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STUDIES ON ECHINODERMS OF THE SOUTHERN PACIFIC OCEAN

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Published papers in support of thesis on inside back cover:

Distribution patterns of New Zealand echinoderms.

The holothurian fauna of Cook Strait, New Zealand.

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INTRODUCTION

The thesis comprises 15 separate contributions, each self-contained and based on a specific expedition or topic. Of these 11 relate to expedition collections and are essentially systematic and faunistic in treatment; one paper is based on photographic records from the porthole of the U.Z. Navy Bathyscaphe Trieste; one paper contains an analysis of the distribution of echinoderms to the east of New Zealand; one paper comprises a biogeographic survey of the holothurians of the Southern Ocean based on relevant data accumulated in the course of the three years' study; and one contains a revised classification of the dendrochirote holothurians, developed near the end of the course of study, on the basis of work carried out over the whole period. As expedition reports have been prepared for the press when each stage of the work was completed, it has necessarily followed that the revised classification is employed only in the two final contributions.

The material comprised 2286 specimens, of which 667 were echinoids, 353 were holothurians, 87 were asteroids and 1179 were ophiuroids. Of the total of 73 genera and 84 species examined, the echinoids comprised 24 genera and 27 species, of which three species are described as new; the holothurians comprised 28 genera and 35 species, of which four genera and five species are described as new; the asteroids comprised nine genera and nine species; the ophiuroids comprised 12 genera and 13 species.

The material was derived from the following regions: New Zealand proper (including Three Kings Islands), 34 genera and 37 species; Kermadec Islands, 7 genera, 7 species; Norfolk Island, 7 genera, 7 species; north of New Zealand, 2 genera, 2 species; Chatham Rise, 7 genera, 8 species; Bounty Islands, 6 genera, 6 species; Antipodes Islands, 4 genera, 4 species; Auckland Islands, 3 genera, 3 species; Campbell Island, 2 genera, 2 species; north of Macquarie Island, 3 genera, 3 species; Macquarie Island, 3 genera, 3 species; Heard Island, 1 genus, 1 species; Snares Islands, 13 genera, 13 species; southern Chile (Isla Chiloe to Isla Navarino), 13 genera, 13 species.

The collection of echinozoans from southern Chile comprises 13 genera and 13 species. A new genus is proposed to accommodate _Psolidium convergens_ (Herouard). Typical temnopleuroid epistroma is present in juveniles of _Pseudechinus magellanicus_ (Philippi), and the disposition of the ocular plates in juveniles of this species is determined by the position of the anal aperture. The shallow water echinozoan fauna of the region includes few restricted species, several elements having a circum-polar distribution. Two echinoid genera are endemic.

The bathyal holothurian fauna of New Zealand is now known to comprise 20 genera and 23 species, of which 13 species are new records. Two new elasipod genera, three new elasipod species and one new molpadid species are described. The bathyal fauna is partly of cosmopolitan facies, and contains many Indo-Pacific elements.

The echinozoan fauna of the Campbell Plateau and adjacent island groups to the south of New Zealand is now known to comprise 14 genera and 16 species. Two species are regarded as new, while new records for the region are the echinoid genera Austrocidaris and Brisaster. The southern islands fauna shows a strong affinity to that of New Zealand; the fauna of Macquarie Island is shown to be more closely related to that of the New Zealand region than has formerly been supposed. The echinozoan fauna of the Chatham Rise has a cosmopolitan to Indo-west-Pacific facies. The fauna of the Chatham Islands is strongly related to that of Cook Strait, but is markedly dissimilar to that of the southern islands of New Zealand.

The asteroid Calvasterias suteri (de Loriol) is recorded from the Cook Strait region, and a probable third Cook Strait species of the asteroid genus Pseudarchaster is also reported.

Twenty-six genera and 29 species of echinoids are now known to occur in the area bounded by the Kermadec Islands, Norfolk Island and northern New Zealand (at latitude approximately 35°S). The genera Prionocidaris, Stereocidaris, Coelopleurus and Oligopodia are new records for this area. The fauna is chiefly of Indo-west-Pacific affinities.

Seventeen genera and 17 species of echinoderms are now known from the Snares Islands. Of these, 13 genera and 13 species are new records, and all but one (Stereoderma leoninoides) were previously known from New Zealand. The fauna of the Snares Islands is therefore closely related to that of New Zealand.

It is deduced that all the land-masses in the southern oceans have apodid holothurian faunas which were initially derived from the Indo-west-Pacific region. The apodid faunas of the Magellanic region and the circum-polar islands were probably derived from that of New Zealand, through the agency of the west-wind-drift. However, the distribution of the aspidochirote genera Holothuria (s.l.) and Stichopus in the southern oceans has not been influenced by the west-wind-drift; rather, the extant species of these two genera at present inhabiting the vicinity of southern land-masses have probably been derived from related populations living further north. While the areas of origin of many dendrochirote genera are not readily determinable, it is considered that the west-wind-drift has contributed significantly to the distribution of these genera in the Southern Ocean. The holothurian fauna of Australia is clearly derived from the Indonesian region, while that of South Africa is merely part of a generalised Indo-west-Pacific fauna. New Zealand has a fauna which is apparently of Australian-Indo-Pacific origin. The Magellanic region has chiefly a west-wind-drift fauna, though it includes some elements derived from further north.

The so-called "Antarctic elements" in the Magellanic fauna may more reasonably be interpreted as Magellanic elements which have, in addition, spread into Antarctica.

The faunas of the circum-polar islands have apparently been derived mainly from the Magellanic region through the agency of the west-wind-drift.

A revised classification of the dendrochirote holothurians is presented. Such characters as the presence or absence of large plates in the bodywall, tentacle shape, and the degree of complexity of the calcareous ring are regarded as of greater diagnostic value than tentacle-number. A new order and three new families are proposed.

ACKNOWLEDGMENTS

I am deeply indebted to my supervisor, Professor H.B. Fell, for his most valuable advice and patient guidance throughout the course of this study.

I am grateful to all those institutions and individuals who have allowed me access to their echinoderm collections for examination. These are acknowledged where relevant throughout this thesis.

I thank Mr. M.D. King for photographing specimens, and Mrs. J. Benfield for photocopying the line drawings. My thanks are also due to the staff of the Victoria University Library, and to Miss M. Wood and Mrs. M. Allerhand of the Royal Society Library for their assistance in obtaining literature. I am grateful to Mrs. D. Freed for her care in typing this thesis and to Mr. J.R.H. Andrews for assistance in proof-reading the final copy.

I would like to thank my colleagues at the Zoology Department, Victoria University who have helped me in so many ways, and finally, I thank my wife Mary, for her continued encouragement and fortitude.

THE ECHINOZOA COLLECTED BY THE ROYAL SOCIETY EXPEDITION TO SOUTHERN CHILE, 1958-9. - HOLOTHUROIDEA

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ABSTRACT

The collection comprises ten genera (of which one is new) and ten species. Neopsolidium n.g., type species Psolidium convergens (Herouard) has dorsal deposits in the form of small perforated plates up to 0.4 mm in diameter, and cups.

The holothurian fauna of southern Chile is generalised, containing few restricted species, and sharing many elements with distant subantarctic islands and with Antarctica.

INTRODUCTION

During late 1958 and early 1959, an expedition sponsored by the Royal Society carried out marine and terrestrial observations and collections in Southern Chile. Stations were established in three separate areas, namely:

1. Isla Chiloe (approx. 42°S.).
2. Puerto Eden to Punta Arenas (approx. 49°S. to 52°S.).
3. Isla Navarino and Southern Regions (approx. 55°S.).

These three areas, considered together, were expected to provide a good picture of the changes in flora and fauna along the Patagonian coastline. The present paper contains an account of the holothurians collected by the marine biologist to the expedition, Professor G.A. Knox, of Canterbury University, Christchurch.

A total of 180 specimens of holothurians were collected, and these comprise ten genera and ten species. The collection represents a good cross-section of the known fauna, although a number of species, hitherto regarded as common, were not found.

The shallow-water holothurian fauna of southern Chile is not large in terms of species, although a wide variety of genera are represented. This is particularly true for the Order Dendrochirotida. Previous authors such as Ludwig (1898a, 1898b), Perrier (1905), Ekman (1925) and Deichmann (1947) have provided a clear picture of the composition of the fauna. It is unlikely that many new shallow water species will be taken from this region.

I am grateful for the opportunity to study this most interesting collection, and I would like to thank Professor G.A. Knox and the Royal Society for material collected during the Royal Society Expedition to southern Chile 1958-59.

LIST OF SPECIES COLLECTED

Order DENDROCHIROTIDA

Family Phyllophoridae

Subfamily Thyonidiinae

Athyonidium chilensis (Semper)

Family Cucumariidae

Subfamily Cucumariinae

Cladodactyla crocea (Lesson)

Stereoderma laevigata (Verrill)

Pseudocnus dubiosus (Semper)

Subfamily Colochirinae

Trachythyone lechleri (Lambert)

Family Psolidae

Neopsolidium convergens (Herouard)

Psolus patagonicus (Ekman)

Order APODIDA

Family Chiridotidae

Chiridota pisanii (Ludwig)

Trochodota purpurea (Lesson)

Taeniogyrus contortus (Ludwig)

Order MOLPADIDA - None.

Order ASPIDOCHIROTIDA - None.

Order ELASIPODOIDA - None.

MATERIAL EXAMINED

A total of 130 specimens were collected from 12 of the 78 stations worked. Collecting was done by hand in the intertidal zone, by diving, dredging or seine netting.

Area 1, Isla Chiloe, stations 1-18

Stn. 4. Punta Gaviota, 42°03'50"S., 74°02'50"W.; intertidal boulder beach, volcanic rocks; hand collecting; October 4,11 and 16, 1958.

Athyonidium chilensis (Semper) 4 specimens

Area 2, Puerto Eden to Punta Arenas, stations 19-49

Stn. 19. Puerto Eden, Isla Wellington, the point to the north of the FACh base, 49°08'20" S., 74°26'55" W.; intertidal granitic gneiss rocks, sheltered; hand collecting, also collection from _Macrocystis_ fronds and holdfasts and sublittoral collection by diving; November 29 and 30, 1958.

Pseudocnus dubiosus (Semper) 1 specimen

Stn. 27. Isla Carlos, 49°09'35" S., 74°25'24" W.; collection from _Macrocystis_ fronds and holdfasts; December 5, 1958.

Pseudocnus dubiosus (Semper) 57 specimens

Stn. 37. Caletta Lackawana, 49°10'32" S., 74°25'52" W., depth 18 m., sand, rock, shell; dredge; December 9, 1958.

<u>Stereoderma laevigata</u> (Verrill) 1 specimen

Stn. 39. Puerto Eden, west side of Canal Sur, 49°09'52" S., 74°26'08" W., intertidal boulder beach of granitic gneiss; hand collecting and collection from <u>Macrocystis</u> fronds and holdfasts; December 9 and 11, 1958.

<u>Pseudocnus dubiosus</u> (Semper) 15 specimens

<u>Psolus patagonicus</u> (Ekman) 30 specimens

Stn. 40. Isla Dulce and Isla Levinson, Puerto Eden, 49°09'02" S., 74°25'10" W.; intertidal and sublittoral granitic gneiss rocks; hand collecting; December 12 and 13, 1958.

<u>Pseudocnus dubiosus</u> (Semper) 2 specimens

<u>Psolus patagonicus</u> (Ekman) 1 specimen

Area 3, Isla Navarino and Southern Regions, Stations 50-78

Stn. 50. Puerto Williams, Isla Navarino, 54°55'40" S., 67°39' W., intertidal boulder beach; hand collecting; January 7, 1959.

<u>Neopsolidium convergens</u> (Herouard) fragment

Stn. 52. Puerto Robalo, Isla Navarino, 54°55'50" S., 67°41'40" W.; intertidal argillite rock; hand collecting and collection from *Macrocystis* fronds and holdfasts; January 10, 16, 23 and 30, 1959.

Pseudocnus dubiosus (Semper)	10 specimens
Neopsolidium convergens (Herouard)	2 specimens

Stn. 54. Puerto Grandi, Isla Bertrand, 55°12' S., 67°55'30" W., boulder beach; intertidal hand collecting; January 12, 1959.

Pseudocnus dubiosus (Semper)	4 specimens
Trachythyone lechleri (Lampert)	9 specimens

Stn. 73. Seno Grandi, small island opposite Puerto Grandi, 55°15" S., 67°56" W., collection from *Macrocystis* fronds and holdfasts; January 5, 1959.

Cladodactyla crocea (Lesson)	24 specimens
Neopsolidium convergens (Herouard)	1 specimen (Juvenile)
Chiridota pisanii (Ludwig)	4 specimens
Trochodota purpurea (Lesson)	8 specimens
Taeniogyrus contortus (Ludwig)	1 specimen

Stn. 77. Puerto Grandi, Isla Bertrand, to the west of the wharf; 55°12' S., 67°55'30" W.; intertidal granitic rocks and boulder beach, semi-sheltered, hand collecting; February 7, 1959; collection by diving among *Macrocystis*; February 8, 1959.

Pseudocnus dubiosus (Semper)	1 specimen
Neopsolidium convergens (Herouard)	2 specimens
Trochodota purpurea (Lesson)	1 specimen

SYSTEMATIC ACCOUNT

Order DENDROCHIROTIDA

Family Phyllophoridae

Subfamily Thyonidiinae Heding and Panning, 1954

Genus Athyonidium Deichmann, 1941

Eucyclus Lampert, 1885, p. 290; Theel, 1886a, p. 268; Ludwig, 1887, p. 1239; Heding and Panning, 1954, p. 36: Name preoccupied.

Type Species: Athyonidium chilensis (Semper)

Remarks: This genus is monotypic. Deichmann (1941) pointed out that the generic name Eucyclus was preoccupied, having been claimed some years earlier for the Mollusca. Heding and Panning (1954) unfortunately persisted with the old generic name.

Athyonidium chilensis (Semper)

Thyone (Stolus) chilensis Semper, 1868, p. 241, pl.40, figs. 3-6; Lampert, 1885, p.156.

Eucyclus duplicatus Lampert, 1885, p.250; Theel, 1886a, p.268.

Thyone chilensis Theel, 1886a, p.139.

Phyllophorus chilensis Ludwig, 1886, p.24.

Athyonidium chilensis Deichmann, 1941, p.127.

Eucyclus chilensis Heding and Panning, 1954, p.36, fig.2.

Diagnosis: Large forms (25 cm) with thick, soft skin and numerous stout feet. Tentacles five large external pairs and five small inner pairs. Calcareous ring with five stout, almost rectangular radials and five insignificant interradials, often completely concealed in surrounding tissue. One large dorsal stone canal, often branched, and one or two tufts of smaller stone canals with minute heads. Numerous tufts of branched Polian vesicles. Inner anatomy otherwise typical of the family.

Deposits large, well-developed end-plates, a few perforated spinous rods; tentacles with few rosettes in younger individuals. Colour greyish mottled to almost black, ventrum paler, tentacles dark. Shallow water forms. (After Deichmann, 1941).

Material Examined: Station 4, 4 specimens from Macrocystis zone.

Remarks: The four specimens in the present collection range in length between 140 mm and 165 mm. The body is well covered in tubefeet, which are more numerous ventrally. Colour in alcohol is dark brown to blackish dorsally, fading to light brownish-grey on the ventral surface. There are 20 black tentacles arranged in two rings. The outer ring has ten regularly spaced, profusely branched larger tentacles, averaging about 25 mm in length. The inner ring lies close around the mouth, and comprises five radially placed pairs of short, sparsely branched tentacles of 8 mm average length. The oral field is about 20 mm in diameter. Immediately outside the ring of large tentacles, in the mid-dorsal interradius, lies a small approximately circular mound of tissue about 1 mm high and 2 mm broad, which supports the genital aperture.

The mouth is large, and examination of the intestinal contents in a dissected specimen showed that hard pieces of _Macrocystis_ stipe up to 42 mm long and 6 mm wide, can be ingested. The intestine also contains fragments of green algae, both filamentous and thalloid, brown algae (predominantly _Macrocystis_), appendages of small crustaceans, and hydroids. This species seems to be primarily a vegetarian browser.

The calcareous ring is large, and has been illustrated by Heding and Panning (1954).

The gut is thin-walled, and takes a large S-shaped loop. The cloaca is broad, thick-walled, attached to the body wall by very numerous muscle strands. Respiratory trees take the form of two broad flat tubes with scattered, profusely branched tufts of respiratory tubules. The trees arise from the anterior end of the cloaca in the lateral dorsal interradii, and extend anteriorly for about half the length of the body cavity.

A tuft of numerous Polian vesicles arises from the ventral side of the water-vascular ring, and gives off smaller canals which lie to each side of the strong dorsal mesentery, and terminate in nodular madreporites.

The gonad almost fills the rest of the body cavity, and consists of two bunches of sparsely branched genital caeca, lying one to each side of the dorsal mesentery. The caeca are orange in colour, with white thickenings scattered along their length.

Radial muscles are represented as broad flat straps. The retractor muscles are each split into two or three narrow bands, joined by a thin web of tissue for most of their length.

In the specimen dissected, a commensal pinnotherid crab was found in the last branch of the intestine, half-way along the body cavity. The crab appeared to have caused little damage to adjacent tissues, apart from a slight rupturing of the wall of the intestine. This rupture might conceivably have been caused during preservation or transport of the specimens.

I found no calcareous deposits in the body wall or in the tubefeet, although end-plates are known to occur in the tubefeet of this species.

Through the work of Deichmann (1941) and Heding and Panning (1954), the systematic position of this species is now quite clear.

Distribution: Deichmann (1941) notes that _Athyonidium chilensis_ is probably "the most common phyllophorid known from Chile". The species is also found along the coast of Peru. The present locality record does not affect the known distribution pattern, and it is apparent that this species is reasonably common in the _Macrocystis_ zone, immediately below lowtide mark.

Family CUCUMARIIDAE

Subfamily Cucumariinae

Genus _Cladodactyla_ Brandt, 1835 emend. Panning, 1940.

Diagnosis: Tentacles ten. Calcareous ring small, without bifurcating processes. Skin deposits merely plates. The plates are thin, smooth, developed from forked rods. (After Panning, 1949).

Type Species: _Cladodactyla crocea_ (Lesson)

Remarks: The genus _Cladodactyla_ contains three species at the present time. _C. senegalensis_ Panning and _C. monodi_ Cherbonnier are known from Dakar and the Cameroons coast respectively.

Cladodactyla crocea (Lesson)

Cucumaria crocea Lesson, 1830, p.153, pl.52, figs.1, 1a;
Theel, 1886a, pp.58, 110, pl.12, figs.1, 2; Ludwig,

1898a, p.15, pl.1, figs.6-13 (list of references); Bell, 1908, p.2; Ekman, 1925, p.75, figs.15-16; Deichmann, 1947, p.331.

Cladodactyla crocea Panning, 1940, p.172; Panning, 1949, p.413; Panning, 1957, p.27, figs.12-13.

Diagnosis: Thin-skinned, small (up to 100 mm), dendrochirotes with equal-sized tentacles. Tubefeet restricted to the ambulacra, larger ventrally, smaller and more numerous dorsally (when present); usually arranged into double rows. Calcareous ring simple, with no posterior processes. Deposits perforated rods or platelets, reduced or lacking in older specimens. Tubefeet with endplates. Brood-protecting.

Material Examined: Station 73, 24 specimens.

Remarks: Cladodactyla crocea is one of the best-known of the holothurians from southern waters, and I have little to add to the thorough accounts given by the workers listed in the synonymy above. The specimens in the present collection range in total length from 10 mm to 27 mm. Colour in alcohol is light brown to dark greyish-brown. In some specimens, tubefeet are entirely lacking from the dorsal radii. Theel (1886) quoted that in the 20 mm to 40 mm specimens, dorsal tubefeet are wanting, but this is not the case in all of the specimens in the present collection. I found no juveniles on the dorsal surface of any specimens, although Theel's (1886) material, which was collected at about the same time of the year, included some specimens carrying broods of juveniles. Examination of the gonad in the larger specimens in my collection indicated that sexual maturity had not as yet been reached.

Calcareous deposits proved to be very rare, the tentacles sometimes containing isolated perforated rods in the smallest specimens (Pl.I, fig.1). In larger specimens the tentacle rods are mainly absent. With the exception of the endplates in the tubefeet (Pl.I, fig.2), bodywall deposits tend to be very scarce or lacking altogether. In a single 14 mm specimen I found but three deposits in the skin of the dorsal side (Pl.I, fig.3). These took the form of perforated platelets.

The features of the internal anatomy have already been described.(Ekman, 1925).

Distribution: Cladodactyla crocea is most commonly found at the southern tip of South America, about the Straits of Magellan, and along the eastern coast of southern South America, as far north as the mouth of the Rio de la Plata. The species is also known from South Georgia and Antarctica, at Coulman Is., Hut Point, and Franklin Island (Bell, 1908). C. crocea has been taken between lowtide mark and 4,300 metres, but is most common to depths of about 30 metres, often associated with seaweed.

Genus *Stereoderma* Ayres, 1851 emend Panning, 1949
Pentactella Verrill, 1876.

Diagnosis: Tentacles ten. Calcareous ring simple, without forked processes. Body wall deposits are knobbed plates, all of the same shape, and arranged in one layer; no tables, no rosettes, no cups. (After Panning, 1949).

Type Species: *Stereoderma unisemita* (Stimpson).

Remarks: The genus *Stereoderma* contains about 12 species at the present time. Four of the species have a circumpolar distribution when considered together.

S. leoninoides (Mortensen)	Auckland and Campbell Islands.
S. godeffroyi (Semper)	West coast of South America 20° -40° S. latitude. (Deichmann, 1947).
S. laevigata (Verrill)	Southern end of South America, Falkland Is., Kerguelen Is., Marion Is., The Crozets, Antarctica.
S. perrieri (Ekman)	Southern Chile, Falkland Is., South Georgia.

These four species seem to be closely related to each other, and their distribution parallels that of certain species of *Trachythyone* (Pawson, 1962).

PLATE I

Cladodactyla crocea (Lesson), Pseudocnus dubiosus (Semper).

Cladodactyla crocea (Lesson)

Fig.1. Tentacle deposits.

Fig.2. Tubefeet endplate.

Fig.3. Platelets from the dorsal bodywall.

Pseudocnus dubiosus (Semper)

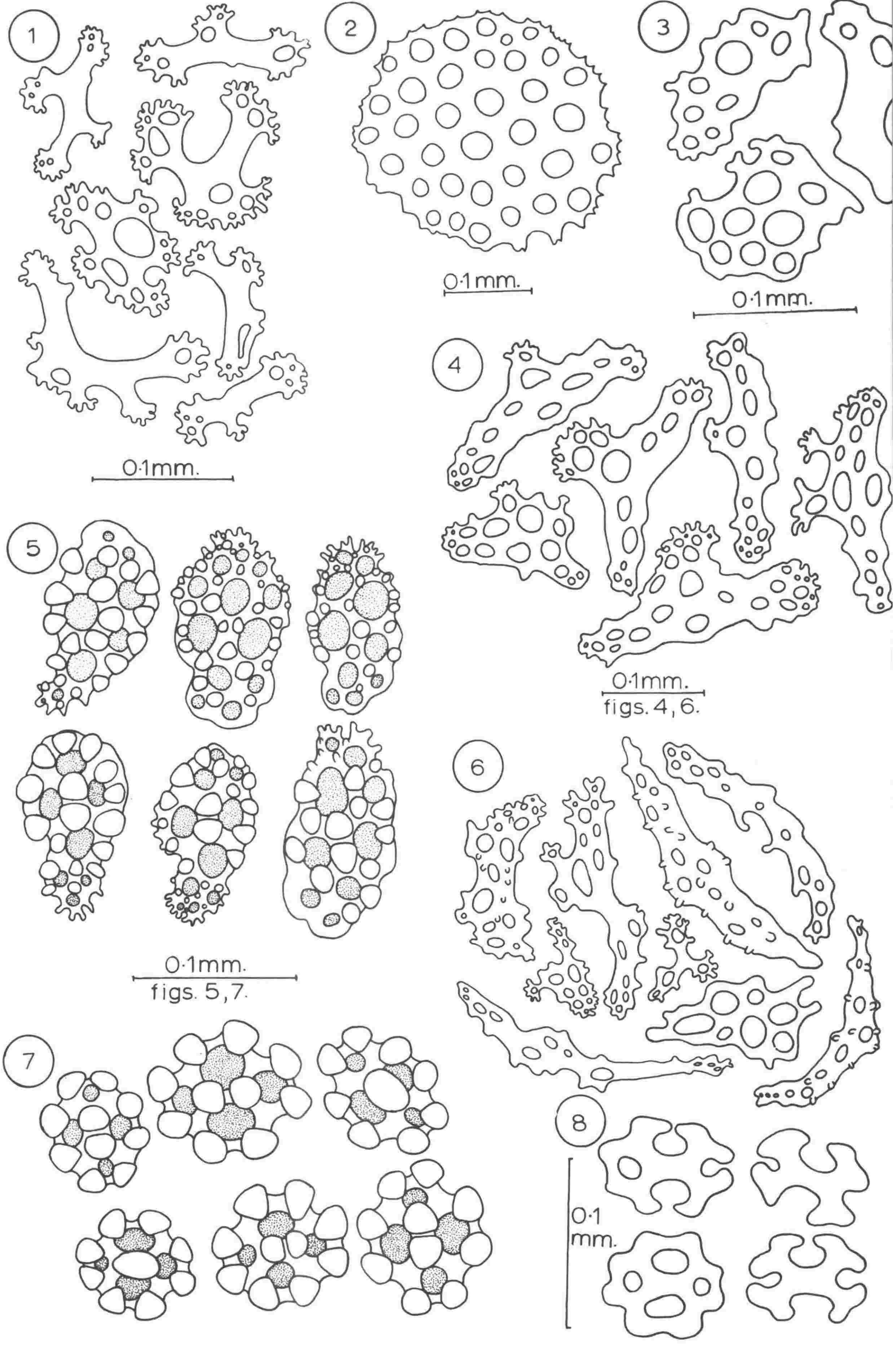
Fig.4. Tubefoot deposits.

Fig.5. Knobbed plates from the bodywall.

Fig.6. Tentacle deposits.

Fig.7. Knobbed buttons from the bodywall.

Fig.8. Developmental stages of knobbed buttons.


1
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0·1mm.
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4
0·1mm.
figs. 4, 6.
5
6
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figs. 5, 7.
7
8
0·1
mm.

Stereoderma laevigata (Verrill)

Pentactella laevigata Verrill, 1876, p.68; Studer, 1876; Studer, 1879; Smith, 1879, p.271.

Cucumaria laevigata Theel, 1886a, p.57, Pl.III, fig.5, Pl.IV, fig.13; Lampert, 1886, p.828; Ludwig, 1898a, p.32, Pl.II, fig.25; Herouard, 1901, p.44; Perrier, 1905, p.22; Herouard, 1906, p.12, Pl.2, figs.5-6; Bell, 1908, p.2; Helfer, 1917, p.164; Ekman, 1925, p.56, text-fig.11; Deichmann, 1947, p.333.

Cucumaria serrata Theel, 1886a, p.73.

Stereoderma laevigata Panning, 1949, p.422.

Diagnosis: Tentacles of equal size, feet restricted to the ambulacra, calcareous ring simple. Spicules as oblong plates with one end denticulate, sometimes knobbed with a reticulated network; they are numerous in smaller specimens, more scattered in larger ones. Tubefeet have endplates and three-armed rods. Tentacles with perforated rods; introvert with four-holed buttons sometimes with an external reticulum. Total length up to 120 mm. (After Deichmann, 1947).

Material Examined: Station 37, 1 specimen.

Remarks: The single specimen is small (total length 8 mm), and is strongly contracted, with many deep transverse wrinkles. Colour in alcohol is light brown. The calcareous deposits are typical of this species and need no further discussion here. _Stereoderma laevigata_ is a species which is readily recognised because of its distinctive calcareous deposits.

Distribution: Deichmann (1947) notes that _S. laevigata_ is known from the southern tip of South America, the Chile coast, Falkland Islands, Kerguelen Island, the Crozets, Marion Island. Bell (1908) reported specimens from the vicinity of McMurdo Bay, Antarctica, to depths of about 41 fathoms.

Genus _Pseudocnus_ Panning, 1949

Diagnosis: Tentacles 10. Calcareous ring simple, without posterior processes. In the bodywall are knobbed plates of two types, in two layers. (After Panning, 1949).

Type Species: _Pseudocnus kollikeri_ (Semper).

Pseudocnus dubiosus (Semper)

For synonymy see Panning (1950).

Diagnosis: Medium sized, length up to 100 mm. Tubefeet in five bands, numerous in the dorsal ambulacra. Tentacles bushy, of unequal size. Calcareous ring simple. Deposits numerous oblong knobbed plates (of average length 0.12 mm) with one end denticulate, and four-holed knobbed buttons (0.09 mm. average length). Tubefeet with rudimentary endplates or none at all, and numerous perforated supporting rods, mostly three-armed. Introvert and tentacles have perforated plates and rods. (After Deichmann, 1941).

Material Examined: Stn.19, 1 specimen. Stn.27, 57 specimens; Stn.39, 15 specimens; Stn.40, 2 specimens; Stn.52, 10 specimens; Stn.54, 4 specimens; Stn.77, 1 specimen.

Remarks: The 90 specimens range in length from 10 mm to 50 mm. The colour varies between white and pink. This species is one of the best-known from Chile, and has been described by many workers. Panning (1950, 1952) has suggested that there are three "forms" of this species. They are P. dubiosus-leonina, from the southern end of South America (all of the present specimens are of this type); P. dubiosus-dubiosa ranges the Atlantic and East Pacific shores, as far south as Chile; P. dubiosus-jageri is known from South Africa.

The deposits of the body wall in the present material (Pl. I, figs.5, 7) are those of the leonina form. Small specimens may show stages in the development of knobbed buttons (Pl. I, fig.8). The tubefoot deposits (Pl.I, fig. 4) are perforated plates, often three-armed, about 0.22 mm in average length. The tentacles contain perforated rods and small plates up to 0.32 mm long (Pl. I, fig.6).

A thorough investigation of all of the species in the genus Pseudocnus is urgently needed, particularly those species which have the body wall deposits as plates with one end denticulate, and buttons. For a successful attempt at a revision, a representative range of specimens of each species would be required, and unfortunately these are not available to the writer at the present time.

Distribution: The leonina-form of this species is known from southern Peru in the west of South America to the Rio de la Plata in the east, and the Falkland Islands, from the intertidal zone to approximately 100 metres.

Subfamily Colochirinae

Genus Trachythyone Studer, 1876

For synonymy, see Panning (1949).

Diagnosis: Calcareous ring simple, without forked processes. In the skin are cups and smooth plates, the plates imbricating in some species. (After Panning, 1949).

Type Species: Trachythyone muricata (Studer).

Remarks: This genus comprises about 20 species, of which eleven are distributed in the southern Pacific Ocean from Australia to South America and also Kerguelen Island. The remaining species are found in the Indo-west-Pacific and Mediterranean regions.

<u>Trachythyone</u> <u>lechleri</u> (Lampert)

<u>Thyone</u> <u>lechleri</u> Lampert, 1885, p.253, fig.64; Theel, 1886a, p.267; Ludwig, 1898a, p.44, Pls.2, 3, figs.26-33; Perrier, 1905, p.35; Ekman, 1925, p.101, fig.22; Deichmann, 1947, p.335.

<u>Thyone</u> <u>hassleri</u> Theel, 1886b, p.11-12.

<u>Trachythyone</u> <u>lechleri</u> Panning, 1949, p.426, figs.12-14.

Material Examined: Station 54, 9 specimens.

Remarks: These are typical specimens of this unusual species. The total length ranges from 47 mm (a strongly contracted specimen) to 130 mm. The colour in alcohol is mottled light brown to dark orange-brown. The tubefeet are lighter in colour than the rest of the body. In most cases the tentacles are completely retracted.

The calcareous ring is simple, with no posterior processes, and is solid, with the five radials and five interradials firmly fused together. The radials each have an anterior notch for insertion of retractor muscles (Pl.II, fig.1). There is a single tubular Polian vesicle about 40 mm in length, which arises from the water-vascular ring in the left dorsal interradius; the madreporite is a small nodule about 1.5 mm in diameter, lying near the posterior edge of the calcareous ring in the mid-dorsal interradius. The gonad comprises two bunches of elongate unbranched orange-coloured caeca, which attach to the long genital duct near the middle of the body in the mid-dorsal interradius.

The skin is packed with a great number of calcareous deposits, which chiefly take the form of thick, oval plates, with few perforations or none, and a length varying between 0.07 mm and 0.2 mm (Pl.II, fig.2). Overlying the plates are a small number of rudimentary "cups" which vary considerably in shape (Pl. II, fig.5), and occasionally carry short, blunt knobs, and may have up to three perforations. At the extreme posterior end of the body the plates are larger, and more complex, with a greater number of perforations, and a tendency to become knobbed or two-layered (Pl. II, fig.4). These plates are up to 0.3 mm long. The tubefeet contain stout endplates which are surrounded by perforated supporting deposits (Pl. II, fig.3), having an average length of about 0.2 mm.

Lampert (1885) apparently stated that this species has a calcareous ring with posterior prolongations, as Theel (1886a), after examining the "Challenger" specimens of Thyone lechleri, stated that "each piece (of the calcareous ring) ... has a bifurcate projection posteriorly". Then Theel (1886b) described a new species, Thyone hassleri, which resembles Lampert's Thyone lechleri in most respects, but lacks posterior processes on the calcareous ring. Ludwig (1898a) illustrated the calcareous ring of what he believed to be Thyone lechleri, and it is similar in every way to the ring illustrated in this paper (Pl. II fig. 1), and lacks forked posterior processes. Panning (1949) also states that the calcareous ring in species _lechleri_ lacks posterior processes. Either Theel (1886b) was quite correct in erecting the species _hassleri_ for those specimens with no posterior processes on the calcareous ring, (in which case some specimens previous workers have assigned to species _lechleri_ are in fact _hassleri_), or Lampert's type specimen of _lechleri_ may have been unusual in possessing posterior processes. The calcareous deposits of species _lechleri_ and _hassleri_ are apparently identical, and are so unique in character that it seems logical to synonymise the two species. The problem cannot finally be resolved until Lampert's type material can be re-examined.

Distribution: _Trachythyone lechleri_ is known from the vicinity of Magellan Straits and Tierra del Fuego in depths of up to 30 metres. A single holothurian from Heard Island, resting in the collection of the Dominion Museum, Wellington, was identified by the author as _Trachythyone lechleri_, and thus the range of this species is now considerably extended.

Family Psolidae

<u>Neopsolidium</u> n.g.

Diagnosis: Small forms, with sole not sharply distinguished from the rest of the body. Dorsal deposits small (up to 0.4 mm) smooth perforated plates, and cups. Ventral deposits plates similar to dorsal plates and perforated buttons; no cups ventrally.

Type Species: <u>Psolidium convergens</u> (Herouard).

Remarks: Deichmann (1941, 1947) stated that the species <u>Psolidium convergens</u> deserves a separate genus because of the nature of its dorsal deposits, which differ from those in most other <u>Psolidium</u> species. This opinion was based chiefly on the thorough description and figures given by Perrier (1905) of this species. Clark (1946) agreed with Deichmann, but neither of those workers elected to propose a new generic name. Examination of specimens of <u>Psolidium convergens</u> in the Royal Society collection has convinced me that this species should be assigned to a separate genus. Although <u>Neopsolidium</u> is monotypic at present, it may accommodate some other <u>Psolidium</u> species, and future work will show whether or not this is possible.

The Family Psolidae contains but a small number of genera, and the genus <u>Psolus</u> itself is in urgent need of revision. Such a revision is beyond the scope of this work.

PLATE II

Trachythyone lechleri (Lampert), *Neopsolidium convergens* (Herouard).

Trachythyone lechleri (Lampert)

Fig.1. Radial and interradial pieces of the calcareous ring.

Fig.2. Plates from the bodywall.

Fig.3. Tubefoot deposits.

Fig.4. Plates from the extreme posterior end of the body.

Fig.5. Rudimentary "cups".

Neopsolidium convergens (Herouard)

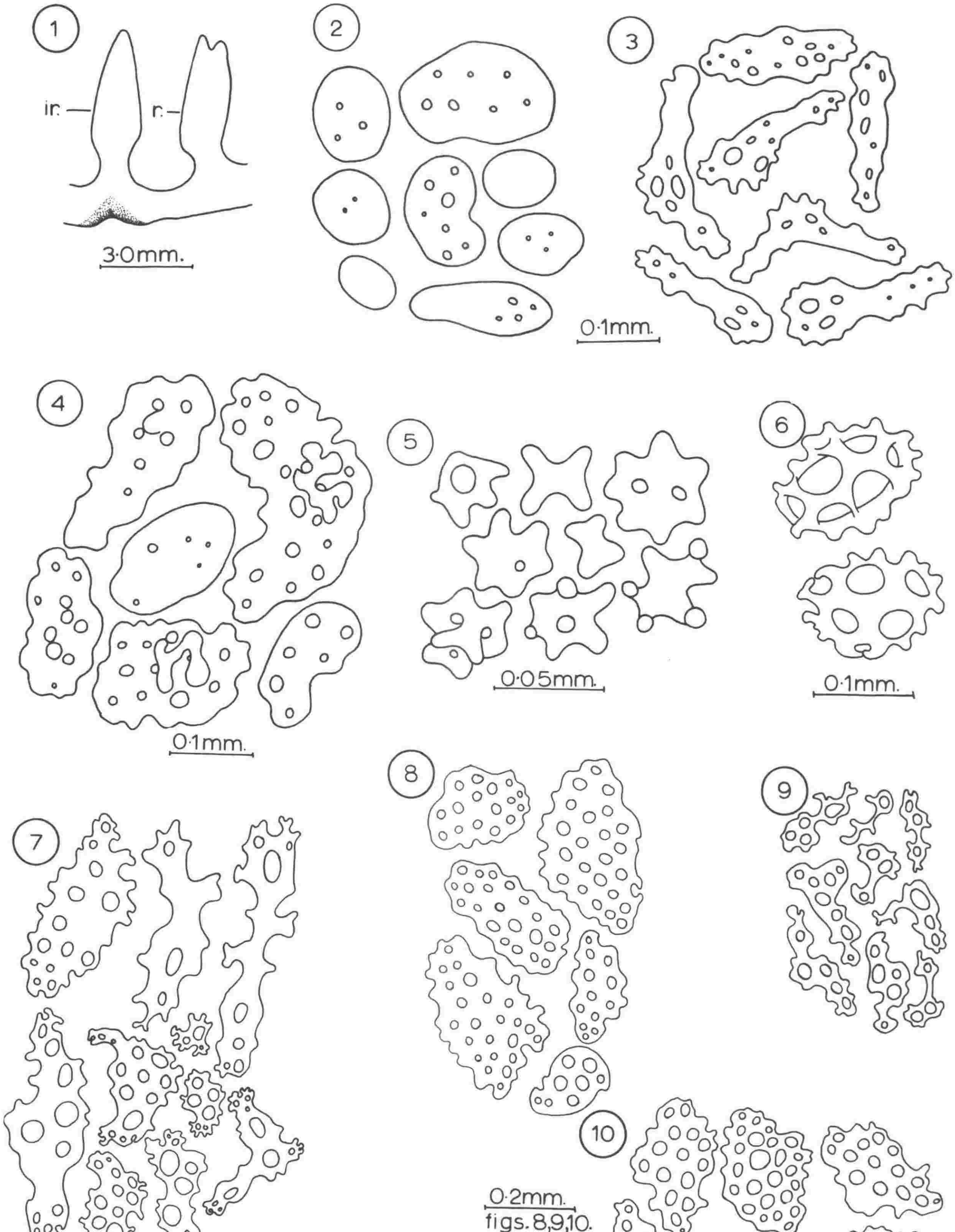
Fig.6. Cups.

