYPE SPECIES: *Asterias subulata* Lamarck, 1816 (= *Asterias longipes* Retzius, 1805).

Chaetaster moorei Bell, 1894 (Pl. 51)

Chaetaster moorei Bell, 1894: 404; A.M. Clark 1951: 1256; Jangoux 1984: 283; Guille *et al.* 1986: 142; Rowe & Gates 1995: 56; A.M. Clark 1993: 189.
Chaetaster vestitus Koehler 1910: 136, pls 18(12), 19(10, 11).
Chaetaster cf. *vestitus:* McKnight 1989a: 9.

MATERIAL EXAMINED: NZOI Stns: Q64(1), Q65(1), Q72(1).

SIZE: Study specimen from NZOI Stn Q64, R/r = 82/10.5 mm, br. 10 mm.

DISTRIBUTION: Here recorded from Capel Bank and near Middleton Reef, northern Tasman Sea, 0–65 m. Elsewhere known from New Caledonia, and Macclesfield Bank, South China Sea, in shallow water.

DESCRIPTION: Outline markedly stellate, *disc* very small, 5 arms tapering very slowly to sharp point; disc inflated, arms rounded.

Abactinal plates all similar, with lobed base and distinct, relatively high tabulum; plates with broad proximal and distal lobes overlapping; on each side usually 2 much narrower lateral lobes connecting to adjacent plates.

Marginal and actinal plates lacking lobes, base simply rectangular or squarish. Abactinal and marginal plates forming distinct longiseries, sometimes slightly irregular distally. Plates in each row tending to alter-nate, so that transverse arrangement somewhat oblique. On disc, tabulae tend to ovoid or circular out-line, on arms subrectangular with rounded ends, wider than long. At arm base, 4 adradial series between superomarginals and carinals. Marginal plates larger than adjacent abactinal or actinal plates, subrect-angular, wider than long. In interradii, an unpaired narrow plate in both marginal series.

Papulae between lobes of abactinal plates in regular longiseries. No papulae below superomarginals.

Anus not apparent, apparently concealed by disc paxillae.

Madreporite sometimes concealed; small, tumid, rounded, diameter about 2 mm, about midway between disc centre and margin; sculpture coarse, radial.

Actinal plates subrectangular to square, in 3 or 4 series in interradii. If 4, then outer composed of 2 or 3 plates only; innermost extending into distal half of arm, with 2 series at half R. Tabulae capped with numerous short spinelets, up to 60 on larger plates; central spinelets 0.2-0.5 mm long, scarcely tapering; tips blunt, spinelets opaque. Peripheral spinelets slightly larger, 0.3-0.8 mm long, glassy, except at base. Often 1 or more peripheral spinelets enlarged, up to 1.2 mm long, slightly flattened. Marginal paxillae similar to abactinal ones, but larger, with more spine-lets, and 3 or 4 of peripheral ones may be enlarged. Actinal paxillae similar.

Adambulacral plates squarish throughout; 5 or 6 opaque furrow spines, about 0.3 mm long, with consecutive combs overlapping; subambulacral spines numerous, in 3 or 4 longiseries or irregular. Inner-most row longest, up to 0.5 mm long, glassy; outer rows shorter, usually opaque but sometimes all glassy.

Oral plates small, inconspicuous; 2–4 short furrow spines, but 1 specimen with proximal spine enlarged and glassy distally; 2 large suboral spines, both pointed, slightly curved and glassy in distal half.

Tubefeet biserial in narrow *ambulacral grooves*, with distinct sucking discs.

COLOUR (dried specimens, ex-ethanol): Uniform dull cream or light brown. In life, the aboral surface is brownish-red, with arm tips yellow, and adoral surface orange.

REMARKS: This species is well characterised by the small disc, elongate, sharply pointed arms, and the hyaline spines on the paxillae, adambulacral, and oral plates. The family contains only one genus, and appears to lack close affinities with any others.

Superfamily **GANERIOIDEA**

Family **GANERIIDAE** Sladen, 1889

Body usually stellate, rarely almost pentagonal, interradial arcs rounded; arms usually 5, rounded. Abactinal plates imbricating, paxilliform or nearly so, sometimes with broadened columns and ill-defined tabulum; sometimes basal lobes reduced and plates obscured by thickened pustular body wall. Plates crowned with clusters of spinelets, these sometimes almost granuliform. Papulae in small groups in skeletal meshes, none on actinal surface. Marginal plates conspicuous or not, with groups of spines or spinelets.

Actinal plates imbricating, forming regular series, each with 1 or more spines or spinelets. Adambulacral plates small, with 1 or 2 furrow spines and several subambulacral spines, these often forming transverse rows. Pedicellariae usually absent, rarely a few spinelets forming a simple fasciculate pedicellaria. No true interradial septum, but a proximal, calcified pillar. No superambulacral plates. (Adapted from A.M. Clark 1983: 376.)

REMARKS: Of genera reported from the area, only one conforms to this diagnosis. This is *Cycethra*, recorded from Macquarie Island. Other local genera, *Hyalinothrix*, *Knightaster*, and *Tarachaster*, have single papulae, and adambulacral spines set in palmate groups, at least for the furrow series. A separate subfamily has been suggested for *Vemaster* (A.M. Clark 1967b: 362), and another may be necessary for those genera from the Pacific Ocean. Although similiar to asterinids such as *Nepanthia*, the marginals, at least in *Knightaster*, are similar to those figured for the Ganeriidae (A.M. Clark 1967: fig. 1c, d).

KEY TO GENERA

1 Adambulacral spines in a single transverse series ..... *Cycethra*
Adambulacral spines in a longitudinal furrow series and a subambulacran fan 2

2 Abactinal spinelets smooth; abactinal plates i oblique transverse rows on sides of ray ..... *Tarachaster*
Abactinal spinelets glassy and thorny 3

3 Abactinal spinelets elongate,very fine, numerous, 50 or more on plates; abactinal plates in oblique transverse rows on sides of ray ..... *Hyalinothrix*
Abactinal spinelets short, coarser, 30 or fewer on plates; plates vary in size, but donot form oblique lateral rows ..... *Knightaster*

Cycethra Bell, 1881

Abactinal skeleton more or less well developed, the plates not deeply buried in skin. Actinal plates regularly arranged, with spinelets small, often clustered and obscured by skin. Marginal plates distinct or even prominent, especially distally.

TYPE SPECIES: *Goniodiscus verrucosus* Philippi, 1857.

Cycethra frigida (Koehler, 1917) (Pl. 52)

Asterina frigida Koehler, 1917: 46–48, pls 6(9–11), 7(8).
Asterina hamiltoni Koehler, 1920: 133–136, pls 35(5–7, 10), 36(1–3), 66(5).
Cycethra macquariensis Koehler, 1920: 139, pls 24(1–4, 6–7), 66(5); A.M.Clark 1962: 24; McKnight 1984: 142.
Cycethra frigida: O'Hara 1998: 177–179, pl. 1c.

MATERIAL EXAMINED: NZOI Stn: A695(1).

SIZE: Specimen from NZOI Stn A695, R/r = 5/3.5 mm. 9 superomarginals along arm.

DISTRIBUTION: Known from Kerguelen and Macquarie Islands.

DEPTH: 0–95 m.

DESCRIPTION: Outline pentagonal-stellate, 5 slowly tapering arms, abactinal surface inflated, actinal surface more or less flat, margins rounded, interbrachial arcs rounded.

Abactinal plates rounded to weakly lobate, all more or less of same size although plates becoming smaller distally and towards margins; plates raised centrally, with ?58 short spinelets about 0.2 mm long; these rounded, tapering only near tip, often thorny distally, concealing plate centre but not edges.

Papulae mainly single, distinct, each almost filling small meshes between plates. No actinal papulae.

Anus not apparent.

Madreporite apparently concealed by spinelets.

Marginal plates distinct, forming rounded margin to body. Superomarginals wider than long, sometimes obliquely placed, and with inferomarginals; plates of both series tumid, with 6–9 spinelets in 1 or 2 transverse series. Terminal plate covered with relatively large spinelets, much broader than long, with shallow notch on outer face.

Actinal areas distinct, plates small, in about 3 series but only 1 extending beyond arm base; plates with 1 spinelet, some proximal plates with 2.

Adambulacral plates somewhat compressed, with spinelets in single transverse row, 1 in furrow and 2, rarely 3, subambulacral spines.

Oral plates small, although distinct, each with 3 furrow spines and 2 suboral spines, all similar to those on adambulacral plates.

Ambulacral furrows narrow; *tubefeet* biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull creamy-white, tubefeet brown.

REMARKS: This is the only species of *Cycethra* which conforms to the diagnosis of the family Ganeriidae given above.

Hyalinothrix Fisher, 1911b

Stellate, arms rounded in section; abactinal and actinal plates convex, with a small, central tabulum, each with cluster of numerous, very fine, glassy spinelets. Abactinal plates with 4 or 5 lobes, irregular on disc and centreline of arms, in oblique series laterally on arms; marginals small, scarcely distinguishable, actinal plates and adambulacrals 4-sided; adambulacrals with 3 or 4 furrow spines, subambulacral spines in clump, similar to those on actinal and abactinal plates; papulae usually single, none present below superomarginals. Ampullae single, incipiently bilobed; gonads interradial; interbrachial septa strongly calcified; superambulacral plates absent.

TYPE SPECIES: *Hyalinothrix millespina* Fisher, 1911b.

Hyalinothrix millespina Fisher, 1911b (Pl. 53)

Hyalinothrix millespina Fisher, 1911b: 661, pls 69, 70, 71(1–7); A.M. Clark 1993: 201.

MATERIAL EXAMINED: NZOI Stn: K795(1).

Size: R / r = 21 / 6 mm, br. = 6 mm.

DESCRIPTION: Outline stellate, *disc* small, arms 5, gently tapering, blunt-tipped, slightly constricted at base. Arms rounded abactinally, arms and disc flat on actinal surface.

Abactinal plates with irregular outlines, 4 or 5 lobed, and overlapping; plates not regularly arranged at disc centre and along midline of arms, forming oblique rows on sides of arms. Plates convex, with small, central tabulum capped by numerous (50+), very fine, glassy spinelets. These longer than tabulum, webbed by skin at base, sometimes bifid near arm tip, abactinal plate simply swollen.

Anus very small, near disc centre, almost obscured by a ring of paxillae.

Madreporite placed at about half r from disc centre, similarly obscured by paxillae.

Papulae single, usually 4 about each plate, sometimes 5 on disc.

Marginal plates small, scarcely larger than abactinal plates, not apparent interradially; near arm tip 2 series of swollen plates, slightly wider than long, in contrast to adjacent abactinals as wide as long; these thought to be marginals, but cannot be easily traced back to disc. Near arm base plates below papular pores tending to irregular in outline.

Actinal plates more or less 4-sided, swollen, in about 3 series in interradius, with innermost series extending to beyond half R but absent near arm tip. Plates with a cluster of numerous, very fine glassy spinelets, slightly thicker than those on abactinal and marginal plates, tips often bifid or trifid. Plates adjacent to adambulacrals with spinelets slightly coarser.

Adambulacral plates almost square, a little larger than adjacent actinals; 3 or 4 furrow spines, basally webbed, longer and thicker than elsewhere on specimen. Spines longitudinally striated, extending across furrow, tips irregularly pointed. Subambulacral spines in clump, similar to actinal spines but slightly thicker.

Oral plates small, furrow spines 6 or 7, suboral spines in group, both series similar to those on adambulacral plates.

Ambulacral furrows narrow; *tubefeet* biserial throughout, with distinct sucking discs.

COLOUR (ex-ethanol): Dull light brown.

REMARKS: This species was originally recorded from the Hawaiian Islands, in 232–282 m. This specimen, apparently the second only known, is from the Kermadec Islands, in 350 m.

Tarachaster Fisher, 1913

Disc small, arms 5, slender, abactinal plates imbricated, forming fairly regular series, both longitudinal and transverse, but somewhat irregular on midradial region of arms. Marginal plates may be actinal on interradial areas. One series of actinal plates extending to arm tip or nearly so, additional series on disc. Papulae single, abactinal. Plates lobate, convex, each with a group of short, smooth, bluntly rounded spinelets; adambulacral plates with furrow comb and subambulacral spines crowded, grading into actinal spinulation; subambulacral spines may form rows across or along plate; superambulacral ossicle present; ampullae double; tubefeet rather small, sucking discs well developed.

TYPE SPECIES: *Tarachaster tenuis* Fisher, 1913.

Tarachaster australis McKnight, 1973 (Pl. 54)

Tarachaster australis McKnight, 1973c: 14; non McKnight 1989a: 10; 1993a: 173, 185 (= *Nepanthia grangei* n.sp.).

MATERIAL EXAMINED: NZOI Stn: E849(1, holotype).

SIZE: Holotype, H-174, R / r = 30/5.5 mm, deposited in the NIWA collection, Wellington.

DISTRIBUTION: Known only from the type locality,

extreme northern New Zealand, 216 m.

DESCRIPTION: Outline stellate, disc small, 5 arms, tapering slowly to blunt tip. Disc and arms somewhat inflated, arms rounded above, actinal surface flat.

Abactinal plates small, more or less equal sized, quadrilobate; plates irregularly disposed on disc and at arm base, forming regular longitudinal and transverse rows on arms. Plates swollen at centre, with compact group of 12–17 short, smooth spines, tip bluntly rounded.

Papulae not extending to superomarginals; papulae pores regularly arranged, usually 4 about each abactinal plate.

Anus not apparent.

Madreporite concealed by adjacent paxillae, slightly tumid, rounded, 0.5 mm diameter; sculpture coarse, placed one-third r from disc centre.

Marginal plates small, scarcely larger than abactinal plates and similarly armed. Plates slightly wider than long throughout arm but distinct only near arm tip where traceable in interradii; both series on actinal surface.

Actinal plates in 3 series at arm base, inner extending to about three-quarters R, middle to one-quarter r, outer only to arm base. Plates also forming transverse series and aligned with marginals; innermost plates usually placed between and outside successive adambulacrals; plates with compact group of 12–15 spines, like those on abactinal and marginal plates, shorter than adambulacral or oral spines.

Adambulacral plates wider than long, slightly separated throughout; furrow spines 2 or 3, forming slightly palmate group, slightly longer and thicker than elsewhere and flattened with narrow face to furrow; subambulacral spines grading from furrow spines to actinals, 7–9 spines forming irregular rows, often in double transverse series.

Oral plates small, subtriangular; 5 furrow spines largest proximally, 4 suboral spines forming row along plate; oral armature resembling that of adambulacrals.

Ambulacral furrows narrow.

Tubefeet biserially arranged with distinct sucking discs.

COLOUR (ex ethanol): Creamy-white.

REMARKS: The only other species is *Tarachaster tenuis* Fisher, from the Philippines, in 296 m. It differs in having a more extensive area of irregularly arranged abactinal plates and more adambulacral furrow spines, but often fewer subambulacral spines.

Knightaster H.E.S. Clark, 1972

Abactinal plates slightly tabulate or tumid, sometimes in varying sizes, with relatively numerous spinelets; marginals small, only slightly differentiated. Actinal plates present, each with a clump of spinelets, similar to those on abactinal and marginal plates. Adambulacral plates with palmate furrow comb of spines; subambulacral spines similar or in a clump; no superambulacral plates; no interradial septum, but a stout calcareous pillar in each interradius; ampullae double.

TYPE SPECIES: *Knightaster bakeri* H.E.S. Clark, 1972.

Knightaster bakeri H.E.S. Clark, 1972

(Frontis, Pl. 55)

Knightaster bakeri H.E.S. Clark, 1972: 147, 1 pl.; A.M. Clark 1993: 203.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: This species is known only from the Poor Knights Islands, northeastern New Zealand, 30–54 m.

DESCRIPTION: Taken from H.E.S. Clark (1972).

Outline stellate; disc small, arms 5, gradually tapering to blunt point.

Abactinal plates varying in size and shape, forming irregular reticulum. Plates bearing short spinelets, either covering plate or only at periphery. Plates slightly enlarged and more regular in shape adjacent to supero-marginals. Spinelets sometimes enclosed in mem-brane.

Papulae single, numerous, more conspicuous on dorsal side of arms.

Madreporite small, inconspicuous, with fine deep sculpture, placed just over half R from disc centre.

Anus more or less central, on small raised area.

Marginal plates small, more or less regular in arrange-ment, larger proximally, each with 15–25 spinelets, slightly longer than those on abactinal plates.

Actinal plates more or less rectangular in outline, forming regular longitudinal and transverse rows. Each actinal plate with 8–15 spinelets like those on abactinal plates.

Adambulacral plates subrectangular, furrow margin almost straight; 5, sometimes 6, furrow spines and 5–10 subambulacral spines in compact clump.

Oral plates with 9 or 10 furrow spines, somewhat crowded and may have basal web; 8–12 suboral spines in 1 or 2 rows, raised above level of adambulacral plates.

Adambulacral grooves narrow, deep; *tubefeet* biserial with distinct sucking discs.

COLOUR: Bright yellow in life (not orange as reported) above and below, arm tips slightly paler; light orange to brown when preserved.

REMARKS: *Knightaster bakeri* differs from other local species of the Ganeriidae in its much larger size, and in having plates of various sizes intermingled over the abactinal surface, and not forming any regular pattern.

Family **ASTERINIDAE** Gray, 1840

Body form stellate to pentagonal; arms 5, or occasionally more, usually short and tapering to a blunt tip; flat below, usually convex or raised above. Marginal plates distinct, but not enlarged, inferomarginals defining the ventrolateral margin. Abactinal plates small, flat or tumid, often crescentic or lobed, all similar or of 2 distinct magnitudes. Plates usually imbricating, with midradial plates overlapping proximally and laterally. Abactinal plates with small spines or granules. Papulae restricted to parts of abactinal surface. Actinal plates in transverse and longitudinal series, small, imbricating, with spinelets sometimes in combs. Pedicellariae, if present, simple alveolar or fasciculate, with few spiniform valves.

KEY TO GENERA

1 Body thin, flat, or arched; abactinal plates flat 2
Body more or less normal thickness; abactinal plates convex 4

2 With a dorsoventral duct in each interradius, abactinal plates with flattened triangular papillae projecting over papular pores, with spaced minute granules *Tremaster*
No interradial dorsoventral duct 3

3 Body flat, abactinal plates forming longitudinal and oblique transverse series, all plates delicate, fan-shaped, papulae restricted to narrow midradial field; abactinal spinelets delicate, with several hyaline points ..... *Anseropoda*
Body often arched, abactinal plates tending to form longi-series, usually bordering an irregular radial field; papular plates crescentic, other rhombic; with very short almost granuliform spinelets ..... *Stegnaster*

4 Shape near pentagonal, with R usually 1–1.4 r; abactinal spinelets usually blunt-tipped 5
Shape stellate, with R > 1.5 r; abactinal spinelets acicular, often hyaline distally 6

5 Abactinal spinelets blunt, opaque, sometimes with several points; actinal plates with 1 or more spinelets *Asterina*
Abactinal and actinal spinelets short, almost granuliform ..... *Patiriella*

6 Outline pentagonal stellate, R 1.5–1.5 r *Paranepanthia*
Outline markedly stellate, R / 2R ..... *Nepanthia*

Patiriella Verrill, 1913

Adambulacral armature reduced to 1 or 2 furrow spines, and 1 or 2 subambulacral spines. Suboral spine present or absent. Actinal plates with 1–3 spines. Abactinal plates of papular area of two types, larger crescentic plates with a papular just proximal to them, and smaller rounded plates.

TYPE SPECIES: *Patiriella regularis* (Verrill, 1867).

KEY TO SPECIES OF *PATIRIELLA*

1 Rays 6, 2 subambularal spines, no suboral spines ..... *gunni*
Rays 5, 1 subambulacral spine, 1 or 2 suboral spines 2

2 Abactinal spinelets almost granuliform; actinal spinelets short, absent proximally; gonopores open ventrlaly, often visible; R < 15 mm ..... *exigua*
Abactinal spnelets longer; actinal spinelets present proximally; R usually > 20 mm 3

3 Abactinal spinelets usually in single row ... *regularis*
Abactinal spinelets in 2 rows on plates ..... *oliveri*

Patiriella exigua (Lamarck, 1816) (Pl. 56)

Asterias exigua Lamarck, 1816: 554.
Patiriella exigua: Verrill 1913: 484; H.L. Clark 1938: 163; 1946: 136; Dartnall 1971: 40, pl. 4(c); A.M. Clark 1993: 225; Rowe & Gates 1995: 40.

MATERIAL EXAMINED: NZOI Stns: P52(15), P88(20).

STUDY SPECIMEN: NZOI Stn P25, R / r = 11/8 mm, also P88.

DISTRIBUTION: Norfolk and Lord Howe Islands. Other records are from Australia south of 28°S latitude, including Tasmania, South Africa, and the Saint Paul Islands.

DESCRIPTION: Outline pentagonal, interbrachial arcs scarcely indented, 5 rays tapering to pointed tip, margin very low with disc and arms inflated. On disc, abactinal plates mostly rounded; while along midline arms crescentic with small plates interspersed between. At sides of arms, cresentic plates gradually passing into rounded to squarish plates. Plates arranged in longitudinal and transverse series, most apparent on sides of arms.

Abactinal plates with 2–6 short, almost granuliform spinelets, finely thorny, blunt tipped, about twice as long as wide.

Papulae absent from an interradial area near margin.

Anus small, almost central, surrounded by spinelets.

Madreporite about one-quarter r from disc centre, rounded to angular, 1.5 mm diameter, with coarse, radiate sculpture.

Marginal plates small, inconspicuous. Superomarginals abactinal, larger than adjacent plates. Each with 3 or 4 spinelets like those on abactinal plates. Inferomarginals project, forming margin, with 6–8 spinelets, slightly longer than those on superomarginals, arranged in 2 rows along plate. Spinelets projecting to form a slight marginal fringe.

Actinal plates rounded to rectangular, arranged in 9 or 10 chevrons, with longitudinal and transverse series evident. Plates adjacent to adambulacrals largest, all rows decreasing size distally. Just behind oral plates a relatively prominent actinal plate, separated from orals and other actinals by a narrow membranous area. Two small gonoducts often evident, lying about opposite 3rd or 4th adambulacrals. Proximal plates and those of row adjacent to adambulacrals usually bare, remainder with 1 or, near margin, 2 spinelets.

Adambulacral plates wider than long over most of arm, with 2 subequal furrow spines basally webbed, and a single, sturdier subambulacral spine.

Oral plates elongate, distally separated by a membranous space; 5 furrow spines, the proximal 2 larger and 1 or 2 suboral spines just proximal to centre of plate.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull light brown. In life the abactinal surface has a ground colour of dull green or brown. Red, orange, purple, or brown may tinge the inferomarginal spines, radial midline, and centre of the disc. The tubefeet are blue-green, and the sucking discs off-white (Dartnall 1971).

Patiriella gunnii (Gray, 1840)

Asterina gunni Gray, 1840: 289.
Patiriella gunni: Verrill 1913: 484; H.L. Clark 1946: 135; Dartnall 1971: 46; A.M. Clark 1993: 225; Rowe & Gates 1995: 40.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Lord Howe Island, with other records from southern Australia, western Australia to New South Wales, including Tasmania.

Patiriella oliveri (Benham, 1911) (Pl. 57)

Asterina oliveri Benham, 1911: 147.
Patiriella oliveri: McKnight 1968: 511; H.E.S. Clark 1970: 5; A.M. 1993: 212; Rowe & Gates 1995: 40.
Patiriella nigra H.L. Clark, 1938: 167, pl. 21(3, 4); 1946: 13

MATERIAL EXAMINED:
NZOI Stns: K81 (field notes), K813(several), K834(10), K864(5), T223(12), Z1927(7), Z199(1).

DISTRIBUTION: Kermadec Islands and Lord Howe Island

STUDY SPECIMEN: NZOI Stn K864, R / r = 35/20 mm.

DESCRIPTION: Outline pentagonal, body relatively thick and cushion-like, inflated arms little produced.

Abactinal plates on radial areas crescentic, much wider than long; interspersed between much smaller ovate plates. Interradially near disc centre plates similar, but towards margin becoming rounded or ovate. All plates covered with short spinelets longer than plate length; spinelets tapering near tip and sometimes slightly widened distally. Tip bluntly pointed, often slightly thorny. Spinelets arranged in rows across plate, commonly 2 such rows, but especially on larger plates 3 or more rows.

Papulae widely distributed on abactinal surface, up to 5 lying just proximal to larger crescentic radial plates, up to 3 elsewhere.

Madreporite about one-quarter r from disc centre, low, rounded, 2 mm diameter. Sculpture relatively coarse and radiate. Madreporite scarcely conspicuous, being slightly lower than surrounding plates.

Anus central, more or less concealed by spinelets.

Marginal plates small, superomarginals scarcely distinguishable, inferomarginals slightly projecting. Both series with short spinelets like those on abactinal plates.

Actinal plates in about 6 chevrons; individual plates ovate to round and spaced apart, becoming small and crowded near margins. Irregular non-calci-fied areas between some proximal plates. Actinal plates with 1, rarely 2, prominent flattened spines, each longer than plate. Near margins, spines becom-ing much smaller and close-set.

Adambulacral plates regularly with 2 subequal furrow spines placed longitudinally; spines flattened, tip varying from pointed to truncate. Near arm tip, plates small and spines usually placed transversely, with 1 spine clearly larger than other.

A thin web of skin linking bases of *furrow spines*. Subambulacral spine single, prominent, flattened; on proximal plates, tip may be truncate and widened, rarely even bifid; more distal spines tending to ovate in section and pointed.

Oral plates with 5 flattened, blunt-tipped furrow spines, largest proximally; 1 similar suboral spine.

COLOUR (dried): Dull uniform brown. In life, blue-green to black.

REMARKS: The character of the abactinal spinelets clearly separates this species from *P. regularis* Verrill from New Zealand.

Patiriella pseudoexigua Dartnall, 1971

Patiriella pseudoexigua Dartnall, 1971: 43, pl. 3; A.M. Clark 1993: 226; Rowe & Gates 1995: 41.
Patiriella obscura Dartnall, 1971: 45, pl. 4(b).

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Recorded from Lord Howe Island, but provenance may be doubtful (Rowe & Gates 1995).

Patiriella regularis (Verrill, 1867) (Frontis, Pl. 58)

Asterina (*Asteriscus*) *regularis* Verrill, 1867: 250.
Patiriella regularis: Verrill 1913: 480; Fisher 1919: 416; Mortensen 1925: 294; H.E.S. Clark 1970: 4, 5; Rowe & Gates 1995: 41.

MATERIAL EXAMINED:

NZOI Stns: A444O(1), A970(2), B218(1), B224(1), B230 (2), B237(1), B245(1), B601(1), B825(1), C598(1), C856(1), C863 (1, in u/w photo), C921(1), C978(12), C989(1), D127 (1), D375 (numerous), D382(2), D384(10), D443(1), D595(1), E439(1), E767(11), E768(13), E809(6), E833(2), F890(2), F930(5), F934 (2), G161(3), G162(1), G660(1), G671(2), G672 (14), G673(1), G680(1), G835(2), I349(1), I617(1), I622(1), I624 (1), I625(1), I627(1), I645(1), I651(1), I652(1), I653(1), I654(1), J157 (field notes), J161 (field notes), J291(4), J292 (field notes), K100(field notes), K102 (field notes), K158(1), K989(1), K996 (field notes), K997 (field notes), M5A(1), M571 (field notes), M574 (field notes), M575 (field notes), M579 (field notes), M678(1), M679(1), M680 (4), M681(3), M691(6), M775(1), M780(1), N923(1), O113(1), O129(1), O156(1), O158(1), O171 (numerous), O172(1), O326(1), O327A(1), O327B(1), O332A (1), O333B(1), O335A(2), O335B(1), Q85(2), Q87(8), Q91(1), Q93A(1), Q93C(1), Q97(1), Q102(2), Q104(1), Q105(1), Q107 (2), Q111(1), Q118(5), S233(2), S247(1), S251(3), S259(2), T460 (field notes), T465(2), T478(2), T486(2), T501(1), T503 (1), T505(2), T528(1), T531(1), T537(1), T539(3), T554(1), T559 (1), T562(1), T567(1), T586(1), T587 (field notes), T588 (field notes), T601(1), T603 (field notes), T605 (field notes), T1020(1), Z1842 (field notes), Z2318(1), Z2322(6), Z3845(1).

DISTRIBUTION: This species occurs throughout New Zealand and the Chatham Islands. It has been reported from southern Australia and Tasmania.

STUDY SPECIMEN: E809, dried specimen, R/r = 24/16 mm.

DESCRIPTION: Outline almost pentagonal, interbrachial arcs slightly concave; 5 rays tapering to a point. Margin low and disc thick, specimen cushion-like.

Abactinal plates of varying sizes and shapes, swollen, often ridged. At disc centre an area of small rounded plates encircled by more prominent plates, with larger elongate and crescentic plates, and smaller rounded plates between. Smaller plates appear to be primary radials and basals. Crescentic plates along centreline of arms, loosely arranged in longiseries, in evident transverse series, with 1 or 2 small round plates between larger ones. At sides of arm and near tip, no smaller plates. Lateral plates crescentic, becoming simply rounded towards margin. At about half R, 6 series of crescentic plates occupying just over half of arm width. Plates swollen, on crescentic-like plates this swelling forming a low ridge along length of plate, covered with short slightly thorny spinelets; up to 20 on larger disc plates and up to 15 on larger plates of arm.

Papular area extensive, covering centre of disc and along arms to tip; laterally extending to limit of crescentic plates.

Anus small, almost central, lacking any encircling spines.

Madreporite rounded, 3 mm diameter with coarse, radiate sculpture, one-third r from disc centre.

Superomarginal plates small, confined to abactinal surface; inferomarginals projecting slightly. Superomarginals regular, a little larger than adjacent abactinals, each plate with 6 or 7 spinelets; adjacent abactinals with 2-4.

Inferomarginal plates slightly wider than superomarginals, with 6-10 spinelets. Marginal fringe scarcely apparent.

Actinal plates in several chevrons, with transverse and longitudinal series evident. Plates swollen centrally, most with single short, stubby spine, those at or near margin with 2. Spines largest on proximal plates, often with skin covering at base or over entire length. Sometimes skin links successive spines, forming transverse basal web. Spine on plates adjacent to adambulacrals often smaller than those outside it.

Adambulacral plates wider than long over most of arm. First 2 adambulacrals with 3 furrow spines, remainder with 2, near arm tip usually 1. Spines united by web of thin skin, either basally or over entire length. If 3 furrow spines, of subequal length; if 2, dis-

tal clearly longer. Spines smooth, bluntly rounded or pointed. One prominent subambulacral spine, longer than furrow spines, blunt tipped.

Oral plates relatively long, often with distinct membranous gap between. Furrow spines 4, larger than adambulacral spines, largest proximally; a single prominent suboral spine placed just distal to centre of plate.

Tubefeet biserial, with distinct sucking discs.

COLOUR: Variable, with blue and grey often predominating, although reddish tints are often apparent.

REMARKS: A broken specimen reveals imbricating abactinal and actinal plates forming internal struts, as in *Anseropoda* (see A.M. Clark 1983: 361, and textfigs 1f, 5b, 5c).

Nepanthia Gray, 1840

Disc small, 5 or more arms elongate, tapering, and subcylindrical, usually flattened actinally. Marginal plates small and not prominent, but may delimit actinal surface. Abactinal plates in distinct radial and lateral fields. Actinal plates in several rows at base of ray, decreasing distally. Adambulacral plates with fan of furrow spines and similar fan of subambulacral spines. Spinelets variable in size and form. Simple fasciculate pedicellariae may be present. Some species fissiparous.

TYPE SPECIES: *Nepanthia maculata* Gray, 1840.

KEY TO SPECIES OF *NEPANTHIA*

1 Often more than 5 unequal rounded arms, and more than 1 madreporite; fissiparous; larger abactinal plates crescentic; with secondary abactinal plates ..... *belcheri*
Not fissiparous; 5 equal arms, 1 madreporite 2

2 A slight actinolateral edge to arm; larger abactinal plates crescentic; with secondary abactinal plates ..... *reinga* n.sp.
A definite actinolateral edge to arm; abactinal plates not crescentic; no secondary plates ..... *grangei* n.sp.

Nepanthia belcheri (Perrier, 1875) (Pl. 59)

Asterina (Nepanthia) belcheri Perrier, 1875: 240.
Nepanthia belcheri: H.L. CLark 1938: 169; 1946: 141; Clark & Rowe 1971: 38, 66; Rowe & Marsh 1982: 99; A.M. Clark 1993: 220; Rowe & Gates 1995: 37.

MATERIAL EXAMINED: NZOI Stn Q82(1).

DISTRIBUTION: Lord Howe Island. This species is widespread in the Indo-West Pacific region, from Burma to the Philippines and Vietnam, and tropical Australia. 0–46 m.

STUDY SPECIMEN: NZOI Stn Q82, R / r = 14 / 6 mm, br. = 4 mm; the 6 arms are unequal, R = 9–14 mm, det. F.W.E. Rowe.

DESCRIPTION: Outline stellate, 6 unequal arms tapering only slightly, bluntly tipped; disc inflated, arms arched abactinally, flattened actinally; ventrolateral angle rounded.

Abactinal plates irregular in size and shape at disc centre, elsewhere crescentic. Along arm midline, plates not forming regular series; small rounded secondary plates interspersed between them; on sides of arms plates in distinct longiseries, each tending to an ovoid shape. Plates imbricating, raised, with a dense covering of small spinelets. Spinelets ridged throughout length, terminating in 1–3 fine points.

Anus and *madreporite* not apparent.

Papulae widespread on disc and arms, extending to last row of crescentic plates.

Marginal plates small, superomarginals irregular in form and size, inferomarginals in regular series at ventrolateral margin of arm, mostly longer than wide or high.

Actinal plates in 4 series interradially, with inner 2 extending along arm to beyond half R, innermost to near tip. Plates slightly elevated, with central clump of spinelets.

Adambulacral plates with 4–6 webbed furrow spines in a fan, up to 10 subambulacral spines in 1 or 2 irregular fans.

Oral plates small, each with 6 or 7 webbed furrow spines and numerous suboral spines tending to form curved or straight longiseries along plate.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex ethanol): Dull cream. In life it is variable, though often with a ground colour of grey-green or fawn with red, green, brown, or black mottling.

Nepanthia reinga n.sp. (Pl. 60)

MATERIAL EXAMINED: NZOI Stn E293(1).

TYPE: Holotype, H-754, in the NIWA collection, Wellington (from NZOI Stn E293, R/r = 77/16 mm, br = 16 mm).

TYPE LOCALITY: NZOI Stn E293, 34°17.50′ S, 172°25.00′ E, 205 m, northeast of Three Kings Islands.

STUDY SPECIMEN: NZOI Stn E293, R/r = 77/16 mm, br. = 16 mm. Specimen is dried and mostly denuded.

DISTRIBUTION: Known only from the northern tip of the North Island, 205 m.

DESCRIPTION: Outline stellate, 5 tapering arms, long, slender, tips blunt. Arms rounded abactinally, a slight actinolateral angle, actinal surface more or less flat. Disc inflated, margins rounded.

Abactinal plates irregular in outline and varying in size; larger plates crescentic in outline, smaller plates oval or round. Plates of both sizes irregularly arranged on disc and along centreline of arms; on sides of arms, smaller plates absent, larger plates forming regular oblique rows. Plates with a broad very low tabulum, not extending to margins, with 15–40 very short spinelets; these cover tabulum, or centre may be bare. Spinelets short, less than 0.5 mm long, glassy, finely thorny; tip usually pointed, although occasionally truncate, with a few subterminal points.

Papulae single, pores large, relatively conspicuous; a pore proximal to most larger plates.

Anal aperture near disc centre, masked by spinelets from adjacent paxillae.

Madreporite small, inconspicuous, with fine, deep striae, ovoid, maximum diameter about 2 mm, placed at about half r from disc centre.

Marginal plates small, distinct, regular, placed at ventrolateral margin, with inferomarginals just actinal in interradii; plates tending to align with oblique abactinal rows but not with actinal rows; with 15–30 spinelets like those on abactinal plates. Superomarginal plates more or less wider than long throughout arm, inferomarginals similar interradially, becoming longer than wide along arm.

Actinal plates forming regular longitudinal and transverse rows; 5 longiseries interradially, 1 extending almost to arm tip. Plates imbricate, squarish, strongly tumid, each with 8–15 spinelets like those on abactinal plates.

Adambulacral plates regular, rectangular, wider than long; furrow spines 5, 4 distally; spines erect, tapering only near pointed tip, almost smooth; basally webbed, usually forming palmate group; subam-bulacral spines 6–8, similar to furrow spines, usually in webbed palmate group like furrow spines, rarely in compact group. Outer margin of plate with 1 or 2 short, slender spinelets.

Oral plates small, with 5 or 6 furrow spines, longest proximally, and 4 suboral spines bordering median suture. Oral spines longest spines on specimen.

Tubefeet biserial, with distinct sucking discs, biserially arranged in narrow *ambulacral furrows*.

COLOUR (dried specimen): Dull, uniform brown.

ETYMOLOGY: Named after northernmost land point in New Zealand, Cape Reinga.

REMARKS: This species and the next are provisionally placed in *Nepanthia*.

The abactinal plates along the midline of the ray are like those in *N. nigrobrunnea*, but spinelets are similar to *N. belcheri*. The only other deepwater species is *N. gracilis*, which differs in having a more compact abactinal skeleton with generally ovoid plates.

Nepanthia grangei n.sp. (Pl. 61)

Tarachaster australis: McKnight 1989a: 10; 1993a: 173, 185 (non *Tarachaster australis* McKnight, 1973c: 14).

MATERIAL EXAMINED: NZOI Stns I729(1), Q69(1), U594(1).

TYPES: Holotype, H-755 in NIWA collection, Wellington, (NZOI Stn U594, R/r = 33/9 mm).

Paratypes, P-1223, from NZOI Stn I729, R/r = 22/6 mm, and P-1224, from NZOI Stn Q69, R/r 15/5 mm, 4-rayed, in NIWA collection, Wellington.

TYPE LOCALITIES: Holotype, NZOI Stn U594, 30°20.1′ S, 172°59.6′ E, 406 m, Three Kings Rise; paratypes, NZOI Stn I729, 25°40.4′ S, 159°27.0′ E, 306 m, Gifford Seamount, Q69, 27°00.0′ S, 159°18.3′ E, 354 m, Gifford Seamount.

STUDY SPECIMEN: Holotype, NZOI Stn U594, R/r = 35/9 mm, br. = 9 mm.

DISTRIBUTION: Gifford Seamount, northern Tasman Sea, and Three Kings Rise, 306–354 m.

DESCRIPTION: Outline stellate, 5 slowly tapering arms, tip blunt. Arms rounded above, flat below, ventrolateral margin angular, formed by both series of marginals.

Abactinal plates small, of similar size throughout except on disc and at arm base where smaller plates found. Plates irregularly arranged on disc and along midline of arms, forming regular oblique rows on sides of arms. Plates close-set, outline variable, rounded, rounded-triangular to ovoid, sometimes almost square; tabulate to simply tumid, margins somewhat depressed, with up to 30 fine spinelets, less than 0.5 mm long, glassy, finely thorny, scarcely tapering, tip with 1–4 fine points. Spinelets forming a radiating paxillate group, often extending beyond plate margins.

Papulae small, single, distinct, regularly arranged

on sides of arms, irregularly spaced and scattered elsewhere, not extending to superomarginals.

Anus not visible.

Madreporite inconspicuous, just less than half r from disc centre, outline irregular, greatest diameter 2 mm, sculpture deep and coarse.

Marginal plates small, distinct, forming ventro-lateral angle throughout, wider than long over all of arm, inferomarginal just actinal throughout. Plates with small spinelets similar to those on abactinal plates, larger plates with up to 30 such spinelets.

Actinal plates tumid, close-set, forming regular longitudinal and transverse rows; 7 rows in interradius, though outermost with only 1 or 2 plates; 5 at arm base; 1 row extending to near arm tip but not reaching it. Plates with 10–20 spinelets like those on abactinal and marginal plates.

Adambulacral plates wider than long, very slightly spaced apart; furrow spines 5 proximally, 4 over most of arm, thicker and longer than actinal spines but otherwise similar. Spines basally webbed, forming palmate group. Subambulacral spines 6–10, on proximal plates tending to form 2 palmate groups, basally webbed like furrow spines, sometimes clumped; from about half R spines generally in 1 palmate group. Outer margin of plate may have 12 spines tending to grade from coarser furrow to actinal spinulation.

Oral plates small, 8–10 furrow spines, slightly longer proximally; 8–10 suboral spines in a series bordering median suture, occasionally spines paired.

Ambulacral furrows narrow; *tubefeet* biserial, with distinct sucking discs, often obscured by *adambulacral furrow* spines.

COLOUR (ex-ethanol): Dull, uniform, very light brown, lighter actinally. The holotype has darker areas at arm bases on abactinal surface.

ETYMOLOGY: Named for Dr Kenneth R. Grange, NIWA, Nelson.

REMARKS: This species is distinguished by the combination of relatively large disc, distinct actinolateral angle, ovoid to rounded abactinal plates, and lack of secondary abactinal plates. Descriptions of species of *Nepanthia* (Rowe & Marsh 1982) indicate that this combination of characters is not matched in any previously described species, or in the genus *Pseudonepanthia* Goto, 1914. It differs from the previous species in having a relatively larger disc (R/r = < 4.0 mm). *Nepanthia gracilis*, the only other deep-water species, lacks the distinct actinolateral angle formed by the marginal plates, and the abactinal spinelets have seven or eight points.

Paranepanthia Fisher, 1917b

A zone of secondary plates along centre of arms intermingled with larger crescentic plates. Actinal plates with tuft of spinelets. Adambulacral plates with furrow spines in fan, subambulacral spines usually similar. Suboral spines numerous. Outline pentagonal-stellate.

TYPE SPECIES: *Nepanthia platydisca* Fisher, 1913.

Paranepanthia aucklandensis (Koehler, 1920)

(Pl. 612

Asterina fimbriata: Benham 1909b: 295, non *A. fimbriata* Perrier 1875: 307.

Asterina aucklandensis Koehler, 1920: 135; Mortensen 1925: 300, pl. 12(14, 15); Fell 1953: 88; H.E.S. Clark 1970: 4, 6; A.M. Clark 1993: 207.

Paranepanthia aucklandensis: Fell 1962: 40.

MATERIAL EXAMINED: NZOI Stns S36(3), S55(5), T43(1).

DISTRIBUTION: Known only from the Auckland and Antipodes Islands, 0–80 m.

STUDY SPECIMEN: NZOI Stn S55, R/r = 24/15 mm.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs very broadly rounded, 5 *arms* tapering to blunt tip; body thin, only slightly inflated centrally and along arms. At *disc* centre an area of smaller rounded to polygonal plates, outside of these a circle of larger crescentic plates, sometimes prominent, usually not. Along centreline of arms a zone of smaller plates flanked by crescentic plates. From beyond disc centre to about two-thirds R along arm a single series of plates, proximally longer than wide, distally becoming wider than long; plates flanked by smaller secondary plates, usually 1 on each side; near arm tip small secondary plates absent. To sides of plates 3 or 4 relatively regular rows of crescentic plates, plates becoming rectangular or squarish beyond; each slightly tumid, with numerous very fine spinelets, with up 100 or more on larger plates.

Papulae small, inconspicuous, over most of disc except for interradial area near margin.

Madreporite rounded, 1.5 mm diameter, with coarse radiate sculpture, about one-quarter r from disc centre. Partly or completely hidden by spinelets on neighbouring plates.

Anus near-central, small, almost completely hidden by spinelets.

Superomarginal plates usually abactinal in position, larger than adjacent abactinal plates. Inferomarginals

projecting slightly to form margin. Both series opposite throughout arm, covered with numerous fine spinelets. No distinct marginal fringe.

Actinal plates numerous, in about 15 chevrons forming longitudinal and transverse series. Each plate slightly tumid, with cluster of numerous fine spinelets, up to 25 on larger plates. Bases of spinelets usually connected by web of skin.

All *adambulacral plates* about as wide as long, with curved furrow margin, and 5 or 6 furrow spines, sometimes 4–8. Spines webbed, in overlapping fans along arm. Up to 15 subambulacral spines, often also in fans, set oblique to furrow series, sometimes in clump. Subambulacral spines also webbed.

Oral plates separated by distinct membranous space over most of length, each 6–8 webbed furrow spines, slightly increasing in size proximally; up to 20 suboral spines in double series, or group covering most of actinal surface. Just distal to oral plates an unpaired actinal plate with clump of spinelets.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex ethanol): Dull brown. In life it is "claret".

REMARKS: This species does not appear to be closely related to any others of the genus recorded from Australia or the Pacific Ocean.

Anseropoda Nardo, 1834

Five or more short arms, body extremely thin and leaf-like, only narrow midradial bands thickened. Sometimes reaching large size, with R = > 100 mm. Abactinal plates thin, flattened, with several lobes on midradial bands where papulae occur; these plates differing from those elsewhere on abactinal surface, superficially rhombic, with internal projection, and closely imbricated in longitudinal and transverse series. Abactinal plates with groups of small spinelets. Actinal plates regularly arranged with longer spinelets. Adambulacral plates with fan of furrow spines, usually webbed, several subambulacral spines in straight or curved series.

TYPE SPECIES: *Asterias placenta* Pennant, 1777.

Anseropoda aotearoa McKnight, 1973c (Pl. 63)

Anseropoda aotearoa McKnight, 1973c: 12, fig. 5; A.M. Clark 1993: 205.

MATERIAL EXAMINED: NZOI Stn Z2375(1).

DISTRIBUTION: Known only from the southern margin of Challenger Plateau, west of central New Zealand, 366 m.

STUDY SPECIMEN: Holotype from NZOI Stn Z2375, R/r = 75/39 mm.

DESCRIPTION: Outline near-pentagonal with 5 slightly produced arms, interbrachial arcs slightly concave, body slightly inflated along radial midline.

Abactinal plates at disc centre irregular in shape, generally with short lobes; in interradii a double series of larger ovoid to elongate plates extending to about half r; on arms 2 rows of cruciform, imbricating plates along midline, these tending to alternate. A few smaller secondary plates interspersed among larger. Mid radial series flanked by 2 series of subcruciform plates wider than long; outside these, ovoid plates forming regular transverse series and less regular longiseries. Abactinal plates with small flat top, sometimes low tabulate, topped by short-tapering, finely serrate, sheathed spines, up to 20 on larger plates.

Papulae inconspicuous; 1–3 between disc plates and also between radial plates at base of arm. Beyond, papulae single, in 6 longiseries.

Anus not evident.

Madreporite at about one-fifth r from disc centre, with fine radiate sculpture.

Marginal plates slightly larger than adjacent abactinal plates, inferomarginals projecting slightly with spinelets like those on abactinal plates.

Actinal plates numerous, imbricated in regular transverse series and longiseries. Plates with low tabulum and cluster of sheathed spines like those on abactinal plates.

Adambulacral plates a little wider than long, with 6 or 7 tapering, webbed, furrow spines in weakly curved fan, 4–6 subambulacral spines also a webbed fan, slightly spaced from furrow spines.

Oral plates with low crest along open median suture, each with 10–13 tapering furrow spines united by a basal web, longest proximal; 9–11 suboral spines in a linear series.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Creamy-white.

REMARKS: Two other species occur in Australian waters; *A. macropora* Fisher, 1913 has longiseries of papulae, with the pores guarded by enlarged plates, while *A. rosacea* (Lamarck, 1816) has 11–15 rays.

Stegnaster Sladen, 1889

Body thin, flattened, slightly raised along radial mid-

line. Abactinal plates imbricating, slightly swollen centrally, in regular longitudinal and transverse series, the interradial plates, at least, with internal projections. Carinal plates superficially appearing longer than wide, flanked by 3 or 4 series of strongly curved plates. Other abactinal plates smaller, subrectangular, usually abutting. Abactinal plates covered with small granules, 1 or more enlarged at or near centre of plate. Marginal plates only slightly enlarged, inferomarginals slightly projecting. No marginal fringe. Papulae confined to disc and radial series of curved plates, in 3 or 4 longiseries on either side of carinal plates, and on centre of disc. Up to 10 papulae to each area. Actinal plates numerous in regular series, covered with granulation finer than on abactinal plates, with 1 or more short glassy spines directed towards actinosome. Adambulacral plates short and broad. No subambulacral or suboral spines. Furrow spines of adambulacral and oral plates united in web of thick skin along ray, with fine granulation on outer side. Two adambulacral furrow spines.

TYPE SPECIES: *Pteraster inflatus* Hutton, 1872.

Stegnaster inflatus (Hutton, 1872) (Pls 39, 64)

Pteraster inflatus Hutton, 1872: 10.
Stegnaster inflatus: Sladen 1889: 778; Farquhar 1895: 199; 1909: 126, pl. 12; Mortensen 1925: 303, pl. 13(11); H.E.S. Clark 1970: 4; A.M. Clark 1993: 227.

MATERIAL EXAMINED:
NZOI Stns: C989(1), E909(2), H917(3), M790(1), Q100(1), Q107(1), Q774(1), T459(1).

DISTRIBUTION: Apparently widespread throughout New Zealand in shallow water. No records from islands to the north or south of New Zealand.

STUDY SPECIMENS: From NZOI Stn C989, R/r = 36/28 mm and one specimen from NZOI Stn E909, R/r = 57/50 mm.

DESCRIPTION: Outline pentagonal, interbrachial arcs only slightly concave; margin thin, disc centre and radial midline of 5 arms raised.

Abactinal plates imbricating, superficially appearing rounded to elongate or strongly crescentic. Along midline of arms plates strongly lobed and notched; outside of region plates with internal projections. At disc centre small, rounded plates, this area delimited by circle of larger elongate, curving plates. Along arm midline, carinals appearing as series of elongate plates, twice as long as wide or longer; flanking these 3 series of strongly crescentic plates proximally, 2 series in distal quarter of arm. Beyond, plates appearing rectangular or rounded. All plates arranged in regular longitudinal and transverse series, granular membrane covering plates tending to conceal outlines. Centre of plates often slightly swollen, granulation here noticeably and abruptly coarser. All granules slightly spaced, blunt-tipped, or flat-topped; about 10 granules to 1 mm in fine granulation and 4 or 5 in coarser areas. Coarser granulation covering most of exposed area of carinal plates, but restricted to central group on flanking plates. In some specimens, especially smaller, only radial plates with larger granules.

Papulae single on disc, while on arms up to 10 in areas between crescentic plates. Papulae in 3 rows on either side of carinals to about half R, in 2 rows beyond.

Anus nearly central, surrounded by larger granules.

Madreporite ovoid, just outside ring of elongate plates on disc; maximum diameter 3 mm, sculpture consists of numerous perforations.

Marginal plates small, regular, superomarginals aligned with inferomarginals, not with abactinals. Both series covered with granules. Inferomarginals projecting, more or less aligned with actinal rows of plates.

Actinal plates numerous, arranged in longitudinal and transverse series, appearing as rounded or rectangular, with slight central swelling but, like abactinal plates, with long internal projection. Exposed surface of plates with granular coat like that on abactinal plates, often, at centre of swelling, a clump or trans-verse row of 3–5 fine glassy spinelets, usually directed towards oral region; tip of spinelets narrowed, with 1 or 2 very fine points.

Adambulacral plates short, broad. Outer part of plate concealed by granules. Plates spaced slightly, with 2 stubby, blunt-tipped, partly flattened, furrow spines, distal, often slightly larger; granular covering of actinal plates extending up outer side of furrow spines almost to tips, linking them in longitudinal web. No subambulacral spines.

Oral plates covered with granules on actinal surface, lacking suboral spines; 4 or 5 furrow spines, like adambulacral spines but slightly larger proximally. Adambulacral web continuing along oral plates, linking spines to adambulacral web.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull cream to light brown.

REMARKS: Preserved specimens often assume the form of a pyramid, so that the oral surface is scarcely visible.

A second species has been reported from the Gulf of Mexico (Perrier 1875).

Tremaster Verrill, 1880b

Body thin, outline almost circular, usually preserved in a domed attitude. In each interradius a dorsoventral duct, dorsal opening slit-like, near disc centre, fringed by fine spinelets, ventral situated just behind combined oral plates, rounded. Dorsal plates regularly arranged in oblique transverse rows, each with sparsely scattered small granules. Papulae confined to radial strip 2–4 plates wide, papular pores single, opening at proximal edge of plates. Margin formed by very small inferomarginals, each with single spinelet. Adambulacral plates wide, with transverse row of spines, all but inner usually flattened. Actinal plates in regular oblique series, usually each with a single flattened spine. Actinosome large, oral plates conspicuous. Ambulacral furrows broad, tubefeet more or less 4-ranked.

TYPE SPECIES: *Tremaster mirabilis* Verrill, 1880b.

Tremaster mirabilis novaecaledoniae Jangoux, 1982

(Pl. 65)

Tremaster novaecaledoniae Jangoux, 1982: 152, pls 1, 2, 4C, D; A.M. Clark 1993: 228.

Tremaster mirabilis novaecaledoniae: Leeling 1984: 274.

MATERIAL EXAMINED:

NZOI Stn Z9898(2).

DISTRIBUTION: The species is known from several widespread localities in the North Atlantic, and in the southern hemisphere off the Falkland and Kerguelen Islands. Off New Caledonia and north of New Zealand, 150–1480 m?, as subspecies *novaecaledoniae*.

DESCRIPTION: Study specimen NZOI Stn Z9898, R/r = 25/25 mm (estimated); specimen is contorted but out-line appears to be more or less circular, with radii end-ing in a small point.

Abactinal plates regularly arranged, overlapping, surface smooth with sparsely scattered small granules.

Papulae confined to radial series and at most 2 adjacent series; on radial series present on proximal border, but on flanking series usually single and present at proximal corner nearest radial series. Each with a very small blunt spinelet over aperture.

At disc centre a pentagonal centrodorsal, with *anus* adjacent as an elongate slit margined by 2 plates, 1 radial, 1 interradial; small blunt-tipped spines on each plate line margin of anal slit.

Madreporite distal to anus, irregularly pentagonnal, about 2.5 mm long, 2 mm wide. Sculpture coarse, radiating from centre. Six plates surrounding centrodorsal, 5 radial, 1 anal interradial.

Radial plates extending to margin, proximal plates wider than long, proximal margin gently curved, laterals gently concave and distal narrow, greatest width in proximal third. Radial plates reducing in size distally, becoming almost lozenge-shaped, relatively shorter than proximal. Proximal plates overlapped on either side and distally; beyond about half R plates simply abutting. Radial row with small papular pore on either side of proximal margin with small, almost tubercular spine over pore. Pores appearing absent from two-thirds R. Plates flanking radial series in regular oblique rows extending to margin. Dorsal openings of dorsoventral ducts between primary radials; these conspicuous, raised above general surface, slit-like, ca. 3 mm long, with short, blunt spines forming marginal fringe. The opening appears composed of 2 elongate, slightly curved ossicles, distal half overlapped by a dorsal disc plate. Interradial plates, like radials, overlapped by adjacent and distal ones, all widest proximally. Plates very small and numerous at margin, regularly arranged, free edge with blunt-tipped flattened spinelet.

Ventral surface: Most noticeable feature a very large ovoid actinosome, diameter ca. 15 mm and 11 mm; long axis transverse relative to madreporite. Interradial pillar or odontophore visible within actinosome behind oral plates.

Actinal plates in regular longitudinal and oblique transverse series, that adjacent to adambulacrals alternating with them. Most plates much wider than long, with more or less recumbent, flattened spine on proximal border; near margin, very small and numerous. Ventral opening of dorsoventral ducts behind oral plates, each subcircular, diameter about 2 mm, distal border formed by 2 interradial actinal plates

Adambulacral plates subrectangular, wider than long, slightly separated along ray, decreasing in size distally; first plates slightly overlapping distal margin of oral plate, with 4 spines, increasing in size from furrow. Lowest spine, deep in furrow, short, rapidly tapering to sharp point from relatively broad base; other spines strongly flattened with tip rounded or bluntly pointed. Next 4 or 5 plates with 3 spines, usually 2 beyond; lowest relatively longer, more slender, not flattened, sharply pointed. A much smaller spine, deep in the furrow, sporadically present.

Oral plates large, prominent, each pair with median crest, strikingly resembling those of Velatida, especially Pterasteridae. Each plate with 5 or 6 spines on proximal margin, 2 or 3 in transverse row just proximal to centre of plate. Spines largest towards median suture, all slightly tapering to bluntly pointed tip, flattened, slightly curving.

Ambulacral furrows broad, conspicuous, with *tube-feet* crowded in 2 zigzag series, appearing 4-ranked; furrow appearing widest at about one-third R, almost petaloid in shape.

COLOUR (ex-ethanol): Dorsal and actinal areas light brown, actinosome and tubefeet darker brown.

REMARKS: A second specimen, of about the same size, is damaged, being split along one ambulacrum. Some of the papular pores are visible from the inner side and are much larger than externally. The actinosome is ovoid.

This is a most unusual, though readily recognisable species; the interradial dorsoventral ducts, coupled with the large actinosome and four-ranked tubefeet, being very distinctive. It apparently clings to rocks and broods the young in the dorsoventral ducts.

The only question is the validity of the Southwest Pacific specimens — a species *fide* Jangoux (1982), a subspecies *fide* Leeling (1984). The apical system as illustrated by Leeling differs from that in the present material.