Fig.7. Tentacle deposits.

Fig.8. Plates from the dorsal bodywall.

Fig.9. Buttons from the ventral bodywall.

Fig.10. Plates from ventral bodywall.


1
ir.
r.
3·0mm.
2
3
0·1mm.
4
0·1mm.
5
0·05mm.
6
0·1mm.
7
0·2 mm.
8
9
10
0·2mm.
figs. 8,9,10.

Key to the Genera in Family Psolidae

1 (10) Tentacles 10.

2 (7) Dorsal surface with tubefeet.

3 (4) Dorsal deposits include hourglass-shaped bodies, but lack cups or baskets . <u>Thyonepsolus</u> Clark

4 (3) Hourglass-shaped bodies lacking, cups or baskets present.

5 (6) Sole sharply set off; dorsal deposits conspicuous scales, and small cups. Dorsal tubefeet may pass through some of the scales. Sole deposits plates or buttons, usually with an external layer of small deep cups . . . . <u>Psolidium</u> Ludwig

6 (5) Sole not sharply set off; dorsal deposits small (up to 0.4 mm), smooth perforated plates, and cups. Ventral deposits plates (similar to dorsal plates), and buttons (no cups) . . . . <u>Neopsolidium</u> n.g.

7 (2) Dorsal surface without tubefeet.

8 (9) Dorsal surface with imbricating scales. Mouth and anus dorsal . . . . <u>Psolus</u> Oken

9 (8) Dorsal surface smooth, deposits sparingly scattered oval perforated plates, sometimes with warty surfaces, of average diameter 0.1 mm. Mouth terminal, anus subdorsal . . . . <u>Pseudopsolus</u> Ludwig

10 (1) Tentacles 15 . . . . <u>Stolinus</u> Selenka

Neopsolidium convergens (Herouard)

Cucumaria convergens Herouard, 1901, p.30.

Psolidium convergens Perrier, 1904, p.15; Perrier, 1905, p.38, text-figs. D-F, Pl.2, figs.2-4; Herouard, 1906, p.12, Pl.1, figs.7-8; Pl.2, figs.10-12; Ekman, 1925, p.111; Deichmann, 1947, p.336.

Diagnosis: As for the genus.

Material Examined: Stn. 50, fragment of anterior end; Stn. 52, 2 specimens; Stn. 73, 1 specimen; Stn. 77, 2 specimens.

Remarks: The material examined agrees well in most respects with the excellent descriptions and figures given by Perrier (1905) and Herouard (1906). The total length ranges between 18 mm and 22 mm, while a single juvenile specimen is 4 mm in length. Colour in alcohol is dirty white to light brown. The tentacles are orange to light brown, darker in colour than the rest of the body. Tube-feet are restricted to the radii ventrally, where they are arranged in a double row in each radius. Near the extreme anterior and posterior ends of the body, the feet decrease in numbers, and adopt a biserial arrangement. Dorsally the feet are scattered over both radii and inter-radii. The mouth and anus are slightly upturned. There are about ten anal teeth or papillae.

Deposits in the dorsal skin are thick perforated plates 0.2-0.4 mm in length (Pl. II, fig.8). The plates are closely aggregated together, and overlain by cups, which are 0.14 mm in diameter (Pl. II, fig.6). The cups are lacking in the juvenile specimen. Ventrally the plates are slightly more irregular in outline and are not so closely crowded together (Pl. II, fig.10). Intermingled with the ventral plates, and more numerous than them, are irregular perforated buttons (Pl. II, fig.9). The tentacles contain perforated plates and button-like deposits in great numbers (Pl. II, fig.7). Some of these deposits are curved and carry small knobs.

This species differs from the others known in the region (Psolidium dorsipes and P. disciformis) in possessing the characteristic small dorsal plates, which have warranted erection of a new genus to accommodate it.

Distribution: Neopsolidium convergens has been taken from the waters about Cape Horn, Magellan Straits, Falkland Islands, and South Georgia, in depths ranging to about 15 metres, and seems to favour life in the Macrocystis zone, where Herouard (1901) first discovered the species.

Genus Psolus Oken, 1815

Diagnosis: Tentacles 10. Dorsal surface lacking tubefeet, covered by imbricating scales. Sole sharply defined, deposits smooth or knobbed plates or buttons.

Type Species: <u>Psolus phantapus</u> (Strussenfeldt)

Remarks: This genus now contains over 30 species, which are spread widely over the Arctic and Antarctic regions and in the tropics. <u>Psolus</u> species are most common in shallow water, but some are known from considerable depths.

<u>Psolus patagonicus</u> Ekman

<u>Psolus patagonicus</u> Ekman, 1925, p.140, text-figs. 35-36; Deichmann, 1941, p.148, Pl.30, fig.8; Deichmann, 1947, p.339, figs.1-2.

Diagnosis: A small psolid, up to 20 mm in total length, with oral and anal valves, and radial teeth between them. Few scales between mouth and anus. Mid-ventral radius naked. Sole deposits mostly four-holed knobbed buttons (average length 0.1 mm), together with a few small plates. Tentacles invested in smooth or knobbed perforated plates (0.07-0.17 mm in length).

Material Examined: Stn. 39, 30 specimens; Stn. 40, 1 specimen.

Description: The specimens are small (total length ranges from 2.5 mm to 11 mm), dorso-ventrally flattened, oval in outline, broadest near the anterior end. The dorsal surface carries mouth and anus, and is invested in overlapping plates. The ventral sole is soft. Colour in life "salmon-pink"; in alcohol, light yellowish-brown dorsally, orange-brown ventrally. The tentacles are orange-yellow, with some small brown spots.

The dorsal plates are about 0.8 mm broad, and tend to overlap towards the midline, while the dorsal surface is bordered by 1-3 rows of smaller marginal plates (Pl. III, fig.1). The plates are thick, reticulated, beset with minute knobs. The plates also carry a small number of tiny pearl-like grains, which are less common in smaller specimens. There are about five plates between mouth and anus.

The dendritic tentacles are extended in most specimens, and the ventral pair are somewhat smaller than the rest, unbranched or weakly branched. There are five conspicuous triangular interradial oral valves (Pl. III, fig.1), between and below which lie five radial valves, which are in the form of elongate isosceles triangles. In a small number of specimens, one to four smaller plates lie near the base of the oral valves. The anal aperture is also covered by five radial valves and five anal valves (Pl. III, fig.1).

The soft sole is semi-transparent, and is bordered by a ring of tubefeet in a single or sometimes double row. The mid-ventral radius is naked (Pl. III, fig.2).

The calcareous ring comprises five radials and five interradials fused together. Each radial piece has an anterior process with a deep, narrow notch. Interradials each have an anterior process with no notch. There are no posterior processes (Pl. III, fig.6). The ring is turned so as to lie parallel with the dorsal surface of the body, to correspond with the dorsal position of the mouth. Therefore the mid-ventral radial piece is the most anterior portion of the ring.

The thin-walled intestine is coiled into three loops, and the mesentery of the posterior loop of the intestine lies as usual in the right ventral interradius. Overall, the intestine is a dark orange-brown in colour. A single bulbous Polian vesicle arises from the water vascular ring in the left ventral radius. The short stone canal and nodular madreporite lie in the mid-dorsal interradius.

The gonads in the larger specimens are well developed as two bunches of light brown tubular unbranched caeca, which extend for the length of the body cavity. The genital duct proceeds along the dorsal side of the calcareous ring (or more correctly, the "posterior" side), and opens to the exterior immediately behind the tentacles, but apparently within the oral valves.

Apart from the dorsal surface, calcareous deposits are present in the sole, the tentacles, and the tubefeet.

1. Sole deposits: The thin sole contains four-holed buttons (Pl. III, fig.3), and some slightly larger knobbed or smooth plates (Pl. III, fig.3). These deposits are sparingly scattered in the sole.

2. Tubefoot deposits: Each tubefoot has an end-plate (Pl. III, fig.7) of average diameter 0.23 mm, which is surrounded by some curved perforated rods and plates, which may carry knoblike projections (Pl. III, fig.5). The length of these deposits varies between 0.06 mm and 0.2 mm.

3. Tentacle deposits: The tentacles are invested in a network of perforated rods and plates, some of which carry knobs. (Pl. III, fig. 4).

Remarks: After having examined these specimens, I thought that I had found a new species, as they differ in some respects from Ekman's (1925) type specimen. Both Ekman (1925) and Deichmann (1941) state that _Psolus patagonicus_ can have small intercalary plates between the larger dorsal plates. The photograph of Ekman's (1925) specimen clearly shows these plates. None of the specimens I examined possess these intercalary plates. Ekman's specimen was 20 mm long, while the largest in the present collection is 11 mm in total length. This size discrepancy could explain the absence of intercalary plates in my material, as they may develop later in the life of the animal.

The present specimens closely resemble the type of _P. patagonicus_ when their calcareous deposits are considered, and thus there is little doubt that they are in fact examples of Ekman's species.

Distribution: The type specimen (Ekman, 1925) was collected from the Patagonian bank, 46°S. latitude, at a depth of 110 metres. Deichmann (1941, 1947) states that the species has been taken from the type locality and various other localities in the Straits of Magellan. Present records indicate that *Psolus patagonicus* may be quite common, in some localities its small size perhaps enabling it to escape notice by the collector.

PLATE III

Psolus patagonicus Ekman, *Trochodota purpurea* (Lesson)

Psolus patagonicus Ekman

Fig.1. Entire animal, dorsal view.

Fig.2. Entire animal, ventral view.

Fig.3. Sole deposits.

Fig.4. Tentacle deposits.

Fig.5. Tubefoot deposits.

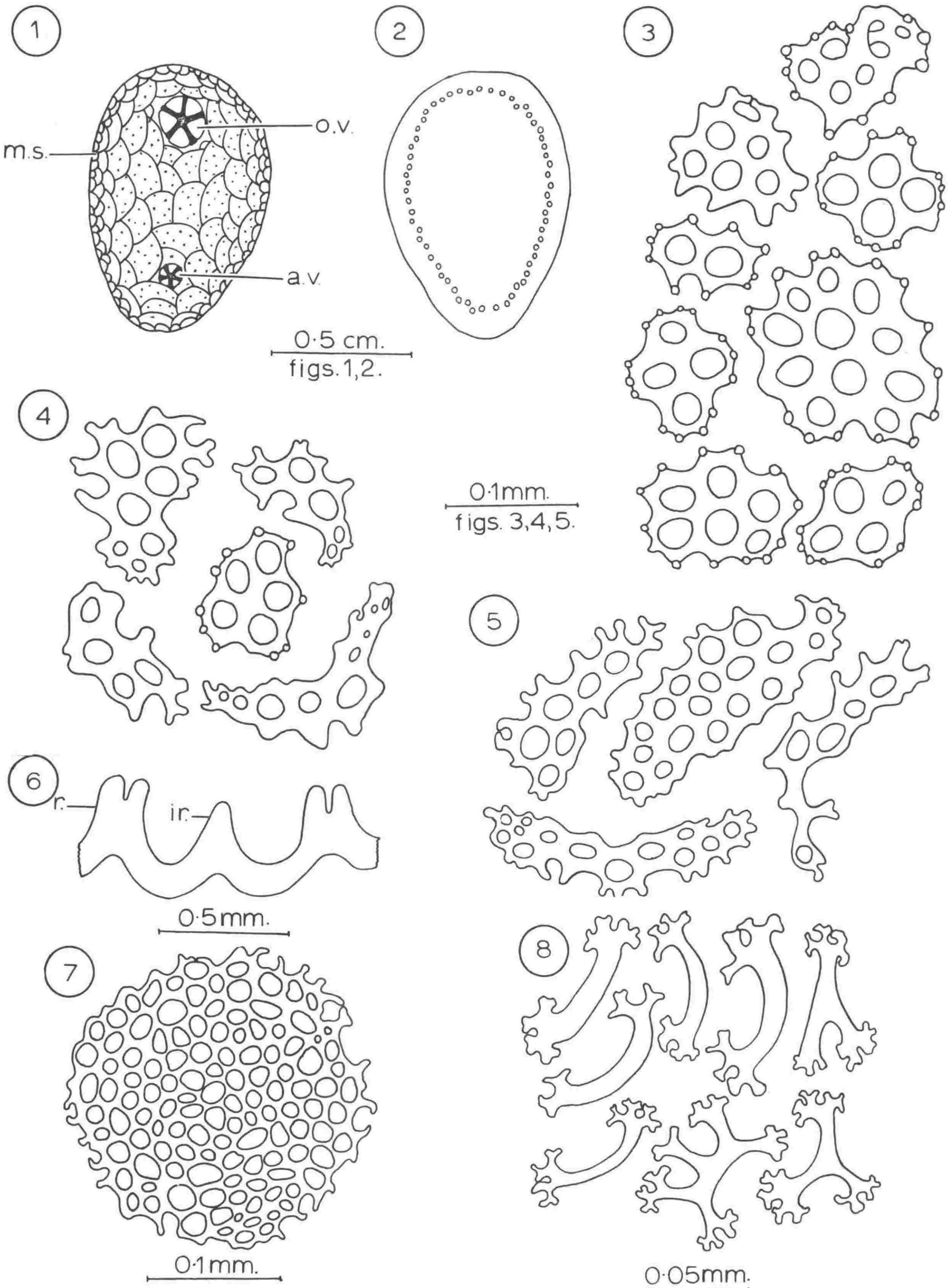
Fig.6. Radial and interradial pieces of the calcareous ring.

Fig.7. Endplate of tubefoot.

Trochodota purpurea (Lesson)

Fig.8. Tentacle deposits.

Abbreviations: a.v., anal valve; m.s., marginal scales; o.v., oral valve; r., radial piece; ir., interradial piece.



1
m.s.
o.v.
a.v.
2
0·5 cm.
figs.1,2.
3
4
0·1mm.
figs. 3,4,5.
5
6
r.
ir.
0·5mm.
7
0·1mm.
8
0·05mm.

ORDER APODIDA

Family Chiridotidae

Genus Chiridota Eschscholtz, 1829

Dactylota Brandt, 1835; Liosoma Brandt, 1835; Trochinus Ayres, 1852; Lioderma Bronn, 1860.

Diagnosis: Tentacles 12, digits 3-10 on each side, the terminal pair being the longest. Polian vesicles numerous (3-20). Deposits six-spoked wheels collected into small papillae containing varying numbers of wheels of diverse sizes. No sigmoid rods, but small curved rods with enlarged ends may be present. Minutely miliary granules often occur in the longitudinal muscles.

Type Species: Chiridota discolor Eschscholtz

Remarks: This is a well-defined genus of world-wide distribution, containing about 25 species, none of which have a very extensive geographic range. Most species occur in shallow waters, although some have been taken at depths in excess of 3,500 metres.

Chiridota pisanii Ludwig

Chiridota pisanii Ludwig, 1886, p.29, Pl. 2, fig.14; Ludwig, 1898a, p.71 (complete list of references); Ludwig, 1898b, p.445; Clark, 1907, p.118; Ekman, 1925, p.145, text-fig.62; Heding, 1928, p.297, text-fig.62; Heding, 1931, p.676; Deichmann, 1947, p.347.

Chirodota purpurea Theel, 1886a, pp.15, 35, Pl.2, fig.1;
Lampert, 1889, p.851.

Diagnosis: Tentacles 12, usually with five pairs of digits each. Calcareous deposits wheels, which are arranged in papillae up to 1.5 mm in diameter. Papillae confined to the interradii, and are more numerous dorsally, where they are arranged in a single row in each interradius. No other deposits in the skin. Radial muscles contain miliary granules. Tentacle rods bracket-shaped, with branched ends, average length 0.05 mm.

Material Examined: Station 73, 4 specimens.

Remarks: The total length of the four specimens ranges between 11 mm and 60 mm. Colour in alcohol dirty white to light brown. There are 12 tentacles, each with five pairs of digits. The wheel papillae vary considerably in diameter, up to a maximum of 1 mm.

Dissection of the largest specimen revealed the presence of seven Polian vesicles, the largest being 7 mm in length. Rows of closely aggregated ciliated funnels lie in the mid-dorsal and left lateral interradii, the rows commencing about 6 mm from the anterior end of the body cavity, and extending to the extreme posterior end. The genital tubules are long, sparsely branched, and packed with eggs averaging 0.3 mm in diameter. Deichmann (1947) has commented on the relationships of this species, and notes that deeper water forms are known which may perhaps be assigned to Chiridota purpurea Theel.

Distribution: Chiridota pisanii is known from both coasts of southern South America, and the Falkland Islands, from the intertidal zone to about 100 metres.

Genus Trochodota Ludwig, 1892

Diagnosis: Tentacles 10, digits 2-6 on each side. One Polian vesicle and one stone canal. Calcareous ring comprises ten pieces, the radial unperforated. Calcareous deposits sigmoid hooks, scattered or arranged into groups, and wheels, scattered and never grouped into papillae. (After Clark, 1907).

Type Species: Trochodota purpurea (Lesson)

Remarks: This is a well-defined, cosmopolitan genus, containing about a dozen species, some of which are inadequately described. There are three species in Australia, two in New Zealand, and one in southern South America. T. dunedinensis from New Zealand resembles T. purpurea from South America in many respects, and the two species may be related.

Trochodota purpurea (Lesson)

Holothuria (Fistularia) purpurea Lesson, 1830, p.155, Pl. 53, fig.1.

Chirodota purpurea Jager, 1833, p.16; Dujardin and Hupe, 1862, p.616.

Chiridota purpurea Brandt, 1835, p.259.

Sigmodota purpurea Studer, 1876, p.454 (partim)

Chirodota australiana Theel, 1886a, p.16.

Chirodota studeri Lampert, 1889, p.339, Pl.xxiv, fig.12.

Trochodota studeri Ludwig, 1892, p.359.

Sigmodota studeri Oestergren, 1898.

Trochodota purpurea Ludwig, 1898a, p.83, Pl.III, figs.43-45; Perrier, 1905, p.76; Clark, 1907, p.123; Clark, 1921, p.166; Ekman, 1925, p.149; Deichmann, 1947, p.351.

Diagnosis: Tentacles ten, each with 2-6 pairs of digits. Wheels (0.13-0.18 mm diameter) scattered in the skin, together with sigmoid hooks (0.12-0.13 mm long). Tentacles deposits, when present, average 0.078 mm in length, and are bracket-shaped, with dichotomously branching ends. Colour in life commonly purple.

Material Examined: Stn. 73, 8 specimens; Stn. 74, 2 specimens; Stn. 77, 1 specimen.

Remarks: The smallest specimen in the collection is 4 mm in total length, and the largest is 100 mm. Colour in alcohol ranges from off white to light brown or violet.

The number of tentacle digits varies. Clark (1921) in his key to the species of *Trochodota* stated that species *purpurea* has tentacles with six digits each. In the present collection, one specimen has 12 digits per tentacle, and another has eight. Clearly the number of tentacle digits is not a reliable diagnostic character in this species. The calcareous deposits in the skin have been well described.

The tentacles in some of the specimens contained a number of bracket-shaped rods with dichotomously branching ends (Pl. III, fig.8). Perrier (1905) stated that the tentacles in his material were "totally devoid of calcareous deposits", while Deichmann (1947) in diagnosing this species, wrote, " ... no spicules in the tentacles". Ludwig (1898a) illustrated a single tentacle rod, and it closely resembles those illustrated here. There is no doubt, then, that tentacle deposits may be present, perhaps in young stages, and become rare or disappear as a specimen grows, as can happen with the wheels and hooks in the body wall.

Distribution: *Trochodota purpurea* is recorded from the southern tip of South America and the Falkland Islands, to depths of about 50 metres. Habitat includes sand, shelly bottom, and holdfasts and fronds of seaweed, especially *Macrocystis*.

Genus *Taeniogyrus* Semper, 1868

Sigmodota Studer, 1876

Diagnosis: Tentacles peltato-digitate, 10 or 12. Digits 5-7 pairs per tentacle, the terminal pair being the longest. Calcareous deposits are wheels gathered into papillae, and sigmoid hooks (about 0.2 mm long) scattered in the skin. No miliary granules in radial longitudinal muscles.

Type Species: *Taeniogyrus australianus* Stimpson.

Remarks: This is a small genus containing about six species. Three species are known from Australia, one from Japan, one from Hawaii, and one from the south-east Pacific Ocean.

Taeniogyrus lies intermediate between *Chiridota* (wheels and occasionally curved rods, no sigmoid hooks) and *Trochodota* (wheels, and sigmoid rods, the wheels not grouped into papillae).

Taeniogyrus contortus (Ludwig)

Chiridota contorta Ludwig, 1874, p.80, Pl.VI, fig.6; Lampert, 1885, p.234; Theel, 1886a, pp.16, 33, Pl.2, fig.2; Theel, 1886b, p.20; Lampert, 1889, pp.851, 853.

Sigmodota purpurea Studer, 1876, p.454; Studer, 1879, p.123.

Chirodota purpurea Bell, 1881, p.101; Lampert, 1885, p.236; Lampert, 1886, p.18, figs.17-20; Ludwig, 1886, p.29.

Chiridota studerii Theel, 1886a, p.33.

Chiridota contorta Ludwig, 1892, p.359; Ludwig, 1897, p. 217; Ludwig, 1898a, p.73, Pl. III, figs.37-42.

Sigmodota contorta Ostergren, 1898; Sluiter, 1901, p.134.

Taeniogyrus contortus Clark, 1907, p.122, Pl. VII, figs. 8-13; Clark, 1921, p.165; Ekman, 1925, p.147; Heding, 1928, p.311, text-fig. 66, 1-9; Deichmann, 1947, p.348.

Diagnosis: Tentacles 12, with 5-7 pairs of digits. Wheels (diameter 0.042-0.13 mm) gathered into well-defined papillae; sigmoid hooks large (0.14-0.2 mm long) scattered in the skin. Tentacle rods 0.17 mm in length.

Material Examined: Station 73, 1 specimen.

Remarks: The single specimen is 50 mm in total length, and has only 11 tentacles. Colour in alcohol is a dull, dark brown. The systematic position of Taeniogyrus contobtus is now quite clear as a result of the work of Clark (1907, 1921) and Heding (1928).

Distribution: The species is known from the southern tip of South America, Falkland Islands, South Georgia, Burwood Bank, and Kerguelen Island, to depths of about 200 metres. Sluiter (1901) recorded Sigmodota contorta from the Java Sea at a depth of 82 metres. Clark (1921) doubted the accuracy of the identification, and it might well be that Sluiter's material represents yet another species. Fisher (1907) found a close relative of _T. contortus_ in Hawaii.

DISCUSSION

1. THE HOLOTHURIAN FAUNA OF SOUTHERN CHILE.

Collections made at 18 stations in the Isla Chiloe area revealed only one species, namely _Athyonidium chilensis_, while at least seven shallow water species are known from this region. _Athyonidium chilensis_ is one of the most conspicuous holothurians in Peru and Chile, and Isla Chiloe represents the extreme southern limit of the range of the species.

From Puerto Eden to Punta Arenas, 31 stations were worked, and holothurians were taken from five stations. They were:

Pseudocnus dubiosus
Stereoderma laevigata
Psolus patagonicus

By far the most common species here was _Pseudocnus dubiosus_, which was collected in numbers at four of the five stations. This species, together with _Cladodactyla crocea_ and _Stereoderma laevigata_, seem to favour the _Macrocystis_ zone as a habitat.

Seven species were found at Isla Navarino and the southern regions, at six of the 29 stations worked. They were:

Pseudocnus dubiosus

Cladodactyla crocea

Trachythyone lechleri

Neopsolidium convergens

Chiridota pisanii

Trochodota purpurea

Taeniogyrus contortus

Of these seven species, three are apodous forms. In an account of the marine work carried out by the Royal Society Expedition, Professor Knox (pers. comm.) noted that "one of the salient features of the southern region is the reduction which has occurred in the number of species present", and he cited the case of species of Brachyura (Crustacea), of which there were 15 at Chepu (Isla Chiloe), and only two in the southern regions. This state of affairs clearly does not apply to holothurians, as at least 14 species are known from the southern region, while approximately seven have been recorded from the Isla Chiloe area.

Between Isla Chiloe and Isla Navarino the character of the holothurian fauna changes, and the number of species gradually increases. There are no drastic changes which might indicate a provincial pattern, although the number of species shows a definite increase at about 52° S., immediately north of the western entrance to the Straits of Magellan.

Apodous species (e.g. Trochodota purpurea, Chiridota pisanii, Taeniogyrus contortus) are more numerous in the southern regions than elsewhere on the Chile coast, but there is no apparent reason why this should be the case.

The fauna of Chile contains a remarkably high percentage of cucumariids (ca. 40%), compared with that of New Zealand (33%) and Australia (22%). This is a striking feature of the fauna, as also is the virtual absence of phyllophorids below about 42° S., whereas New Zealand has 15%.

2. RELATIONSHIPS OF THE FAUNA.

A. With that of Australia, New Zealand and the Antipodean Province Islands: The holothurian fauna of southern Chile bears no close relationship to that of New Zealand and Australia. A single species, Paracaudina chilensis, is common to New Zealand and southern Chile, and this species is a circum-Pacific eurybathic form. Ocnus calcareus is known from New Zealand and Juan Fernandez, but has not as yet been recorded from the Chilean coast. The Antipodean Province Islands (Auckland Is., Campbell Is. in particular) of New Zealand support a holothurian fauna of New Zealand character, and thus the fauna differs fundamentally from that of other southern Islands such as Kerguelen, Macquarie, South Georgia. However, one Antipodean Province species, Stereoderma leoninoides (Mortensen), is a close relative of _Stereoderma laevigata_ from southern Chile, and it is quite possible that these two species may have been derived from some common source.

B. With that of Antarctica: Some species, including _Cladodactyla crocea_, _Stereoderma laevigata_, _Trachythyone parva_, _Psolus antarcticus_, are shared with the fauna of Antarctica. Fell (1961), in discussing the Ophiuroidea of Antarctica, stated that the Magellanic ophiuroid fauna is predominantly of southern American type, mingled with a few Antarctic species which are eurythermal. The four species mentioned above are probably eurythermal, and can readily survive the difference in temperature between Antarctica and southern Chile.

C. With that of the Subantarctic Islands: The Falkland Islands (Islas Malvinas) have a holothurian fauna which is scarcely distinguishable from that of southern Chile. This is understandable when one considers that the islands are but 250 miles east of Tierra del Fuego, in a good position to accept species carried from southern South America by the west wind drift.

Among the Kerguelen Island holothurians are _Cladodactyla crocea_, _Stereoderma laevigata_, _Trachythyone parva_, _Taeniogyrus contortus_. Thus the fauna here also bears a remarkable resemblance to that of southern Chile.

South Georgia, regarded as a separate biotic province by Knox (1960), shares _Cladodactyla crocea_, _Trachythyone parva_, _Stereoderma laevigata_, _Neopsolidium convergens_, _Taeniogyrus contortus_, and (with doubt) _Anapta fallax_ with southern Chile.

Stereoderma laevigata is also known in the fauna of Marion Island and the Crozets.

When considered overall, these islands have faunas which are similar to that of southern Chile, and the similarity is at the specific level. The dispersal of species to these widely separated areas is probably effected epiplanktonically (perhaps on rafts of seaweed), with the aid of the west-wind drift. This is quite conceivable for such species as _Stereoderma laevigata_ and _Cladodactyla crocea_, which commonly live on the fronds and holdfasts of _Macrocystis_, a brown seaweed which is found on all of the islands mentioned above. The west wind drift dispersal mechanism for echinoderms has already been discussed by Mortensen (1925), Fell (1953, 1962), Ekman (1953) and others.

The holothurian fauna of Southern Chile is a generalised fauna, containing few restricted species, and notable because of the number of species which are shared with distant islands, and the Antarctic continent.

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THE BATHYAL HOLOTHURIANS OF THE NEW ZEALAND REGION

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ABSTRACT

The bathyal fauna is now known to comprise 20 genera and 23 species, of which 13 species are new records for the New Zealand region. Material of 13 genera and 14 species has been examined, and is described here. Amperima nom. nov. is proposed to replace the preoccupied elasipod generic name Periamma Perrier, 1896, type species P. roseum. A new elasipod genus, three new elasipod species, and a new molpadid species are proposed.

The fauna is partly of cosmopolitan facies, containing many elements of the Indo-west-Pacific bathyal fauna. The New Zealand shelf contributes little to the bathyal fauna.

INTRODUCTION

In 1874, the "Challenger" occupied four deepwater stations near New Zealand. From two of the stations (168 and 169) holothurians were collected. Station 168 (40°28'S., 177°43'E., 1100 fathoms) revealed material of a new elasipod species, Enypniastes eximia Theel. Station 169 (37°34'S., 179°22'E., 700 fathoms) was more fruitful, and the following holothurian species were taken:

Mesothuria lactea (Theel)

Heteromolpadia marenzelleri (Theel)

Molpadia violacea (Studer)

Hedingia albicans (Theel)

Since the publication of these discoveries (Theel, 1882, 1886a) no further deepwater species were recorded from the New Zealand region until this year, when *Paracaudina chilensis* (Muller) was described from the bathyal zone in Cook Strait (Pawson, 1963). Fell (1958) has reported on the extremely rich deep-sea fauna of echinoderms other than holothurians of the New Zealand region, and it was expected that the holothurians were correspondingly diverse, and would reward further study. Recently, several scientific institutions in New Zealand have carried out local investigations of the bathyal zone, and the holothurians collected during these expeditions have been examined by the writer, and are described here.

Throughout this account, the bathyal zone (= archibenthal) is taken to comprise the continental slope, from the edge of the shelf (at a depth of ca. 180 metres) to the abyssal zone.

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CHECKLIST OF NEW ZEALAND BATHYAL HOLOTHURIANS

Species new to the fauna are marked with an asterisk (*).

Order ELASIPODIDA

- * *Ilyodaemon abstrusus* Sluiter
- *Pannychia moseleyi* Theel
- * *Laetmogone violacea* Theel
- * *Bathygone papillata* n.g., n.sp.
- * *Benthogone rosea* Koehler
- *Enypniastes eximia* Theel
- * *Benthodytes hystrix* Sluiter
- * *Amperima tui* n.sp.
- * *Scotoplanes gilpinbrowni* n.sp.

Order ASPIDOCHIROTIDA

- *Stichopus mollis* (Hutton)
- * *Bathyplotes natans* (Sars)
- *Mesothuria lactea* (Theel)

Order DENDROCHIROTIDA

- * *Echinocucumis hispida* (Barrett)
- * *Ypsilothuria bitentaculata* (Ludwig)
- *Pentadactyla longidentis* (Hutton)
- *Heterothyone alba* (Hutton)

Order MOLPADIDA

- * *Molpadia musculus* (Risso)

Molpadia violacea (Studer)

* *Molpadia antarctica* (Theel)

* *Molpadia* sp. (? nov.)

Heteromolpadia marenzelleri (Theel)

* *Heteromolpadia pikei* n.sp.

Paracaudina chilensis (Muller)

Hedingia albicans (Theel)

Three species, *Pentadactyla longidentis*, *Heterothyone alba* and *Stichopus mollis* are believed to be shelf species which may have entered deeper water accidentally, and these are described elsewhere (Pawson, 1963).

MATERIAL EXAMINED

The material forming the basis of this report has been collected by various institutions, as follows:

Department of Zoology, Victoria University of Wellington

Deep water investigations in Cook Strait have revealed four bathyal species of holothurians, namely Paracaudina chilensis (Muller), Molpadia violacea (Studer), Heteromolpadia marenzelleri (Theel), and Benthodytes hystrix Sluiter. The first three of these species have been described elsewhere (Pawson, 1963).

Stn.VUZ 109 Off Palliser Bay, 41°50'S., 175°5'E., 29/12/57, ca. 600 fms. (1080 metres), mud, 4 metre cone net fished on bottom.

Benthodytes hystrix Sluiter — 2 specimens

New Zealand Oceanographic Institute, Wellington (N.Z.O.I.)

Stn. C603 Chatham Rise, 42°33'S., 176°41.9'E., 25/4/61, 1530 metres.

Echinocucumis hispida (Barrett) — 2 specimens

Enypniastes eximia Theel — 1 specimen

Stn. C604 Chatham Rise, 42°49'S., 179°30'E., 26/4/61, 990-865 metres.

Molpadia antarctica (Theel) — 1 specimen

Stn. C609 Chatham Rise, 43°03'S., 178°58'E., 27/4/61, 580-570 metres.

Molpadia musculus (Risso) 1 specimen

Stn. C619 Chatham Rise, 43°52'S., 174°48'E., 2/5/61, 805-780 metres.

Laetmogone violacea Theel 3 specimens

Stn. B291 42°28.2'S., 173°38.7'E., 12/6/60, 220 fms. (396 metres), sloppy grey mud.

Molpadia sp. (? nov.) 2 specimens

Dominion Museum, Wellington

Stn. B.S.201 N.56 E. of Taiaroa Head, 44°45.6'S., 171°5'E., 23/1/57, ca. 300 fms. (ca. 540 metres).

Ypsilothuria bitentaculata (Ludwig) 2 specimens + fragment

Stn. B.S.202 N.66 E. of Taiaroa Head, 45°44'S., 171°2'E., 23/1/57, 75 fms. (135 metres).

Ypsilothuria bitentaculata (Ludwig) 1 specimen + fragment

Stn. B.S.209 Off Mayor Island, Bay of Plenty, 37°20.5'S, 27/2/57, 270 fms. (486 metres)

Laetmogone violacea Theel 1 specimen

Department of Zoology, University of Auckland

("Tui" Expedition Stations)

Stn. 003 34°20'S., 175°12'E., 990 fathoms (1782 metres), N.Z.O.I. Beam trawl.

Sample 02 *Scotoplanes gilpinbrowni* n.sp. 1 specimen

Stn. 098 $30^{\circ}18'$S., 180°E., ca. 650 fathoms (1170 metres), Isaacs-Kidd midwater trawl (hit bottom)

Sample 11	_Amperima tui_ n.sp.	14 specimens
Sample 17	_Benthogone rosea_ Koehler	2 specimens
Sample 46	_Amperima tui_ n.sp.	2 specimens

Fisheries Laboratory, Marine Department, Wellington

(All stations established in or near the Bay of Plenty)

Stn.2 Between Alderman Islands and Red Mercury Islands, 25/9/1962, 204 fms. (370 metres)

Heteromolpadia marenzelleri (Theel)	1 specimen
Heteromolpadia pikei n.sp.	2 specimens

Stn.3 Between Alderman Islands and Red Mercury Islands, 25/9/1962, 250 fms. (450 metres)

Heteromolpadia marenzelleri (Theel)	6 specimens

Stn.5 Between Alderman Islands and Red Mercury Islands, 26/9/1962, 340 fms. (612 metres)

Heteromolpadia marenzelleri (Theel)	5 specimens

Stn.11 14 miles N. 20°E. of Motiti Island, 29/9/1962, 290 fms. (522 metres)

Laetmogone violacea Theel	6 specimens

Stn.16 23 miles N.E. of Cuvier Island, 8/11/1962, 260-270 fms. (468-486 metres)

Heteromolpadia marenzelleri (Theel)	2 specimens

Stn.20 30 miles N.N.E. of Arid Island, 9/11/1962, 200 fms. (360 metres)

Bathygone papillata n.g., n.sp.	7 specimens

Stn. 21 30 miles E.N.E. of Poor Knights Islands, 11/11/1962, 280 fms. (504 metres)

	Heteromolpadia pikei n.sp.	1 specimen

Stn. 23 23 miles N.E. of Poor Knights Islands, 11/11/1962, 296-276 fms. (543-490 metres)

	Laetmogone violacea Theel	1 specimen
	Ilycdaemon abstrusus Sluiter	1 specimen

Stn. 24 24 miles E.N.E. of Poor Knights Islands, 11/11/1962, 235-250 fms. (423-450 metres)

	Bathyplotes natans (Sars)	2 specimens

Stn. 25 33 miles E.N.E. of Poor Knights Islands, 13/11/1962, 265 fms. (477 metres)

	Heteromolpadia pikei n.sp.	2 specimens
	Bathyplotes natans (Sars)	2 specimens

Stn. 27 18 miles N.30°E. of Poor Knights Islands, 20/11/1962, 256-267 fms. (461-481 metres)

	Bathyplotes natans (Sars)	4 specimens
	Laetmogone violacea Theel	3 specimens

Stn. 31 17 miles N.E. of Cavalli Islands, 22/11/1962, 260 fms. (468 metres)

	Ilyodaemon abstrusus Sluiter	4 specimens
	Bathyplotes natans (Sars)	4 specimens

Stn. 32 16 miles N. of Cavalli Islands, 23/11/1962, 350 fms. (630 metres)

	Laetmogone violacea Theel	1 specimen (juvenile)

ORDER MOLPADIDA

For diagnoses and remarks on included families see Pawson (1963), pp.10, 16.

Family Molpadiidae

Key to the New Zealand genera in Family Molpadiidae

1 (2) Calcareous deposits include anchors and three-armed anchor plates, and spired tables . . . . <u>Heteromolpadia</u> Pawson

2 (1) Calcareous deposits may include anchors and rosettes of racquet-shaped plates, fusiform rods, spired tables. Single three-armed anchor plates lacking. . <u>Molpadia</u> Risso

<u>Heteromolpadia</u> Pawson, 1963

Diagnosis: Molpadids whose calcareous deposits include two-armed anchors associated with single perforated anchor plates of varying shapes, usually having three marginal projections. No rosettes of racquet-shaped plates; no fusiform rods. Phosphatic bodies present, at least in adult specimens.

Type Species: <u>Ankyroderma</u> <u>marenzelleri</u> Theel.

Remarks: This genus was erected (Pawson, 1963) to accommodate those molpadids with peculiar anchor plates, and two species, the type and <u>Ankyroderma</u> <u>tridens</u> Sluiter, were included.

Material collected by the Marine Department in the Bay of Plenty included four specimens of a new species of *Heteromolpadia* and this is described below.

Heteromolpadia marenzelleri (Theel)

For synonymy, see Pawson (1963), p.11.

Material Examined: Marine Dept., Stn. 2, 2 specimens; Stn. 3, 6 specimens; Stn. 5, 5 specimens; Stn. 16, 2 specimens.

Remarks: These are typical specimens of the species, ranging in length from 19 mm to 45 mm. Colour in alcohol grey, body-wall thin and prickly to touch. Characteristic anchors, anchor-plates and tables are abundant, and phosphatic deposits are rare.

Distribution: So far known only from New Zealand in depths ranging between 14 and 400 fathoms.

Heteromolpadia pikei n.sp.

Pl. IV, figs.5, 9, 10

Material Examined: Marine Dept. Stn.2, 1 specimen; Stn.21, 1 specimen; Stn.25, 2 specimens.

Description: The body is of molpadid shape, total length varying between 26 and 33 mm. The tail is 5 mm to 8 mm in length, approximately 20% of the length of the body.

The body-wall is thin, semi-transparent, rough to touch. Colour in alcohol, grey.

Calcareous deposits include anchors and anchor-plates and perforated tables. No complete anchors were found, as the flukes in most cases were broken off, and in others the shaft was broken. Fragments indicate that the anchors have two arms, a straight cylindrical shaft 0.27 mm in length, and a saucer-shaped basal disc with three perforations (Pl. IV, fig.9). Each anchor is supported on a single anchor plate, so that it projects above the level of the skin.

The anchor plates are large, up to 0.45 mm across, and typically have a central perforated portion which supports the anchors (Pl.IV, fig.9). From this central plate arise three narrow projections, two long (0.15 mm) and one short (0.075 mm), and each of these projections usually carries a single perforation at the slightly widened distal extremity. In addition, the larger projections may have up to three perforations along their length, or none. The anchor plates are scattered irregularly among large numbers of spired tables.