"*Asterina*" Nardo, 1834

REMARKS: As noted in Rowe and Gates (1995) the genus *Asterina* may be restricted to the Atlantic Ocean and adjacent seas, while those species known from the Pacific Ocean need to be reassigned to other genera. Four species within the study area have been attributed to *Asterina*. There are no specimens in the NIWA collection, and their assignment of the species is not clear.

PROVISIONAL KEY TO SPECIES

1 Ray 5 2
Rays 6-8 3

2 r usually half R or less; abactinal plates bare, actinals with 1–3 minute spinelets; white ..... *alba*
Outline pentagonal, r usually two-thirds R or more; abactinal plates almost bare; actinals with 2 or 3 spinelets in a central group; colour variable, whitish with yellow-orange ..... *inopinata*

3 usually 7 rays (5-8); abactinal spinelets minute, acute; actinal plates with 3 or more spinelets; red or gree, red predominant ..... *anomala*
6-8 rays, abactinal spinelets blunt, actinal plates with 1 or 2 minute acute spinelets; salmon-pink to light orange above, whitish below ..... *heteractis*

Asterina alba H.L. Clark, 1938

Asterina alba H.L. Clark, 1938: 150, pl. 22(7); 1946: 132; Rowe 1989: 290; A.M. Clark 1993: 207; Rowe & Gates 1995: 33.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: This species is known from Norfolk and Lord Howe Islands, 0–220 m.

DISTINCTIVE FEATURES: Rays five, with outline more or less stellate with r = half R or less. Abactinal plates bare; actinal plates with 1–3 minute spinelets.

COLOUR: "Pure white, but the largest individuals show under a lens, traces of orange-yellow, and a few scattered dusky or purple patches, on the aboral surface" (H.L. Clark 1938).

Asterina anomala H.L.Clark, 1921

Asterina anomala H.L.Clark, 1921: 95, pls 7(8), 23(5), 26(2, 3); 1946: 133; A.M. Clark 1993: 207; Rowe & Gates 1995: 33.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Tropical Australia and Christmas Island. Recorded from Lord Howe Island by H.L. Clark (1938: 460) but not in Rowe and Gates (1995).

DISTINCTIVE FEATURES: Rays usually seven (five to eight); abactinal spinelets minute, acute, three or more short spinelets on actinal plates.

COLOUR: "Red and green, with red predominant" (H.L. Clark 1946).

Asterina heteractis H.L.Clark, 1938

Asterina heteractis H.L. Clark, 1938: 152, pl. 22(5); 1946: 133; A.M. Clark 1993: 210; Rowe & Gates 1995: 34.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Lord Howe Island and Middleton Reef, and northeastern Australia, the Great Barrier Reef and Queensland. Restricted to shallow water.

DISTINCTIVE FEATURES: Rays 6-8, abactinal spinelets low and blunt; actinal plates with 1 or 2 minute acute spinelets.

COLOUR: "Salmon pink above and whitish below" or "light orange or whitish" (H.L. Clark 1938).

Asterina inopinata Livingstone, 1933

Asterina inopinata Livingstone, 1933: 3, pl. 5(1–8, 14); H.L. Clark 1946: 131; A.M. Clark 1993: 210; Rowe & Gates 1995: 35.
Asterina perplexa H.L. Clark, 1938: 155, pl. 22(4); 1946: 131; A.M. Clark 1993: 213.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Lord Howe Island and east coast of Australia, from Queensland to Tasmania. Restricted to shallow water.

DISTINCTIVE FEATURES: Five rays, outline more or less pentagonal with r = two-thirds R or more. Two or three spinelets on actinal plates in a central group; abactinal plates almost bare.

COLOUR: Variable, "white with indefinite orange-yellow areas aborally, orally pure white"; "white more or less clouded and blotched with blue, the younger the specimen the less the blue. The shade of blue varies from dusky to definite dark blue" (Livingstone 1933).

Family **PORANIIDAE** Perrier, 1894

Outline pentagonal to stellate, with short arms; actinal surface flat to slightly convex, abactinal surface arched, a more or less distinct ventrolateral angle; body covered by thick skin, concealing plate outlines. Abactinal skeleton irregular, compact in small specimens, open in larger; entire skeleton may degenerate in larger specimens. Abactinal, marginal, and actinal plates with a few spines, or with granules, or armament absent. Actinal plates with longest series adjacent to inferomarginals, plates tending to form transverse rows from adambulacrals to inferomarginals, sometimes with spaced, often forked, grooves between. Pedicellariae not known; interradial septum present, reinforced by vertical plating, unless skeleton is degenerate.

KEY TO GENERA

1 Abactinal plates with occasional spines, up to 4 mm long; inferomarginals with 1 or 2 flattened spines; 10–15 papulae in abactinal meshes ..... *Porania*
Abactinal plates with a few granuliform spinelets; inferomarginals projecting, with 5 or 6 flattened spines forming a distinct marginal fringe; papulae in linear series around abactinal plates ..... *Marginaster*

Porania Gray, 1840

Body covered by skin; larger abactinal plates joined by smaller elongate plates; marginal plates and often a few intermarginals; actinal plates in transverse rows from adambulacral to inferomarginals, with conspicuous transverse furrows in thick skin; spines sparsely scattered abactinally; 1 or 2 furrow spines, 1 subambulacral; no intermarginal or actinal papulae; gonads open dorsally or ventrally.

TYPE SPECIES: *Asterias pulvillus* O.F. Müller, 1776.

Porania antarctica Smith, 1876 (Pl. 66)

Porania antarctica Smith, 1876: 108; Sladen 1889: 360, pl. 59(3); Koehler 1920: 178, pl. 33(6, 7); Fisher 1940: 154; A.M. Clark 1962: 34; McKnight 1984: 142; A.M. Clark 1993: 231; O'Hara 1998: 180, pl. 1e.

MATERIAL EXAMINED: NZOI Stns: C733(1), E233(1).

DISTRIBUTION: Macquarie Island, and circumpolar in Antarctic and subantarctic seas, 0–1335 m.

STUDY SPECIMEN: NZOI Stn C733, R/r = 49/24 mm.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs rounded, actinal surface flat, abactinal arched; margin more or less rounded, with marginal fringe, lying on actinal surface in interradii. Thick skin overlying both abactinal and actinal surfaces and spines, plate outlines partly obscured.

Abactinal plates of 2 types — rounded to lobate, tumid plates, often spine-bearing, and smaller elongate connecting plates, latter commoner on disc and arm base. Spines single, rarely paired, rounded in section, up to 4 mm long, with tip rounded or truncate, occasionally slightly expanded. Spines and plates not regularly arranged, with relatively large skeletal meshes, smaller near arm tip.

Papulae small, inconspicuous, 10–15 in meshes on disc and arm base, 5 or less near tip; papulae occurring down to between superomarginals where occurring singly; no papulae below superomarginals.

Anus nearly central, surrounded by small spinelets.

Madreporite at about half r from disc centre, ovoid, maximum diameter 3 mm, with coarse radial sculpture.

Superomarginal plates somewhat irregular, lobate, each with 1 truncate spine. Few irregular intermarginals in interradii, all without spines. Inferomarginals forming ventrolateral margin, but interradially actinal in position. Plates wider than long resembling large actinals; each with 1 or 2 flattened spines.

Actinal plates numerous, in transverse series from adambulacrals, about 5 between oral plates and first inferomarginals. Plates extending to just over half R lacking spines, thick skin forming shallow fascioles between rows.

Adambulacral plates short throughout; 1 furrow spine, tapering near tip, may be slightly flattened; 1 larger subambulacral spine, strongly flattened through-out, tip broadened. Plates at one-third to three-quarters R often with 2 spines, inner larger.

Oral plates small, 2 or 3 furrow spines, strongest proximally; 2 or 3 suboral spines.

Adambulacral furrows narrow, *tubefeet* biserial, with distinct sucking discs.

COLOUR: Dull uniform brown.

REMARKS: These specimens have been referred to *P. antarctica antarctica*, but following O'Hara (1998) the trinomial is now dropped.

Marginaster Perrier, 1881

Spines or spinelets on marginal plates; abactinal plates not regularly arranged with spinelets or granules, no prominent carinal series of plates or spines; inferomarginals with a comb of flattened spines forming a broad marginal fringe.

TYPE SPECIES: *Marginaster pectinatus* Perrier, 1881.

Marginaster sp. McKnight, 1968 (Fig. 40)

Marginaster sp. McKnight 1968: 513; H.E.S. Clark 1970: 5.

MATERIAL EXAMINED: NZOI Stn C531(1).

STUDY SPECIMEN: NZOI Stn C531, R/r = 4 /3.5 mm, a juvenile with 8 inferomarginals to interbrachial arc, and 15 adambulacrals.

DISTRIBUTION: Known only from the Kermadec Islands, 179 m. H.E.S. Clark lists *Marginaster* sp. from the Kermadecs, 0–30 m.

DESCRIPTION: Outline pentagonal, 5 barely produced arms; abactinal surface domed, actinal flat.

Abactinal plates elongate, forming reticulate, skin-covered skeleton, carinals most evident, superomarginals not distinct. Plates with 1–6 almost granuliform spinelets. Inferomarginals broad, thin, forming margin, abactinal surface with 6 spinelets and 4 or 5 flattened spines at margin. Spines widened or rounded-angular distally, with small terminal points.

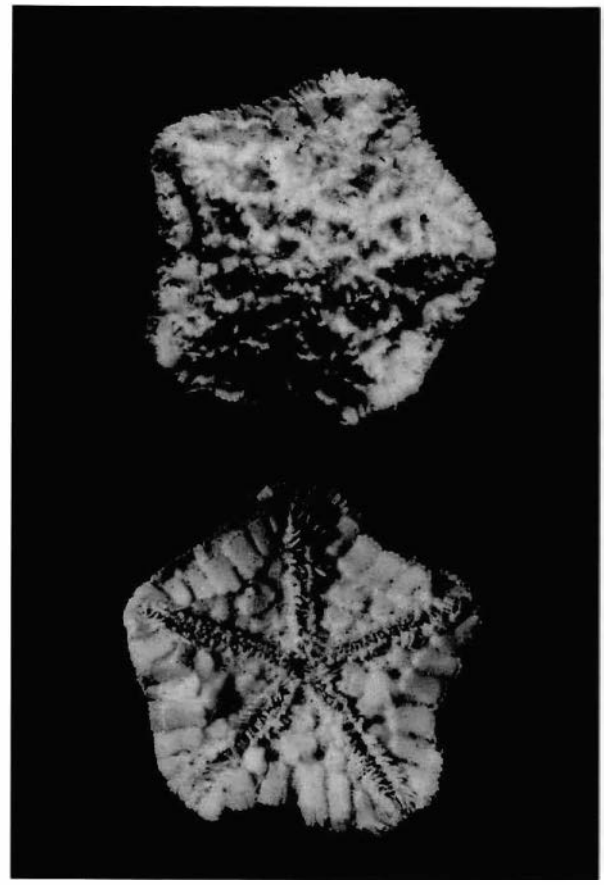

Fig. 40. *Marginaster* sp. McKnight. NZOI Stn C531. R/r = 4/3.5 mm. Abactinal and actinal surfaces.

Anus subcentral, encircled by plates.

Madreporite not apparent.

Actinal plates rounded, skin-covered, without spinelets or spines; 8 in each interradius, largest behind oral plates.

Adambulacral plates subrectangular, longer than wide; 1 or 2 blunt spines, deep in furrow on first 2 or 3 plates; 2 heavier blunt subambulacral spines at furrow edge, all linked by basal web of skin.

Oral plates small with 4 furrow and 2 suboral spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex ethanol): Dull cream.

REMARKS: *Marginaster paucispinus* Fisher (1913) from near Hong Kong, 183 m, is very similar, but has clavate abactinal spines. A small specimen from off Tasmania, 155–174 m, described as *Marginaster* sp. (A.M. Clark 1962) differs in having expanded subambulacral spines, no basal web, and a very stout proximal oral furrow spine.

Superfamily **OPHIDIASTEROIDEA**

Family **OPHIDIASTERIDAE**

Arms 5, sometimes 4–7. Disc usually small, arms more or less long, cylindrical, or at least convex abactinally. Interradial arcs angular. Superomarginals lateral, sometimes inconspicuous. Abactinal plates tessellate, regular or not. Plates with granules or completely covered by thick skin. Actinal areas small, although at least 1 series of plates extending along arm. Adambulacral plates short, spines sometimes short or inset and appearing granuliform. Pedicellariae alveolar, with or without sockets for valves.

REMARKS: A widespread family, but not present in colder waters. In the study area there are nine genera and 20 species, almost all from the area to the north of New Zealand.

KEY TO GENERA

1 Adambulacral armature "ophidiasterid" with usually 2 furrow spine bases set deep in furrow, tips only slightly projecting and 1 or 2 often flattened subambulacral spines surrounded by the actinal granulation 2
Adambulacral spines with base set at or near margin of furrow, standing well above actinal surface; 2 or more subambulacral spines, both series free from actinal granulation 7

2 Abactinal plates in regular rows 3
Abactinal plates not in regular rows 6

3 No actinal papulae 4
Actinal papulae present 5

4 Abactinal plates with granules ..... *Ophidiaster*
4 Abactinal plates and entire body covered with smooth skin ..... *Leiaster*

5 Granules more or less covering abactinal plates *Tamaria*
Granules clustered at centre of abactinal plates ..... *Dactylosaster*

6 No actinal papulae; abactinal plates skin-covered ..... *Oneira*
Actinal papulae present; abactinal plates with granules ..... *Linckia*

7 Abactinal plates in regular rows 8
Abactinal plates not in regular rows 9

8 Arms rounded and arched on dorsal surface ..... *Heteronardoa*
Arms flattened ..... *Dissogenes*

9 No actinal papulae 10
Actinal papulae present; papulae single; body more or less flat, marginals defining outline ..... *Fromia*

10 Some abactinal plates abruptly conical and conspicuous 11
No abruptly enlarged abactinal plates, though some, as well as marginals, may be convex and bare *Neoferdina*

11 Enlarged abactinal plates often crowned with enlarged nipple-like tubercle; papulae single ..... *Gomophia*
No tubercle surmounting enlarged abactinal plates; papulae usually in groups ..... *Nardoa*

Ophidiaster L. Agassiz, 1836

Body wall rigid; abactinal plates in regular longiseries, covered with granules, lacking spines; adambulacral spines usually 2, set deep in furrow, with tips slightly projecting; papulae in 8 rows, 1 row below inferomarginals; rays cylindrical, madreporite single, small.

TYPE SPECIES: *Asterias ophidiana* Lamarck, 1816.

KEY TO SPECIES OF *OPHIDIASTER*

1 Granules present between adambulacral furrow spines 2
No granules between adambulacral furrow spines; 2–10 papulae to each area; jaw of pedicellariae tapering to a point ..... *macknighti*

2 3–8 papulae to each area; pedicellariae not known ..... *hemprichi*
10–20 papulae to each area 3

3 Jaw of pedicellariae tapering to a point *kermadecensis*
Jaw of pedicellariae expanded and denticulate ..... *confertus*

Ophidiaster confertus H.L. Clark, 1916 (Pl. 67)

Ophidiaster confertus H.L. Clark, 1916: 55, 138, pl. 10(2, 3); McKnight 1967: 324; Rowe 1989: 289; A.M. Clark 1993: 346.

MATERIAL EXAMINED:
NZOI Stns: D56(1), I77(2), I78(1), I95(2), I723(5), I767(1), I769(1), P20(1), P22(3), P23A(1), P29(1), P39(1), P90(1), P94 (2), P95(2), P108(1), P110(2), Q51(1), Q56(1), Q60(5), Q61(3), Q62(1), Q63(4), Q64(3), Q78(6), Q79(1).

STUDY SPECIMEN: NZOI Stn I723, R / r = 84 / 10 mm, br.= 10 mm. The arms are unequal, with R = 84, 82, 70, 70 and 56 mm.

DISTRIBUTION: Lord Howe Island, Middleton and Elizabeth Reefs, and Norfolk Island.

DESCRIPTION: *Disc* small, 5 unequal arms scarcely tapering, except at tip, often slightly recurved; margins of disc rounded like arms.

Abactinal and marginal plates in more or less regular longiseries, carinals and single adradial series extending to terminal plate. Plates slightly tumid, mostly wider than long, lateral margins concave around papular areas. Plates densely covered with small granules, largest at plate centres.

Marginal plates more or less corresponding along arm, about equal in size. A single series of actinal plates, extending almost to arm tip, plates with similar granular coat.

Papular areas regular in arrangement, a single series below inferomarginals; 15–25 papulae to each area. Granulation continuous across areas. Small alveolate pedicellariae common in papular areas, with distal part of jaws expanded into near semicircle, teeth set around margin; alveolus similarly shaped to fit retracted jaws.

Anus almost central, surrounded by slightly enlarged granules.

Madreporite just over half r from disc centre, rounded, 2 mm diameter with fine radiate sculpture.

Adambulacral plates with 2 short stubby furrow spines, vertical in furrow; all separated by granules. Granulation also investing outer side of spines, so that only blunt tip projecting. A single subambulacral spine, placed at distance from furrow spines; short and vari-able in form, either rounded with truncate tip, or flattened, pointed and recumbent on almost all plates.

Oral plates small, with actinal surface covered by granules, and 2 small furrow spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull uniform brown. In life, recorded as "deep tawny yellow or orange brown; extremes are yellow-orange, and, on the other hand, almost a red-brown. The oral side along the ambulacral grooves, shows the brightest tints" (H.L. Clark 1946: 122).

Ophidiaster hemprichi Müller & Troschel, 1842

Ophidiaster hemprichi Müller & Troschel, 1842: 29; Clark & Rowe 1971: 61, pl. 8(3); A.M. Clark 1993: 348; Rowe & Gates 1995: 91.

Ophidiaster squameus Fisher, 1906: 1079, pls 31(6-6b), 37(4); H.L. Clark 1921: 83, pl. 8(2).

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Recorded from Middleton Reef, northern Tasman Sea, also relatively widespread in the Indo-West Pacific region, 0–276 m.

Ophidiaster kermadecensis Benham, 1911 (Pl. 68)

Ophidiaster kermadecensis Benham, 1911: 148; Mortensen 1925: 294, pl. 13(9–10); H.E.S. Clark 1970: 4, 5; McKnight 1969: 510–511; A.M. Clark 1993: 348.

MATERIAL EXAMINED:

NZOI Stns: B157(2), K812(4), K833(2), K834(5), K848 (field notes), K865(5), P967(3), T220 (fragment), T223(1), T261(1).

STUDY SPECIMEN: NZOI Stn K848, R/r =67/7 mm, br. = 10 mm.

DISTRIBUTION: Kermadec Islands and northern New Zealand, 0–60 m, although no further New Zealand records since that of Mortensen (1925).

DESCRIPTION: *Disc* small, 5 near-equal rays tapering only at tip, blunt; arms and margin of disc rounded.

Abactinal and marginal plates in regular longiseries, slightly tumid. Entire surface, including papular areas, with close granular coating, those at plate centre slightly enlarged.

Papular areas conspicuous, regular, 10–20 papulae in each. Small alveolate pedicellariae common in papular areas; jaws tapering distally to single fine tooth; alveolus similarly shaped to accommodate jaws.

Madreporite inconspicuous, about one-third r from margin, rounded, 2 mm diameter, with fine radiate sculpture.

Anus inconspicuous, near-central, surrounded by slightly enlarged granules.

Adambulacral plates with 2 stubby furrow spines, with granules separating them; subambulacral spine flattened, blunt-tipped, partly recumbent, of regular occurrence throughout. Actinal granulation occur-ring to outer side of furrow spines.

Oral plates small, with 3 furrow spines, actinal surface covered by granules.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Uniform dull brown.

Ophidiaster macknighti H.E.S. Clark, 1962

(Pls 39, 69)

Ophidiaster macknighti H.E.S. Clark, 1962: 2–4, figs 1–4, pl. 1; 1970: 30; McKnight 1993a: 171; A.M. Clark 1993: 349; Rowe & Gates 1995: 92.

MATERIAL EXAMINED:

NZOI Stns: C814(1), I757(1), J675(3), J974(1), P7(1).

DISTRIBUTION: Northeastern New Zealand, also Wanganella Bank and New South Wales, 20–202 m.

STUDY SPECIMEN: NZOI Stn J974, R / r = 71 / 12 mm, br. = 12 mm. R varies from 71 to 24 mm.

DESCRIPTION: *Disc* small, 5 unequal arms scarcely tapering except at extreme tip, arms often unequal, rounded like margin of disc.

Abactinal and marginal plates in regular longiseries proximally, but may be irregular distally. Abactinal and actinal surfaces covered by thin skin with dense coating of very fine uniform granules. Outlines of plates usually visible. Plates slightly tumid, broadly T-shaped, with crossbar distal.

Papular areas relatively large, with only 2–10 papulae.

Alveolate *pedicellariae* common in papular areas and at margins of plates. Jaws tapering to fine point or tooth, points often crossed; alveolus similarly pointed to accommodate jaws.

Madreporite one-quarter r from margin, rounded, 4 mm diameter, flat, inconspicuous, sculpture very fine.

Anus near-central, surrounded by slightly enlarged granules.

Adambulacral plates with 2 furrow spines, no granules between; subambulacral spine flattened with blunt tip, usually recumbent, on almost all plates.

Oral plates small, with 2 furrow spines, actinal surface covered with granules.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull light brown, with darker brown in irregular blotches. See original description for other notes.

REMARKS: This species has much finer granulation than the other three and the abactinal plates differ in shape.

Dactylosaster Gray, 1840

Abactinal plates in regular longiseries, each with cluster of coarse granules or tubercles at centre, rest of plate skin-covered. Adambulacral armature granuliform, 1 series of actinal papulae. Adambulacral armature spiniform, spines short and blunt. No papulae below inferomarginals.

TYPE SPECIES: *Asterias cylindrica* Lamarck, 1816.

Dactylosaster cylindricus (Lamarck, 1816)

Asterias cylindrica Lamarck, 1816: 567.
Dactylosaster cylindricus: Clark & Rowe 1971: 59, pl. 8(5); A.M. Clark 1993: 329; Rowe & Gates 1995: 81.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Recorded from Middleton Reef, northern Tasman Sea, also widespread in tropical Indo-West Pacific region, 0–5 m.

Dissogenes Fisher, 1913

Disc large, slightly inflated; arms slender, abactinal and actinal surfaces flat, plates covered with uniform fine granulation; marginal plates similar or naked, spines present or absent; actinal plates with spines; adambulacral armature spiniform; papulae abac-tinal, not extending to superomarginal plates.

TYPE SPECIES: *Dissogenes styracia* Fisher, 1913.

Dissogenes petersi Jangoux, 1981a (Pl. 70)

Dissogenes petersi Jangoux, 1981a: 709; McKnight 1993a: 173; A.M. Clark 1993: 330.

MATERIAL EXAMINED: NZOI Stn U594(6).

STUDY SPECIMEN: NZOI Stn U594, R/ r = 51 / 12 mm.

DISTRIBUTION: New Caledonia and Three Kings Rise, 406–590 m.

DESCRIPTION: Outline somewhat stellate, interbrachial arcs distinctly rounded, 5 arms tapering to pointed tip, rounded; abactinal surface of disc slightly inflated, actinal surface more or less flat. Fine uniform granulation covering abactinal and marginal plates, continuing onto actinal plates, but coarser; not masking outlines of plates.

Abactinal plates flat, of varying sizes and shapes, smaller at margins. Most larger plates tending to circular or ovoid outline.

Anus small, more or less centrally placed, surrounded by slightly enlarged granules.

Madreporite small, inconspicuous, about half r from disc centre, rounded, 2 mm diameter, with coarse radiate sculpture.

Papulae single, more or less arranged in 4 longiseries, 2 on either side of inconspicuous carinal series and 2 shorter series outside these. Inner series extending from near disc centre to distal quarter of arm, outer series extending to just beyond arm base only.

Both series of *marginal plates* forming rounded margin, superomarginals extending onto abactinal surface and inferomarginals onto actinal. Marginals not tumid, both series more or less opposite along arm.

Actinal plates in 5 series in interradii; outer 3 series not extending beyond arm base; innermost inner 2 series extending into distal third of arm, and adjacent series extending almost to half R. Plates flat, with covering of granules, coarser than on marginal plates. Each plate on innermost series of actinals out to about half R with small *pedicellariae*; both jaws flat, somewhat curving in outline, tips rounded, smooth. No distinct alveolus, granulation absent from part of plate where jaws lie when recumbent. At base of jaws a small pore, often flanked by 1 or 2 blunt spines up to 0.5 mm long. Interadial actinals, except those of outer 2 series, with 1 or 2 blunt, flattened spines up to 1 mm long.

Adambulacral plates longer than wide, with 5 or 6 flattened subequal furrow spines set with edge to furrow, and 3 broader, more blunt-tipped subambulacral spines, also flattened, set with broad face to furrow; spines up to 2 mm long; 12–18 granules beyond subambulacral spines.

Oral plates comparatively long, with 8–10 furrow spines in continuation of adambulacral furrow series. On actinal face of plate, 5–8 suboral spines in linear series near median suture; 3 or 4 further spines in second series near furrow margin. Distal part of plate with several granules, some a continuation of suboral spine series, others scattered.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull uniform cream.

Fromia Gray, 1840

Abactinal plates not in regular longiseries; adambulacral armature spiniform; actinal papulae present; papulae single, body more or less flattened, marginals defining outline.

TYPE SPECIES: *Asterias milleporella* Lamarck, 1816.

KEY TO SPECIES OF *FROMIA*

1 Granulation fine, abactinal plates distinct, superomarginals visible from above, and alternating larger and smaller distally; actinal papulae few and proximal only ..... *monilis*
Granulation coarser, masking plate outlines, superomarginals lateral, scarcely visible from above 2

2 Actinal papulae few, not extending as far as mid-arm ..... *milleporella*
Actinal papulae extending beyond half R ....*polypora*

Fromia milleporella (Lamarck, 1816) (Pl. 71)

Asterias milleporella Lamarck, 1816: 564.
Fromia milleporella: Gray 1840: 286; H.L. Clark 1946: 112; Clark & Rowe 1971: 34, 63, pl. 8 (10); A.M. Clark 1993: 342; Rowe & Gates 1995: 82.

MATERIAL EXAMINED: NZOI Stn P23A (1).

STUDY SPECIMEN: NZOI Stn P23A, R/r = 41/8 mm, br. = 9 mm.

DISTRIBUTION: Widespread in shallow waters of the Indo-West Pacific region, east Africa, and Madagascar to Japan; northern Australia and the tropical Southwest Pacific Ocean. Here recorded from Norfolk Island.

DESCRIPTION: Outline stellate, 5 gradually tapering, rounded arms with blunt tip; interbrachial arcs rounded; marginal plates not conspicuous.

Abactinal plates rounded, of varying sizes, in no apparent order; plates with covering of distinct, slightly spaced granules, longest almost as long as wide. Larger plates with up to 25 granules, size grading from peripheral to slightly larger granules. Carinal plates not evident. Marginal and actinal plates with similar granulation.

Marginal plates rounded–angular, corresponding over most of arm.

Papulae single, occurring around abactinal plates intermarginally throughout arm, also actinally. Only 1 or 2 proximal papulae between adambulacrals and innermost actinal plates.

Madreporite at about one-quarter r from margin, rounded, 2 mm diameter, with deep coarse sculpture.

Anus not apparent.

Actinal plates in 3 series, inner 2 extending into distal third of arm. Outermost not extending beyond arm base.

Adambulacral plates wider than long over most of arm, with 2 stubby furrow spines (3 on proximal plates) and 2 series of shorter subambulacral spines, 2, rarely 3, spines in each.

Oral plates small, with about 3 furrow and 2 suboral spines a little larger than those on adambulacral plates.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull brown. See Guille *et al.* (1986) for colour of New Caledonian specimens.

Fromia monilis Perrier, 1875 (Pls 72, 89)

Fromia monilis Perrier, 1875: 179; Hayashi 1973a: 58, pl. 8(5); Clark & Rowe 1971: 36, 62; A.M. Clark 1993: 332; Rowe & Gates 1995: 82.

MATERIAL EXAMINED: NZOI Stn I769(2).

STUDY SPECIMENS: NZOI Stn I769, R/r = 47/13 mm, br. = 13 mm and 43/12 mm, br. = 12 mm (det. F.W.E. Rowe 1986).

DISTRIBUTION: Widespread in shallow waters of the Indo-West Pacific region. Here recorded from Elizabeth Reef, northern Tasman Sea.

DESCRIPTION: Outline stellate, interbrachial arcs rounded, 5 arms gradually tapering from relatively broad base; abactinal and actinal surfaces flat, margin vertical. Superomarginals encroaching on abactinal surface, inferomarginals lateral interradially, but distally visible from below. Abactinal and actinal surfaces covered with fine granulation, not obscuring plate outlines. Granules polygonal in outline, scarcely higher than wide, with bluntly pointed tips.

Abactinal plates rounded, of varying sizes, in no obvious pattern; larger slightly tumid. At arm base, 5 plates in transverse series across arm. At centre of plates, granules not, or scarcely, enlarged while papular pores with single circle of slightly enlarged granules, distinct under low magnification.

Papulae single, with up to 8 around larger abactinal plates; rare between proximal marginal plates, absent distally, only 1 or 2 proximal papulae on actinal surface.

Madreporite about two-thirds r from disc centre, rounded, 4 mm diameter, distinctly tumid with fine sculpture.

Anus central, surrounded by slightly enlarged granules.

Superomarginal plates regularly decreasing in size in proximal third of arm, irregularly alternating beyond, larger and smaller; proximal plates relatively conspicuous with definite abactinal surface.

Inferomarginals regularly decreasing in size along arm, although occasional plates may be larger or smaller. Both series tumid with close cover of small granules.

Actinal plates in 3 series in interradius, inner series extending to near arm tip, median to distal third of arm, outer not extending beyond proximal quarter of arm. Plates slightly tumid, covered with small granules.

Adambulacral plates wider than long over most of arm; flat, so that suture between them and inner tumid actinals is evident; 3 furrow spines, 2 distal, 2 or 3 subambulacral, all flattened and blunt-tipped. Furrow series longer, subambulacral series often wider, 18–22 granules beyond subambulacral spines, roughly arranged in 4 longiseries.

Oral plates small, with 3 furrow spines, and 2 slightly larger suboral spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex ethanol): Dull uniform cream. For colour photo see Guille *et al.* (1986: 130, notes on 131). Disc reddish centrally, arms yellow, shading to reddish distally.

Fromia polypora (H.L. Clark, 1916) (Pl. 73)

Austrofromia polypora H.L. Clark, 1916: 51, pl. 14(1, 2); 1946: 114.

Fromia polypora: Rowe 1989: 289; Rowe & Gates 1995: 83.

MATERIAL EXAMINED:

NZOI Stns: I77(2), P51(2). All material identified by F.W.E. Rowe.

DISTRIBUTION: Southern and southeastern Australia (Zeidler & Shepherd 1992), Norfolk Island (Rowe 1989).

STUDY SPECIMENS: NZOI Stn I77, R/r = 84/16 mm, br. = 18 mm and 86/17 mm, br. = 17 mm; Stn P51, R/r = 62/15 mm, br. = 16 mm, arms unequal, and R = 62, 44, 35, 22 mm.

DESCRIPTION: Outline stellate, 5 arms slowly tapering, slightly flattened, interbrachial arcs rounded, marginal plates relatively inconspicuous.

Abactinal plates rounded, almost flat, of varying sizes, in no apparent order, no evident carinal series. Plates with covering of slightly spaced angular granules, tips slightly flattened; up to 28 granules on larger plates. Marginal and actinal plates with similar granules.

Papulae single, relatively conspicuous, up to 5 around larger plates; also found intermarginally over most of arm, and actinally. Series between adambulacrals and innermost actinals extending for at least half of arm.

Madreporite about half r from margin, rounded, 4 mm diameter, with fine sculpture.

Anus not apparent.

Marginal plates irregularly arranged along arm, in varying sizes, the 2 series of marginals corresponding or alternating.

Adambulacral plates wider than long over most of arm, with 2 stubby furrow spines, 3 on proximal plates. Subambulacral spines in 2 or 3 rows, 2 or 3 spines in each. Spines graded in size, so that outer only slightly larger and longer than granules on adjacent actinals.

Oral plates small, each with 4 furrow and 2 suboral spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Uniform dull brown. A dried specimen from NZOI Stn P51 is dark, almost black.

Gomophia Gray, 1840

Adambulacral armature spiniform; no papulae below inferomarginals; some abactinal plates abruptly and conspicuously conical, often crowned with an enlarged nipple-like tubercle.

TYPE SPECIES: *Gomophia egyptiaca* Gray, 1840.

Gomophia watsoni (Livingstone, 1936) (Pl. 74)

Ophidiaster watsoni Livingstone, 1936: 386, pl. 28(1, 3, 5, 7).
Gomophia watsoni: A.M. Clark 1976a: 169, 176; A.M. Clark 1993: 333; Rowe & Gates 1995: 84.

MATERIAL EXAMINED:
NZOI Stn Q58(1).

STUDY SPECIMEN: NZOI Stn Q58, R/r = 38/9 mm, br. = 9 mm (ident. by F.W.E. Rowe).

DISTRIBUTION: Indo-Pacific region including north-eastern Australia, 0–35 m. Here recorded from Middleton Reef, northern Tasman Sea.

DESCRIPTION: Outline stellate, interbrachial arcs narrowly rounded, 5 arms tapering to apointed tip, slightly flattened; abactinal plates slightly sunken in interradii.

Abactinal, marginal, and actinal plates covered with a fine granulation, granules slightly spaced so that individual granules apparent. Granules slightly enlarged towards centre of plates; coarser on lower half of inferomarginals and on actinals. Most abactinal plates of 2 types: larger, conical tubercular plates on disc in trio around anus, as alternate carinals at arm base. Beyond arm base, 2 irregular series of these plates. Most remaining plates smaller, simply tumid; very few smaller flat plates present. In each interradius, basal plate evident with 2 plates distal to it.

Papular areas small, 2–5 papulae in each, areas tending to ovoid or circular form and distinctly separated. Only a few single intermarginal papulae. Single pores between inferomarginals and actinals on actinal surface, and between actinals themselves; no soft tissue in them in contrast to abactinal pores.

Anus small, central, surrounded by a few enlarged granules, these flanked by 3 large tubercular and conical abactinal plates.

Madreporite just less than half r from disc centre, small, inconspicuous, with coarse radiate sculpture, rounded, diameter 2 mm.

Superomarginal plates more or less alternating along arm, larger conical tubercular plates separated by 3 or 4 smaller tumid plates over most of arm. A single series of small intermarginal plates extending to about one-third R.

Inferomarginal plates tumid except towards arm tip where higher. All with distinct terminal tubercle.

Actinal plates tumid, in 3 series in interradii; outer with 1 or 2 plates extending only to distal end of first inferomarginal; median series with 4 plates extending to second inferomarginal; inner series extending to about half R.

Adambulacral plates about as wide as long, with 3 stubby furrow spines and 3 shorter, heavier, subambulacral spines, of which proximal is shortest. Two subambulacral spines distally, with proximal small and distal enlarged. Consecutive combs of furrow and subambulacral spines overlapping slightly. About 9 granules in 2 or 3 series, outside of subambulacral spines, each as large as adjacent actinal granules.

Oral plates small, with 5 stubby furrow spines and 2 or 3 suboral spines, distinctly spaced from furrow series. A covering of granules on distal part of plate only.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Uniform dull cream. Guille *et al.* (1986) published a colour photograph, recording "orange to cream abactinally with orange to red annulations. Others have the brown with the nodosities whiter."

Heteronardoa Hayashi, 1973

Abactinal plates in regular longiseries, covered with granules, these finer towards plate edges and between plates; adambulacral plates with spines in the furrow and subambulacral series; no actinal papulae; actinal plates in 2-4 series.

TYPE SPECIES: *Heteronardoa sagamina* Hayashi, 1973b.

Heteronardoa carinata (Koehler, 1910) (Pl. 75)

Nardoa carinata Koehler, 1910: 165, pls 15(6), 16(10, 11).
Certonardoa carinata: H.L. Clark 1921 : 56.
Heteronardoa carinata: Rowe 1976: 86; A.M. Clark 1993: 334; Rowe & Gates 1995: 85.

MATERIAL EXAMINED:
NZOI Stns K819(1), K820(2), P26(1), P108(1), P109(1).

DISTRIBUTION: Widespread in Indo-West Pacific region; Gulf of Aden and Arabian Sea to Japan, northwestern Australia, Norfolk Island and the Kermadec Islands.

STUDY SPECIMEN: NZOI Stn K820, R/r = 78/15 mm, br = 14 mm.

DESCRIPTION: Outline stellate, 5 rays gradually tapering to pointed tip, disc high at centre, arms strongly arched on abactinal surface, more or less flat actinally; actinosome slightly sunken.

Abactinal and marginal plates in fairly regular series, with marginals relatively inconspicuous. Plates covered with a fine granulation, slightly coarser at plate centres. Marginal plates set at lower margin of arm; 6 adradial series of plates at arm base. Only the series adjacent to carinals extending to arm tip; 3 rows of actinal plates in interradius, 1 extending along arm. Actinal plates covered with short, blunt, angular-tipped spinelets.

Papular areas small, 4–6 relatively inconspicuous papulae in each.

Pedicellariae not observed.

Madreporite almost half r from disc centre, small, rounded, 2 mm diameter, with fine radiate sculpture.

Anus more or less central, surrounded by slightly enlarged granules.

Adambulacral plates longer than wide, with 3 series of spines graded in size from furrow series outward; 6 or 7 furrow spines below furrow margin; 2 series of subambulacral spines, 5 or 6 in inner row, 4 or 5 in outer.

Oral plates small, with crowded series of 5 or 6 furrow spines and 3 or 4 suboral spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull uniform cream.

REMARKS: For the pedicellariae and colour refer to Rowe (1976). Alveolate pedicellariae have been recorded by A.M. Clark (1967) and Rowe (1976). Hayashi (1973) illustated bi- and trivalved pedicellariae.

Leiaster Peters, 1852

Abactinal and marginal plates in regular longiseries, entire body but sheathed in thick, smooth skin and plate outlines obscured. Adambulacral furrow and subambulacral spines lincked by web of skin.

TYPE SPECIES: *Ophidiaster (Leiaster) coriaceus* Peters, 1852.

KEY TO SPECIES OF *LEIASTER*

1 Adambulacral furrow spines cylindrical; no calcareous nodules between successive groups of furrow spines .. .. *leachii*
Adambulacral furrow spines grooved on furrow face; calcareous nodules between successive groups of furrow spines ..... *speciosus*

Leiaster leachii (Gray, 1840) (Pl. 76)

Ophidiaster leachii Gray, 1840: 284.
Leiaster leachi: H.L.Clark 1946: 119; Clark & Rowe 1971: 36, 58; Jangoux 1980: 91, pl. 5(1–6); A.M. Clark 1993: 335; Rowe & Gates 1995: 86.

MATERIAL EXAMINED: NZOI Stns: P43(2), P90(1).

STUDY SPECIMENS: From Stn P43, R/r = 167/12, br. = 14 mm; and R/r = 142/10 mm., br. = 10 mm; from Stn P90, R = 195/12 mm, br.= 12 mm, with unequal arms.

Specimens from both stations identified by F.W.E. Rowe.

DISTRIBUTION: Lord Howe and Norfolk Islands and northern Australia; widespread in the Indo-west Pacific region, 2–183 m.

DESCRIPTION: *Disc* small, margin rounded, 5 elongate rounded arms, scarcely tapering except near blunt tip. Arms may be inflated just beyond base.

Abactinal and *actinal surfaces* covered by a thick skin, lacking spines or granules. Skeleton partly obscured in wet specimens but usually visible when dried. Abactinal skeleton of lobate plates with embedded crystal bodies quite visible in dried state, and when cleaned. Carinal, single adradial, and marginal series all similar. Below inferomarginals, 2 actinal series; series adjacent to adambulacrals with about twice as many plates as outer series. Latter series aligned with inferomarginals and inner series with adambulacrals.

Abactinal *papular areas* with up to 15 papulae; single actinal series of papulae just below inferomarginals with up to 22 .

A few small alveolate *pedicellariae* on abactinal surface, commoner on proximal parts of actinal surface. Jaws of pedicellariae narrow, tapering to fine point, like alveolus. On actinal surface, most pedicellariae placed on a small tumid area on actinal plates.

Anus at disc centre surrounded by circle of small spines.

Madreporite rounded, 5 mm diameter, about two-thirds r from disc centre, with fine radiate sculpture.

Adambulacral plates short, each with 2 or 3 rounded furrow spines, entire series linked by skin; subambulacral spine larger, often flattened at tip. Proximally 1 subambulacral spine to each plate but often gaps in sequence beyond basal third of arm. Subambulacral spines linked by longitudinal web of skin over most of arm.

Oral plates small, with continuation of adambulacral and subambulacral spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull red-brown. Guille *et al.* (1986) have provided a photograph and notes.

Leiaster speciosus von Martens, 1866

Leiaster speciosus von Martens, 1866: 70; H.L. Clark 1946: 119; Clark & Rowe 1971: 36, 58; Jangoux 1980: 94, pl. 6(1, 3); Rowe & Gates 1985: 86; A.M. Clark 1993: 336.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Lord Howe Island, and widely distributed in the Indo-West Pacific region in shallow water.

REMARKS: This species differs from that above in having the adambulacral furrow spines grooved on the furrow side.

Linckia Nardo, 1834

Abactinal plates not arranged in regular longiseries; no papulae below inferomarginals; arms cylindrical; adambulacral spines usually 2, set deeply in furrow, with tips slightly projecting. Madreporite may be multiple. Some species fissiparous?

TYPE SPECIES: *Asterias laevigatus* Linnaeus, 1758.

KEY TO SPECIES OF *LINCKIA*

1 Granules between adambulacral furrow spines ... 2
No granules between adambulacral furrow spines; 6 arms, 1 madreporite; 10–12 papulae to each area; brownish ..... *guildingi*

2 5 subequal arms; 1 madreporite; 20-40 papulae to each area; bright bue ..... *laevigata* (Linnaeus)
5 unequal arms; about 10 papulae to each area; usually more than 1 madreporite; colour variable, usually not bright blue ..... *multifora*

Linckia guildingi Gray, 1840 (Pl. 77)

Linckia guildingi Gray, 1840: 285; H.L. Clark 1946: 117; Clark & Rowe 1971: 36, 61, pl. 8(7); A.M. Clark 1993: 338; Rowe & Gates 1995: 87.

MATERIAL EXAMINED:
NZOI Stns: I77(1), P23A(1), P54(1), P589(1), P90(1), Q62(1), Q63(2), Q79(1), Z2464(1).

STUDY SPECIMEN: NZOI Stn P90, R/r = 107/9 mm, br. = 8 mm; arms unequal, with R = 26, 66, 85, 92, and 107 mm (specimen det. F.W.E. Rowe).

DISTRIBUTION: Lord Howe and Norfolk Islands, widespread in the Indo-West Pacific region in shallow water; 0–60 m.

DESCRIPTION: Arms 6, long, rounded, scarcely tapering, except at blunt tip; *disc* small with sloping margins.

Abactinal plates small, tumid with ovoid to rounded outlines. Both abactinal and actinal surfaces covered with relatively uniform granulation, slightly enlarged centrally. Abactinal plates irregularly arranged, marginals more regular. Two series of actinal plates over most of arm.

Papular areas not conspicuous, up to 12 papulae in each. No papulae below inferomarginals.

Anus small, inconspicuous, centrally placed, encircled by slightly enlarged granules.

Madreporite small, placed near centre, circular, about 3 mm diameter, with coarse sculpture.

Adambulacral plates short, 2 stubby, flattened furrow spines; just outside them and more or less contiguous, 2 subambulacral spines, often appearing as large granules. Furrow spines often unequal in size. Adambulacral armature continuing over small oral plates.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull brown. Guille *et al.* (1986) have provided a photo and colour notes.

Linckia laevigata (Linnaeus, 1758) (Pl. 78)

Asterias laevigata Linnaeus, 1758 : 662.
Linckia laevigata: H.L. Clark 1946: 117; Clark & Rowe 1971: 36, 62; A.M. Clark 1993: 338; Rowe & Gates 1995: 87.

MATERIAL EXAMINED: NZOI Stns: I78(1), I723(1), Q61(7).

DISTRIBUTION: Lord Howe Island, and widely distributed in the Indo-west Pacific region in shallow water; 0–60 m.

STUDY SPECIMEN: From NZOI Stn I723, R/r = 122/22 mm, br. = 22 mm.

DESCRIPTION: *Disc* small, 5 rounded arms, scarcely tapering, bluntly tipped.

Abactinal plates irregularly arranged, 8 series between superomarginals at arm base.

Marginal plates low on sides of arm, forming fairly regular series; 3 series of actinal plates to near arm tip. Entire surface covered with dense coating of small granules, partly masking outlines of tumid plates. Granules slightly enlarged at plate centres.

Papular areas relatively conspicuous with 20–40 papulae in each. Intermarginal papular areas present, but none on actinal surface.

Madreporite ovoid, 4 x 2 mm, about half r from disc centre, with coarse radiate sculpture.

Anus more or less central, surrounded by slightly enlarged granules.

Actinal plates covered by granules like those of abactinals and marginals.

Adambulacral plates with 2 short stubby furrow spines, proximal larger. All spines separated by granules. Subambulacral spine low, tubercular, distinctly spaced from furrow spines. Occasional plates with second, outer subambulacral spine.

Oral plates small, actinal surface covered by granules with 2 small furrow spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull blue. In life the blue is much more vivid.

Linckia multifora (Lamarck, 1816) (Pl. 79)

Asterias multifora Lamarck, 1816: 522–568.
Linckia multifora: Clark & Rowe 1917: 36, 62; A.M. Clark 1993: 339; Rowe & Gates 1995: 87.

MATERIAL EXAMINED:
NZOI Stns: I77(3), I723(1), I768(1), Q61(3).

DISTRIBUTION: Middleton Reef, widespread in the Indo-west Pacific region in shallow water; 0–50 m.

STUDY SPECIMEN: NZOI Stn Q61, R/r = 62/7 mm, br. = 7 mm, arms unequal, with R = 62, 59, 45, 36, 33 mm.

DESCRIPTION: *Disc* small, 5 unequal, rounded arms tapering only near blunt tip.

Abactinal plates tumid, irregular in shape and arrangement. More or less uniform granulation covering all plates of abactinal and actinal surfaces, with slightly coarser granules at plate centres.

Marginal plates more regularly arranged towards arm tips, while actinals most regular, in 2 series over most of arm.

Papular areas relatively conspicuous, up to 10 papulae; no papulae below inferomarginals.

Anus not apparent.

Madreporites, 2 of equal size, both placed near margin in adjacent interradii, ovoid, about 3 mm in greatest diameter, with coarse radiate sculpture.

Adambulacral plates short, each with 2 stubby, flattened furrow spines, separated by granules and a single low, tubercular subambulacral spine, placed a little distance from furrow series. Adambulacral armature continued onto small oral plates.

Tubefeet biserial, with distinct sucking discs.

COLOUR (dried): Dull uniform cream. Guille *et al.* (1986) provided a photograph and colour notes.

Neoferdina Livingstone, 1931

Abactinal plates not forming regular longiseries. Some marginal, and often abactinal plates, convex and bare, others with a covering of granules.

TYPE SPECIES: *Scytaster cancellata* Grube, 1857 = *Ferdina cumingii* Gray, 1840.

Neoferdina cumingi (Gray, 1840)

Ferdina cumingi Gray, 1840: 283.
Ferdina ocellata H.L. Clark, 1921: 60, pls 6(5), 31(1, 2); Livingstone 1930: 18, pl. 6(1, 2).
Neoferdina ocellata: Livingstone 1931: 307; H.L. Clark 1946: 116.
Neoferdina cumingi: Jangoux 1973: 775–794; A.M. Clark 1993: 344; Rowe & Gates 1995: 89.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Lord Howe Island, and widespread in the tropical Indo-West Pacific region, 0–30 m.

Oneria Rowe, 1981

Seven longitudinal rows of primary abactinal and marginal plates, quadrilobate, and separated laterally, so that internal connecting plates visible. On actinal surface 2 rows of actinal plates, inner adjacent to adambulacrals with plates twice as numerous as inferomarginals; outer corresponding to inferomarginals. All plates smooth, skin-covered; skin containing small, flat, perforated grains. Crystal bodies absent. Small spines on a few marginal plates. Adambulacral armature in 2 rows; papulae in 8 longitudinal rows. Pedicellariae large, jaws laterally compressed and dentate, alveolae boat-shaped.

TYPE SPECIES: *Oneria tasmanensis* Rowe, 1981.

Oneria tasmanensis Rowe, 1981

Oneria tasmanensis Rowe, 1981: 91; A.M. Clark 1993: 345.

MATERIAL EXAMINED: Nil.

DESCRIPTION: Taken from Rowe (1981). R/r = 30/3.5 mm, br. = 4 mm.

Outline stellate, 5 arms, each slightly constricted at base, tapering distally to blunt tip; arms rounded, actinal surface flat. Body covered by thin skin not obscuring plate outlines. Skin containing small, flat, perforated grains, most numerous on disc.

Abactinal plates of arm quadrilobate, in longiseries, with 7 rows of abactinals, and marginals, latter not differentiated. Elongated proximal lobe of each plate overlapping shorter distal lobe of preceding plate; lateral lobes not in contact except near arm tip, so that internal connecting plates visible.

Marginal plates not differentiated from abactinals. Occasional marginals with a small pointed spine near distal end of plate, about 2 mm long. Terminal plate wider than long, with 2 stout spines on actinal surface.

Papular areas relatively large, with 1, occasionally 2, papulae; papulae in 8 longitudinal rows.

Pedicellariae scattered over abactinal surface in papular areas above superomarginals. Jaws elongate, curved, laterally compressed, with 1 glassy terminal spine and 3 or 4 lateral spines. Alveolae deep, boat-shaped, but often embedded in skin, so only jaws visible.

Anus visible, surrounded by inner ring of 5 prominent granules, and outer ring of smaller granules.

Madreporite small, circular, 0.7 mm diameter, slightly elevated, just over half r from disc centre.

Actinal plates in 2 rows; row below inferomarginals corresponding with and overlapped by them; inner row, with plates twice as numerous, overlapped by outer row.

Adambulacral plates short, with 2, sometimes 1, furrow spines tapering to acute tip, up to 0.7 mm long; spines connected by web of skin, not separated by granules. Subambulacral spine single on all plates to about half R then on alternate plates. Spines up to 1 mm long, flattened, tapering to rounded point, connected by skin for about half of length.

Oral plates small, with 4 furrow spines, largest proximal, continuous with adambulacral furrow spines. A single suboral spine near distal end of plate.

Tubefeet biserial, with small sucking discs.

COLOUR (dried): "Generally pale straw, but the skeletal plates and the pedicellariae show through white" (Rowe 1981).

REMARKS: The genus and species are known only from Ball's Pyramid, Lord Howe Island, 100–180 m.

Tamaria Gray, 1840

Body wall rigid; abactinal plates well developed, in regular longiseries, at least over basal half of arm; abactinal and actinal plates covered with granules, but lacking spines; adambulacral spines usually 2, set deep in furrow with tips slightly projecting; papulae in 4–6 series, none below inferomarginals; arms more or less cylindrical.

TYPE SPECIES: *Tamaria fusca* Gray, 1840.

KEY TO SPECIES OF *TAMARIA*

1 R/r about 7/1; papulae usually single; distal subambulacral spines not tubercular ..... *tenella*
R/r less than 4/1; 8–14 papulae to each area; distally subambulacral spines becoming tubercular ..... *giffordensis* n.sp.

Tamaria tenella (Fisher, 1906) (Pl. 80)

Ophidiaster tenellus Fisher, 1906: 1082, pl. 31 (5, 5a).
Ophidiaster sp. McKnight 1975: 56.
Tamaria tenellus: McKnight: 1993a: 173, 185; A.M. Clark 1993: 354.

MATERIAL EXAMINED: NZOI Stn S572(1).

STUDY SPECIMEN: R/r = 48/6.4 mm, br. = 8 mm.

DISTRIBUTION: Local records are from Three Kings Rise and Norfolk Ridge, 403–503 m. The only other record is from Hawaii, 238–276 m.

DESCRIPTION: Outline markedly stellate, arms 5, slowly tapering with tip pointed; disc and arms slightly flattened, arms rounded distally.

Abactinal, marginal, and *actinal plates* in regular series. Individual plates tumid or domed centrally; abactinals and superomarginals with 4 lobes, inferomarginals with lower lobe absent; actinals roughly rectangular. At arm base, a carinal, adradial, 2 marginal, and 4 series of actinals; 2 actinal series extending beyond base. Fine uniform granulation covering abactinal and marginal plates, about 12 granules in 1 mm. Granulation a little coarser on actinal plates, with 9 or 10 granules in 1 mm. On interradial actinals, often a flattened recumbent spine up to 1 mm long;

on actinals adjacent to adambulacrals often an alveolate pedicellaria, jaws and alveolus slightly expanded distally, with smooth margin.

Papulae single, none below inferomarginals.

Anus small, inconspicuous, more or less centrally placed.

Madreporite inconspicuous, rounded, 2 mm diameter with coarse radiate sculpture, about midway between disc centre and margin.

Adambulacral plates with 2 stubby furrow spines 1 or 2 mm long, and single flattened, recumbent, subambulacral spine about 1 mm long, on almost all plates. A single row of granules intervening between furrow and subambulacral spines, and occasionally an enlarged individual granule.

Oral plates small, with 2 furrow spines and single suboral spine.

COLOUR (ex-ethanol): Brownish above, brown to creamy-white below.

Tamaria giffordensis n.sp. (Pls 81, 89)

Ophidiaster sp. McKnight 1975: 56–57.
Tamaria sp. McKnight 1989a: 9.

MATERIAL EXAMINED: NZOI Stns: I729(3), I744(1, with unequal attenuate arms), Q70(3).

DISTRIBUTION: Gifford and Nova Seamounts in the northern Tasman Sea; 306-427 m.

TYPES: Holotype, H-756 in NIWA collection, Wellington (NZOI Stn I729, R/r = 61+/12 mm, br. = 12 mm).

Paratypes (2), P-1225 from NZOI Stn I729, in the NIWA collection, Wellington.

TYPE LOCALITY: 26°40.40′ S, 159°27.00′ E, Gifford Seamount, northern Tasman Sea, 306 m.

STUDY SPECIMEN: From NZOI Stn I729, R/r = 61+/12 mm, br. = 12 mm.

DESCRIPTION: Outline stellate, *disc* small, 5 rounded arms gently tapering, tip blunt. Most specimens with 1 arm distinctly shorter, all with irregular abactinal skeleton near arm tip.

Abactinal plates in regular longiseries for at least proximal half of arm, also forming regular transverse series. Carinal, adradial, and superomarginal plates all similar, with central part slightly inflated and length slightly less than width. Plates with 4 lobes, proximal lobe longer, overlapping short distal lobe of preceding plate; rows of plates in contact throughout except at arm base, where supplementary plate FF be present. Inferomarginal plates lacking lower lobe, actinal plates rectangular; 3 series of actinals in interradius, 2 extending into arm, and innermost extending beyond one-third R. Actinals and adambulacrals more or less aligned, 2 corresponding to each inferomarginal. Fine, uniform granulation covering abactinal and actinal surfaces, about 10 granules in 1 mm.

Papular areas rectangular, conspicuous; disc and arm bases each with 8–14 papulae; 8 at half R. No papulae below inferomarginals.

Alveolate *pedicellariae* on abactinal, marginal, and actinal plates; jaws slightly curved and slightly expanded at smooth tip. Alveolus of similar shape, about 1.5 mm long. Some actinal alveoli with an enlarged granule, placed near centre, on side facing furrow.

Anus subcentral, surrounded by circle of enlarged granules, up to 0.4 mm long.

Madreporite about midway between disc centre and disc margin, rounded to ovoid, maximum diameter 3 mm, with coarse sculpture.

Adambulacral plates short, each with 2 stubbby, flattened furrow spines and single subambulacral spine on most plates, occasionally absent beyond half R. Proximal subambulacral spines flattened and recumbent, beyond arm base becoming shorter and tubercular. Around subambulacral spines granulation slightly coarser.

Oral plates small, each with 2 or 3 furrow spines.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull brown with pore areas darker.

ETYMOLOGY: Named after the Gifford seamount near which it was found.

REMARKS: The two species of *Tamaria* described herein are readily differentiated — *T. tenellus* has long slender arms with R/r about 7/1; the papulae are usually single and the distal subambulacral spines are not tubercular. *Tamaria giffordensis* n.sp. has R/r less than 4/1, 8–14 papulae to each area, and the subambulacral spine becomes tubercular distally.

Nardoa Gray, 1840

Abactinal plates not forming regular rows; adambulacral armature spiniform; papulae usually in groups, actinal papulae sometimes present; abactinal plates and superomarginals may vary in size and elevation, but not regularly.

TYPE SPECIES: *Asterias variolata* Retzius, 1805.

Nardoa cf. *tumulosa* Fisher, 1917a (Pl. 82)

Cf. *Nardoa tumulosa* Fisher, 1917a: 90; 1919: 386, pls 95(9), 109(2), 111(2); A.M. Clark 1993: 343.

MATERIAL EXAMINED: NZOI Stn I733(1).

DISTRIBUTION: Capel Seamount, northern Tasman Sea, 66 m.

STUDY SPECIMEN: R / r = 103 / 16 mm, br. at base of ray = 17 mm.

DESCRIPTION: Outline strongly stellate, arms more or less regularly tapering to sharp tip. Rays flattened, probably owing to preservation.