Tables have an average diameter of 0.3 mm, and have up to 15 large perforations. Generally there are three or four central perforations which are larger than the rest, while the marginal perforations are often incomplete. A centrally-placed three-pillared spire of average length 0.2 mm is present, sometimes lacking (Pl.IV, fig.10). The pillars of the spire are united by several crossbars. Anchor plates and tables are scattered, never overlapping.

In smaller specimens, phosphatic deposits are very rare, but some anchor plates and tables (Pl.IV, figs.9, 10) were found to be undergoing transformation into light orange phosphatic material. Larger specimens have scattered clumps of phosphatic material, which may be seen as light orange spots when the skin is viewed under low magnification.

Tail deposits are elongate perforated tables (Pl.IV, fig.5) of average length 0.17 mm, usually with a short (0.03 mm) three-pillared spire, the pillars united by two to three crossbars. These deposits have 6-10 perforations, and are extremely numerous and closely packed, lying transverse to the longitudinal axis of the tail.

Internal anatomy typical of the molpadiids, although the genital caeca are deep purple in colour.

Holotype: The holotype, total length 33 mm, and a paratype are lodged in the collection of the Dominion Museum, Wellington.

Remarks: This species most closely resembles _H. marenzelleri_ (Theel) which has been described elsewhere (Theel, 1886; Pawson, 1963), but differs in the form of the anchor plates and tables. In _H. marenzelleri_ the anchor plates are rather more variable in shape than in the present species.

The tables in H. pikei have more numerous perforations and are larger than those in H. marenzelleri. There is little doubt that these species are distinct. From the third species included in Heteromolpadia, namely H. tridens (Sluiter), H. pikei can be distinguished on the basis of the anchor-plates, which in H. tridens have numerous angular perforations in the marginal projections.

This species is named for Dr. R.B. Pike of the Fisheries Laboratory, Marine Department, Wellington, whose biological investigations in the Bay of Plenty region have added greatly to our knowledge of the New Zealand deep water fauna.

Molpadia Risso

Diagnosis: Molpadiids whose calcareous deposits include tables, anchors, and rosettes of racquet shaped plates and large fusiform rods in various combinations. Tail deposits elongate to fusiform.

Type Species: Molpadia musculus Risso.

Remarks: Attempts to subdivide the genus Molpadia by Heding (1931, 1935) have proved unsuccessful, as some genera were based on extremely variable characters of doubtful diagnostic importance. Our knowledge of the species in this heterogeneous assemblage is far from complete, and the matter is complicated by the changes which take place during the life histories of so many of the species in the calcareous deposits. Deichmann's (1936) stopgap proposal of "groups" of species seems a logical approach to the problem, at least until the life histories of a few typical species have been worked out.

Key to species of _Molpadia_ known from New Zealand

1 (4) Calcareous deposits include large fusiform rods, which are present in the bodywall and in the tail.

2 (3) Anchors and rosettes of racquet-shaped plates present . . . . _M. musculus_ (Risso)

3 (2) Anchors and rosettes lacking . . . . _M. violacea_ (Studer)

4 (1) Fusiform rods lacking from bodywall and tail. Deposits spired tables . . . . _M. antarctica_ (Theel)

Molpadia musculus (Risso)

Pl.IV, figs.1-4, 6.

Molpadia musculus Risso, 1836, p.293; Clark, 1907, p.165 (complete list of references); Herouard, 1923, p. 132, Pl.5, fig.1; Deichmann, 1931, p.198, Pl.23, figs.4-7; Heding, 1931, p.279.

Ankyroderma loricata Perrier, 1902, p.535, Pl.33 figs.23-28; Herouard, 1923, p.133.

Molpadia holothuroides Clark, 1920, p.129.

Eumolpadia asaphes Heding, 1935, p.42, Pl.5, figs.9-10, Pl.7, fig.2, Pl.8, fig.3, Text-fig.9.

Material Examined: N.Z.O.I. Stn. C609, 1 specimen.

Description: The single specimen is strongly contracted anteriorly and the total length is 23 mm (probably more in life); the oral disc is 3 mm in diameter; tail 3 mm in length (broken, probably about 6 mm long in life). The shape is typical of the species, and the skin is quite thin and prickly to the touch. Colour in alcohol grey, the anterior end slightly lighter.

Calcareous deposits in the bodywall excluding the tail are anchors and rosettes of racquet-shaped plates, together with perforated plates, closely aggregated and often overlapping. The racquet-shaped plates (Pl.IV, fig.4) are 0.4 - 0.7 mm in length, with 10-25 perforations at the broad end. The handle carries no perforations. These plates are always aggregated into rosettes, with the broad ends overlapping, the diameter of each rosette being approximately 1.3 mm. There are usually five or six racquets to each rosette. Each rosette supports at its centre a single anchor, which has a saucer-shaped base and a smooth cylindrical shaft of average length 0.6 mm. The distal end of the shaft supports two anchor arms (Pl.IV, fig.6), which may be smooth or have one or two serrations near the tips. The anchors project above the level of the bodywall, and can be seen with the naked eye. Rosettes and anchors are numerous, scattered regularly in the skin. The spaces between the rosettes are completely filled by the large perforated plates.

The plates are of variable shape (Pl.IV, fig.2), and usually carry three large perforations, and often some smaller holes. Some plates tend to become fusiform in shape, and range in length from 0.3 mm to 1.0 mm. Although these deposits lack spires, some slightly smaller and less robust tables with three perforations (Pl.IV, fig.3) and their developmental stages, are present, and these carry a spire composed of a single rod, which has a small crown of spines at its distal extremity. Average diameter of the tables is 0.3 mm. Height of spire is 0.15 mm.

Phosphatic deposits are extremely rare, scattered in very small numbers, and easily overlooked. Colour of these deposits is light orange. No calcareous deposits in the process of dissolution into phosphatic material were seen.

The tail contains great numbers of fusiform rods with two to four small, angular central perforations (Pl.IV, fig.1). The length of these rods ranges from 0.55 mm to 0.81 mm, with an average length of 0.73 mm.

Remarks: There is little doubt that this species falls into the musculus group as defined by Deichmann (1936); therefore I have assigned the specimen to the type species of the genus Molpadia. The rosettes of racquets, and the fusiform deposits in the bodywall and tail, are characteristic of M. musculus.

Molpadia violacea is also known from the New Zealand region (Théel, 1886; Pawson, 1965). In some respects, this

PLATE IV

Molpadia musculus (Risso), Molpadia antarctica (Theel)

Heteromolpadia pikei n.sp.

Molpadia musculus (Risso)

Fig.1. Tail deposits.

Fig.2. Plates from the bodywall.

Fig.3. Tables.

Fig.4. Racquets.

Fig.6. Distal portions of anchors, showing arms.

Molpadia antarctica (Theel)

Fig.7. Tables from the bodywall.

Fig.8. Tail deposits.

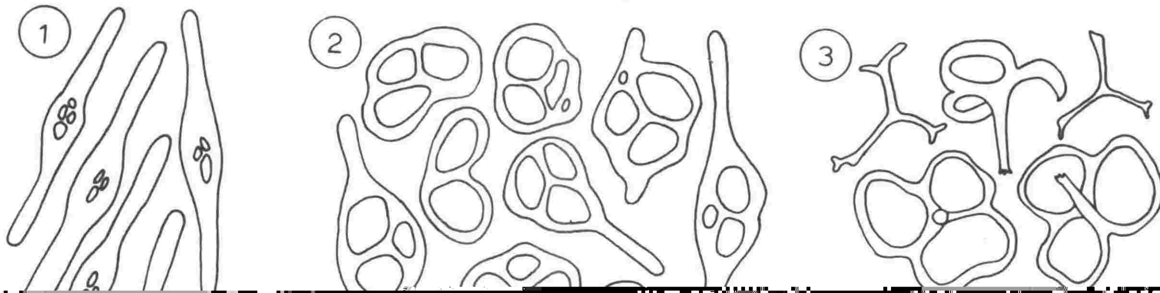
Heteromolpadia pikei n.sp.

Fig.5. Tail deposits.

Fig.9. Anchor plates.

Fig.10. Tables from the bodywall.

Abbreviations: Ph.mat., phosphatic material.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species resembles the typical M. musculus, but differs in apparently completely lacking any trace of anchors and rosettes. The smallest specimen of M. violacea recorded from New Zealand is 47 mm in length. The present specimen of M. musculus probably had a length when extended of ca. 30 mm. Thus, although there is a considerable size difference between these two specimens, if they belong to the same species, the specimen of M. violacea should, at some stage of its life history, have possessed anchors and rosettes in the bodywall. It is very difficult to imagine the anchors and racquets completely disappearing without a trace sometime in the course of 17 mm growth. Young specimens of Heteromolpadia marenzelleri (Theel) have numerous anchors and anchor-plates, and although they tend to disappear with advancing age, traces of these deposits can almost always be found in medium-sized specimens (30-70 mm in length).

The presence of typical M. musculus in New Zealand waters, in relatively close proximity to M. violacea is of great interest, and may possibly lend some support to a theory that these two species are synonymous. It must also be conceded that some of the calcareous deposits in the two species are similar, differing slightly in respect of size, and to a certain degree in shape. But I must for the present regard these species as distinct, basing my conclusions on the work of previous writers, and also on recent examination of actual material of the two species.

If, however, further material of M. violacea shows traces of anchors and racquets, then the problem must be reconsidered in the light of the new evidence.

<u>Molpadia antarctica</u> (Théel)

Pl.IV, figs. 7, 8.

<u>Trochostoma antarcticum</u> Théel, 1886a, p.44, Pl.II, fig.7; Théel, 1886b, p.16; Hérouard, 1901, p.42; Augustin, 1908, p.35, Text-fig.22 a-c.

<u>Molpadia antarctica</u> Clark, 1907, p.32, 168; Ohshima, 1915, p.252.

Material Examined: N.Z.O.I. Stn. C.604, 1 specimen.

Description: Total length 20 mm, diameter of oral disc 3 mm. The tail of the specimen is broken off near its base, and its length cannot be determined. The bodywall is thin, and quite prickly to touch. Colour in alcohol uniformly grey.

Calcareous deposits in the bodywall are exclusively tables, usually with six or more large perforations (Pl.IV, fig.7), and with an average diameter of 0.28 mm. In general, the three central perforations are the largest. From the centre of each table arises a tall three-pillared spire, the pillars being united by three or four crossbars. The spires project above the level of the bodywall, and can barely be seen with the naked eye. The tables are very closely crowded together, and in many areas they are overlapping slightly.

Anchors and anchor plates or rosettes are lacking.

In the tail are great numbers of elongate three-pillared tables (Pl.IV, fig.8) with four or more perforations and a complex spinous spire. These deposits have an average length of 0.16 mm, and carry 6-10 perforations.

Phosphatic deposits are present, but exceedingly scarce. A small number of tables were seen to be in the first stages of dissolution into phosphatic material, and the phosphatic material is a very light yellow colour, therefore easily overlooked.

Remarks: This specimen probably represents the species as originally described by Theel (1886). Ohshima (1915) recorded a specimen of the same species from off Japan, noting that the average diameter of the tables in the bodywall is 0.185 mm as against 0.3 mm in the present specimen. Also the tail deposits in Ohshima's material are smaller (0.04 - 0.11 mm diameter) than those in present material (0.16 mm length). However, Ohshima gave no indication of the shape of the tail deposits in his material, and quoted the "disc diameter", which may be interpreted simply as the dimensions of the perforated area of the tail deposit.

Ohshima's specimen was 33 mm in length, and phosphatic deposits were entirely absent, but he noted some tables undergoing a change in colour.

Molpadia antarctica is now known from off Chile (Theel, 1886a), between Florida and Cuba (Theel, 1886b), off Alexander Land, Antarctica (Herouard, 1901), and from various localities off Japan (Augustin, 1907; Ohshima, 1915). Thus it is a widespread species in depths ranging from about 80 metres to 1,218 metres.

<u>Molpadia</u> ? n.sp.

Pl.V, figs. 6, 7

Material Examined: N.Z.O.I. Stn. B.291, 2 specimens.

Remarks: Total length of specimens, 38 mm and 61 mm. The body is of typical molpadid shape. Colour in alcohol grey, with large numbers of small light red spots, which are more closely aggregated in the smaller specimen. Tail gray.

Calcareous deposits in the bodywall are almost completely transformed into phosphatic material (Pl.V, fig.6), and seem to comprise tables only. No trace of anchors, rosettes or anchor plates were found anywhere in the bodywall. The original shape of the tables cannot be accurately determined, but fragments indicate that they may have been of a similar shape to those in <u>Molpadia</u> <u>antarctica</u> (Theel). The phosphatic bodies vary greatly in size and shape, and remain aggregated in small, scattered clusters (replacing the calcareous deposits), forming red spots visible to the naked eye.

The tail contains elongate tables with three-pillared spires (Pl.V, fig.7), and numerous (10-16) small perforations. Average length of the tail deposits is 0.22 mm.

These specimens clearly represent a species which has its calcareous deposits entirely transformed into phosphatic material (apart from those in the tail), probably early in its life history. It is possible that these are representatives of a known species, closely allied to _M. antarctica_, but differing from _M. antarctica_ in some respects. _M. antarctica_ has smaller (0.16 mm) tail deposits with fewer perforations (6-10). Clark (1907, p.32) notes that calcareous deposits tend to disappear from the bodywall of _M. antarctica_ with growth but makes no mention of phosphatic deposits. Also the bodywall in present material is quite thin, but not delicate, as it is stated to be in _M. antarctica_.

Without a better knowledge of the calcareous deposits of the bodywall, it is felt that these specimens should not be assigned to a new species, and for the present they must remain unnamed, at least until further material comes to hand.

Family CAUDINIDAE

Paracaudina Heding, 1931

Tentacles with two pairs of digits. Caudal appendage usually long and slender. Deposits not tables but cups (buttons), perforated plates or irregular rods. (Heding, 1931, in part).

Type Species: _Paracaudina chilensis_ (Muller).

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<u>Paracaudina</u> <u>chilensis</u> (Muller)

For synonymy, see Pawson, 1963, p.18.

Material Examined: None.

Remarks: A circum-Pacific species, ranging from 0 to more than 900 metres.

<u>Hedingia</u> Deichmann, 1938

Diagnosis: Tentacles with two pairs of digits. Deposits large tables (0.15-0.27 mm diameter), with high spires composed of three converging rods.

Type Species: <u>Trochostoma</u> <u>albicans</u> Theel.

<u>Hedingia</u> <u>albicans</u> (Theel)

<u>Trochostoma</u> <u>albicans</u> Theel, 1886a, p.44, Pl.XI, fig.3.

<u>Trochostoma</u> <u>albicans</u> var. <u>glabra</u> Theel, 1886a, p.46; Koehler & Vaney, 1905, p.89; Perrier, 1902, p.526, Pl.22, figs.7-8.

<u>Caudina</u> <u>arenata</u> var. <u>armata</u> Theel, 1886b, p.17; Gerould, 1897, p.19, Pl.III, figs.34-37.

<u>Caudina</u> <u>albicans</u> Clark, 1907, p.174, Pl.X, fig.12; Deichmann, 1931, p.201, Pl.24, fig.1; Heding, 1931, p.283.

<u>Haplodactyla</u> <u>albicans</u> Heding, 1935, p.65; Pl.IV, fig.9, Pl.V, fig.17, Pl.VIII, fig.10.

<u>Hedingia</u> <u>albicans</u> Deichmann, 1938, p.112; Madsen, 1953, p.167.

Material Examined: None.

Remarks: This species is now known off New Zealand, south of Iceland, off the north-east coast of U.S.A., the Cape Verdes, Mediterranean Sea, Bay of Bengal in depths ranging from 500 metres to 3,200 metres (Madsen, 1953). Theel (1882) described H. albicans from off East Cape, New Zealand, where it was collected from a depth of 700 fathoms.

ORDER DENDROCHIROTIDA

Family YPSILOTHURIIDAE Heding, 1942

Diagnosis: Spherical to U-shaped holothurians, with eight to ten tentacles, of which two are much larger than the others. Calcareous deposits of the bodywall large plates with a spiny spire. Tubefeet slightly developed, usually placed along the radii. (Partly after Heding, 1942).

Remarks: Heding (1942) diagnosed this family to include the genera Ypsilothuria Perrier and Echinocucumis Sars, which are distinguished from the Cucumariidae in possessing the unique scales in the bodywall together with simple finger-shaped tentacles, of which two are usually larger than the rest.

Panning (1949) reduced the family to the status of a subfamily (Ypsilothuriinae), and included several other genera in the group, namely Ekmocucumis Heding, Abyssocucumis Heding, Psólicucumis Heding, Staurocucumis Ekman and Ypsilocucumis Panning. Ypsilocucumis was proposed to accommodate Echinocucumis asperrima Theel as the type species. Deichman (1931) was of the opinion that this species is a Ypsilothuria (= Sphaerothuria), while Heding (1942) regards the species as "a good Echinocucumis". In his diagnosis of the genus, Panning (1949) notes that the species asperrima has ten tentacles, and in the bodywall large plates composed of many layers. Ypsilothuria has eight tentacles according to Heding (1942) and eight to ten in the opinion of Deichmann (1931). Deichmann notes that the two ventral tentacles may tend to become aborted. However, in view of Heding's emphatic statement that Ypsilothuria has "always ... eight tentacles", it is probably desirable to maintain the genus Ypsilocucumis Panning. Further work should clarify the situation with regard to this genus.

The remainder of the genera included in this group by Panning (1949) do not have the remarkable combination of characters as found in Ypsilothuria, Echinocucumis and Ypsilocucumis, and it is felt that they should be separated from the Ypsilothuriidae and replaced in the Cucumariidae, where they may constitute a taxon in themselves. As the status of some of these genera is in doubt (vide Clark and Deichmann, 1936; Heding, 1942), I am unwilling to propose a new taxon to accommodate these genera, which must, for the present, remain incertae sedis. A comparative study of these rather unusual holothurians is urgently required.

Key to the genera in Family Ypsilothuriidae

1 (4) Tentacles eight or ten, bodywall with large spired plates composed of many layers of calcareous material.

2 (3) Tentacles ten . . . Ypsilocucumis

3 (2) Tentacles eight . . Ypsilothuria

4 (1) Tentacles ten, spired plates of bodywall composed of a single layer of calcareous material . . . . <u>Echinocucumis</u>

<u>Ypsilothuria</u> Perrier, 1886

<u>Sphaerothuria</u> Ludwig, 1894

Diagnosis: Tentacles eight, lateral tentacles enlarged. Body U-shaped, mouth and anus dorsal. Body invested in large (ca. 1 mm diameter) thick scales composed of many layers of calcareous material. Each scale carries a long spire at or near its centre.

<u>Ypsilothuria</u> <u>bitentaculata</u> (Ludwig)

Pl.V, figs. 2, 3, 4, 5

<u>Sphaerothuria</u> <u>bitentaculata</u> Ludwig, 1893, p.112; Ludwig, 1894, p.141, Pl.12, figs.16-17, Pl.14, figs.5-14; Mitsukuri, 1897, p.149; Koehler, 1898, p.384; Sluiter, 1901b, p.115; Ohshima, 1915, p.266; Deichmann, 1931, p.152, Pl.19, figs.4-5; Ludwig & Heding, 1935, p.196; Baranova, 1957, p.242.

<u>Ypsilothuria</u> <u>bitentaculata</u> Koehler & Vaney, 1905, p.87; Heding, 1942, p.28; Panning, 1949, p.455.

Material Examined: Dominion Museum Stn. B.S.201, 2 specimens + fragment of juvenile; B.S.202, 1 specimen + fragment of adult.

PLATE V

Echinocucumis hispida (Sars), Ypsilothuria bitentaculata (Ludwig), Molpadia ? n.sp.

Echinocucumis hispida (Sars)

Fig.1. Outline of body, showing typical shape.

Ypsilothuria bitentaculata (Ludwig)

Fig.2. Tentacle deposits.

Fig.3. Outline of body, showing typical shape.

Fig.4. Spired scales (outline only).

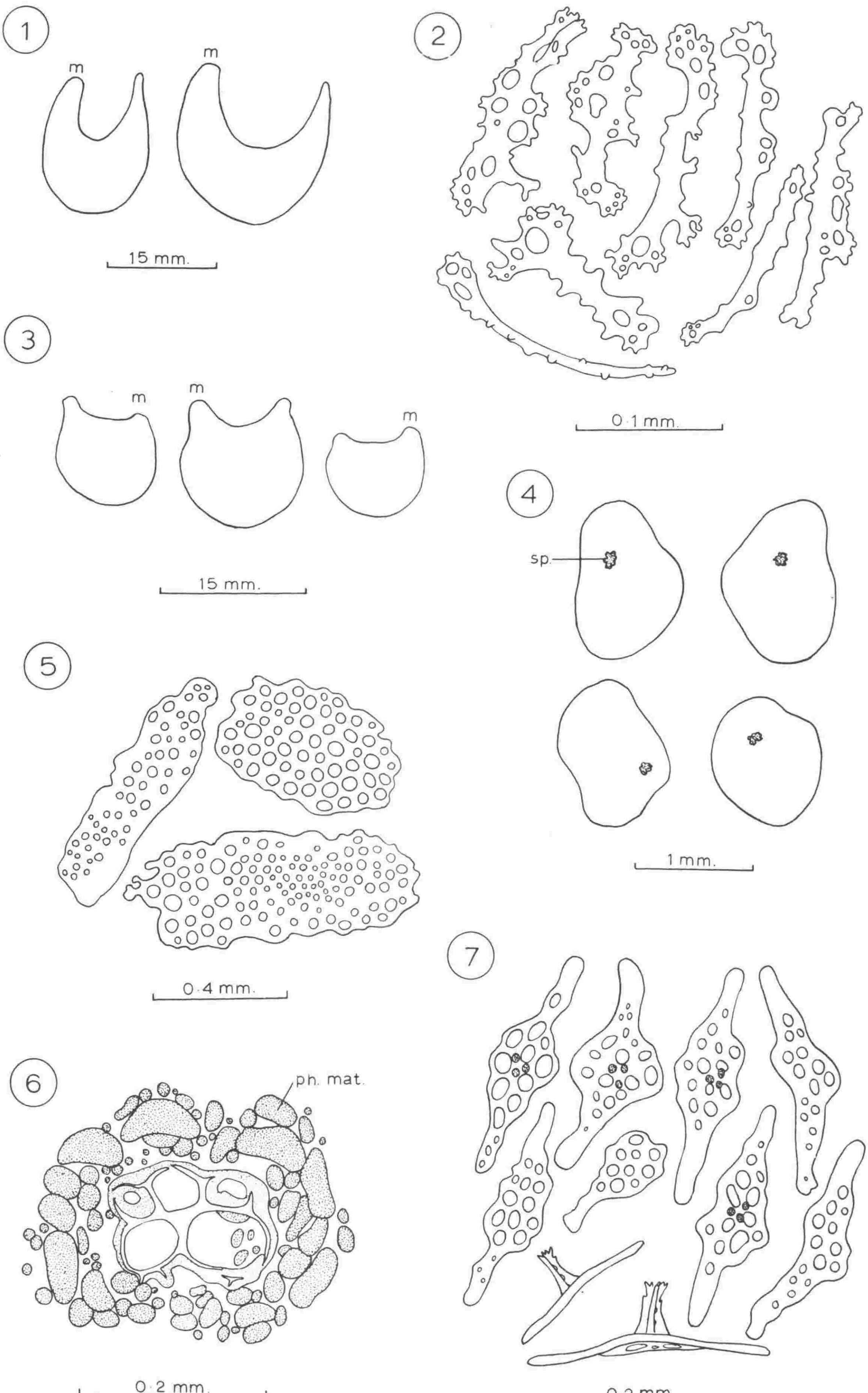
Fig.5. Plates from posterior extremity of body.

Molpadia ? n.sp.

Fig.6. Red spot of bodywall, magnified to show phosphatic material, and remains of calcareous deposit (table).

Fig.7. Tail deposits.

Abbreviations: m., oral end of body; ph.mat., phosphatic material; sp., spire.


1
m
m
15 mm.
2
0·1 mm.
3
m
m
m
15 mm.
4
sp.
1 mm.
5
0·4 mm.
6
ph. mat.
0·2 mm.
7
0·2 mm.

Remarks: In all complete specimens the body is globular, with the anterior and posterior ends drawn out to form short "siphons" (Pl.V, fig.3). The anterior (oral) siphon is wider at its extremity than the posterior siphon.

	Length (measured about greater curvature)	Diameter (horizontal)
1.	32 mm	10 mm
2.	25 mm	8 mm
3.	24 mm	9 mm

The bodywall carries numerous projecting spines, and is prickly to touch. Tubefeet are rare, restricted to the radii, more common on the siphons than elsewhere. Colour in alcohol greyish-white to very light brown.

The fragment of a juvenile specimen has the anal and oral siphons intact. The distance between these structures is 2 mm.

The tentacles are typical, with two lateral tentacles much larger than the rest. Internal anatomy is similar to that in <u>Echinocucumis</u> <u>hispida</u> (Barrett) (see p. 85).

The body is invested in overlapping spired scales, each scale being composed of many layers of calcareous material, forming a reticulated network. The scales are of a varying shape (Pl.V, fig.4), usually tending to be oval in outline, and of average diameter 1.2 mm. An almost solid spiny spire arises from the centre, or near the centre of each scale; the spires have an average height of 0.5 mm. Even in the juvenile fragment, the scales are composed of many layers.

In the anterior and posterior siphons, the scales are reduced to form simple perforated plates (Pl.V, fig.5), which lack spires, and have an average length of 0.7 mm.

The largest tentacles contain straight or curved narrow plates which have many short and blunt projections along their length, and a few perforations (Pl.V, fig.2). Average length of these deposits is 0.13 mm.

Ludwig (1894) and Heding (1942) have given complete descriptions of this well-known species. The New Zealand specimens are typical of the species in all respects.

Ypsilothuria bitentaculata has been recorded from numerous localities in the Pacific Ocean (see Ohshima, 1915), and appears to be circum-Pacific in depths ranging from about 250 metres to 4,000 metres. Ohshima (1915) also notes that while in tropical regions Y. bitentaculata has a considerable bathymetric range, in the temperate regions the animal lives in depths not exceeding about 700 metres. Heding (1942) has established Ypsilothuria (= Sphaerothuria) attenuata Perrier as a variety of Y. bitentaculata, and notes that this form is "distributed in the abyssal parts of the Atlantic, from Davis Strait to the type locality off Senegal". In the same paper Heding erects another variety, var. virginiensis, for a specimen collected in the West Indies at a depth of 375 metres.

Clearly, Y. bitentaculata is a cosmopolitan species, capable of some variation in the form of its deposits, but nevertheless well defined and readily recognisable.

<u>Echinocucumis</u> Sars, 1859

Diagnosis: Tentacles 10, unequal in size. Body spherical, with mouth and anus placed at end of tubes which seem to be nonretractile. Few pedicels, arranged in the ambulacra, slender, threadlike. Body covered by very large scales (diameter greater than 1 mm), which are perforated by numerous regular holes. Scales composed of a single layer; never built up into several layers of reticulated network. Most scales with a single long spire placed near the margin. (Partly after Deichmann, 1931).

Type Species: <u>Echinocucumis</u> <u>hispida</u> (Barrett).

Remarks: This genus, together with <u>Ypsilothuria</u>, is remarkable in possessing large overlapping spired scales in the bodywall, which give the body rigidity, and a characteristic shape.

Two species, the type and <u>E. paratypica</u> Heding, are known with certainty, the latter having been described from material collected off East Africa in a depth of 1289 metres.

<u>Echinocucumis</u> <u>hispida</u> (Barrett)

(Pl.V, fig.3; Pl.VI)

<u>Eupyrgus</u> <u>hispidus</u> Barrett, 1856, p.7, 46, Pl.4, figs.1A-6.

Echinocucumis typica Sars, 1861, p.102, Pl.10, figs.11-20, Pl.11, figs.1-17; Pourtales, 1869, p.151; Theel, 1886a, p.118; Theel, 1886b, p.9, fig.3; Herouard, 1923, p.118.

Cucumaria typica Ludwig, 1901, p.232 (list of references).

Echinocucumis hispida Mortensen, 1927, p.404, figs.242 (1), 243; Deichmann, 1931, p.150; Ludwig & Heding, 1935, p.167; Heding, 1942, p.329, figs.31, 32; Panning, 1949, p.454.

Material Examined: N.Z.O.I. Stn. C.603, 2 specimens.

Description: Both specimens are U-shaped with a total length (measured about the greater curvature of the body) of 50 mm in one specimen and 40 mm in the other. The oral extremity in both specimens is 2.5 mm in diameter. The body-wall is hard and brittle, but thin, with numerous elongate spinous projections. Tubefeet are present in small numbers, confined to the radii, more common ventrally, and they are difficult to distinguish from the spinous projections. Colour in alcohol greyish-white, darker at the extremities. The tentacles are fingerlike, conical, typical of the genus.

The calcareous ring is fragile, each piece having a shallow posterior notch. The intestine is long, coiled at the middle (Pl.VI, fig.1); rectum transparent, large, supported in the "tail" by fine muscle fibres. Overall, the intestine is light yellow in colour. There are three respiratory trees, of which one extends to the anterior end of the body cavity (Pl. VI fig.1). The other two trunks are quite short, about half the length of the body cavity (Pl.VI, fig.1). Respiratory caeca are simple sacs, sparsely scattered on the trunks (Pl.VI, fig.1). At the base of one of the short trunks is a small clump of respiratory caeca. There are two elongate, tubular Polian vesicles, and a minute stone canal.

A tuft of short unbranched genital caeca lies at the middle of the body (Pl.VI, fig.1). The caeca are filled with large eggs. The long genital duct opens to the exterior in the mid-dorsal interradius, immediately posterior to the tentacles.

Intestine, gonad, and (to a lesser extent) respiratory trees are held close against the lesser curvature of the body by a fragile and short dorsal mesentery, and thus large portions of the body cavity are virtually empty. Radial muscles are thin strands, retractors well developed.

Calcareous deposits in the body wall consist exclusively of perforated plates (Pl.VI, fig.3). The plates are oval to rectangular in outline, of average length 1.0 mm, and are single-layered, with many perforations, which are slightly larger at the centre. Most plates carry a single tall ex-centric spire, which lies near the edge of each plate. The spire is spinous (Pl.VI, fig.2), and is up to 0.7 mm in length. Spires are apparently derived from three vertical pillars joined by several crossbars. Smaller perforated

PLATE VI

<u>Echinocucumis</u> <u>hispida</u> (Sars)

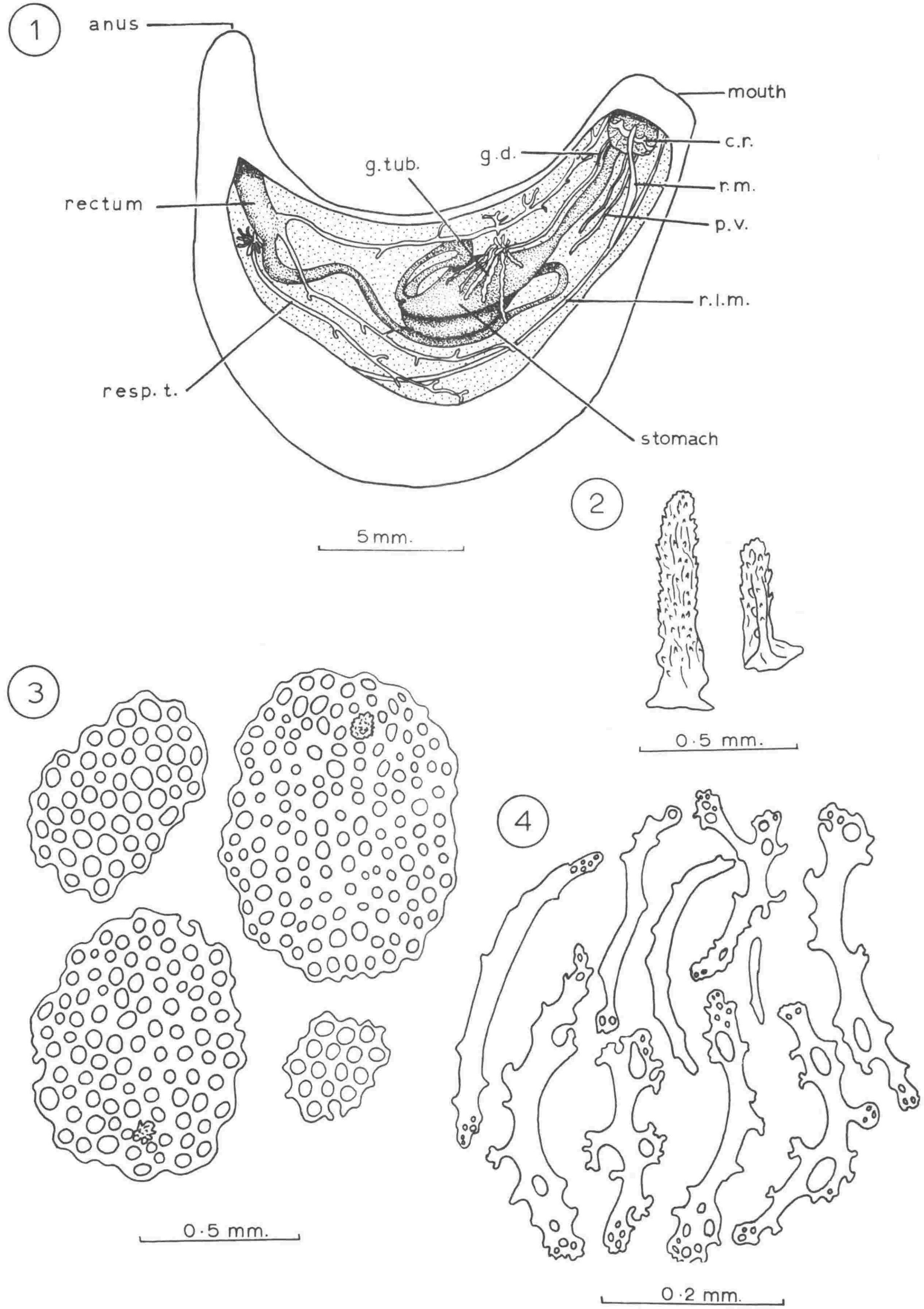
Fig.1. Internal anatomy (partly diagrammatic).

Fig.2. Spires from bodywall plates.

Fig.3. Plates.

Fig.4. Tentacle deposits.

Abbreviations: c.r., calcareous ring; g.d., genital duct; g.tub., genital tubules (caeca); p.v., polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; resp.t., respiratory tree.



1
anus
mouth
c.r.
g.d.
g.tub.
r.m.
rectum
p.v.
r.l.m.
resp. t.
stomach
5 mm.
2
0·5 mm.
3
4
0·5 mm.
0·2 mm.

plates, lacking spires, are also commonly encountered, especially near the anterior and posterior ends of the body, but in other features they resemble spired plates. The tubefeet pass between the plates, and not through them.

Tentacles contain large numbers of curved rods, with perforations, mainly at the extremities, and some short blunt projections. Average length of the tentacle rods (Pl.VI, fig. 4) is 0.3 mm.

Remarks: These specimens represent _Echinocucumis hispida_, or a near relative of that species. Some slight differences in the calcareous deposits and internal anatomy between the present specimens and the typical _E. hispida_ are observable. The large spired plates in the New Zealand specimens seem to have more numerous perforations than those in _E. hispida_ from northern waters. Also, Deichmann (1931) notes that the respiratory trees are "quite abortive, with 1-2 small lobes" in _E. hispida_, while Heding (1942) states that the trees are well developed, and each has "two main branches of nearly equal size". In the New Zealand specimens the trees are not equal-sized (Pl.VI, fig.1), and while there are two main branches in one tree, the other has one branch, and a small bunch of caeca at its base (an aborted second branch?).

However, in spite of these differences, it is felt that the specimens should be placed within the species _E. hispida_, and at best they may be given subspecific status.

Echinocucumis hispida is now known from the northeastern part of the Atlantic Ocean, from scattered localities in the West Indies (these West Indies specimens may not be the typical form of E. hispida, but may rather represent another species, or young of Sphaerothuria sp.), and from east of New Zealand. Bathymetric range is from about 50 metres to 1400 metres. Whether or not the species can be regarded as bipolar rests on the identity of the West Indies specimens. It is probable that E. hispida has a wide geographic range, and further sampling in southern oceans should bring to our attention further specimens of this species.

ORDER ASPIDOCHIROTIDA

Family SYNALLACTIDAE Ludwig, 1894

Diagnosis: Tentacle ampullae lacking. Respiratory trees usually not connected with a rete mirabile. Stone canal usually in connection with the bodywall, sometimes opening outwards through the bodywall. No Cuvierian organs. Deposits tables; C-shaped bodies may be present and, very rarely, buttons. (After Mortensen, 1927).

Remarks: This family is cosmopoliten, comprising mainly deep sea forms. Approximately fifteen genera are recognised at the present time, of which two, Bathyplotes Ostergren and Mesothuria Ludwig, are now known from the New Zealand region.

Bathyplotes Ostergren, 1898

Diagnosis: Tentacles 15-20, mouth ventrally turned, anus subdorsal. Ventrolateral radii with feet in one or more rows. Midventral radius naked, or with a small number of feet. Dorsal surface with small papillae more or less distinctly in rows. Genital organs in two tufts. Radial muscles undivided. Deposits tables with cross-shaped disc and spire built up of four rods, usually with several cross beams.

Type Species: Holothuria natans M.Sars.

Remarks: According to Deichmann (1931) this genus is very closely related to <u>Synallactes</u> Ludwig. <u>Bathyplotes</u> is a cosmopolitan genus, containing in excess of twenty species. Known bathymetric range is from 60 metres (<u>B. rubicundus</u> Sluiter) to about 3,000 metres (<u>B. profundens</u> Koehler and Vaney).

<u>Bathyplotes</u> <u>natans</u> (Sars)

Plate VII

<u>Holothuria</u> <u>natans</u> M.Sars, 1868, p.4.

<u>Stichopus</u> <u>tizardi</u> Theel, 1882, p.696.

<u>Bathyplotes</u> <u>tizardi</u> Ostergren, 1896, p.354, Pl.13, figs.36-43; Ludwig, 1901, p.138, Pl.12, figs.3-4, Pl.18, figs. 1-9; Mitsukuri, 1912, p.35, Text-fig.8; Ohshima, 1915, p.224.

<u>Bathyplotes</u> <u>fallax</u> Ostergren, 1896, p.355.

<u>Bathyplotes</u> <u>natans</u> Ludwig, 1901, p.137 (complete list of references); Greig, 1921, p.7; Mortensen, 1924, p.220, figs.105, 106; Mortensen, 1927, p.384, figs.228, 229; Deichmann, 1931, p.100, Pl.9, figs.1, 2, 8; Heding, 1942, p.11, Text-figs.11, 12 (1-2).

<u>Bathyplotes</u> <u>reptans</u> Perrier, 1902, p.352, Pl.12, figs.3-4, Pl.18, figs.1-9.

Material Examined: Marine Dept. Stn. 24, 2 specimens; Stn. 25, 1 specimen; Stn. 27, 4 specimens; Stn.31, 4 specimens; Lower Chalky Sound, 160 fathoms, fragment.

Description: Total length varies between 100 mm and 230 mm, while most specimens are over 150 mm in length. The body is approximately five times as long as broad, flattened ventrally. All specimens have the outer layer of the bodywall lacking, or partly removed. A single specimen in reasonable condition shows a naked midventral radius, and lateral ventral raddi each with two rows of irregularly scattered, short papillae approximately 2 mm in diameter. The papillae are soft, and many lack calcareous deposits, or at most contain a small number of spinous rods. The dorsal surface of the body carries some small papillae in the radii, but their arrangement cannot be determined. Tentacles 16-19, surrounding a ventrally turned mouth.

In alcohol, the dorsal surface of the body is light brown, with numerous small dark brown spots of varying size, up to 1.5 mm diameter. The ventral surface is similar laterally, but at the centre, the body wall is light violet, with brown spots in general approximately half the size of those on the dorsal side. The tentacles are uniformly light to dark brown.

The calcareous ring is firm, the pieces fused together. Radials are notched anteriorly, while the interradials are bluntly pointed (Pl.VII, fig.2). Radial pieces are rather larger than the interradials and small anterior projections are carried, one to each side of the anterior notch. Both radials and interradials are notched posteriorly.

A single bulbous Polian vesicle (Pl.VII, fig.1) arises from the ventral side of the water-vascular ring. The madreporite is small, attached to the bodywall, but not deeply embedded. The stone canal is a simple, short tube, not coiled. Gonad comprises two bunches of weakly branching caeca (Pl.VII, figs.1, 3), one bunch to each side of the dorsal mesentery. The common genital duct is 20 mm in length, opening to the exterior near the madreporite. Respiratory trees are long (approximately 2/3 the length of the body), unbranched, slightly flattened tubes, which subtend numerous simple respiratory sacs (Pl.VII, figs.1, 7). The two trunks arise from a single root, and they contain small brown pigment (?) spots along their entire length (Pl.VII, fig.7).

The thinwalled light to dark brown intestine describes an S-shaped loop in the posterior half of the body. Radial longitudinal muscles are broad, flat, undivided straps, dark brown in colour. The dorsal radial muscles lie very close together for most of their length (Pl.VII, fig.1), so that the area of the mid-dorsal interradius is greatly reduced.

Calcareous deposits of the bodywall are four-armed tables, the extremities of the arms branching dichotomously, forming terminal perforations. Arm length varies from 0.04 mm to 0.08 mm. A spire comprising four pillars united by several crossbars arises from the centre of each table, at the point of union of the arms. The spire is in general long, with several crossbars, but in some cases (Pl.VII, fig.4) the spire

PLATE VII

Bathyplotes natans (Sars)

Fig.1. Internal anatomy.

Fig.2. Portion of calcareous ring.

Fig.3. Portion of gonad, showing weakly branching genital caeca.

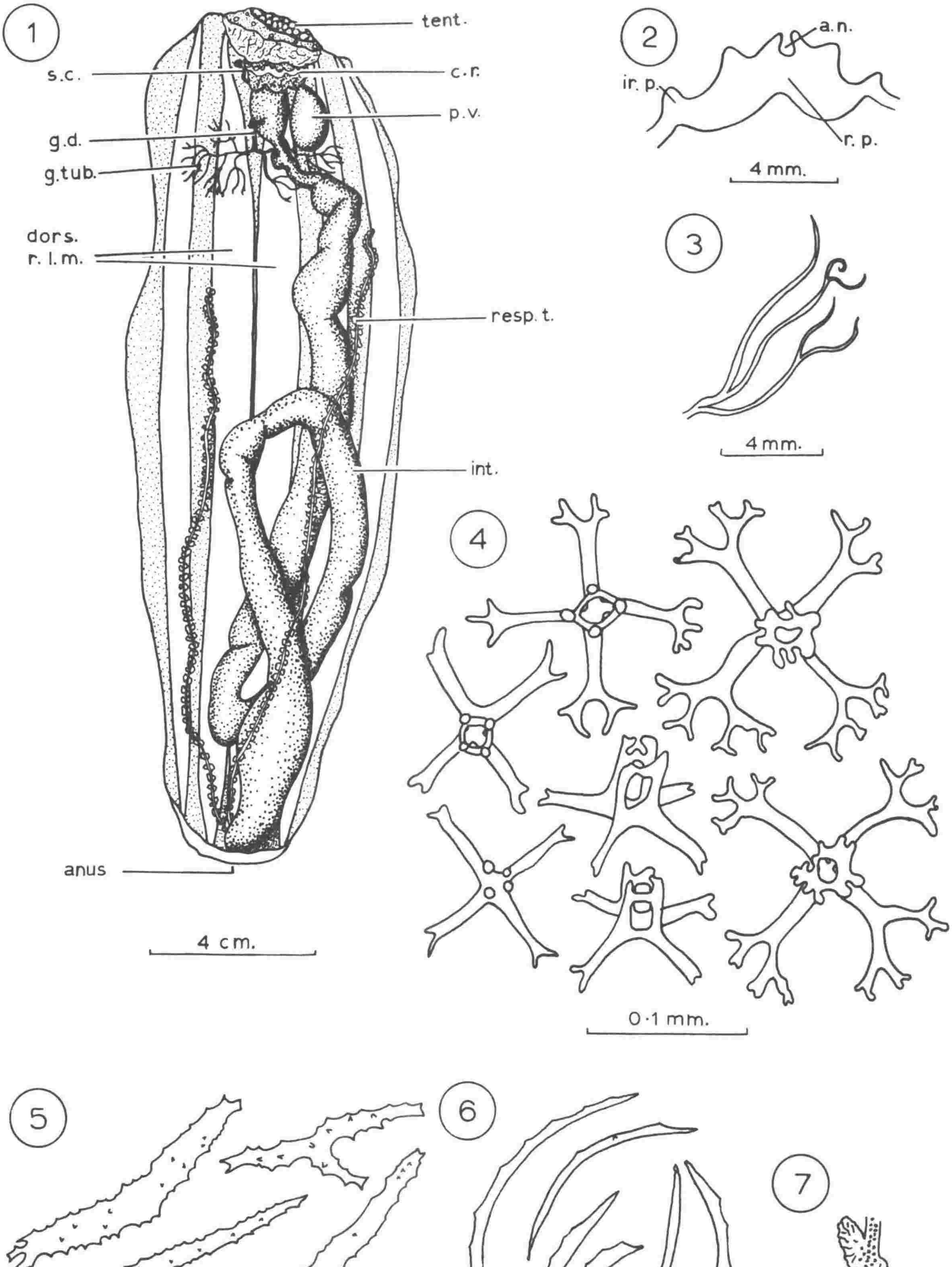
Fig.4. Deposits from bodywall.

Fig.5. Prickly tentacle deposits.

Fig.6. Curved tentacle deposits.

Fig.7. Portion of respiratory tree.

Abbreviations: a.n., anterior notch; c.r., calcareous ring; dors.r.l.m., dorsal radial longitudinal muscles; g.d., genital duct; g.tub., genital tubules (caeca); int., intestine; ir.p., interradial piece; p.v., polian vesicle; r.p., radial piece; resp.t., respiratory tree; s.c., stone canal; tent., tentacles.


1
tent.
s.c.
c.r.
p.v.
g.d.
g.tub.
dors.
r. l. m.
resp. t.
int.
anus
4 cm.
2
a.n.
ir. p.
r. p.
4 mm.
3
4 mm.
4
0·1 mm.
5
0·2 mm.
6
0·1 mm.
7
1 mm.

is short, with but one or two crossbars. Average diameter of the tables is 0.13 mm. No other deposits were found elsewhere in the bodywall, apart from some rods with one or two spines in the ventrolateral papillae.

The tentacles contain rods of two types. There are large thick prickly rods (Pl.VII, fig.5), sometimes curved, or Y-shaped, often with a small number of perforations at the extremities. These deposits have an average length of 0.35 mm and are found in the tentacle stems, and in the terminal discs. Also present in the discs are smaller curved rods (Pl.VII, fig.6), which usually carry a few small spines on the outer edge (greater curvature). The lesser curvature is quite smooth. Average length of the smaller rods is 0.15 mm.

Remarks: In features of internal anatomy and calcareous deposits, these specimens most closely resemble the type species of _Bathyplotes_, to which they have been assigned. The tables with short spires and with large perforations, while not especially typical of _B. natans_, appear to fall within the range of variation for that species.

Bathyplotes natans is a species with a wide distribution. Ludwig (1901) notes that it ranges from 60° to 69°N latitude along the coast of Norway, at a depth of 183-1229 metres. Mortensen (1927) describes the distribution as "Faroe Channel .. and off the Irish west coast ... elsewhere distributed from Lofoten to the Cape Verdes; also recorded from the West Indies and off Japan". Deichmann (1954) notes that the Japanese record needs reinvestigation. This apparently has not been done, but the occurrence of the species in New Zealand waters establishes the species in the Pacific Ocean, and the Japanese record is probably correct. The bathymetric range of this cosmopolitan species is approximately 200-1600 metres.

<u>Mesothuria</u> Ludwig, 1894

<u>Allantis</u> Herouard 1902; <u>Zygothuria</u> Perrier, 1898.

Diagnosis: Gonad comprising only a single tuft. Ventral surface flattened. Tubefeet all over body, or in a single or double row on the paired radii. Deposits in the form of tables with an approximately circular disc with large perforations, carrying a spire composed of three processes united by crossbars.

Type Species: <u>Mesothuria multipes</u> Ludwig.

Remarks: This is a large genus, containing in excess of 25 species, of which several are cosmopolitan in distribution. Deichmann (1931, 1954) is in favour of retaining <u>Zygothuria</u> Perrier (type species <u>Zygothuria lactea</u> (Theel)) as a distinct genus to accommodate the "almost footless" species <u>lactea</u>. Heding (1942) reduced <u>Zygothuria</u> to the status of a subgenus of <u>Mesothuria</u>. The type species of <u>Zygothuria</u> is known from the New Zealand region.

<u>Mesothuria lactea</u> (Theel)

<u>Holothuria lactea</u> Theel, 1886a, p.183; 1886, p.6.

<u>Holothuria aspera</u> Bell, 1892, p.50.

<u>Zygothuria lactea</u> Perrier, 1902, p.322, Pl.XVII, fig.1-10; Deichmann, 1931, p.108, Pl.8, figs.8-9; Deichmann, 1954, p.386.

<u>Zygothuria lactea</u> var. <u>oxysclera</u> Perrier, 1902, p.323.

<u>Mesothuria lactea</u> Sluiter, 1910, p.332; Herouard, 1902, p.21, Pl.1, figs.17-19; Herouard, 1923, p.13, Pl.4, figs. 1-3; Mortensen, 1927, p.382, fig.227.

<u>Mesothuria</u> (<u>Zygothuria</u>) <u>lactea lactea</u> Heding, 1940, p.126, Text-fig.7 (3); Heding, 1942, p.9, Text-fig. 9.

Material Examined: None.

Remarks: This species was originally described from specimens collected near New Zealand ("Challenger" Station 169) and near the Azores (Sta. 78), in depths of 1260 metres and 1800 metres respectively (Theel, 1886a). Subsequently the species was collected from many localities in the Pacific and Atlantic Oceans, and in the Arctic. <u>Mesothuria lactea</u> is cosmopolitan, in depths ranging from approximately 700 metres to 5,100 metres.

ORDER ELASIPODIDA

Diagnosis: Tentacles shield-shaped, retractor muscles and respiratory trees absent. Tubefeet usually present. Body bilaterally symmetrical. Calcareous deposits include pointed rods or their derivatives, wheels, cruciform bodies, or are lacking altogether.

Remarks: Most elasipods are exclusively deep-sea forms, living on a soft bottom, although some species are bathy-pelagic in habit. As a result of several deep-sea expeditions the elasipods have been well described by many workers (Theel, 1882; Ludwig, 1894; Sluiter, 1901; Koehler & Vaney, 1905; Ohshima, 1915; Herouard, 1923; Heding, 1940; Madsen, 1953; Hansen, 1956, and others), and the group at present contains over 100 species. It is likely that many more species are yet to be discovered.

Currently, five families are recognised. These may be distinguished as follows:

1 (2) Body ovoid, gelatinous, lacking calcareous deposits. Usually a large brim developed anteriorly . . . . Pelagothuriidae

2 (1) Body bilaterally symmetrical. No conspicuous anterior brim. Calcareous deposits present.

3 (4) Elongate nonretractile lateral processes present. Skin usually thin, parchment-like or brittle . . . . Deimatidae

4 (3) Lateral processes lacking; skin usually thick, gelatinous.

5 (6) Calcareous deposits include wheels . . . . Laetmogonidae

6 (5) Wheels lacking.

7 (8) Calcareous deposits most commonly include straight or curved rods, three-armed spicules, rarely minute net-like plates, rosette-shaped or elliptical bodies . . . . . Elpidiidae

8 (7) Deposits simple rods or four-armed bodies, with inwardly curved arms and often an outer central projection . . . Psychropotidae

Of these five families, all but the Deimatidae are so far known from the New Zealand region. It is expected that the Deimatidae will eventually be discovered here, as the family has a cosmopolitan distribution.

Family LAETMOGONIDAE Ekman, 1925

Diagnosis: Body elongate, more or less cylindrical. Ventrolateral radii each with large, well developed pedicels, distributed throughout the radius. Midventral radius naked, or with some small pedicels. Dorsal processes elongate, flexible, distributed throughout the radii. Calcareous deposits include wheels in large numbers. Gonads branched. Mesenteries as continuous membranes. (After Mortensen, 1927; Deichmann, 1931).

This family is well defined on the basis of the presence of numerous wheels in all genera. Representatives are found in all depths, and the family is cosmopolitan.

The family Laetmogonidae contains eight genera, of which those known from New Zealand may be keyed as follows:

1 (8) Midventral radius naked.

2 (3) Apart from the deposits in the processes and pedicels, deposits of the dorsal bodywall aggregated into heaps . . . . <u>Bathygone</u> n.g.

3 (2) Deposits scattered, not aggregated.

4 (5) Dorsal processes elongate, not retractile, usually not in a crowded series . . . . <u>Laetmogone</u> Theel

5 (4) Dorsal processes short, small, retractile, in a crowded series in each radius.

6 (7) Deposits wheels of one type, strongly vaulted . . . . <u>Benthogone</u> Koehler

7 (6) Deposits wheels of two distinct types . . . . <u>Ilyodaemon</u> Theel

8 (1) Midventral radius with a double series of pedicels . . . . <u>Pannychia</u> Theel

<u>Ilyodaemon</u> Theel

Tentacles 15, large, non-retractile. Ventrolateral pedicels large, in a single row throughout each radius. Midventral radius naked. Dorsal radii each with a crowded series of very numerous, retractile slender processes, usually in a double row.

Type Species: _Ilyodaemon_ _maculatus_ Theel.

The genus is widespread in the Indo-west-Pacific (_I. fimbriatus_, _I. maculatus_ and _I. abstrusus_) and off Japan (_I. ijimai_ and _I. muriense_) in depths ranging between about 150 metres and 1,000 metres. The fact that _Ilyodaemon_ is now known to occur in New Zealand waters considerably extends the known range of distribution, and it seems likely that the genus will be found to have a far wider distribution than has formerly been supposed.

Ilyodaemon contains five species, which may be keyed as follows:

1 (4) Deposits include dichotomously branching "rosettes".

2 (3) Approximately 140-150 processes in each dorsal radius . . . . _I. maculatus_ Theel

3 (2) Approximately 100 processes in each dorsal radius . . . . _I. muriense_ Ohshima

4 (1) "Rosettes" lacking.

5 (8) Less than 50 pedicels in each ventrolateral interradius.

6 (7) Each ventrolateral radius with 21-23 pedicels. Dorsal radii each with approximately 140-160 processes. Colour in alcohol violet to dark violet . . . . _I. abstrusus_ Sluiter

7 (6) Each ventrolateral radius with 22-25 pedicels. Dorsal radii each with approximately 100 processes. Colour in alcohol whitish-grey . . . . *I. ijimai* Mitsukuri

8 (5) At least 50 pedicels in each ventrolateral radius . . . . *I. fimbriatus* Sluiter

Ilyodaemon abstrusus Sluiter

Pl.VIII, figs.1-4

Ilyodaemon abstrusus Sluiter, 1901a, p.24; 1901b, p.69, Pl. IV, figs.1-3, Pl.XX, fig.9.

Material Examined: Marine Dept. Stn. 23, 1 specimen; Stn. 31, 4 specimens.

Description: Total length ranges from 108 mm to 142 mm. The body is elongate, approximately four times as long as broad. The body wall is extremely slimy, thick and gelatinous. Midventral radius naked, lateral ventral radii each with a single row of soft triangular processes, which are up to 13 mm in length, with an average length of 10 mm. These processes are regularly spaced along the radii, and their number varies between 16 and 20 in each radius, although 18 processes seem to be the usual number. Lateral dorsal radii each carry approximately 55 pairs of short (5 mm long) processes, regularly arranged. Thus there are two rows of processes in each dorsal radius. Mouth ventrally turned, anus terminal.

In the five specimens the tentacle numbers are 11, 10, 15, 14, 14. Unfortunately the anterior end of each specimen is in poor condition, and the normal tentacle number is indeterminate, although it is probably at least 15.

Colour in alcohol dark purple overall, dorsal processes violet, ventrolateral processes lighter in colour. Tentacles dark brown, with leathery circular terminal discs.

Intestine is purplish-black, describing a large S-shaped loop. Polian vesicle large, bulbous. Gonad as small deep purple tufts.

Calcareous deposits include large wheels, smaller wheelshaped perforated deposits, and spinous rods.

Large wheels (Pl.VIII, fig.2) are regular, with 9-11 spokes and some central perforations. Most commonly, wheels with 9 spokes (45%), or with 10 (40%), are found. Diameter of wheels ranges from 0.085 mm to 0.13 mm, with an average diameter of 0.1 mm.

Small wheels (Pl.VIII, fig.4) typically have four larger central perforations and twelve spokes. The margin of the small wheels is often slightly indented opposite each spoke. Average diameter of these deposits is 0.04 mm.

In the dorsal bodywall, large and small wheels are present, but sparsely scattered. Ventrally, both types are also present, but more closely aggregated.

The dorsal processes contain only small wheels in large numbers, scattered irregularly. Ventral processes contain large wheels near the bases, but toward the distal extremities these are replaced by numerous rods of varying shape (Pl.VIII, fig.1), up to 0.5 mm in length. Some of these rods carry a few small spines. In the stems and discs of the tentacles are curved rods (Pl.VIII, fig.3) up to 0.6 mm long, with weakly spinous ends.

Remarks: These specimens are representatives of Ilyodaemon abstrusus, a species first described by Sluiter (1901a). Sluiter's largest specimen was 170 mm in length, while the number of pairs of dorsal processes is given as 70 to 80. It is possible that this number increases with growth. However, none of the present specimens has less than 50 pairs of dorsal processes. Sluiter (1901b) notes that there are 18 "aspidochiroten Fuhlern" surrounding the mouth; this is a rather larger number of tentacles than in the present specimens. The tentacles in Sluiter's specimens are violet, while here they are brown. In spite of these differences, it is apparent that the specimens represent Sluiter's species, to which they have here been assigned.

In the specimen from Marine Dept. Stn. 31, five nematodes were found in the coelomic cavity, near the posterior end of the intestine. They were free and unattached, lying entwined in the small muscle fibres supporting that part of the intestine. Body length of these worms ranges from 16 mm to 30 mm. The colour in alcohol approximates that of the intestine, although two of the specimens are

PLATE VIII

Ilyodaemon abstrusus Sluiter, ? Laetmogone violacea juv.

Ilyodaemon abstrusus Sluiter

Fig.1. Deposits from ventral processes.

Fig.2. Large wheels.

Fig.3. Tentacle deposits.

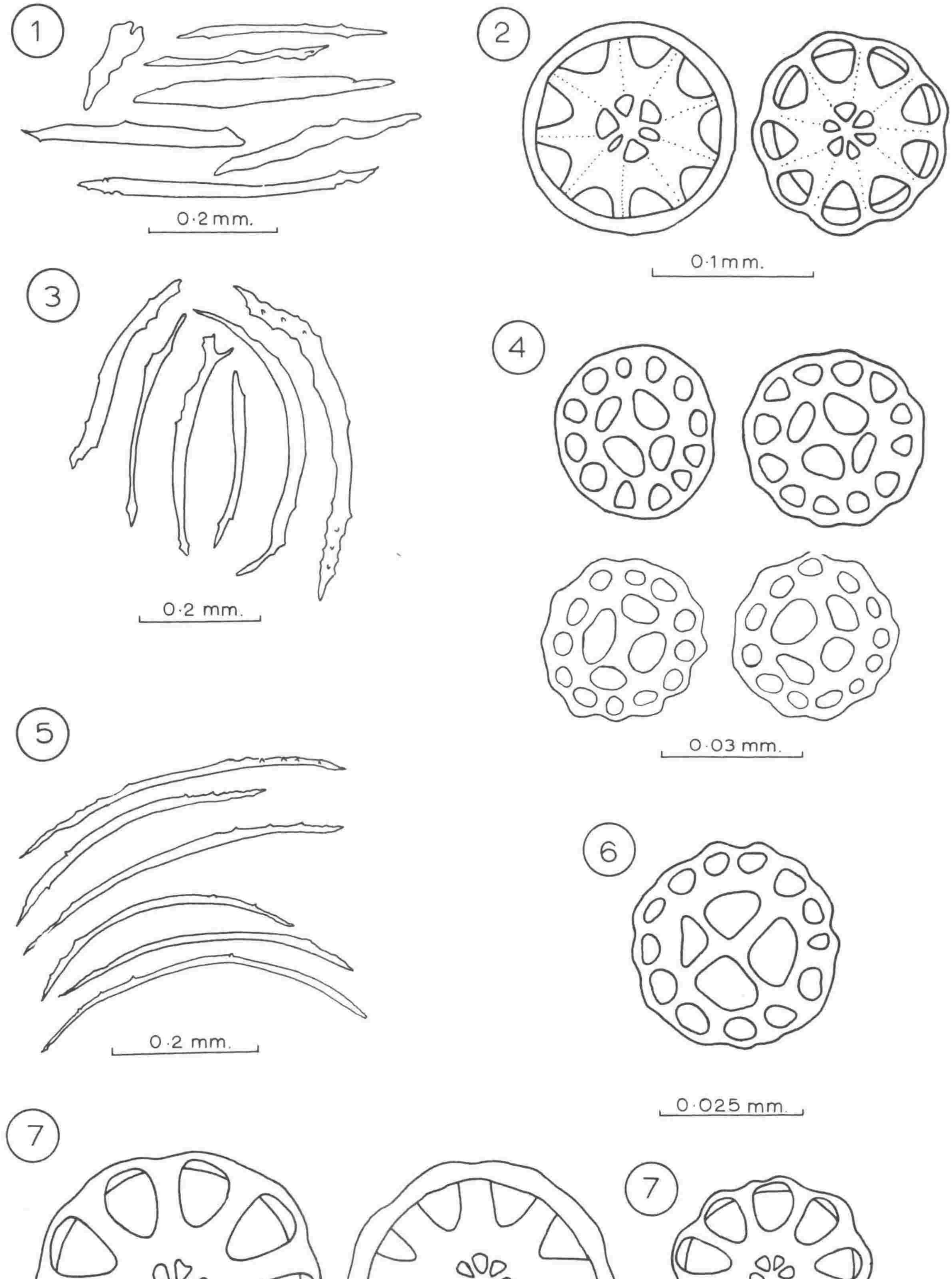
Fig.4. Small wheels.

? Laetmogone violacea juv.

Fig.5. Tubefoot deposits.

Fig.6. Small wheel.

Fig.7. Large wheels.


1
0·2 mm.
2
0·1 mm.
3
0·2 mm.
4
0·03 mm.
5
0·2 mm.
6
0·025 mm.
7
7
0·1 mm.

light brown. As knowledge of the systematics of deep-sea nematodes is largely fragmentary, these beasts must, for the present, remain unidentified. This is possibly the first record of the presence of nematodes in an elasipod holothurian, and is a matter of extreme interest. The relationship between the "host" and its "parasites" is not clear. The intestine of the specimen contained no further nematodes, nor was there any evidence of damage to surrounding tissues in the region in which the nematodes were found. As there are no respiratory trees, it is difficult to imagine how the nematodes came to enter the coelomic cavity, unless by boring through the wall of the intestine, or somehow penetrating into the water-vascular system.

Pannychia Theel, 1882

Diagnosis: Tentacles twenty, large, non-retractile. Ventrolateral radii with large pedicels in a single row throughout each radius. Midventral radius with a double row of pedicels. Dorsal surface with a crowded series of very numerous slender processes all along each side. Deposits large wheels and small wheel-shaped plates.

Type Species: *Pannychia moseleyi* Theel.

A genus containing five species, of which the type species is wide ranging in the Pacific Ocean in depths of 500 - 2,000 metres.

Pannychia moseleyi Theel

Pannychia moseleyi Theel, 1882, p.88, Pls.XVII, XXXII, figs. 1-13; Ludwig, 1894, p.95; Sluiter, 1901b, p.71; Mitsukuri, 1912, p.207; Ohshima, 1915, p.235; Djakonov, Baranova & Saveljeva, 1958, p.360.

Material Examined: None.

Remarks: Theel (1882) described two specimens of this species, one taken from east of Australia (34°8'S, 152°0'E) in 1710 metres, the other from off New Zealand (37°34'S., 179°22'E) in 1260 metres. Since that time the species has been recorded from several localities in the Pacific Ocean (see Ohshima, 1915, p.235).

Laetmogone Theel, 1879

Diagnosis: Tentacles 15, large, non-retractile, Ventrolateral radii with large pedicels in a single row throughout each radius. Midventral radius naked. Dorsal radii each with a single series of extremely elongated flexible, slender non-retractile processes. Deposits include wheels and often cruciform bodies.

Type Species: *Laetmogone wyvillethomsoni* Theel.

This genus contains about ten species, of which two, *L. violacea* Theel and *L. wyvillethomsoni* Theel, are known to be cosmopolitan. Deichmann (1931) has indicated that these two species have undoubtedly been confused on many occasions, because of their great similarity to each other. Species of Laetmogone have been taken in depths ranging from 200 metres to 3,500 metres.

Laetmogone violacea Theel

Plate IX

Laetmogone violacea Theel, 1879, p.11; Theel, 1882, p.78, Pl.13, figs.1-3; Pl.36, figs.20-24, Pl.42, fig.2; Perrier, 1902, p.390, Pl.19, figs.1-7; Augustin, 1908, p.21; Mitsukuri, 1912, p.192, Pl.6, figs. 52-54, Text-fig.36; Ohshima, 1915, p.237; Greig, 1921, p.9; Herouard, 1923, p.37; Mortensen, 1927, p.361, figs.213-4; Deichmann, 1931, p.120; Heding, 1942, p.14, Text-fig.14.

Cyrodora spongiosa Theel, 1879, p.9.

Laetmogone spongiosa Theel, 1882, p.80, Pl.14, figs.1-3, Pl. 39, figs.5-6.

Laetmogone jourdaini Petit, 1885, p.9.

Laetmogone brogniarti Perrier, 1886, fig.241.

Material Examined: N.Z. O.I. Stn. C.619, 3 specimens. Marine Dept. Stn.11, 6 specimens; Stn.23, 1 specimen; Stn.27, 3 specimens. Dominion Museum, B.S.209, 1 specimen.

Description: Body elongate, flattened ventrally, about three times as long as broad. Mouth subventral, anus subdorsal. Total length ranges from 57 mm (an autoeviscerated specimen) to 102 mm. Tentacles 15 (14 in one specimen). Dorsal surface with elongate processes in each radius, ventrolateral radii with short, broad pedicels. Midventral radius naked. Colour in alcohol light grey with a purple tinge; dorsal processes dark reddish-purple. Bodywall thick, soft and gelatinous. Tentacles with grey stems and a brown leathery terminal disc.

The dorsal processes have a length of up to 25 mm, while the ventral pedicels are up to 13 mm long. There is some variation in the number of processes and pedicels as shown in the following table:

Dorsal Processes		Ventral Pedicels	
Left dorsal radius	Right dorsal radius	Left ventral radius	Right ventral radius
28 mm	27 mm	15 mm	14 mm
ca. 23	ca. 19	14	12 (damaged)
ca. 26	ca. 23	16	16 (damaged)
—	—	15	—
24	23	15	15
—	—	13	15 (damaged)
23	22	14	15
24	21	13	15
25	23	14	13
24	24	13	13
—	—	14	13 (damaged)
—	—	13	— (damaged)
24	25	13	11
26	23	15	15

The average number of dorsal processes is 24, and of ventral pedicels the average number is 14.

The fragile calcareous ring is a continuous network of calcareous material; the radial areas of the ring have faint anterior processes for the attachment of the radial muscles. A thinwalled intestine describes a very large loop (Pl.IX, fig.1); the cloaca is attached to the bodywall by some fine muscle fibres. While most of the intestine is transparent, the cloaca is light violet in colour. The single Polian vesicle is elongated and cylindrical (Pl.IX, fig.1), arising from the ring vessel in the left ventral interradius. The stone canal runs posteriorly for a short distance in the dorsal mesentery, and terminates in a minute nodular madreporite, which opens to the exterior near the opening of the genital duct (Pl.IX, fig.1).

The gonad comprises a large bunch of dichotomously branching genital caeca (Pl.IX, fig.6). The genital duct is short, opening to the exterior at the tip of a genital papilla, which is placed a short distance from the anterior end of the body in the mid-dorsal interradius. Longitudinal muscles are five broad undivided dark brown straps.

Calcareous deposits include wheels and spinous spicules. The wheels are of two types, large and small. Large wheels (Pl.IX, fig.8d) typically have 8-9 spokes and average 0.9 mm in diameter. Smaller wheels (Pl.IX, fig.8c) have 12-13 spokes, and are 0.05 mm in diameter. All of the wheels are

PLATE IX

Laetmogone violacea Theel

Fig.1. Internal anatomy.

Fig.2. Unusual deposit from dorsal bodywall.

Fig.3. Spinous deposits from ventral bodywall.

Fig.4. Deposits from dorsal processes.

Fig.5. Whole animal, ventral side.

Fig.6. Portion of gonad.

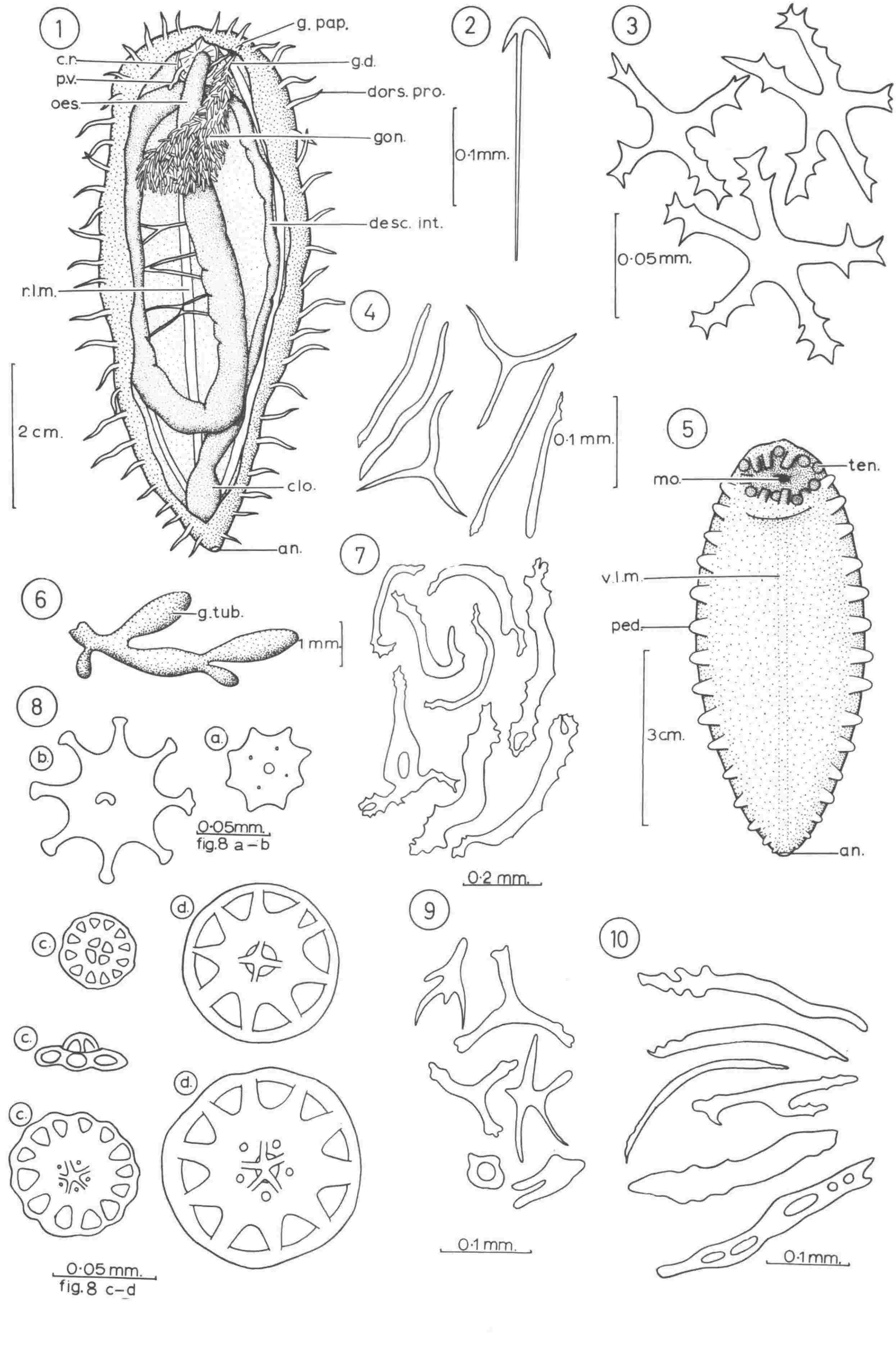
Fig.7. Tentacle deposits.

Fig.8. Wheels.

Fig.9. Deposits forming "endplate" of ventro-lateral process.

Fig.10. Deposits from around "endplate".

Abbreviations: an., anus; clo., cloaca; c.r., calcareous ring; desc.int., descending intestine; g.d., genital duct; gon., gonad; g.pap., genital papilla; g.tub., genital tubules (caeca); mo., mouth; oes., oesophagus; ped., pedicel; p.v., polian vesicle; r.l.m., radial longitudinal muscle; ten., tentacle; v.l.m., ventral longitudinal muscle.



1
g. pap.
c.r.
g.d.
p.v.
dors. pro.
oes.
gon.
desc. int.
r.l.m.
2 cm.
clo.
an.
2
0·1mm.
3
0·05mm.
4
0·1 mm.
5
ten.
mo.
v.l.m.
ped.
3cm.
an.
6
g.tub.
1 mm.
7
0·2 mm.
8
b.
a.
0·05mm.
fig.8 a – b
c.
d.
c.
c.
d.
0·05 mm.
fig.8 c – d
9
0·1 mm.
10
0·1mm.

approximately saucer-shaped, and lie in the skin with their concave surfaces facing outwards. Stages in the development of large wheels are commonly found (Pl.IX, fig.8, a, b).

Three- to six-armed spinous deposits are numerous in the ventral bodywall, but they are rare dorsally (Pl.IX, fig.3). These deposits have an average length of 0.1 mm.

The dorsal processes contain wheels, together with numerous rods and three-armed deposits, often with weakly spinous extremities (Pl.IX, fig.4). Small wheels are more common near the distal extremities of the processes, while large wheels are mostly found near their bases. In the ventrolateral pedicels wheels are numerous, and at the distal extremity is an "endplate" composed of an aggregation of small, smooth deposits of variable shape (Pl.IX, fig.9), surrounded by a ring of curved spinous rods (Pl.IX, fig.10).

The tentacles contain wheels, and in addition spinous rods of variable size (Pl.IX, fig.7). Average length of these deposits is 0.4 mm. In the walls of the genital caeca are small spinous rods of average length 0.2 mm.

In the dorsal bodywall, a spicule of unusual character, resembling an anchor, was found (Pl.IX, fig.2). This spicule is 0.2 mm in length.

Remarks: The variation shown by the dorsal processes and ventrolateral pedicels is quite considerable. Examination of several specimens shows that the spiculation can vary also to a large extent. Heding (1942) also describes variation in specimens collected during the "Ingolf" Expedition, and states that the variations are too slight to be used for distinguishing the numerous forms of this species.

This is the first record of this species from New Zealand waters. Its occurrence here is not unexpected, as L. violacea is one of the most widespread of elasipod species, being known from Atlantic and Pacific Oceans, and the Arctic. Heding (1942) notes that "L. violacea appears to be a cosmopolitic species, originating from the Indo-Pacific ..." The species is usually confined to deeper waters beyond the continental shelf, and has been taken from depths exceeding 1800 metres.

?Laetmogone violacea Theel juv.

Pl.VIII, figs.5, 6, 7

Material Examined: Marine Dept. Stn. 32, 1 specimen.

Remarks: A single specimen of total length 15 mm is a juvenile elasipod, and has calcareous deposits greatly resembling those of Laetmogone violacea. The body is contracted, and the skin is thick, gelatinous and translucent, light purple in colour. Lateral ventral pedicels and dorsal processes are present, and the midventral radius is naked.

The ventral processes are in the form of elongate tubefeet, each about 4 mm in length. There is a concave perforated endplate (0.5 mm diameter), surrounded by curved spinous rods up to 0.5 mm in length (Pl.VIII, fig.5), and small wheels (Pl.VIII, fig.6). The stems are packed with spinous rods, and these lie transverse to the longitudinal axes of the tube-feet. There are 18 ventral processes in the left ventral radius, and 11 in the right (damaged).

The dorsal processes are up to 6 mm in length, and have thick gelatinous bases. Colour of these processes is deep red. The processes are less numerous than the ventral tubefeet, there being only eight in the left dorsal radius and nine in the right. Calcareous deposits in these structures include numerous large and small wheels (Pl.VIII, figs.6, 7).

Calcareous deposits are apparently lacking from the ventral side, but dorsally wheels are common. Smaller wheels have an average diameter of 0.037 mm, and have 12 spokes and four central holes. Large wheels have an average diameter of 0.146 mm, and typically have nine spokes, although wheels with more or less than nine spokes are not uncommon. The raised central boss has about six perforations.

There is little doubt that this is a juvenile of an elasipod of genus Laetmogone, or a closely allied genus. However, there are some puzzling features about the specimen. The ventral processes are more numerous than the dorsal processes. This is not the case in L. violacea, although it is quite possible that L. violacea does not achieve its full complement of dorsal processes until later in its life history. Moreover, the ventral pedicels of the juvenile specimen exceed in number those of the adult.

Until a richer material is available, it seems the best course to designate this specimen as a possible juvenile of L. violacea. Further material should establish the systematic position of this specimen with certainty.

Bathygone n.g.

Diagnosis: Tentacles 15. Body elongate, flattened ventrally, arched dorsally. Midventral radius naked. Latero-ventral radii each with approximately 50 narrow, elongate pedicels arranged in a single, often apparently double series. Dorsal radii each with about ten small retractile processes, regularly spaced. Deposits include wheels, circular perforated plates and spinous rods. Wheels and plates tend to be aggregated into scattered heaps on the dorsal side of the body.

Type Species: Bathygone papillata n.sp.

This genus differs from the others in Family Laetmogonidae in possessing the peculiar heaps of calcareous deposits in the dorsal side of the body. Also the extremely numerous circular plates, while not unique in this family, are usually found in the papillae or pedicels, and are rare elsewhere.

Bathygone seems most closely related to Laetmogone Theel, differing from that genus in the smaller size of the dorsal papillae, and in the absence of accessory rods and cross-shaped deposits. From Benthogone Koehler, Bathygone differs in having smaller ventrolateral processes, and more than one type of deposit in the bodywall.

<u>Bathyzone papillata</u> n.sp.

Pl. X, figs. 1-5.

Diagnosis: As for the genus.

Material Examined: Marine Dept. Stn. 20, 7 specimens.

Description: All specimens are extensively damaged. Total length ranges between 29 mm and 58 mm. The body is elongate, approximately three times as long as broad, flattened ventrally, with the dorsal side arched. The mouth is ventrally turned, the anus subdorsal. Midventral radius naked, lateral ventral radii each with ca. 50 narrow elongate pedicels, arranged in a single often apparently double series in each radius. Dorsal radii each carry about ten regularly spaced small and rather inconspicuous (retractile) processes. The bodywall is firm and thick, although all specimens are strongly contracted, and most have autoeviscerated. Tentacles 15, short, with the terminal disc divided, so that the end of the stem carries 5-10 short, fingerlike processes radiating from a small central disc. Mouth large, oral field broad.