Abactinal plates lobate, centrally tumid, forming an irregular reticulum. Plates covered by moderately fine flattened granules. Occasional plates much higher, and prominent, dome-shaped or almost hemispherical, almost as wide as high. Many broken, the larger with basal diameter of 3.5 mm. Granulation extending to summit of plates, slightly coarser there. Dome-like plates extending for about three-quarters arm length, about 20 to each arm, distal plates smaller and lower than proximal.

Marginal plates in more or less regular rows, occasional plates varying in size; last 4–6 inferomarginals definitely swollen, with small, naked central tubercle; 3 series of intermarginals at arm base, median extending to about half R, others confined to basal area.

Papular areas not extending below inferomarginals; papulae more or less concealed by granulation, this less dense within areas.

Actinal plates in 2 series at arm base, outer with only 1–3 plates, inner extending almost to or beyond half R.

Adambulacral plates with 5 furrow and 4 subambulacral spines and outer granules in proximal half of arm. Spines close-set, short, flattened, with truncate tips. Furrow series slightly overlapping those of next distal plate, subambulacral series usually slightly curved. Outer granules longer than those on actinal plates.

Oral plates with 7 furrow and 5 suboral spines.

COLOUR (ex-ethanol): Dull uniform very light brown.

REMARKS: This specimen appears to differ from *N. tumulosa* in the abactinal tubercles being about as high as wide, not low and cushion-like.

Nardoa tumulosa is known from the Philippines, China, southern Japan, and the Caroline Islands.

Family MITHRODIIDAE Viguier, 1878

Disc very small, arms normally 5, elongate, rounded above, flattened below, sometimes of unequal length. Abactinal skeleton well developed, with larger rounded plates, surrounded by smaller plates of varying shapes, the latter mostly arranged in star-like fashion around larger ones. Larger plates in longitudinal rows, some with large movable, cylindrical or conical spines. Plates with excavations, slightly rimmed for attachment of spines; the larger obtuse spines beset with rough scales or spinelets; spines more or less in carinal, marginal, and actinal rows. Small plates often with short, near-granuliform spine. Body covered by skin, containing small calcareous grains. Adambulacral furrow spines webbed by skin in convex fan, and single prominent subambulacral spine. Pedicellariae usually near edges of papular areas, composed of circlet of 4–7 small, curved, pincer-like spines, arising from small, circular plate. Furrows narrow, tubefeet biserial, with sucking discs; no interbrachial septum, ampullae double.

Mithrodia Gray, 1840

Diagnosis as for family, as this is the only genus.

TYPE SPECIES: *Mithrodia spinulosa* Gray, 1840 (= *Asterias clavigera* Lamarck, 1816).

Mithrodia clavigera (Lamarck, 1816) (Pl. 83)

Asterias clavigera Lamarck, 1816: 562.
Mithrodia clavigera: Pope & Rowe 1977: 202, 213–215; A.M. Clark 1993: 324; Rowe & Gates 1995: 76.

MATERIAL EXAMINED:
NZOI Stns Q61(1), Q63(1).

STUDY SPECIMEN: From Stn Q63, specimen contorted, R / r = 189 / 18 mm, br. = 20 mm.

DISTRIBUTION: Middleton Reef and Lord Howe Island, also tropical Australia. A widespread species in shallow waters of the Indo-West Pacific region, with southernmost records from Fiji, New Caledonia, and Middleton Reef.

DESCRIPTION: Outline markedly stellate, 5 elongate arms tapering near tip; arms and disc with rounded margin; arms slightly constricted at base. Entire body and spines invested by skin.

Abactinal plates of several sizes, with larger rounded

plates connected by small, elongate plates forming an irregular network. Larger plates often with single spines, up to 10 mm long; spines stumpy, blunt-tipped, may be flattened, with tip bifid. Smaller plates sometimes with spine, similarly stumpy, but only up to 3 mm long. Spines, plates, and skeletal meshes overlain by thick skin containing numerous small but conspicuous grains, imparting a rough texture. Larger spines spaced apart, forming irregular longiseries, with carinal and 2 marginal rows evident.

Papulae inconspicuous, owing to granulation.

Anus not apparent.

Madreporite more or less pentagonal, greatest diameter about 3 mm, placed just less than half r from disc centre, with fine sculpture.

Marginal plates not especially prominent; spines forming 2 relatively conspicuous rows along arm. Inferomarginal spines sometimes doubled.

On actinal surface, outside of adambulacral plates, a single row of spaced spines similar to those on abactinal and marginal plates.

Adambulacral plates short, with 6–9 (usually 7) furrow spines; theses slender, set in curved series, longest medianly, webbed by skin to near tip; subambulacral spine single, placed close to furrow edge, longer and stouter than furrow series, resembling actinal spine, and forming a continuous series along furrow edge.

Oral plates small, indistinct, entire area around mouth with crowded spines and subambulacral and suboral series.

Ambulacral grooves narrow.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Light brown, with distal half of arms deep purple. Guille *et al.* (1986) provided a photograph and colour notes.

Superfamily **OREASTEROIDEA**

Family **OREASTERIDAE** Fisher, 1911a

Normally 5 arms; outline pentagonal to stellate, sometimes cushion-like. Interradial arcs rounded, disc and arms sometimes elevated, actinal surface flat. Size often large, over 100 mm, young stages goniaster-like. Abactinal plates tending to form reticulum around large pore areas, midradial plates often enlarged and in regular longiseries; isolated plates may be more convex, with tubercle; some interradial and dorso-lateral plates similar; alternatively, entire surface may be covered with coarse granules and tubercles. Superomarginal plates often inconspicuous in adult specimens. Actinal plates numerous, in several series, granule-covered. Pedicellariae alveolar, jaws spatulate, or short and broad.

Acheronaster H.E.S. Clark, 1982

Outline pentagonal-stellate, interbrachial arcs rounded; abactinal plates forming distinct reticulum, plates with small, rounded spines and covering of granules. Papularia distinct. Marginal plates distinct, no enlarged spines. Actinal areas large; adambulacral plates with 2 or 3 rows of spines. Valvate pedicellariae on abactinal and actinal surfaces.

TYPE SPECIES: *Acheronaster tumidus* H.E.S. Clark, 1982.

Acheronaster tumidus H.E.S. Clark, 1982

(Pl. 84, Fig.41)

Acheronaster tumidus H.E.S. Clark, 1982: 39–41, figs 10–14; A.M. Clark 1993: 294; Rowe & Gates 1995: 94.

MATERIAL EXAMINED: Nil.

DISTRIBUTION: Near Raoul Island, Kermadec Islands, NE of New Zealand, 110–146 m, and coast of New South Wales, Australia.

DESCRIPTION: Taken from H.E.S. Clark (1982).

Outline pentagonal-stellate; 5 arms tapering from a broad base; actinal surface flat, disc tumid, arms arched; margin partly rounded.

Abactinal plates masked by skin, forming distinct reticulum, 3 or 4 rows extending to terminal plate. Plates of disc and proximal part of arm lobate, distal plates round. Plates with a single, central, enlarged, squat, round-tipped spine, and paved with small close-fitting granules; spines absent on interradial plates and distally.

Papulae numerous conspicuous, between lobes of plates; absent from distal third of arm and often interradially.

Madreporite less than half r from disc centre, pear-shaped, conspicuous, with fine, deep sculpture.

Anus central, surrounded by irregular granules and short spines.

Marginal plates large, forming well-defined edge to body; 24 or 25 plates to each arm; plates of both series corresponding proximally and distally, subalternate between, covered with close-set granules and 3–6 (rarely 10) valvate pedicellariae; distal superomarginals may have a squat spine. Inferomarginals granulose, with 6–10 pedicellariae; inferomarginals slightly larger than superomarginals.

Actinal plates more or less rectangular, slightly tumid, covered by rows of polygonal, spaced granules. Marginal granules smaller, plates also with 1–5 central valvate pedicellariae.

Adambulacral plates large, tumid, distinct. Furrow spines 9 or 10 proximally, 6 distally, slender, flattened, close together, proximal spines shortest. Spines tending to form fan-shaped groups, almost meeting across furrow. Subambulacral spines in conspicuous clump at edge of furrow, sometimes 2 spines forming a pedicellaria. Remainder of plate with small, angular granules.

Oral plates with crowded furrow spines continuing adambulacral armature. Actinal surface with isolated angular granules.

Ambulacral grooves narrow.

Tubefeet biserial, with distinct sucking discs.

COLOUR (in life): "Abactinally, this striking animal has blotches of deep orange and fawn (or cream), with orange predominating interradially and on distal half of arms. The actinal surface is marked with distinct orange bars on a cream background. Markings are more distinct actinally with bands of orange on either side of midline and near the oral plates and at the entrance to the arms; the arms themselves are fawn" (H.E.S. Clark 1982: 41).

Family ASTEROPSEIDAE
Hotchkiss & Clark, 1976

Outline stellate, though near-pentagonal in young specimens, interradial arc rounded or bluntly angular; arms normally 5, flattened actinally, convex or carinate abactinally with distinct ventrolateral angle; body covered with thick skin, obscuring plate outlines in larger specimens. Abactinal skeleton with primary plates usually distinct, secondary plates present in larger, and skeleton becoming an open reticulum; abactinal, marginal and actinal plates with or without spines; papulae single, becoming grouped in larger specimens. Marginal plates well developed, infero-marginals thick, wedge-shaped, usually projecting; actinal plates arranged in longitudinal series parallel to adambulacrals and longest row adjacent to them; pedicellariae if present granuliform, bivalved or tong-shaped. Interradial septum present, membranous where known, with a vertical calcified column in each interradius.

KEY TO GENERA

1 No spines on abactinal or marginal plates; body covered by thick skin; usually a valvate pedicellaria at each side of arm base ..... *Petricia*
A single spine on carinals and superomarginals ..... *Asteropsis*

Asteropsis Müller & Troschel, 1840

Abactinal and actinal plates covered by skin; carinal and superomarginals with spines; superomarginals forming margin; abactinal plates forming longitudinal and transverse series, carinal plates elongated, dorsolaterals elongated transversely.

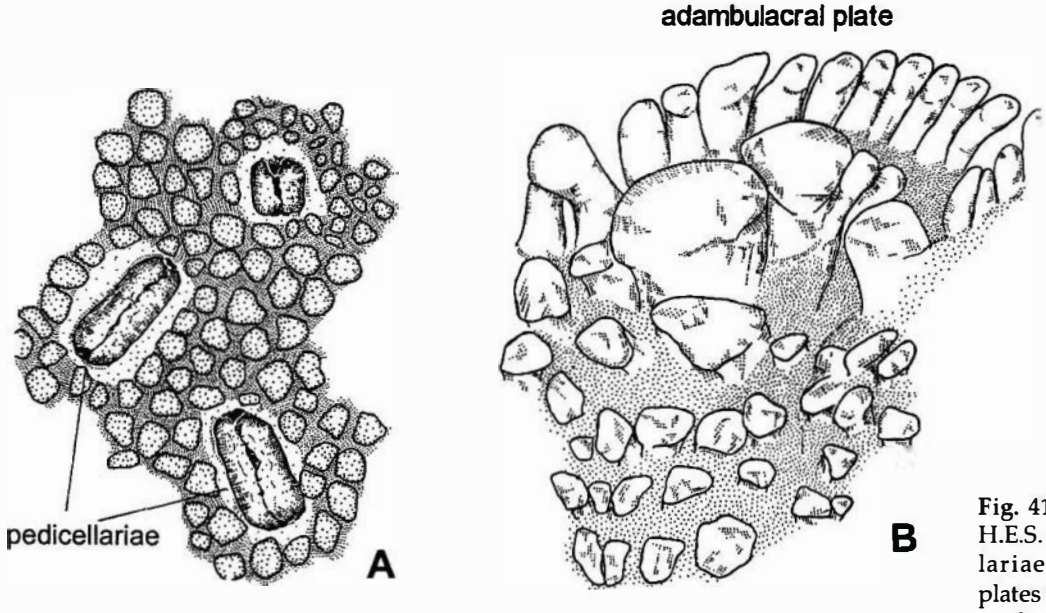

Fig. 41. ***Acheronaster tumidus.*** H.E.S. Clark. A. Three pedicellariae from superomarginal plates near interradial angle. B. Ambulacral plate.

TYPE SPECIES: *Asterias carinifera* Lamarck, 1816.

Asteropsis carinifera (Lamarck, 1816) (Pl. 85)

Asterias carinifera (Lamarck, 1816: 556).
?*Gymnasteria lissotergum* Benham, 1911: 145.
Asterope carinifera: H.L. CLark 1946: 109.
Asteropsis carinifera: Clark & Rowe 1971: 38, 65, pl. 9(9); Guille *et al.* 1986: 142; A.M. Clark 1993: 320.

MATERIAL EXAMINED: NZOI Stn P967(2).

STUDY SPECIMENS: R/r = 47/19 mm, br. = 21 mm; R/r = 97/23 mm, br. = 25 mm.

DISTRIBUTION: This species is recorded from only the South Minerva Reef, in the extreme northeast of the study area. Elsewhere it is known as widespread in shallow water of the Indo-West Pacific region.

DESCRIPTION: Outline pentagonal-stellate, 5 arms tapering from relatively broad base; interbrachial arcs rounded–angular; actinal surface more or less flat, but abactinal inflated; arm cross-section forming broad, low triangle; distinct marginal fringe of flattened and spinose superomarginals.

Abactinal surface paved with rounded, flat plates, with embedded crystal bodies, sometimes appearing granular in wet specimens. Carinal plates subtriangular at arm base, almost rectangular distally, becoming longer than wide. Carinals forming broad ridge to arm, more prominent in smaller specimens, R less than about 50 mm. Every second or third carinal with single, rounded, pointed spine up to 3 mm long. Superomarginals flattened, forming margin, rounded on inner margin, each with single rounded, pointed spine up to 4 mm long. Inferomarginals subrectangular with rounded outer margins, confined to actinal surface, lying inside superomarginal fringe.

Papulae confined to abactinal surface, up to 10 in each area, on disc and at arm bases, usually single near arm tip. Often skin-covered spaces between plates on actinal surface, no papulae.

Anus placed more or less central, close to centrodorsal with usually 1 or 2 spines like those on carinal plates. Aperture small, encircled by small spinelets.

Madreporite inconspicuous, about one-third r from disc centre, rounded, 2 mm diameter, with fine radiate sculpture.

Actinal plates small, rounded to rectangular, in 3 series in interradii, but only inner extending along arm to near tip. Both abactinal and actinal surfaces covered by skin partially masking plate outlines.

Adambulacral plates relatively short with 3 or 4 short, blunt-tipped, slightly flattened furrow spines, all linked by longitudinal web of skin, tips usually free. A single, larger subambulacral spine up to 3 mm long, often flattened; in larger specimens may appear tubercular. Skin covering on actinal surface investing these spines and sometimes forming longitudinal web at their bases. Adambulacral armature continuing over small *oral plates*.

Tubefeet biserial, with distinct sucking discs.

COLOUR (ex-ethanol): Dull brown. In life abactinal surface is predominantly greenish, with mauve transverse bands on arms. Guille *et al.* (1986) provided a colour photograph.

REMARKS: Benham (1911) described two small sea-stars from the Kermadec Islands as *Gymnasteria lisssotergum*, indicating differences from *A. carinifera*. The species does not appear to have been subsequently collected and is possibly referable to *Asteropsis carinifera*.

Petricia Gray, 1847

No spines, spinelets, or granules on abactinal or marginal plates. Abactinal plates slightly lobate or irregular, not forming a reticulum; adambulacral plates with 2 furrow and 2 subambulacral spines; a pair of large obvious abactinal pedicellariae at base of each arm.

TYPE SPECIES: *Asterias vernicina* Lamarck, 1816.

Petricia vernicina (Lamarck, 1816) (Pls 39, 86)

Asterias vernicina (Lamarck, 1816: 554).
Petricia punctata Gray, 1847: 81.
Asteropsis imperialis Farquhar, 1897: 193, pl. 13; Benham 1911: 141.
Petricia vernicina: Fisher 1908: 357; H.L. CLark 1946: 110; Rowe 1989: 290; A.M. Clark 1993: 321.
Petricia obesa H.L. Clark, 1923b: 241, pl. 13(1–2).
Pectria imperialis [sic]: McKnight 1968: 506.
Petricia imperialis: H.E.S. Clark 1970: 5.

MATERIAL EXAMINED:
NZOI Stns: K801(2), K812(4), K833(6), K871(1), N895(1), P967(3), P968(2), T261(1).

STUDY SPECIMENS: From Stn K871 (dried specimen), R/r = 64/22 mm, br. = 24 mm; from Stn P967, R/r = 56/25 mm, br. = 22 mm.

DISTRIBUTION: Southern Australia, Norfolk Island, and the Kermadec Islands, 0–18 m.

DESCRIPTION: Outline pentagonal-stellate, interbrachial arcs rounded; disc flattened or inflated; 5 arms, though often flattened at base, tapering slightly and rounded towards blunt tip. Thick skin covering abactinal and actinal surfaces, masking plate outlines (unless specimen dried).

Abactinal plates lobate, more or less regularly arranged, forming relatively wide meshes. On arms a carinal and an adradial series, with (at arm base) elongate plates connecting these and superomarginals.

Papulae confined to relatively large skeletal meshes of abactinal surface, 10–25 papulae in each.

Anus small, inconspicuous, centrally placed, lacking any encircling armature.

Madreporite small, commonly not apparent in wet specimens, being covered by skin. In dried specimen, small and rounded, 2 mm diameter, with fine sculpture, about one-quarter r from disc centre. In each interradius, on abactinal surface, 1–3 valvate pedicellariae, may be very inconspicuous in wet specimens but readily apparent when dried. Pedicellariae appearing as slits in skin, sometimes standing on slight eminence, up to 5 mm long.

Marginal plates tumid, opposite or slightly alternating along arm. No marginal spines. Interradially 3 series of actinal plates, outer extending only to distal end of first inferomarginals; median series extending to distal end of third inferomarginal; innermost series extending to distal third of arm. Plates rounded and covered by thick skin.

Adambulacral plates short, wider than long over most of arm. Each plate with 2 flattened, blunt-tipped furrow spines, a single similar, slightly larger, subambulacral spine. Both furrow and subambulacral spines connected in longitudinal series by web of skin extending to near tip of spines.

Oral plates apparent, furrow spines spaced further apart than on adambulacrals; 4 or 5 flattened furrow spines, broader than adambulacral series, and 2 similar suboral spines, both series linked to *adambulacral furrow* and subambulacral series by continuation of webs.

COLOUR (dried or ex-ethanol): Uniform dull light brown. In life often reddish, orange, or dull brown.

Family **ACANTHASTERIDAE** Sladen, 1889

Abactinal skeleton well developed, with plates in longitudinal series and forming an open irregular meshwork; larger plates with prominent pedicel and conspicuous isolated spines; disc large, arms numerous, often multiple madreporites. Prominent elongate pedicellariae, usually 2-jawed, among abactinal spines. Oral plates small, ambulacral furrows narrow, tubefeet in 2 rows, with sucking discs. Ampullae double, interbrachial septa plated.

Acanthaster Gervais, 1841

Diagnosis as for family, as this is the only genus.

TYPE SPECIES: *Asterias planci* Linnaeus, 1758.

KEY TO SPECIES

1 Abactinal spines on a high pedicel; long and widely spaced; adambulacral and subambulacral spines flattened; abactinal pedicellariae much longer than wide, conspicuous ..... *planci*
Pedicel of abactinal spines low; spines short, closely spaced, nearly as wide as long, inconspicuous ..... *brevispinus*

Acanthaster brevispinus Fisher, 1917a (Pl. 57)

Acanthaster brevispinus Fisher, 1917a: 92; 1919: 442, pls 117, 118(1), 131(6, 6a-d); Clark & Rowe 1971: 71; A.M. Clark 1993: 323; Rowe & Gates 1995 : 23.

MATERIAL EXAMINED:
No specimens from the study area.

SIZE: R / r = 115 / 64 mm, of one uncatalogued specimen from Queensland, Australia.

DISTRIBUTION: Recorded from Elizabeth Reef, northern Tasman Sea. Also known from northeastern Australia, and the Philippine Islands.

DEPTH: 0–20 m.

DESCRIPTION: Disc large, arms gently tapering to blunt tip, rounded above; disc almost flat, ventral surface flat.

Abactinal plates of disc forming a relatively close-set reticulum, individual plates scarcely raised, often with 1–3 short tapering spines up to 5 mm long. Tip of spine sometimes triangular in section. Some bare areas on disc. Abactinal plates more widely spaced on arms with spine usually 5–8 mm long. Disc with sparse covering of small granules, becoming denser on plates and particularly on spines, extending for at least half length of spine.

Papulae almost invisible (dried specimen), possibly 1 or 2 in skeletal meshes.

Abactinal *pedicellariae* small, inconspicuous, up to 1 mm long; jaws rounded on distal margin, width almost equal to height.

Madreporites visible, 8, small and rounded, each slightly inflated, about 3 mm in diameter, with deep reticulate sculpture.

Marginal plates small, inconspicuous, plates of both series with 1, occasionally 2, tapering spines up to 10 mm long, bedecked with small granules.

Actinal areas small, plates barely visible, most with 1 or 2 short, blunt spines up to 5 mm long. A single series of spines extending to near arm tip. A few small pedicellariae scattered among the spines.

Adambulacral plates short, each with usually 3, sometimes 2, subequal furrow spines at edge of furrow, each tapering to rounded tip. A 2-jawed pedicellaria sometimes sited just proximal to spines; often another pedicellaria deep in furrow below spines. These pedicellariae clearly higher than broad, jaws evenly tapering to blunt tip. A single tapering subambulacral spine, up to 7 mm long, usually with much shorter pedicellaria placed just proximal to it. These pedicellariae very variable in shape; some similar to abactinal pedicellariae, others similar to those in furrow, and many intermediate.

Oral plates elongate, conspicuous, with 5–7 flattened furrow spines.

Ambulacral furrows broad; *tubefeet* biserial, with distinct sucking discs.

COLOUR (dried specimen): Abactinal surface dark, almost black, with deep reddish spines. Actinal surface and spines brownish.

Acanthaster planci (Linnaeus, 1758) (Pl. 88)

Asterias planci Linnaeus, 1758: 823.

Acanthaster planci: Fisher 1919: 441; Clark & Rowe 1971: 38,71, pl. 11 (3); McKnight 1978: 17; 1979: 21; 1989a: 10; 1989b: 25; Wilkinson 1990: 93-172; Wilkinson & MacIntyre 1992: 51-122; A.M. Clark 1993: 323; Rowe & Gates 1995: 23.

MATERIAL EXAMINED:

NZOI Stns: K01(1), K812(4), K833(1), P967(1), Q78(1), Q505(8), T222(1).

STUDY SPECIMEN: From NZOI Stn K833, R/r = 144/73 mm, 14 arms.

DISTRIBUTION: Widespread in shallow waters of the Indo-West Pacific region, with southern records from Elizabeth Reef, Tasman Sea, also Raoul and Macauley Islands, Kermadec Group.

DESCRIPTION: *Disc* large, arms close-set, scarcely tapering, except near tip; arms rounded and inflated, actinal surface of arms and disc more or less flat.

Abactinal plates forming irregular, wide-meshed reticulum, with larger plates lobate, more or less conical, up to 4 mm tall, bearing a long (up to 10 mm) tapering, sharply pointed, prominent spine, tip often grooved. Smaller plates oval or rounded, connecting larger plates, often with small spine or erect 2-jawed pedicellaria, with slender blades, sometimes appearing as 2 adjacent spines.

Pedicellariae up to 3 mm long. Thin skin covering abactinal surface; with finely granulated appearance on larger plates and bases of spines.

Papulae common in skeletal meshes but inconspicuous owing to finely thorny skin in meshes.

Marginal plates forming rounded margin of arms, not prominent, but closely connected, with small skeletal meshes, if at all. Plates with 1 or 2 long, prominent spines like those of abactinal surface.

Actinal areas small, skin-covered, plates rarely visible, usually lacking spines.

Adambulacral plates short, with usually 2, rarely 1 or 3, furrow spines, often widening distally, flattened, the broad tip curved laterally, with grooves on outer face. Either spine may be larger. Subambulacral single, like furrow spines, but larger, up to 5 mm long. Between furrow and subambulacral spines, often an erect 2-jawed pedicellariae with rounded tips, lower and broader than those of abactinal surface.

Oral plates elongate, quite conspicuous, with 6 or 7 furrow spines, similar to adambulacral series, larger proximally, distal 3 or 4 much shorter; 1 or 2 similar suboral spines. Adambulacrals forming an adoral carina distal to oral plates.

Ambulacral furrows broad, *tubefeet* more or less quadriserial, or in 2 zigzag series, with distinct sucking discs.

COLOUR (ex-ethanol): Dull uniform brown. Guille *et al.* (1986) have provided photographs.

REMARKS: This species has been the subject of several recent studies, owing to its depredation of coral reefs.

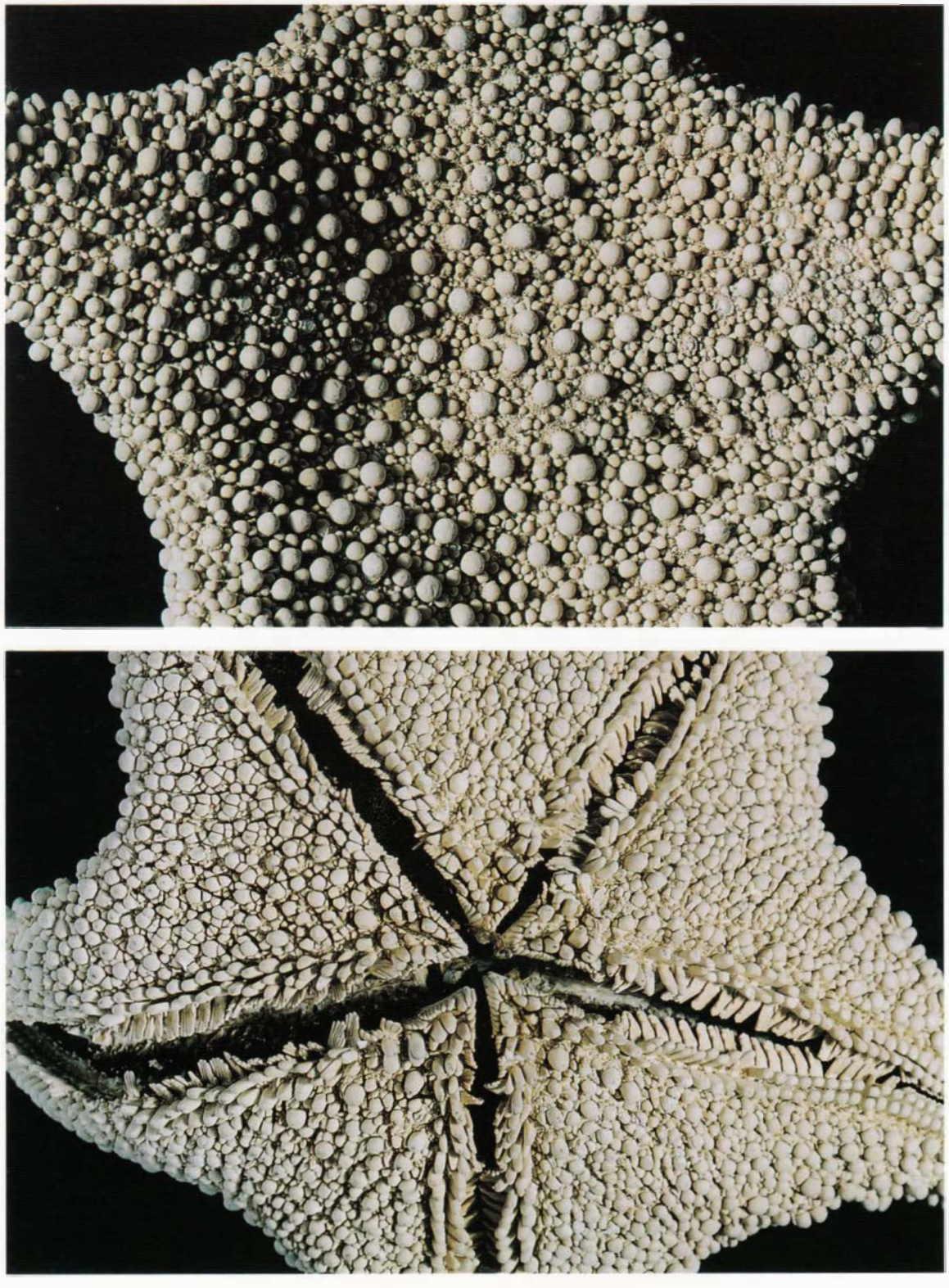

Plate 40. ***Asterodiscides grayi*** Rowe. NZOI Stn I90. R/r = 77/43 mm. Abactinal and actinal surfaces.

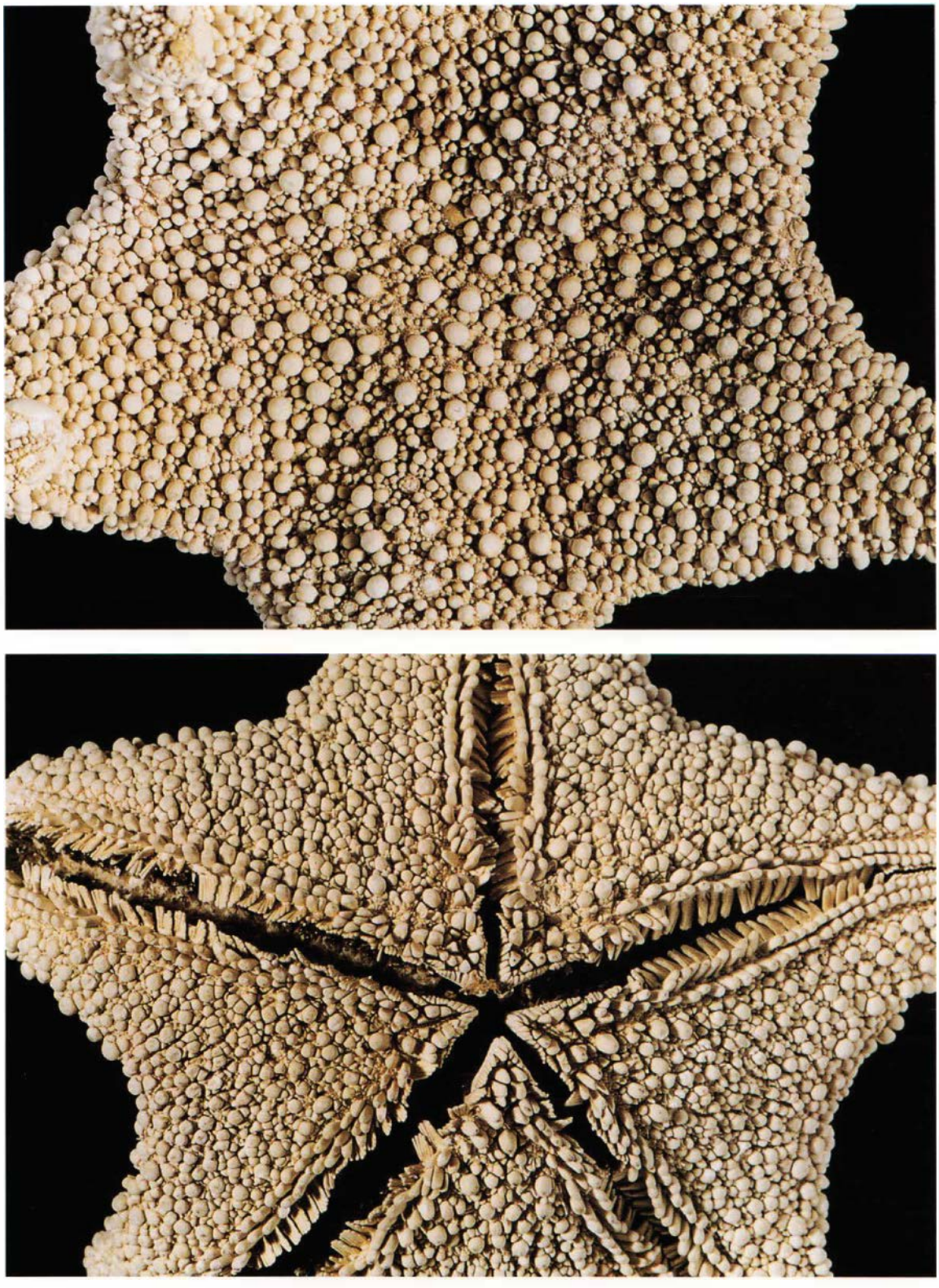

Plate 41. ***Asterodiscides truncatus*** (Coleman). NZOI Stn I357. R/r 117/54 mm. Abactinal and actinal surfaces.

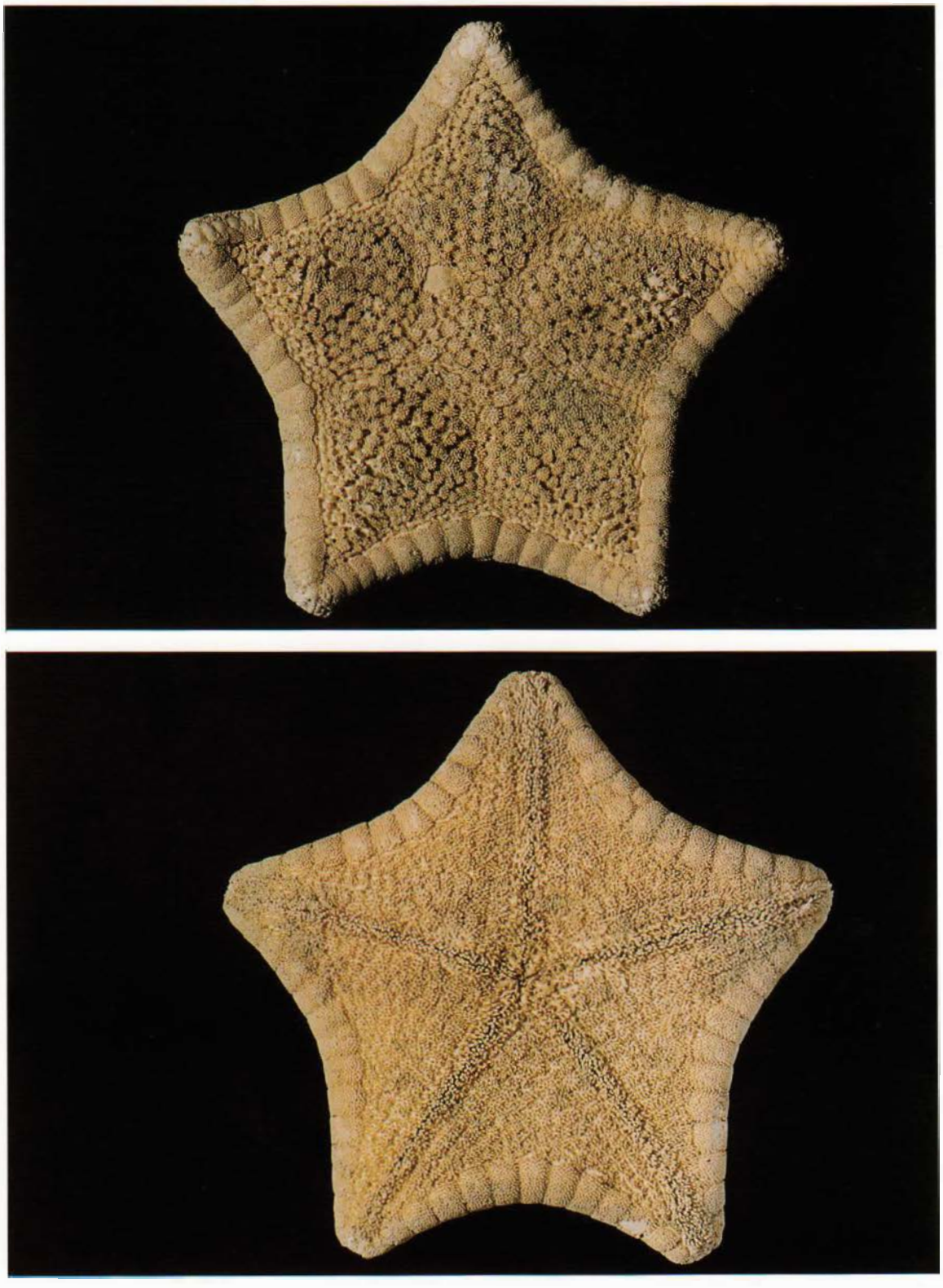

Plate 42. ***Odontaster aucklandensis*** McKnight. NZOI Stn G674. R/r = 35/24 mm. Abactinal and actinal surfaces.

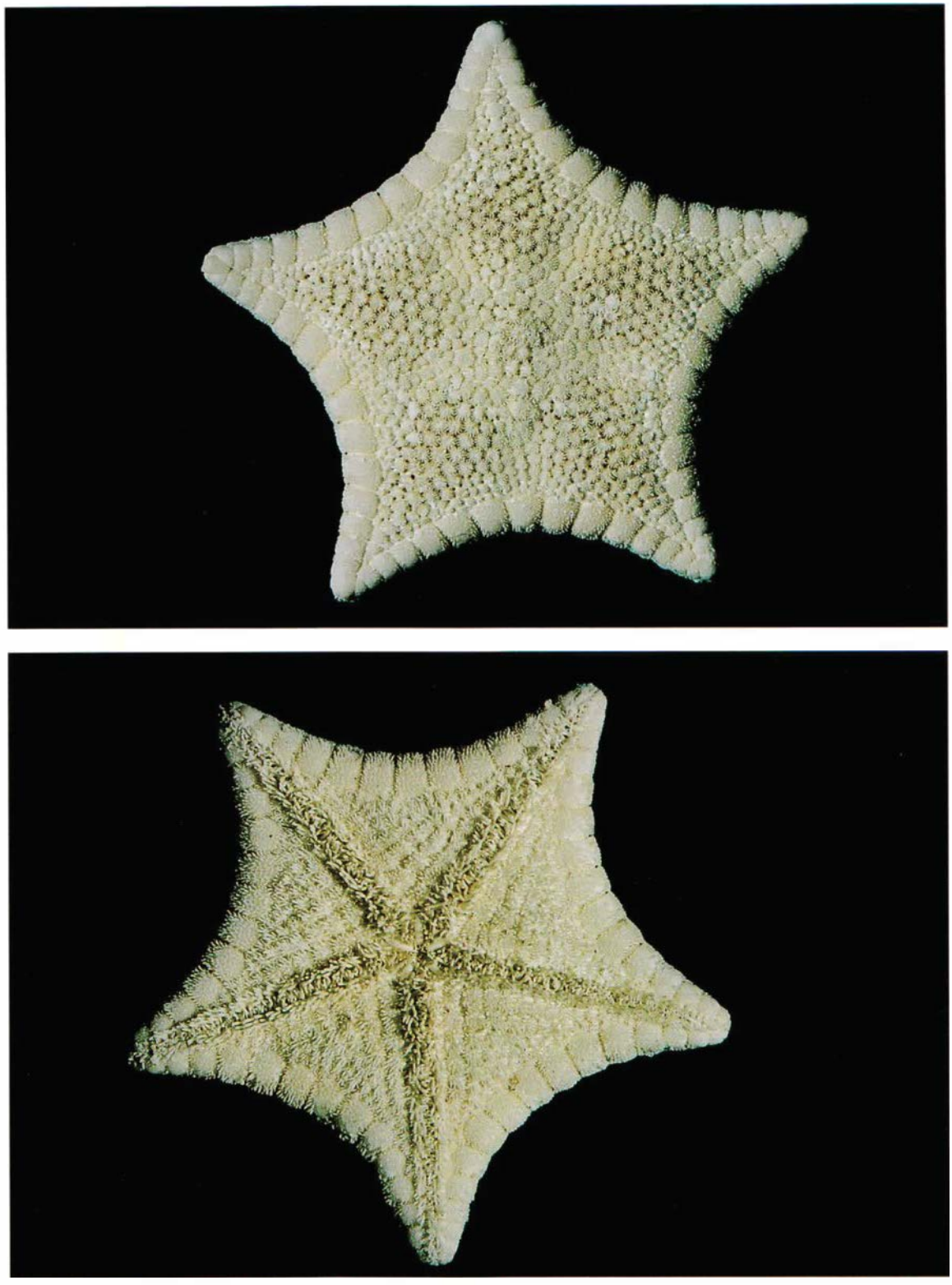

Plate 43. ***Odontaster benhami*** Mortensen. NZOI Stn F97. R/r = 19/11 mm. Abactinal and actinal surfaces.

Plate 44. ***Odontaster penicillatus*** (Philippi). NZOI Stn E228. R/r = 13/8 mm. Abactinal and actinal surfaces.

Plate 52. ***Cycethra frigida*** (Koehler). NZOI Stn A695. R/r = 5/3.5 mm. Abactinal and actinal surfaces.

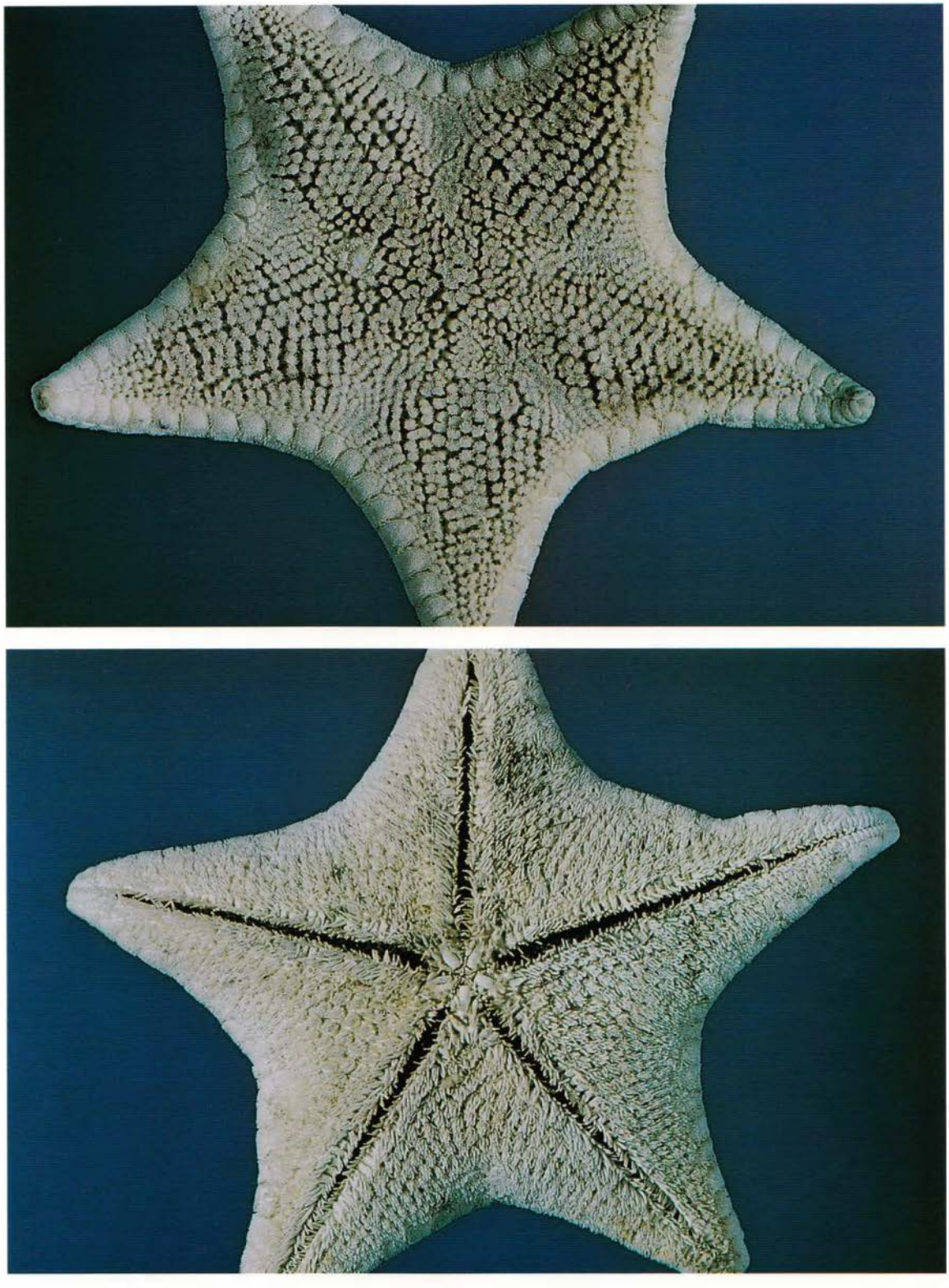

Plate 45. ***Odontaster rosagemmae*** n.sp. Holotype. NZOI Stn Z8978. R/r = 47/27 mm. Abactinal and actinal surfaces.

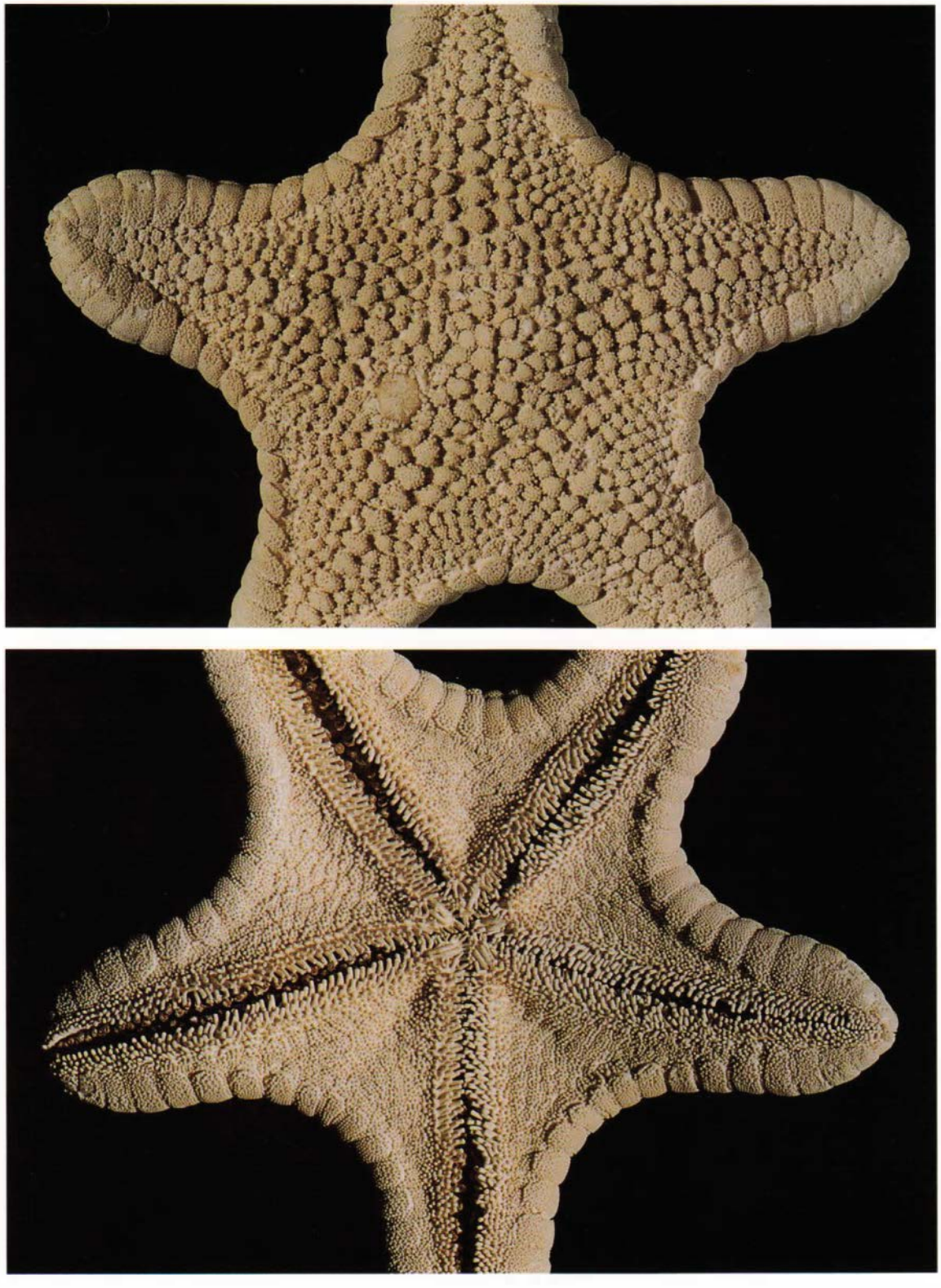

Plate 46. ***Diplodontias dilatatus***. NZOI Stn T752. R/ r = 47/26 mm. Abactinal and actinal surfaces.

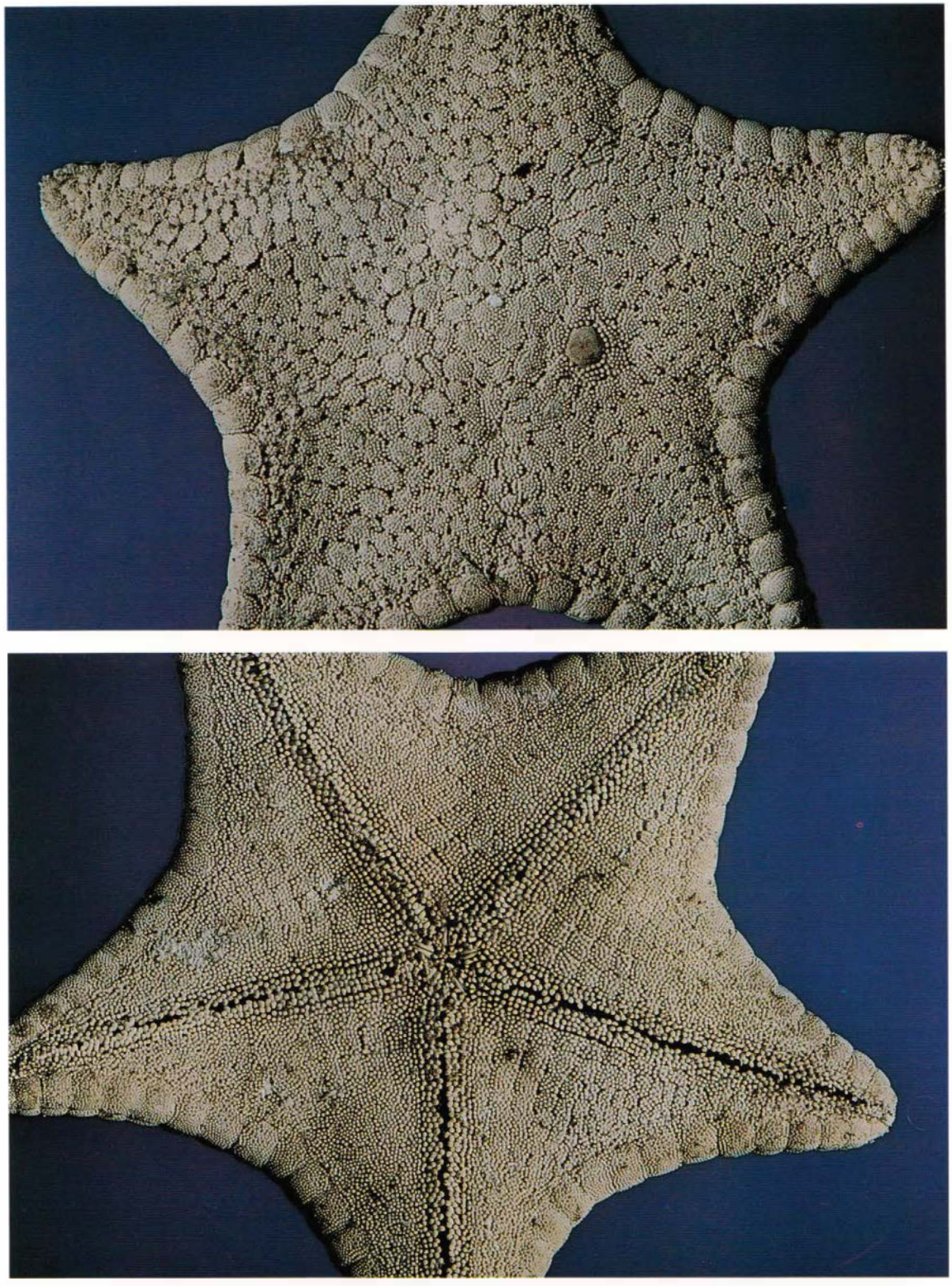

Plate 47. ***Diplodontias miliaris*** (Gray). NZOI Stn B554. R/r = 64/32 mm. Abactinal and actinal surfaces.

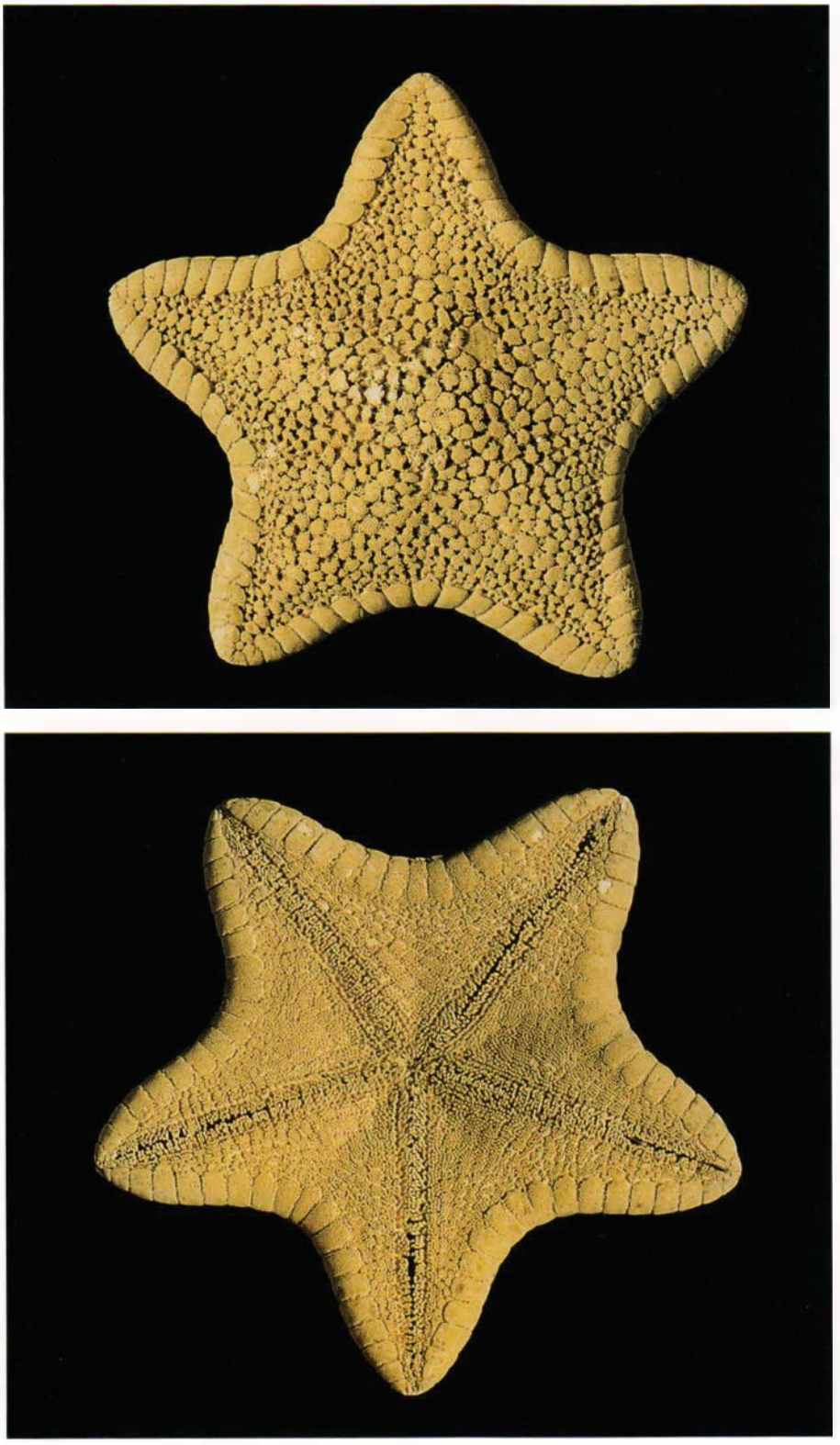

Plate 48. ***Diplodontias robustus*** Fell. Holotype. NMNZ. R/r = 64/42 mm. Abactinal and actinal surfaces.

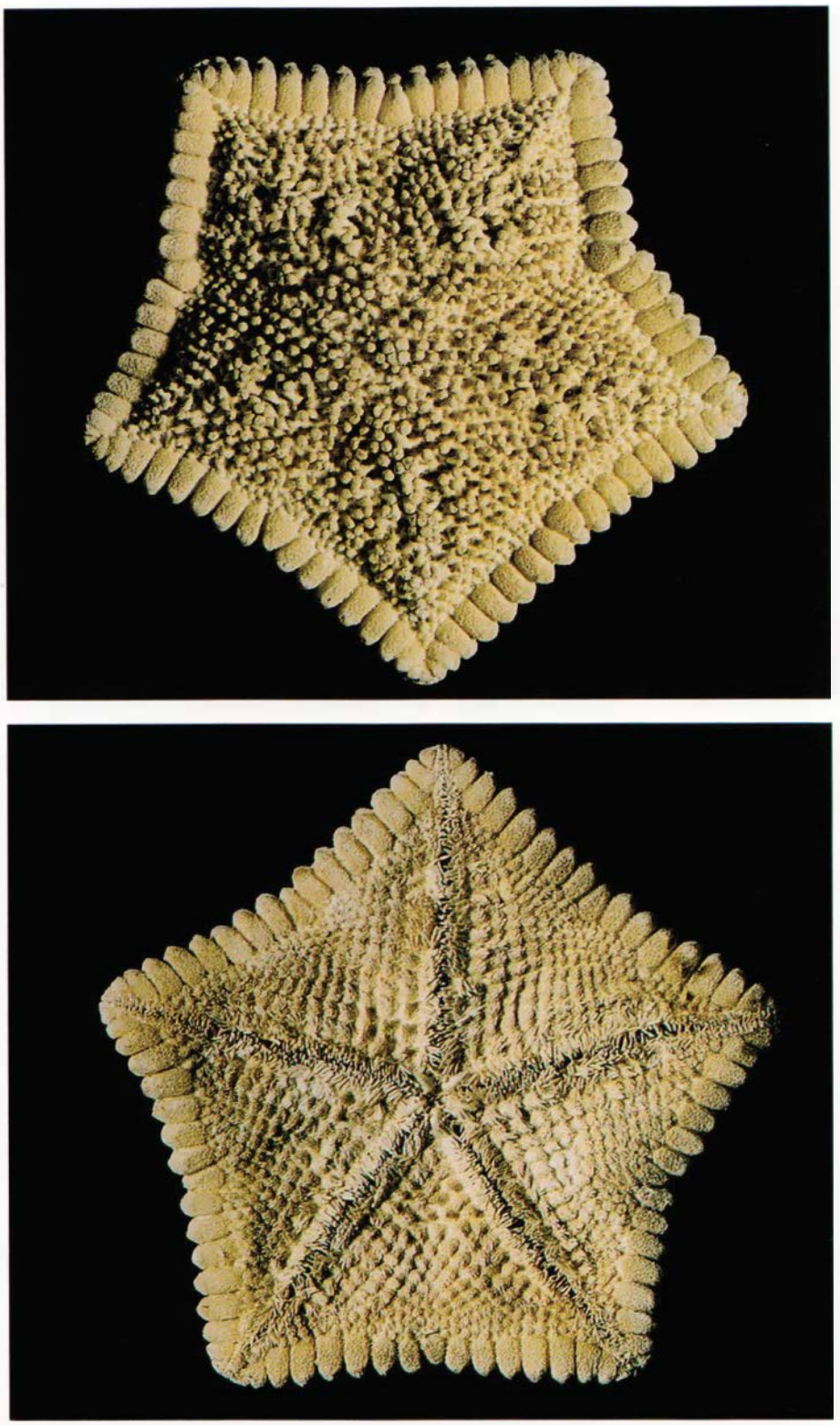

Plate 49. ***Eurygonias hyalacanthus*** Farquhar. NZOI Stn T752. R / r = 39 / 28 mm. Abactinal and actinal surfaces.

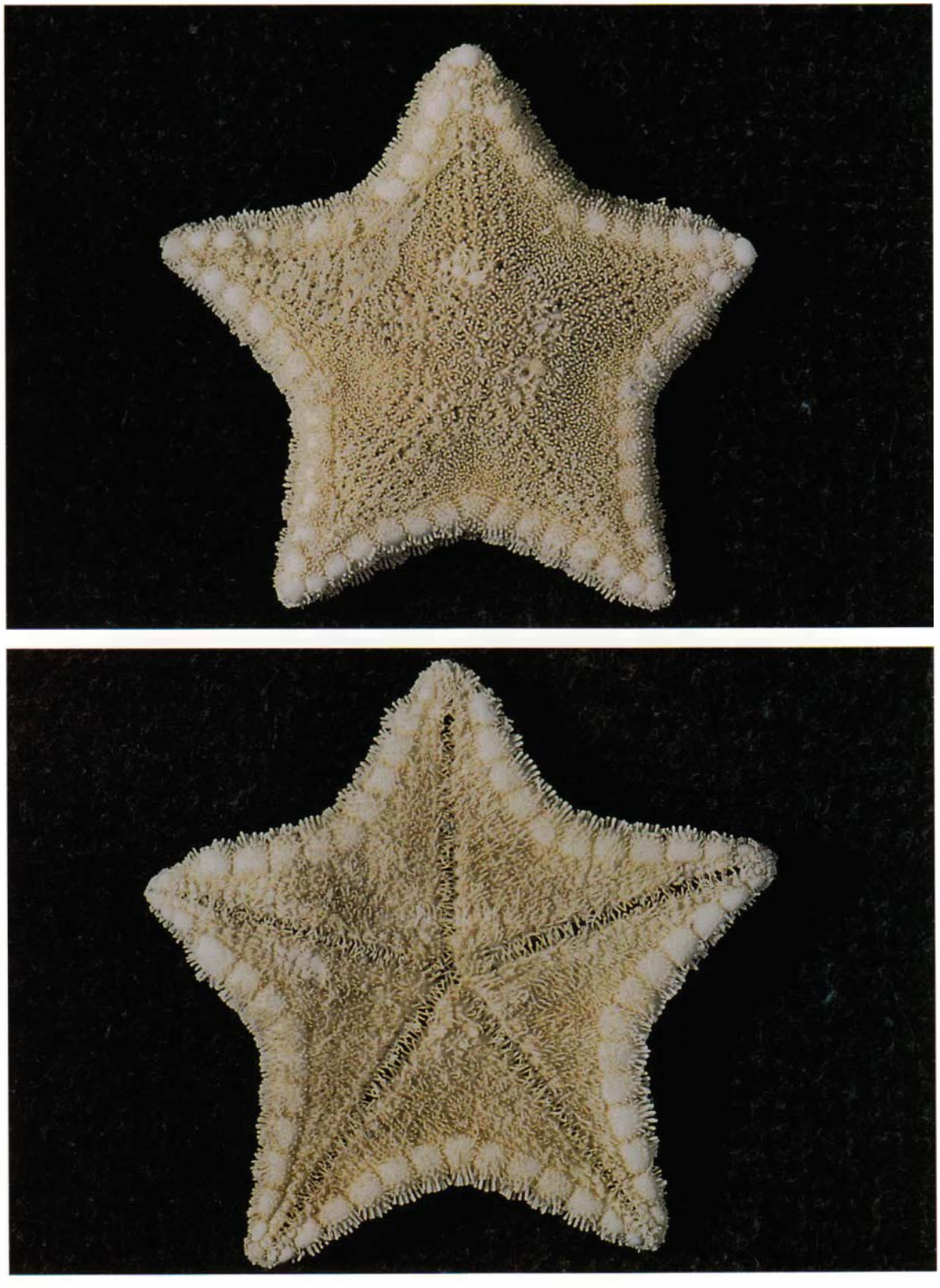

Plate 50. ***Hoplaster kupe*** McKnight. NZOI Stn U226. R/r = 19/11 mm. Abactinal and actinal surfaces.

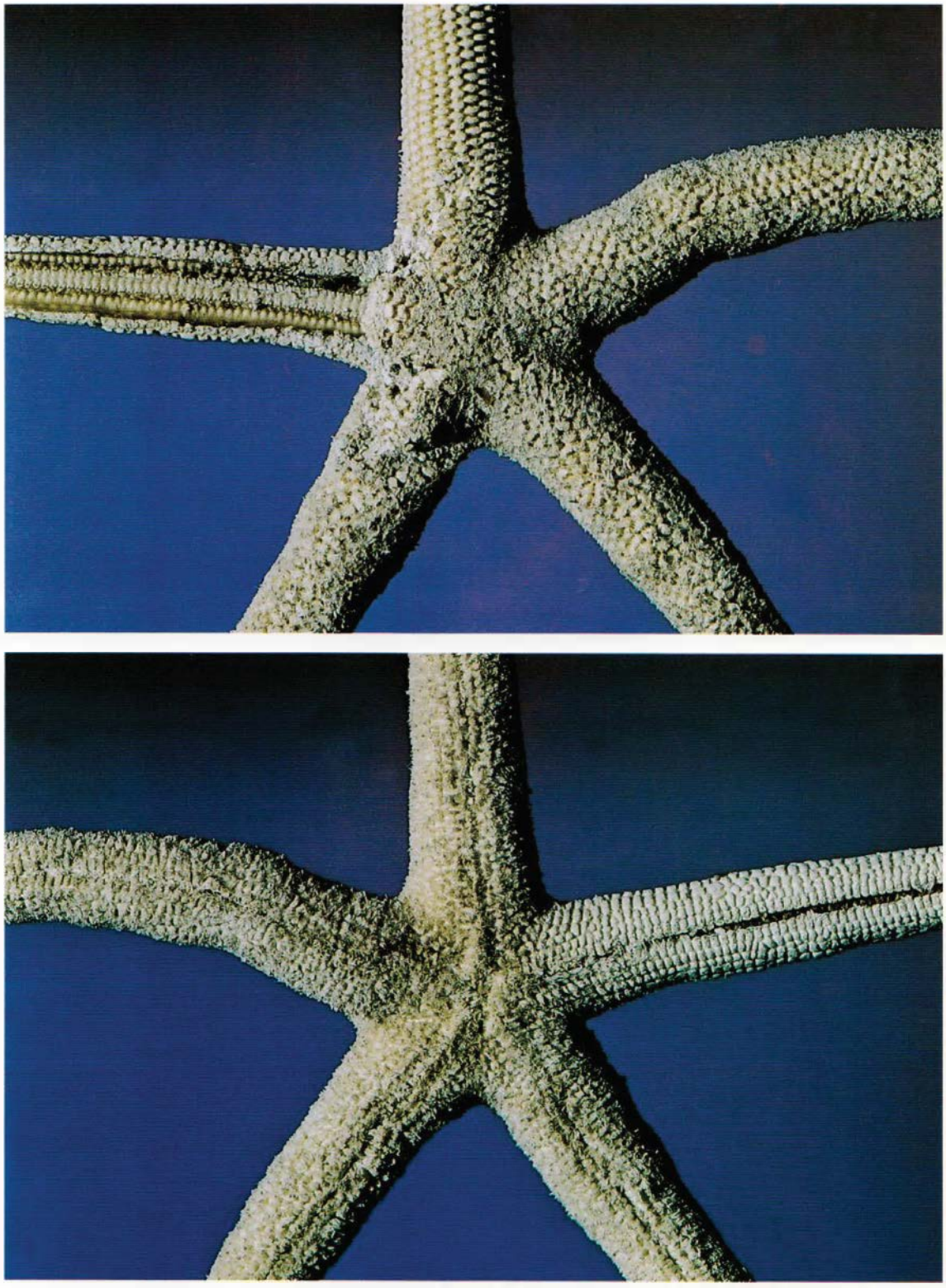

Plate 51. ***Chaetaster moorei*** Bell. NZOI Stn Q64. R/r = 82/10.5, br. 10 mm. Abactinal and actinal surfaces.

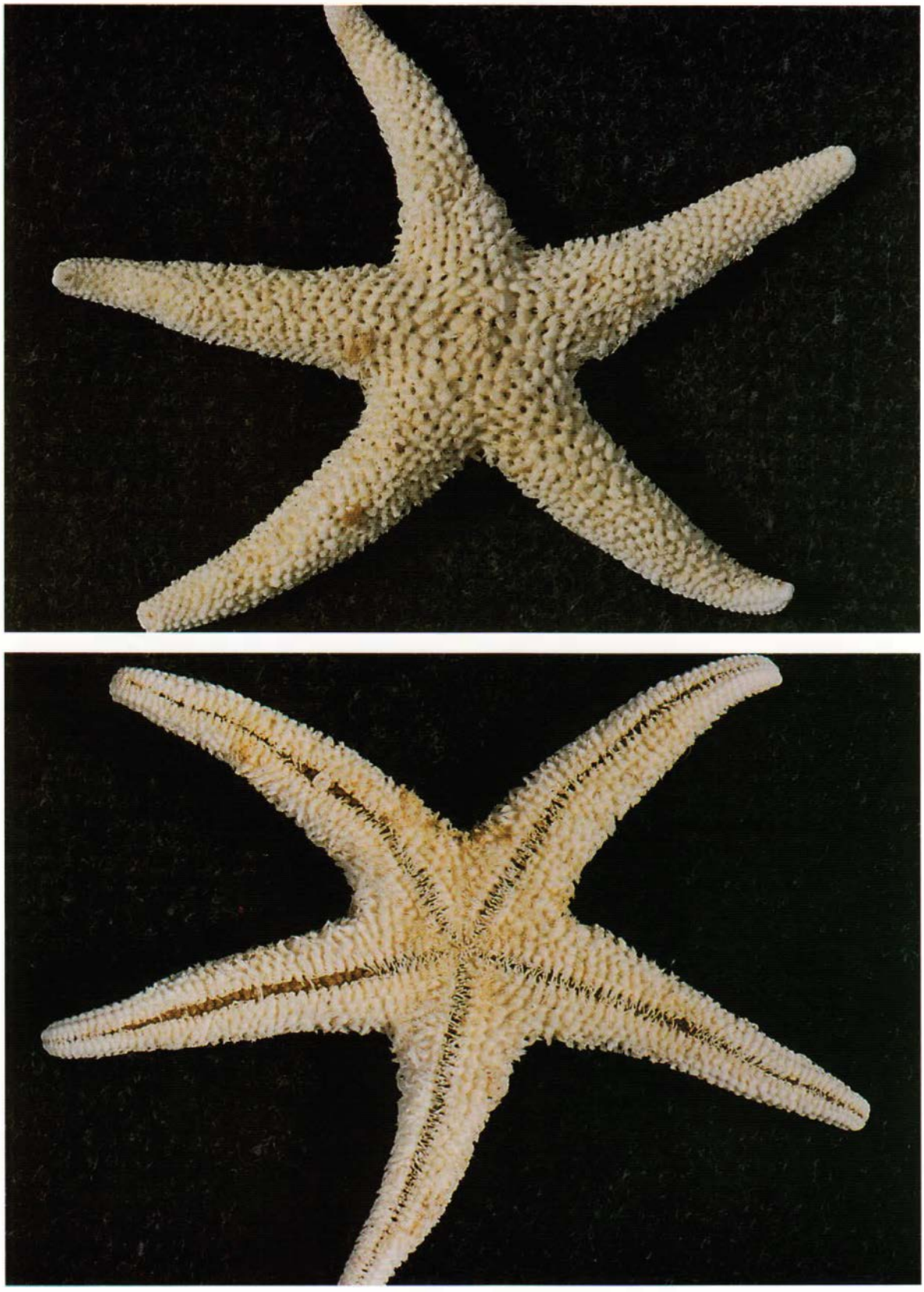

Plate 53. ***Hyalinothrix millespina*** Fisher. NZOI Stn K795. R/r = 21/6 mm. Abactinal and actinal surfaces.

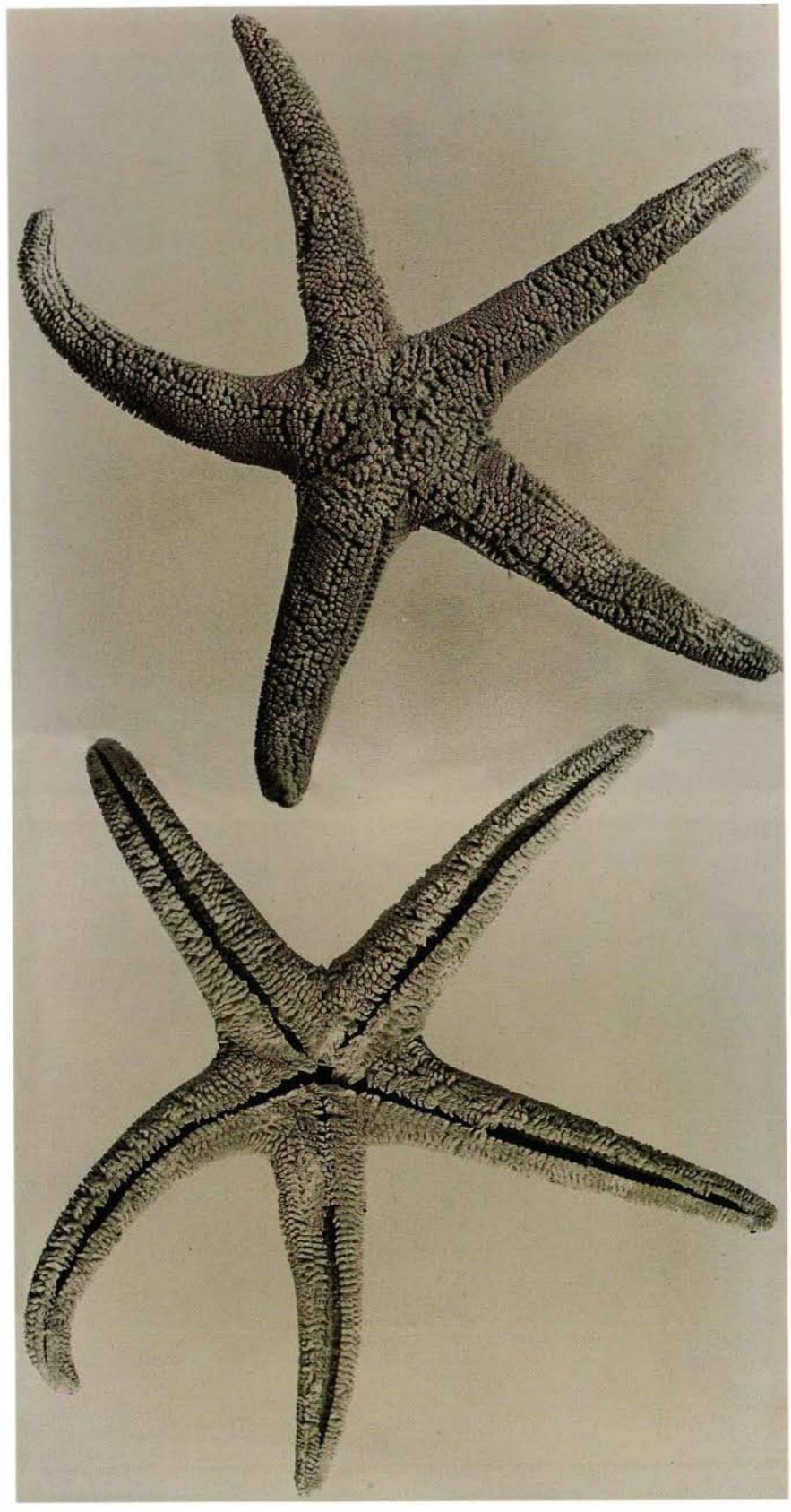

Plate 54. ***Tarachaster australis*** McKnight. Holotype. NZOI E849. R/r = 30/5.5 mm. Abactinal and actinal surfaces.

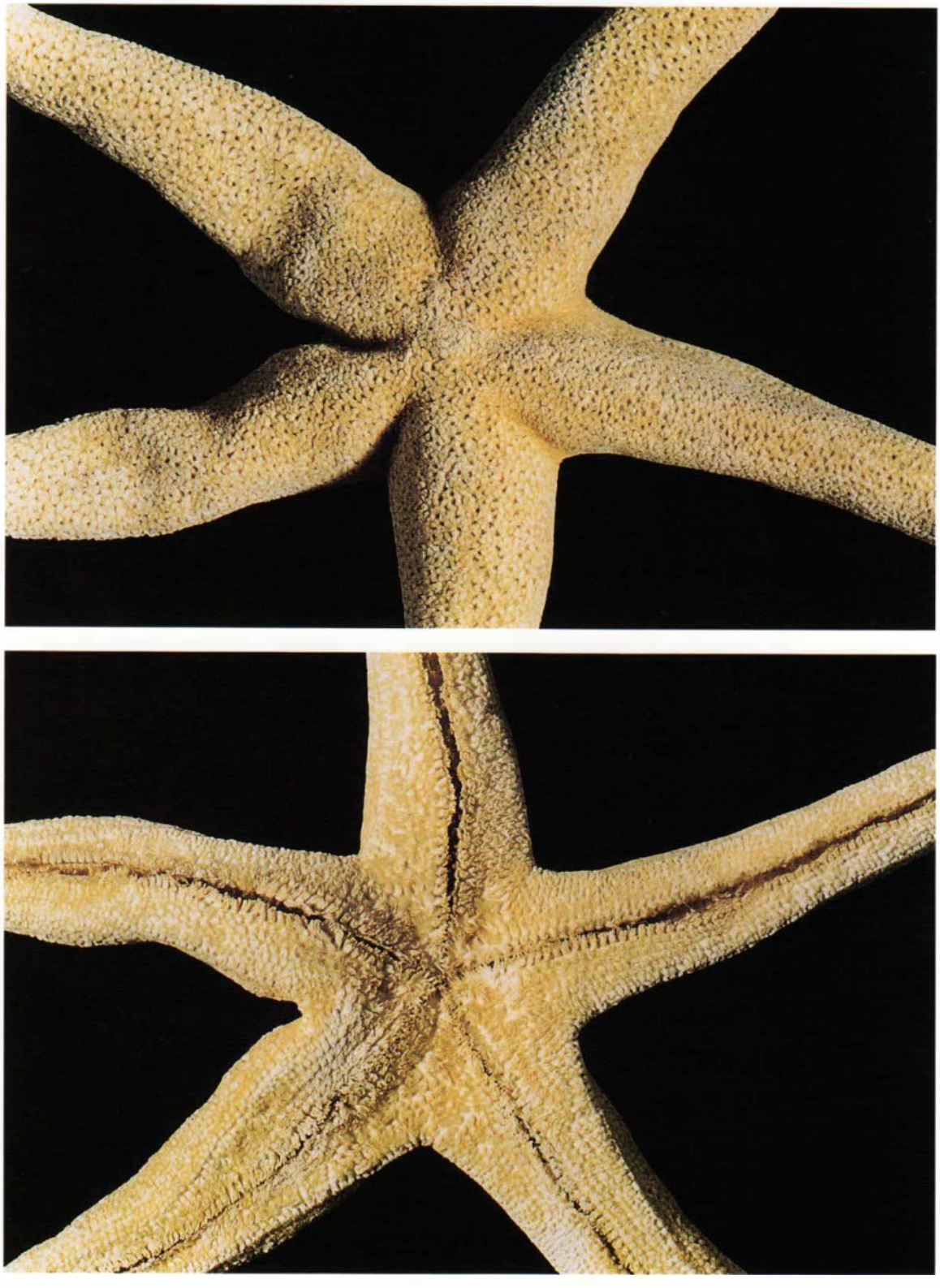

Plate 55. ***Knightaster bakeri*** H.E.S. Clark. Holotype. NMNZ Ech. 1151. R/r = 72/14 mm. Abactinal and actinal surfaces.

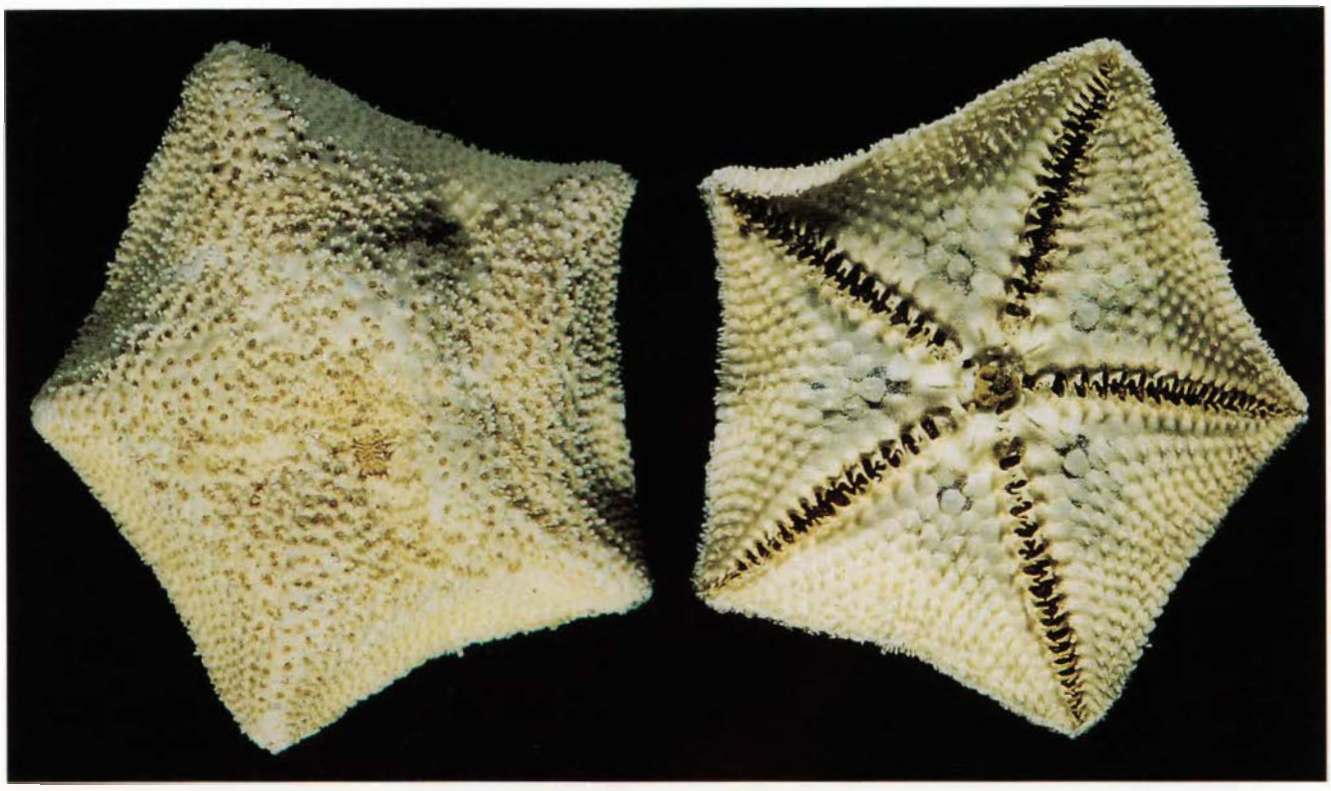

Plate 56. ***Patiriella exigua*** (Lamarck). NZOI Stn P25, R = 11 mm, r = 8 mm. Abactinal and actinal surfaces.

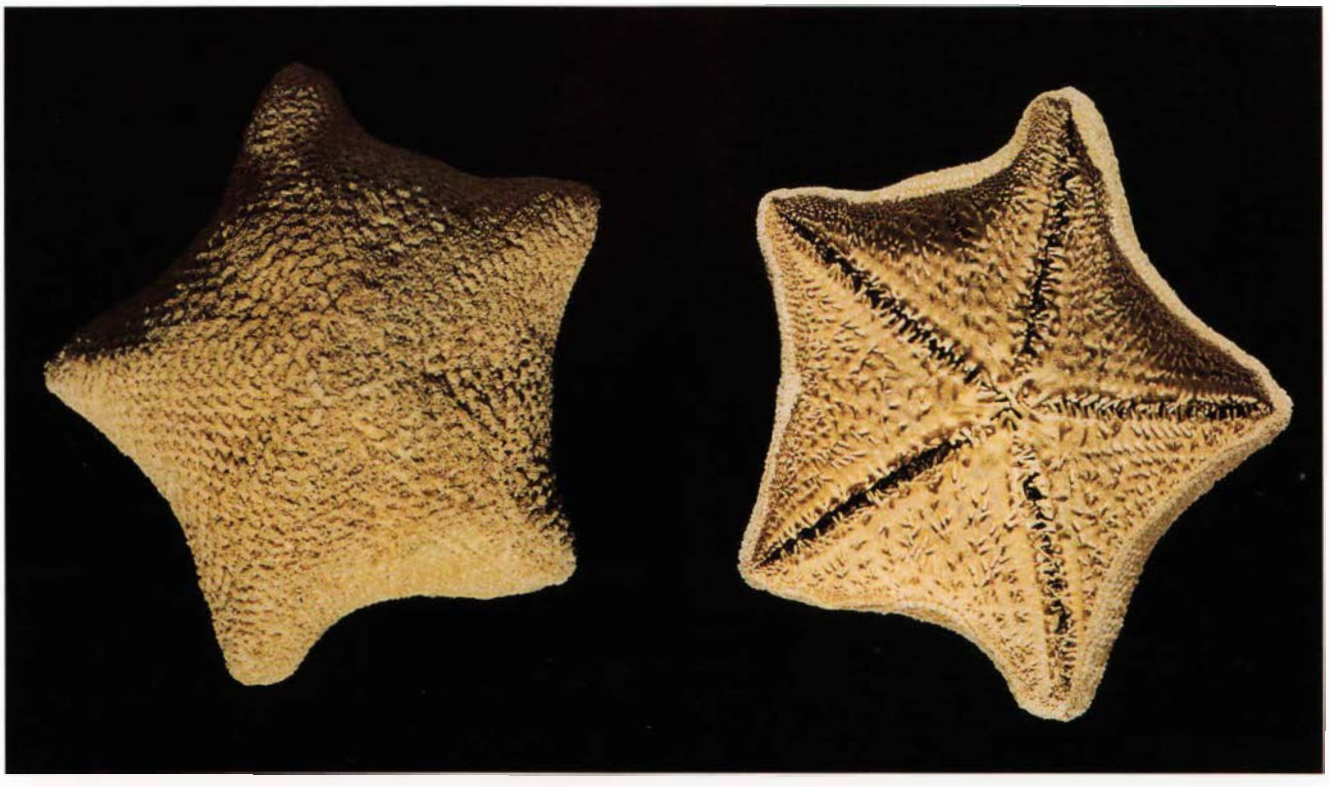

Plate 57. ***Patiriella oliveri*** Benham. NZOI Stn K864. R/r = 35/20 mm. Abactinal and actinal surfaces.

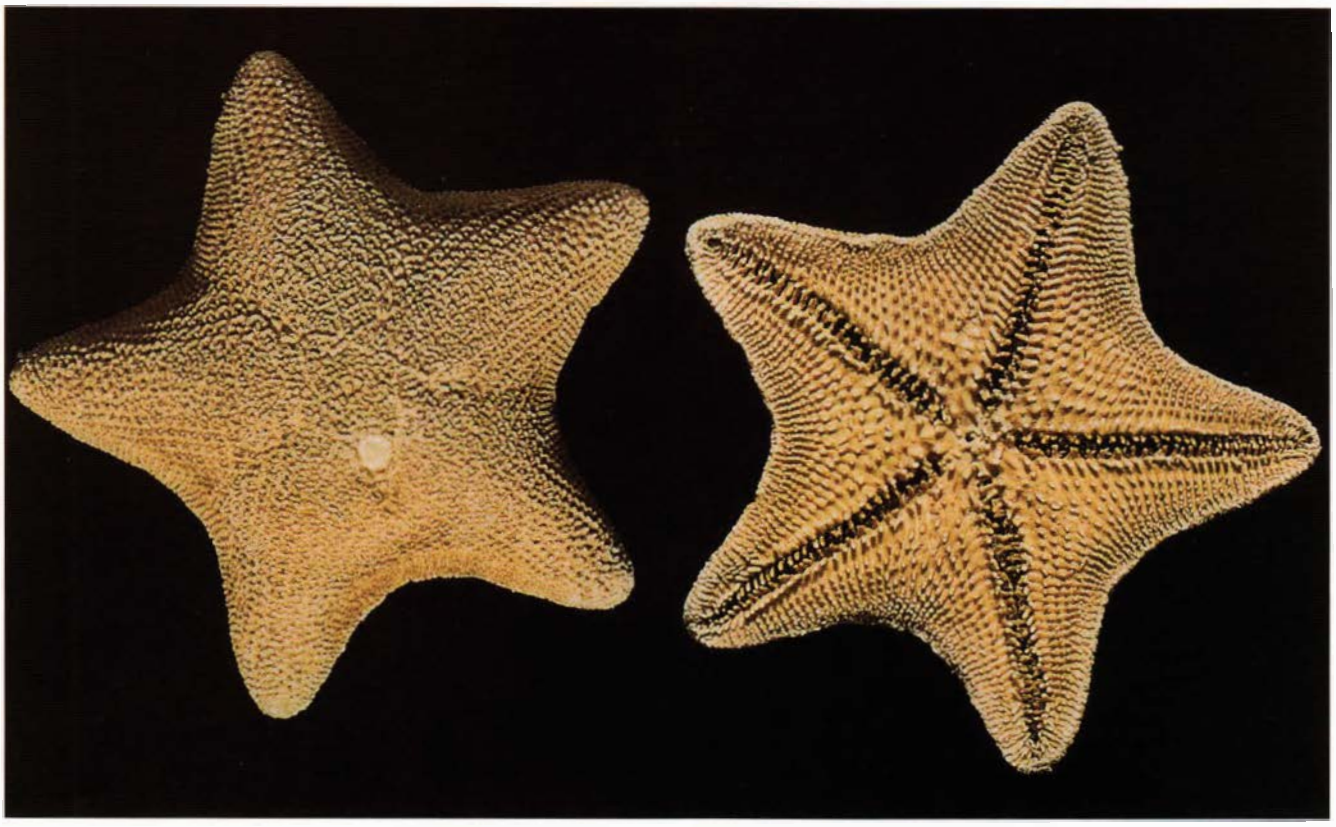

Plate 58. ***Patiriella regularis*** Verrill. NZOI Stn E809. R/r = 24/16 mm. Abactinal and actinal surfaces.

Plate 59. ***Nepanthia belcheri*** (Perrier). NZOI Stn Q82. R/r = 14/6 mm, br = 4 mm. Abactinal and actinal surfaces.

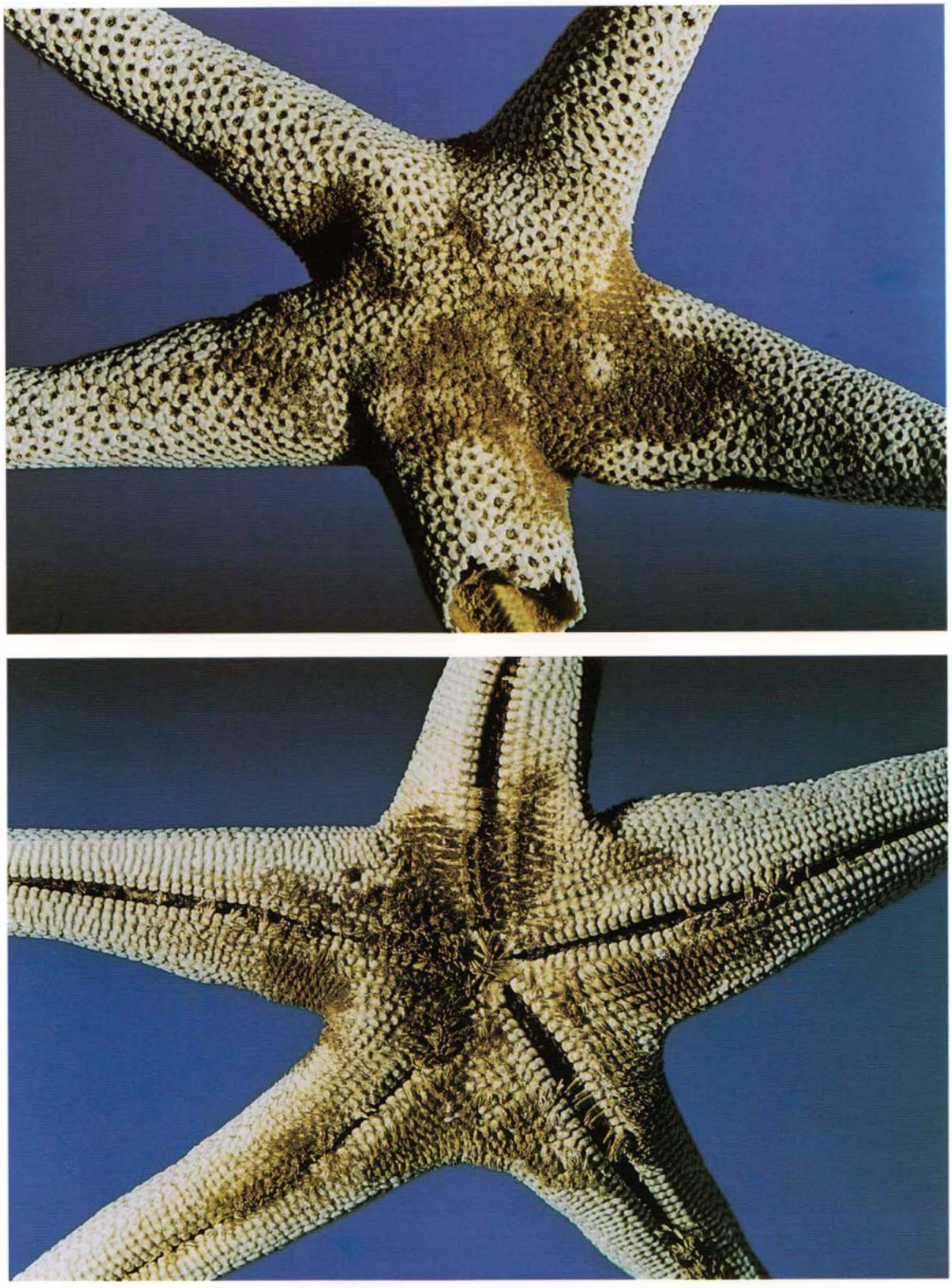

Plate 60. ***Nepanthia reinga*** n.sp. Holotype. NZOI Stn E293. R/r = 77/16 mm, br = 16 mm. Abactinal and actinal surfaces.

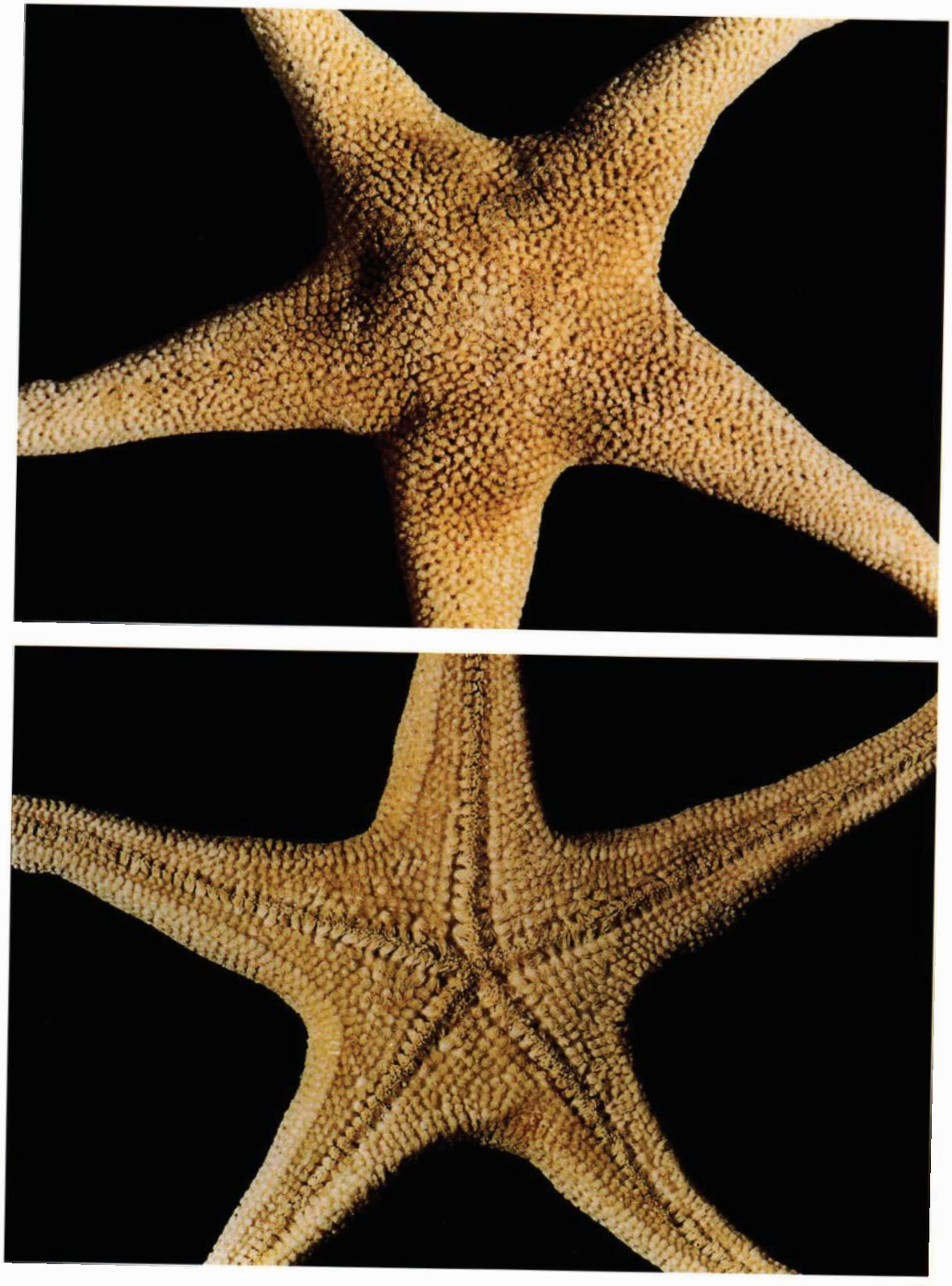

Plate 61. *Nepanthia grangei* n.sp. Holotype. NZOI Stn U594. R / r = 33/9 mm. Abactinal and actinal surfaces.

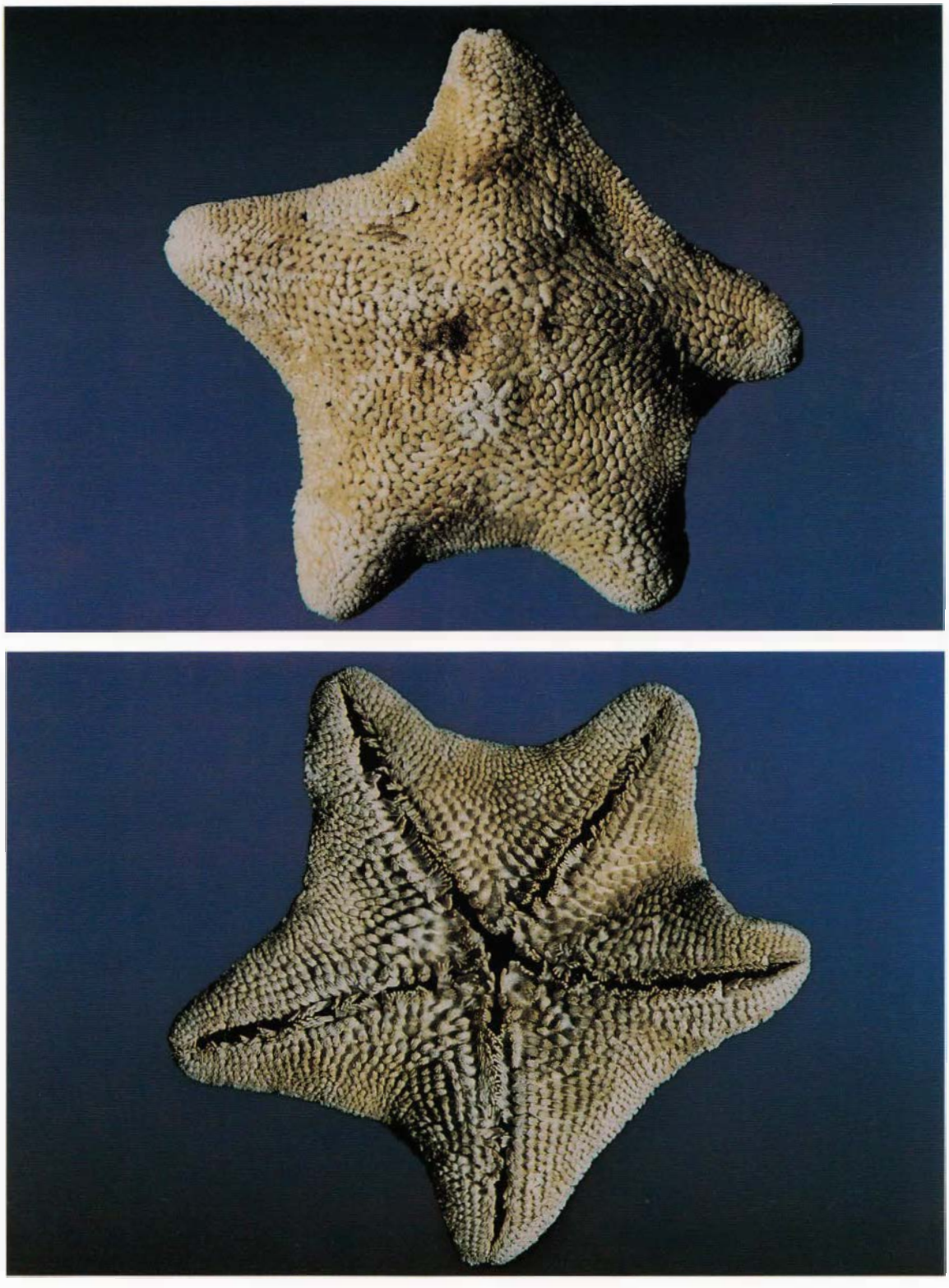

Plate 62. ***Paranepanthia aucklandensis*** (Koehler). NZOI Stn S55. R/r = 24/15 mm. Abactinal and actinal surfaces.

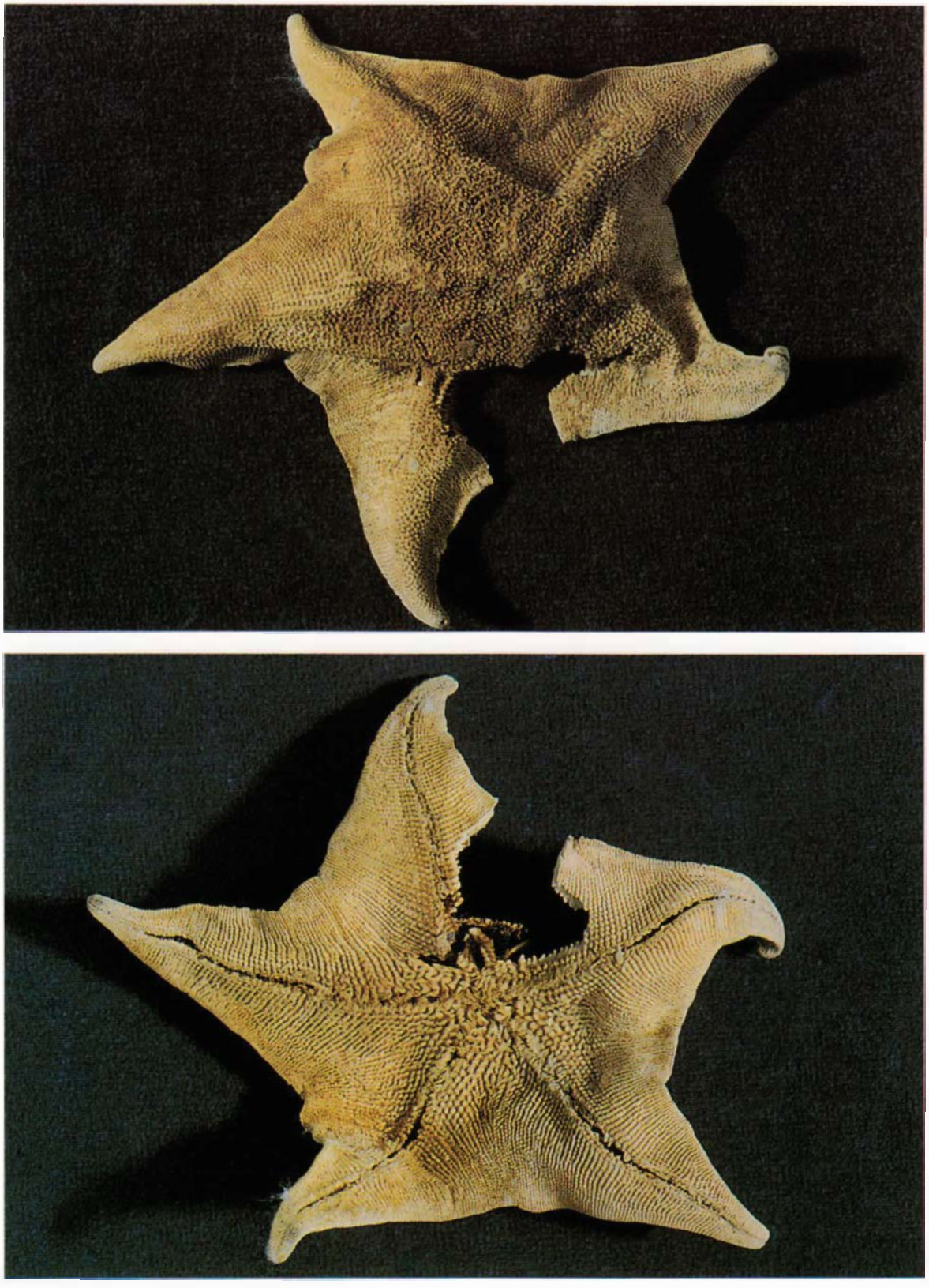

Plate 63. ***Anseropoda aotearoa*** McKnight. NZOI Stn Z2375. R/r = 75/39 mm. Abactinal and actinal surfaces.

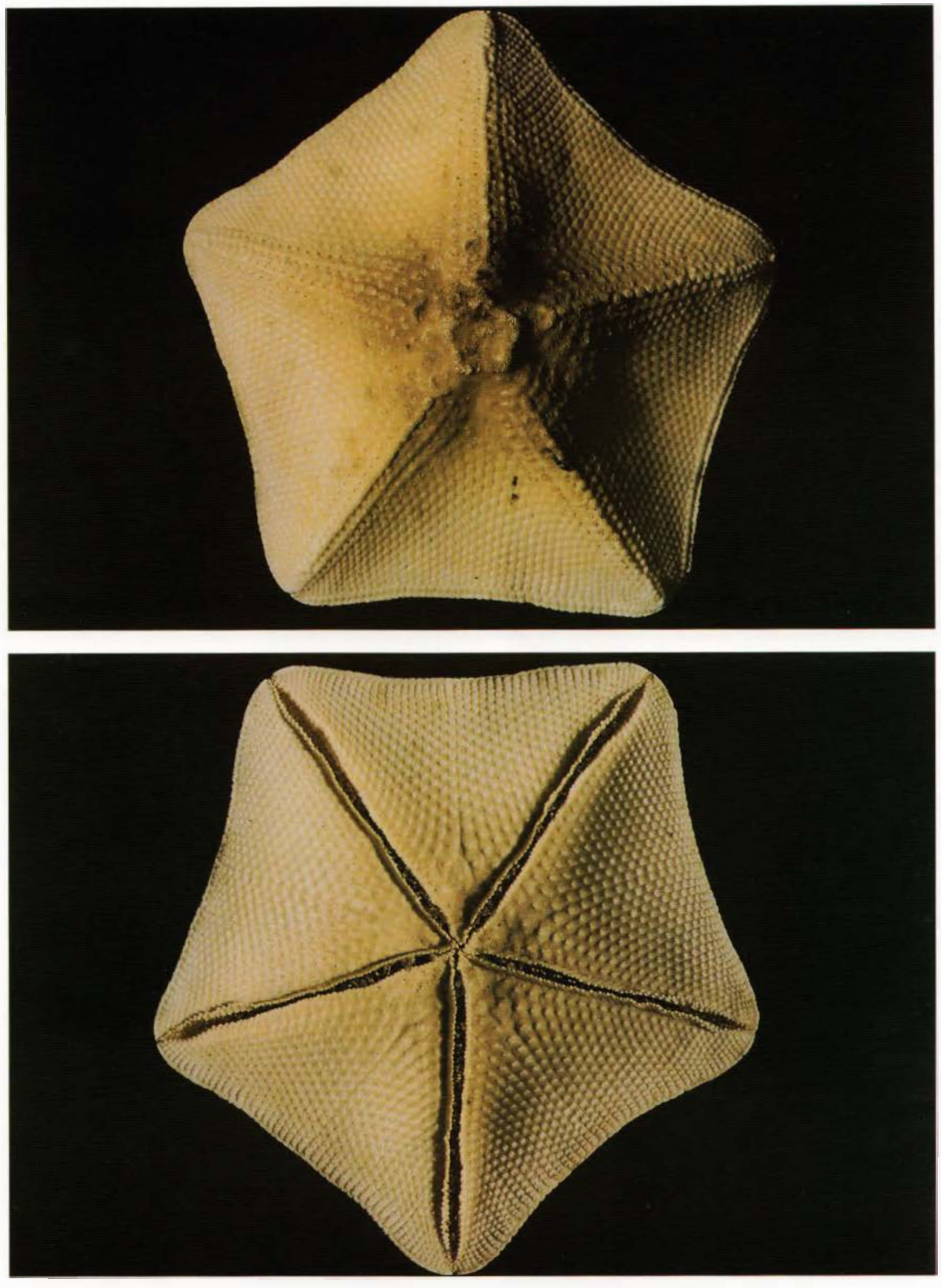

Plate 64. ***Stegnaster inflatus*** (Hutton). NZOI Stn C989 R/r = 36/28 mm. Abactinal and actinal surfaces.

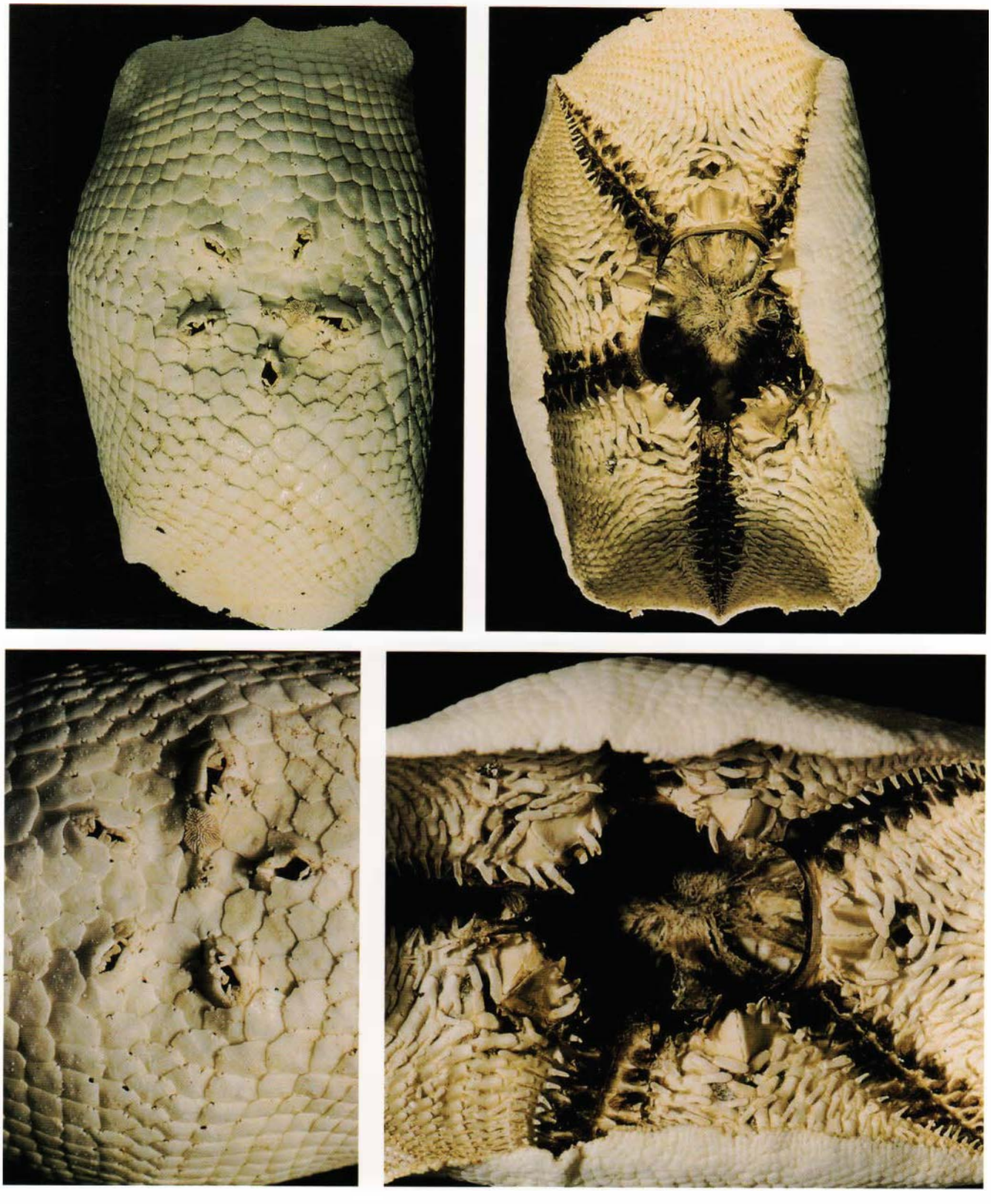

Plate 65. ***Tremaster mirabilis novaecaledoniae*** Jangoux. NZOI Stn Z9898. R / r = 25/25 mm. Abactinal and actinal surfaces.