Colour in alcohol light purple, dorsal processes reddish, tentacles greyish-white.

Calcareous deposits include wheels, circular perforated plates and spinous rods. The wheels typically have nine spokes and about six central perforations (Pl.X, fig.1); a very small number of wheels have ten or eleven spokes. Diameter ranges from 0.19 mm to 0.25 mm, with an average diameter of 0.23 mm. A single wheel of a most unusual shape was found (Pl.X, fig.1).

The circular perforated plates usually have four central perforations larger than the rest, and the perforations gradually decrease in size toward the outer edge of the deposits (Pl.X, fig.4). At the outer edge, most of the perforations are incompletely closed. Average diameter of these deposits is ca. 0.045 mm, but they can vary somewhat in size.

In the dorsal bodywall, wheels and circular perforated plates are numerous, tending to be aggregated, forming small (1 mm diameter) white protuberances, which are scattered, having no regular arrangement. Ventrally, deposits are extremely rare, and easily overlooked.

Dorsal processes contain spinous rods (Pl.X, fig.3) in small numbers, the rods being up to 0.4 mm in length. In the ventral pedicels similar rods are found, but they are more closely packed, and in addition, the pedicels have a terminal endplate, which is an irregularly perforated deposit of ca. 0.6 mm diameter, usually fragmented. A small portion of the endplate is illustrated (Pl.X, fig.5). Also present, sparingly scattered in the pedicels, are circular perforated deposits.

PLATE X

Bathygone papillata n.g., n.sp., Benthogone rosea Koehler

Bathygone papillata n.g. n.sp.

Fig.1. Large wheels.

Fig.2. Deposits from tentacles.

Fig.3. Rods from dorsal processes.

Fig.4. Circular perforated deposits.

Fig.5. Portion of an endplate.

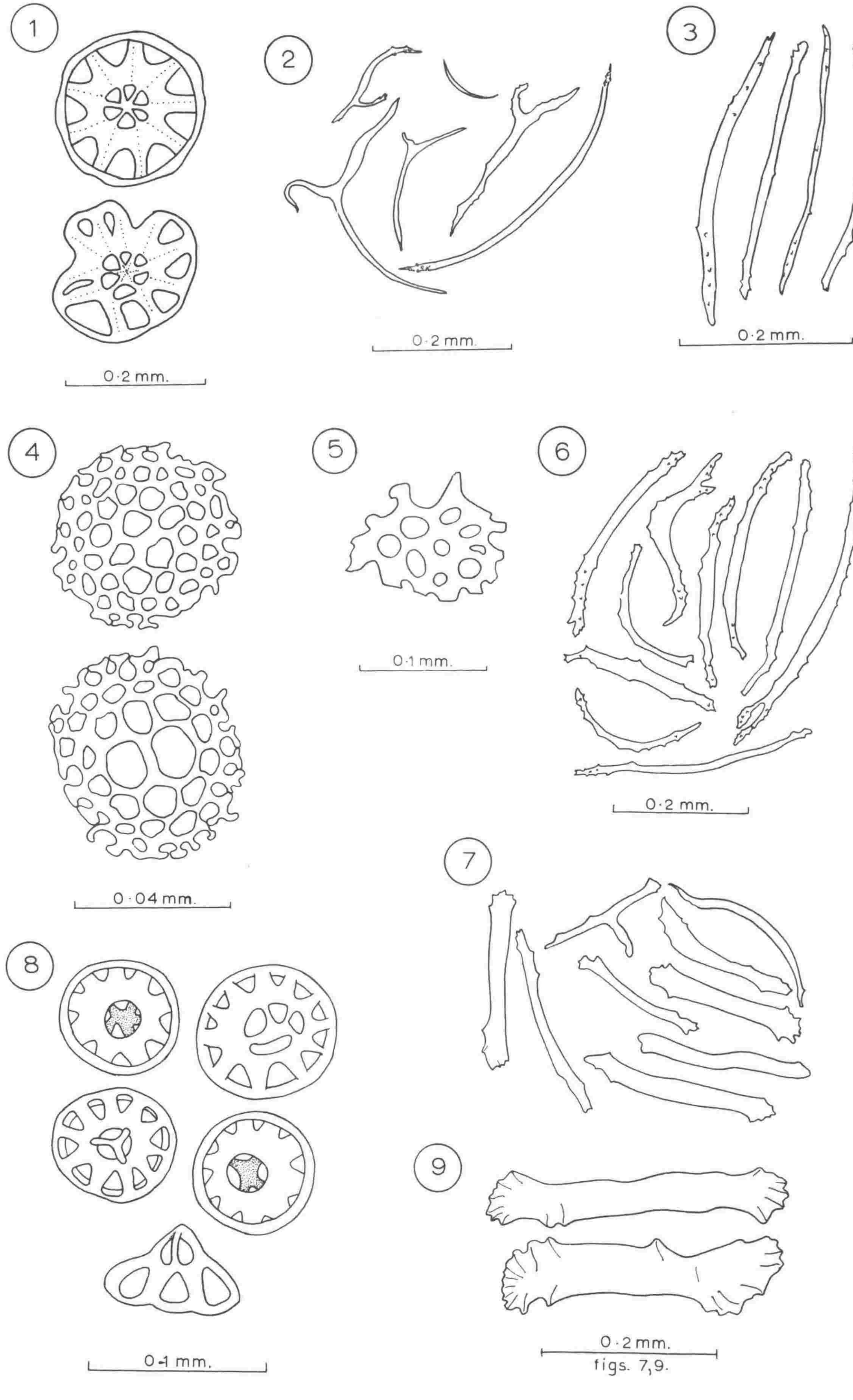
Benthogone rosea Koehler

Fig.6. Deposits from tentacles.

Fig.7. Small rods from ventral pedicels.

Fig.8. Wheels.

Fig.9. Large rods from ventral pedicels.



1
2
3
0·2 mm.
0·2 mm.
0·2 mm.
4
5
6
0·1 mm.
0·2 mm.
0·04 mm.
7
8
9
0·1 mm.
0·2 mm.
figs. 7,9.

The discs and stems of the tentacles contain curved and straight rods of greatly variable form (Pl.X, fig.2), some of which are spinous or branched, or both. These deposits attain a considerable length (up to 0.7 mm).

Holotype: The holotype (42 mm total length) and two paratypes are lodged in the collection of the Dominion Museum, Wellington.

Remarks: It is probable that the circular perforated plates in this species are derived from the "small wheels" found so commonly in laetmogonid species, by the addition of calcareous material to the circumference of the wheel.

<u>Benthogone</u> Koehler, 1896

Diagnosis: Mouth ventral, surrounded by 15-20 tentacles. Body flattened or almost cylindrical. Ventrolateral radii each with a single row of ca. 15 retractile pedicels; mid-ventral radius naked. Dorsal radii with numerous small processes in a single to double row. Deposits strongly vaulted wheels of one type, with an average diameter of 0.078 mm.

Type Species: <u>Benthogone</u> <u>rosea</u> Koehler.

This genus is monotypic, differing from other genera in Family Laetmogonidae in possessing wheels of only one type, which are not associated with any other deposits, except in the pedicels. Accessory deposits are spinous rods, which are found in the pedicels, processes and tentacles.

<u>Benthogone</u> <u>rosea</u> Koehler

Pl.X, figs.6-9

<u>Benthogone</u> <u>rosea</u> Koehler, 1896, p.114; Perrier, 1902, p.399, Pl.XIX, figs.8-14; Mortensen, 1927, p.363, fig. 215; Deichmann, 1931, p.121; Heding, 1940, p.369.

<u>Benthogone</u> <u>rosea</u> var. <u>cylindrica</u> Perrier, 1902, p.400.

<u>Benthogone</u> <u>rosea</u> var. <u>quadrilineata</u> Perrier, 1902, p.401.

<u>Benthogone</u> <u>quadrilineata</u> Heding, 1940, p.369; Heding, 1942, p.15.

Material Examined: "Tui" Stn. 098-17, 2 specimens.

Description: Both specimens are extensively damaged and autoeviscerated. Total length 103 and 105 mm. Average breadth, 23 mm. The body is flattened dorsoventrally, elongate. Mouth subterminal, ventrally placed; anus subdorsal. Tentacles 15, with leathery terminal discs. The bodywall is thick, firm. The ventrolateral radii each carry approximately 13 retractile pedicels; midventral radius naked. Each dorsal radius has ca. 40 short, retractile processes arranged in a single, sometimes double, row. Colour in alcohol greyish white to light mottled violet dorsally, darker mottled violet ventrally. Tentacles light brown.

Oesophagus and rectum are light purple, radial muscles are narrow light yellow bands. The single Polian vesicle is elongate, tubular, white in colour.

The bodywall contains wheels of only one type (Pl.X, fig.

8). The wheels have 7-13 spokes (40% have 11, 20% have 12), and are strongly vaulted. Diameter ranges from 0.064 mm to 0.11 mm, with an average diameter of 0.078 mm. There is no correlation between wheel size and spoke numbers. Dorsally, the wheels are scattered in small numbers, but they are rather more numerous ventrally.

The ventral pedicels contain, beside numerous wheels, small numbers of large (Pl.X, fig.9) and small (Pl.X, fig.7) rods, usually straight or slightly curved, with weakly spinous ends. The smaller rods have an average length of 0.18 mm, while the larger type average 0.32 mm in length.

The stems and terminal discs of the tentacles contain spinous rods (Pl.X, fig.6), many of which are curved. The curved rods are most commonly found in the tentacle discs; they have an average length of 0.3 mm.

Remarks: These are typical specimens of Benthogone rosea, differing little from those described by Koehler (1896) and Perrier (1902). The varieties cylindrica and quadrilineata originally described by Perrier (1902) were, according to Mortensen (1927) and Deichmann (1931) based on specimens in various stages of contraction, and thus neither of those authors was in favour of maintaining these doubtful varieties. Heding (1940, 1942), however, regarded the var. quadrilineata as worthy of specific rank, and elevated it to that level. His evidence for doing so seems unconvincing to the writer, more especially so since B. rosea and B. quadrilineata were collected at the same "Valdivia" station, and it is felt best that the "species" B. quadrilineata should be reduced to complete synonymy with B. rosea.

Distribution: Mortensen (1927) notes that this species is known from off south-west Ireland from 1200-1765 metres, the Bay of Biscay, off the Azores, and the Africa coast to the Cape Verde Islands in 1,00-2,320 metres. Heding (1940) records B. quadrilineata from near the Cape Verde Islands in depths of 2,480 metres ("Valdivia" Stn. 33) and 1,694 metres, and B. rosea from "Valdivia" Stn. 33. Later, Heding (1942) reported B. quadrilineata from west of Ireland at a depth of 1,330-1,440 metres. Its occurrence north of New Zealand is therefore unexpected, but the depth tolerance of the species would facilitate its wide distribution, and it is likely that B. rosea is widespread in the Pacific Ocean as well as in the Atlantic.

Family PELAGOTHURIIDAE Ludwig, 1894

Cyclionidae Herouard, 1923.

Diagnosis: Tentacles 12-20. Bodywall thick, gelatinous, completely lacking calcareous deposits. A large brim is usually developed anteriorly, enabling the members to adopt a bathypelagic habit.

This most unusual group of holothurians of bathypelagic habit is represented in New Zealand by a single genus. As Hansen and Madsen (1956) have pointed out, the systematic position of this group is not established with certainty. It is suggested that the bathypelagic elasipods are neotenic (Hansen & Madsen, 1956).

Enypniastes Theel

Diagnosis: Tentacles 20. Body very depressed, with an extension of the bodywall around its anterior extremity, constituting a very broad, large flat brim. Dorsal surface with some small projections around the margin of the brim, and also some very small processes on the ambulacra. Calcareous deposits lacking. (After Theel, 1882).

Type Species: *Enypniastes eximia* Theel.

The three species in this genus are all so far known only from the Pacific Ocean, while *E. eximia* Theel is known from off Japan (Mitsukuri, 1912; Ohshima, 1915), the Moluccas (Sluiter, 1901b), and New Zealand (Theel, 1882). In commenting on Heding's (1950) attempt to revise the classification of the bathypelagic holothurians, Hansen & Madsen (1956) note that perhaps at least three species are confused under the name *Enypniastes eximia*.

Enypniastes eximia Theel

Enypniastes eximia Theel, 1882, p.56, Pl.8, figs.6, 7; Sluiter, 1901b, p.77, Pl.2, figs.8, 9, Pl.10, fig.5; Mitsukuri, 1912, p.215, Pl.7, figs.59, 60; Ohshima, 1915, p.243; Heding, 1950, p.117.

Material Examined: N.Z.O.I. Stn. 603, 1 specimen.

Remarks: The single specimen is very badly damaged, 80 mm in length and 55 mm broad. As far as can be ascertained, the mouth is ventral, and a large web of tissue projects from the anterior end of the body. Other external features are indistinguishable, but the anus appears to be dorsally placed. Colour in alcohol grey, tentacles purple. Most of the internal structures are missing or lacerated. The small remaining fragment of the intestine is dark brown, supported by strong mesenteries. Longitudinal muscles are pinkish-brown. Calcareous deposits lacking.

The general form of this specimen somewhat resembles that of _E. eximia_ Theel, which was described (Theel, 1882) from from four specimens taken near New Zealand (40°28'S, 177°43'E) at a depth of 1100 fathoms, and it is here referred to that species. As the specimen was taken from the vicinity of the type locality of the species it probably represents the true _E. eximia_, and not one of the synonyms referred to by Hansen & Madsen (1956).

Family PSYCHROPOTIDAE Theel

Diagnosis: Tentacles ten to twenty. Body elongate, either subcylindrical or depressed; the anterior end always depressed. Bodywall thick, forming a brim anteriorly. Lateral ventral radii with a single row of numerous small pedicels. Midventral radius naked, or with a double row of minute pedicels. Dorsal surface naked, or with numerous or few large or small processes. Deposits usually four-armed bodies, with inwardly curved arms, and often an outer central projection. Mesenteries continuous membranes; calcareous ring composed of five separate pieces, incompletely developed. (After Theel, 1882, Ekman, 1925).

This family contains four genera, of which three have a cosmopolitan distribution. The fourth genus (Psycheostrephes) is so far known from a single central Pacific species.

The collection includes two specimens of the genus Benthodytes Theel.

Benthodytes Theel, 1882

Diagnosis: Midventral radius with a double row of pedicels. Dorsal surface lacking any large appendages.

Type Species: Benthodytes typica Theel.

Benthodytes contains approximately 20 species, of which one, B. typica, has a cosmopolitan distribution, while B.

sanguinolenta ranges the Pacific Ocean. The species seem to be most commonly found at depths of approximately 3,000 metres, and has been taken from depths in excess of 5,000 metres.

Benthodytes hystrix Sluiter

Plate XI

Benthodytes hystrix Sluiter, 1901b, p.59, Pl.IV, fig.4, Pl. IX, fig.10; Heding, 1940, p.367.

Material Examined: In the collection of the Department of Zoology, Victoria University of Wellington, VUZ 109, off Palliser Bay, 600 fathoms, mud, 2 specimens.

Description: Both specimens are extensively damaged externally, and some important features of their external anatomy are impossible to determine. One specimen is approximately 130 mm long, while the other is approximately 155 mm long. The body is approximately cylindrical, four to five times as long as broad. Tentacles destroyed in both specimens. The mouth appears to lie on the ventral side of the body, a short distance behind the anterior end. Anus subdorsal, a large aperture. The bodywall is thick and soft, and in parts of the dorsal side there is a thin rough layer comprising calcareous deposits investing the bodywall. This layer of calcareous material may have been continuous in the living specimens. On examination under low magnification, this layer is seen to be finely papillate, each papilla containing a calcareous deposit.

Colour in life, "uniformly dark purple". In alcohol, the specimens are grey ventrally, while the dorsal side is mottled dark purple.

Dissection showed that the two specimens were a male and a female of the same species. In both the oesophagus is thinwalled and the intestine takes a large S-shaped loop (Pl.XI, figs.1, 2). The cloaca is enlarged, attached to the bodywall by fine muscle fibres. The entire alimentary canal is purplish-black in colour.

The male has lost the water-vascular ring and some related structures, but in the female, there is a single Polian vesicle 45 mm long, which is cylindrical in shape, arising from the ventral side of the water-vascular ring. Dorsally, the stone canal emerges from the ring vessel, and terminates in a small bulbous madreporite, which opens to the exterior in the dorsal interradius, about 20 mm from the anterior end of the body.

The gonad is well developed in both specimens. In the male, there are two genital ducts, each about 45 mm in length, which subtend short branching tufts of genital caeca. The female has two genital ducts, one being about 30 mm long, while the other is almost twice that length. The genital caeca are a small number of conspicuous bifurcate sacs, containing large eggs 0.9-1.1 mm in diameter. In the male and the female, the two genital ducts unite to form a single canal

PLATE XI

Benthodytes hystrix Sluiter

Fig.1. Internal anatomy of female.

Fig.2. Internal anatomy of male.

Fig.3. Portions of madreporite meshwork in female.

Fig.4. Four-armed deposits of male.

Fig.5. Small five-armed deposit from bodywall of male.

Fig.6. Deposits from male genital duct.

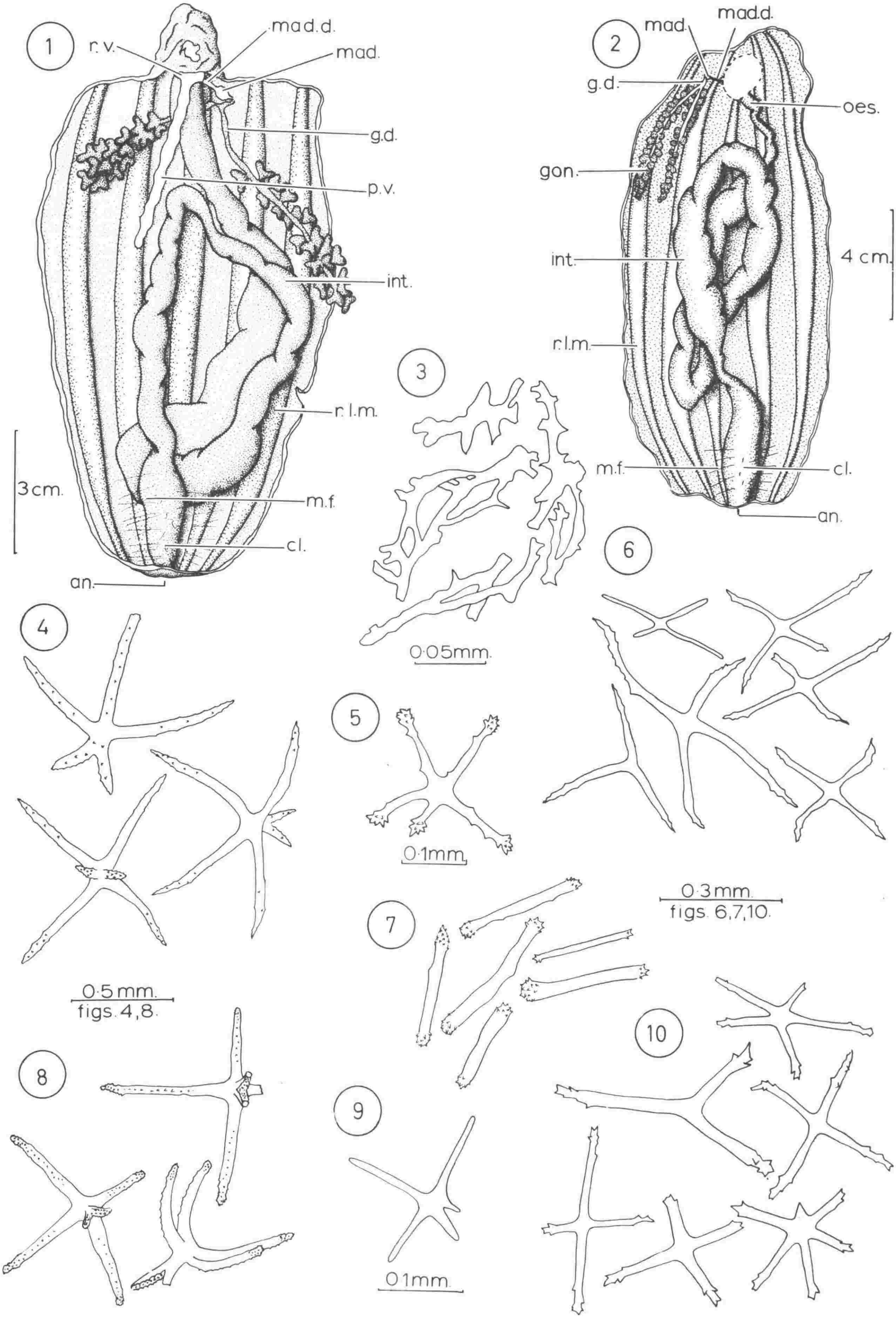
Fig.7. Stone canal deposits of female.

Fig.8. Four-armed deposits of female.

Fig.9. Developing deposit from a genital caecum of female.

Fig.10. Deposits from the genital caeca of female.

Abbreviations: an., anus; cl., cloaca; g.d., genital duct; gon., genital caeca; int., intestine; mad., madreporite; mad.d., madreporic duct (stone canal); m.f., muscle fibres; oes., oesophagus; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.v., ring vessel.



1
r.v.
mad.d.
mad.
g.d.
p.v.
int.
r.l.m.
3cm.
m.f.
cl.
an.
2
mad.
mad.d.
g.d.
oes.
gon.
4 cm.
int.
r.l.m.
m.f.
cl.
an.
3
0·05mm.
4
0·5 mm.
figs. 4,8.
5
0·1mm.
6
0·3 mm.
figs. 6,7,10.
7
8
9
0·1mm.
10

which opens to the exterior immediately adjacent to the madreporite. (Pl.XI, figs.1, 2).

Longitudinal muscles are broad straps, dark brown in the male, violet in the female. Transverse muscles are inconspicuous.

Calcareous deposits were found in the bodywall, the gonad, stone canal and madreporite.

The bodywall contains large numbers of four-armed spicules, the arms radiating from a central point, which carries two smaller processes. The arms are 0.4-0.6 mm in length, spinous and curved, while the inner faces of the central processes are densely spinous (Pl.XI, figs.4, 8). The spicules of the male (Pl.XI, fig.4) differ little from those of the female (Pl.XI, fig.8), although in the former they carry fewer spines. These deposits are orientated in the body wall in such a way that the curved arms are directed inwards, and the central processes project above the level of the bodywall. A single spicule of an unusual shape was found in the bodywall of the male specimen (Pl.XI, fig.5).

Genital ducts and caeca carry three- to five-armed deposits in their walls. Those of the female (Pl.XI, fig.10) are slightly more robust than those of the male (Pl.XI, fig.6). The ends of the arms are smooth or weakly spinous. Developmental stages of these deposits are also common (Pl.XI, fig.9).

The madreporite is invested in a complex meshwork of calcareous material (Pl.XI, fig.3), and the meshwork also contains four-armed spicules of the type found in the gonad and genital caeca. The stone canal contains straight rods of average length 0.3 mm with spinous extremities (Pl.XI, fig.7), together with widely scattered four-armed deposits.

Remarks: The systematic position of these specimens is not absolutely clear. As external features cannot be used as a guide in determining the species, identification is rendered difficult. The calcareous deposits of the skin and gonads resemble those described by Sluiter (1901) for Benthodytes hystrix, from a single specimen collected in the Indonesian region at a depth of 2,798 metres. Some differences in spiculation, especially the size of the spicules and certain features of their shape, between the present material and Sluiter's may not be significant, when the unique character of the spicules themselves is considered. Ohshima (1915) notes that B. gotoi has some spicules of exactly the same type as those in B. hystrix, but also has others with an anchor-shaped spire, similar to those in B. anchora Herouard. Theel (1882) illustrates the gonads of male and female of B. abyssicola Theel, and his figures show that the gonads in that species greatly resemble those in B. hystrix. It is apparent that sexual dimorphism of this nature is not uncommon throughout the elasipods. The slight differences between the calcareous deposits of male and female in the present material are not important, but it is of considerable importance to have some indication of the range of variation of these deposits.

Distribution: B. hystrix was previously known only from the Dutch East Indies in depths ranging from 768 to 2,798 metres (Sluiter, 1901b; Heding, 1940).

Family ELPIDIIDAE Theel, 1882

Elpidiinae Ekman, 1925.

Diagnosis: Tentacles ten, rarely eleven to twelve or twenty. Midventral radius naked. Lateral ventral radii each with a single row of pedicels, which may be distributed throughout the radius, or confined to the posterior half or posterior extremity. Dorsally, a smaller number of long or short to rudimentary processes, more common anteriorly, where they may form a branched or unbranched lobe-like appendage. Calcareous deposits most commonly include straight or slightly curved, C-shaped or horseshoe-shaped rods, three-armed spicules; rarely minute net-like plates, rosette-shaped or elliptical bodies. (After Theel, 1882).

This is a large family, containing a dozen nominal genera. Distribution cosmopolitan, more common in the northern hemisphere, with representatives in all depths below about 500 metres.

Two genera within this family are now known to be present in the vicinity of New Zealand. They may be diagnosed as follows:

1 (2) Lateral ventral radii with pedicels distributed along their entire length . . . . Scotoplanes Theel

2 (1) Pedicels of the lateral ventral radii confined to the posterior half of each radius . . . . Amperima (nom.nov. for Periamma Perrier)

Amperima nom. nov.

Periamma Perrier, 1896, p.901, type species P. roseum Perrier. (Preoccupied).

Diagnosis: Body slightly elongate or egg-shaped, at most two and a half times as long as broad; tentacles 10. Dorsal side on its anterior part presenting a transversal row of 3-4 papillae sometimes distinct, sometimes adjoining, sometimes fused into a voluminous transverse four-lobed appendix. Immediately behind these papillae a small number of isolated very small papillae are found on the dorsal ambulacra. Ventral sides each with a lateral row of pedicels which are usually developed behind the middle part of the body. Deposits triradiate body, together with sigmaes. (After Perrier, 1901 in Deichmann, 1931).

Remarks: Neave (Nomenclator Zoologicus, 1940) notes that the generic name Periamma was first used in 1848 (Gistlen, Nat. Thierr, viii) for a beetle. It was unfortunate that Perrier (1896) selected a preoccupied name for his new genus. Deichmann (1931, p.134) uses two spellings for this generic name, _Periamma_ and _Perriamma_, and it was first thought that because of this, the name _Perriamma_, differing by the required single letter from the original name, should automatically become the correct name for this genus. The matter was referred to Professor H.B. Fell of this Department, who has the following comments to make:

"The fact that _Periamma_ and _Perriamma_ are used several times on the same page as alternatives, both names being attributed to R. Perrier, and both referring to the one genus with the one type species (_roseum_ Perrier), shows clearly that Deichmann (through either a typographical error or _lapsus calami_) intended only the one spelling. Both the names _Periamma_ and _Perriamma_ refer to the one genus, and are of the same origin and meaning.

"Article 35, subsection (d) of the _Code_ explicitly states that two specific names of the same origin and meaning shall be considered homonyms if they are distinguished from each other by only a single or double consonant.

"Opinion 147, dated September 30, 1943, explicitly adopts for generic and subgeneric names the same principles as are enumerated in Article 34 of the _Code_, and in particular specifies that the principle of Article 35, subsection (d) shall be applied to parallel cases in genera and subgenera.

"It is therefore evident that _Perriamma_ Deichmann, 1931, p.134 is a junior homonym of *Periamma* Perrier, 1896, which is itself a junior homonym of *Periamma* Gistlen, 1848.

"Under Article 34 of the *Code* a generic name which is a homonym of a name previously used for some other genus is to be rejected.

"Consequently it follows that neither *Periamma* Perrier nor *Perriamma* Deichmann is available for the type species *roseum* Perrier, and a new name is required for the genus of which *roseum* Perrier is the type." H.B.Fell, 14/9/1963.

The new name given here is an anagram of *Periamma*.

This genus is cosmopolitan, containing seven species, of which five are known from the Pacific and Indian Oceans. Most species are found in depths exceeding 3,000 metres (Madsen, 1953), and recently specimens of "*Periamma*" *naresi* were taken from the Sunda Trench in depths of 7,130-7,160 metres. A new species has been taken from north of New Zealand.

Amperima tui n.sp.

Pl.XII, figs.1-3

Material Examined: "Tui" Stn. 098-111, 14 specimens; Stn.098-46, 2 specimens.

Description: The body is elongate, approximately cylindrical, with a well defined high anterior end, which is narrower than the rest of the body (Pl.XII, figs.2, 3). Total length ranges from 42 mm to 70 mm. The mouth is ventral, surrounded by a ring of 10-12 tentacles with poorly defined terminal discs; anus subdorsal. Midventral radius naked. The anterior half of each ventrolateral radius is naked, while the posterior half carries short pedicels in a single row, six larger pedicels (ca. 2 mm diameter) followed by six small and very inconspicuous pedicels. Dorsally, there are four fingerlike processes (Pl.XII, fig.2) arranged in a transverse row approximately 15 mm from the anterior end of the body. Slightly behind and lateral to this row of processes are two small pairs of papillae (Pl.XII, fig.2), which are often difficult to see. These papillae lie in the radii. In the dorsal interradius, immediately behind the row of large processes, is a single small unpaired papilla (Pl.XII, fig.2).

The bodywall is thick and firm, colour in alcohol light yellow to light greyish-brown. The ventrolateral pedicels are sometimes darker than the rest of the body.

The calcareous ring is a fragile network. A single polian vesicle is long, tubular (Pl.XII, fig.1) and semi-transparent. The intestine is broad, describing a large loop in the posterior half of the body. This loop is supported by mesenteries which are reduced to strong narrow bands attached in the lateral interradii. The rectum is supported by numerous muscle fibres, which attach in the left lateral interradius and the right ventral interradius.

The gonad comprises a single elongate, flattened tube, which broadens in the distal half of its length (Pl.XII, fig.1), and subtends isolated tufts of short, branching genital caeca. The genital duct opens to the exterior immediately anterior to the large dorsal processes. A short stone canal also opens to the exterior adjacent to the genital duct.

Radial muscles are well developed as broad straps, light orange in colour. Transverse muscles are feebly developed.

No calcareous deposits were found anywhere in the body.

Remarks: This species closely resembles Amperima robustum (Theel) in the character of its dorsal papillae, but in A. robustum there is generally only a single pair of smaller papillae posterior to the large processes. However, such small structures may easily be overlooked in poorly preserved material. The complete lack of calcareous deposits in the in the bodywall is a feature which immediately separates A. tui from the other species in the genus, and because of this lack of deposits and the arrangement of the dorsal appendages the New Zealand material has been assigned to a new species.

Species completely lacking calcareous deposits are not common in the Elasipodida (apart from the Pelagothuriidae, whose members characteristically lack deposits), and thus the question arises as to whether the present specimens have lost their deposits as a result of the method of their preservation. This is very doubtful, as other holothurians taken during the "Tui" cruise (Scotoplanes gilpinbrowni, Benthogone rosea) still retain their calcareous deposits in excellent condition. Moreover, past experience has shown that in material which has lost deposits due to preservation, for example, in acid formalin, traces of the deposits can generally still be detected.

Scotoplanes Theel, 1882

Syn. Ellipinion Herouard, 1923.

Diagnosis: Elpidiids with body elongate to ovate. Tentacles ten. Dorsal surface of the body with a small number of processes, which may be restricted to the anterior end of the body, or present anteriorly and posteriorly. Ventrolateral pedicels present in small numbers throughout the radii. Midventral radius naked. Deposits include C-shaped spicules, unbranched rods, and three-armed spicules, of which the last two types may be spinous.

Type Species: Scotoplanes globosa Theel.

Scotoplanes contains seven species, and ranges the Atlantic and Pacific oceans, to depths of approximately 10,000 metres (in the case of S. galatheae Hansen).

Herouard (1923) erected the genus Ellipinion (type species Scotoplanes delagei Herouard) to accommodate those

PLATE XII

<u>Amperima</u> <u>tui</u> n.sp., <u>Scotoplanes</u> <u>gilpinbrowni</u> n.sp.

<u>Amperima</u> <u>tui</u> n.sp.

Fig.1. Internal anatomy.

Fig.2. Entire animal, viewed from dorsal side.

Fig.3. Entire animal, viewed from left lateral side.

<u>Scotoplanes</u> <u>gilpinbrowni</u> n.sp.

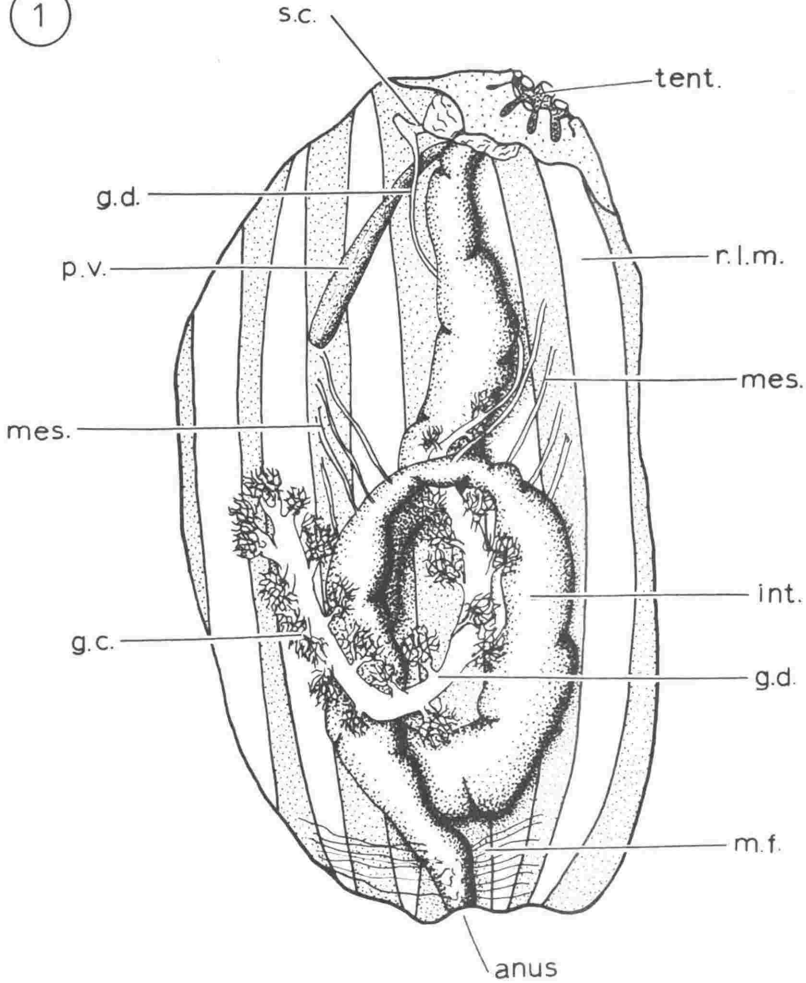
Fig.4. Rods from the dorsal bodywall.

Fig.5. Rods from the ventrolateral pedicels.

Fig.6. Rods from the ventral bodywall.

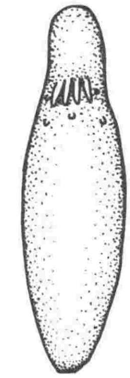
Abbreviations: g.c., genital caeca; g.d., genital duct; int., intestine; mes., mesentery; m.f., muscle fibres; p.v., polian vesicle; r.l.m., radial longitudinal muscle; s.c., stone canal; tent, tentacle.

1

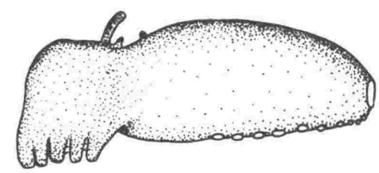


10 mm.

2

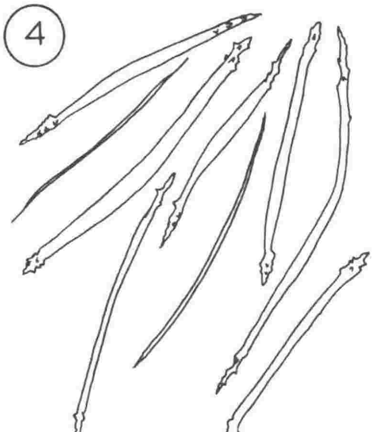


3

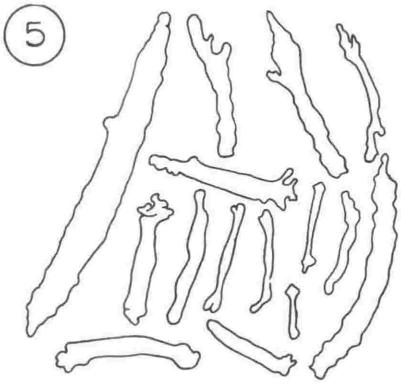


40 mm.
figs. 2,3.

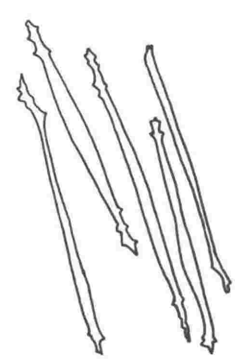
4



5



6



0·3 mm.
figs. 4,5,6.

species of _Scotoplanes_ which have the dorsal processes restricted to the anterior end of the body. Thus _Scotoplanes sensu stricto_ contained only species which have both anterior and posterior dorsal processes. However, this genus, based as it was on easily damaged external features, was discarded by Hansen (1956), who notes that the spicules in the two genera are "so similar that species belonging to each of the genera may have indistinguishable spicules". In the same paper Hansen (1956) diagnoses a new elasipod species _Scotoplanes galatheae_, and that species would fall into the genus _Ellipinion_ on the basis of its external features, for although the anterior end of the dorsal side of the body in the single specimen was damaged, and the character of the anterior processes could not with certainty be determined, the fact that posterior processes were lacking immediately gives cause for including the species in _Ellipinion_.

Elasipods are generally fragile animals, and only the more robust types reach the surface of the sea in a net or dredge without being extensively damaged. For this reason, taxa based on the readily accessible and reliable calcareous deposits are desirable. Unfortunately, throughout the group, and within families, the deposits may be fairly uniform in nature, and then externals must be used for diagnosis. With regard to the present case, the deposits of _Ellipinion_ and _Scotoplanes_ are indistinguishable, and therefore the two genera should be synonymised.

<u>Scotoplanes</u> <u>gilpinbrowni</u> n.sp.

Pl.XII, figs.4-6

Material Examined: "Tui" Stn. 003-02, 1 specimen.

Description: The single specimen is damaged anteriorly, so that the tentacles are completely lacking. Total length 47 mm, width at the widest part, 16 mm. The body is rounded posteriorly. Midventral radius naked, ventrolateral radii each with 11 short pedicels, which are regularly spaced anteriorly, slightly more crowded posteriorly. Dorsal surface of the body apparently naked. The skin is thin, but firm and leathery. Colour in life "greyish with irregular orange markings", in alcohol grey overall, pedicels light yellow.

The intestine is large, describing a large loop. Gonad comprises a bunch of small light yellow branching caeca.

Calcareous deposits consist exclusively of spinous rods. In the dorsal bodywall the rods are long and narrow, sometimes slightly curved and very occasionally C-shaped, and have spinous extremities (Pl.XII, fig.4). Average length of these rods is 0.38 mm. They are present in great numbers, with no regularity of arrangement. Ventrally, the deposits are somewhat similar (Pl.XII, fig.6), but they are even more numerous, and tend to lie transverse to the longitudinal axis of the body. The ventral rods are of the same order of size as the dorsal rods, although some individual rods are considerably longer.