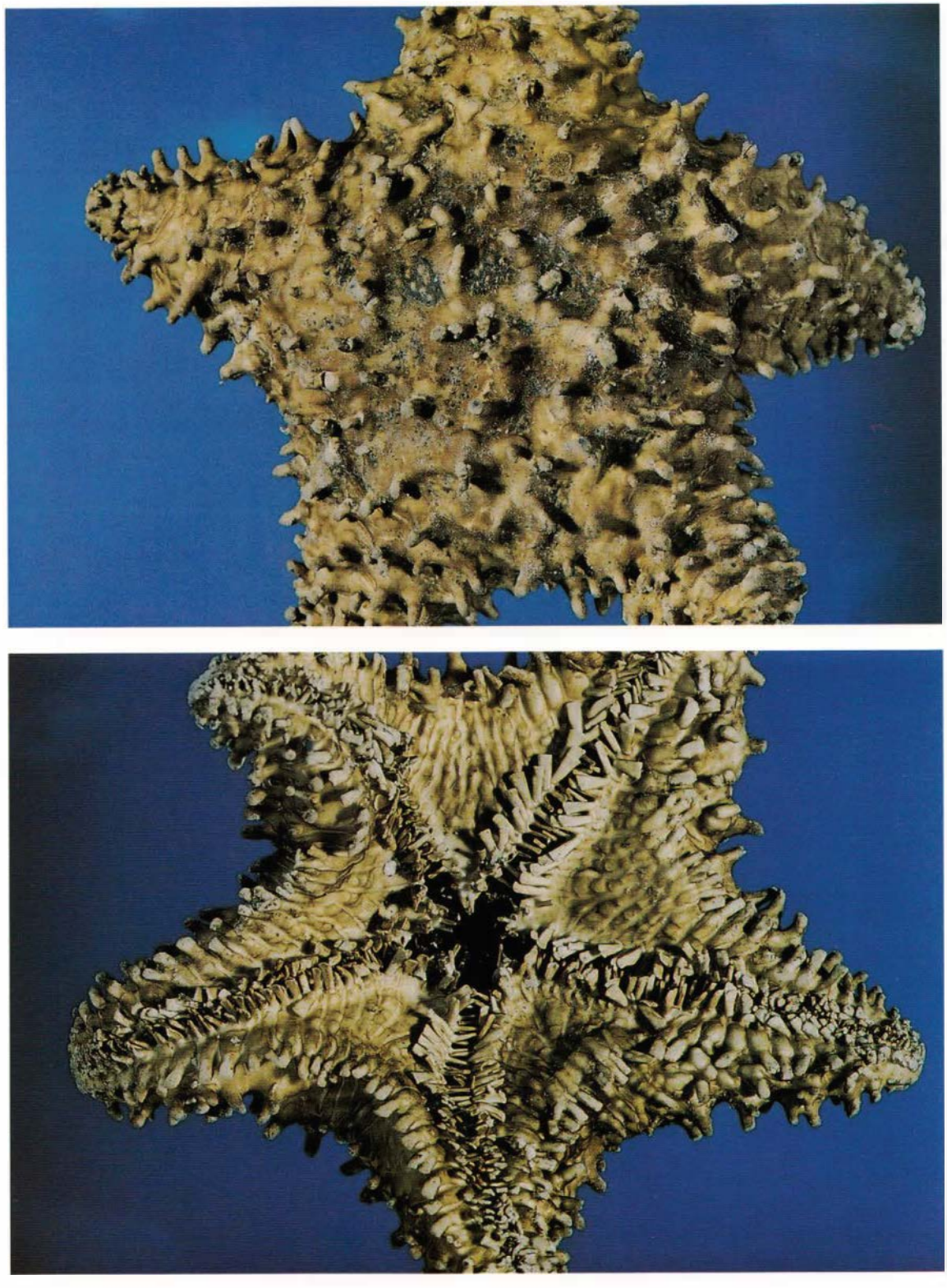

Plate 66. *Porania antarctica* Smith. NZOI Stn C733. R/ r = 49/24 mm. Abactinal and actinal surfaces.

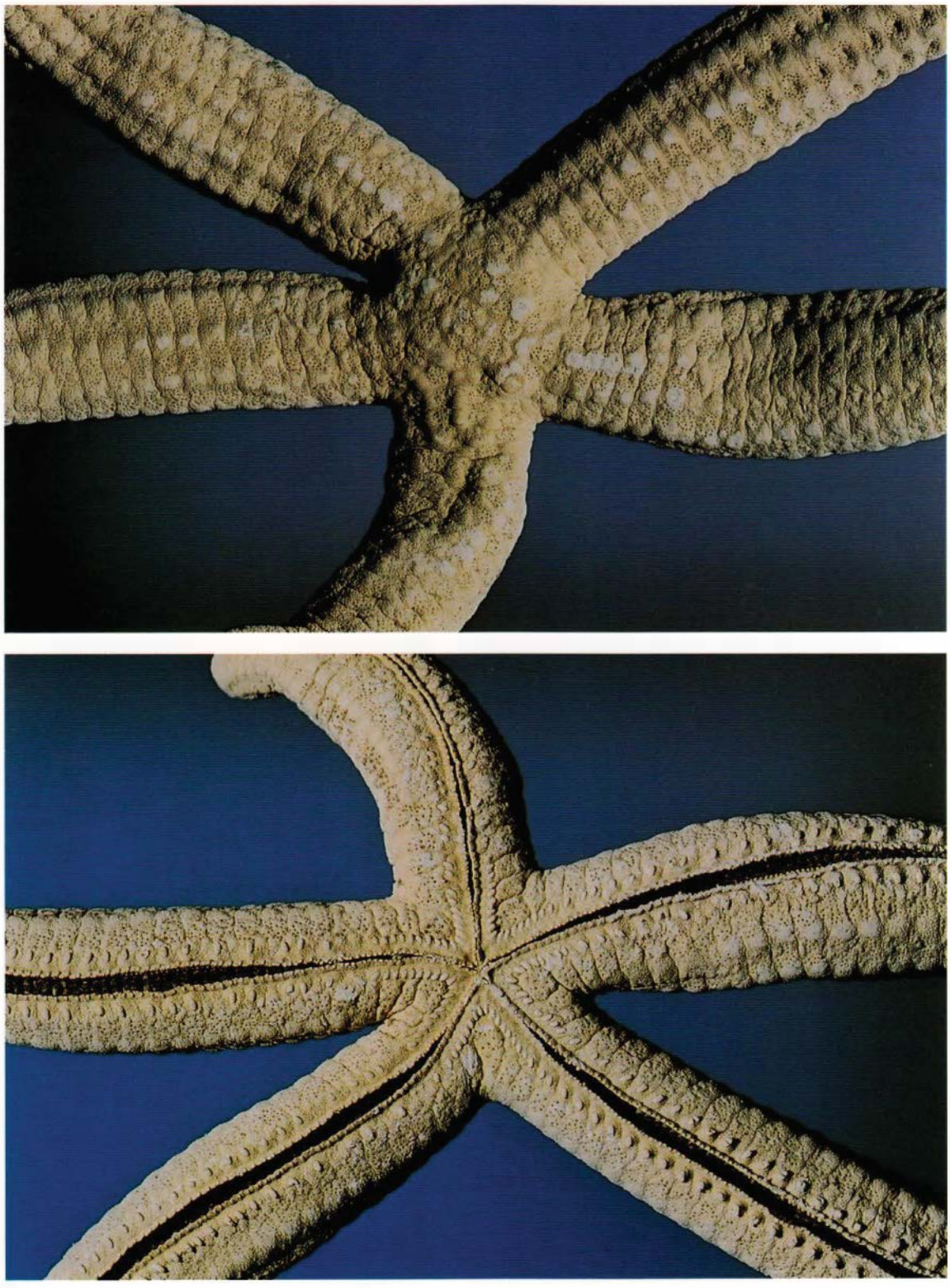

Plate 67. ***Ophidiaster confertus*** H.L. Clark. NZOI Stn I723, R/r = 84/10 mm, br. = 10 mm. Abactinal and actinal surfaces.

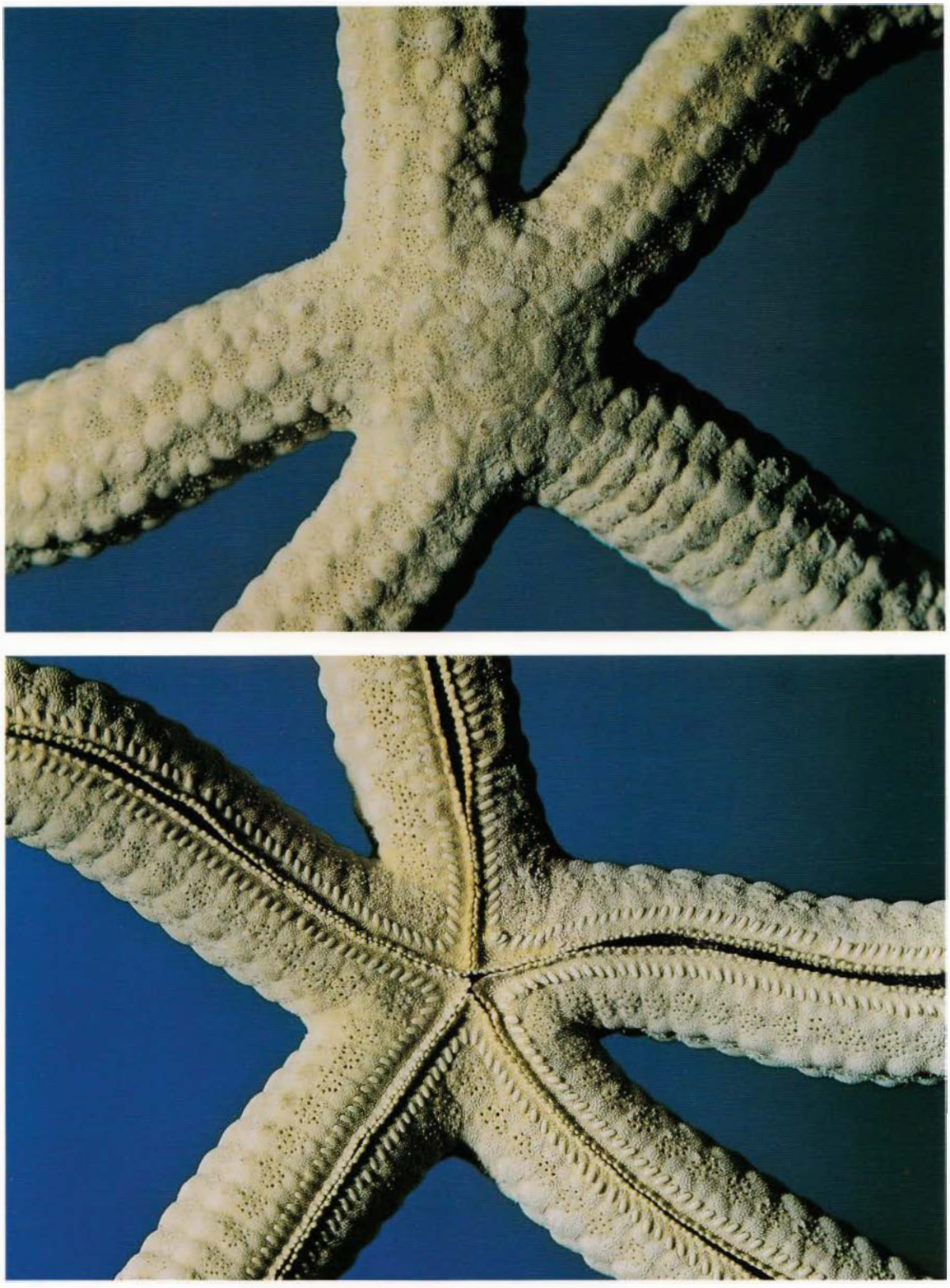

Plate 68. ***Ophidiaster kermadecensis*** Benham. NZOI Stn K848. R/r = 67/7 mm, br = 10 mm. Abactinal and actinal surfaces.

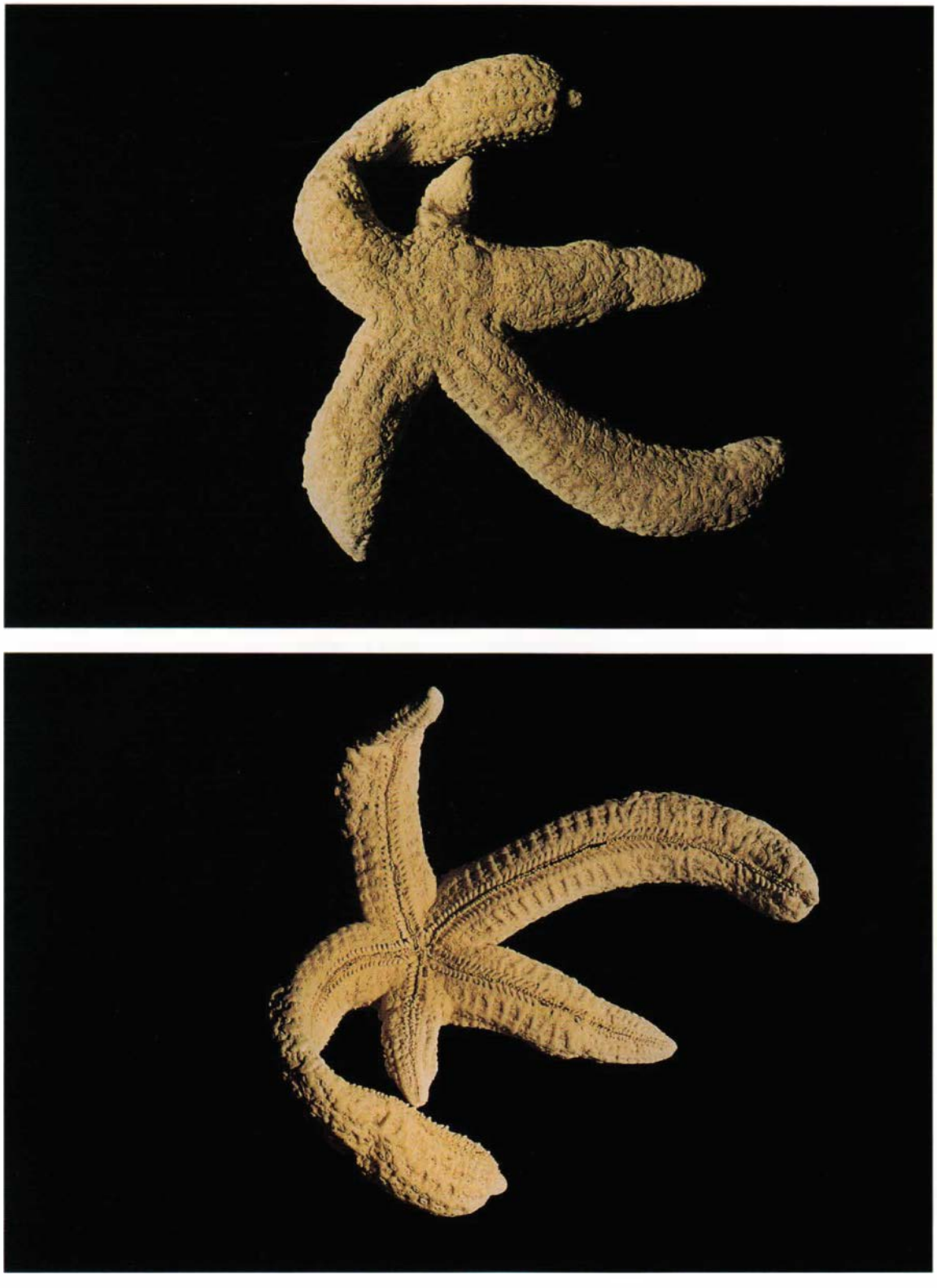

Plate 69. ***Ophidiaster macknighti*** H.E.S. Clark. NZOI Stn J974. R / r = 71 / 12 mm, br = 12 mm. Abactinal and actinal surfaces.

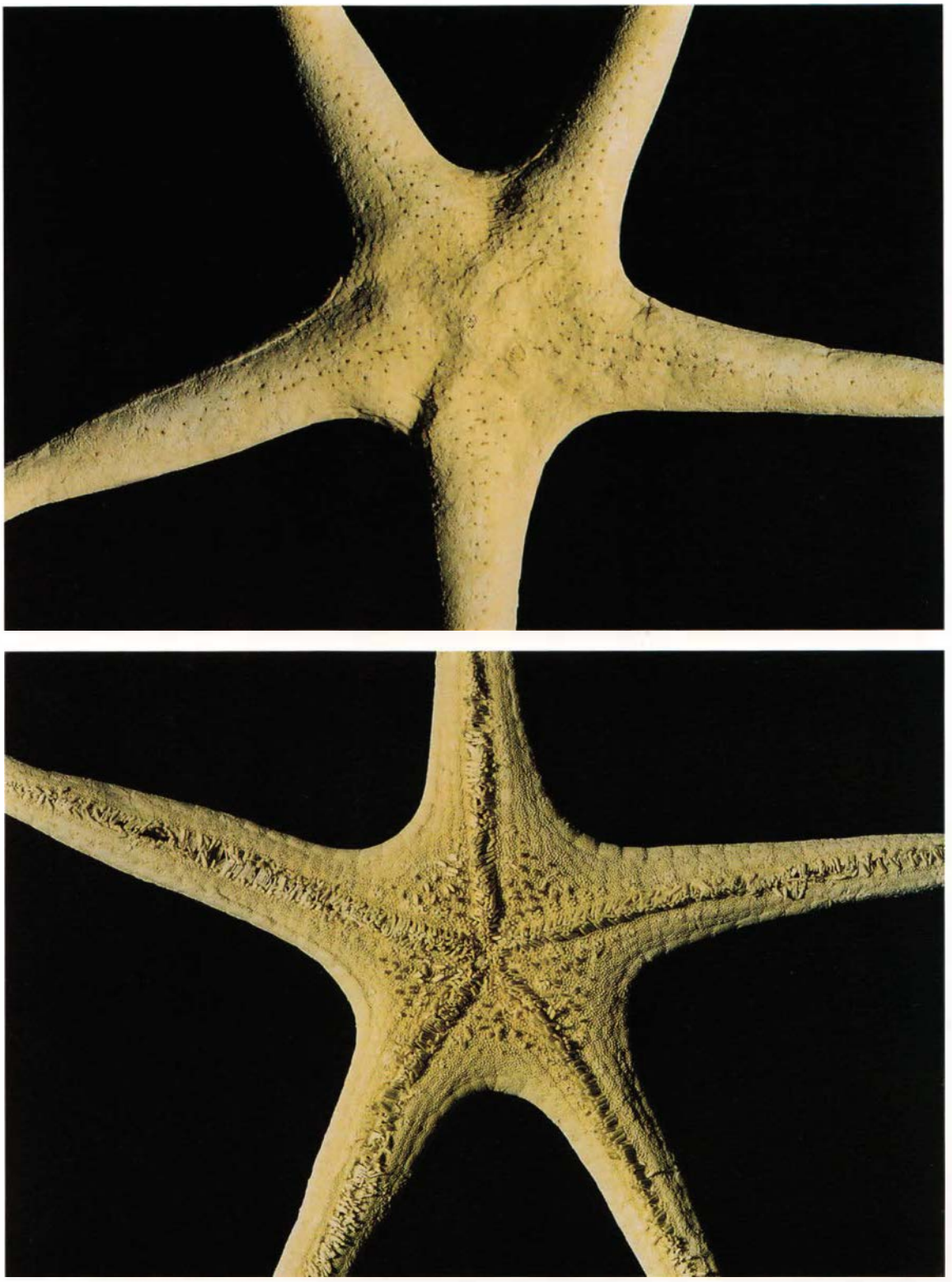

Plate 70. *Dissogenes petersi* Jangoux. NZOI Stn U594. R/r = 51/12 mm. Abactinal and actinal surfaces.

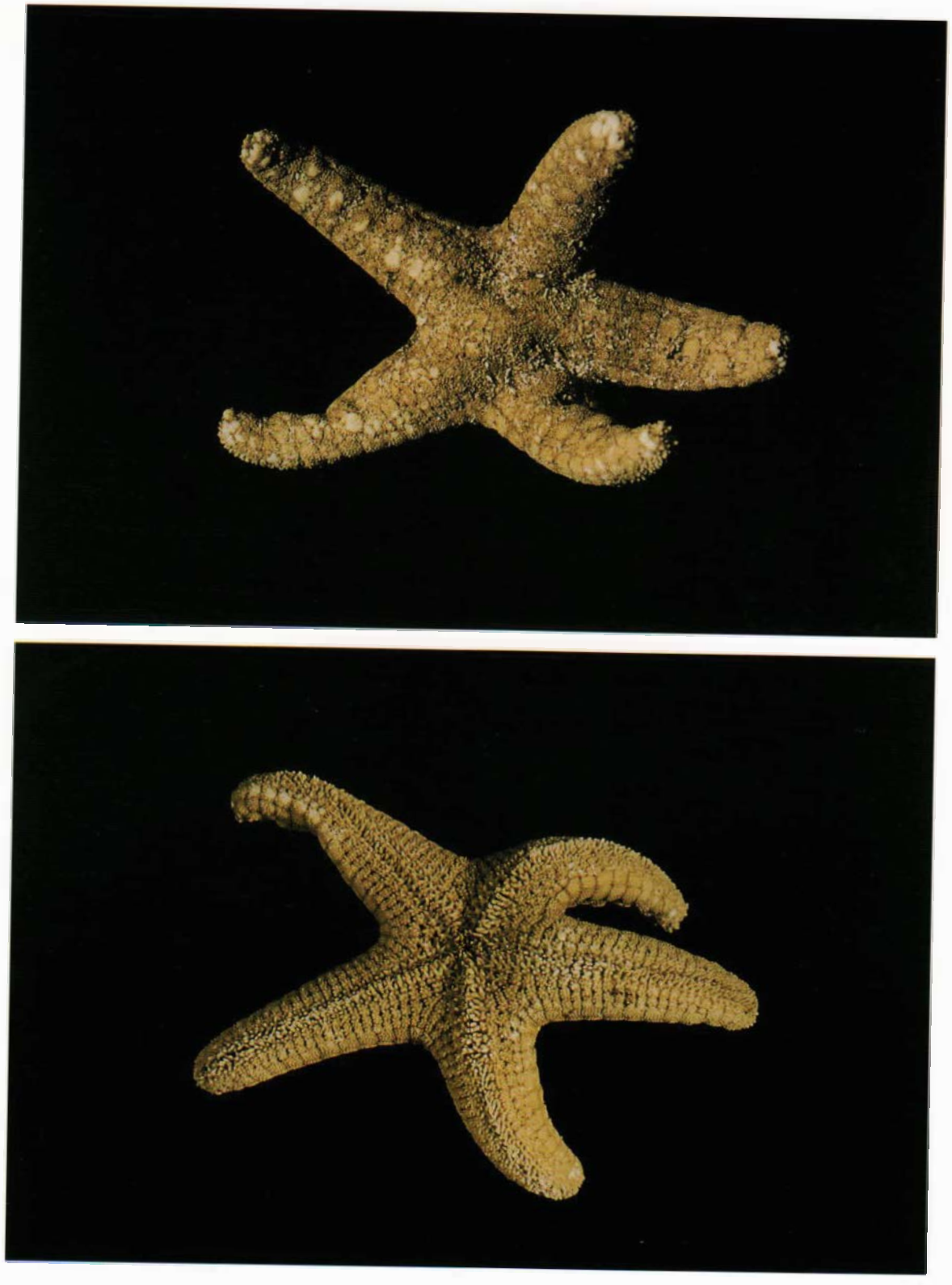

Plate 71. ***Fromia milleporella*** (Lamarck). NZOI Stn P23A. R/r = 41/8 mm, br = 9 mm. Abactinal and actinal surfaces.

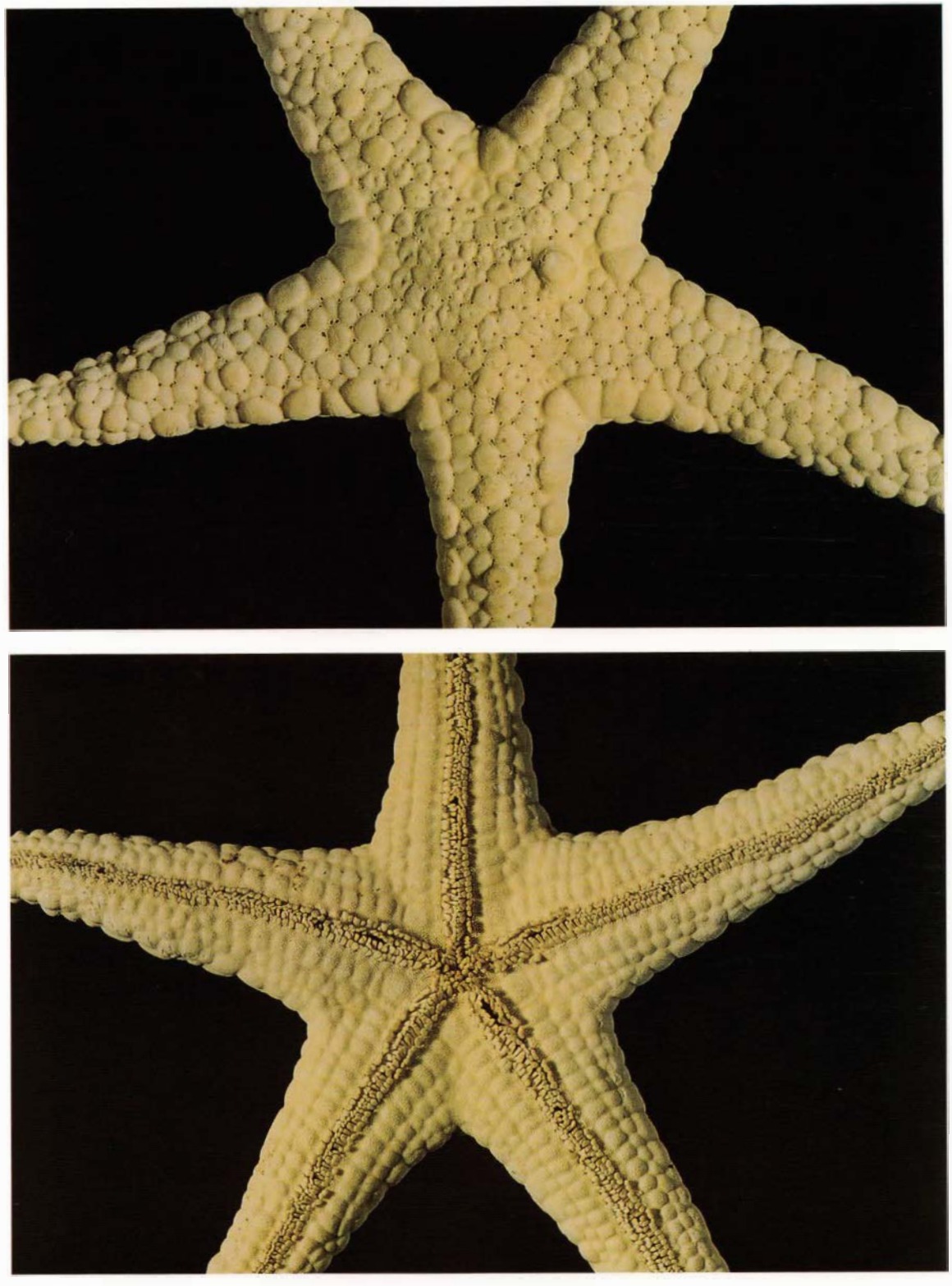

Plate 72. ***Fromia monilis*** Perrier. NZOI Stn I769. R/r = 47/13 mm, br. = 13 mm. Abactinal and actinal surfaces.

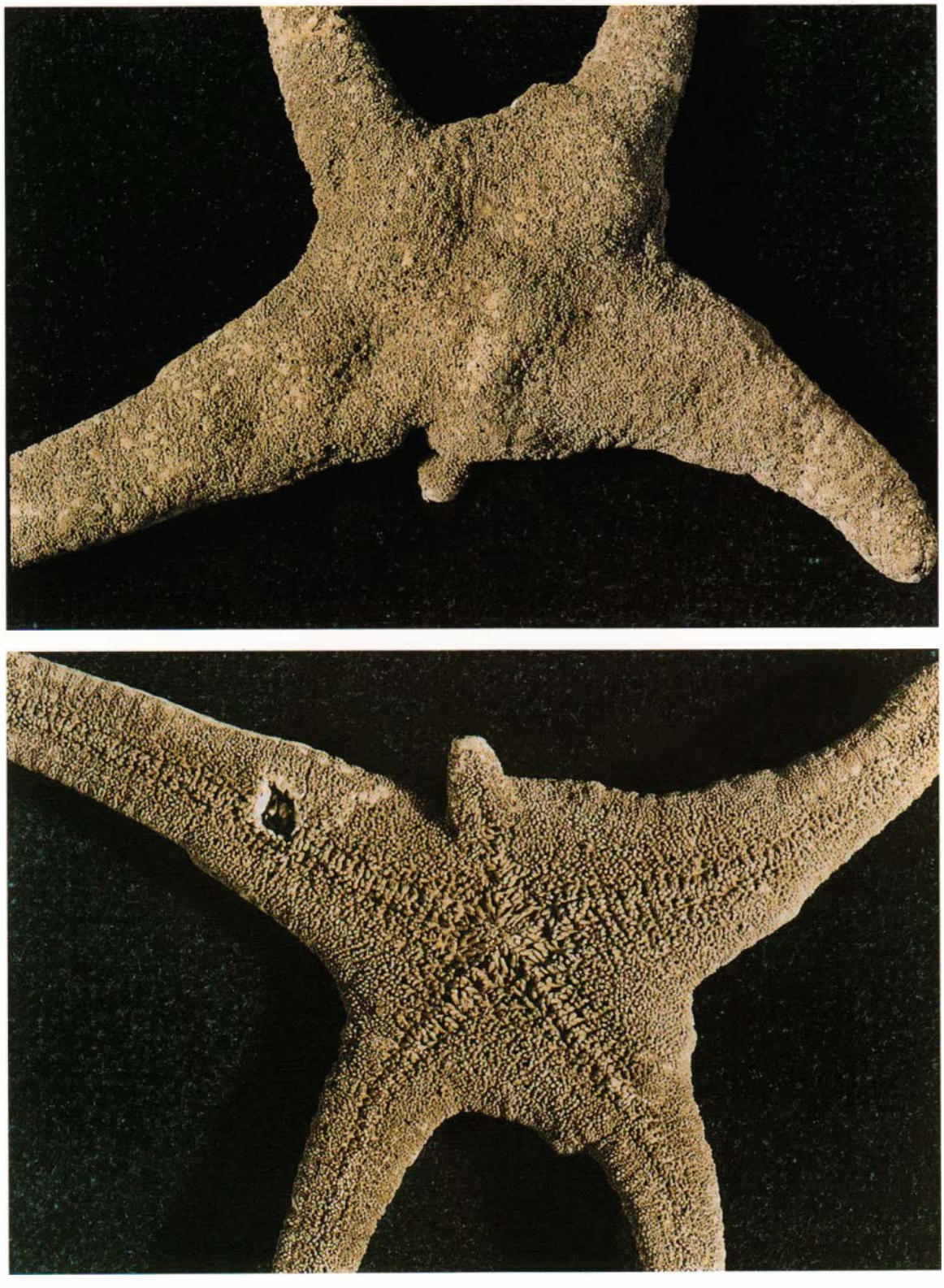

Plate 73. ***Fromia polypora*** (H.L. Clark). NZOI Stn P51. R/r = 62/15 mm, br. = 16 mm. Abactinal and actinal surfaces.

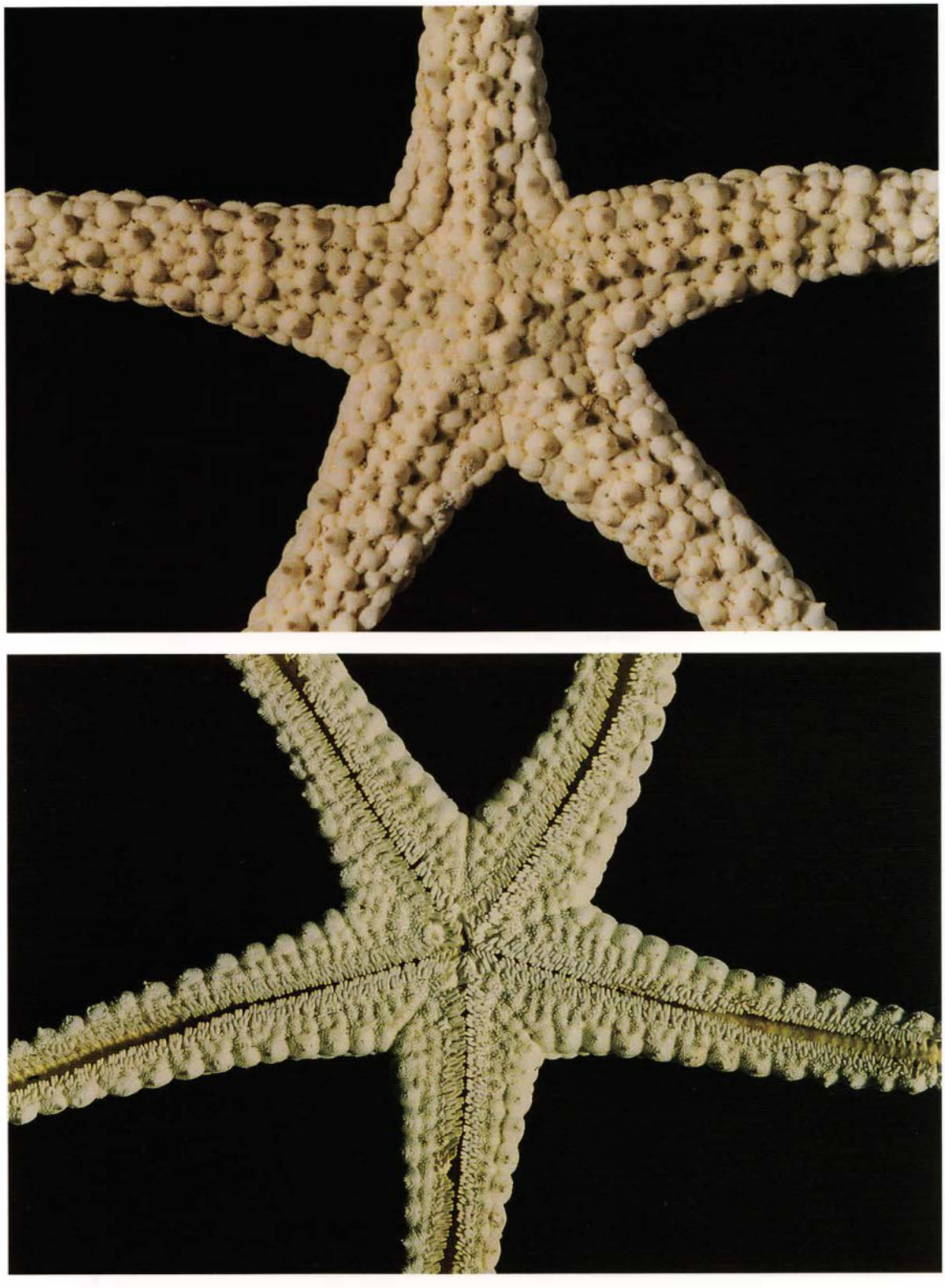

Plate 74. ***Gomophia watsoni*** (Livingstone). NZOI Stn Q58. R/r = 38/9 mm, br. = 9 mm. Abactinal and actinal surfaces.

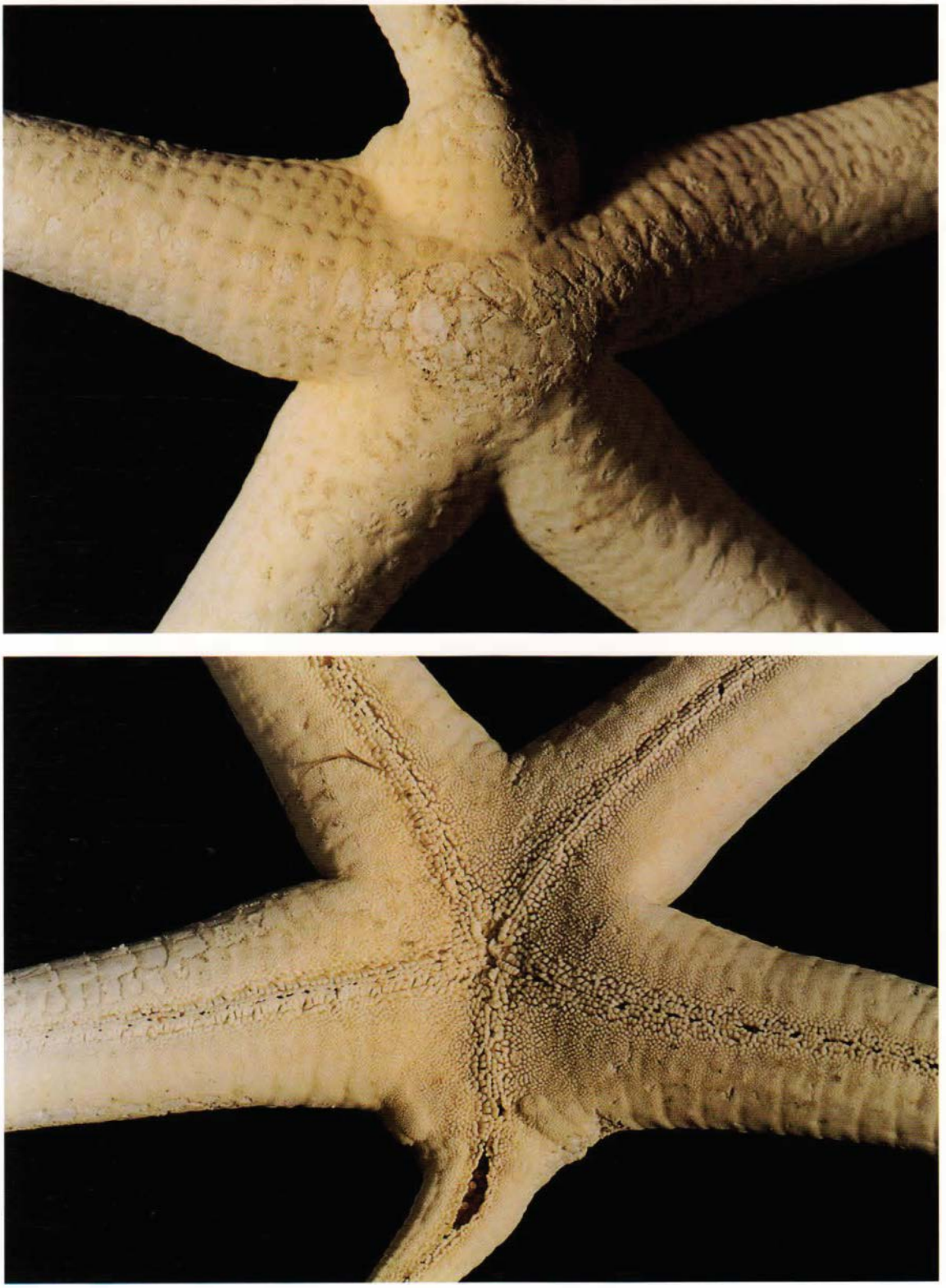

Plate 75. ***Heteronardoa carinata*** (Koehler). NZOI Stn K820. R/r = 78/15 mm, br = 14 mm. Abactinal and actinal surfaces.

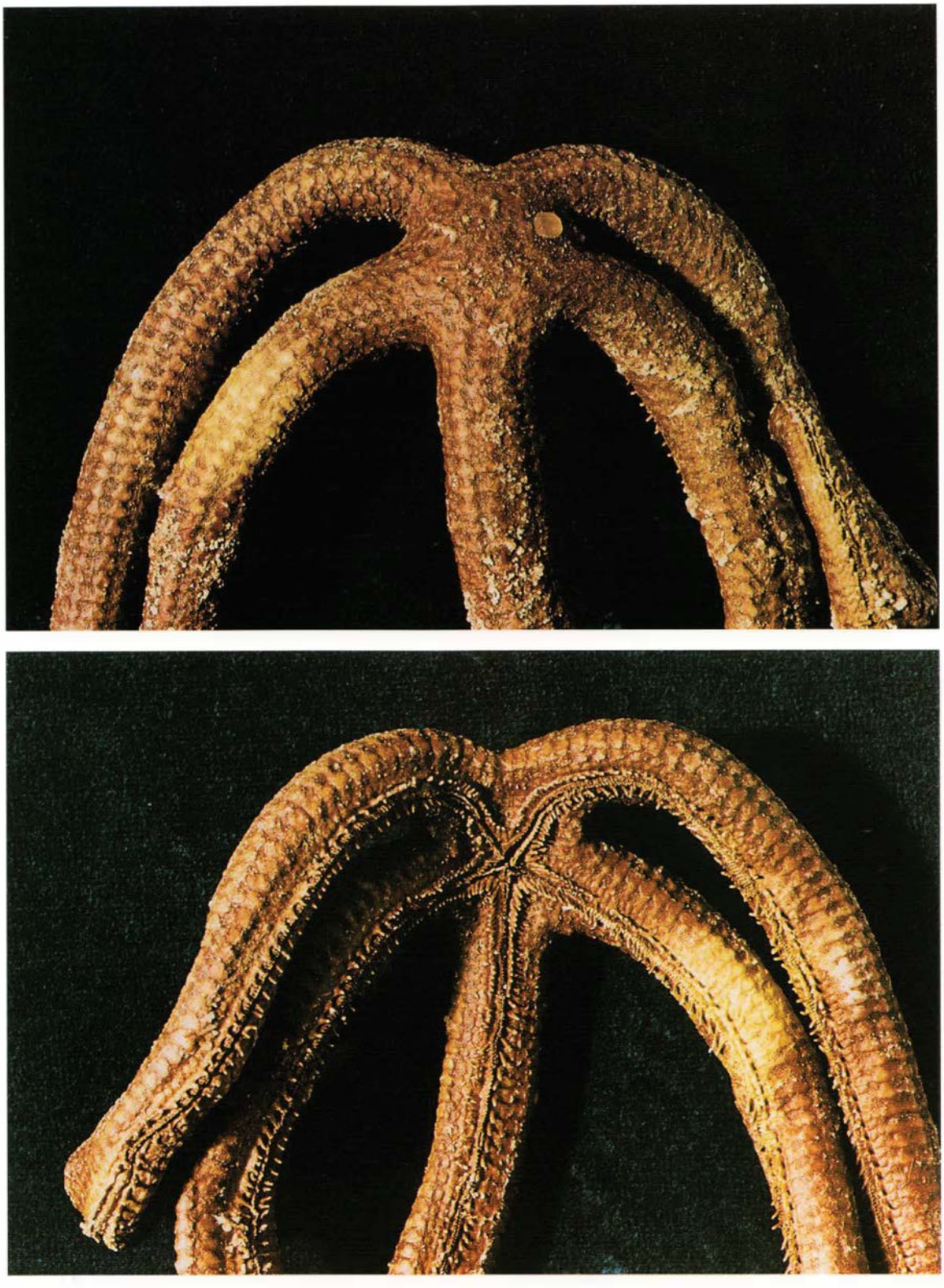

Plate 76. ***Leiaster leachii*** (Gray). NZOI Stn P43. R/r 167/12 mm, br. = 14 mm. Abactinal and actinal surfaces.

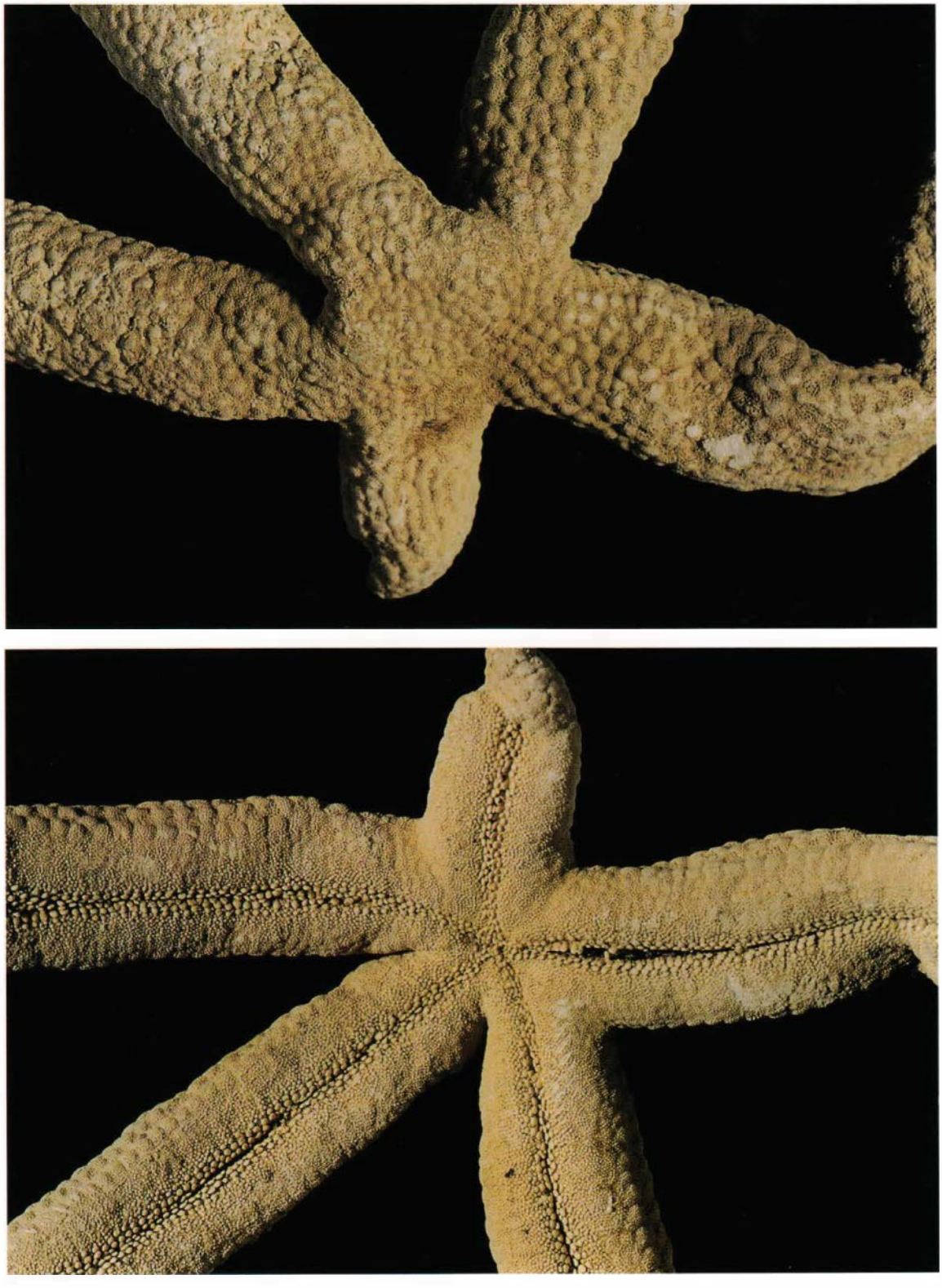

Plate 77. ***Linckia guildingi*** Gray. NZOI Stn P90. R/r = 107/9 mm, br = 8 mm. Abactinal and actinal surfaces.

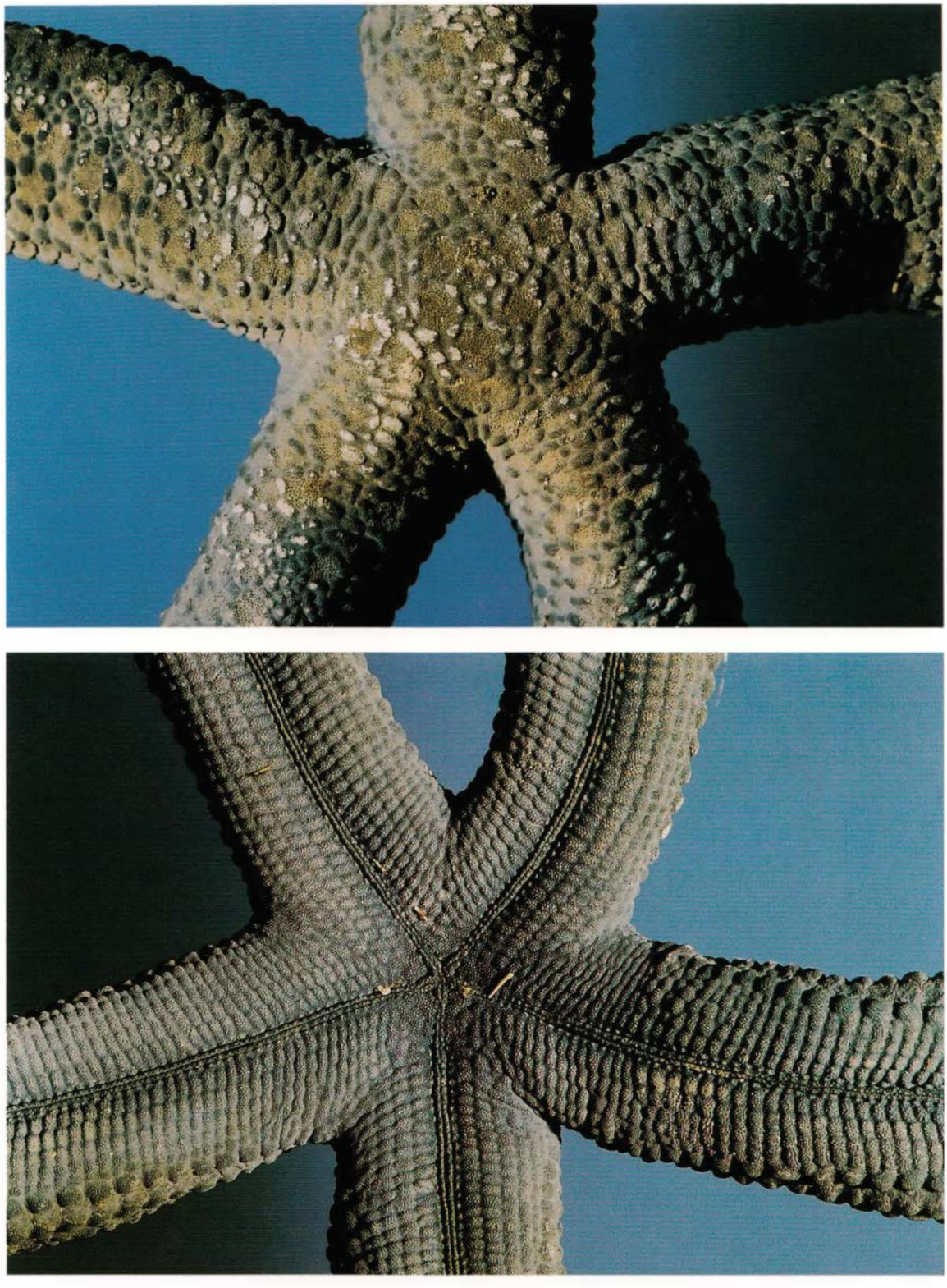

Plate 78. ***Linckia laevigata*** (Linnaeus). NZOI Stn I723. R/r =122/22 mm, br = 22 mm. Abactinal and actinal surfaces.

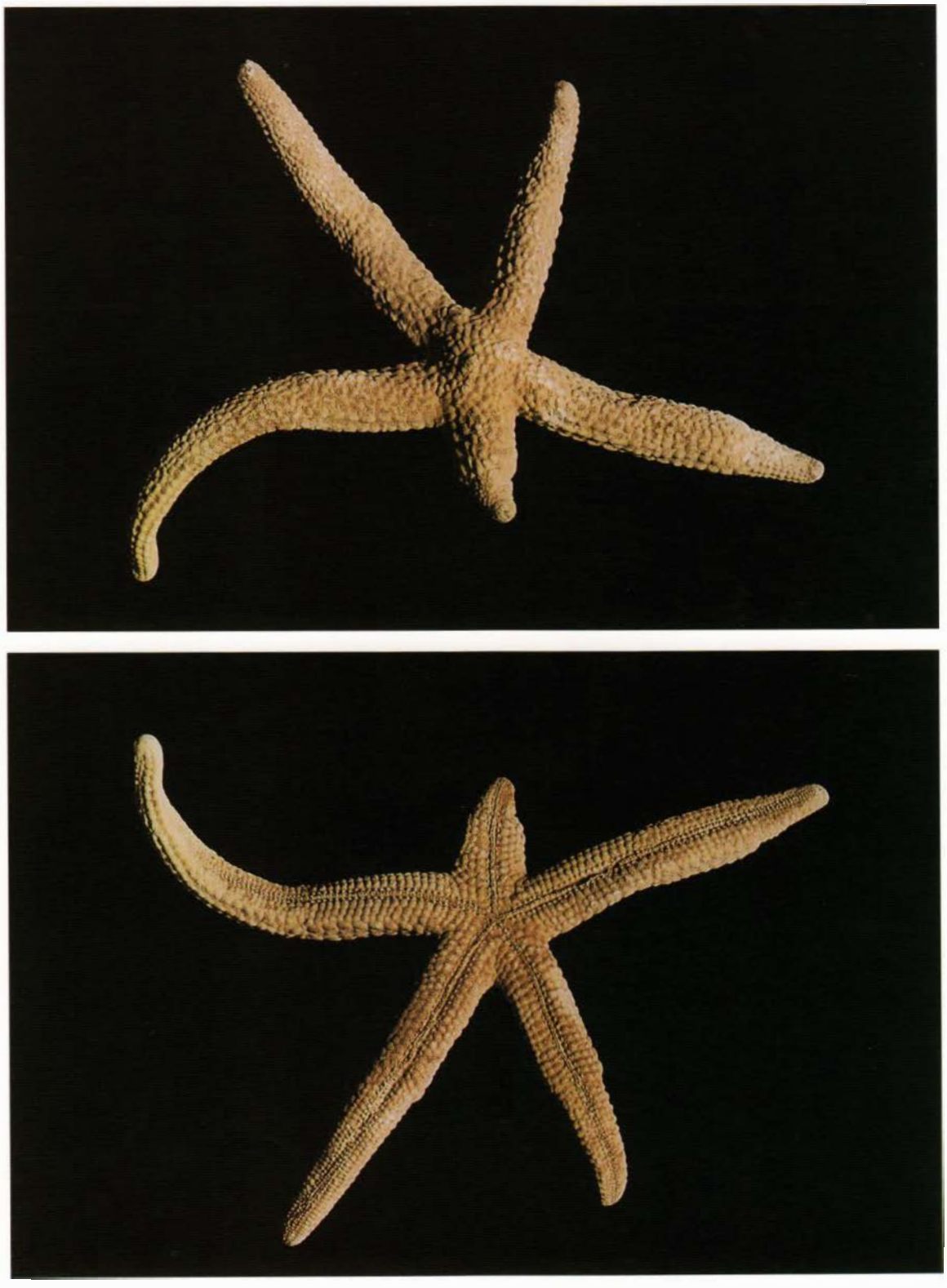

Plate 79. ***Linckia multifora*** (Lamarck). NZOI Stn Q61. R/r = 62/7, br = 7 mm. Abactinal and actinal surfaces.

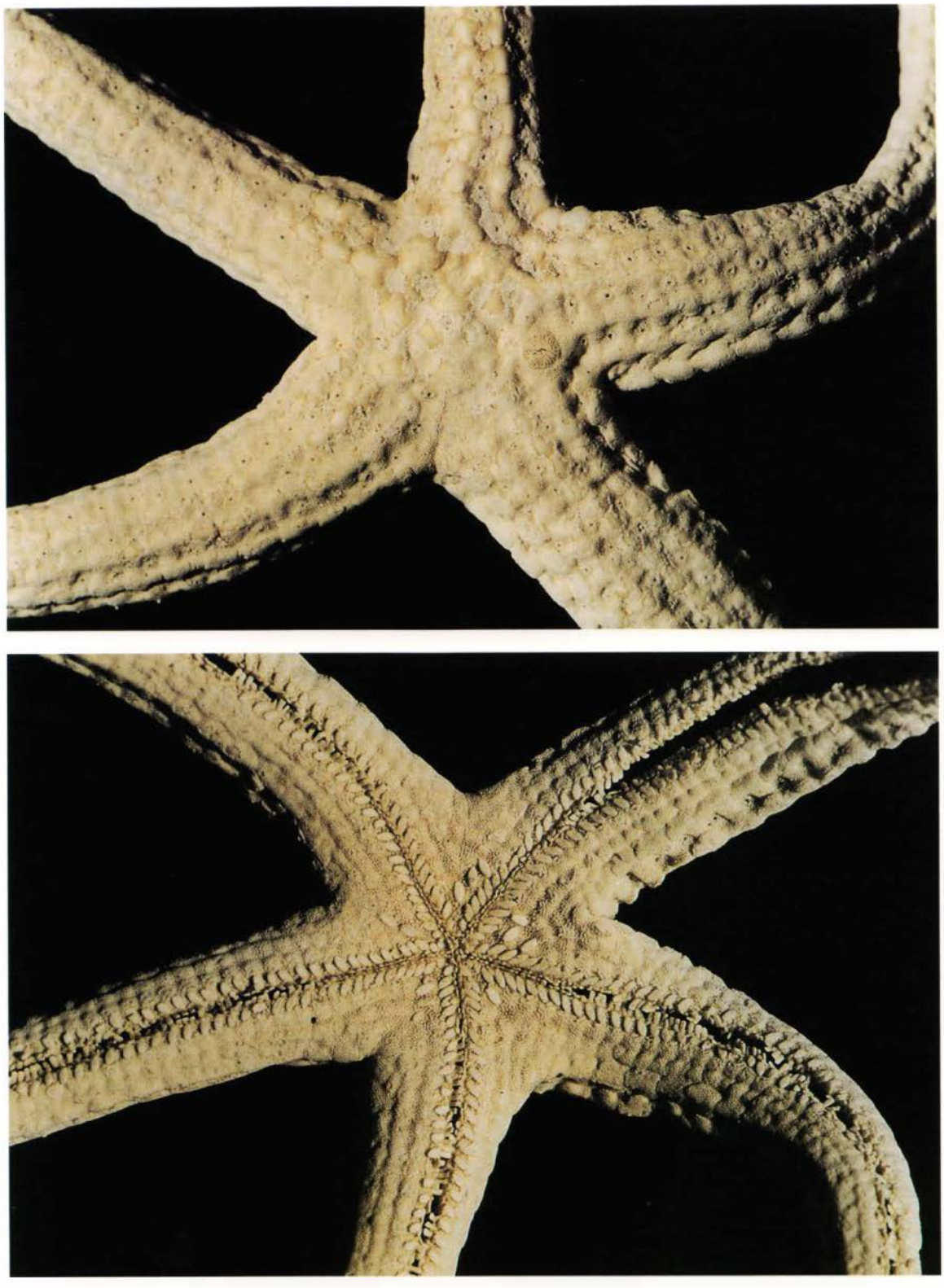

Plate 80. ***Tamaria tenella*** (Fisher). NZOI Stn S572. R/ r = 48/6,4, br = 8 mm. Abactinal and actinal surfaces.