The tentacles are lacking, so their deposits remain unknown.

Ventrolateral pedicels carry at their distal extremities a large number of knobbed to spinous rods of variable shape and size (Pl.XII, fig.5). The length of these rods varies from 0.07 mm to 0.5 mm.

Remarks: The character of the calcareous deposits in this specimen is unique. The simple rods, straight or curved, with weakly spinous extremities, although found in many elasipod genera, are usually present in association with deposits of other types. After a thorough search of the bodywall in the present specimen, no other deposit types were found.

Three genera in the Family Elpidiidae have deposits in the form of simple rods. Some species of <u>Scotoplanes</u> Theel have simple rods, but these are usually associated with C-shaped deposits or triradiate spicules. <u>Kolga</u> Danielssen and Koren and <u>Irpa</u> Danielssen and Koren have rods usually associated with minute horseshoe-shaped spicules. On the basis of the calcareous deposits alone, the present specimen cannot be placed in any of these three genera.

It is most unfortunate that the anterior end of the body is missing from the specimen, as this region is of prime taxonomic importance. Because of this lack of certain important anatomical details, it is considered unwise to erect a new genus to accommodate this specimen, although the deposits seem to warrant such a course. There is very little doubt that the specimen should be placed in a new species.

The generic placement of the specimen is therefore rendered extremely difficult. The number and disposition of the lateral pedicels, and the leathery character of the bodywall, recall certain species of the genus *Scotoplanes* Theel. Therefore, until more and better material becomes available, it seems the best course to place this species into genus *Scotoplanes*, noting that the species may eventually be transferred to another genus, or, as is more probable, be given the status of a new genus.

COMPOSITION OF THE BATHYAL FAUNA

Bathyal holothurians now known from the New Zealand region comprise 20 genera and 23 species. Elasipodida (nine genera, nine species) and Molpadida (four genera and seven, perhaps eight species) are particularly well represented, while the number of synallactid aspidochirotes (two genera and two species) is surprisingly small. Of the four dendrochirote species recorded, two, _Pentadactyla longidentis_ and _Heterothyone alba_ may not be permanent residents in the bathyal zone, while _Echinocucumis hispida_ and _Ypsilothuria bitentaculata_ represent the peculiar deep water family, the Ypsilothuriidae.

Dell (1956) has demonstrated that for the New Zealand Mollusca there is always some interrelationship between typically shelf and typically archibenthal (bathyal) species, and the same writer notes that the interrelationship becomes particularly marked where the change from shelf to bathyal conditions takes place suddenly, where the continental shelf is steep. Three shelf holothurian species have been taken from the bathyal zone in Cook Strait (Pawson, 1963). But apart from the presence in the fauna of such strays, the bathyal fauna as it is known at present bears no close relationship to that of the shelf, although two molpadid species _Paracaudina chilensis_ (bathymetric range 0-990 metres) and _Heteromolpadia marenzelleri_ (bathymetric range 25-1,260 metres) are common both on the shelf and in bathyal depths.

Further sampling of the deep bathyal and abyssal zones is needed before the vertical distribution of the New Zealand holothurians can be properly studied.

RELATIONSHIPS OF THE BATHYAL FAUNA

The bathyal holothurian fauna of the New Zealand region comprises an assemblage of genera and species which are in general widely distributed in the Pacific Ocean, or are cosmopolitan. Most of the genera are shared with the Indo-west-Pacific, and the influence of the Indo-west-Pacific region is also evident at the specific level. This is also true for the shelf echinoderm genera.

The presence of northern Atlantic species in the New Zealand fauna is remarkable. Such forms as Benthogone rosea and Echinocucumis hispida are probably rather more widespread species than has formerly been supposed, and a statement that these species are bipolar in their distribution is probably erroneous.

It is indeed unfortunate that very little is known of the bathyal fauna of Australia. This applies not only to the Echinodermata, but to most marine animal groups. Undoubtedly, the deep-sea fauna of Australia contains much of great interest, but up to the present time, little sampling has been carried out in that area. Knowledge of the echinoderms of the New Zealand region and of the East Indies has increased greatly in recent years, and a situation has been reached in which the content of the deepwater Australian fauna must be deduced on the basis of the known faunas of nearby areas. Thus, it is probable that a genus such as Bathyplotes occurs in the Australian region, and it is felt that we can safely infer that most deepsea New Zealand genera occur also in Australian waters.

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THE ECHINOZOA OF THE ISLANDS TO THE EAST AND SOUTH OF NEW ZEALAND

by D.L. Pawson

ABSTRACT

The collection includes 15 genera and 16 species. Two species are regarded as new. New records for the New Zealand region are the echinoid genera Brissaster and Austrocidaris. The southern islands of New Zealand have an echinozoan fauna which comprises 14 genera and 16 species. The fauna shows a strong affinity with that of New Zealand. Six species are now known from Macquarie Island, and distinct relationships between the fauna of that island and that of New Zealand are evident. While the west-wind-drift has apparently contributed no external elements at the specific level to the present-day fauna of the southern islands, it has apparently functioned as an effective agent in establishing continuity in the faunas of the individual islands. The Chatham Rise echinozoan fauna has a cosmopolitan to Indo-west-Pacific facies. The fauna of the Chatham Islands is strongly related to that of Cook Strait, New Zealand, but is markedly dissimilar to that of the southern islands of New Zealand.

INTRODUCTION

The isolated groups of islands to the south and south-east of New Zealand, namely the Auckland, Campbell, Bounty and Antipodes Islands, have been visited by several scientific expeditions over the past sixty years. As a result of publications by Farquhar (1898), Benham (1909), Mortensen (1921, 1924, 1925) and Fell (1953), the echinoderm faunas of these islands were regarded as being quite well known. Eight of the 26 echinoderm species known from the islands up to the present time are echinozoans. These are listed here:

Pseudechinus novaezealandiae (Mortensen)
Apatopygus recens (Milne-Edwards)
Ocnus brevidentis (Hutton)
Stereoderma leoninoides (Mortensen)
Trachythyone amokurae (Mortensen)
Chiridota nigra (Mortensen)
Chiridota carnleyensis (Mortensen)
Trochodota dunedinensis (Parker)

The echinozoan fauna of Macquarie Island has not been particularly well studied. Mortensen (1925) listed three echinozoans from the island, namely *Pseudechinus novaezealandiae*, *Ocnus calcareus* and *Pseudopsolus macquariensis*. Recently the writer has described a new species *Trachythyone macphersonae* Pawson from the intertidal zone at Macquarie Island (Pawson, 1962).

In recent years the New Zealand Oceanographic Institute have carried out an extensive series of benthic sampling operations in the vicinity of the southern islands of New Zealand, and Macquarie Island. The large collections of echinozoans recovered have been examined by the writer, and they have proved to be of major importance, greatly adding to our knowledge of the echinozoan fauna of the area.

MATERIAL EXAMINED

The collection includes 454 specimens and fragments, collected from a total of 51 stations. Where possible, details of associated benthic animals and the type of bottom are given.

Abbreviations: f., fathoms; m., metres; Mrtsn., Mortensen; spec., specimens.

Bounty Islands Stations
(Stations A701-A717, A746-A753)

A701 47°41'S., 179°23'E., 3/11/1962, 85 f. (153 m.), *Chlamys*, brachiopods, polychaete tubes.

Pseudechinus novaezealandiae (Mrtsn.)	6 spec.
Apatopygus recens (Milne-Edwards)	fragments
Spatangus thor Fell	fragments
Stolus squamatus n.sp.	1 spec. + fragments

A702 47°41'S., 179°31'E., 3/11/1962, 90 f. (162 m.), pebbles, *Chlamys*, brachiopods.

Pseudechinus novaezealandiae (Mrtsn.)	1 spec.
Brisaster edentatus n.sp.	fragments

A703 47°42'S., 179°39'E., 3/11/1962, 100 f. (180 m.), broken shell, pebbles.

Brisaster edentatus n.sp.	fragments

A704 47°42'S., 179°27'E., 4/11/1962, 82 f. (148 m.), pebbles, shell, polychaetes.

Pseudechinus novaezealandiae (Mrtsn.)	1 spec. + fragments

A705 47°41.6'E., 179°5.1'E., 4/11/1962, 24 f. (43 m.), rocks, encrusted by sponges and hydroids.

Pseudechinus novaezealandiae (Mrtsn.) 2 spec.

A706 47°42°.7'S., 178 43'E., 4/11/1962, 170 f. (306 m.), rocks, dead shell.

Pseudechinus novaezealandiae (Mrtsn.) 8 spec. + fragments

Spatangus thor Fell fragments

Paramaretia peloria Clark fragments

A710 47°32'S., 178°42'E., 5/11/1962, 456 f. (821 m.).

Brisaster edentatus n.sp. fragments

A712 47°47'S., 178°42'E., 5/11/1962, 180 f. (324 m.).

Brisaster edentatus n.sp. fragments

Spatangus thor Fell fragments

A713 47°45'S., 178°52.5'E., 5/11/1962, 110 f. (198 m.).

Pseudechinus novaezealandiae (Mrtsn.) 2 specimens

A714 47°43.5S., 179°04'E., 5/11/1962, 90 f. (162 m.), white shelly sand and pebbles.

Pseudechinus novaezealandiae (Mrtsn.) fragments

Apatopygus recens (Milne-Edwards) fragments

Brisaster edentatus n.sp. fragments

Stolus squamatus n.sp. 1 specimen + fragments

A715 47°41'S., 179°03'E., 5/11/1962, 64 f. (115 m.), cobbles, pebbles, shell, brachiopods and bryozoans.

Stolus squamatus n.sp. fragments

A716 47°49'S., 179°04'E., 5/11/1962, 86 f. (155 m.), fine shell sand with large molluscs and starfish.

Apatopygus recens (Milne-Edwards) fragments

A717 47°55'S., 179°04'E., 5/11/1962, 112 f. (202 m.), fine white sand with *Chlamys*.

Pseudechinus novaezealandiae (Mrtsn.) 167 spec. + fragments

A746 47°30'S., 179°30'E., 15/11/1962, 85 f. (153 m.), *Chlamys*, sponges, bryozoans.

Pseudechinus novaezealandiae (Mrtsn.) 18 spec. + fragments

A747 47°40.9'S., 179°03.1E., 16/11/1962, 60 f. (108 m.)

Pseudechinus novaezealandiae (Mrtsn.) fragments

Apatopygus recens (Milne-Edwards) fragments

Brisaster edentatus n.sp. fragment

A748 47°41.2'S., 179°03.5'E., 16/11/1962, 32 f. (57 m.).

Pseudechinus novaezealandiae (Mrtsn.) 13 spec.

Apatopygus recens (Milne-Edwards) 1 spec.

A749 47°42.3'S., 179°04'E., 16/11/1962, 32 f. (57 m.).

Apatopygus recens (Milne-Edwards) 4 spec. + fragments

A751 47°44.6'S., 179°07.4'E., 16/11/1962, 86-76 f. (155-139 m.), grey coarse biotite granite.

Pseudechinus novaezealandiae (Mrtsn.) 27 spec.

A753 47°55'S., 179°35'E., 17/11/1962, 100 f. (180 m.), fine pale sand

Brisaster edentatus n.sp. fragments

Antipodes Islands Stations

(Stations A722 - A745)

A722 49°48.25'S., 178°51'E., 7/11/1962, 24 f. (43 m.), dark "volcanic" sand and gravel, worms and small molluscs.

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mrtsn.) fragment

<u>Spatangus</u> <u>thor</u> Fell fragment

A723 49°43'S., 178°50.3'E., 7/11/1962, 65 f. (117 m.), brachiopods.

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mrtsn.) 9 spec. + fragments

A724 49°43'S., 178°50'E., 7/11/1962, 110 f.(198 m.), coarse bryozoan sand and brachiopods.

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mrtsn.) 2 spec. + fragments

A727 49°38.7'S., 178°52'E., 7/11/1962, 80 f. (144 m.), bryozoans, hydroids, gastropods.

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mrtsn.) 1 spec.

A728 49°38.4'S., 178°48.7'E., 7/11/1962, 50 f. (94 m.), black pebbly "volcanic" sand with shell fragments.

<u>Pseudechinus</u> <u>novaezealandiae</u> 1 spec. + fragment

A729 49°38.2'S., 178°47.3'E., 7/11/1962, 40 f. (72 m.), bryozoans, sponges.

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mrtsn.) 1 spec.

<u>Ocnus</u> <u>brevidentis</u> (Hutton) 1 spec.

A730 49°40.3'S., 178°53.3'E., 7/11/1962, 170 f. (306 m.),

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mrtsn.) 2 spec.

A734 49°42'S., 178°44.3'E., 8/11/1962, 80 f. (144 m.), rock and shelly shingle and gravel.

Pseudechinus novaezealandiae (Mrtsn.) 3 spec. + fragments

A738 49°40.1'S., 178°47.3'E., 9/11/1962, 32 f. (58 m.), bryozoa, red algae, molluscs.

Pseudechinus novaezealandiae (Mrtsn.) 3 spec. + fragments

Ocnus brevidentis (Hutton) 5 specimens

A739 49°40.2'S., 178°44.3'E., 9/11/1962, 60 f. (108 m.), coarse white shell sand with molluscs.

Pseudechinus novaezealandiae (Mrtsn.) 2 spec. + fragments

A740 49°41'S., 178°40.2'E., 9/11/1962, 172 f. (310 m.), rocks, Chlamys, corals, ophiuroids, brachiopods.

Pseudechinus novaezealandiae (Mrtsn.) fragments

Austrocidaris sp. 2 primary radioles

A741 49°41.5'S., 178°51.5'E., 9/11/1962, 70 f. (126 m.), shelly sand, pebbles.

Pseudechinus novaezealandiae (Mrtsn.) 3 spec. + fragments

A743 49°39.8'S., 178°50.2'E., 9/11/1962, 20 f. (36 m.), hard calcareous bottom with Macrocystis holdfasts, green algae.

Ocnus brevidentis (Hutton) 1 spec.

A745 49°36.7'S., 178°50.5'E., 9/11/1962, 220 f. (396 m.), coarse shell sand with small volcanic pebbles.

Austrocidaris sp. fragments of te[st] and radiole

Auckland Islands Stations

(Stations B175-B184, D47-D55)

B175 50°15.8'S., 166°41'E., 9/10/1959, 53 f. (95 m.), yellow mud, shell fragments, corals.

<u>Chiridota carnleyensis</u> Mrtsn. 21 spec.

B183 Auckland Islands, 11/10/1959, 112 f. (202 m.), very rocky bottom.

<u>Chiridota carnleyensis</u> Mrtsn. 9 spec.

B184 Auckland Islands, 11/10/1959, 104 f. (188 m.), rocky bottom, sponges, brachiopods.

<u>Chiridota carnleyensis</u> Mrtsn. 1 spec.

D47 50°52.2'S., 166°13.3'E., 8/5/1963, 35 f. (63 m.), mass of large broken shell fragments.

<u>Apatopygus recens</u> (Milne-Edwards) 2 spec.

D52 50°40.09'S., 166°13.4'E., 9/5/1963, 35 f. (63 m.), muddy medium fine sand with shell fragments.

<u>Pseudechinus novaezealandiae</u> (Mrtsn.) 2 radioles

D55 50°38.7'S., 166°03.8'E., 9/5/1963, 25 f. (45 m.), shell.

<u>Chiridota carnleyensis</u> Mrtsn. 1 spec.

D74 50°55.65'S., 165°54.8'E., 12/5/1963, 90 f. (162 m.), molluscs, starfish, brachiopods.

<u>Stolus squamatus</u> n.sp. fragment

D83 49°53'S., 167°09'E., 13/5/1963, 80 f. (144 m.), masses of sponge, crabs.

<u>Apatopygus recens</u> fragments

Campbell Island Station

D35 52° 56.4'S., 169° 33'E., 5/5/1963, 100 f. (180 m.), shell sand with brachiopods and *Chlamys*.

Pseudechinus novaezealandiae (Mrtsn.) 64 spec.

Trochodota dunedinensis (Parker) 1 spec.

Macquarie Island Stations

(Stations B339, D6-D10)

B339 Wireless Bay, Macquarie Island, 15/12/1960, 150 f. (270 m.)

Psolus antarcticus (Philippi) 2 spec.

D6 55° 29'S., 158° 31.5'E., 20/4/1963, 225 f. (405 m.), dense volcanic rocks, little fine sediment.

Psolus antarcticus (Philippi) 13 spec. + fragments

D7 55° 11.4'S., 158° 43'E., 20/4/1963, 130 f. (234 m.), rocks.

Psolus antarcticus (Philippi) 7 spec.

D8 54° 52'S., 158° 39'E., 20/4/1963, 75 f. (135 m.).

Psolus antarcticus (Philippi) 5 spec.

D9 54° 53'S., 158°.5 E., 20/4/1963, 60 f. (108 m.)

Pseudechinus novaezealandiae (Mrtsn.) 1 spec.

Psolus antarcticus (Philippi) 2 spec.

D10 54° 40'S., 159° 01'E., 21/4/1963, 37 f. (67 m.)

Trochodota dunedinensis (Parker) 6 spec.

Stations NNE of Macquarie Island

(Stations D17-D20)

D17 52° 33'S., 160° 32'E., 23/4/1963, 66 f. (119 m.).

Goniocidaris umbraculum Hutton 5 spec.

D18 $52^{\circ}31$'S., $160^{\circ}31.8$'E., 23/4/1963, 68 f. (112 m.).

Goniocidaris umbraculum Hutton 18 spec.

Stereoderma leoninoides (Mrtsn.) 1 spec.

D20 $49^{\circ}39.8$'S., $164^{\circ}2.2$'E., 24/4/1963, 70-65 f. (126-117 m.), large rounded boulders with bryozoan shell sand.

Trochodota dendyi Mortensen fragment

Chatham Rise Stations

(Stations A759, A760, D1)

A759 $43^{\circ}16$'S., $176^{\circ}11$'E., 21/11/1962, 192 f. (346 m.), fine glauconitic sand.

Pentadactyla longidentis (Hutton) 22 spec.

Bathyplotes natans (Sars) fragments

A760 $43^{\circ}11$'S., $176^{\circ}09$'E., 21/11/1962, 202 f. (364 m.)

Pentadactyla longidentis (Hutton) 2 spec.

D1 $44^{\circ}18$'S., $176^{\circ}40$'E., 12/4/1963, 50 f. (90 m.).

Pseudechinus novaezealandiae (Mrtsn.) 7 spec.

Spatangus thor Fell fragments

Class HOLOTHUROIDEA

Order DENDROCHIROTIDA

All three families in this Order are represented in the New Zealand region. To the south of New Zealand, two families are found, while the third, Family Phyllophoridae, is recorded here from the Chatham Rise.

Family Psolidae Perrier, 1902

Psolus Oken, 1815

Diagnosis: Tentacles ten. Dorsal surface of body lacking tubefeet, invested in scales. Mouth and anus dorsal.

Type species: Holothuria phantapus (Strussenfeldt).

Only one species of this genus has been recorded from New Zealand, and that is P. neozelanicus Mortensen, an apparently rare species known only from off North Cape, at a depth of 55 fathoms. Several psolids were dredged by the New Zealand Oceanographic Institute from near Macquarie Island. They prove to be representatives of Psolus antarcticus (Philippi).

Psolus antarcticus (Philippi)

(Plate XIII, figs.1-4)

Holothuria antarctica Philippi, 1857, p.133.

Psolus antarcticus Ludwig, 1898, p.53, Pl.3, figs.34-36 (complete list of references); Ekman, 1923, p.42, figs.31-33; 1925, p.139, text-fig.34; Deichmann, 1947, p.339.

Material Examined: Str. B339, 2 specimens; D6, 13 specimens and fragments; D7, 7 specimens; D8, 5 specimens; D9, 2 specimens.

Diagnosis: Like Psolus squamatus, but with five large oral and five small anal (interradial) valves, and lacking radial valves. Dorsally, delicate plates in the skin outside the reticulate scales. In the sole four-holed buttons with large holes and marginal knobs. Tentacles with large perforated plates. Size up to 55 mm. (After Deichmann, 1947).

Remarks: Colour in alcohol light brownish-yellow, sole slightly darker. The largest specimen is 35 mm in total length, and has a greatest breadth of 28 mm. Dorsally the body is invested in large imbricating scales (Pl.XIII, fig.1), while the margin of the dorsal side carries two to three rows of smaller scales. The introvert is retracted, guarded by five triangular oral valves (Pl.XIII, fig.1). The anus is placed near the small marginal plates at the posterior end of the body, and is also covered by five valves (Pl.XIII, fig.1).

The thin ventral sole is bordered by two rows of tubefeet, the tubefeet of the inner row being considerably larger than those of the outer row (Pl.XIII, fig.2); these feet are carried on the ventrolateral radii, and the midventral radius is naked, except at its anterior and posterior ends, where it carries about five tubefeet.

Calcareous deposits of the sole are knobbed buttons

(Pl.XIII, fig.3) of average length 0.1 mm. Each button when fully developed usually has four larger perforations, and occasionally some smaller holes near the margin. Stages in the development of the buttons are common (Pl.XIII, fig.4), and the method of formation of the buttons by dichotomous branching of a simple rod can be seen. The small marginal and central knobs apparently develop after the four large perforations are formed. The deposits are closely aggregated in the sole, and when the sole is viewed under low magnification they appear as minute shining grains.

The specimens are typical of the species, and cannot be distinguished from the magellanic form. Compared with other common southern _Psolus_ species, _P. antarcticus_ is distinctive in possessing only five oral valves. _P. squamatus_ (Muller) and _P. patagonicus_ Ekman both have radial valves lying below and between the interradial oral valves, and thus at least ten plates cover the introvert aperture. _P. neozelanicus_ Mortensen, a rare species, has sole deposits which differ from those in _P. antarcticus_, having more perforations and lacking marginal knobs (Mortensen, 1925). _P. spinuliferus_ Clark has smaller and more numerous dorsal plates than _P. antarcticus_.

Species of _Psolus_ now known from Australasia and Macquarie Island may therefore be keyed as follows:

1 (4) Midventral radius with tubefeet throughout.

2 (3) Sole deposits baskets and plates, usually with four perforations, two larger and two smaller . . . . *P. minutus* Clark

3 (2) Sole deposits merely plates with four equivalent large perforations . . . *P. spinuliferus* Clark

4 (1) Midventral radius naked, or with only a small number of tubefeet at the anterior and posterior ends.

5 (8) Only five interradial valves cover the introvert.

6 (7) Anus surrounded by 3-4 circles of small scales. Sole deposits with numerous (up to 15) perforations . . . . *P. neozelanicus* Mortensen

7 (6) Anus not surrounded by small scales. Sole deposits with few (up to 10 perforations . . . . *P. antarcticus* (Philippi)

8 (5) More than five (usually 10) valves cover the introvert.

9 (10) Oral and anal valves regular in shape. Up to 20 mm total length . . . *P. patagonicus* Ekman

10 (9) Oral and anal valves not regular in shape. Up to 80 mm total length . . . *P. squamatus* (Muller)

It has already been noted (Deichmann, 1947) that some smaller *Psolus* specimens from the Magellanic region which have previously been referred to *P. squamatus*, may possibly belong to *P. patagonicus*. As a juvenile, *P. squamatus* bears a strong resemblance to *P. patagonicus*.

Psolus antarcticus is well known from the Magellanic region of South America, where it is commonly found offshore. Vaney (1906) and Ekman (1925) record the species from off Graham Land, Antarctica. Its occurrence at Wireless Bay, Macquarie Island is quite surprising, and serves to indicate that this species is possibly circumpolar in its distribution. Its known depth range is from 35 metres to 1080 metres, and it is here suggested in the light of this additional knowledge of its geographic range that _P. antarcticus_ may tolerate depths even in excess of 1080 metres.

Family Cucumariidae Ludwig, 1894

Previously, two cucumariid genera, namely _Ocnus_ Forbes and _Stereoderma_ Ayres, have been recorded from south of New Zealand, by Mortensen (1925). Both of these genera are represented in the present collection, and a new species of the genus _Stolus_ Selenka is described here.

The three genera may be distinguished as follows:

1 (2) Calcareous ring slender, long, with long processes, composed of a mosaic of minute pieces . . . . _Stolus_

2 (1) Calcareous ring simple, short, without processes.

3 (4) Deposits plates and cups . . . . _Ocnus_

4 (3) Deposits plates only . . . . _Stereoderma_

Ocnus Forbes, 1841

Diagnosis: Calcareous ring simple without divided processes. Calcareous deposits include cups and knobbed plates of two types.

Type species: Ocnus brunneus Forbes.

Three species of this genus as emended by Panning (1948) are known from New Zealand waters. One, Ocnus farquhari (Mortensen) is so far known only from off North Cape. O. calcareus (Dendy) ranges the entire coast of New Zealand, and has also been described from Juan Fernandez (Ludwig, 1898). The third species, O. brevidentis (Hutton) also ranges the New Zealand coast, and Mortensen (1925) recorded this species from both the Auckland and Chatham Islands.

Ocnus brevidentis (Hutton)

Thyone brevidentis Hutton, 1872, p.16.

Pentadactyla brevidentis Hutton, 1878, p.307.

Colochirus brevidentis Dendy, 1896, p.40, Pl.5, figs.54-61; Farquhar, 1898, p.325.

Cucumaria brevidentis Perrier, 1905, p.110; Dendy & Hindle, 1907, p.99; Mortensen, 1925, p.31, fig.26 a-b; Dawbin, 1950, p.38, Pl.2, fig.10.

Ocnus brevidentis Panning, 1949, p.437, abb.32.

Non: Colochirus calcareus Dendy, 1896; nec Colochirus brevidentis Ludwig, 1898, p.442, Taf.26, figs.22-29 (= Ocnus calcareus (Dendy)).

PLATE XIII

Psolus antarcticus (Philippi), Stolus squamatus n.sp.

Psolus antarcticus (Philippi)

Fig.1. Dorsal aspect of entire animal.

Fig.2. Ventral aspect.

Fig.3. Knobbed buttons from the sole.

Fig.4. Developing sole deposits.

Stolus squamatus n.sp.

Fig.5. Scales from the bodywall (outline only).

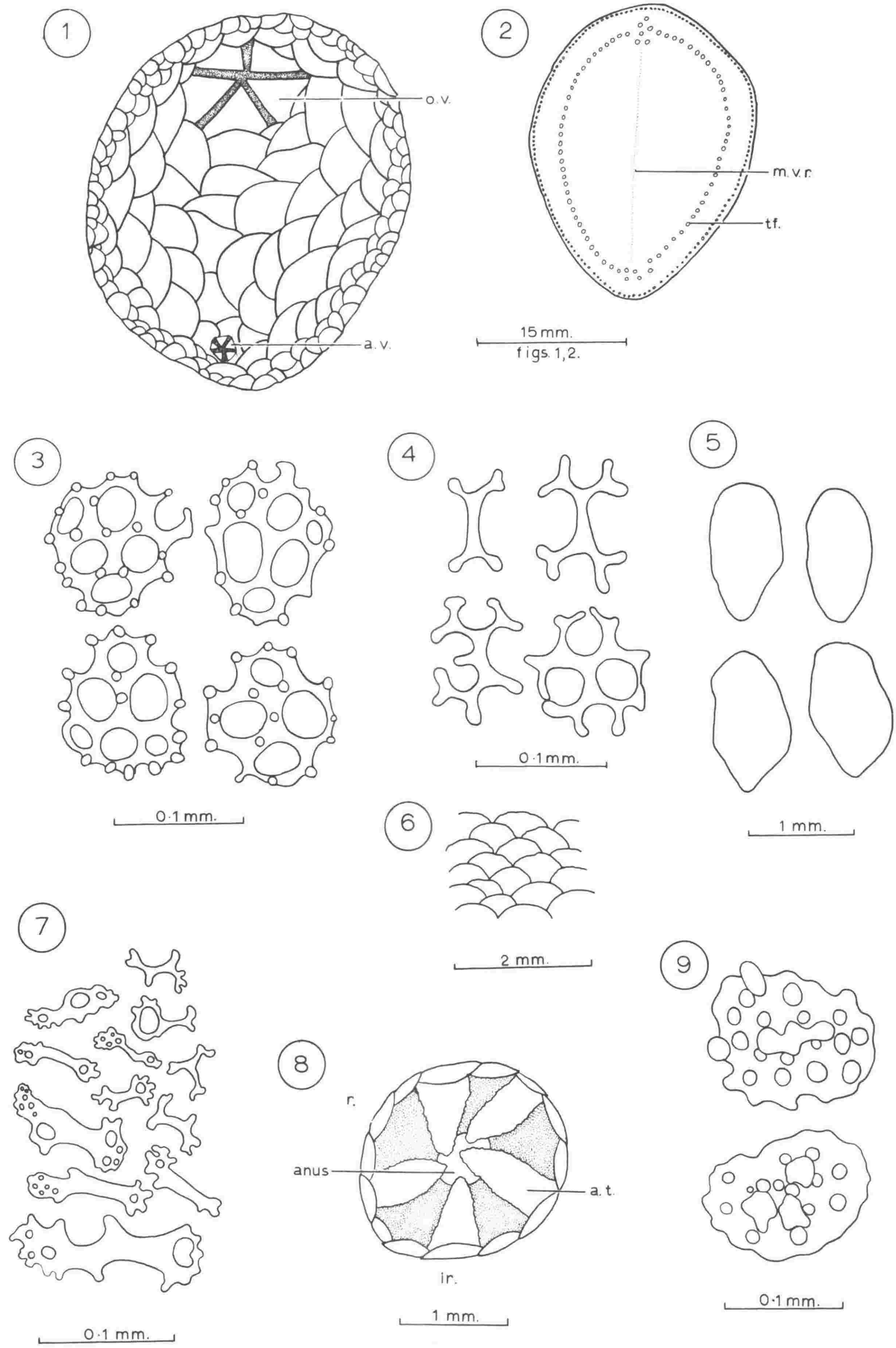
Fig.6. Portion of bodywall showing overlapping scales.

Fig.7. Tentacle deposits.

Fig.8. Posterior end of body showing anal teeth.

Fig.9. Buttons from the bodywall.

Abbreviations: a.t., anal tooth; a.v., anal valve; m.v.r., mid-ventral radius; o.v., oral valve; r., radius; tf., tubefoot.


1
o.v.
a.v.
2
m.v.r.
t.f.
15 mm.
figs. 1,2.
3
0·1 mm.
4
0·1 mm.
5
1 mm.
6
2 mm.
7
0·1 mm.
8
r.
anus
a.t.
ir.
1 mm.
9
0·1 mm.

Material Examined: Stn. A729, 1 specimen; Stn. A738, 5 specimens; Stn. A743, 1 specimen.

Remarks: All the present specimens of this well described species are completely contracted. Colour in alcohol grey to light brown. One specimen is almost black dorsally at the anterior end of the body. The calcareous deposits are exactly similar to those figured by Dendy (1896) and Mortensen (1925).

Mortensen (1925) has pointed out the differences between this species and Ocnus calcareus (Dendy). The knobbed buttons in O. brevidentis usually have 10 marginal knobs, while those in O. calcareus have 12. This difference appears to be quite constant.

O. brevidentis is known from Great Barrier Island, Stewart Island and the Chatham Islands (Dendy & Hindle, 1907), Cape Maria van Diemen, Slipper Island, Auckland Islands. The present locality (Antipodes Islands) is a new record for the species, but its occurrence on such southern islands is not unexpected, and further investigations should prove that O. brevidentis is also represented at the Bounty and Campbell Islands.

Stereoderma Ayres, 1851

Diagnosis: Calcareous ring simple, without processes. Deposits knobbed plates, all of the same shape and arranged in one layer; no tables, rosettes or cups. (Panning, 1949).

Type Species: Stereoderma unisemita Stimpson.

The southern species of this genus are discussed elsewhere (p. 20).

Stereoderma leoninoides (Mortensen)

Cucumaria leonina var. Dendy, 1909, p.146, Pl.VI, fig.1A-c.
Cucumaria leoninoides Mortensen, 1925, p.338, fig.27 a-b;
Dawbin, 1950, p.38.
Stereoderma leoninoides Panning, 1949, p.422.

Material Examined: Stn. D18, 1 specimen.

Remarks: The specimen is well expanded, total length 12 mm. Colour in alcohol grey, tentacles light yellow. Both Dendy (1909) and Mortensen (1925) have given full descriptions of this species, and the present specimen conforms well with these descriptions. The characteristic knobbed perforated plates with one end denticulate completely fill the bodywall, and no other deposits are found in association with them.

This species seems to be most closely related to another southern species, S. laevigata (Verrill), but S. laevigata is a brood-protecting species, while S. leoninoides is not (Mortensen, 1925).

Dendy described material from Carnley Harbour, Auckland Islands. Mortensen (1925) examined specimens from Carnley Harbour and Campbell Island. The present locality (approximately 150 miles NNE of Macquarie Island) somewhat extends the known distribution. Further, Professor G.A. Knox obtained four specimens from the Snares Islands. Thus, S. leoninoides ranges intertidally the Auckland, Campbell and Snares Islands, also occurring in 68 fathoms (122 metres) north of Macquarie Island.

Stolus Selenka, 1867

Diagnosis: Calcareous ring with long posterior processes, composed of a mosaic of small pieces. Deposits plates only.

Type Species: Stolus sacellus Selenka

The present collection includes a new species, closely related to S. huttoni (Dendy).

Stolus squamatus n.sp.

Pl. XIII, figs.5-9

Diagnosis: Like S. huttoni (Dendy) but lacking the numerous perforated buttons in the bodywall. Anal teeth present.

Material Examined: Stn. A701, 1 specimen and 4 fragments; A714, 1 specimen and 6 fragments; A715, 2 fragments; D74, fragment.

Description: Complete specimen approximately U-shaped, with mouth and anus placed at the ends of long "tubes". Total length measured about greater curvature, 45 mm. Body completely invested by large overlapping scales. Colour in alcohol white. Tubefeet poorly developed, present on the ventral side of the body in very small numbers. Their arrangement cannot definitely be determined.

The anal aperture is guarded by five large teeth, which are placed in the interradii (Pl.XIII, fig.8). The teeth are conspicuous in dried material.

Internal anatomy similar to that in Stolus huttoni (see Pawson, 1963). Two Polian vesicles. Gonad comprises a bunch of sparse unbranched caeca. Tentacles (retracted) are white, with a very small number of reddish-brown spots. Radial longitudinal muscles are thin straps; retractor muscles well developed.

Calcareous deposits of the bodywall large scales which have an average length of 1.2 mm. The scales are elongate, with one end rounded and the other tending to be pointed (Pl.XIII, fig.5), and they lie overlapping in the bodywall with the rounded end projecting (Pl.XIII, fig.6). In microscopic structure, they are composed of several layers of calcareous material which forms a complicated network. Intermingled with the scales, but occurring only in very small numbers, are perforated buttons with some irregular knobs and numerous perforations (Pl.XIII, fig.9). Average length of the buttons is 0.13 mm.

The tentacles contain very sparsely scattered perforated rods (Pl.XIII, fig.7) which have an average length of 0.6 mm and are usually perforated at the extremities. These deposits are more closely aggregated at the base of the tentacle stem than elsewhere.

Holotype: The holotype and a paratype are lodged in the collection of the New Zealand Oceanographic Institute, Wellington.

Remarks: At first it was thought that the material examined represented specimens of <u>Stolus huttoni</u>, as the shape of the body, the presence of overlapping scales and the poorly developed tubefeet point to an affinity with that species. But the present material has conspicuous anal teeth, while such are lacking in <u>Stolus huttoni</u>, as pointed out by Dendy (1896) and Mortensen (1925), and the thick glassy buttons which occur in great numbers in <u>S. huttoni</u> are also lacking from this species. It may be argued that lack of the characteristic buttons is due to the small size of the present material, and that the buttons develop with growth, but such cannot be said for the anal teeth, and on the basis of these differences a new species is proposed. Undoubtedly the species <u>S. huttoni</u> and <u>S. squamatus</u> are closely related.

Family Phyllophoridae Ostergren, 1907

No phyllophorids are known from south of New Zealand, although four species have been recorded from the New Zealand coast. A single species is here recorded from two Chatham Rise stations.

<u>Pentadactyla</u> Hutton, 1879

Diagnosis: Medium-sized dendrochirotes with 20 tentacles in two rings. Tubefeet distributed evenly over the body. Deposits either spired tables of irregular shape with rough tapered spires or smooth perforated plates.

Type Species: <u>Thyone longidentis</u> Hutton.

<u>Pentadactyla longidentis</u> (Hutton)

Synonymy: See Pawson, 1963, p.24.

Material Examined: Stn. A759, 22 specimens; Stn.A760, 2 specimens.

Remarks: All but one of the specimens are completely contracted, approximately U-shaped. Total length, measured about the greater curvature of the body, ranges from 46 mm to 84 mm. Colour in alcohol light brown, posterior end of the body greyish-white. The tentacles of the expanded specimen are yellowish-white, supported on a light yellow introvert. A description of this species is given elsewhere (Pawson, 1963).

No differences can be seen between these specimens and those known from the New Zealand coast.

This Chatham Rise record of the species is not unexpected in view of its large bathymetric range (3-400 fathoms). <u>P. longidentis</u> is widespread on the New Zealand shelf and slope.

Order ASPIDOCHIROTIDA

From station A759 on the Chatham Rise fragments of a synallactid holothurian were recovered. These are probably fragments of <u>Bathyplotes natans</u> (Sars), which has elsewhere been recorded from the Bay of Plenty (see p. 62), New Zealand.

Family Synallactidae Ludwig, 1894

Bathyplotes natans (Sars)

Plate XIV, figs.1-3

Synonymy: See p. 90.

Material Examined: Stn. A759, fragments.

Remarks: The collection includes fragments of possibly three specimens of a species of Bathyplotes, and the deposits indicate that the species is B. natans (Sars). Colour of the fragments yellow to white, with brown spots. Tentacles dark brown. The numbers and disposition of papillae on the bodywall cannot be determined.

Calcareous deposits of the bodywall are exclusively spired tables with four arms (Pl.XIV, fig.1). The spires are composed of four rods, joined by two or more crossbars. The extremities of the arms are perforated, and the number and size of the perforations is greatly variable, some arms having but one perforation and others having up to seven or eight. Average width of these deposits is 0.1 mm.

The stems of the tentacles contain prickly rods (Pl.XIV, fig.3), which may be straight, curved or branched. Average length of the rods is 0.3 mm. The tentacle discs contain curved or straight rods of an entirely different type (Pl.XIV, fig.2), which have an average length of 0.09 mm, and carry very few small spinous projections.

Despite slight differences from the specimens of *Bathyplotes* described elsewhere in this work (p. 90), the present material apparently belongs to *B. natans* (Sars).

Distribution: Atlantic-Pacific in 200-1600 metres.

Order APODIDA

Family Chiridotidae Ostergren, 1898

Three chiridotid genera are known from New Zealand. *Kolostoneura* Becher may be restricted to the New Zealand coast, but species of *Chiridota* Eschscholtz and *Trochodota* Ludwig have been recorded also from the islands to the south of New Zealand (Mortensen, 1925).

Chiridota and *Trochodota* may be readily distinguished as follows:

1 (2) Deposits include sigmoid hooks and wheels, the wheels scattered or arranged into loose heaps . . . . *Trochodota*

2 (1) Deposits wheels aggregated into papillae. Sigmoid hooks lacking . . . . *Chiridota*

Chiridota Eschscholtz, 1829

Diagnosis: Tentacles 12, with 3-10 pairs of digits, the terminal pair being the longest. Deposits in the form of 6-spoked wheels collected into papillae. Sigmoid hooks lacking, but curved rods with enlarged ends may be present.

Type Species: Chiridota discolor Eschscholtz.

Chiridota carnleyensis Mortensen and C. nigra Mortensen have been recorded from the Auckland Islands (Mortensen, 1925), and the former species is restricted to the southern islands of New Zealand.