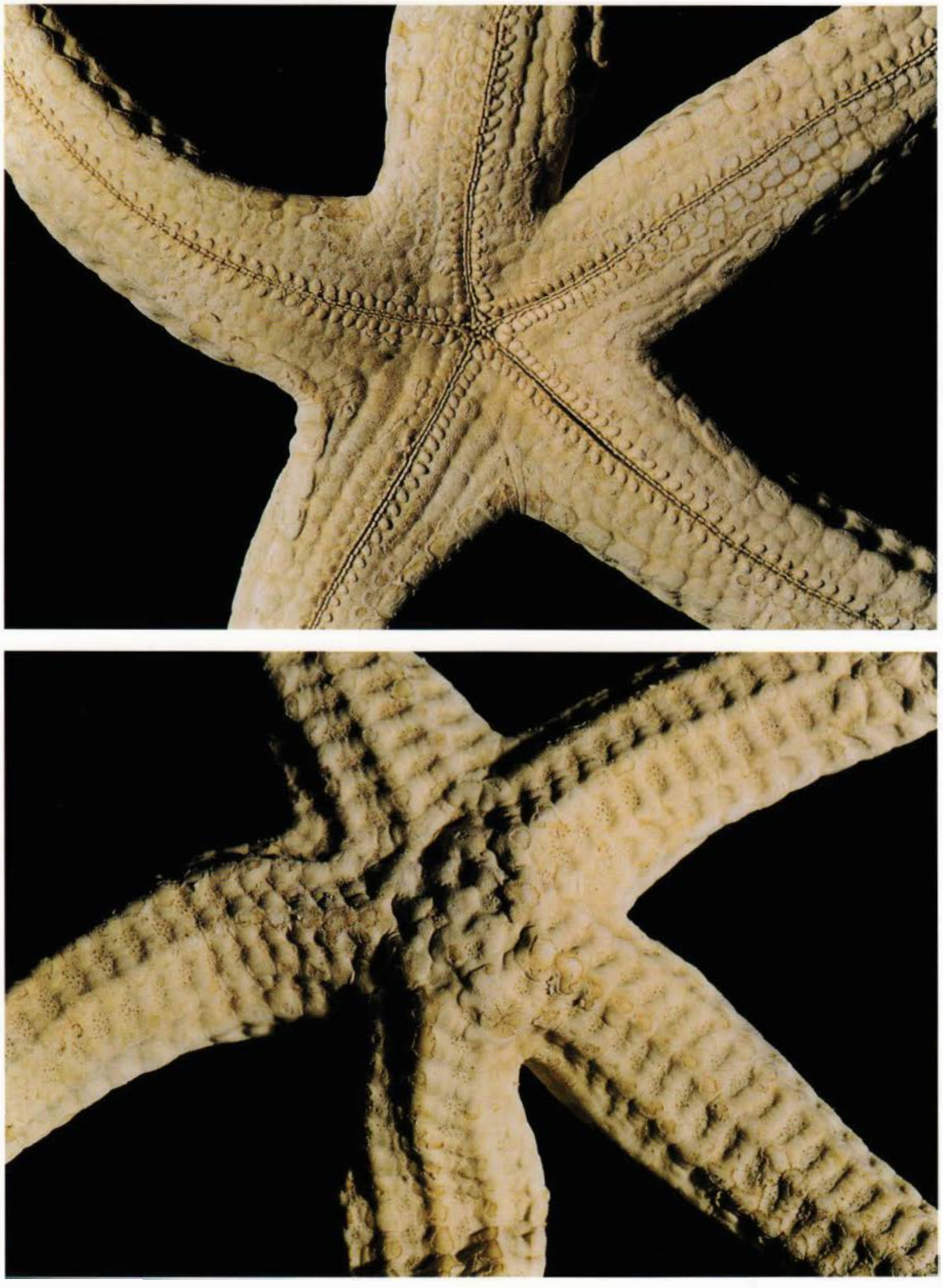

Plate 81. ***Tamaria giffordensis*** n.sp. Holotype. NZOI Stn I729. R / r = 61+ / 12 mm, br = 12 mm. Abactinal and actinal surfaces.

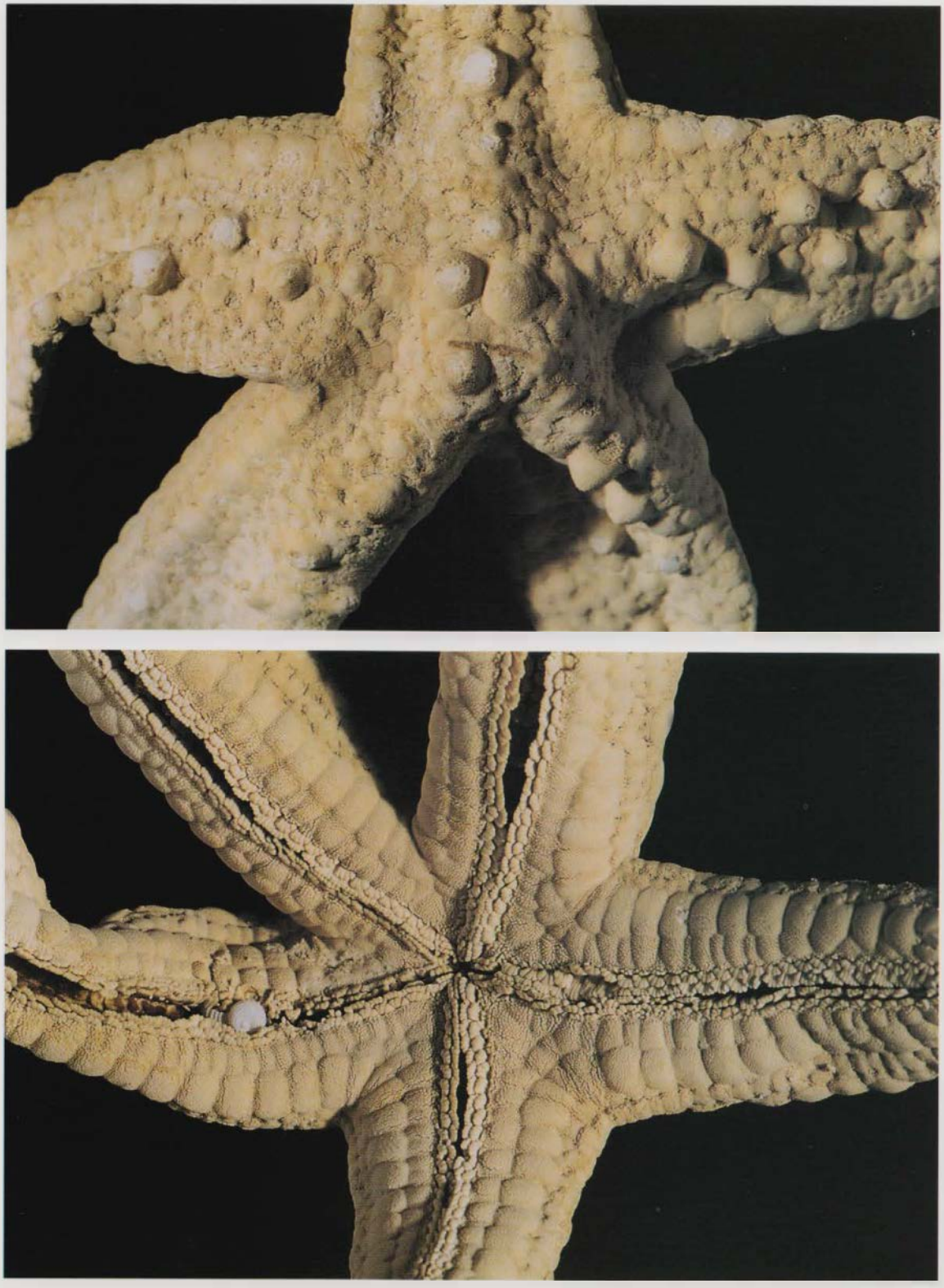

Plate 82. *Nardoa* cf. *tumulosa* Fisher. NZOI Stn I733. R/r = 103/16 mm, br. at base of ray = 17 mm. Abactinal and actinal surfaces.

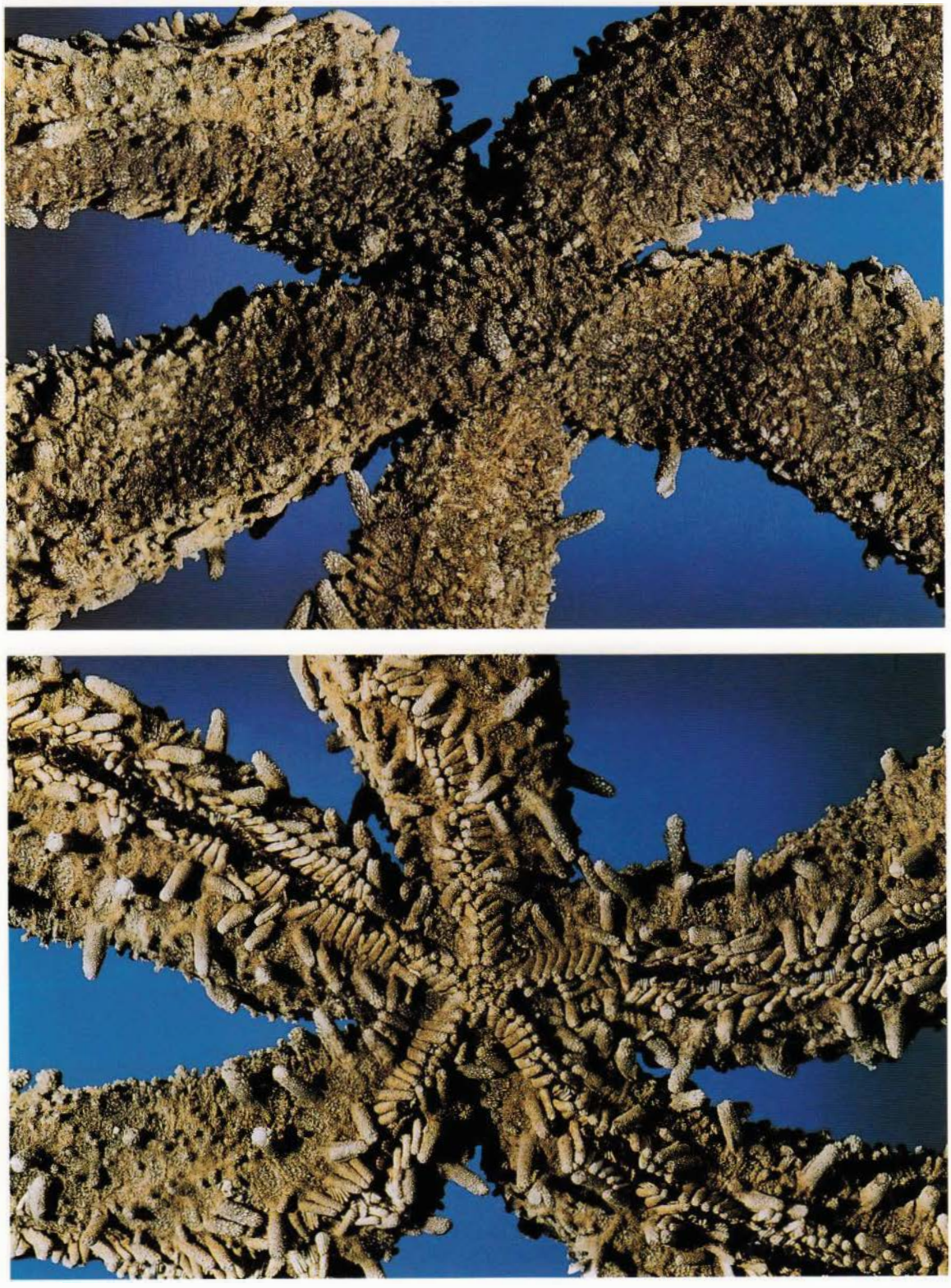

Plate 83. ***Mithrodia clavigera*** (Lamarck). NZOI Stn Q63. R / r = 189 / 18 mm, br = 20 mm. Abactinal and actinal surfaces.

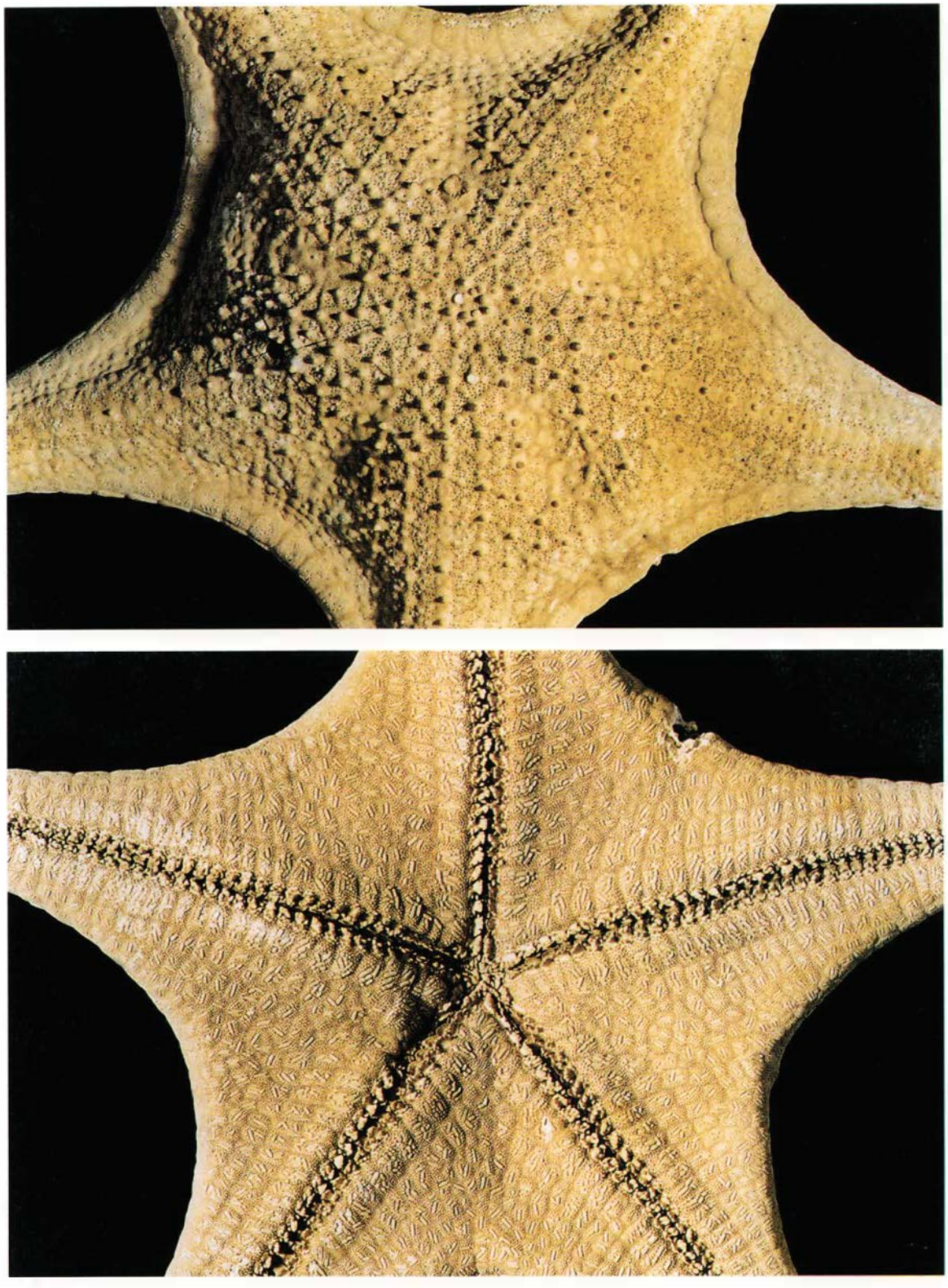

Plate 84. ***Acheronaster tumidus*** H.E.S. Clark. Holotype. NMNZ Ech. 3488, BS307. R/r = 165/63 mm. Abactinal and actinal surfaces.

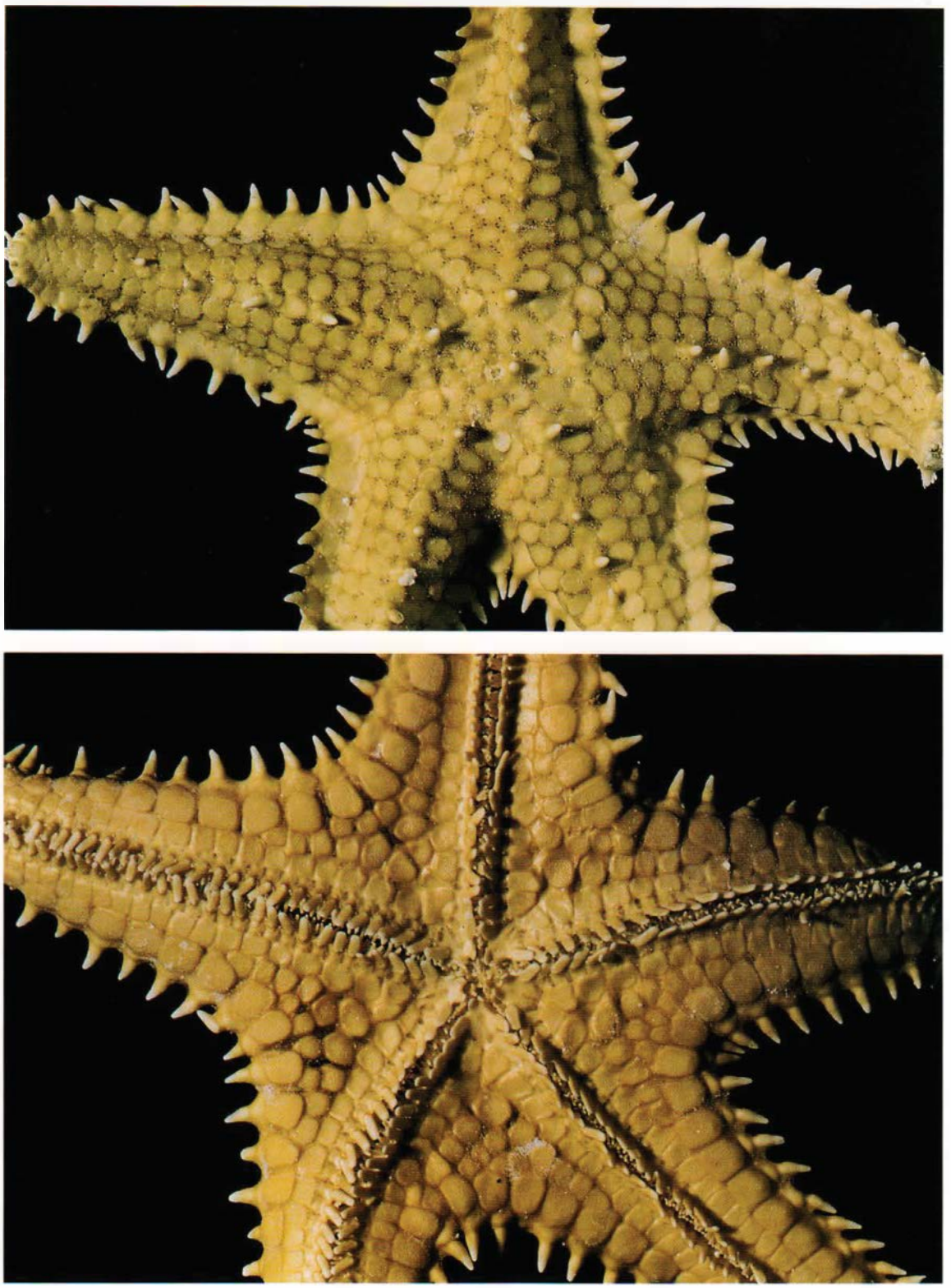

Plate 85. ***Asteropsis carinifera*** (Lamarck). NZOI Stn P967. R/ 4 = 47 / 19 mm, br. = 21 mm. Abactinal and actinal surfaces.

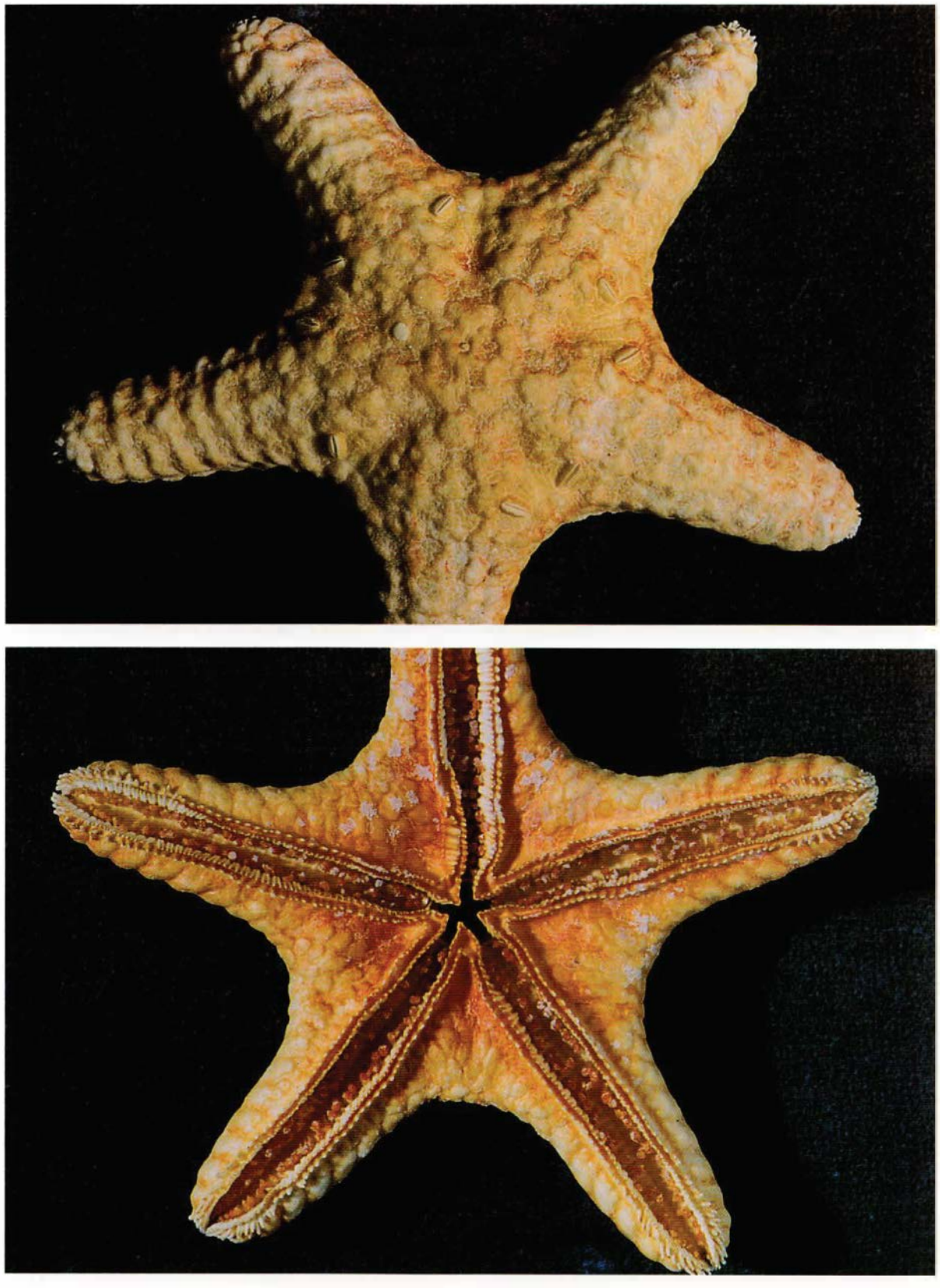

Plate 86. ***Petricia vernicina*** (Lamarck). NZOI Stn P967. R/r = 56/25 mm. Abactinal and actinal surfaces.

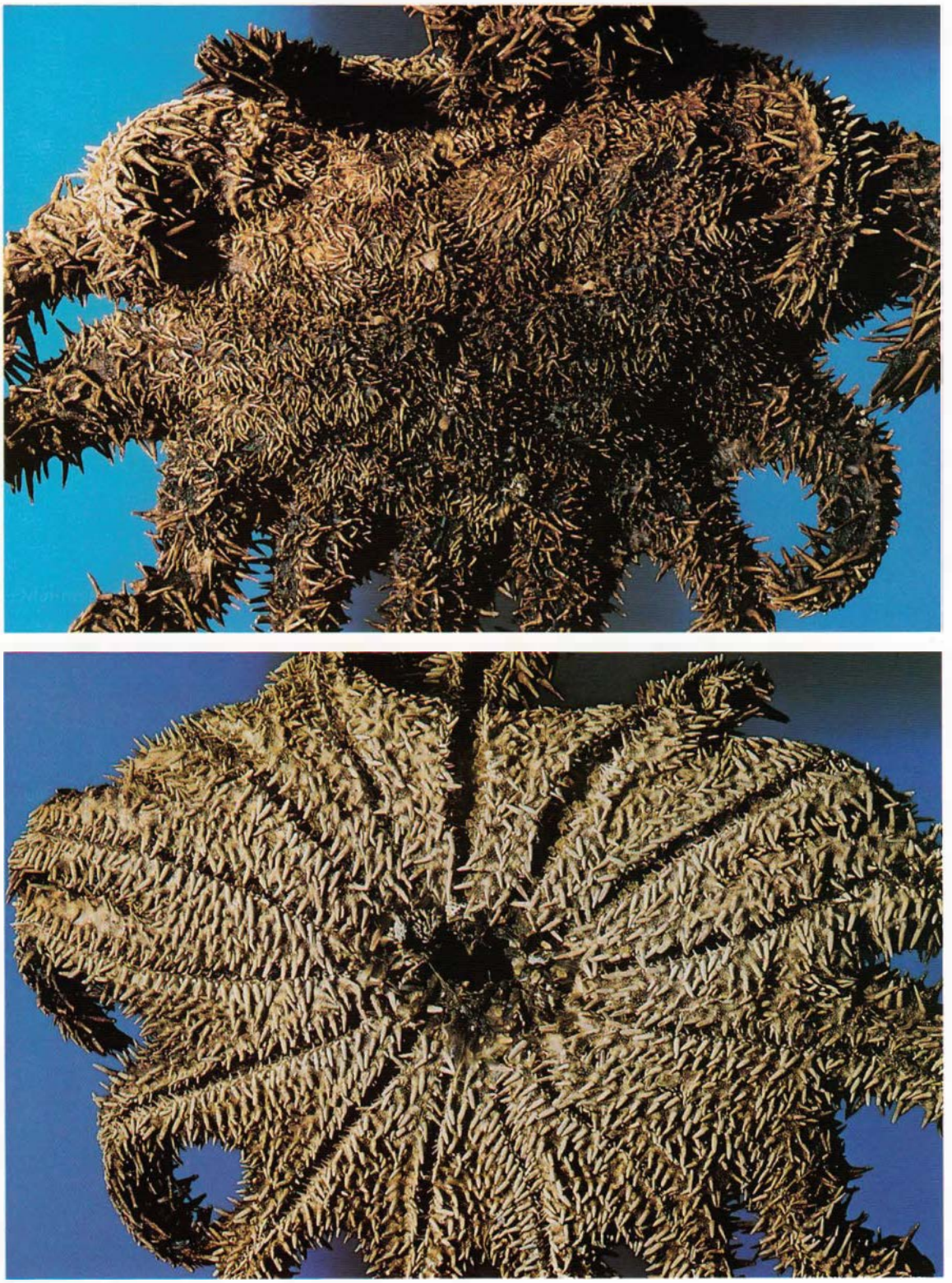

Plate 87. *Acanthaster brevispinus* Fisher. Uncatalogued Australian specimen. Abactinal and actinal surfaces.

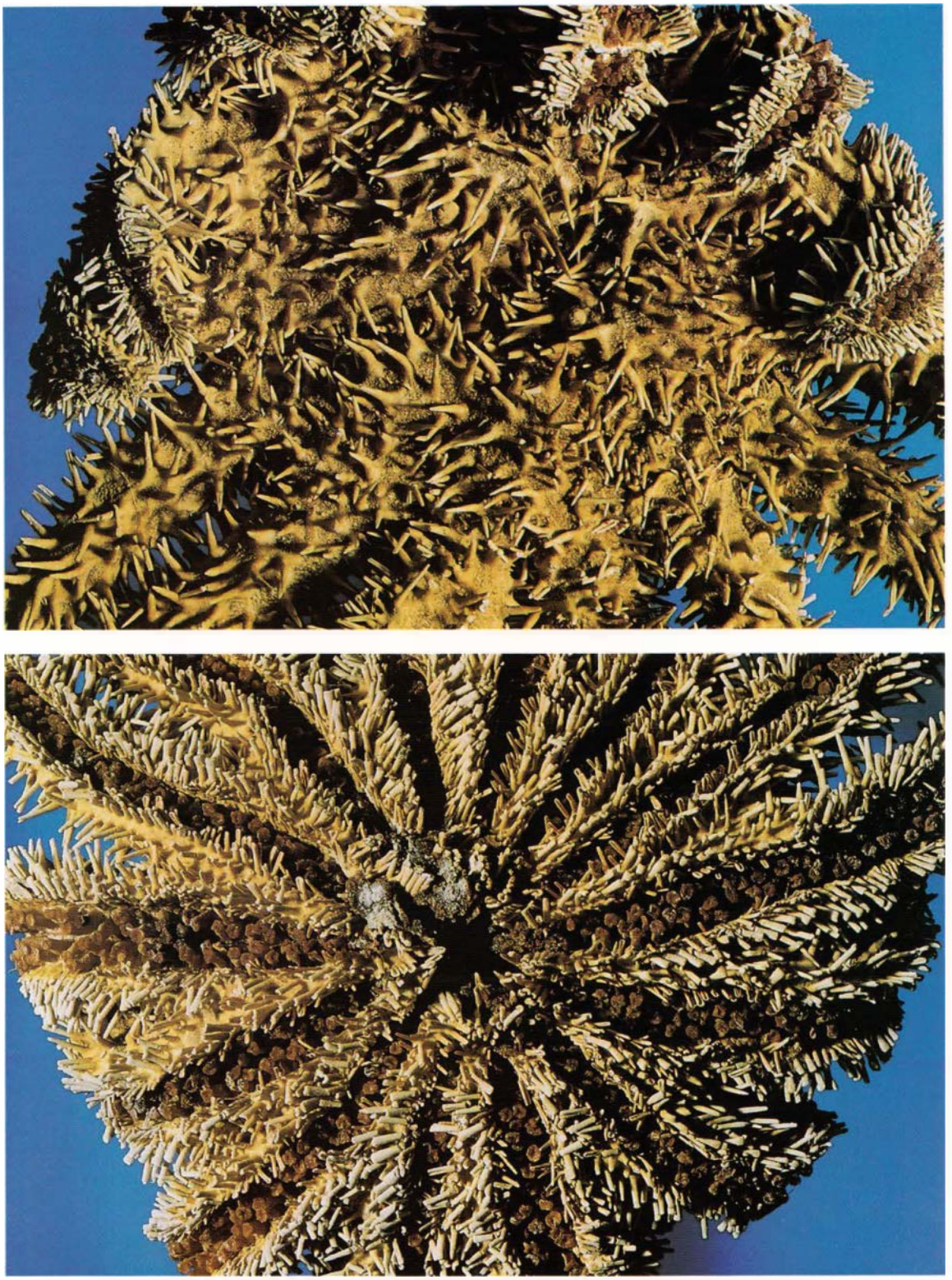

Plate 88. *Acanthaster planci* (Linnaeus). NZOI Stn K833. R/r = 144/73 mm, 14 arms. Abactinal and actinal surfaces.

Plate 89. (top) ***Fromia monilis*** **Perrier.** Live specimens after capture by scuba, 10 m, at NZOI Stn I769. (bottom) ***Tamaria giffordensis*** **n.sp.** Live specimen after capture, NZOI Stn I729, 300 m, Gifford Seamount, 10 May 1979. Photos : K.R. Grange.

DISCUSSION

ABUNDANCE

With some 12 families and 95 species the order Valvatida is strongly represented in the New Zealand region. At the family level the Goniasteridae clearly dominates the fauna, comprising over 50% of the species records. The Asterinidae and Odontasteridae are relatively common, and the Ophidiasteridae somewhat less so, these three families combining to make up 40% of the records. The remaining eight families are rare and comprise the balance of the records.

In numbers of species the Goniasteridae also dominate, with some 35% of the total; the Ophidiasteridae 21%, and the Asterinidae 17%, are moderately speciose, while the other nine families combined total only 25% of the species.

At the species level, four species are abundant, with more than 50 records in NIWA collections:

Ceramaster patagonicus
Odontaster benhami
Patiriella regularis
Pseudarchaster garricki

Five species, with 25–46 NIWA records, are relatively common:

Lithosoma novaezealandiae
Mediaster sladeni
Ophidiaster confertus
Pentagonaster pulchellus
Pillsburiaster aoteanus

Seven species, with 10–23 NIWA records, are relatively uncommon:

Anthenoides cristatus
Anthenoides granulosus
Diplodontias dilatatus
Hippasteria phrygiana
Mediaster arcuatus
Odontaster aucklandensis
Ophidiaster kermadecensis

There remain some 79 species, all with fewer than 10 NIWA records which can be considered as rare; included here are 19 species not represented in the NIWA collections:

Acanthaster planci
Anseropoda aotearoa
Anthenoides epixanthus
Asterodiscides grayi
Asterodiscides truncatus
Asteropsis carinifera
Calliaster sp.
Ceramaster glasbyi
Ceramaster patagonicus australis
Chaetaster moorei
Cycethra frigida
Diplontias miliaris
Dissogenes petersi
Eknomiaster macauleyensis
Eurygonias hyalacanthus
Fromia milleporella
Fromia monilis
Fromia polypora
Gilbertaster anacanthus
Glyphodiscus mcknighti
Gomophia watsoni
Heteronardoa carinata
Hoplaster kupe
Hyalinothrix millespina
Kermitaster pacificus
Leiaster leachii
Linckia guildingi
Linckia laevigata
Linckia multifora
Marginaster sp.
Mediaster gartrelli
Mithrodia clavigera
Nepanthia belcheri
Nepanthia grangei
Nepanthia reinga
Odontaster penicillatus
Odontaster rosagemmae
Ophidiaster macknighti
Paraonaster ridgwayi
Paragonaster stenostichus
Paragonaster sp.
Paranepanthia aucklandensis
Patiriella exigua
Patiriella oliveri
Pectricia vernicina
Philonaster sp.
Pseudoceramaster hunti
Rosaster endilius
Rosaster mimicus
Sphaerodiscus irritatus
Sphaerodiscus maui
Stegnaster inflatus
Tamaria giffordensis
Tamaria tenella
Tarachaster australis
Tremaster mirabilis novaecaledoniae

Species not represented in NIWA collections are:

Acanthaster brevispinus
Acheronaster tumidus
Asterina alba
Asterina anomala
Asterina heteractis
Asterina inopinata
Dactylosaster cylindricus
Diplodontias robustus
Enigmaster scalaris
Knightaster bakeri
Leiaster speciosus
Milteliphaster wanganellensis
Neoferdina cumingi
Oneria tasmanensis
Ophidiaster hemprichi
Patiriella gunni
Patiriella pseudoexigua
Pillsburiaster sp.
Plinthaster dentatus

BATHYMETRIC DISTRIBUTION

All of the twelve families are present on the continental shelf, and six appear confined to depths of less than 200 m — Poraniidae, Oreasteridae, Mithrodiidae, Chaetasteridae, Asteropseidae and Acanthasteridae. Three families — Asterodiscididae, Ophidiasteridae, and Ganeriidae — are recorded from the continental slope in depths of less than 1000 m, while the remaining three families, Goniasteridae, Odontasteridae, and Asterinidae extend into deeper waters.

Sixty-two species were recorded from the continental shelf, 0–200 m; 45 of these are more or less confined to the continental shelf. The following 36 species are recorded from 100 m or shallower:

Acanthaster brevispinus
Acanthaster planci
Asterina alba
Asterina anomala
Asterina heteractis
Asterina inopinata
Asterodiscides grayi
Asteropsis carinifera
Chaetaster moorei
Cycethra frigida
Dactylosaster cylindricus
Diplodontias dilatatus
Diplodontias miliaris
Diplodontias robustus
Eurygonias hyalacanthus
Fromia milleporella
Fromia monilis
Gomophia watsoni
Knightaster bakeri
Leiaster speciosus
Linckia guildingi
Linckia laevigata
Linckia multifora
Mithrodia clavigera
Neoferdina cumingi
Nepanthia belcheri
Ophidiaster confertus
Ophidiaster kermadecensis
Paranepanthia aucklandensis
Patiriella exigua
Patiriella gunni
Patiriella oliveri
Patiriella pseudoexigua
Patiriella regularis
Petricia vernicina
Stegnaster inflatus

Five species occur across the continental shelf:

Fromia polypora
Leiaster leachii
Ophidiaster hemprichi
Ophidiaster macknighti
Pentagonaster pulchellus

Four species are present only on the outer continental shelf:

Acheronaster tumidus
Marginaster sp.
Oneria tasmanensis
Porania antarctica

Seventeen species are recorded from the continental shelf and slope, 11 of which are not recorded from depths greater than about 800 m:

Anthenoides cristatus
Anthenoides epixanthus
Anthenoides granulosus
Asterodiscides truncatus
Ceramaster patagonicus australis
Heteronardoa carinata
Mediaster gartrelli
Mediaster sladeni
Odontaster aucklandensis
Odontaster benhami
Odontaster penicillatus

Six species extend to beyond 1000 m:

Ceramaster patagonicus
Hippasteria phrygiana
Lithosoma novaezealandiae
Pillsburiaster aoteanus
Pseudarchaster garricki
Rosaster mimicus

Twenty-seven species are known only from the continental slope, and most (23) less than 1000 m:

Anseropoda aotearoa
Calliaster thompsonae
Ceramaster glasbyi
Dissogenes petersi
Eknomiaster macauleyensis
Enigmaster scalaris
Gilbertaster anacanthus
Glyphodiscus mcknighti
Hyalinothrix millespina
Kermitaster pacificus
Milteliphaster wanganellensis
Nepanthia grangei
Nepanthia reinga
Odontaster rosagemmae
Paragonaster stenostichus
Philonaster sp.
Pseudarchaster sp.
Pseudoceramaster hunti
Rosaster endilius
Sphaeriodiscus irritatus
Tamaria giffordensis
Tamaria tenella
Tarachaster australis

Four species extend to depths exceeding 1000 m:

Mediaster arcuatus
Plinthaster dentatus
Sphaeriodiscus maui
Tremaster mirabilis novaecaledoniae

The remaining six species are confined to deeper waters, with no records from less than 1000 m:

Hoplaster kupe
Paragonaster ridgwayi
Paragonaster sp.
Pillsburiaster maini
Pillsburiaster sp.
Pseudarchaster macdougalli

GEOGRAPHIC DISTRIBUTION

In the New Zealand region charting area (CANZ 1997) members of the order Valvatida are recorded from between latitudes 25° and 54° South. Five families — Goniasteridae, Odontasteridae, Ganeriidae, Asterinidae and Poraniidae —have extensive ranges of at least 19 degrees of latitude. Of these, only the Odontasteridae remains unrecorded to the north of New Zealand. In comparison, the other seven families are quite restricted, and do not occur in the south. Three families — Asterodiscididae, Chaetasteridae, and Ophidiasteridae — cover 5–12 degrees of latitude, and do not extend south of 38° South. The other four — Mithrodiidae, Oreasteridae, Asteropseidae, and Acanthasteridae —with ranges of 1 to 2 degrees of latitude, are not known south of 31° South.

Of the 95 species present 72 have a known latitudinal range of 6 degrees or less, equal to 20% or less of the maximum; 49 of these species are known only to the north of New Zealand:

Acanthaster brevispinus
Acanthaster planci
Acheronaster tumidus
Asterina alba
Asterina anomala
Asterina heteractis
Asterina inopinata
Asterodiscides grayi
Asteropsis carinifera
Ceramaster glasbyi
Chaetaster moorei
Dactylosaster cylindricus
Dissogenes petersi
Eknomiaster macauleyensis
Fromia milleporella
Fromia monilis
Fromia polypora
Glyphodiscus mcknighti
Gomophia watsoni
Heteronardoa carinata
Hyalinothrix millespina
Kermitaster pacificus
Leiaster leachii
Leiaster speciosus
Linckia guildingi
Linckia laevigata
Linckia multifora
Marginaster sp.
Milteliphaster wanganellensis
Mithrodia clavigera
Neoferdina cumingi
Nepanthia belcheri
Nepanthia grangei
Oneira tasmanensis
Ophidiaster confertus
Ophidiaster hemprichi
Paragonaster stenostichus
Paragonaster sp.
Patiriella exigua
Patiriella gunni
Patiriella oliveri
Patiriella pseudoexigua
Petricia vernicina
Pseudoceramaster hunti
Sphaeriodiscus irritatus
Tamaria giffordensis
Tamaria tenella

Tarachaster australis
Tremaster mirabilis novaecaledoniae

Fifteen species occur off the shores of New Zealand; 11 of these are northern:
Anthenoides cristatus
Anthenoides epixanthus
Calliaster thompsonae
Gilbertaster anacanthus
Hoplaster kupe
Knightaster bakeri
Nepanthia reinga
Paragonaster ridgwayi
Pillsburiaster maini
Pillsburiaster sp.
Plinthaster dentatus

four are from central or southern New Zealand:
Anseropoda aotearoa
Diplodontias miliaris
Philonaster sp.
Stegnaster inflatus

Some eight species are recorded from south of New Zealand:
Ceramaster patagonicus australis
Cycethra frigida
Diplodontias robustus
Enigmaster scalaris
Odontaster penicillatus
Paranepanthia aucklandensis
Porania antarctica
Pseudarchaster sp.

Thirteen species have latitudinal ranges of 20–33% of the maximum; seven are northern, extending into northern New Zealand:
Anthenoides granulosus
Asterodiscides truncatus
Mediaster gartrelli
Ophidiaster kermadecensis
Ophidiaster macknighti
Rosaster endilius
Sphaeriodiscus maui

two are present centrally:
Odontaster rosagemmae
Pseudarchaster macdougalli

four species extend from central New Zealand to the south:
Diplodontias dilatatus
Eurygonias hyalacanthus
Odontaster aucklandensis
Odontaster benhami

Ten species are widespread with a range of at least 43% of the maximum; all occur to the south of New Zealand, three extend only as far as the Bay of Plenty:
Ceramaster patagonicus
Hippasteria phrygiana
Pentagonaster pulchellus

while the other eight are known to the north:
Lithosoma novaezealandiae
Mediaster arcuatus
Mediaster sladeni
Patiriella regularis
Pillsburiaster aoteanus
Pseudarchaster garricki
Rosaster mimicus

EXTERNAL RELATIONSHIPS

Of the 95 species of the order Valvatida known from the New Zealand region, some 45-47% are endemic. In the four families with most records, endemics comprise 78% of Odontasteridae and 69% of Goniasteridae; they are not as common in the Asterinidae, (44%), or Ophidiasteridae (15%). In the other eight families combined, only 27% of the species are endemic. Endemic species are:
Acheronaster tumidus
Anseropoda aotearoa
Asterina alba
Calliaster thompsonae
Ceramaster glasbyi
Ceramaster patagonicus australis
Diplodontias dilatatus
Diplodontias miliaris
Diplodontias robustus
Eknomiaster macauleyensis
Enigmaster scalaris
Eurygonias hyalacanthus
Glyphodiscus mcknighti
Hoplaster kupe
Kermitaster pacificus
Knightaster bakeri
Lithosoma novaezealandiae
Marginaster sp.
Mediaster gartrelli
Mediaster sladeni
Milteliphaster wanganellensis
Nepanthia grangei
Nepanthia reinga
Odontaster aucklandensis
Odontaster rosagemmae
Oneria tasmanensis
Ophidiaster kermadecensis
Paragonaster ridgwayi

Paragonaster sp.
Paranepanthia aucklandensis
Patiriella oliveri
Pentagonaster pulchellus
Philonaster sp.
Pillsburiaster aoteanus
Pillsburiaster maini
Pillsburiaster sp.
Pseudarchaster macdougalli
Pseudarchaster sp.
Pseudoceramaster hunti
Rosaster endilius
Sphaeriodiscus irritatus
Sphaeriodiscus maui
Stegnaster inflatus
Tamaria giffordensis
Tarachaster australis

Fourteen species are shared only with Australia:
Asterina anomala
Asterina heteractis
Asterina inopinata
Asterodiscides truncatus
Fromia polypora
Odontaster benhami
Ophidiaster confertus
Ophidiaster macknighti
Patiriella exigua
Patiriella gunni
Patiriella pseudoexigua
Patiriella regularis
Petricia vernicina
Pseudarchaster garricki

Twenty-five species are also recorded from the Indo-West Pacific region, and most are known from northern Australia:
Acanthaster brevispinus
Acanthaster planci
Anthenoides cristatus
Anthenoides epixanthus
Anthenoides granulosus
Asterodiscides grayi
Asteropsis carinifera
Chaetaster moorei
Dactylosaster cylindricus
Fromia milleporella
Fromia monilis
Gomophia watsoni
Heteronardoa carinata
Leiaster leachii
Leiaster speciosus
Linckia guildingi
Linckia laevigata
Linckia multifora
Mediaster arcuatus
Mithrodia clavigera
Neoferdina cumingi
Nepanthia belcheri
Ophidiaster hemprichi
Paragonaster stenostichus
Rosaster mimicus

Four species are recorded only from a single other Indo-West Pacific locality; 3 from Hawaii:
Gilbertaster anacanthus
Hyalinothrix millespina
Tamaria tenella

and two from New Caledonia:
Dissogenes petersi
Tremaster mirabilis novaecaledoniae

A further four species are recorded from southern localities, and may be circumpolar in subantarctic and south temperate latitudes:
Ceramaster patagonicus
Cycethra frigida
Odontaster penicillatus
Porania antarctica

Finally there are two species with widespread distributions, being recorded from both the Pacific and Atlantic Oceans:
Hippasteria phrygiana
Plinthaster dentatus

Table 1

Abundance, depth, and geographic range of species in the New Zealand region charting area (24°–57.30° S, 157° E–167° W. For the family Goniasteridae, + refers to specimens from the Museum of New Zealand Te Papa Tongarewa (NMNZ).

	No. of records	Depth range (m)	Latitude (° S)
Family Goniasteridae	493	0–2930	28–55
Anthenoides cristatus	13+1	117–510	33–37
Anthenoides epixanthus	1	100–488?	37
Anthenoides granulosus	16+15	143–731	28–3743?
Calliaster thompsonae	1	?	?
Ceramaster glasbyi	1	?406	30
Ceramaster patagonicus patagonicus	85+23	1 8-1125	
Ceramaster patagonicus australis	2	148–415	54–55
Ekonniaster macauleyensis	1	?448–510	30
Enigmaster scalaris	0+1	520	50
Gilbertaster anacanthus	1+1	463–913	37–39
Glyphodiscus mcknighti	1	450–475	28
Hippasteria phrygiana	22+37	20–1275	37–51
Kermitaster pacificus	1	610	29
Lithosoma novaezealandiae	36+30	120–1190	32–53
Mediaster arcuatus	23+13	601–1280	33–49
Mediaster gartrelli	6	142–720	28–38
Mediaster sladeni	46+44	41–600	34–48
Milteliphaster wanganellensis	0+1	422–437	32
Paragonaster ridgwayi	2	?2113-2150	36
Paragonaster stenostichus	1	315 -900	30
Paragonaster sp.	1	2930	34
Pentagonaster pulchellus	38+93	0–215	36-48
Philonaster sp.	1	500	44
Pillsburiaster noteanus	41+32	120–1573	30–52
Pillsburiaster maini	1	?1996–2008	36
Pillsburiaster sp.	0+1	?1354–1995	
Plinthaster dentatus	0+1	?229–2910	
Pseudarchaster garricki	134+72	56–2598	34–53
Pseudarchaster macdougalli	2+2	1140–2146	36–42
Pseudarchaster sp.	1	360	53
Pseudoceramaster hunti	1	486	30
Rosaster endilius	3	352–850	28–37
Rosaster mimicus	6+5	178–1030	30–42
Sphaeriodiscus irritatus	1	530	30
Sphaeriodiscus mawi	3	?926–1180	30-37
Family Asterodiscididae	4	14–792	29–37
Asterodiscides grayi	2	20–108	29–32
Asterodiscides truncatus	2	14-792	29–37
Family Odontasteridae	118	0–2417	36–55
Odontaster benhami	75	0–549	41–48
Odontaster aucklandensis	16	5–353	43–51
Odontaster penicillatus	3	55–372	54–55
Odontaster rosagemmae	4	424–985	37–44
Diplodontias miliaris	3	0–101	42–47
Diplodontias dilatatus	11	0–70	41–48
Diplodontias robustus	0	0–5?	50
Eurygonias hyalacanthus	2	0–20	41–48
Hoplaster kupe	4	2000–2417	36–38
Family Chaetasteridae	3	0–65	25–30
Chaetaster moorei	3	0–65	25–30
Family Ganeriidae	3	0–350	33–54
Cycethra frigida	1	0–95	54
Tarachaster australis	1	216	33
Hyalinothrix millespina	1	232–350	33
Knightaster bakeri	0	30–54	35
Family Asterinidae	153	0–1480	26–50
Asterina alba	0	0–20	29–31
Asterina heteractis	"littoral"	30–31	210
Asterina anomala ?	0	0–18	31
Asterina inopinata	0	0–25	31
Patiriella regularis	126	0–?	34–48
Patiriella oliveri	7	0–20?	29–32
Patiriella exigua	"littoral"	29–31	
Patiriella pseudoexigua	"littoral"	31?	
Patiriella gunni	0	0–30	31
Paranepanthia aucklandensis	3	0–80	49–50
Nepanthia belcheri	1	0–46	31
Nepanthia reinga	1	205	34
Nepanthia grangei	3	306–354	26–30
Anseropoda aotearoa	1	366	42
Stegnaster inflatus	8	0–35	41–45
Tremaster mirabilis novaecaledoniae	1	550–1480	28
Family Poraniidae	3	55–179	29–54
Porania antarctica	2	135–105	54
Marginaster sp.	1	179	29
Family Ophidiasteridae	77	0–590	26–38
Ophidiaster confertus	26	0–50	29–32
Ophidiaster kermadecensis	10	0–60	29–36
Ophidiaster hemprichi	0	0–276	30
Ophidiaster macknighti	5	20–205	32–38
Dactylosaster cylindricus	0	0–5	30
Dissogenes petersi	1	406–590	30
Fromia milleporella	1	0–30	29
Fromia monilis	1	0–40	29
Fromia polypora	1	0–160	29
Gomophia watsoni	1	0–35	29

	No. of records	Depth range (m)	Latitude (°S)
Heteronardoa carinata	5	34–549	29–31
Leiaster leachii	2	2–183	29–31
Leiaster speciosus	0	0–5	31
Linckia guildingi	3	0–30	29–31
Linckia laevigata	8	0–60	31
Linckia multifora	4	0–46	30
Neoferdina cumingi	0	0–30	31
Oneria tasmanensis	0	100–180	31
Tamaria tenella	2	238–503	30–32
Tamaria giffordensis	3	306–376	26
Family Mithrodiidae	2	0–80	30–31
Mithrodia clavigera	2	0–80	30–31
Family Oreasteridae	0	110–146	30
Acheronaster tumidus	0	110–146	30
Family Asteropseidae	9	0–18	29–31
Petricia vernicina	8	0–18	29–31
Asteropsis carinifera	1	3–10	29
Family Acanthasteridae	7	0–20	29–30
Acanthaster planci	7	0–18	29–30
Acanthaster brevispinus	0	0–20	29
12 Families	**872**	**0–2930**	**25–54**

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APPENDIX 1

LIST OF STATIONS

N.Z. Oceanographic Institute (NZOI/NIWA)

Paxillosida: 2077 specimens from 697 stations. Of these, 349 specimens (from 167 stations) have an asterisk (*), i.e., specimens were recorded but not kept (are not in the collections).

Notomyotida: 308 specimens from 122 stations.