The collection includes several specimens of C. carnleyensis. The two species may be distinguished as follows:

1 (2) Colour black with white spots. Deposits present in radial muscles . . C. nigra Mortensen

2 (1) Colour white transparent. No deposits in radial muscles . . . . C. carnleyensis Mortensen

Chiridota carnleyensis Mortensen

Plate XIV, figs.7-8

Chiridota carnleyensis Mortensen, 1925, p.374, figs.56b, 58; Heding, 1928, p.283; Dawbin, 1950, p.40.

Material Examined: Stn. B175, 21 specimens; Stn. B183, 9 specimens; Stn. B184, 1 specimen; D55, 1 specimen.

Description: All specimens are strongly contracted and contorted, with a total length varying between 12 mm and 63 mm. Probably the body was cylindrical in life, and the total length very much greater than in preserved material. In all cases but one the anterior end of the body is completely lacking.

PLATE XIV

Bathyplotes natans (Sars), _Trochodota dendyi_ Mortensen,

Chiridota carnleyensis Mortensen

Bathyplotes natans (Sars)

Fig.1. Tables from the bodywall.

Fig.2. Rods from tentacle discs.

Fig.3. Rods from tentacle stems.

Trochodota dendyi Mortensen

Fig.4. Sigmoid hooks.

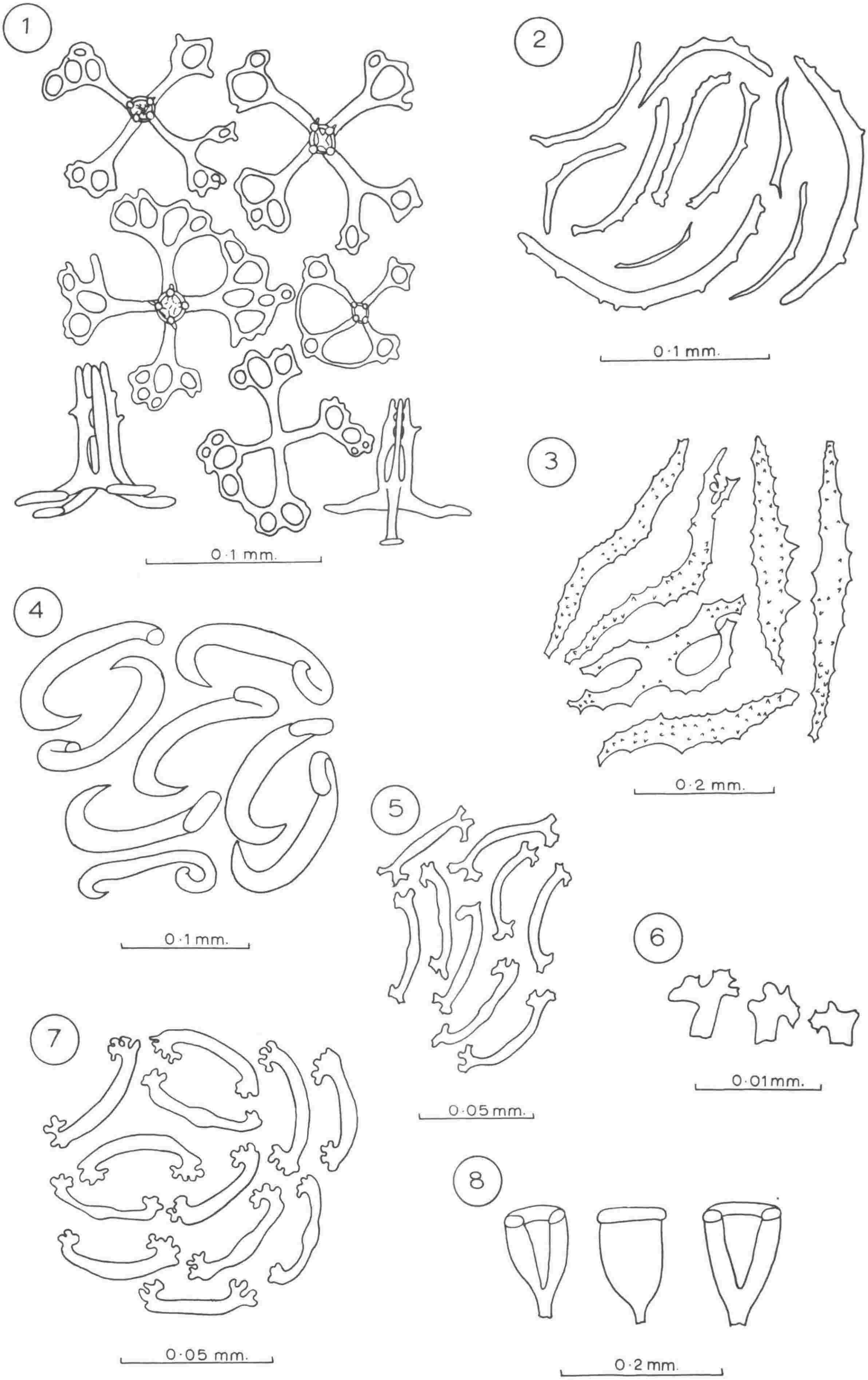
Fig.5. Bracket-shaped tentacle deposits.

Fig.6. Ends of tentacle rods.

Chiridota carnleyensis Mortensen

Fig.7. Tentacle deposits.

Fig.8. Ciliated funnels.


1
0·1 mm.
2
0·1 mm.
3
0·2 mm.
4
0·1 mm.
5
0·05 mm.
6
0·01mm.
7
0·05 mm.
8
0·2 mm.

The tentacles are pinnate, with seven pairs of digits, which increase in length towards the end of the tentacle. The bodywall is extremely thin and transparent, so that the radial muscles and intestine can clearly be seen through it.

The ventral interradii are naked, but the three dorsal interradii each carry a single row of large irregularly spaced white papillae, which are approximately circular, having a diameter of 0.6-1.0 mm. These papillae comprise aggregations of up to ca. 100 wheels.

In all specimens the intestine is packed with coarse detrital material, comprising mainly small pebbles, fragments of mollusc shells and bryozoans.

Ciliated funnels are scattered in small clusters in the left ventral and left dorsal interradii. They are small (0.13 mm in length) with short stalks, and have a narrow opening (Pl.XIV,fig.8). A very small number of large funnels, up to 0.8 mm long, were found among the more numerous smaller funnels.

Deposits in the bodywall comprise only wheels, which are always aggregated into papillae. The wheels are typical of those found in other Chiridota species, and their diameter ranges from 0.08 to 0.2 mm. No deposits are present in the radial longitudinal muscles.

The tentacle digits carry double rows of very closely aggregated and consequently very numerous rods, with dichotomously branched extremities (Pl.XIV, fig.7). These C- to bracket-shaped deposits are also found scattered in the tentacle stems. Averege length of the tentacle rods os 0.04 mm.

Remarks: Some slight differences between the specimens described by Mortensen and those in the present collection are worthy of comment. Mortensen (1925) described the wheel papillae as "diffuse round heaps ... 2-3 mm in diameter", while here the papillae scarcely exceed a diameter of 1.0 mm. Also the ciliated funnels in Mortensen's material were confined to the mid-dorsal, left dorsal and right ventral interradii, while in the present specimens they were found only in the left ventral and left dorsal interradii.

However, there are good reasons for regarding the present specimens as representing C. carnleyensis on the basis of such characters as the transparent bodywall, arrangement of wheel papillae, absence of radial muscle deposits, and shape of the ciliated funnels.

Consequently it may be stated that the position of the ciliated funnels is quite variable, as also is the size of the wheel papillae.

Distribution: Mortensen's (1925) material was collected from Carnley Harbour in the Auckland Islands at a depth of 45 fathoms. The present specimens were all taken near the Auckland Islands, in depths between 25 fathoms and 112 fathoms.

<u>Trochodota</u> Ludwig, 1892

Diagnosis: Tentacles 10. Digits 2-6 on each side. Polian vesicle single. Calcareous ring of ten pieces, the radials not perforated. Calcareous deposits sigmoid hooks, scattered or arranged into groups, and wheels, scattered, never grouped into papillae (Clark, 1907).

Type Species: Trochodota purpurea (Lesson).

Remarks: Trochodota is represented in New Zealand by two species, both of which are now also known from the southern islands. They may be distinguished as follows:

1 (2) Skin smooth, not papillate, with numerous scattered sigmoid hooks and wheels . . . . T. dunedinensis (Parker)

2 (1) Skin papillate. Sigmoid hooks arranged into groups in the papillae. Wheels numerous or scarce . . . . T. dendyi Mortensen

Trochodota dunedinensis (Parker)

Synonymy: See Pawson, 1963, p.8.

Material Examined: Stn. D10, 6 specimens; Stn. D35, 1 specimen.

Remarks: The largest specimen has a total length of 7 mm (contracted). All specimens are light brown in alcohol, and agree in all respects with the description given by Mortensen (1925) and Pawson (1963).

The viviparous species T. dunedinensis is common about the coasts of New Zealand, and has been recorded from the Auckland

Islands (Dendy, 1909; Mortensen, 1925) and Campbell Island (Mortensen, 1925). The two present records, off Macquarie Island, 37 fathoms and off Campbell Island, 100 fathoms, are of considerable zoogeographic importance. The species was previously unknown from Macquarie Island, and here it is definitely recorded from that area for the first time. Also T. dunedinensis has not hitherto been taken from below 5 fathoms, and the present depths of 37-100 fathoms indicate that while T. dunedinensis may be restricted to the shelf, it is widespread, especially to the south of New Zealand.

Trochodota dendyi Mortensen

Plate XIV figs.4-6

Trochodota dendyi Mortensen, 1925, p.381, figs.62, 63a; Dawbin, 1950, p.40; Pawson, 1963, p.9.

Material Examined: Stn. D20, fragment.

Remarks: The fragment is 9 mm in length, comprising the anterior extremity of the body. Diameter, 4 mm. The mouth is circular, surrounded by ten tentacles, each of which carries 6-7 pairs of digits, the terminal pair being the longest. Colour in alcohol light purple, with a single narrow darker purple band along each radius. The bodywall is closely papillate. The small portion of intestine remaining in the fragment is filled with coarse detrital material, mainly shell and bryozoan fragments.

Deposits in the bodywall are sigmoid hooks (Pl.XIV, fig.4) of average length 0.12 mm. These hooks are typical of those found in the genus Trochodota. No wheels were found. The hooks are loosely aggregated, and lie in groups of 3-6 at the base of the papillae in the bodywall. Some are also scattered between the papillae, and are more numerous along the radii.

The tentacle stems and digits contain bracket-shaped rods (Pl.XIV, fig.5) of average length 0.05 mm, which have weakly branching ends. Under high magnification, the branched ends of the rods are seen to carry 2-5 short, sharp projections (Pl.XIV, fig.6).

The complete absence of wheels in this fragment at first led to the inference that the fragment represented the genus Scoliorhapis Clark. This monotypic genus, containing the species S. theeli (Heding) is so far known only from Port Jackson, New South Wales, and is characterised by completely lacking wheels in the bodywall. Otherwise the genus is very closely allied to Trochodota Ludwig, and is obviously derived from that genus by loss of wheels.

Scoliodota theeli is very similar to Trochodota dendyi Mortensen, as has been pointed out by Mortensen (1925) and Heding (1928), and apart from the absence of wheels in the former species, the two are distinguishable on the basis of their tentacle rods, which are unbranched in S. theeli and branched in T. dendyi.

In the present material the tentacle rods are definitely branched, and are identical in shape and size to those figured by Mortensen (1925), under his description of T. dendyi. The arrangement of the sigmoid hooks in the bodywall of _T. dendyi_, the relative sizes of the tentacle digits, and to a lesser extent, the colour, are identical to those found in the present specimen.

The absence of wheels from the bodywall does not appear important, as Mortensen has found larger specimens of _T. dendyi_ at Stewart Island and Auckland Harbour in which wheels are scarce, and in one specimen he found only a single wheel, and that wheel was abnormal in structure.

Therefore the fragment in this collection has been assigned to the species _T. dendyi_. The occurrence of _T. dendyi_ approximately 100 miles northwest of Auckland Island in a depth of 70-65 fathoms is of extreme interest. Formerly the species was known from intertidal and shallow localities near Wellington, Auckland and at Stewart Island. It appears that _T. dendyi_ is a wide-ranging species in New Zealand waters, and may be found to have a wide distribution on the shelf.

CLASS ECHINOIDEA

Order CIDAROIDA

Family Cidaridae Gray, 1825

The two cidarid genera now known to occur in waters south of New Zealand may be separated on the basis of their primary radioles.

Primary radioles tapering, slender, cylindrical . . . . *Austrocidaris*

Primary radioles coarse or coarsely thorny, basal spurs present. Adapical primaries with distal cups . . . . *Goniocidaris*

Austrocidaris Clark, 1907

Diagnosis: Test low. A sunken median furrow in both ambs and interambs. Pores oblique, close together. Areoles deep, well separated, sometimes confluent adorally. Secondary tubercles of same size as scrobicular tubercles. Apical system less than ½ h.d. Primary spines cylindrical, slender, fairly smooth. Oral primaries simple, not specialised. Secondary spines flattened, somewhat appressed. (After Mortensen, 1928).

This genus is represented only in subantarctic seas according to Mortensen (1928) and both of the included species *A. canaliculata* (A. Agassiz) and *A. spinulosa* Mortensen are known from the Magellanic region of South America, and the

Falkland Islands to depths of ca. 270 metres.

<u>Austrocidaris</u> sp.

Material Examined: Stn. A740, 2 primary radioles; Stn. A745, test fragments and fragment of a primary radiole.

Remarks: The two test fragments each comprise two interambulacral plates, and one of the fragments carries seven interamb plates. Both pieces are overgrown by bryozoans. The test is approximately 1 mm thick. Interamb plates with large perforate, non-crenulate primary tubercles; the boss arises smoothly from the floor of the areole. Areoles deep, approximately circular, surrounded by a complete ring of scrobicular tubercles. In the horizontal sutures the scrobicular tubercles are reduced in size, and on one fragment they are lacking altogether, so that the areoles are broadly confluent. It is suspected that the fragment with confluent areoles is from the adoral portion of the test, while the other fragment is ambital. Secondary tubercles are numerous, of same size as scrobicular tubercles, and these almost fill the admedian and adradial areas of each plate. Apparently a sunken median furrow is present in the interambs.

The ambs are narrow (approximately 22% of the interambs). Pores slightly sunken, oblique. Pores and pore-pairs separated by a more or less conspicuous ridge. Marginal tubercles large, in vertical linear series. A small internal tubercle is present, median to, and above the marginal tubercle on each plate. A sunken median furrow is present in the ambs.

The two primary radioles are 52 mm and 46 mm in length, and both have the distal extremities broken off, but it is probable that their original length did not exceed 65 mm. Diameter at neck 2.3 mm. The shaft is straight, approximately cylindrical, gently tapering from its midpoint towards the distal extremity, bearing 12 straight ridges, which are broken into spinelets. The milled ring is conspicuous, 3.6 mm in diameter. Neck and collar 1.2 mm in length.

From the characters of the test, and more particularly of the spines, these fragments appear to belong to representatives of genus Austrocidaris, but there is insufficient material to enable a specific determination. A comparison of these radioles with those of the monotypic genus Ogmocidaris shows that they do not belong to that genus, as the radioles of O. benhami Mortensen scarcely exceed 40 mm in length, and also their milled rings are quite inconspicuous.

If the present material does in fact represent Austrocidaris, then the range of distribution of that genus is considerably enlarged, to include the Antipodes Islands, at depths of 172-220 fathoms (309-396 metres). Therefore the genus probably has a circumpolar distribution, on the shelf and slope.

Goniocidaris Agassiz and Desor, 1846

Diagnosis: Apical spines in adult specimens widened distally to form a crown, or disc. Often a basal disc present.

Goniocidaris umbraculum Hutton

Plate XV, fig.1

Goniocidaris umbraculum Hutton, 1878, p.306; Mortensen, 1928, p.164, Pls.XII, figs.10-12, LXIX, fig.15, LXXIX, fig.1 (complete list of references); Fell, 1952, p.33; Fell, 1954, p.40; Fell, 1958, p.32.

Material Examined: 23 specimens from the following stations: Stn. D17, 5 specimens; Stn. D18, 18 specimens.

Remarks: The largest specimen in the collection has a horizontal diameter of 19 mm, while the smallest specimen, a single juvenile, has a horizontal diameter of 1.23 mm. Colour in alcohol, test and secondary radioles dark brown, primary radioles dirty white. The larger specimens are typical of the species, and in most cases the primary radioles carry numerous epizoans, particularly the tubicolous annelid Spirorbis.

Of special interest is the single juvenile specimen. Mortensen (1926) recorded the fact that G. umbraculum is a brood-protecting species, the embryos being carried on the peristome, covered by the primary oral radioles. In another paper Mortensen (1927) described an embryo of horizontal diameter 0.9 mm. Apparently the embryos of G. umbraculum are unique among all echinoids in that each plate carries "instead of a single spine, a bundle of slender, embryonal spines, all attached to the same tubercle ..." (Mortensen, 1927b). The present juvenile is, of course, somewhat larger than Mortensen's material, and no trace of such bundles of spines is evident. All of the primary radioles are well formed, but hardly resemble those of the adult. The adapical primaries are short and thick (Pl.XV, fig.1c), approximately 0.75 mm in average length. At the ambitus the primaries reach their greatest length (ca. 1.31 mm), and most are slightly curved in an adoral direction. The oral primaries are very small, widened distally (Pl.XV, fig.1a). All of these radioles carry spines, while the ambital primaries have about 6 whorls of larger spines scattered along their length (Pl.XV, fig.1b). Pedicellariae are present in small numbers (ten were seen on the specimen). They are of the globiferous type, representing the generalised form. The test is unfortunately broken, but it can be seen that the tubercles are poorly developed simple circular elevations, with no distinct areoles. When dried, the test is very light brown in colour. Above the ambitus, the primaries are uniformly dark brown as also are the oral primaries. Ambital primaries are light green for most of their length, brown distally.

The presence of this small specimen has led to a thorough investigation of the peristome of every specimen of G. umbraculum in the collection, but no embryos were seen, and it is indeed remarkable that Fell (pers. comm.) during several years of study of New Zealand echinoderms has never found any specimens of G. umbraculum brooding young, in spite of searching through a large amount of material of that species.

It is possible that the embryos are carried on the peristome only for a very short time. Unfortunately, Mortensen (1927a, 1927b) gives no indication of the time of the year at which his material was collected.

G. umbraculum was previously known to range from Cook Strait to Foveaux Strait in depths of 40-300 fathoms. Such a bathymetric range permits a wide distribution, but until the present time the species was unknown from elsewhere but the New Zealand shelf. The discovery of G. umbraculum in latitudes of 52°S. is very important, for this is the most southern record for the genus Goniocidaris, which is centred in the Indo-west-Pacific.

Order Temnopleuroida

Family Temnopleuridae Agassiz, 1872

Pseudechinus Mortensen, 1903

Diagnosis: See p.

Pseudechinus novaezealandiae (Mortensen)

Plate XV, fig.2

Echinus angulosus Farquhar, 1898, p.319; Hutton, 1904, p.289; Benham, 1909, p.25, Pl.XI, fig.5.

Notechinus novaezealandiae Mortensen, 1921, p.153, Pl.VI, figs. 7-10, Pl.VII, figs.4, 5, 7-11; Koehler, 1926, p.

Pseudechinus novaezealandiae Clark, 1925, p.119; Lambert & Thiery, 1925, p.572; Mortensen, 1943, p.237; Fell, 1952, p.33; Fell, 1953, p.105.

Diagnosis: Globiferous pedicellariae with 1-2 lateral teeth to each side of the valves. Apical system with ocular I insert, madreporite elevated, suranal plate small, naked.

Material Examined: 344 specimens and fragments from the following stations: Stn. A701, 6 specimens; Stn. A702, 1 specimen; Stn. A704, 1 specimen and fragments; Stn.A705, 2 specimens; Stn. A706, 8 specimens and fragments; Stn. A713, 2 specimens; Stn. A714, fragments; Stn. A717, 167 specimens and fragments; Stn. A722, fragment; Stn. A723, 9 specimens and fragments; Stn. A724, 2 specimens and fragments; Stn. A727, 1 specimen; Stn. A728, 1 specimen and fragment; Stn. A729, 1 specimen; Stn. A730, 2 specimens; Stn. A734, 3 specimens and fragments; Stn. A738, 3 specimens and fragments; Stn. A739, 2 specimens and fragments; Stn. A740, fragments; Stn. A741, 3 specimens and fragments; Stn. A746, 18 specimens and fragments; Stn. A747, fragments; Stn. A748, 13 specimens; Stn. A751, 27 specimens; Stn. D1, 7 specimens; Stn. D9, 1 specimen; Stn. D35, 64 specimens; Stn. D52, fragments.

Remarks: These typical specimens of Pseudechinus novaezealandiae have a horizontal diameter ranging from 2 mm up to 46 mm. The largest specimen (from Stn. A729) has a height of 26 mm, apical system diameter of 9 mm (20% h.d.), and a peristome width of 14 mm (30% h.d.).

The spines are usually light green in colour, with whitish tips, although there is some variation in colour of the spines.

PLATE XV

<u>Goniocidaris</u> <u>umbraculum</u> Hutton, <u>Pseudechinus</u> <u>novae-zealandiae</u> (Mortensen), <u>Brisaster</u> <u>edentatus</u> n.sp.

<u>Goniocidaris</u> <u>umbraculum</u> Hutton

Fig. 1a Adoral primary radiole of juvenile.

Fig. 1b Ambital primary radiole of juvenile.

Fig. 1c Adapical primary radiole of juvenile.

<u>Pseudechinus</u> <u>novaezealandiae</u> (Mortensen)

Fig.2 Abnormal apical system. (For explanation, see text).

<u>Brisaster</u> <u>edentatus</u> n.sp.

Fig.3 Valves of tridentate pedicellariae.

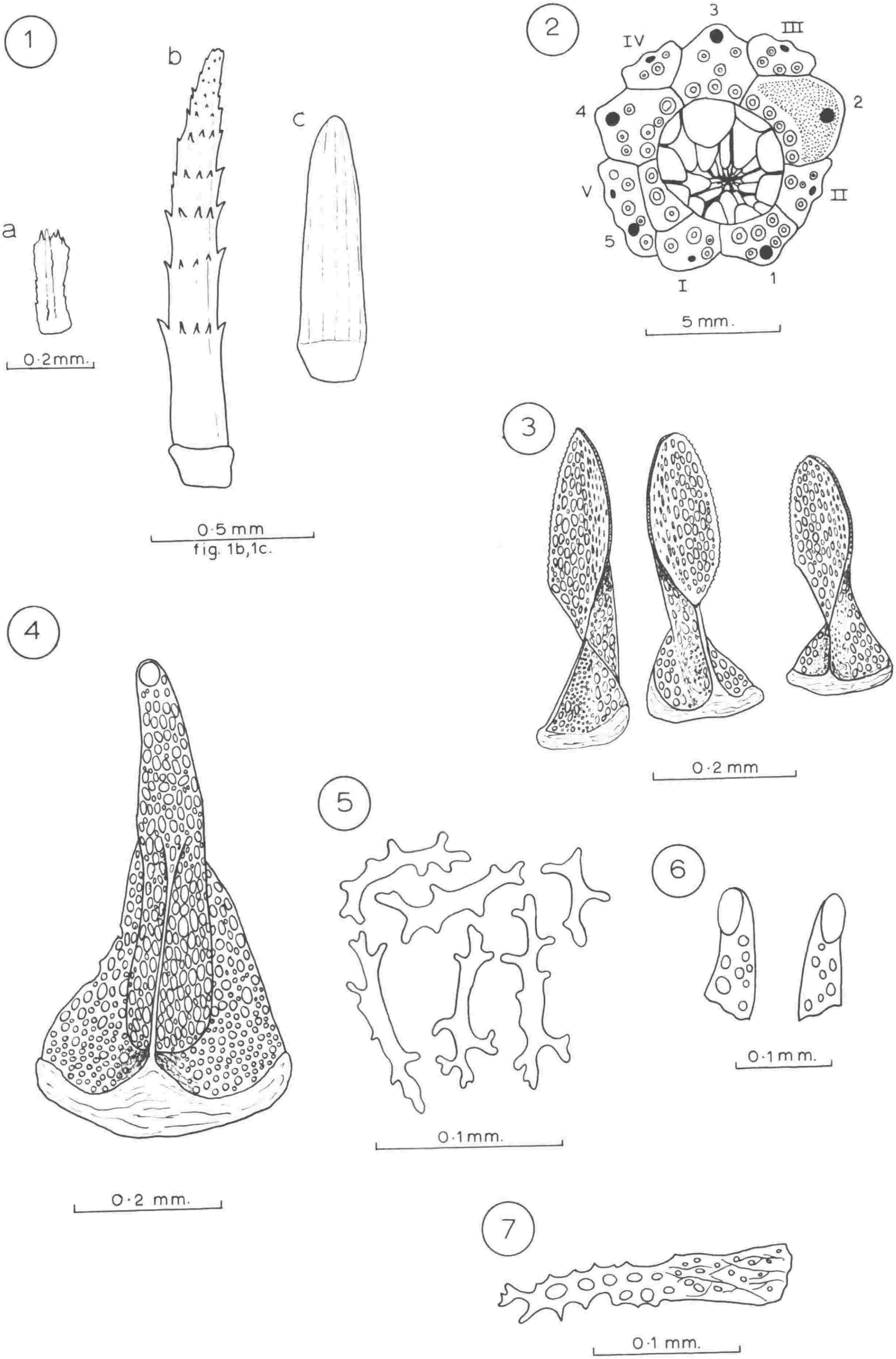
Fig.4 Valve of a globiferous pedicellaria.

Fig.5 Deposits from the stem of a tubefoot.

Fig.6 Terminal portions of valves of a globiferous pedicellaria.

Fig.7 Calcareous lamella from disc of tubefoot.

Abbreviations: I, II, III, IV, V, ocular plates; 1, 2, 3, 4, 5, genital plates.


1
a
b
c
0·2mm.
0·5 mm
fig. 1b,1c.
2
3
IV
III
4
2
V
II
5
I
1
5 mm.
3
0·2 mm
4
0·2 mm.
5
0·1mm.
6
0·1 mm.
7
0·1 mm.

A large number of specimens have spines which are more or less uniformly grey. The colour of the test is also subject to considerable variation. Most specimens have a test which is greyish, with shades of green in the median areas of ambs and interambs. Others have a light brown test, with darker brown in the median areas of ambs and interambs. But in general the test colours are dull, as compared with the colours in other species of this genus.

The apical systems of 50 specimens were examined, and in all cases but one, ocular I is insert, while the other four ocular plates, especially oculars III and IV, are widely exsert. The anus is always placed posteriorly in the periproct. One specimen of 37 mm horizontal diameter has an abnormal apical system (Pl.XV, fig.2) in which oculars I and II are broadly insert, while genital 5 and ocular V are fused together, lying against another plate which adjoins the periproct. Ocular I is also of unusual shape. Mortensen (1921) has called attention to an abnormal apical system in a specimen of 28 mm h.d. In this example, genital 4 or ocular V had divided to form two plates, a situation somewhat similar to that in the present specimen.

In the smallest specimens of h.d. 2-3 mm, the spines are very light green, and the test is greenish to very light red medially in the ambs and interambs, elsewhere greyish-white. In the apical system, all oculars are exsert, and the genital pores are not developed. Tuberculation of the plates in the apical system is sparse, there being only 1-2 tubercles to each plate. The suranal plate is here conspicuous, and virtually fills the periproctal area. The apical system is larger in proportion in the juveniles (ca. 45% h.d.) than it is in fully grown specimens (ca. 22% h.d.).

This species may now be recognised as the most common of the southern New Zealand echinoids. Mortensen (1925) reported P. novaezealandiae from Campbell Island, and Koehler (1926) described material from Macquarie Island. Fell (1953) noted its presence at Auckland Islands and Bounty Islands. The present locality records cover Macquarie, Auckland, Bounty, Campbell and Antipodes Islands, also the Chatham Rise, in depths ranging from 24 fathoms to 170 fathoms. The Antipodes Islands record is new for the species.

Order NUCLEOLITOIDA

Family Nucleolitidae Agassiz & Desor, 1847

Apatopygus Hawkins, 1920

Diagnosis: Test small to medium, of ovoid outline, wider posteriorly; aboral side low vaulted, oral side more or less conspicuously concave, sunken toward the peristome. Ambs subpetaloid, the pores small, round, of equal size. Bourrelets moderately developed. No naked granular midline in the posterior interamb. Apical system anterior; four genital pores, genital plates separate, tending to merge into the madreporite in adult specimens. Peristome anterior, transverse.

Periproct in a continuous groove aborally. Tubercles perforate, crenulate. Lantern present in young specimens, resorbed in course of growth.

Type Species: Nucleolites recens Milne Edwards.

This remarkable genus comprises two extant species, A. recens (Milne-Edwards) (peristome transverse, broader than long) from New Zealand waters, and A. occidentalis Clark (peristome circular, not broader than long) from Western Australia.

The collection contains seven specimens and fragments of A. recens.

Apatopygus recens (M. Edwards)

Pls. XVI, XVII

Nucleolites recens Milne-Edwards, 1836, Pl.XIV, fig.3.

Apatopygus recens Hawkins, 1920, p.393; Mortensen, 1948, p.181, figs.158-163 (complete list of references); Fell, 1952, p.34; Fell, 1953, p.107; Fell, 1960, p.72.

Diagnosis: Peristome transverse, broader than long.

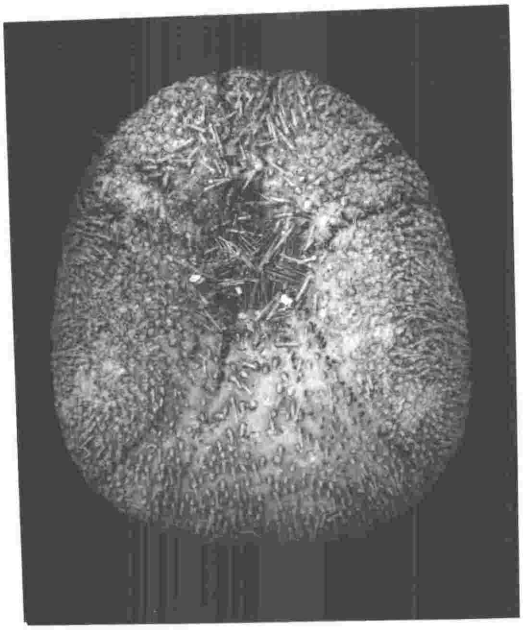
Material Examined: 7 specimens and fragments from the following stations: Stn. A701, fragments; Stn. A714, fragments; Stn. A716 fragments ; Stn. A747, fragment; Stn. A748, 1 specimen; Stn. A749, 4 specimens and fragments; Stn. D47, 2 specimens; Stn. D83, fragments.

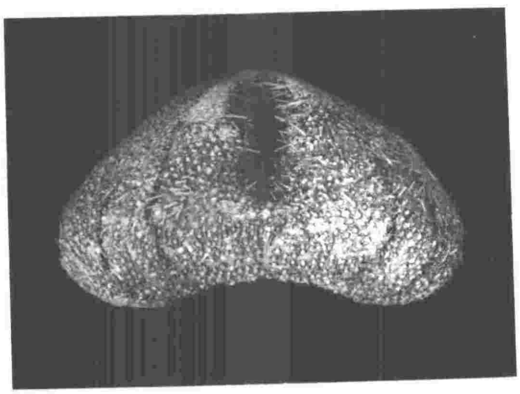
PLATE XVI

Apatopygus recens (Milne-Edwards)

Upper: Adoral aspect, showing sparse tuberculation posterior to the peristome. Total length of specimen 46 mm.

Lower: Posterior aspect, showing arched ventral surface. Greatest breadth of specimen 40 mm.





Remarks: The collection includes seven complete specimens of this well-known species. Colour in alcohol is, as usual, green. The largest specimen is 46 mm in length, and 40 mm wide at its broadest part (at the level of the anus).

This large specimen differs from the others in the collection in some respects. The underside of the specimen posterior to the peristome is not as densely tuberculate as usual, and conspicuous naked areas can be seen (Pl.XVI, fig.1). Also this area is concave, and the specimen has an arched ventral side when viewed from the posterior end (Pl.XVI, fig.2). Such a deviation from the normal shape and tuberculation is rare, but it is interesting to note that the only other abnormal specimen of A. recens known was reported by Fell (1953), and moreover this specimen was collected at the Auckland Islands. The specimen examined by Fell is illustrated here (Pl.XVII, figs.1, 2). Points of particular interest are the very large size of the specimen (length 50 mm), its height (28 mm), and the exceptionally large gonopores.

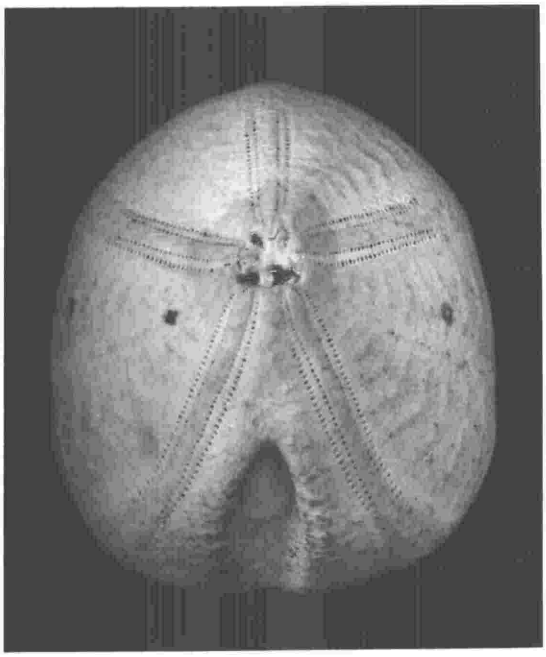
A. recens is known from many points about the South Island of New Zealand, but is unknown from north of Cook Strait. Fell (1953) recorded the species from the Auckland Islands, but with some doubt, as the labelling of the specimen may have been unreliable. The present records show most definitely that A. recens is wide-ranging among the southern islands of New Zealand, and is also known from the Chatham Islands (Fell, 1960). The known bathymetric range (10-162 metres) is small, and probably the species is restricted to the shelf.

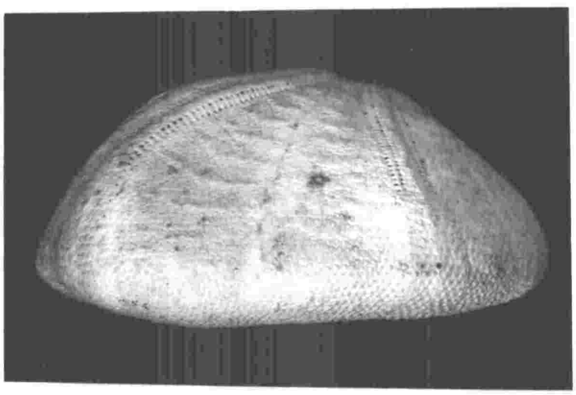
PLATE XVII

Apatopygus recens (Milne-Edwards)

Upper: Aboral aspect, showing large gonopores. Total length of specimen 50 mm.

Lower: Right lateral aspect. Height of specimen, 28 mm.





Order SPATANGOIDA

Two families within this order, Family Spatangidae and Family Schizasteridae, are now known to occur in waters to the immediate south of New Zealand. They may be distinguished as follows:

Peripetalous and lateroanal fasciole present . . .
. . . . Schizasteridae
Subanal fasciole only present . . . . Spatangidae

Family Spatangidae Gray, 1825, emend. Mortensen, 1951

Two genera, _Spatangus_ and _Paramaretia_, are represented in New Zealand waters by a total of five species (Fell, 1963), of which none have until the present time been recorded from south of New Zealand, although _Spatangus multispinus_ Mortensen and _Paramaretia multituberculata_ Mortensen occur near the Chatham Islands (Fell, 1960).

1 (2) Plastron fully covered by tubercles. ._Spatangus_
2 (1) Plastron with large naked areas . . . _Paramaretia_

Spatangus Gray, 1825

Diagnosis: Test large, broadly oval in outline, with a deep frontal groove. Aboral side arched, high, oral side flat. Paired ambs form distinct petals, almost closed distally, not sunken. Pores of frontal amb small in regular single series. Apical system ethmolytic, subcentral, with four genital pores. Madreporite extends beyond posterior oculars, widening into a conspicuous plate. Peristome anterior, labrum prominent. Sternum narrow, often forming a distinct keel, wholly covered by tubercles. Posterior end truncate, carrying periproct. Subanal fasciole only present. Colour more or less dark purplish. (After Mortensen, 1951).

Type Species: Spatangus purpureus O.F.Muller.

Remarks: This genus contains thirteen species, and recently Fell (1963) has examined the content of the genus, and given a key to all known species, diagnosing three new species in the same paper.

The present collection contains only fragments, unfortunately, of a species of Spatangus, probably one of the new species described by Fell. A large fragment which includes portions of the posterolateral interambs undoubtedly belongs to Spatangus thor Fell. All of the Spatangus fragments in the collection have been provisionally assigned to this species. Further investigations in the area sampled may show that there is more than one Spatangus species present in the area.

Spatangus thor Fell

Spatangus thor Fell, 1963, p.2, figs.2, 6, 7, 12.

Diagnosis: A dozen or more tubercles in each posterolateral interamb. Tubercles lacking from anterolateral interambs, and in the posterolateral interambs the tubercles are restricted to the area within the petals. Sternum keeled. Periproct subambital, visible from below. Colour deep reddish purple (large forms). (Fell, 1963).

Material Examined: Fragments from the following stations: Stn. A701; Stn. 706; Stn. A712; Stn. A722; Stn. A746; Stn. D1;

Remarks: Most fragments are very small, and some carry numerous tubercles and are strongly reminiscent of Spatangus multispinus Mortensen, but these cannot be placed with any certainty. The largest fragment (Stn. D1) shows the complete apical system together with portions of the paired ambs. The posterolateral interamb of the right side is almost complete and there five conspicuous tubercles are carried. Because of the presence of these tubercles in the posterolateral interambs, the specimens cannot be placed into S. beryl Fell, as that species lacks such tubercles. However, S. thor Fell has about 12 tubercles in that area, but this number is rather more than those found in the present material. In the holotype of S. thor, the anterolateral petal is 47 mm in length, while the corresponding petal in the large fragment has a length of 30 mm. Thus it is presumed that this fragment is of a specimen which had not yet reached the size of specimens found in Foveaux Strait, and possibly the full complement of tubercles in the posterolateral interambs had not as yet been attained. On the other hand, the fragment, with its small number of tubercles, may represent a hybrid S. thor x beryl. Possible hybridisation between these two species has been discussed by Fell (1963). The material available does not allow of a definite answer to this problem, but it is considered to be more likely that these fragments represent S. thor, to which species the material is here assigned.

Distribution: The holotype was taken from Foveaux Strait in a depth of 29-34 metres. The present records (Bounty and Antipodes Islands, 24-180 fathoms, 43-324 metres; Chatham Rise, 50 fathoms, 90 metres) establish the presence of spatangids to the east and south of New Zealand, with Spatangus thor definitely occurring on the Chatham Rise (Stn. D1, Veryan Bank). Fell (1960) has also recorded the presence of S. multispinus Mortensen on the Chatham Rise, the species being taken from several arthibenthal stations occupied by the Chatham Islands (1954) Expedition.

Paramaretia Mortensen, 1950

Diagnosis: Test large, aboral side low, arched, oral side concave, edge of test sharp. Petals narrow, not sunken or closed distally. Anterior series of anterior petals rudimentary, pores sometimes totally obliterated. Frontal amb narrow, scarcely sunken. Aboral side more or less densely covered by large non-crenulate primary tubercles, which are also present in the posterior interamb. Plastron tuberculated only posteriorly. Labrum forming a prominent lip, carrying a long and narrow posterior prolongation. Apical system almost central; four genital pores. No peripetalous fasciole. Subanal fasciole distinct in juveniles. (After Mortensen, 1951).