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
A444E	5.10.58	41 18.70	174 30.20 E	256	*Odontaster benhami* (1)
A444K	"	41 20.00	174 29.67 E	192	*Odontaster benhami* (1)
A444O	"	41 19.60	174 31.80 E	220	*Patiriella regularis* (1)
A695	1.3.62	54 36.40	158 57.00 E	91	*Cycethra frigida* (1)
A823	25.8.63	46 35.20	167 04.99 E	390	*Pseudarchaster garricki* (2)
A843	26.8.63	47 13.50	167 15.00 E	139	*Odontaster benhami* (1)
A887	31.8.63	45 15.50	171 27.50 E	135	*Odontaster benhami* (1)
A910	13.9.63	43 04.00	178 39.00 W	549	*Odontaster benhami* (4)
A970	25.9.63	46 40.00	169 06.00 E	0	*Patiriella regularis* (2)
B157					*Ophidiaster kermadecensis* (2)
B175	8.10.59	26.50.00	166 37.50 E	95	*Odontaster aucklandensis* (21)
B196	18.10.59	46 20.60	170 27.60 E	135	*Odontaster benhami* (1)
B197	"	46 14.10	170 32.50 E	110	*Pentagonaster pulchellus* (1), *Pseudarchaster garricki* (1), *Odontaster benhami* (3)
B205	2.11.59	41 25.00	174 45.00 E	60	*Odontaster benhami* (1)
B218	21.5.60	46 50.00	168 09.80 E	39	*Pentagonaster pulchellus* (1), *Patiriella regularis* (1)
B220	"	46 40.00	168 09.79 E	37	*Pentagonaster pulchellus* (4)
B224	"	46 45.00	168 16.80 E	32	*Pentagonaster pulchellus* (1), *Patiriella regularis* (1)
B225	"	46 49.99	168 18.00 E	31	*Pentagonaster pulchellus* (1)
B230	"	46 40.00	168 02.50 E	26	*Pentagonaster pulchellus* (1), *Patiriella regularis* (2)
B233	23.5.60	46 39.70	167 48.00 E	37	*Pentagonaster pulchellus* (1)
B237	"	46 35.00	168 11.00 E	25	*Patiriella regularis* (1)
B241	24.5.60	47 00.00	168 16.79 E	53	*Pentagonaster pulchellus* (1)
B245	26.5.60	46 30.00	167 48.00 E	49	*Patiriella regularis* (1)
B260	27.5.60	46 45.40	168 38.99 E	25	*Pentagonaster pulchellus* (1)
B264	"	46 39.49	168 07.00 E	17	*Pentagonaster pulchellus* (2)
B267	29.5.60	46 49.99	168 45.79 E	72	*Pentagonaster pulchellus* (2)
B270	"	46 42.00	169 00.00 E	33	*Pentagonaster pulchellus* (2)
B272	"	46 43.99	168 31.39 E	21	*Pentagonaster pulchellus* (1)
B488	7.6.61	46 28.70	166 14.30 E	164	*Odontaster benhami* (1)
B515	5.2.62	43 27.00	175 03.00 E	165	*Odontaster benhami* (2)
B554	6.10.62	44 00.00	172 58.20 E	81	*Diplodontias miliaris* (1)
B560	7.10.62	44 40.00	172 24.00 E	240	*Odontaster benhami* (3)
B561	"	45 18.20	171 28.50 E	176	*Odontaster benhami* (1)
B562	"	45 18.20	171 27.50 E	128	*Odontaster benhami* (1)
B568	8.10.62	46 00.00	170 43.20 E	75	*Pentagonaster pulchellus* (1)
B581	11.10.62	48 00.00	168 06.00 E	138	*Odontaster benhami* (1)
B583	"	48 00.00	167 26.00 E	143	*Odontaster benhami* (3)
B587	12.10.62	48 00.20	166 39.00 E	155	*Odontaster benhami* (4)
B591	13.10.62	48 46.00	167 05.00 E	143	*Odontaster benhami* (1)
B592	"	48 46.00	167 19.00 E	152	*Odontaster benhami* (2)
B601	15.10.62	47 14.55	167 36.00 E	15	*Patiriella regularis* (1)
B658	24.10.62	38 39.00	173 25.00 E	143	*Mediaster sladeni* (4)
B825	20.3.63	40 51.00	173 02.00 E	13	*Patiriella regularis* (1)
C224	14.9.59	41 22.40	174 24.00 E	146	*Odontaster benhami* (1)
C531	19.9.60	29 14.40	178 02.00 W	179	*Marginaster* sp. (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
C598		37 00.50	175 19.00 E	17	*Patiriella regularis* (1)
C601	24.4.61	44 18.00	176 16.00 E	144	*Odontaster benhami* (5)
C605	26.4.61	43 40.00	179 30.00 E	441	*Pseudarchaster garricki* (1)
C624	7.5.61	43 57.50	175 52.00 W	124	*Odontaster benhami* (2)
C672	16.6.61	42 43.60	173 30.60 E	64	*Diplodontias miliaris* ( )
C683	17.6.61	42 28.10	173 40.70 E	88	*Odontaster benhami* (1)
C703	19.6.61	42 42.00	173 37.80 E	184	*Odontaster benhami* (7)
C706	20.6.61	42 26.30	173 45.60 E	104	*Odontaster benhami* (3)
C732A	25.11.61	54 29.50	158 58.5 E	77	*Odontaster penicillatus* (1)
C733	"	54 25.00	159 02.00 E	204	*Porania antarctica* (1)
C734	"	53 55.00	158 55.00 E	360	*Pseudarchaster* sp. (1)
C814	25.2.62	37 40.00	178 56.40 E	194	*Ophidiaster macknighti* (1)
C844	1.3.62	41 38.30	175 11.20 E	88	*Odontaster benhami* (11)
C856	2.3.62	40 55.20	173 50.70 E	22	*Patiriella regularis* (1)
C863	4.3.62	40 57 30	174 00.20 E	75	*Patiriella regularis* (1, in u/w Photo)
C921	10.2.63	41 04.90	173 57.30 E	75	*Patiriella regularis* (1)
C957	7.3.63	43 09.00	175 15.00 E	123	*Odontaster benhami* (2)
C978	14.5.61	41 20.00	174 48.00 E	0	*Patiriella regularis* (12)
C989	8.9.64	41 20.20	174 48.00 E	0	*Patiriella regularis* (1), *Stegnaster inflatus* (1)
D35	5.5.63	52 56.39	169 33.00 E	188	*Pseudarchaster garricki* (1)
D56	9.5.63	50 36.19	166 10.69 E	35	*Ophidiaster confertus* (1)
D85	13.5.63	49 49.99	170 13.00 E	611	*Ceramaster patagonicus patagonicus* (33), *Hippasteria phrygiana* (1), *Lithosoma novaezelandiae* (2), *Pseudarchaster garricki* (2)
D92	19.5.63	37 31.00	177 07.99 E	183	*Pseudarchaster garricki* (1)
D100	26.9.63	48 02.00	166 36.00 E	161	*Odontaster benhami* (4)
D104	29.9.63	50 49.20	166 15.60 E	95	*Odontaster aucklandensis* (1)
D114	7.10.63	44 12.00	173 18.00 E	84	*Odontaster benhami* (1)
D117	10.10.63	43 15.00	178 40.00 E	432	*Pseudarchaster garricki* (1)
D127	7.1.64	46 42.00	168 17.30 E	29	*Patiriella regularis* (1)
D131	11.1.64	48 02.00	167 03.00 E	132	*Odontaster benhami* (36)
D132	12.1.64	48 06.00	167 36.50 E	134	*Odontaster benhami* (4)
D133	"	48 11.50	168 21.00 E	141	*Odontaster benhami* (22)
D134	"	48 16.00	168 43.50 E	677	*Ceramaster patagonicus patagonicus* (1), *Lithosoma novaezelandiae* (2)
D136	"	48 33.49	169 10.00 E	390	*Ceramaster patagonicus patagonicus*(2), *Lithosoma novaezelandiae* (3)
D137	"	48 50.50	169 07.00 E	668	*Ceramaster patagonicus patagonicus* (3), *Lithosoma novaezelandiae* (4), *Pillsburiaster aoteanus* (1)
D138	13.1.64	48 31.99	168 19.49 E	668	*Ceramaster patagonicus patagonicus* (3), *Lithosoma novaezelandiae* (3)
D140	"	48 01.00	166 34.50 E	0	*Diplodontias dilatatus* (1)
D144	14.1.64	48 31.00	167 17.00 E	132	*Odontaster benhami* (1)
D148	"	49 48.00	167 02.50 E	146	*Odontaster aucklandensis* (1)
D155	16.1.64	48 02.00	166 38.00 E	141	*Odontaster benhami* (1)
D176	21.1.64	51 06.00	167 48.50 E	216	*Odontaster aucklandensis* (1)
D193	22.1.64	50 40.50	166 21.50 E	73	*Odontaster aucklandensis* (1)
D194	"	50 44.00	166 21.00 E	95	*Odontaster aucklandensis* (1)
D200	23.1.64	50 22.00	167 28.00 E	113	*Odontaster aucklandensis* (4)
D203	24.1.64	51 00,00	169 29.50 E	565	*Pseudarchaster garricki* (2)
D207	25.1.64	50 04.00	171 22.99 E	510	*Ceramaster patagonicus* (2)
D208	"	49 18.00	171 46.50 E	150	*Odontaster aucklandensis* (1)
D211	26.1.64	48 52.99	172 17.50 E	519	*Ceramaster patagonicus patagonicus* (14), *Hippasteria phrygiana* (2), *Pillsburiaster aoteanus* (2), *Pseudarchaster garricki* (9)
D226	27.9.64	39 54.00	168 40.00 E	823	*Lithosoma novaezelandiae* (1)
D243	2.10.64	38 49.99	169 19.99 E	519	*Lithosoma novaezelandiae* (1)
D245	3.10.64	39 54.00	172 00.00 E	466	*Mediaster sladeni* (1)
D273	6.10.64	40 45.00	173 49.49 E	75	*Pentagonaster pulchellus* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
D375	20.11.64	41 15.50	174 54.00 E	12	*Patiriella regularis* (numerous)
D382	21.11.64	41 17.50	174 48.50 E	19	*Patiriella regularis* (2)
D384	"	41 18.60	174 50.50 E	12	*Patiriella regularis* (10)
D443	5.5.65	41 15.70	174 52.20 E	4	*Patiriella regularis* (1)
D468	4.11.65	37 31.99	179 21.00 E	1280	*Mediaster arcuatus* (1)
D595	29.1.67	43 59.00	176 37.00 W	0	*Pentagonaster pulchellus* (1), *Patiriella regularis* (1),
D870	24.3.69	43 30.00	178 40.00 W	440	*Ceramaster patagonicus patagonicus* (1), *Mediaster sladeni* (1)
D872	"	43 30.00	178 19.99 W	435	*Mediaster sladeni* (3)
D876	25.3.69	43 19.99	176 49.99 W	148	*Mediaster sladeni* (4)
D895	28.3.69	43 40.00	175 55.00 W	246	*Mediaster sladeni* (1), *Pseudarchaster garricki* (4)
D900	30.3.69	43 55.00	177 19.99 W	286	*Mediaster sladeni* (1)
D901	"	43 55.00	177 30.00 W	366	*Mediaster sladeni* (4)
D902	"	43 55.00	177 19.99 W	420	*Mediaster sladeni* (1)
D908	31.3.69	43 54.00	179 43.99 W	432	*Pseudarchaster garricki* (1)
E76	23.3.64	44 00.00	178 00.00 E	821	*Mediaster sladeni* (1)
E79	24.3.64	43 04.99	178 00.00 E	371	*Mediaster sladeni* (1)
E80	25.3.69	43 22.99	179 31.99 W	459	*Pseudarchaster garricki* (2)
E106	11.10.64	43 55.00	177 10.00 W	98	*Pseudarchaster garricki* (13)
E117	13.10.64	43 30.00	176 00.00 W	333	*Pseudarchaster garricki* (2)
E118	"	43 15.00	176 00.00 W	496	*Pseudarchaster garricki* (4)
E121	14.10.64	43 15.00	175 40.00 W	693	*Hippasteria phrygiana* (1)
E158	19.10.64	44 00.00	177 19.99 W	384	*Mediaster sladeni* (1)
E159	"	44 00.50	176 59.00 W	165	*Pseudarchaster garricki* (5), *Odontaster benhami* (1)
E164	20.10.64	43 15.00	177 19.99 W	380	*Mediaster sladeni* (1)
E228	24.2.65	54 41.0	158 55.00 E	148	*Ceramaster patagonicus australis* (3), *Odontaster penicillatus* (2)
E233	26.2.65	54 29.50	158 58.50 E	55	*Odontaster penicillatus* (1), *Porania antarctica* (1)
E293	8.4.65	34 17.50	172 25.00 E	205	*Nepanthia reinga*
E401	7.10.65	46 00.00	171 11.99 E	914	*Ceramaster patagonicus* (1), *Mediaster arcuatus* (2), *Pillsburiaster aoteanus* (2), *Pseudarchaster garricki* (2)
E404	9.10.65	47 19.99	169 43.99 E	716	*Ceramaster patagonicus* (1), *Lithosoma novaezelandiae* (1), *Pillsburiaster aoteanus* (1)
E409	10.10.65	46 40.99	170 21.00 E	743	*Lithosoma novaezelandiae* (1)
E411	"	46 38.50	170 58.99 E	1275	*Hippasteria phrygiana* (1)
E412	11.10.65	45 10.00	171 41.00 E	249	*Odontaster benhami* (1)
E414	"	45 16.00	171 49.00 E	999	*Mediaster arcuatus* (1), *Pseudarchaster garricki* (4)
E424	16.10.65	44 40.00	172 38.00 E	293	*Odontaster benhami* (1)
E426	"	44 46.99	172 48.00 E	1130	*Mediaster arcuatus* (1)
E433	18.10.65	43 43.00	174 30.00 E	571	*Pseudarchaster garricki* (3)
E434	"	43 30.00	174 30.00 E	556	*Pseudarchaster garricki* (1)
E439	22.10.65	41 04.00	174 19.00 E	22	*Patiriella regularis* (1)
E719	23.3.67	38 46.00	178 48.00 E	913	*Gilbertaster anacanthus* (1), *Mediaster arcuatus* (2), *Pseudarchaster garricki* (1)
E732	25.3.67	37 16.00	177 15.70 E	960	*Mediaster arcuatus* (1)
E734	26.3.67	37 36.49	176 48.00 E	402	*Lithosoma novaezelandiae* (1), *Pseudarchaster garricki* (3)
E757	30.3.67	42 03.19	174 27.19 E	1081	*Ceramaster patagonicus patagonicus* (1), *Pseudarchaster garricki* (4)
E767	1.4.67	41 19.20	174 10.00 E	0	*Patiriella regularis* (11)
E768	2.4.67	41 18.50	174 07.30 E	0	*Patiriella regularis* (13)
E776	15.10.67	42 43.00	169 15.49 E	978	*Mediaster arcuatus* (1)
E783	16.3.67	43 22.99	168 36.49 E	966	*Mediaster arcuatus* (2), *Pseudarchaster garricki* (1)
E804	21.10.67	45 58.50	166 18.50 E	183	*Odontaster benhami* (1)
E809	22.10.67	46 06.70	166 40.60 E	0	*Patiriella regularis* (6)
E817	23.10.67	46 13.50	166 29.00 E	235	*Odontaster benhami* (2)
E819	"	46 28.99	166 08.99 E	416	*Pseudarchaster garricki* (1)
E820	"	46 35.00	165 58.00 E	220	*Mediaster sladeni* (1), *Odontaster benhami* (2)
E826	24.10.67	46 37.50	166 44.20 E	823	*Lithosoma novaezelandiae* (3)
E827	"	46 35.50	166 44.50 E	530	*Pseudarchaster garricki* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
E828	24.10.67	46 30.00	166 49.00 E	220	*Mediaster sladeni* (1)
E832	25.10.67	47 21.00	167 21.00 E	251	*Odontaster benhami* (8)
E833	26.10.67	46 56.80	168 08.90 E	53	*Pentagonaster pulchellus* (3), *Patiriella regularis* (2)
E836	28.10.67	41 48.80	174 17.60 E	70	*Diplodontias dilatatus* (field notes)
E841	16.3.68	33 52.99	172 16.99 E	262	*Lithosoma novaezelandiae* (1)
E848	17.3.68	33 59.00	171 40.00 E	250	*Asterodiscides truncatus* (1)
E849	17.3.68	33 55.00	171 32.00 E	216	*Tarachaster australis* (1)
E877	22.3.68	35 19.99	172 46.99 E	251	*Pseudarchaster garricki* (8)
E886	23.3.68	36 00.00	173 31.99 E	245	*Pseudarchaster garricki* (1)
E902	26.3.68	37 34.00	172 04.99 E	1064	*Sphaeriodiscus maui* (1)
E903	27.3.68	37 32.99	172 04.99 E	952	*Mediaster arcuatus* (1)
E909	28.3.68	40 51.00	173 49.00 E	0	*Stegnaster inflatus* (2)
F77	12.1.65	47 00.00	169 30.00 E	117	*Odontaster benhami* (8)
F78	13.1.65	48 32.00	167 09.00 E	139	*Odontaster benhami* (16)
F90	16.1.65	49 30.49	167 40.00 E	601	*Ceramaster patagonicus patagonicus* (1), *Lithosoma novaezelandiae* (1), *Mediaster arcuatus* (1)
F91	"	49 00.00	167 30.00 E	687	*Lithosoma novaezelandiae* (2)
F93	17.1.65	48 31.00	167 30.00 E	141	*Odontaster benhami* (2)
F94	"	48 31.00	168 01.00 E	604	*Pseudarchaster garricki* (1)
F95	"	48 52.99	168 38.99 E	646	*Ceramaster patagonicus patagonicus* (1)
F97	"	48 00.00	168 32.00 E	134	*Odontaster benhami* (30)
F99	18.1.65	48 31.99	168 54.49 E	706	*Lithosoma novaezelandiae* (1)
F100	"	49 01.99	168 53.50 E	733	*Lithosoma novaezelandiae* (2), *Pillsburiaster aoteanus* (1)
F102	19.1.65	48 39.00	169 51.00 E	810	*Ceramaster patagonicus patagonicus* (1), *Pseudarchaster garricki* (1)
F104	20.1.65	48 40.00	170 48.49 E	814	*Ceramaster patagonicus patagonicus* (8), *Mediaster arcuatus* (2), *Pillsburiaster aoteanus* (8), *Pseudarchaster garricki* (9)
F106	"	49 30.00	172 00.00 E	371	*Pseudarchaster garricki* (1)
F107	"	48 45.00	172 00.00 E	658	*Ceramaster patagonicus patagonicus* (39), *Pillsburiaster aoteanus* (5), *Pseudarchaster garricki* (3)
F109	21.1.65	49 10.99	173 00.00 E	501	*Ceramaster patagonicus patagonicus* (3), *Pseudarchaster garricki* (4)
F120	25.1.65	48 17.99	179 16.00 E	494	*Ceramaster patagonicus patagonicus* (1)
F122	26.1.65	48 05.99	179 56.99 W	252	*Ceramaster patagonicus patagonicus* (2)
F124	27.1.65	47 34.00	179 55.99 W	476	*Ceramaster patagonicus patagonicus* (6)
F135	30.1.65	50 58.00	173 56.99 E	832	*Ceramaster patagonicus patagonicus* (1), *Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (1)
F136	"	51 19.99	172 41.99 E	547	*Pseudarchaster garricki* (2)
F138	31.1.65	52 03.00	170 23.00 E	353	*Odontaster aucklandensis* (1)
F150	2.2.65	49 28.00	174 28.00 E	501	*Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (1)
F151	3.2.65	48 31.99	174 49.99 E	814	*Ceramaster patagonicus patagonicus* (11), *Pillsburiaster aoteanus* (1)
F567	28.10.65	43 26.80	173 30.90 E	112	*Odontaster benhami* (1)
F753	18.8.66	44 45.00	174 30.00 E	765	*Lithosoma novaezelandiae* (1)
F755	19.8.66	43 00.00	174 30.00 E	854	*Pillsburiaster aoteanus* (1)
F763	21.8.66	41 01.79	176 32.50 E	711	*Pillsburiaster aoteanus* (1)
F870	2.10.68	37 25.49	178 10.79 E	263	*Pseudarchaster garricki* (1)
F890	5.10.68	36 58.00	176 06.00 E	0	*Patiriella regularis* (2)
F906	10.10.68	35 22.00	174 51.49 E	260	*Pseudarchaster garricki* (45)
F909	"	35 06.40	175 10.99 E	1002	*Lithosoma novaezelandiae* (1)
F914	11.10.68	34 52.00	174 28.00 E	510	*Anthenoides granulosus* (1)
F915	"	34 58.69	174 18.00 E	251	*Athenoides cristatus* (2), *Pseudarchaster garricki* (24)
F916	12.10.68	34 38.50	173 28.00 E	249	*Mediaster sladeni* (1), *Pseudarchaster garricki* (3)
F930	15.10.68	34 28.70	173 01.50 E	0	*Patiriella regularis* (5)
F934	"	34 25.6	172 55.6 E	0	*Patiriella regularis* (2)
G56	27.2.67	43 49.99	175 40.00 W	232	*Pseudarchaster garricki* (1)
G154	12.11.67	42 46.00	173 40.00 E	137	*Mediaster sladeni* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
G155	"	42 46.00	173 38.99 E	137	*Mediaster sladeni* (1)
G156	13.11.67	42 58.00	173 30.00 E	110	*Odontaster benhami* (3)
G161	"	42 48.00	173 28.00 E	55	*Pentagonaster pulchellus* (3), *Odontaster benhami* (1), *Patiriella regularis* (3)
G162	15.11.67	42 55.0	173 33.0 E	101	*Odontaster benhami* (5), *Diplodontias miliaris* (3), *Patiriella regularis* (1)
G163	"	42 45.00	173 37.99 E	128	*Pseudarchaster garricki* (1)
G185	18.1.68	44 07.99	179 23.99 W	410	*Pseudarchaster garricki* (1)
G259	23.1.68	43 32.99	179 22.00 E	419	*Pseudarchaster garricki* (1)
G276A	24.1.68	43 34.99	179 15.00 E	413	*Pseudarchaster garricki* (5)
G283	24.1.68	43 31.00	179 07.00 E	413	*Pseudarchaster garricki* (1)
G283A	"	43 31.00	179 07.00 E	413	*Pseudarchaster garricki* (1)
G329	1.2.68	44 05.99	179 00.00 W	417	*Pseudarchaster garricki* (2)
G329A	"	44 05.99	179 00.00 W	417	*Pseudarchaster garricki* (1)
G343	2.2.68	43 47.99	178 52.00 W	408	*Pseudarchaster garricki* (1)
G403	7.2.68	43 54.00	179 43.99 W	391	*Pseudarchaster garricki* (1)
G651	17.1.70	44 00.00	174 31.00 E	572	*Pseudarchaster garricki* (1)
G660	18.1.70	44 25.00	172 00.00 E	63	*Patiriella regularis* (1)
G665	"	44 43.00	172 40.00 E	934	*Ceramaster patagonicus patagonicus* (1), *Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (4)
G666	"	44 52.19	172 20.20 E	1015	*Ceramaster patagonicus patagonicus* (1), *Mediaster arcuatus* (1), *Pillsburiaster aoteanus* (2), *Pseudarchaster garricki* (16)
G667	19.1.70	44 57.00	172 04.99 E	872	*Ceramaster patagonicus patagonicus* (1), *Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (3)
G671	"	45 10.00	171 04.00 E	23	*Patiriella regularis* (2)
G672	"	45 20.00	170 57.00 E	29	*Pentagonaster pulchellus* (1), *Patiriella regularis* (14)
G673	"	45 27.00	171 01.00 E	48	*Pentagonaster pulchellus* (2), *Patiriella regularis* (1)
G674	"	45 27.00	171 12.00 E	98	*Odontaster benhami* (2)
G680	20.1.70	45 43.00	171 02.40 E	113	*Odontaster benhami* (5), *Patiriella regularis* (1)
G684	"	45 47.99	170 56.99 E	108	*Pentagonaster pulchellus* (1)
G685	"	45 52.99	170 48.00 E	68	*Pentagonaster pulchellus* (9), *Odontaster benhami* (2)
G686	"	45 53.00	170 54.00 E	108	*Odontaster benhami* (2)
G688	"	46 10.00	171 00.19 E	731	*Pseudarchaster garricki* (1)
G689	"	46 09.00	170 48.00 E	133	*Odontaster benhami* (6)
G690	21.1.70	46 09.00	170 36.00 E	78	*Mediaster arcuatus* (3), *Odontaster benhami* (1)
G691	"	46 09.00	170 24.00 E	63	*Pentagonaster pulchellus* (5), *Odontaster benhami* (1)
G695	"	46 19.69	170 11.80 E	73	*Pentagonaster pulchellus* (11)
G697	"	46 19.50	170 41.99 E	528	*Hippasteria phrygiana* (1)
G700	22.1.70	46 19.99	171 15.00 E	1116	*Pillsburiaster aoteanus* (1)
G707	24.1.70	45 48.19	170 56.20 E	91	*Pentagonaster pulchellus* (5)
G823	15.1.71	33 10.39	162 59.20 E	798	*Lithosoma novaezelandiae* (1)
G835	23.2.71	40 47.60	174 09.60 E	62	*Patiriella regularis* (2)
G836	11.9.72	41 27.00	174 49.12 E	6	*Eurygonias hyalacanthus* (1)
G877	6.12.70	43 37.00	173 31.00 E	80	*Odontaster benhami* (1)
G878	"	44 01.80	173 21.70 E	80	*Odontaster benhami* (1)
G879	"	44 12.00	173 05.00 E	100	*Odontaster benhami* (1)
G881	7.12.70	43 06.80	175 16.80 E	140	*Pseudarchaster garricki* (2), *Odontaster benhami* (2)
G884	12.1.70	47 52.00	179 09.00 E	180	*Odontaster aucklandensis* (1)
G886	13.12.70	48 13.99	179 40.99 E	335	*Ceramaster patagonicus patagonicus* (2), *Pseudarchaster garricki* (1)
G887	"	48 21.49	179 31.00 E	470	*Ceramaster patagonicus patagonicus* (1), *Hippasteria phrygiana* (1)
G888	13.12.70	48 16.00	177 50.39 E	1020	*Ceramaster patagonicus patagonicus* (3)
G893	16.12.70	49 37.00	178 19.00 E	570	*Hippasteria phrygiana* (1)
G894	18.12.70	49 31.99	173 34.99 E	480	*Ceramaster patagonicus patagonicus* (2)
G898	19.12.70	49 12.70	171 40.39 E	150	*Pseudarchaster garricki* (4)
G900	20.12.70	49 04.90	171 26.89 E	470	*Ceramaster patagonicus patagonicus* (5)

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G901	21.12.70	49 13.49	171 30.10 E	260	*Ceramaster patagonicus patagonicus* (7), *Pillsburiaster aoteanus* (3), *Pseudarchaster garricki* (1)
G902	"	49 12.59	171 13.09 E	440	*Ceramaster patagonicus patagonicus* (1)
G903	"	49 10.10	170 58.00 E	550	*Ceramaster patagonicus patagonicus* (5)
G904	22.12.70	49 46.69	171 32.20 E	460	*Ceramaster patagonicus patagonicus* (5), *Hippasteria phrygiana* (1), *Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (1)
G905	23.12.70	50 04.30	171 43.39 E	500	*Ceramaster patagonicus patagonicus* (2)
G907	"	49 49.99	171 49.60 E	460	*Ceramaster patagonicus patagonicus* (1)
G908	24.12.70	49 46.90	172 36.90 E	480	*Ceramaster patagonicus patagonicus* (1)
G911	25.12.70	50 29.59	173 28.99 E	620	*Hippasteria phrygiana* (2)
G912	"	50 24.40	173 43.99 E	755	*Hippasteria phrygiana* (3), *Pillsburiaster aoteanus* (2)
G913	25.12.70	50 28.99	174 10.00 E	965	*Ceramaster patagonicus patagonicus* (3), *Pillsburiaster aoteanus* (1)
G914	7.1.71	50 59.10	169 49.49 E	560	*Ceramaster patagonicus patagonicus* (1)
G916	"	51 34.99	169 37.99 E	480	*Ceramaster patagonicus patagonicus* (2), *Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (1)
G917	8.1.71	52 01.99	169 13.00 E	200	*Ceramaster patagonicus patagonicus* (1)
G919	"	51 56.00	170 14.00 E	200	*Odontaster aucklandensis* (1)
G922	9.1.71	53 59.20	169 56.99 E	950	*Pillsburiaster aoteanus* (2)
G923	11.1.71	53 18.40	170 04.99 E	440	*Pillsburiaster aoteanus* (4)
G927	12.1.71	53 32.80	172 16.60 E	580	*Hippasteria phrygiana* (2), *Lithosoma novaezelandiae* (1)
G929	13.1.71	51 58.20	171 29.59 E	520	*Pseudarchaster garricki* (1)
G938	17.1.71	49 33.89	166 44.50 E	490	*Pseudarchaster garricki* (3)
G939	"	48 55.0	166 55.2 E	315	*Odontaster benhami* (1)
G953	2.6.73	42 35.80	177 16.99 E	1534	*Pseudarchaster macdougalli* (1)
H528	9.8.73	38 28.49	172 28.99 E	1175	*Pillsburiaster aoteanus* (1)
H917	12.8.73	43 48.80	176 42.10 W	15	*Pentagonaster pulchellus* (1), *Stegnaster inflatus* (3)
I2	2.5.75	35 47.99	174 50.20 E	122	*Mediaster sladeni* (2), *Pseudarchaster garricki* (2)
I5	"	35 47.99	174 50.20 E	122	*Athenoides cristatus* (1)
I6	3.5.75	35 47.80	175 36.60 E	257	*Athenoides cristatus* (1), *Mediaster sladeni* (2), *Pseudarchaster garricki* (28)
I7	"	35 47.80	175 50.10 E	367	*Pseudarchaster garricki* (1), *Rosaster mimicus* (1)
I11	4.5.75	35 35.89	175 12.79 E	308	*Pseudarchaster garricki* (1)
I24	5.5.75	35 22.30	175 47.20 E	615	*Anthenoides granulosus* (1), *Lithosoma novaezelandiae* (1)
I31	7.5.75	35 11.70	174 39.79 E	245	*Mediaster sladeni* (3), *Pseudarchaster garricki* (52)
I32	"	35 11.70	174 49.80 E	375	*Pseudarchaster garricki* (1)
I38	8.5.75	34 59.50	174 23.99 E	296	*Pseudarchaster garricki* (9)
I39	"	35 00.00	174 11.99 E	175	*Pseudarchaster garricki* (1)
I46	9.5.75	35 12.00	174 50.39 E	364	*Mediaster sladeni* (1), *Pseudarchaster garricki* (5)
I48	"	35 59.98	174 49.49 E	86	*Pseudarchaster garricki* (1)
I64	12.5.75	36 12.00	176 11.80 E	335	*Pseudarchaster garricki* (1)
I77	21.7.75	29 01.80	167 49.50 E	18	*Ophidiaster confertus* (2), *Fromia polypora* (2), *Linckia guildingi* (1), *Linckia multifora* (3)
I78	22.7.75	29 06.79	167 56.29 E	6	*Ophidiaster confertus* (1), *Linckia laevigata* (1)
I90	23.7.75	29 25.00	168 05.60 E	71	*Asterodiscides grayi* (2)
I95	24.7.75	29 04.09	167 55.50 E	15	*Ophidiaster confertus* (2)
I345	17.11.77	34 40.39	173 31.00 E	182	*Athenoides cristatus* (1), *Pseudarchaster garricki* (2)
I346	"	34 42.00	173 40.39 E	–	*Athenoides cristatus* (6), *Pseudarchaster garricki* (4)
I349	18.11.77	34 50.90	173 13.60 E	19	*Patiriella regularis* (1)
I351	19.11.77	34 40.60	173 50.50 E	0	*Anthenoides granulosus* (3)
I355	"	34 50.09	174 06.19 E	330	*Rosaster mimicus* (17)
I356	"	34 52.39	174 05.70 E	275	*Mediaster sladeni* (5), *Pseudarchaster garricki* (27)
I357	20.11.77	35 27.80	174 44.10 E	0–5	*Astrodiscides truncatus* (2)
I359	"	35 17.29	174 50.50 E	260	*Mediaster sladeni* (1), *Pseudarchaster garricki* (26)
I363	"	34 50.20	174 00.19 E	227	*Pseudarchaster garricki* (15)
I364	"	34 46.00	174 05.80 E	492	*Pseudarchaster garricki* (1)
I368	23.11.77	34 12.79	173 01.30 E	452	*Rosaster mimicus* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
I381	23.11.77	34 58.00	172 15.19 E	492	*Lithosoma novaezelandiae* (1)
I617	20.2.79	46 56.75	168 03.05 E	0 –10	*Patiriella regularis* (1)
I622	22.2.79	45 56.10	166 55.90 E	0–20	*Patiriella regularis* (1)
I624	"	45 58.60	166 50.70 E	0–17	*Patiriella regularis* (1)
I625	"	45 59.80	166 48.20 E	0–20	*Patiriella regularis* (1)
I627	"	46 02.50	166 46.90 E	0–25	*Patiriella regularis* (1)
I645	27.2.79	46 56.66	168 05.89 E	25	*Patiriella regularis* (1)
I651	28.2.79	46 56.47	168 06.78 E	24	*Patiriella regularis* (1)
I652	"	46 56.32	168 05.34 E	26	*Patiriella regularis* (1)
I653	"	46 55.50	168 05.70 E	24	*Patiriella regularis* (1)
I654	28.2.79	46 55.15	168 05.10 E	24	*Patiriella regularis* (1)
I664	12.3.79	47 39.79	179 27.79 W	595	*Hippasteria phrygiana* (1)
I667	13.3.79	47 45.59	179 16.99 W	648	*Ceramaster patagonicus patagonicus* (2), *Pseudarchaster garricki* (1)
I672	13.3.79	48 00.30	179 43.99 W	380	*Pseudarchaster garricki* (1)
I678	14.3.79	48 10.00	179 45.00 W	457	*Ceramaster patagonicus patagonicus* (2)
I679	15.3.79	48 10.00	180 00.00	327	*Ceramaster patagonicus patagonicus* (2), *Fromia monolis* (2)
I680	"	48 09.49	179 46.99 E	220	*Ceramaster patagonicus patagonicus* (1), *Hippasteria phrygiana* (1),
I683	"	48 18.49	179 56.80 W	516	*Ceramaster patagonicus patagonicus* (17)
I686	16.3.79	48 30.49	179 45.00 W	710	*Ceramaster patagonicus patagonicus* (1), *Pseudarchaster garricki* (1)
I690	17.3.79	48 50.99	179 15.00 E	700	*Ceramaster patagonicus patagonicus* (1), *Pseudarchaster garricki* (3)
I698	19.3.79	48 19.99	178 30.00 E	726	*Ceramaster patagonicus patagonicus* (1)
I699	"	48 16.00	179 00.00 E	532	*Ceramaster ppatagonicus atagonicus* (10)
I704	21.3.79	48 00.00	178 28.99 E	475	*Ceramaster patagonicus patagonicus* 1)
I707	22.3.79	47 19.99	179 30.00 E	552	*Pseudarchaster garricki* (1)
I719	25.3.79	44 07.30	175 55.20 E	140	*Odontaster aucklandensis* (1)
I723	9.5.79	29 27.20	159 04.70 E	2	*Ophidiaster confertus* (5), *Linckia laevigata* (1), *Linckia multifora* (1)
I729	10.5.79	26 40.40	159 27.00 E	306	*Nepanthia reinga* (1), *Tamaria giffordensis* (3)
I733	"	25 01.00	159 37.50 E	66	*Nardoa tumulosa* (1)
I744	12.5.79	22 22.00	159 11.00 E	317-316	*Tamaria giffordensis* (1)
I757	16.5.79	21 51.10	159 25.69 E	5–16	*Ophidiaster macknighti* (1)
I767	25.5.79	29 54.30	159 02.89 E	10	*Ophidiaster confertus* (?)
I768	26.5.79	29 55.60	159 03.10 E	0–14	*Linckia laevigata* (1), *Linckia multifora* (1)
I769	"	29 56.10	159 00.80 E	10	*Ophidiaster confertus* (?), *Fromia monilis* (2)
J31	16.4.70	38 39.00	169 15.00 E	525	*Lithosoma novaezelandiae* (1)
J40	18.4.70	36 49.99	170 00.00 E	2113	*Paragonaster ridgwayi* (1)
J42	19.4.70	36 50.00	170 26.00 E	2008	*Pillsburiaster maini* (1), *Hoplaster kupe* (2)
J44	"	36 40.00	170 13.00 E	2112	*Hoplaster kupe* (2)
J45	20.4.70	36 40.00	170 00.00 E	2146	*Pseudarchaster macdougalli* (1)
J48	"	36 30.00	170 25.99 E	2150	*Paragonaster ridgwayi* (1)
J51	21.4.70	36 52.00	170 42.00 E	2000	*Hoplaster kupe* (1)
J122	16.4.71	46 07.99	166 16.49 E	322	*Pentagonaster pulchellus* (13)
J157	2.2.72	39 02.99	174 00.00 E	14	*Patiriella regularis* (field notes)
J161	29.2.72	39 02.99	174 00.00 E	36	*Patiriella regularis* (field notes)
J291	27.11.72	39 02.99	174 00.00 E	6	*Patiriella regularis* (4)
J292	"	39 02.99	174 00.00 E	6	*Patiriella regularis* (field notes)
J481	6.12.73	49 00.79	170 24.60 E	730	*Ceramaster patagonicus patagonicus* (1), *Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (4)
J482	"	49 30.00	169 59.80 E	638	*Hippasteria phrygiana* (1) *Lithosoma novaezelandiae* (1)
J483	7.12.73	50 31.60	169 02.10 E	575	*Ceramaster patagonicus patagonicus* (1)
J484	"	50 34.60	168 59.59 E	575	*Ceramaster patagonicus patagonicus* (4), *Pseudarchaster garricki* (1)
J538	14.12.73	52 56.20	169 31.90 E	180	*Odontaster aucklandensis* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
J550	17.12.73	49 04.00	172 40.30 E	535	*Ceramaster patagonicus patagonicus* (14), *Pillsburiaster aoteanus* (2), *Pseudarchaster garricki* (10)
J675	8.9.74	37 32.10	177 11.09 E	20	*Ophidiaster macknighti* (3)
J678	"	37 24.70	177 11.99 E	352	*Rosaster endilius* (1)
J711	11.9.74	37 14.98	176 50.05 E	366	*Lithosoma novaezelandiae* (7)
J974	22.8.81	35 42.59	175 19.20 E	152	*Ophidiaster macknighti* (1)
K81	28.2.71	40 45.10	173 19.90 E	47	*Patiriella oliveri* (field notes)
K100	1.3.71	41 10.09	173 09.75 E	14	*Patiriella regularis* (field notes)
K102	"	41 10.09	173 09.75 E	14	*Patiriella regularis* (field notes)
K158	6.4.71	41 04.45	173 39.10 E	17	*Patiriella regularis* (1)
K795	18.7.74	33 02.60	179 36.40 W	350	*Hyalinothrix millespina* (1)
K800	22.7.74	29 11.89	177 50.80 W	555	*Mediaster gatrelli* (1)
K801	"	29 14.70	177 51.70 W	18	*Petricia vernicina* (2), *Acanthaster planci* (1)
K804	"	29 14.80	177 49.60 W	590	*Anthenoides granulosus* (5), *Mediaster gatrelli* (2),
K812	24.7.74	29 17.00	177 54.00 W	10	*Ophidiaster kermadecensis* (4), *Petricia vernicina* (4), *Acanthaster planci* (4)
K813	"	29 17.10	177 54.85 W	6	*Patiriella oliveri* (several)
K819					*Heteronardoa carinata* (1)
K820	"	29 13.30	177 59.80 W	95	*Heteronardoa carinata* (2)
K826	25.7.74	28 47.99	177 48.00 W	142	*Mediaster gatrelli* (4)
K829	26.7.74	29 13.00	177 52.39 W	610	*Kermitaster pacificus* (2), *Mediaster gatrelli* (11)
K833	28.7.74	30 14.00	178 25.10 W	18	*Ophidiaster kermadecensis* (2), *Petricia vernicina* (6), *Acanthaster planci* (1)
K834	28.7.74	30 13.80	178 25.30 W	8	*Patiriella oliveri* (10), *Ophidiaster kermadecensis* (5)
K848	30.7.74	30 32.90	178 33.60 W	60	*Ophidiaster kermadecensis* (field notes)
K860	"	30 35.80	178 25.69 W	605	*Mediaster gatrelli* (1)
K861	"	30 36.49	178 22.50 W	1030	*Rosaster mimicus* (3), *Sphaeriodiscus maui* (1)
K864	31.7.74	30 31.60	178 34.00 W	20	*Patiriella oliveri* (5)
K865	"	30 31.60	178 34.00 W	18	*Ophidiaster kermadecensis* (5)
K871	2.8.74	31 21.25	178 49.25 W	10	*Petricia vernicina* (1)
K989	10.2.77	46 56.29	168 09.50 E	22	*Patiriella regularis* (1)
K996	11.2.77	46 56.80	168 08.70 E	22	*Patiriella regularis* (field notes)
K997	"	46 56.80	168 08.60 E	23	*Patiriella regularis* (field notes)
M5A	19.11.74	41 05.99	174 52.99 E	–	*Patirirella regularis* (1)
M571	12.2.79	46 54.44	168 06.55 E	3	*Patiriella regularis* (field notes)
M574	13.2.79	46 56.30	168 08.70 E	13–14	*Patiriella regularis* (field notes)
M575	14.2.79	46 56.30	168 08.70 E	12	*Patiriella regularis* (field notes)
M579	16.2.79	46 54.52	168 07.35 E	–	*Patiriella regularis* (field notes)
M678	4.4.80	45 16.99	166 52.00 E	–	*Patiriella regularis* (1)
M679	"	45 16.99	166 52.00 E	–	*Patiriella regularis* (1)
M680	"	45 16.99	166 52.00 E	–	*Patiriella regularis* (4)
M681	"	45 16.99	166 52.00 E	–	*Patiriella regularis* (3)
M691	5.4.80	45 18.60	166 56.29 E	–	*Patiriella regularis* (6)
M775	30.3.81	44 38.88	167 55.20 E	20	*Patiriella regularis* (1)
M780	1.4.81	44 36.58	167 52.08 E	40	*Patiriella regularis* (1)
M790	4.4.81	44 37.10	167 51.53 E	35	*Stegnaster inflatus* (1)
N895	22.2.77	31 21.50	178 49.90 W	10	*Petricia vernicina* (1)
N923	28.8.77	41 24.90	175 02.50 E	27	*Patiriella regularis* (1)
O113	20.11.76	37 02.92	174 36.52 E	0	*Patiriella regularis* (1)
O129	24.11.76	37 00.60	174 34.15 E	0	*Patiriella regularis* (1)
O156	5.3.77	37 01.11	174 33.94 E	1	*Patiriella regularis* (1)
O158	6.3.77	37 02.60	174 36.52 E	4	*Patiriella regularis* (1)
O171	8.3.77	37 00.46	174 36.49 E	1	*Patiriella regularis* (numerous)
O172	"	36 59.76	174 37.09 E	5	*Patiriella regularis* (1)
O326	23.12.78	34 54.40	173 18.00 E	0	*Patiriella regularis* (1)
O327A	"	34 54.50	173 18.60 E	1.5	*Patiriella regularis* (1)
O327B	"	34 54.50	173 18.60 E	1.5	*Patiriella regularis* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
O332A	24.12.78	34 54.75	173 17.25 E	1.3	*Patiriella regularis* (1)
O333B	"	34 54.99	173 16.2 E	7.6	*Patiriella regularis* (1)
O335A	"	34 56.15	173 15.9 E	8	*Patiriella regularis* (2)
O335B	"	43 56.15	173 15.9 E	8	*Patiriella regularis* (1)
P7	25.1.77	32 40.99	167 28.60 E	150	*Ophidiaster macknighti* (1)
P18	"	29 34.60	168 03.00 E	90	*Asterodiscides grayi* (1)
P20	"	29 32.29	167 59.80 E	52	*Ophidiaster confertus* (1)
P22	26.1.77	29 30.89	167 58.79 E	56	*Ophidiaster confertus* (3)
P23A	26.1.77	29 06.74	167 56.94 E	15-24	*Ophidiaster confertus* (1), *Fromia milleporella* (1), *Linckia guildingi* (1)
P26	"	29 30.89	167 58.79 E	56	*Heteronardoa carinata* (1)
P29	28.1.77	18 54.49	167 57.79 E	37	*Ophidiaster confertus* (1)
P39	29.1.77	29 10.39	167 51.70 E	77	*Ophidiaster confertus* (1)
P40	"	29 10.20	167 49.99 E	394	*Anthenoides granulosus* (3)
P43	30.1.77	29 02.65	167 55.05 E	15	*Leiaster leachii* (2)
P46	"	28 42.18	167 56.42 E	475	*Glyphodiscus mcknighti* (1)
P51	"	29 06.90	167 57.30 E	5	*Fromia polypora* (2)
P52	"	29 06.80	167 57.00 E	0	*Patiriella exigua* (15)
P54	2.2.77	29 00.29	167 57.60 E	15	*Linckia guildingi* (1)
P61	5.2.77	35 14.29	172 42.19 E	216	*Pseudarchaster garricki* (1)
P65	7.2.77	35 04.99	172 26.59 E	302	*Mediaster sladeni* (7), *Pseudarchaster garricki* (79)
P66	"	35 03.79	172 22.60 E	435	*Mediaster sladeni* (1), *Pseudarchaster garricki* (2), *Rosaster mimicus* (1)
P67	8.2.77	37 04.60	174 00.79 E	338	*Mediaster sladeni* (1), *Pseudarchaster garricki* (4)
P68	9.2.77	38 39.00	172 38.20 E	313	*Mediaster sladeni* (2), *M. gatrelli* (3), *Rosaster mimicus* (2)
P88	28.5.77	31 33.20	159 02.20 E	0	*Patiriella exigua* (20)
P90	"	31 31.60	159 02.70 E	0	*Ophidiaster confertus* (1), *Leiaster leachii* (1), *Linckia guildingi* (1)
P94	30.5.77	31 31.60	159 05.10 E	10	*Ophidiaster confertus* (2)
P95	"	31 45.40	159 14.89 E	0	*Ophidiaster confertus* (2)
P108	31.5.77	31 32.10	159 01.20 E	30	*Ophidiaster confertus* (1), *Heteronardoa carinata* (1)
P109	"	31 30.19	158 57.89 E	69	*Heteronardoa carinata* (1)
P110	"	31 35.40	159 01.00 E	41	*Ophidiaster confertus* (2)
P119	3.6.77	35 45.00	165 02.39 E	950	*Mediaster arcuatus* (1)
P120	"	35 45.70	165 04.09 E	950	*Mediaster arcuatus* (8), *Pillsburiaster aoteanus* (2), *Pseudarchaster garricki* (14)
P589	1.7.78	34 14.59	172 35.80 E	90	*Linckia guildingi* (1)
P655	11.6.77	42 19.99	170 37.99 E	249	*Mediaster sladeni* (1), *Pseudarchaster garricki* (1)
P927	18.4.80	40 50.09	168 14.80 E	1009	*Hippasteria phrygiana* (1), *Mediaster arcuatus* (1)
P961	8.6.80	23 36.70	178 54.90 W	0–3	*Asteropsis carinifera* (1)
P967	11.6.80	29 14.70	177 51.00 W	3	*Ophidiaster kermadecensis* (3), *Petricia vernicina* (3), *Asteropsis carinifera* (2), *Acanthaster planci* (1)
P968	"	29 14.70	177 52.30 W	10	*Petricia vernicina* (2)
Q12B	15.3.78	43 51.49	179 51.40 W	410	*Pseudarchaster garricki* (1)
Q29	22.3.78	44 19.69	176 52.60 W	360	*Pseudarchaster garricki* (1), *Pseudarchaster* sp. (1)
Q30	23.3.78	44 17.10	176 53.70 W	250	*Mediaster sladeni* (1)
Q34	"	44 10.19	176 59.20 W	278	*Mediaster sladeni* (12), *Pseudarchaster garricki* (3)
Q35	"	44 03.40	176 49.90 W	100	*Pseudarchaster garricki* (1)
Q38	24.3.78	44 24.80	176 43.60 W	345	*Odontaster benhami* (1)
Q41	"	44 17.40	176 10.40 W	15	*Pentagonaster pulchellus* (3), *Diplodontias dilatatus* (1)
Q51	25.5.78	31 30.70	159 04.69 E	19	*Ophidiaster confertus* (1)
Q56	27.5.78	31 36.00	159 03.70 E	25	*Ophidiaster confertus* (1)
Q58	28.5.78	29 55.00	159 02.50 E	0	*Gomophia watsoni* (1)
Q60	29.5.78	29 55.00	159 02.50 E	0	*Ophidiaster confertus* (5)
Q61	30.5.78	29 27.00	159 05.50 E	0	*Ophidiaster confertus* (3), *Linckia laevigata* (7), *Linckia multifora* (3), *Mithrodia clavigera* (1)
Q62	"	29 27.00	159 05.50 E	0	*Ophidiaster confertus* (1), *Linckia guildingi* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
Q63	31.3.78	29 26.60	159 04.70 E	0	*Ophidiaster confertus* (4), *Linckia guildingi* (2), *Mithrodia clavigera* (1)
Q64	"	29 26.70	159 04.80 E	0	*Chaetaster moorei* (1), *Ophidiaster confertus* (3)
Q65	1.6.78	29 28.70	159 02.80 E	58	*Chaetaster moorei* (1)
Q69	2.6.78	27 00.00	159 18.30 E	354	*Nepanthia reinga* (1)
Q70	3.6.78	26 59.70	159 18.90 E	376	*Tamaria giffordensis* (3)
Q72	4.6.78	24 52.90	159 37.30 E	65	*Chaetaster moorei* (1)
Q78	5.6.78	29 55.30	159 02.90 E	0	*Ophidiaster confertus* (6), *Acanthaster planci* (1)
Q79					*Ophidiaster confertus* (1), *Linckia guildingi* (1)
Q82	6.6.78	31 31.70	159 02.80 E	0	*Nepanthia belcheri* (1)
Q83	7.6.78	33 00.19	163 01.20 E	816	*Mediaster arcuatus* (1)
Q85	2.11.78	41 13.40	174 28.50 E	340	*Odontaster benhami* (4), *Patiriella regularis* (2)
Q87	3.11.78	40 45.00	173 58.80 E	37	*Patiriella regularis* (8)
Q91	"	40 38.50	174 01.00 E	215	*Pentagonaster pulchellus* (1), *Patiriella regularis* (1)
Q93A	6.11.78	46 03.20	166 47.30 E	5	*Odontaster benhami* (1), *Patiriella regularis* (1)
Q93B	"	46 03.19	166 47.29 E	8	*Pentagonaster pulchellus* (3)
Q93C	"	46 03.2	166 47.3 E	16	*Patiriella regularis* (1)
Q97	"	46 03.00	166 46.20 E	5	*Patiriella regularis* (1)
Q99	7.11.78	46 04.80	166 37.60 E	6	*Pentagonaster pulchellus* (1), *Odontaster benhami* (1)
Q100	"	45 43.80	160 43.90 E	0	*Stegnaster inflatus* (1)
Q102	8.11.78	45 38.80	166 53.30 E	0	*Pentagonaster pulchellus* (1), *Patiriella regularis* (2)
Q104	9.11.78	45 01.60	167 15.40 E	0	*Patiriella regularis* (1)
Q105	"	44 38.10	167 52.80 E	0	*Patiriella regularis* (1)
Q107	12.11.78	40 55.00	173 45.50 E	0	*Pentagonaster pulchellus* (2), *Patiriella regularis* (2), *Stegnaster inflatus* (1)
Q111	"	41 06.50	173 58.90 E	0	*Patiriella regularis* (1)
Q118	13.11.78	41 11.80	174 00.00 E	0	*Pentagonaster pulchellus* (2), *Patiriella regularis* (5)
Q343	14.11.78	44 07.80	175 47.80 E	500	*Mediaster sladeni* (1), *Philonaster* sp. (1)
Q505	6.8.80	29 14.50	177 52.20 W	6	*Acanthaster planci* (8)
Q729	6.3.82	40 52.80	171 24.79 E	195	*Pseudarchaster garricki* (1)
Q774	25.7.82	45 54.50	166 40.9 E	35	*Stegnaster inflatus* (1)
R435	15.6.90	39 25.80	178 25.3 E	985	*Pseudarchaster garricki* (1), *Odontaster benhami* (1), *Odontaster rosagemmae* (1), *Eurygonias hyalacanthus* (1)
R439	16.6.90	39 26.80	178 19.99 E	1000	*Mediaster arcuatus* (1), *Pillsburiaster aoteanus* (1)
S14	13.9.78	48 17.29	168 42.10 E	607	*Ceramaster patagonicus* (1), *Lithosoma novaezelandiae* (10), *Pseudarchaster garricki* (1)
S14B	"	48 17.29	168 42.10 E	607	*Lithosoma novaezelandiae* (2), *Pillsburiaster aoteanus* (2)
S16	14.9.78	49 49.99	170 13.99 E	593	*Ceramaster patagonicus patagonicus* (2), *Pillsburiaster aoteanus* (2)
S30	18.9.78	50 41.00	167 40.80 E	265	*Odontaster aucklandensis* (2)
S36	20.9.78	52 34.30	169 14.30 E	80	*Paranepanthia aucklandensis* (3)
S41	"	52 55.50	169 32.70 E	184	*Odontaster aucklandensis* 3)
S43	21.9.78	53 29.10	170 04.20 E	93	*Ceramaster patagonicus patagonicus* (1), *Lithosoma novaezelandiae* (1), *Pseudarchaster garricki* (9)
S44	"	53 45.00	170 31.20 E	960	*Pillsburiaster aoteanus* (3)
S55	23.9.78	49 40.60	178 48.80 E	60	*Paranepanthia aucklandensis* (5)
S61	25.9.78	48 15.19	179 48.79 E	370	*Ceramaster patagonicus patagonicus* (3), *Hippasteria phrygiana* (1)
S65	26.9.78	48 10.35	179 41.29 E	490	*Ceramaster patagonicus patagonicus* (3), *Hippasteria trojana* (1)
S66	"	48 03.79	179 40.30 E	466	*Pseudarchaster garricki* (1)
S68	"	48 14.05	179 59.40 E	440	*Ceramaster patagonicus patagonicus* (2)
S70	"	47 45.59	178 30.79 E	353	*Ceramaster patagonicus patagonicus* (?)
S72	27.6.78	48 06.49	178 46.79 E	420	*Ceramaster patagonicus patagonicus* (?)
S80	23.11.78	47 50.20	179 15.20 E	126	*Odontaster aucklandensis* (1)
S121	20.10.79	43 30.59	175 58.09 E	335	*Pseudarchaster garricki* (2)
S122	"	43 35.50	175 57.30 E	322	*Mediaster sladeni* (5)
S123	"	43 37.09	175 56.59 E	322	*Mediaster sladeni* (1), *Pseudarchaster garricki* (1)
S126	"	43 33.40	175 58.60 E	322	*Mediaster sladeni* (1), *Pseudarchaster garricki* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
S127	"	43 35.40	175 57.30 E	322	*Mediaster sladeni* (2), *Pseudarchaster garricki* (1)
S130	21.10.79	43 34.00	175 57.70 E	335	*Mediaster sladeni* (1)
S134	23.10.79	44 09.00	176 06.50 E	126	*Odontaster benhami* (2)
S140	24.10.79	44 33.89	174 51.19 E	750	*Ceramaster patagonicus patagonicus* (1), *Lithosoma novaezelandiae* (6), *Pseudarchaster garricki* (2)
S141	"	44 32.59	174 51.79 E	730	*Lithosoma novaezelandiae* (1)
S142	"	44 30.89	174 52.50 E	715	*Ceramaster patagonicus patagonicus* (1), *Lithosoma novaezelandiae* (1), *Pseudarchaster garricki* (1)
S147	25.10.79	44 30.10	174 18.79 E	760	*Ceramaster patagonicus patagonicus* (1), *Lithosoma novaezelandiae* (4)
S148	"	44 40.99	174 20.89 E	859	*Pillsburiaster aoteanus* (3)
S155	28.10.79	44 05.30	173 11.40 E	85	*Odontaster benhami* (3)
S160	"	44 13.90	173 39.49 E	550	*Lithosoma novaezelandiae* (1)
S161	"	44 19.99	173 54.19 E	675	*Ceramaster patagonicus patagonicus* (1), *Pillsburiaster aoteanus* (1)
S166	29.10.79	44 25.39	174 07.39 E	720	*Ceramaster patagonicus patagonicus* (1)
S167	"	44 13.90	174 07.99 E	608	*Hippasteria phrygiana* (2)
S168	29.10.79	44 10.60	174 23.29 E	594	*Pseudarchaster garricki* (1)
S173	30.10.79	43 59.40	174 01.99 E	486	*Pseudarchaster garricki* (1)
S177	"	43 53.40	173 54.20 E	400	*Odontaster benhami* (1)
S180	31.10.79	43 30.00	173 35.00 E	100	*Odontaster benhami* (3)
S184	"	43 22.40	173 21.90 E	75	*Odontaster benhami* (1)
S186	"	43 16.50	173 35.60 E	450	*Odontaster benhami* (1)
S201	1.11.79	42 56.60	173 39.00 E	340	*Odontaster benhami* (1)
S215	4.11.79	42 40.00	173 44.59 E	750	*Ceramaster patagonicus* (1)
S217	"	42 41.40	173 31.80 E	130	*Odontaster benhami* (2)
S233	15.2.80	46 01.8	166 46.2 E	3	*Patiriella regularis* (2)
S247	19.2.80	44 37.70	167 52.70 E	22	*Pentagonaster pulchellus* (1), *Patiriella regularis* (1)
S251	20.2.80	45 10.85	167 07.40 E	20	*Pentagonaster pulchellus* (1), *Patiriella regularis* (3)
S259	21.2.80	45 27.0	167 09.8 E	40	*Patiriella regularis* (2)
S378	31.1.83	41 37.80	169 56.20 E	900	*Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (1)
S379	"	41 59.40	170 26.99 E	527	*Lithosoma novaezelandiae* (3)
S386	4.2.83	41 20.70	170 42.10 E	513–507	*Lithosoma novaezelandiae* (1)
S395	8.2.83	41 26.40	171 07.70 E	179–178	*Pseudarchaster garricki* (3)
S398	10.2.83	40 52.40	171 32.90 E	175–172	*Mediaster sladeni* (3), *Pseudarchaster garricki* (28)
S568	13.8.83	30 10.00	171 20.20 E	900	*Paragonaster stenostichus* (1)
S572	15.8.83	30 45.49	172 47.69 E	530	*Sphaeriodiscus irritatus* (1), *Tamaria tenellus* (1),
T17	10.3.81	47 22.00	179 28.69 E	450	*Pseudarchaster garricki* (1)
T29	12.3.81	48 20.29	179 30.70 W	768	*Pseudarchaster garricki* (3)
T31	"	48 23.50	179 39.49 W	687	*Mediaster arcuatus* (1), *Pseudarchaster garricki* (3)
T32	13.3.81	48 23.59	179 42.60 W	668	*Ceramaster patagonicus patagonicus* (?)
T36	"	48 43.69	179 27.10 E	775	*Hippasteria phrygiana* (1), *Mediaster arcuatus* (1)
T37	"	48 59.59	179 21.40 E	565	*Hippasteria phrygiana* (1)
T38	"	49 04.60	178 58.20 E	740	*Mediaster arcuatus* (7)
T43	14.3.81	49 40.50	178 49.60 E	–	*Paranepanthia aucklandensis* (1)
T48	15.3.81	49 18.60	177 54.70 E	990	*Mediaster arcuatus* (1)
T50	"	48 39.60	178 20.89 E	890	*Hippasteria trojana* (1)
T52	16.3.81	48 00.59	178 39.49 E	401–409	*Ceramaster patagonicus patagonicus* (3)
T53	16.3.81	48 00.59	178 39.49 E	–	*Ceramaster patagonicus patagonicus* (1)
T56	20.3.81	46 53.20	168 44.80 E	75	*Pseudarchaster garricki* (1)
T65	22.3.81	49 49.69	170 13.90 E	600	*Hippasteria phrygiana* (3)
T71	24.3.81	49 59.50	175 02.69 E	870	*Ceramaster patagonicus patagonicus* (2)
T72	25.3.81	50 25.49	173 44.40 E	692	*Ceramaster patagonicus patagonicus* (4)
T73	"	50 53.80	173 56.80 E	850	*Pseudarchaster garricki* (?)
T88	31.3.81	44 01.99	174 46.60 E	500	*Pseudarchaster garricki* (6)
T220	20.3.82	29 14.50	177 52.19 W	0	*Ophidiaster kermadecensis* (fragment)
T223	"	29 14.00	177 52.00 W	0	*Patiriella oliveri* (12), *Ophidiaster kermadecensis* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
T235	23.3.82	30 19.30	178 21.00 W	510	*Eknomiaster macauleyensis* (1)
T261	28.3.82	31 21.20	178 49.80 W	0	*Ophidiaster kermadecensis* (1), *Petricia vernicina* (1)
T449	3.12.83	42 42.60	173 29.50 E	17	*Diplodontias dilatatus* (4)
T459	5.12.83	41 45.00	174 15.00 E	27	*Pentagonaster pulchellus* (2), *Diplodontias dilatatus* (1), *Stegnaster inflatus* (1)
T460	"	41 18.20	174 08.10 E	27	*Patiriella regularis* (field notes)
T465	6.12.83	41 04.60	174 17.20 E	17	*Patiriella regularis* (2)
T478	7.12.83	41 03.20	174 21.50 E	93	*Patiriella regularis* (2)
T486	8.12.83	41 05.95	174 22.20 E	21	*Patiriella regularis* (2)
T501	10.12.83	41 15.95	174 02.50 E	14	*Patiriella regularis* (1)
T503	"	41 13.40	173 59.85 E	19	*Patiriella regularis* (1)
T505	"	41 16.50	173 59.90 E	13	*Patiriella regularis* (2)
T528	13.12.83	40 59.25	174 08.60 E	19	*Patiriella regularis* (1)
T531	"	40 58.55	174 05.80 E	16	*Patiriella regularis* (1)
T537	"	40 55.10	174 08.10 E	33	*Patiriella regularis* (1)
T539	"	40 55.00	174 05.90 E	32	*Patiriella regularis* (3)
T554	14.12.83	41 05.30	173 48.10 E	18	*Patiriella regularis* (1)
T559	15.12.83	41 03.50	173 57.40 E	65	*Patiriella regularis* (1)
T562	"	41 05.20	174 01.55 E	21	*Patiriella regularis* (1)
T567	"	41 09.30	173 49.7 0 E	11	*Patiriella regularis* (1)
T574	17.12.83	41 23.09	170 52.99 E	247	*Pseudarchaster garricki* (1)
T586	19.12.83	41 03.90	173 38.5 0 E	21	*Patiriella regularis* (1)
T587	20.12.83	41 03.80	173 40.60 E	17	*Patiriella regularis* (field notes)
T588	"	41 03.50	173 42.60 E	17	*Patiriella regularis* (field notes)
T601	21.12.83	4051.10	173 57.50 E	35	*Patiriella regularis* (1)
T603	"	40 47.40	173 58.70 E	23	*Patiriella regularis* (field notes)
T605	"	40 44.80	173 58.50 E	27	*Patiriella regularis* (field notes)
T752	2.12.85	Snares Islands		0–20	*Diplodontias dilatatus* (3), *Eurygonias hyalacanthus* (1)
T754	3.12.85	Snares Islands		0–20	*Pentagonaster pulchellus* (4), *Diplodontias dilatatus* (1)
T758	6.12.85	Snares Islands		0	*Diplodontias dilatatus* (1)
T760	7.12.85	Snares Islands.		20	*Odontaster benhami* (1), *Diplodontias dilatatus* (1)
T1020	22.6.88	41 00.80	174 14.10 E	16	*Patiriella regularis* (1)
U195	23.9.82	34 31.50	166 21.00 E	2930	*Paragonaster* sp. (1)
U197	25.9.82	34 09.79	163 36.70 E	1186	*Mediaster arcuatus* (5), *Pillsburiaster aoteanus* (6), *Pseudarchaster garricki* (9)
U198	26.9.82	34 59.29	162 11.20 E	1573	*Pillsburiaster aoteanus* (1)
U226	16.10.82	38 37.30	165 36.00 E	7421	*Hoplaster kupe* (numerous)
U227	18.10.82	39 33.89	169 14.69 E	604	*Pseudarchaster garricki* (3)
U569	3.2.88	34 55.49	169 22.39 E	1210	*Pillsburiaster aoteanus* (1), *Pseudarchaster garricki* (1)
U591	7.2.88	30 50.59	172 48.29 E	486	*Pseudoceramaster hunti* (1), *Rosaster endilius* (1)
U594	"	30 20.10	172 59.6 E	406	*Ceramaster glasbyi* (1), *Nepanthia grangei* (1), *Dissogenes petersi* (6)
U595	"	30 21.49	173 08.70 E	1474	*Pillsburiaster aoteanus* (1)
V375	13.9.89	44 05.56	179 02.35 E	470	*Ceramaster patagonicus patagonicus* (1), *Pillsburiaster aoteanus* (1)
V381	15.9.89	43 20.46	177 00.04 E	242	*Pseudarchaster garricki* (1)
V387	16.9.89	43 49.62	176 59.81 E	498	*Hippasteria phrygiana* (2)
V388	"	43 34.83	176 59.91 E	331	*Mediaster sladeni* (1)
V389	"	43 20.02	176 59.83 E	237	*Pseudarchaster garricki* (6)
Z1842	–	Off Mana Island. (field notes)		146	*Odontaster benhami* (field notes), *Patiriella regularis* (field notes)
Z1926	23.11.62	34 49.99	165 00.00 E	480	*Anthenoides granulosus* (1)
Z1927	22.11.62	30 05.00	177 00.00 E	0	*Patiriella oliveri* (7)
Z1996	–	29 15.00	177 55.00 W	0	*Patiriella oliveri* (1)
Z2098	4.9.67	28 39.49	173 01.00 E	850	*Rosaster endilius* (1)
Z2318	14.9.69	41 05.00	176 04.00 E	0	*Patiriella regularis* (1)
Z2322	19.5.70	41 16.30	174 54.50 E	0	*Patiriella regularis* (6)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
Z2363	1.1.71	37 20.99	176 25.99 E	311	*Anthenoides granulosus* (1), *Mediaster sladeni* (1), *Pseudarchaster garricki* (5)
Z2364	–.–.71	37 25.00	176 25.99 E	277	*Athenoides cristatus* (1), *Pseudarchaster garricki* (9)
Z2365	"	37 19.99	176 28.99 E	373	*Pseudarchaster garricki* (8)
Z2366	"	37 19.00	176 26.50 E	366	*Anthenoides granulosus* (1), *Pseudarchaster garricki* (1)
Z2367	"	37 20.99	176 30.00 E	339	*Mediaster sladeni* (2), *Pseudarchaster garricki* (1)
Z2369	"	36 52.50	176 23.99 E	307	*Anthenoides epixanthus* (1)
Z2371	15.4.71	41 22.99	170 46.99 E	366	*Mediaster sladeni* (1)
Z2372	"	41 32.99	170 46.00 E	294	*Mediaster sladeni* (1), *Pseudarchaster garricki* (1)
Z2373	"	41 32.99	170 38.99 E	274	*Mediaster sladeni* (1)
Z2374	16.4.71	42 09.00	170 36.00 E	366	*Mediaster sladeni* (2)
Z2375	"	42 30.00	170 36.00 E	348	*Lithosoma novaezelandiae* (1), *Mediaster sladeni* (1), *Anseropoda aotearoa* (1)
Z2464	-.-.71	29 01.99	167 56.99 E	15	*Linckia guildingi* (1)
Z3845	30.3.73	40 59.00	174 03.00 E	30	*Patiriella regularis* (1)
Z3865	8.1.80	Lyall Bay, Wellington		5	*Diplodontias dilatatus* (1)
Z8371	10.8.95	39 50.00	177 39.000 E	1000–1100	*Pillsburiaster aoteanus* (1)
Z6173		Makara, Wellington		0	*Diplodontias dilatatus* (3), *Pillsburiaster aoteanus* (1)
Z8263	"	36 33.40	176 07.80 E	250	*Anthenoides cristatus* (1)
Z8568	18.10.96	36 55.74–37 02.70	176 17.24–176 15.82 E	405–404	*Anthenoides cristatus* (1)
Z8635					*Odontaster benhami* (1)
Z8978	13.1.97	44 08.54–44 08.13	178 37.83–178 41.97 W	482–483	*Odontaster rosagemmae* (1)
Z8679					*Ceramaster patagonicus patagonicus* (1)
Z8985	17.1.98	37 28.93–37 31.33	176 31.93–176 34.21 E	247–256	*Anthenoides cristatus* (1)
Z8993	18.1.98	37 37.77–37 36.68	176 42.89–176 39.36 E	299–340	*Anthenoides cristatus* (1)
Z8994	19.1.98	37 20.19–37 21.54	176 22.04–176 24.15 E	242–272	*Anthenoides granulosus* (1)
Z9000	20.1.98	37 37.11–37 39.62	177 13.94–177 13.08 E	460–467	*Odontaster rosagemmae* (1)
Z9001	"	37 37.89–37 40.44	177 09.10–177 09.45 E	445–467	*Anthenoides granulosus* (1)
Z9003	"	37 32.61–37 33.56	177 05.01–177 08.60 E	323–327	*Anthenoides granulosus* (9)
Z9005	21.1.98	37 37.00–37 37.04	176 48.50–176 44.73 E	360–367	*Anthenoides granulosus* (1)
Z9009	22.1.98	37 13.40–37 15.42	176 14.37–176 11.52 E	224–264	*Anthenoides cristatus* (3)
Z9011	"	37 05.60–37 02.74	176 15.20–176 16.44 E	393–435	*Anthenoides granulosus* (1)
Z9019	24.1.98	36 52.65–36 49.65	176 14.08–176 13.83 E	200–212	*Anthenoides cristatus* (1)
Z9020	"	36 42.17–36 39.23	176 15.89–176 01.11 E	520–527	*Anthenoides granulosus* (1)
Z9022	"	36 38.78–36 41.61	17610.97–176 12.21 E	535–545	*Anthenoides granulosus* (1)
Z9188	9.5.98	46 47.74–46 48.84	166 56.22–167 00.45 E	800–842	*Ceramaster patagonicus patagonicus* (1)
Z9194	13.5.98	49 13.92–49 16.45	168 15.24–168 15.24 E	637–639	*Ceramaster patagonicus patagonicus* (1)
Z9302	15.9.98	49 09.99	168 36.00 E	750	*Ceramaster patagonicus patagonicus* (1)
Z9380	16.9.98	34 07.03–34 07.06	162 48.06–162 49.06 E	582	*Ceramaster patagonicus patagonicus* (1)

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
Z9604	11.12.98	48 33.60	164 57.50 E	1056	*Anthenoides cristatus* (1)
Z9568	11.1.98	43 42.39–	178 43.53–	424–	*Odontaster rosagemmae* (2)
		43 42.38	178 47.67 W	445	
Z9576					*Ceramaster patagonicus patagonicus* (1)
Z9611					*Ceramaster patagonicus patagonicus* (1)
Z9793	4.7.99	42 43.52–	179 55.23–	1055–	*Pillsburiaster aoteanus* (1)
		42 43.49	179 55.46 W	1110	
Z9898					*Tremaster mirabilis novaecaledoniae* (2)
KAH9401/2					*Anthenoides granulosus* (1)

Museum of New Zealand (NMNZ)
List of specimens recorded from different localities. For location see map on p. 266.

Location and Collector or vessel	Date	Cat. No. (Ech.)	Depth (m)	Species and number
Cook Strait		29		*Pentagonaster pulchellus* (1)
Cook Strait, coll. M.K. Mestayer		30		*Pentagonaster pulchellus* (1)
Wellington Harbour, Worser Bay	1922	37		*Pentagonaster pulchellus* (4)
Wellington Harbour, Thorndon	20.3.24	87		*Pentagonaster pulchellus* (1)
Kermadec Is, coll. Haylock		91		*Pentagonaster pulchellus* (2)
Auckland Is, Laurie Harbour coll. W.H. Dawbin	16.2.43	161		*Pentagonaster pulchellus* (1)
Admiralty Bay, coll. A.M. Rapson		179		*Pentagonaster pulchellus* (1)
Wellington Harbour, Oriental Bay coll. Haylock		180		*Pentagonaster pulchellus* (2)
Cook Strait	-.1.33	181		*Pentagonaster pulchellus* (1)
Stewart Island, Ocean Beach coll. R.K. Dell	31.10.48	182		*Pentagonaster pulchellus* (2)
Foveaux Strait, N. of Ruapuke Is	30.4.50	183	20–23	*Pentagonaster pulchellus* (2)
Foveaux Strait, N. of Ruapuke Is	30.4.50	184	20–23	*Pentagonaster pulchellus* (4)
Wellington, Lyall Bay, coll. R. Clark	-.2.34	185		*Pentagonaster pulchellus* (1)
Otago, edge of Canyon A, *Alert*, 35°8'S, 171°2'E	14.8.55	511	219	*Pentagonaster pulchellus* (6)
Foveaux Strait, coll. B.M. Bary	16.1.51	545	36	*Pentagonaster pulchellus* (1)
Cape Campbell	-.3.57	571	109–128	*Mediaster sladeni* (1)
Oamaru, coll. W.R.B. Oliver	18.12.51	580		*Pentagonaster pulchellus* (1)
Lord Howe Is, south reef	14.11.13	621		*Pentagonaster pulchellus* (1)
Chatham Is, The Sisters, *Alert*	29.1.54	643		*Pentagonaster pulchellus* (1)
Chatham Rise, 44°02'S, 177°19'W, *Alert*	10.1.54	647	236	*Mediaster sladeni* (1)
Hastings, Te Awanga, coll. P.M. Burden	-.9.57	653		*Pentagonaster pulchellus* (2)
Otago, east coast, 45°47'S, 171°7'E, *Alert*	16.8.55	654	457–549	*Mediaster sladeni* (2)
Bay of Plenty, off Mayor Is, 37°20.5'S, 176°26.5'E, *Alert*	27.2.57	727	493	*Anthenoides granulosus* (1)
Bay of Plenty		738		*Anthenoides granulosus* (3)
Oamaru, coll. J. Graham	-.-.60	760	36–54	*Pentagonaster pulchellus* (3)
Cook Strait, Chetwode Is, coll. R.A. Falla	12.11.61	769		*Pentagonaster pulchellus* (1)
Cavalli Is, N.Z. Marine Dept	23.11.62	851	479	*Anthenoides granulosus* (2)
Queen Charlotte Sound, Long Is coll. M.A. Crozier	21.9.63	858		*Pentagonaster pulchellus* (2)
Foveaux Strait, coll. B. Nielson	1964	917	29–36	*Pentagonaster pulchellus* (6)

Location and Collector or vessel	Date	Cat. No. (Ech.)	Depth (m)	Species and number
Foveaux Strait, coll. B. Nielson	1964	918	29–36	*Pentagonaster pulchellus* (11)
Tory Channel, Erie Bay, coll. E.M. Perano	1961–1964	957		*Pentagonaster pulchellus* (2)
Bay of Plenty, N of Mayor Is coll. R.B. Pike	28.9.62	1009	365	*Pseudarchaster garricki* (1)
Great Barrier Is, coll. R.B. Pike	9.11.62	1014	365	*Anthenoides granulosus* (1)
Bay of Plenty	22.11.62	1015		*Pentagonaster pulchellus* (3)
Fiordland, Puysegur Pt, coll. M. Pilone	1967	1188		*Pentagonaster pulchellus* (1)
Pegasus Bay, *James Cook*	27.8.71	1261	585	*Hippasteria phrygiana* (2)
Auckland Is, *James Cook*	21.2.72	1262	560–306	*Hippasteria phrygiana* (1)
Auckland Is, *James Cook*	21.2.72	1263	558	*Hippasteria phrygiana* (1)
Auckland Is, *James Cook*	21.2.72	1264	540	*Hippasteria phrygiana* (1)
Farewell Spit, *James Cook*	15.1.70	1265	244	*Mediaster sladeni* (1)
Greymouth, off, *James Cook*	23.11.70	1266	405–423	*Mediaster sladeni* (1)
Ninety Mile Beach, *James Cook*	11.1.71	1267	274	*Mediaster sladeni* (3)
Mernoo Bank		1268		*Mediaster sladeni* (3)
Port Pegasus, off, *James Cook*	14.8.71	1269	429–456	*Mediaster sladeni* (3)
Hokianga, *James Cook*	12.1.71	1270	260	*Mediaster sladeni* (4)
Solander Trough, *James Cook*	24.4.71	1271	320	*Mediaster sladeni* (2)
Kaipara Harbour, *James Cook*	9.1.71	1272	113	*Pentagonaster pulchellus* (1)
Stewart Is, Port Pegasus, *Acheron*	27.2.1972	1273	30	*Pentagonaster pulchellus* (1)
Stewart Is, Port Pegasus, *Acheron*	26.2.72	1274	40	*Pentagonaster pulchellus* (2)
Hokianga, *James Cook*	12.1.71	1275	260	*Pseudarchaster garricki* (9)
Farewell Spit, *James Cook*	15.1.71	1276	241	*Pseudarchaster garricki* (2)
Ninety Mile Beach, *James Cook*	11.1.71	1277	274	*Pseudarchaster garricki* (4)
Oamaru, *James Cook*	14.8.71	1278	405	*Pseudarchaster garricki* (1)
Pegasus Bay, *James Cook*	27.8.71	1279	585	*Pseudarchaster garricki* (1)
Hokianga, *James Cook*	12.1.71	1496	260	*Pseudarchaster garricki* (1)
Auckland Is, *James Cook*	21.2.72	1497	558	*Ceramaster patagonicus patagonicus* (1)
37°02'S, 17°13'E, coll. R.D. Cooper	1.1.69	1598	255–292	*Anthenoides granulosus* (2)
37°06'S, 176°15'E, coll. R.D. Cooper	8.1.69	1603	340–394	*Anthenoides granulosus* (2)
37°05'S, 176°12'E, coll. R.D. Cooper	7.1.69	1605	293–332	*Mediaster sladeni* (22)
37°06'S, 176°13.5 'E, coll. R.D. Cooper	7.1.69	1606	293–346	*Mediaster sladeni* (15)
Chatham Rise	1.2.54	1607	228	*Mediaster sladeni* (1)
37°04'S, 176°14'E, coll. R.D. Cooper	1.1.69	1608	365–410	*Mediaster sladeni* (3)
37°06'S, 176°15'E, coll. R.D. Cooper	8.1.69	1609	340–394	*Mediaster sladeni* (1)
Bay of Plenty, coll. R.D. Cooper	-.1.69	1610	150–306	*Mediaster sladeni* (1)
Chatham Rise	10.2.54	1611	228	*Mediaster sladeni* (1)
Oamaru, between Moeraki and	-.11.54	1612	73–109	*Pentagonaster pulchellus* (7)
Stewart Is, Paterson Inlet, coll. R.K. Dell	29.10.48	1613		*Pentagonaster pulchellus* (3)
Pukerua Bay, coll. P. Conway	5.6.65	1614		*Pentagonaster pulchellus* (1)
Makara, Wellington, coll. W. Heaphy	20.6.54	1615		*Pentagonaster pulchellus* (1)
Kapiti Is	30.11.69	1618	23	*Pentagonaster pulchellus* (1)
Kapiti Is	16.11.69	1619	7	*Pentagonaster pulchellus* (1)
Kapiti Is	30.11.69	1620	21	*Pentagonaster pulchellus* (1)
Mana Is	8.6.69	1622	5	*Pentagonaster pulchellus* (1)
Mana Is	27.4.69	1623	23	*Pentagonaster pulchellus* (1)
Mana Is	27.4.69	1624	5	*Pentagonaster pulchellus* (1)
27°05'S, 176°12'E, coll. R.D. Cooper	7.1.69	1626	293–332	*Pseudarchaster garricki* (10)
37°02'S, 176°13'E, coll. R.D. Cooper	1.1.69	1627	255–292	*Pseudarchaster garricki* (18)
37°08'S, 176°15'E, coll. R.D. Cooper	1.1.69	1628	380–400	*Pseudarchaster garricki* (24)
36°59'S, 176°16'E, coll. R.D. Cooper	2.1.69	1629	350–376	*Pseudarchaster garricki* (9)
37°03'S, 176°17'E, coll. R.D. Cooper	8.1.69	1630	293–475	*Pseudarchaster garricki* (3)
37°01'S, 176°14'E, coll. R.D. Cooper	1.1.69	1631	210–372	*Pseudarchaster garricki* (5)
37°06'S, 176°13.5'E, coll. R.D. Cooper	7.1.69	1632	255–292	*Pseudarchaster garricki* (98)
36°32'S, 176°14'E, coll. R.D. Cooper	2.1.69	1633	480–555	*Pseudarchaster garricki* (1)
35°23'S, 176°06'E, coll. R.D. Cooper	10.1.69	1634	350–373	*Pseudarchaster garricki* (1)
37°16'S, 176°16'E, coll. R.D. Cooper	8.1.69	1635	361–410	*Pseudarchaster garricki* (21)
37°06'S, 176°19'E, coll. R.D. Cooper	8.1.69	1636	440–450	*Pseudarchaster garricki* (5)
37°08'S, 176°18'E, coll. R.D. Cooper	8.1.69	1637	370–408	*Pseudarchaster garricki* (68)

Location and Collector or vessel	Date	Cat. No. (Ech.)	Depth (m)	Species and number
37°04'S, 176°14'E, coll. R.D. Cooper	1.1.69	1638	365–410	*Pseudarchaster garricki* (58)
Bay of Plenty	13.6.62	1639	457	*Pseudarchaster garricki* (1)
35°29'S, 175°02'E, *Acheron*	14.2.74	1677	256–360	*Pseudarchaster garricki* (1)
35°29'S, 175°02'E, *Acheron*	14.2.74	1679	256–360	*Mediaster sladeni* (1)
34°49'S, 174°17'E	24.2.74	1680	468–475	*Anthenoides granulosus* (1)
Port Pegasus	20.2.72	1705	23–27	*Pentagonaster pulchellus* (1)
Pukaki Rise, 50°01'S, 172°16'E	15.1.77	2016	484–487	*Pseudarchaster garricki* (1)
Snares Island Shelf, 48°19'S, 167°55'E		2017	210–292	*Lithosoma novaezelandiae* (2)
Cathedral Banks, 51°20'S, 166°34'E	19.1.77	2019	646–670	*Pseudarchaster garricki* (1)
Snares Island Shelf, 48°10'S, 168°13'E	23.1.77	2020	700–706	*Lithosoma novaezelandiae* (1)
Snares Island Shelf, 48°10'S, 168°13'E	23.11.77	2023	700–706	*Lithosoma novaezelandiae* (1)
Westport, 40°51'S, 170°56'E	25.9.76	2024	212–332	*Pseudarchaster garricki* (2)
Cathedral Banks, 51°48'S, 167°23'E	19.1.77	2025	670–680	*Lithosoma novaezelandiae* (1)
Cathedral Banks, 51°48'E, 167°23'E	19.1.77	2026	670–680	*Ceramaster patagonicus patagonicus* (1)
Otago, Taiaroa Trench	18.8.74	2027	670–680	*Pillsburiaster aoteanus* (3)
Otago, Taiaroa Trench	18.8.74	2029	700–760	*Pillsburiaster aoteanus* (2)
Snares Island Shelf, 48°10'S, 168°13'E	23.11.77	2030	700–706	*Ceramaster patagonicus patagonicus* (1)
Perpendicular Point, 41°57'S, 170°25'E	27.9.76	2038	556–598	*Lithosoma novaezelandiae* (1)
Challenger Plateau, 39°14'S, 169°27'E	23.9.76	2039	560–572	*Lithosoma novaezelandiae* (1)
Westland, 40°53'S, 171°11'E	28.9.76	2042	350–400	*Lithosoma novaezelandiae* (4)
Challenger Plateau, 39°03'S, 169°08'E	22.9.76	2044	484–508	*Lithosoma novaezelandiae* (2)
Westport, 40°51'S, 170°56'E	24.9.76	2045	492–528	*Lithosoma novaezelandiae* (1)
Westport, 40°51'S, 170°66'E	25.9.76	2046	212–332	*Lithosoma novaezelandiae* (4)
Westland, 40°53'S, 171°11'E	28.9.76	2047	350–400	*Lithosoma novaezelandiae* (1)
Challenger Plateau, 38°58'S, 169°21'E	22.9.76	2048	520–528	*Lithosoma novaezelandiae* (1)
Otago, Taiaroa Trench	18.8.74	2049	700–760	*Lithosoma novaezelandiae* (3)
46°18'S, 166°35'E, *James Cook*	15.12.77	2383	200	*Lithosoma novaezelandiae* (1)
43°13.1'S, 173°51'E, *James Cook*	18.12.77	2384	610	*Hippasteria phrygiana* (2)
Foveaux Strait		2386		*Ceramaster patagonicus patagonicus* (1)
46°59'S, 169°58.8'E, *James Cook*	14.12.77	2387	745–750	*Pillsburiaster aoteanus* (1)
456°59'S, 169°58.8'E, *James Cook*	14.12.77	2388	745–750	*Lithosoma novaezelandiae* (1)
46°18'S, 166°35'E, *James Cook*	15.12.77	2389	200	*Mediaster sladeni* (2)
Oamaru		2406	intertidal	*Pentagonaster pulchellus* (4)
Bounty Plateau, coll. J. James	17.11.75	2418	502–547	*Ceramaster patagonicus patagonicus* (2)
Auckland Is	21.2.72	2419	558	*Hippasteria phrygiana* (3)
Snares Is, *James Cook*	16.12.77	2672	600	*Mediaster sladeni* (2)
Campbell Rise, *James Cook*	19.1.78	2698	687–695	*Hippasteria phrygiana* (2)
Campbell Rise, *James Cook*	19.1.78	2699	687–695	*Ceramaster patagonicus patagonicus* (4)
Auckland Island Shelf, *James Cook*	21.1.77	2700	520–562	*Ceramaster patagonicus patagonicus* (3)
46°49'S, 169°48'E	24.10.79	3100	120	*Ceramaster patagonicus patagonicus* (1)
46°49'S, 169°48'E	24.10.79	3102	120	*Lithosoma novaezelandiae* (1)
46°49'S, 169°48'E	24.10.79	3103	120	*Pillsburiaster aoteanus* (4)
Challenger Plateau		3381	–	*Lithosoma novaezelandiae* (2)
48°59.04'S, 171°04'E	6.1.78	3434	–	*Ceramaster patagonicus patagonicus* (1)
Bounty Plateau, *Shinkai Maru*, Stn 79	17.11.75	3437		*Ceramaster patagonicus patagonicus* (2)
Wellington Harbour, coll. W. Anderson	21.6.79	3439		*Pentagonaster pulchellus* (1)
Bounty Plateau, 48°24'S, 178°50'E	17.11.75	3460		*Hippasteria phrygiana* (1)
48°59'04"S, 171°04'E	6.1.78	3461	–	*Hippasteria phrygiana* (1)
Wanganella Bank	10.9.74	3780	–	*Milteliphaster wanganellensis* (1)
Norfolk Ridge		3781		*Rosaster mimicus* (1)
Chatham Rise, coll. B.M. Marshall	10.1.81	3782		*Rosaster mimicus* (1)
Aldermen Is	23.1.79	3783		*Rosaster mimicus* (1)
Chatham Is, coll. S. & A. Penniket	11.12.82	3872		*Pentagonaster pulchellus* (1)
Castlepoint, 40°50.2'S, 176°59.2'E	26.11.81	3900	1180–1200	*Pillsburiaster aoteanus* (1)
Castlepoint, 40°50.2'S, 176°59.2'E	26.11.81	3901	1180–1200	*Hippasteria phrygiana* (1)
Chatham Rise, 44°07.3'S, 178°26.4'E	14.12.81	3904	1000–1040	*Hippasteria phrygiana* (1)
42°49.9'S, 177°13'W	10.6.79	3911	890	*Hippasteria phrygiana* (2)
Cape Reinga, 34°04'S, 172°12.9'E	23.4.81	4093	481–503	*Mediaster sladeni* (2)
Cape Reinga, 34°04'S, 172°12.9'E	23.4.81	4094	481–503	*Rosaster mimicus* (1)

Location and Collector or vessel	Date	Cat. No. (Ech.)	Depth (m)	Species and number
44°49.4'S, 172°49.1'E, *James Cook*	18.2.84	4166	1166–1179	*Hippasteria phrygiana* (1)
44°41.2'S, 173°07.7'E, *James Cook*	10.6.84	4167	830–860	*Hippasteria phrygiana* (1)
44°35.1'S, 174°02.9'E, *James Cook*	15.6.84	4168	870–890	*Hippasteria phrygiana* (1)
42°45.4'S, 177°03.6'W, *Kaltan*		4169	1100	*Hippasteria phrygiana* (3)
42°46.1'S, 176°55.1'W, *Kaltan*		4170	1100	*Hippasteria phrygiana* (1)
42°38.1'S, 176°39.6'W, *Kaltan*		4177	1140	*Pseudarchaster macdougalli* (2)
42°50.8'S, 177°19.1'W, *Kaltan*		4179	810	*Pillsburiaster aoteanus* (1)
42°38.1'S, 176°39.6'W, *Kaltan*		4180	1140	*Pillsburiaster aoteanus* (1)
41°13.8'S, 176°22'E, *James Cook*	2.4.84	4181	1193	*Pillsburiaster aoteanus* (1)
42°45.5'S, 177°03.6'W, *Kaltan*		4188	1100	*Pillsburiaster aoteanus* (1)
42°45.5'S, 177°26.0'W, *Kaltan*		4189	1070	*Pillsburiaster aoteanus* (1)
44°37.8'S, 173°25.6'E	11.6.84	4196	772–790	*Mediaster arcuatus* (2)
40°46.1'S, 176°59.6'E, *Kalinovo*	25.11.81	4197	1010–1035	*Ceramaster patagonicus patagonicus* (1)
44°37.8'S, 173°25.6'E, *James Cook*	11.6.84	4199	772–790	*Pillsburiaster aoteanus* (2)
40°46.1'S, 176°59.6'E, *Kalinovo*	25.11.81	4200	110–1035	*Mediaster arcuatus* (3)
44°52'S, 173°12'E, *Aktuba*	4.12.79	4633		*Ceramaster patagonicus patagonicus* (1)
42°50'S, 177°07'W	3.6.79	4634	907	*Ceramaster patagonicus patagonicus* (1)
Clarence River, off, 42°16'S, 174°20'E	14.1.79	4635		*Ceramaster patagonicus patagonicus* (6)
Stewart Is, Port Pegasus, *Acheron*	26.2.72	4636	46–49	*Pentagonaster pulchellus* (1)
Stewart Is	3.3.72	4637		*Pentagonaster pulchellus* (2)
Marlborough Sounds, *Acheron*	30.8.75	4638	84–88	*Pentagonaster pulchellus* (3)
Durville Is, 40°47'S, 173°48'E	5.3.76	4639	62	*Pentagonaster pulchellus* (8)
Durville Is, 40°46'S, 173°57'E	11.3.76	4640	59–64	*Pentagonaster pulchellus* (3)
Kapiti Is	25.7.71	4642	5	*Pentagonaster pulchellus* (1)
Snares Is, Trumpeter Bay, coll. C. Holmes	10.2.75	4644	1	*Pentagonaster pulchellus* (1)
Wellington, Island Bay	1947	4645		*Pentagonaster pulchellus* (1)
Chatham Is, Port Hutt	23.6.71	4646	reef face	*Pentagonaster pulchellus* (1)
Oamaru, coll. J. Graham	-.5.62	4647		*Pentagonaster pulchellus* (4)
Portobello Marine Biological Station		4648		*Pentagonaster pulchellus* (3)
Oamaru Heads, coll. J. Graham	-.9.59	4649	73	*Pentagonaster pulchellus* (1)
Chatham Rise, north	15.11.75	4650	920–939	*Pillsburiaster aoteanus* (1)
Clarence River, 42°16'S, 174°20'E	14.1.79	4651		*Pillsburiaster aoteanus* (1)
44°53'S, 173°05'E, *Aktuba*	30.11.79	4653	900	*Hippasteria phrygiana* (2)
44°52'S, 173°12'E, *Aktuba*	4.12.79	4654	990	*Hippasteria phrygiana* (1)
Canterbury Bight, *James Cook*	15.6.84	4655		*Hippasteria phrygiana* (2)
Palliser Slope, 41°42'S, 175°15'E	9.1.79	4656	461	*Pseudarchaster garricki* (1)
Clarence River, 42°16.3'S, 174°20.8'E	14.1.49	4657	860–790	*Pseudarchaster garricki* (7)
Cape Campbell, 42°0'S, 174°41'E	14.1.79	4658	939–1019	*Pseudarchaster garricki* (1)
Aldermen Is, 37°00'S, 176°13'E,	23.1.79	4659	178–248	*Pseudarchaster garricki* (3)
44°53'S, 173°05'E, *Aktuba*	30.11.79	4660	900	*Pseudarchaster garricki* (1)
44°19'S, 179°17'W	25.5.79	4661	852	*Pseudarchaster garricki* (1)
Otago, Taiaroa Trench, *Acheron*	11.8.74	4662	700–760	*Pseudarchaster garricki* (1)
Chatham Is, *Viti*	27.4.61	4663	450	*Pseudarchaster garricki* (1)
35°33'S, 174°57'E, *Acheron*	14.2.74	4664	183–201	*Pseudarchaster garricki* (1)
34°35'S, 173°33'E, *Acheron*	21.2.74	4665	256	*Pseudarchaster garricki* (1)
42°42'S, 175°15'E, *Acheron*	9.1.79	4666	461	*Pseudarchaster garricki* (2)
Hikurangi Trench, 42°08.4'S, 175°48'E, *Acheron*	10.1.79	4667	2598	*Pseudarchaster garricki* (1)
Mernoo Slope, 42°38'S, 176°10'E, *Acheron*	11.1.79	4668	984–999	*Pseudarchaster garricki* (1)
Clarence River, 42°16.3'S, 174°20.8'E	14.1.79	4669	790–860	*Pseudarchaster garricki* (1)
Cape Campbell 41°55.9'S, 174°43.2'E, *Tangaroa*	14.1.79	4670	424–454	*Pseudarchaster garricki* (1)
White Island Trench 37°00'S, 177°35'E, R*Tangaroa*	18.1.79	4671	2142–2202	*Pseudarchaster garricki* (1)
Kahurangi Point, 40°40'S, 171°39'E	24.9.76	4672	208–264	*Pseudarchaster garricki* (3)
Cape Campbell, coll. F. Abernethy	-.3.57	4673		*Pseudarchaster garricki* (1)
43°31–43°30'S, 176°10–178°08'W, *Eltanin*	28.5.66	4674	143–183	*Pseudarchaster garricki* (2)

Location and Collector or vessel	Date	Cat. No. (Ech.)	Depth (m)	Species and number
Aldermen Is, NE of Mayor Is	9.1.69	4675	377-443	*Pseudarchaster garricki* (12)
37°05'S, 176°12'E, coll. R.D. Cooper	7.1.69	4676	293–332	*Pseudarchaster garricki* (2)
35°29'S, 175°02'E, *Acheron*	14.2.74	4677	256–269	*Pseudarchaster garricki* (1)
Auckland Is		4678		*Pseudarchaster garricki* (1)
Hokianga, 38°06'S, 173°52'E, *James Cook*	12.1.71	4679	260	*Pseudarchaster garricki* (4)
Kahurangi Point, 40°40'S, 171°39'E	14.9.76	4680	208–264	*Pseudarchaster garricki* (1)
37°02'S, 176°13'E, coll. R.D. Cooper	1.1.69	4681	255–292	*Pseudarchaster garricki* (3)
37°08'S, 176°15'E, coll. R.D. Cooper	1.1.69	4682	380–400	*Pseudarchaster garricki* (7)
37°04'S, 176°14'E, coll. R.D. Cooper	1.1.69	4683	365–410	*Pseudarchaster garricki* (2)
37°06'S, 176°13.5'E, coll. R.D. Cooper	7.1.69	4684	293–346	*Pseudarchaster garricki* (46)
Mayor Is, coll. R.D. Cooper	8.1.69	4685	361-4015	*Pseudarchaster garricki* (2)
37°08'S, 176°18'E, coll. R.D. Cooper	8.1.69	4686	370–408	*Pseudarchaster garricki* (14)
37°08'S, 176°18'E, coll. R.D. Cooper	8.1.69	4687	370-408	*Pseudarchaster garricki* (2)
Mernoo Slope, 42°41'S, 174°28'E	13.1.79	4688	1542–1723	*Pseudarchaster macdougalli* (2)
Cape Maria van Diemen, *Tangaroa*	11.1.81	4689		*Lithosoma novaezelandiae* (1)
Norfolk Ridge, Wanganella Bank	29.1.87	4690	357-487	*Lithosoma novaezelandiae* (3)
Kahurangi Point, 40°31'S, 171°20'E	24.9.76	4691	408-472	*Lithosoma novaezelandiae* (1)
Kahurangi Point, 40°24'S, 171°08'E	24.9.76	4692	570–590	*Lithosoma novaezelandiae* (1)
34°47'S, 74°17'E	24.2.74	4695	228–264	*Mediaster sladeni* (1)
Mernoo Slope, 43°02'S, 175°24'E, *Tangaroa*	12.1.79	4696	253	*Mediaster sladeni* (2)
Mernoo Bank, 43°06'S, 175°20'E, *Tangaroa*	12.1.79	4697	153	*Mediaster sladeni* (2)
Ahipara Bay		4698		*Mediaster sladeni* (1)
Aldermen Is, 30°01'S, 176°14'E		4699		*Mediaster sladeni* (1)
44°42'S, 173°11'E, *Aktuba*	20.2.79	4700		*Mediaster arcuatus* (1)
Tasman Basin		4701		*Mediaster sladeni* (6)
East Cape, off		4702		*Mediaster sladeni* (1)
Challenger Plateau		4703		*Mediaster sladeni* (1)
Kahurangi, 40°40'S, 171°39'E	24.9.76	4704	208–264	*Mediaster sladeni* (1)
Kahurangi, 40°31'S, 171°20'E		4705	408–472	*Mediaster sladeni* (3)
Challenger Plateau		4706		*Mediaster sladeni* (3)
Westland, 40°54'S, 171°07'E	28.9.76	4708		*Mediaster sladeni* (4)
Pegasus Bay, NE of, *James Cook*	27.8.71	4709	585	*Mediaster sladeni* (1)
Cape Campbell, coll. F. Abernethy	-.3.57	4710	101–115	*Mediaster sladeni* (1)
Bay of Plenty, coll. R.D. Cooper	8.1.69	4711	369-410	*Mediaster sladeni* (7)
Mernoo Slope, 42°38'S, 176°10'E	11.1.79	4713	984–999	*Pillsburiaster aoteanus* (2)
Clarence River, off, 42°16'S, 174°20'E	14.1.79	4714	790–860	*Pillsburiaster aoteanus* (1)
Pukaki Rise, 49°59'S, 172°16'E		4715		*Pillsburiaster aoteanus* (1)
Otago, J. Graham Collection	1978	5294		*Ceramaster patagonicus patagonicus* (1)
Otago, Taiaroa Trench	18.8.74	5295	700–760	*Ceramaster patagonicus patagonicus* (1)
46°18'S, 166°35'E	15.12.77	5296	200	*Ceramaster patagonicus patagonicus* (1)
Oamaru, H.E.S. Clark Collection	1961	5297		*Pentagonaster pulchellus* (2)
Oamaru, H.E.S. Clark Collection		5298	73	*Pentagonaster pulchellus* (2)
Otago, J. Graham Collection	1957	5299		*Pentagonaster pulchellus* (14)
Otago, J. Graham Collection	1973	5300		*Pentagonaster pulchellus* (2)
Otago, J. Graham Collection	-.9.63	5301		*Pentagonaster pulchellus* (1)
Otago, J. Graham Collection	-.12.66	5302		*Pentagonaster pulchellus* (1)
Otago, J. Graham Collection	-.8.70	5303		*Pentagonaster pulchellus* (1)
Otago, J. Graham Collection	-.7.70	5304		*Pentagonaster pulchellus* (1)
Chatham Is, J. Graham Collection	-.11.83	5305	5.5	*Pentagonaster pulchellus* (1)
Cape Wanbrow, J. Graham Collection	-.10.79	5306	14–18	*Pentagonaster pulchellus* (2)
Oamaru, J. Graham Collection		5307		*Pentagonaster pulchellus* (3)
Oamaru, J. Graham Collection	23.1.82	5308	73	*Pentagonaster pulchellus* (1)
Otago, J. Graham Collection	1963	5309	68	*Pentagonaster pulchellus* (13)
Oamaru, J. Graham Collection		5310		*Pentagonaster pulchellus* (1)
Stewart Is, J. Graham Collection	3.4.84	5311	31	*Pentagonaster pulchellus* (15)
Foveaux Strait, J. Graham Collection	1960	5312		*Pentagonaster pulchellus* (14)
Kermadecs, Raoul Is, *Acheron*	5.4.73	5315	1188–1224	*Plinthaster dentatus* (1)
Bay of Plenty, Mayor Is	7.1.69	5318	283–347	*Anthenoides granulosus* (3)
Chatham Rise, *James Cook*	-.1.76	5320	220	*Hippasteria phrygiana* (1)

Location and Collector or vessel	Date	Cat. No. (Ech.)	Depth (m)	Species and number
Cavalli Is, 34°59'S, 174°25'E	26.1.81	5323	317–327	*Pseudarchaster garricki* (3),
40°31'S, 171°21'E	24.9.76	5324	408-472	*Pseudarchaster garricki* (1)
34°04'S, 172°12'E	23.4.81	5325	481–503	*Pseudarchaster garricki* (7)
Bay of Plenty, H.E.S. Clark Collection		5326		*Pseudarchaster garricki* (2)
Mernoo Bank, 43°07'S, 175°22'E	12.1.79	5327	148–150	*Pseudarchaster garricki* (1)
Mayor Is, 37°11'S, 176°10'E, *Tangaroa*	22.1.79	5328	198–273	*Pseudarchaster garricki* (6)
Otago, J. Graham Collection	1960	5332		*Mediaster sladeni* (5)
J. Graham Collection	1979	5333	1006	*Mediaster arcuatus* (1)
Tasman Basin, 40°50'S, 168°14'E, *Tangaroa*	18.4.80	5334	1005–1009	*Mediaster arcuatus* (1)
Tasman Basin, 40°46'S, 167°54'E, *Tangaroa*	18.4.80	5335	1028–1029	*Mediaster arcuatus* (6)
Mernoo Slope, 42°38'S, 176°10'E	11.7.79	5341	984–999	*Pillsburiaster aoteanus* (2)
Otago, J. Graham Collection	1971	5345		*Pseudarchaster garricki* (2)
Challenger Plateau		5346		*Pillsburiaster aoteanus* (3)
Oamaru, J. Graham Collection	-.10.63	5522	46	*Pentagonaster pulchellus* (1)
Cape Campbell, *Tangaroa*	14.1.79	5523	434-446	*Pseudarchaster garricki* (1)
Otago, J. Graham Collection	27.8.78	5524		*Mediaster arcuatus* (1)
37°40'S, 167°22'E, *Arrow*	14.9.83	5525	994	*Mediaster arcuatus* (1)
39°26'S, 178°22'E, *James Cook*	18.8.86	5526	989	*Mediaster arcuatus* (1)
Cape Campbell, *Tangaroa*	14.1.79	5578	939–1019	*Pseudarchaster garricki* (3)
Banks Peninsula, *James Cook*	1971	5589	405	*Lithosoma novaezelandiae* (1)
48°44'S, 172°00'E	7.1.78	5687	630	*Hippasteria phrygiana* (1)
Mayor Is, coll. R.W.C.	9.1.69	5688	377–443	*Pseudarchaster garricki* (1)
40°56'S, 170°21'E	28.8.76	5689	160–165	*Pseudarchaster garricki* (1)
35°00'S, 174°34'E	21.4.81	5690	463–464	*Pseudarchaster garricki* (1)
North Cape, near		5691		*Pseudarchaster garricki* (1)
Westland, 40°54'S, 171°04'E	28.9.76	5692	350–400	*Mediaster sladeni* (3)
40°56'S, 171°29'E	28.9.76	5693	165–1600	*Mediaster sladeni* (2)
34°53'S, 172°19'E	24.4.81	5695	461–463	*Mediaster sladeni* (2)
Challenger Plateau	11.9.86	6266		*Pseudarchaster garricki* (1)
43°45'S, 175°56'W, *Oyang*	21.5.87	6284	189	*Mediaster sladeni* (2)
39°32.5–29.5'S, 178°16.0–18.4'E	29.9.89	6419	800–860	*Mediaster arcuatus* (1)
39°40.5–43.5'S, 179°09.2–07.2'E	29.9.89	6426	764–848	*Pillsburiaster aoteanus* (1)
42°49.8–49.5'S, 177°37.5–42.1'W	13.8.89	6432	815	*Hippasteria phrygiana* (2)
42°50.5–50.1'S, 177°41.34-45.4'W	13.8.89	6433	763–775	*Hippasteria phrygiana* (1)
Port Pegasus, coll. G.S. Hardy 47°91.7'S, 167°37.5'E	30.6.89	6440	27	*Pentagonaster pulchellus* (1)
Passage Bay, coll. G.S. Hardy 42°12.4'S, 167°39.4'E	31.1.89	6447	7–12	*Pentagonaster pulchellus* (2)
47°30.5'S, 169°14.7'E, *Chiyo Maru*	13.9.87	6466	529–537	*Lithosoma novaezelandiae* (1)
Chatham Rise	-.9.87	6472		*Mediaster sladeni* (9)
39°32.85–34°4'S, 178°16.5–14.3'E	29.9.89	6476	875–880	*Gilbertaster anacanthus* (1)
Chatham Is, *Akebono Maru*	9.12.84	6489		*Mediaster sladeni* (1)
Aldermen Is, *Trinity*	–	6492	410–415	*Anthenoides granulosus* (1)
Aldermen Is, *Trinity*, coll. R. MacGrath	31.7.87	6503	410–415	*Pseudarchaster garricki* (1)
Otago, Blueskin Bay, *Munida*	9.5.90	6504	20–22	*Pentagonaster pulchellus* (4)
Otago		6505		*Mediaster sladeni* (2)
Aldermen Is, *Trinity*	–	6506	410–415	*Mediaster sladeni* (1)
Aldermen Is, Trinity	–	6507	410–415	*Ceramaster patagonicus patagonicus* (4)
Stewart Is, *Shinkai Maru*	-.7.86	6514	200–600	*Hippasteria phrygiana* (1)
Stewart Is, *Shinkai Maru*	-.7.86	6515	200–600	*Lithosoma novaezelandiae* (1)
Stewart Is, *Shinkai Maru*	-.7.86	6516	200–600	*Ceramaster patagonicus patagonicus* (1)
Stewart Is, *Akebono Maru*	-.2.88	6519		*Mediaster sladeni* (1)
Chatham Is, coll. S. Taylor	1989	6545	33	*Pentagonaster pulchellus* (1)
Hawke Bay, 39°34.4'S, 178°14.3'E		6551	857–880	*Pillsburiaster aoteanus* (2)
Hawke Bay, 39°34.4'S, 178°14.3'E	29.9.89	6552	857–880	*Mediaster arcuatus* (1)
T39 *Jenny II*, coll. Hadfield-Romen		6567		*Hippasteria phrygiana* (1)
T39 *Jenny II*, coll. Hadfield-Romen		6568		*Ceramaster patagonicus patagonicus* (2)
Hawke Bay		6589		*Pillsburiaster aoteanus* (1)
Chatham Is, 39°34.4'S, 178°14.3'E	29.9.89	6590	857–880	*Pillsburiaster aoteanus* (1)

Location and Collector	Date	Cat. No. (Ech.)	Depth (m)	Species and number
39°36.9'S, 178°00.5'E	20.9.89	6593	720–840	*Hippasteria phrygiana* (1)
41°10.1'S, 176°38.4'E	11.9.89	6595	1185–1204	*Pillsburiaster aoteanus* (1)
38°21'S, 168°51'E, coll. A. Smirnov	14.9.88	6618		*Lithosoma novaezelandiae* (1)
Challenger Plateau, coll. B. Connell, *Oyang*	1986	6622		*Pillsburiaster aoteanus* (1)
Challenger Plateau, coll. B. Connell, *Oyang*	1986	6624		*Hippasteria phrygiana* (1)
Challenger Plateau, coll. B. Connell, *Oyang*	1986	6625		*Hippasteria phrygiana* (1)
Challenger Plateau, coll. B. Connell, *Oyang*	1986	6627		*Pillsburiaster aoteanus* (1)
Chatham Is, 44°02'S, 176°19'W	10.2.91	6638	15–17	*Pentagonaster pulchellus* (2)
Chatham Is, 43°41'S, 176°37'W	8.2.91	6642		*Pentagonaster pulchellus* (1)
Chatham Is, Point Hutt		6651	low tide	*Pentagonaster pulchellus* (3)
Chatham Is, Te Raki Bay	11.2.91	6654	8–10	*Pentagonaster pulchellus* (2)
Chatham Is,	-.12.91	6659	beach drift	*Pentagonaster pulchellus* (2)
49°55.82'S, 171°37.24'E	3.12.90	6874	486–490	*Lithosoma novaezelandiae* (1)
Stewart Is, Port Adventure, coll. A. Stewart	8.3.92	6881	5–8	*Pentagonaster pulchellus* (2)
Stewart Is, Paterson Inlet	5.3.92	6882	1–7	*Pentagonaster pulchellus* (1)
Snares Is, 48°01.0'S, 166°36.7'E	2.12.84	6883	15	*Pentagonaster pulchellus* (1)
Bounty Is, 47°46.0'S, 178°13.3'E	9.12.90	6885	616–660	*Ceramaster patagonicus patagonicus* (2)
48°42.92'S, 173°26.45'E	6.12.90	6891	685–729	*Hippasteria phrygiana* (2)
Stewart Is, coll. A. Stewart	4.3.92	7148	2–5	*Pentagonaster pulchellus* (2)
Oamaru, 45°48'S, 170°53'E, *Munida*	5.3.92	7305	80	*Pentagonaster pulchellus* (3)
Oamaru, 45°49'S, 170°54'E, *Munida*	5.3.92	7318	90	*Pentagonaster pulchellus* (1)
Oamaru, 45°48'S, 170°52'E, *Munida*	5.3.92	7323	70	*Pentagonaster pulchellus* (1)
45°48'S, 170°52'E, *Munida*	5.3.92	7324	70	*Pentagonaster pulchellus* (2)
Cook Strait		7342		*Pentagonaster pulchellus* (1)
44°42.6'S, 173°20.8'E	5.10.84	7343	891–920	*Lithosoma novaezelandiae* (4)
44°42.6'S, 173°20.8'E	5.10.84	7344	891–920	*Hippasteria phrygiana* (1)
44°58.1'S, 174°01.5'E	4.10.84	7348	1178–1190	*Lithosoma novaezelandiae* (1)
44°42.9'S, 173°06.4'E	5.10.84	7355	880–916	*Hippasteria phrygiana* (1)
44°19.9'S, 173°36.6'E	29.9.84	7356	614–617	*Hippasteria phrygiana* (3)
Great Barrier Is, *Tangaroa*	1992	7368		*Pillsburiaster aoteanus* (1)
Great Barrier Is, *Tangaroa*	1992	7369		*Hippasteria phrygiana* (1)
47°00.6'S, 165°26.5'E	10.7.92	7372	1119–1150	*Hippasteria phrygiana* (1)
46°15.3'S, 170°54.8'E	27.7.92	7373	811–1015	*Pillsburiaster aoteanus* (1)
46°15.3'S, 170°54.8'E	27.7.92	7375	811–1015	*Hippasteria phrygiana* (1)
37°35.17'S, 176°43.56'E, *Kaharoa*	1993	7376	443	*Lithosoma novaezelandiae* (1)
Bay of Plenty, 37°27'S, 177°42'E	1981	7377	815–843	*Hippasteria phrygiana* (1)
48°30'S, 171°58'E, *Kaiyo Maru 6*	-	7378		*Hippasteria phrygiana* (1)
Breaksea Sound, 45°30.6'S, 167°00.10'E	20.3.93	7379		*Pentagonaster pulchellus* (1)
Campbell Rise, 51°47'S, 168°19'E	1977	7380	687–596	*Pillsburiaster aoteanus* (3)
Bay of Plenty, coll. R.D. Cooper	7.1.69	7381		*Anthenoides granulosus* (3)
51°10'S, 166°34'E, *Petersen*	-.10.94	7382	490–510	*Hippasteria phrygiana* (9)
Bay of Plenty, 37°40'S, 177°14'E	16.1.95	7390	235	*Athenoides cristatus* (1)
Bay of Plenty, 37°36'S, 177°10'E	15.1.95	7391	352	*Anthenoides granulosus* (1)
Bay of Plenty	14.1.95	7392	326	*Anthenoides granulosus* (3)
Bay of Plenty	16.1.95	7393	324	*Anthenoides granulosus* (3)
Auckland Is, 51°07'S, 166°33'E	10.10.94	7394	485–520	*Hippasteria phrygiana* (1)
Auckland Is,		7395		*Hippasteria phrygiana* (1)
Chatham Rise, Mernoo Bank, *Petersen*	27.12.94	7418	368–411	*Mediaster sladeni* (3)
Chatham Rise, Mernoo Bank, *Petersen*	27.12.94	7422	368–411	*Anthenoides granulosus* (1)

Auckland Institute and Museum (AK)

79700	1.1.93	Auckland Islands coll: Siminovich Fisheries	520	*Enigmaster scalaris* (1)
79702	-	Northland, North Cape	446–471	*Pillsburiaster aoteanus* (1)

***Eltanin* Stns**

Stn No.	Date	Latitude (° S)	Longitude (°)	Depth (m)	Species and number
1403	31.1.65	41 42′	175 29′–175 22′E	946–951	*Pillsburiaster aoteanus* (1)
1411	8.2.65	51 00′–51 01′	162 01′E	333–371	*Ceramaster patagonicus australis* (1)
1709	24.5.66	43 31′–43 30′	176 10′–178 08′W	143–183	*Pseudarchaster garricki* (2)
1712	28.5.66	38 24′–38 26′	178 53′–	1354–	*Pillsburiaster* sp. (1)
1974	15.2.67	54 30′–54 34′	158 59′E	88–278	*Ceramaster patagonicus patagonicus* (1)
1989	24.2.67	47 21′–47 18′	147 52′–147 51′E	882–915	*Lithosoma novaezelandiae* (1)
2215	18.6.68	54 31′	159 00′E	99–320	*Ceramaster patagonicus patagonicus* (8)

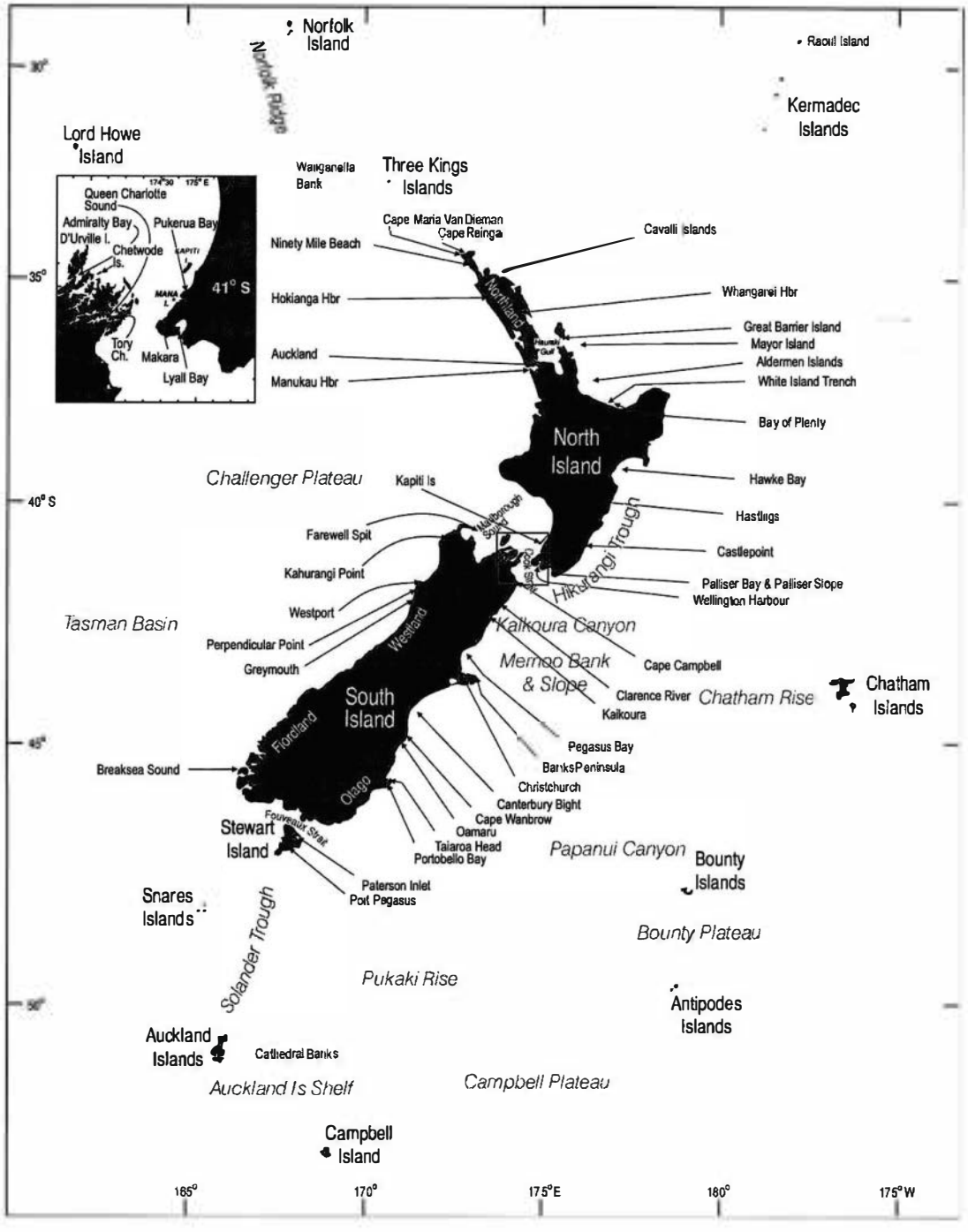

Fig. 42. Locations for Museum of New Zealand (NMNZ) station data.

TAXONOMIC INDEX

This index has been compiled from the text. It does not include species names in Appendix 1 (List of Stations). Bold numbers indicate a photographic plate and/or a line drawing.