Type Species: Paramaretia multituberculata Mortensen.

Paramaretia peloria (Clark)

Maretia peloria Clark, 1916, p.121, Pl.XLIV, figs.1-3; 1917, p.248, Pl.145, fig.25; Lambert & Thiery, 1925, p.458; Clark, 1946, p.380.

Paramaretia peloria Mortensen, 1951, p.51; Fell, 1963, p.8.

Diagnosis: Very few (one or two) large primary tubercles in the posterior unpaired interamb.

Material Examined: Stn. A706, fragments.

Remarks: Several fragments of a species of Paramaretia were taken from Station A706. They are completely white in colour. One fragment includes a portion of a posterolateral interamb, in which the tubercles are scattered irregularly, there being 16 in the area. Such a small number of tubercles in the posterolateral interambs is a character of P. peloria. The only other species in the genus, P. multituberculata, has, according to Mortensen, "in the youngest specimens ... ca. 150 such tubercles in the lateral interambulacra". Undoubtedly, then, these fragments represent P. peloria.

Distribution: Clark (1916) described the species from material collected by the "Endeavour" in Bass Strait, at a depth of ca. 165 metres. Fell (1963) formally recorded the presence of P. peloria in New Zealand waters, noting that it ranges the south-eastern and southern coasts of the South Island in 30-75 metres. The present record, Bounty Islands, 170 fathoms (306 metres), further extends the known distribution of this species.

Family Schizasteridae Lambert, 1905

Brisaster Gray, 1855

Diagnosis: Test of moderate size, of more or less elongate ovoid outline, low, vertex posterior. Frontal amb forming a deep notch in the anterior end of the test; pores in frontal amb in single regular series. Posterior petals considerably shorter than the anterior. Three genital pores. Latero-anal fasciole well developed, reduced, or lacking. Globiferous pedicellariae characteristic, valves terminating in a single tooth, with the opening of the poison gland on one side.

Type Species: Brissus fragilis Duben and Koren.

Remarks: Mortensen (1951) lists seven species in this genus. Four species have a northern distribution in the Atlantic and Pacific Oceans, and three are known from isolated subantarctic localities.

Northern species:

B. fragilis (Duben and Koren) Norway, Faroe Channel, South of Iceland, east coast of North America as far south as Florida, 40-1300 metres.

<u>B. townsendi</u> (Agassiz) West coast of North America, from Alaska to the Gulf of Panama, 35-1900 metres.

<u>B. latifrons</u> (Agassiz) West coast of North America, from Alaska to southern California. Type specimen from ca.1800 metres.

<u>B. owstoni</u> Mortensen Sagami Sea and Gulf of Tokyo, 10-530 metres.

Southern species:

<u>B. capensis</u> (Studer) off Cape Peninsula, South Africa, 215-350 metres.

<u>B. moseleyi</u> (Agassiz) Magellanic region, 110-1240 metres.

<u>B. kerguelenensis</u> Clark Kerguelen Island, 130-215 metres.

A new species is described here, from near the Bounty Islands. Thus there are four southern species, each known from isolated localities, as also are the northern species (except <u>B. townsendi</u> and <u>B. latifrons</u>, which occur together). This southern distribution apparently represents the result of a west-wind-drift dispersal, as described by Fell (1962). Isolation with severely reduced facilities for gene flow resulted in the eventual formation of four separate species.

<u>Brisaster</u> <u>edentatus</u> n.sp.

Plate XV, figs.3-7; Plate XVIII.

Material Examined: Fragments from the following stations: Stn. A703; A710; A712; A714; A746; A747; A753.

Description: The material comprises only fragments of the dorsal side of the body of approximately eight specimens. The largest fragments are illustrated (Pl.XVIII). The test is apparently ovoid, approximately 70 mm long and 60 mm broad, low, vertex apparently posterior.

The frontal amb forms a deep notch, with the pores in a single series.

Anterolateral petals slightly sunken, long (27 mm), narrow (4 mm), widely divergent, the angle between them being approximately 90°. The petals broaden gradually toward their distal extremities, and they are straight to sinuate (Pl.XVIII, figs. 1, 2). These petals touch the well marked peripetalous fasciole.

Posterior petals are small, 10-13 mm in length ca 1/3 the length of the anterolateral petals. They are sunken, slightly sinuate, widely divergent (angle between them ca. 100°).

Because of the slightly sunken petals, small keels are developed between them, and the keel between the posterior petals is pronounced.

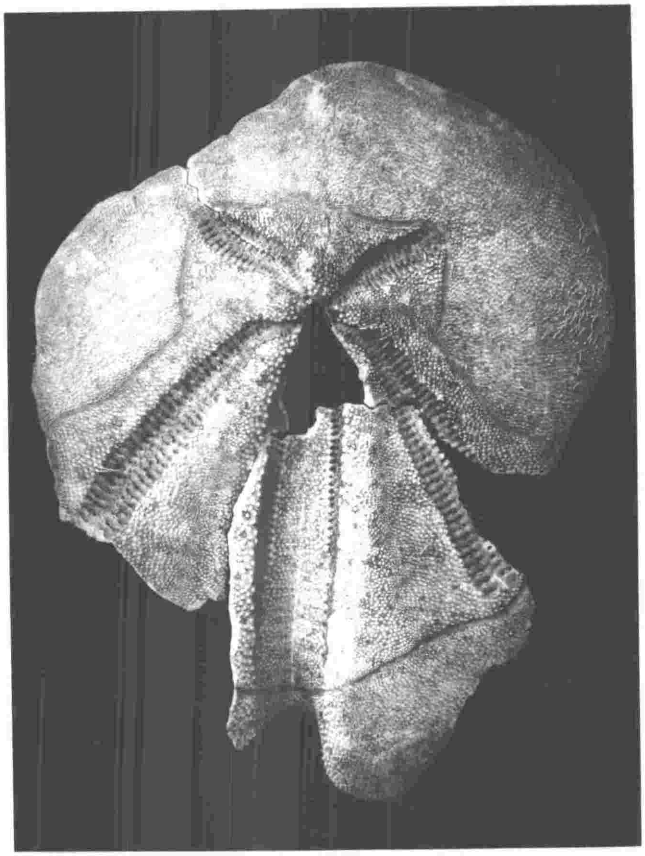
The peripetalous fasciole is typical, not running to the ventral side anteriorly, but traversing the frontal notch. The lateroanal fasciole is present, but its course cannot be determined exactly because of the fragmentary material.

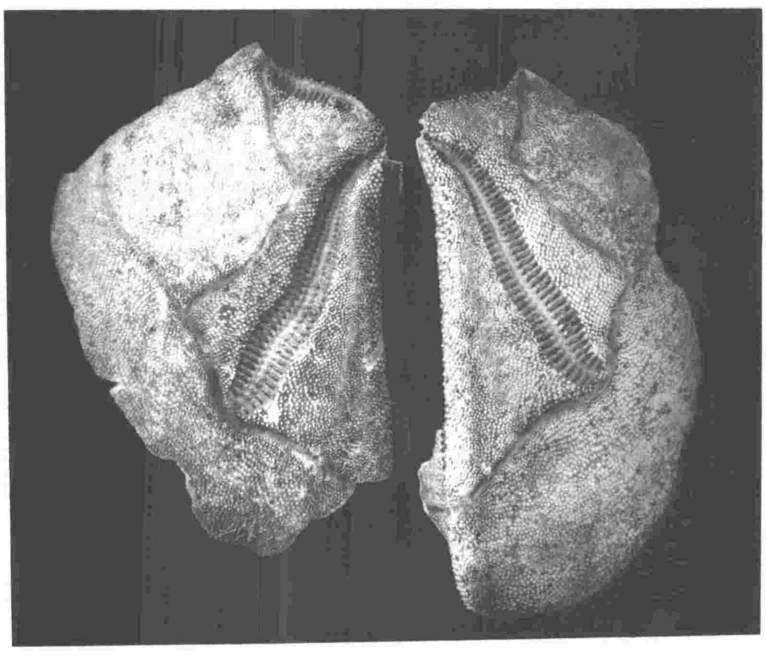
PLATE XVIII

<u>Brissaster edentatus</u> n.sp.

Upper: Holotype, aboral aspect. Length of anterolateral petals 27 mm.

Lower: Paratypes, aboral aspect.





In all cases apical systems are missing, but fragments show that there are probably three genital pores. The ocular pores are enlarged, so that they closely resemble genital pores.

Colour when dried light purplish to brown; petals light purple or brown.

A fragment of the frontal notch contained two types of pedicellariae and several tubefeet.

A single globiferous pedicellaria was found. The valves are enclosed by a thick coat of skin, which extends down to the upper part of the stalk. Each valve is broad elongate (0.65 mm), curved, and contains a large space for a poison gland, with an aperture at the point of the valve (Pl.XV, figs.4, 6). No evidence of terminal teeth was found.

Tridentate pedicellariae are numerous, and are apparently all of the same type, with a broad leaflike blade, which is narrow at the base, and becomes wider distally. The edges of the blade carry numerous serrations (Pl.XV, fig.3). No rostrate or ophicephalous pedicellariae were found.

The tubefeet each have a large terminal crown supported by calcareous lamellae (Pl.XV, fig.7), which radiate from a central point. Deposits in the stems of the tubefeet are simple rods with a small number of branches (Pl.XV, fig.5). The rods have an average length of 0.08 mm, and lie very closely aggregated, transverse to the longitudinal axis of the tubefeet stem.

Remarks: The genus Brisaster is characterised by the features listed in the diagnosis given above. Mortensen (1951) attaches particular importance to the presence of a single terminal tooth on the valves of the globiferous pedicellariae in this genus. The globiferous pedicellaria found in the present material has no teeth, and thus it may be argued that this species does not belong in genus Brisaster.

However, the characters of the test, and the presence of a distinct lateroanal fasciole clearly show that Brisaster edentatus very closely resembles B. fragilis (Duben and Koren) and B. capensis (Studer). On the basis of their distribution patterns, tridentate pedicellariae, petals and test shape, Mortensen (1951) regards the two latter species as distinct, in spite of a statement by Clark (1923) that they are identical. B. fragilis has an elongate oval test, with petals which are curved, slightly sinuate, while B. capensis has a test which is broadly rounded, with petals which are quite straight. Mortensen (1951) notes that there is considerable variation in shape, and in the course of the petals. The present species, then, seems most closely related to B. fragilis, because of its sinuate petals, but on the basis of the structure of the globiferous pedicellaria, it is distinct.

A richer material may establish the status of this southern species with certainty. I do not regard several test fragments and one globiferous pedicellaria as enough material on which to base a new genus, but if the pedicellaria illustrated proves to be typical of this species, then perhaps a new genus may be erected to accommodate it.

The presence of this species near the Bounty Islands is of considerable interest from the zoogeographical point of view, as has already been indicated.

DISCUSSION

1. Auckland Islands

Nine echinozoan species are now known from the Auckland Islands. They are:

Trochodota dunedinensis is a new record for this island. As can be seen, all of the Campbell Island species are also known from the Auckland Islands. This is to be expected, as the islands are not particularly far apart, both standing on the Campbell Plateau. It is probable that most of the species listed for the Auckland Islands will ultimately be recorded also from Campbell Island.

3. Bounty Islands

Five species are now known from this group of small islands.

Pseudechinus novaezealandiae
Apatopygus recens
Spatangus sp.
Stolus squamatus
Brisaster edentatus
Paramaretia peloria

Of the above, all but _Pseudechinus novaezealandiae_ are new records. Such a number of new records is expected, as the fauna of the Bounty and Antipodes Islands has received very little attention up to the present time.

4. Antipodes Islands

Four species are known from the Antipodes Islands.

Pseudechinus novaezealandiae
Spatangus sp.
Austrocidaris sp.
Ocnus brevidentis

All of the above species are new records. The presence of the magellanic cidarid genus Austrocidaris in this fauna is of particular interest.

5. Macquarie Island

The faunal list for Macquarie Island now includes six species.

Pseudechinus novaezealandiae

Psolus antarcticus

Pseudopsolus macquariensis

Ocnus brevidentis

Trachythyone macphersonae

Trochodota dunedinensis

Two species, namely Psolus antarcticus and Trochodota dunedinensis, are new records for the area of Macquarie Island.

The New Zealand Oceanographic Expedition to Macquarie Island early in 1963 discovered north of Macquarie Island "a number of high spots, ranging from steep, almost pinnacle-like mounts to more gently sloping seamounts, and rising to less than 100 fathoms, were found on an almost continuous submarine ridge rising to 300 to 400 fathoms from a bottom on each side of 2,000 to 3,000 fathoms" (Dawson, pers. comm.). Of course the existence of this ridge and its mounts and pinnacles is of great interest, as such structures as these provide ideal "stepping stones" for benthic species which may be eurybathic, enabling them to have quite a wide distribution. During this expedition, several specimens of Goniocidaris umbraculum were recovered from a shallow mount, approximately 150 miles NNE of Macquarie Island. As has been noted, this is the most southern locality known for any species of Goniocidaris; and the said species, hitherto unrecorded from near the Auckland, Campbell, Bounty, Antipodes and Chatham Islands, was regarded as having a restricted distribution about the southern coast of New Zealand. This is certainly not the case, and with a bathymetric range of 72-540 metres, it must be assumed that this brood-protecting species will be taken from other southern localities, especially on the Campbell Plateau.

Knowledge of this newly discovered ridge also necessitates a re-examination of the relationships of the echinozoan fauna of Macquarie Island. Three of the five species listed for Macquarie Island are also known from New Zealand coastal waters. Pseudechinus novaezealandiae has a pelagic larval stage, and thus can achieve a wide distribution as a member of the plankton. Mortensen (1925) accounts for the presence of P. novaezealandiae near Macquarie Island "through the transport of pelagic larvae". It may be argued that the west-wind-drift would tend to carry larvae away from the Macquarie Island region rather than towards it, in which case a larva should have to completely circumnavigate Antarctica before it is able to reach Macquarie Island. But there is apparently no evidence to indicate that the west-wind-drift has been constant throughout Tertiary times, and a small recession in the drift with the attendant counter currents might enable larval transport across the relatively short gap between the Campbell

Plateau and Macquarie Island. In support of this suggestion, Finlay (1924) has evidence to suggest that the East Australian current did not operate until the late Pliocene. Fleming (1951) states that the East Australian Current (together with the East Cape Current of New Zealand) "are bodies of water moving polewards in the western south Pacific ... probably their strength and courses varied under different climatic regimes". As the East Australian Current impinges upon the west-wind-drift to a varying degree, any variations in the East Australian Current would naturally have some effect on the west-wind-drift, and such local variations as may arise should have some influence on the current flow between the Campbell Plateau and the vicinity of Macquarie Island, and such an influence may enable transport of planktonic larvae from east to west.

It may alternatively be postulated that with a known bathymetric range of 10-306 metres, P. novaezealandiae may have reached Macquarie Island by migration across ridges which are now known to exist. Such a method of achieving distribution is indeed the only one open to Trochodota dunedinensis, which is a viviparous species, but has a bathymetric range of 0-180 metres. Pseudopsolus macquariensis is known from Macquarie Island, and is recorded (with some doubt) from Stewart Island, New Zealand. Oenus brevidentis is also known from Macquarie Island and New Zealand, and is widespread in the southern islands. Mortensen (1925) accounts for the presence of these two species at Macquarie as being due to their transport on floating algae, a theory which has received considerable support from the observations of Mortensen (1925, 1933) and Fell (1962).

Trachythyone macphersonae is apparently an endemic species, but related species of the same genus, T. bollonsi (Mortensen) and T. farquhari (Mortensen) are known from New Zealand.

Psolus antarcticus is now known from the southern (magellanic) portion of South America, Graham Land (Antarctica) and Macquarie Island. The distribution of this virtually sedentary species with a bathymetric range of 35-1080 metres must have been achieved by spreading across the deep sea floor, and P. antarcticus should be found in several subantarctic localities.

After this re-examination of the echinozoan fauna of Macquarie Island, the conclusion can be drawn that the fauna of Macquarie Island does in fact bear a distinct relationship to that of New Zealand and the Campbell Plateau. There is also a small degree of endemism and some affinities with the Antarctic fauna. However, only six species are being considered here. With a larger number of species, a more definite pattern should emerge. The few additional asterozoans collected by the New Zealand Oceanographic Institute from near Macquarie Island have not as yet been described, but they include species of Henricia and Ophiomyxa: of these, Ophiomyxa at least is likely to be a derivative of the adjacent temperate Pacific (Fell, pers. comm.).

6. Relationships of the southern islands fauna.

The faunal list which follows includes all echinozoan species known from the southern islands, and their distribution.

Abbreviations employed: N.Z., New Zealand coast; A, Auckland Islands; C., Campbell Islands; B., Bounty Islands; Antip., Antipodes Islands; M.,Macquarie Islands; Mag., Magellanic region of South America.

Pseudechinus novaezealandiae N.Z., A., C., B., Ant., M.

Apatopygus recens N.S., A., B.

Spatangus thor N.Z., B., Antip.

Paramaretia peloria N.Z., B., Australia.

Brissaster edentatus, B.

Goniocidaris umbraculum N.Z., 150 miles NNE of M.

Austrocidaris sp. Antip., Mag.

Stolus squamatus A., B.

Stereoderma leoninoides A., C., Snares Islands, 150 miles NNE of M.

Ocnus brevidentis N.Z., A, C., Antip., M.

Trachythone amokurae N.Z., A.

Pseudopsolus macquariensis N.Z., M.

Chiridota carnleyensis A.

Chiridota nigra N.Z., A.

Trochodota dunedinensis N.Z., A., C.

Trochodota dendyi N.Z., 100 miles NW of A.

Thus 16 species may now be recorded from the southern islands.

By far the most widespread of these species is <u>Pseudechinus novaezealandiae</u>, which is known from New Zealand and all of the southern islands. <u>Ocnus brevidentis</u> is known from all localities but the Bounty Islands, and it is expected that the species also occurs there.

Eleven of the 16 species are shared with the New Zealand mainland. Clearly, then, the statement made by Fell (1953) that the echinoderm fauna of these islands is derived from an assemblage of species common to all parts of the New Zealand plateau receives ample support from our present knowledge of the echinozoan fauna.

There are four endemic species, although one, <u>Stereoderma leoninoides</u>, has been taken from the Snares Islands, and possibly the same species occurs in southern New Zealand. Elements known also from the magellanic region number two, namely <u>Austrocidaris</u> sp. and <u>Psolus antarcticus</u>. The latter species is also known from Graham Land, Antarctica. Apparently the west-wind-drift has contributed nothing at the present day specific level to the echinozoan fauna of the southern islands of New Zealand, but has only exhibited local influences in establishing continuity among the faunas of these islands. At the level of the genus, the influence is somewhat stronger, several species of the seaweed-inhabiting holothurian genera <u>Trachythyone</u>, <u>Stereoderma</u> and <u>Ocnus</u>, and the echinoid <u>Pseudechinus</u> being distributed about the subantarctic region of the Southern Hemisphere. This influence is, however, greatly overwhelmed by that of the more widespread Australian, Indo-

Pacific and Cosmopolitan genera such as Trochodota, Chiridota, Spatangus, Paramaretia, Brisaster and Psolus, which have contributed eight species to the fauna.

The known bathymetric tolerances of the species here considered enable them to achieve a wide distribution without recourse to drift in a pelagic larval stage. Those species which are not known from deeper waters are commonly found living on brown seaweed and may have achieved their distribution in an epiplanktonic manner.

After a preliminary examination of the Asterozoa from the Campbell Plateau, Fell (pers. comm.) has made the following statement about three of the genera taken.

"From station D85 (49°59'S., 170°13'E, 330 fathoms), the asterozoans taken include, apart from genera already known from the New Zealand Plateau, Lithosoma and Ceramaster, 2 genera of Asteroidea not previously recorded from Australasia. Lithosoma is represented by a species, probably new, but related to L. penichra Fisher. The genus comprises five known species, all Indo-west-Pacific forms. This is the first record of the genus south of the tropics, the only other non-tropical species occurring in Japan. Lithosoma must be regarded as widely distributed in the western Pacific, and not representing a so-called Indonesian element in the New Zealand fauna.

"Ceramaster is a large genus with numerous representatives in all oceans. The species taken from Station D85 has not yet been identified, but it is clear that it is not closely related to the only other known southern form, C. patagonicus.

"The collection also includes from Station D32 (52°08'S., 158°50'E., 100 fathoms) a species of Solaster (s.s.), apparently new. This genus comprises approximately 20 species, with representatives in all seas. The present species is only the second to be recorded from the New Zealand area; its precise identification and relationships have not yet been determined."

Here, then, is further evidence in favour of Australian, Indo-Pacific and cosmopolitan elements contributing to the fauna of the area, with subantarctic and Antarctic elements being rarely encountered.

7. The Chatham Rise and Chatham Islands.

It is here intended to make a brief comparison between the shelf fauna of the Chatham Islands and the fauna of the Campbell Plateau. Although not strictly relevant to the present discussion, a revised faunal list is presented for the Chatham Rise. The list is based on results obtained by Fell (1960), and the writer (present collection and p.145). Most of the species listed were recovered from bathyal stations, with the exception of Pseudechinus novaezealandiae and Spatangus thor, which were taken from N.Z.O.I. Station D1 (90 metres).

Bathymetric ranges are given in metres. Abbreviations: N.Z., New Zealand; S.Is., southern islands of New Zealand.

Goniocidaris parasol (254 m.)

Pseudechinus novaezealandiae (10-306 m.) N.Z., S.Is.

Pseudechinus flemingi (90-614 m.)

Phormosoma bursarium (170-2340 m.) Pacific

Parameretia multituberculata (280-600 m.) Australia.

Brissopsis oldhami (75-990 m.) Indo-west-Pacific

Spatangus multispinus (36-783 m.) N.Z.

Spatangus thor (29-90 m.) N.Z., S.Is.

Echinocucumis hispida (50-1400 m.) N.Z., Atlantic

Pentadactyla longidentis (6-720 m.) N.Z.

Bathyplotes natans (200-1600 m.) Cosmopolitan

Molpadia antarctica (80-1218 m.) Indo-west-Pacific, Antarctic

Molpadia musculus (100-900 m.) Cosmopolitan

Enypniastes eximia (ca. 1980 m.) Pacific

Laetmogone violacea (450-3240 m.) Cosmopolitan.

Of the above species, all are probably represented off the New Zealand mainland, although *Goniocidaris parasol* is known so far from but a single record. The cosmopolitan and Indo-west-Pacific influences are strongly reflected in the fauna of the Chatham Rise, as it is in the entire New Zealand bathyal echinoderm fauna.

The echinozoans of the Chatham Islands themselves have been listed by Fell (1960) and no further additions to that fauna have so far been discovered. Four of the echinozoans recorded from the Chatham Islands by Fell (1960), namely *Apatopygus recens*, *Evechinus chloroticus*, *Chiridota gigas* and *Ocnus brevidentis*, are also known from the New Zealand mainland.

It is also notable that *Apatopygus recens* and *Ocnus brevidentis* are widespread among the southern islands of New

Zealand, while the remainder of the species listed for the southern islands (p.205) are unknown from the Chatham Islands. Fell (1960) has already pointed out the essentially New Zealand character of the Chatham Islands shelf echinoderm fauna, and regards the area as part of the Cook Strait sub-region (between 38°S. and 46°S.).

The above considerations indicate that while the faunas of both the Chatham Islands and the southern islands are of New Zealand character, they are themselves dissimilar. Several southern island species are represented in southern New Zealand, and a distinct relationship exists between the faunas of these two areas (see Pl.XXXII), a relationship paralleled by that between the echinozoans of the Cook Strait region and those of the Chatham Islands.

It may therefore be inferred that the Cook Strait echinoderm fauna differs in some important respects from that of the southern part of the South Island, and these differences are discussed elsewhere (p.345).

The differences between the faunas of the southern islands and the Chatham Islands may be due to the interposition of the deepwater Bounty Trough. This trough must hinder northward migration of stenobathic species from the Bounty and Antipodes Islands and the Campbell Plateau, but it presents no barrier to species, such as _Apatopygus recens_ (which has a pelagic larval stage) and _Ocnus brevidentis_ (which inhabits seaweeds). It may be expected, therefore, that other southern island species which possess pelagic larval stages, or can adhere to rafts of weed, will be found at the Chatham Islands.

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A COLLECTION OF ECHINODERMS FROM COOK STRAIT

ABSTRACT

The collection of 1,142 specimens comprises 21 species, representing 20 genera. Fourteen species were taken from a single station. Hemilepis abernethyi (Fell) is a synonym of H. norae (Benham). A probable third Cook Strait species of Pseudarchaster is recorded.

Distributional and bathymetric data are given for all species.

INTRODUCTION

Cook Strait is noted for its rich benthic fauna at all depths. The shelf in particular supports a wide variety of animal species, and this is particularly true for the Echinodermata, as no less than 75 echinoderm species are known from the area. This comprises one-third of the entire New Zealand echinoderm fauna. The shelf supports at least 56 species in Cook Strait, of which several have peak populations in bathyal depths, with occasional wanderers reaching the shelf. An example of this group is Spatangus multispinus Mortensen, which appears to be represented on the shelf by a very small number of specimens, but reaches peak populations in lower bathyal depths. Of course the reverse situation equally applies, several species peaking on the shelf, and also being known from a few specimens in the bathyal zone.

Recently, the Fisheries Laboratory of the New Zealand Marine Department employed the M.V. "Ikatere" for some investigations in Cook Strait and environs. Echinoderms were collected from eight benthic stations, of which six were occupied in Tasman Bay, near the western entrance to Cook Strait. I am grateful to Dr. R.B. Pike and Mr. L.J. Paul of the Marine Department for collecting echinoderm material, and for allowing me to examine it.

MATERIAL EXAMINED

The collection comprises material from the following localities:

4½ miles east of Tory Channel, 41°13'S., 173°25'E., 15/8/1963, 84-100 fathoms (151-180 metres).

Astrothorax waitei (Benham)	1 specimen
Ophiomyxa brevirima Clark	19 specimens
Monamphiura spinipes (Mortensen)	1 specimen
Ophiacoma bollonsi Farquhar	ca. 750 specimens
Pectinura maculata (Verrill)	6 specimens
Pectinura gracilis Mortensen	21 specimens
Ophionereis fasciata Hutton	1 specimen
Ophiactis resiliens Lyman	1 specimen
Odontaster benhami (Mortensen)	20 specimens
Sclerasterias mollis (Hutton)	5 specimens
Coscinasterias calamaria (Gray)	1 specimen
Allostichaster insignis (Farquhar)	8 specimens

Pseudechinus novaezealandiae (Mortensen) 9 specimens

Stichopus mollis (Hutton) 1 specimen

Tasman Bay, 40°47'S., 173°18'E., 3/8/1963, 25 fathoms (45 metres).

Ophiomyxa brevirima Clark	1 specimen
Hemilepis norae (Benham)	ca.40 specimens
Pectinura gracilis Mortensen	1 specimen
Echinocardium cordatum (Pennant)	1 specimen

Tasman Bay, 40°58'S., 172°58'E., 5/8/1963, 18 fathoms (32 metres).

Hemilepis norae (Benham)	ca.200 specimens
Echinocardium cordatum (Pennant)	1 specimen

Tasman Bay, 40°38'S., 173°37'E., 31/7/1963, 24 fathoms (44 metres).

Ophiomyxa brevirima Clark	6 specimens
Hemilepis norae (Benham)	2 specimens

Tasman Bay, 40 20'S., 172 41'E., 8/8/1963, 45-55 fathoms (81-99 metres).

Ophiomyxa brevirima Clark	2 specimens
Ophiozonoida picta Clark	1 specimen
Pectinura gracilis Mortensen	4 specimens
Stichopus mollis (Hutton)	1 specimen

Tasman Bay, 40°17'S., 172°14'E., 8/8/1963, 110 fathoms (198 metres).

Luidia neozelanica Mortensen	1 specimen
Psilaster acuminatus Sladen	6 specimens
Pseudarchaster sp.	2 specimens

Tasman Bay, 40°53'S., 173°08'E., 4/8/1963, 18 fathoms (32 metres).

Ophiomyxa brevirima Clark	6 specimens
Ophiozonoida picta Clark	2 specimens
Pectinura gracilis Mortensen	4 specimens
Stichopus mollis (Hutton)	2 specimens

Off Croixelles, Tasman Bay, 31/7/1963, 25 fathoms (45 metres), snapper gut.

Pentadactyla longidentis (Hutton)	1 specimen

Cape Farewell, 8/8/1963

Ophiomyxa brevirima Clark	3 specimens
Ophiozonoida picta Clark	1 specimen
Pectinura gracilis Mortensen	10 specimens

The first station listed is remarkable in that it revealed 14 species of echinoderms, of which one, *Ophiocoma bollonsi*, is clearly a dominant organism in the area in which the station was occupied. Together with the numerous echinoderms were *Chlamys* spp., *Pallium convexum* (Q & G), and several other molluscs, numerous brachiopods (*Liothyrella neozelanica*

Thomson), some pycnogonids, corals, anomuran and brachyuran crustaceans.

Subclass OPHIUROIDEA

Suborder Euryalae Muller and Troschel, 1840

Astrothorax Doederlein, 1911

Astrothorax waitei (Benham)

Astrotoma waitei Benham, 1909, p.61, Pl.IX, figs.1-6.

Material Examined: 1 specimen.

Remarks: The single specimen is typical of the species in all respects. As the material was fresh when examined, the disc and arms still retained traces of the lemon yellow colouration of the living specimen. Colour when dried dirty white. This specimen was tightly coiled about a piece of "five-finger" sponge. A viviparous species known from Cook Strait, Westland, off Otago, Chatham Islands in 54-540 metres.

Suborder Ophiurae Muller and Troschel, 1840

Family Ophiomyxidae Ljungman, 1866

Ophiomyxa brevirima Clark

Ophiomyxa brevirima Clark, 1915, p.169, Pl.1, figs.3-4.

Material Examined: 37 specimens.

Remarks: The specimens fall into two well-defined colour groups. Twenty are of the dark purple-brown colour characteristic of shallow-water members of the species, while 15 specimens are light yellow to orange in colour. No other differences between the two groups can be seen. Distributed throughout New Zealand, intertidal to 540 metres.

Family Amphiuridae Ljungman, 1867

Hemilepis norae (Benham)

(Pl.XIX; Pl.XX, fig.1)

Amphiura norae Benham, 1909, p.64, Pl.X, figs.1-3; Fell, 1949, p.122; Fell, 1958, p.26.

Amphiura abernethyi Fell, 1951, p.1; Fell, 1952, p.16.

Hemilepis abernethyi Fell, 1962, p.10.

Hemilepis norae Fell, 1962, p.10.

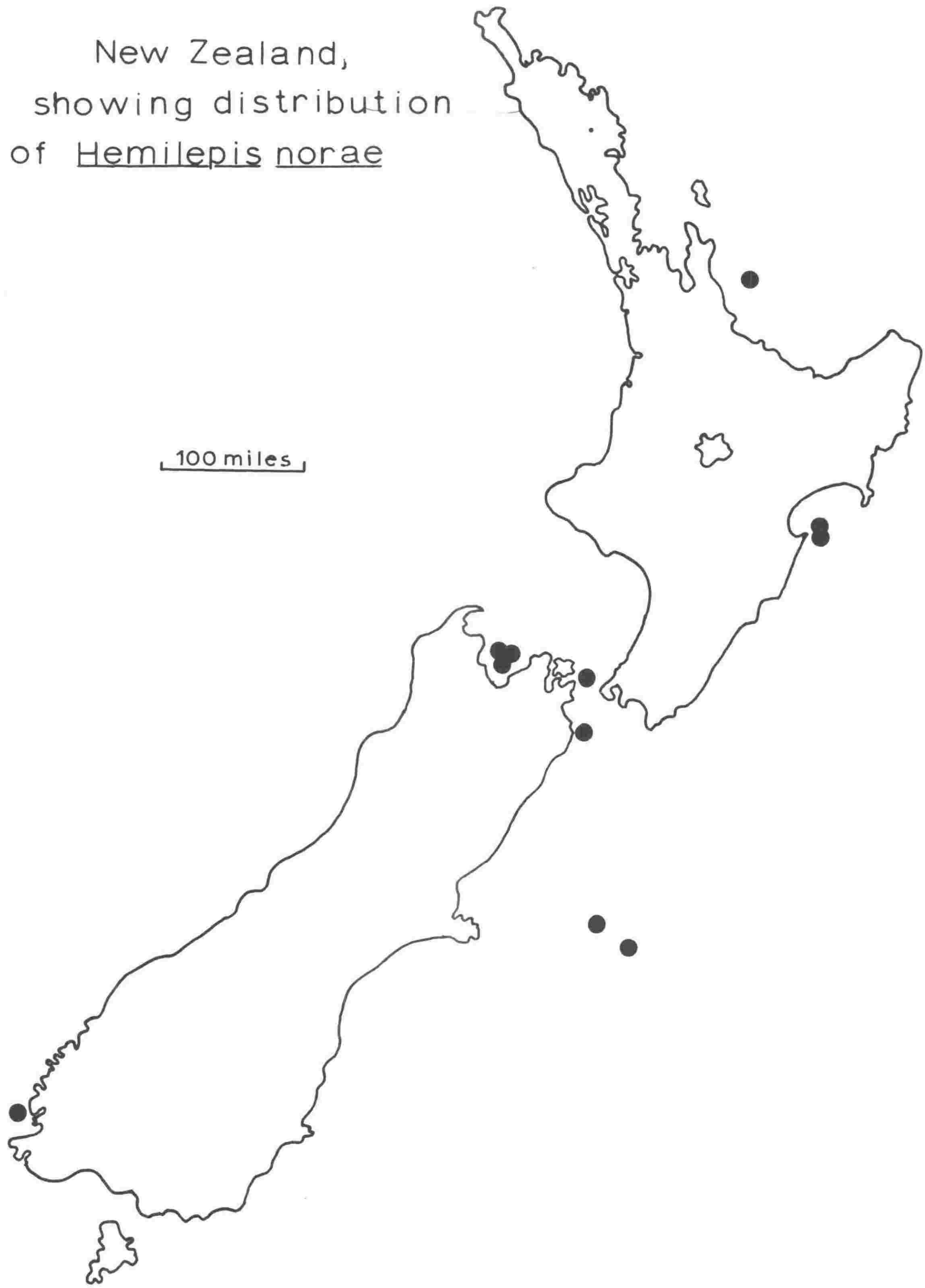
Material Examined: Tasman Bay, 18 fathoms, 5/8/1963, ca. 200 specimens; Tasman Bay, 25 fathoms, 3/8/1963, ca. 40 specimens; Tasman Bay, 24 fathoms, 31/7/1963, 2 specimens.

Remarks: The rich material of this species in the collection enables the status of Hemilepis abernethyi Fell to be determined with certainty. Fell (1951, 1952) has suggested that H. norae and H. abernethyi may rather represent limiting points of a cline than separate species. In a more recent paper, Fell (1958) records several specimens of H. norae from various bathyal stations about the New Zealand coast, and from the Chatham Rise, suggesting that H. abernethyi may represent a more robust form of H. norae, perhaps confined to the shelf.

H. norae as originally described has the radial shields

PLATE XIX

New Zealand, showing distribution of <u>Hemilepis norae</u> (Benham) = <u>H. abernethyi</u> (Fell)).


New Zealand,
showing distribution
of Hemilepis norae
100 miles

separated by an intervening space which is but little broader than the width of one shield, and occupied by five to seven mosaic platelets. The lateral arm plates each bear four arm spines. H. abernethyi has the radial shields widely separated, the intervening space occupied by about 25 to 30 polygonal mosaic platelets of varying size. Lateral arm plates each bear five arm spines, the upper four directed outwards from the arm, the lowermost directed distally, parallel to the axis of the arm. (Fell, 1951).

Present material comprises specimens with a disc diameter ranging from 3 mm to 13 mm. The space between the radial shields is filled by mosaic platelets, which generally increase in number as the size of the disc increases. Those specimens with a disc ca. 6-8 mm in diameter represent the "norae-stage", in which the radial shields are separated by approximately eight platelets. Larger specimens with a disc diameter of ca. 10-12 mm represent the "abernethyi-stage" in which the shields are separated by approximately 25 platelets. All intermediates between the "norae-stage" and the "abernethyi-stage" are here represented. A small number of specimens were seen to retain the "norae-stage" of development even when a disc diameter of 11 mm has been reached, but these are quite rare.

The upper side of the disc of a juvenile specimen of disc diameter 3 mm shows clearly the original embryonic primary plates (Pl.XX, fig.1). The centrodorsal, basal and radial plates are conspicuous, and lie very close together. Fell (1951) notes that these primary plates are visible in large specimens, but have become widely separated as a result of the interpolation of smaller scales between the plates.

The numbers of armspines are subject to some variation. Most specimens have four armspines, carried on the lateral armplate. Juveniles, with a disc diameter of 3 mm, generally have three to four, while large specimens with a disc diameter of 10-13 mm commonly have five, and often have four. A survey of present material revealed that seven specimens of 9-11 mm disc diameter have five armspines on the first few proximal arm joints, and the number is reduced to four on the remainder of the arm. Clearly, then, such variation somewhat detracts from the importance of armspine numbers as a diagnostic character in this complex of forms.

On the basis of the evidence afforded by the present material, it is therefore concluded that _H. norae_ and _H. abernethyi_ represent growth stages of the same species (_H. norae_), a species which can vary in the number of platelets between the radial shields, and also in the numbers of armspines. This variation appears not to be connected with environmental factors as the "_norae-stage_", the "_abernethyi-stage_" and intermediate stages may be taken from the same area, and in the same depth. _H. abernethyi_ may thus be interpreted as a large specimen of _H. norae_.

Hemilepis norae may be diagnosed as follows:

A single outer oral papilla, widely separated from the infradental papilla. Two tentacle scales. No spines on the

the disc. Adoral surface of disc naked, or with incomplete covering of scales. Radial shields separated by numerous platelets (5-30). Four to five armspines. Colour in life bright orange; when dried disc greenish or grey, arms pink dorsally, white ventrally.

Distribution: The known distribution of H. norae is given in Plate XIX. The bathymetric range is from 10 fathoms to 300 fathoms.

Monamphiura spinipes (Mortensen)

Amphiura spinipes Mortensen, 1924, p.134, figs.15b, 16a-c.

Material Examined: 1 specimen.

Remarks: The single specimen agrees in all respects with the description given by Mortensen (1924). The closely related species M. magellanica (Ljungman) is also known from Cook Strait, but is not represented in the present collection. The species are distinguishable on the basis of their armspines, which are less robust in M. spinipes than in M. magellanica. Also M. magellanica is viviparous and hermaphroditic, while M. spinipes apparently has a typical pelagic larva (Mortensen, 1924).

M. spinipes is distributed throughout the New Zealand region, from north of Cape Maria van Diemen to Stewart Island. Its previous known bathymetric range was from 22 metres to 117 metres. Thus the present depth record (151-180 metres)

PLATE XX

<u>Hemilepis</u> <u>norae</u> (Benham), <u>Ophiactis</u> <u>resiliens</u> Lyman

<u>Hemilepis</u> <u>norae</u> (Benham)

Fig.1. Aboral surface of disc of juvenile specimen, showing embryonic primary plates.

<u>Ophiactis</u> <u>resiliens</u> Lyman

Fig.2. Dorsal aspect of arm, showing fragmented dorsal armplates.

Fig.3. Dorsal aspect of arm, showing entire dorsal armplates.

Abbreviations: b, basal plate; cd., centrodorsal; m.p., mosaic platelet; r., radial plate; r.s., radial shield.

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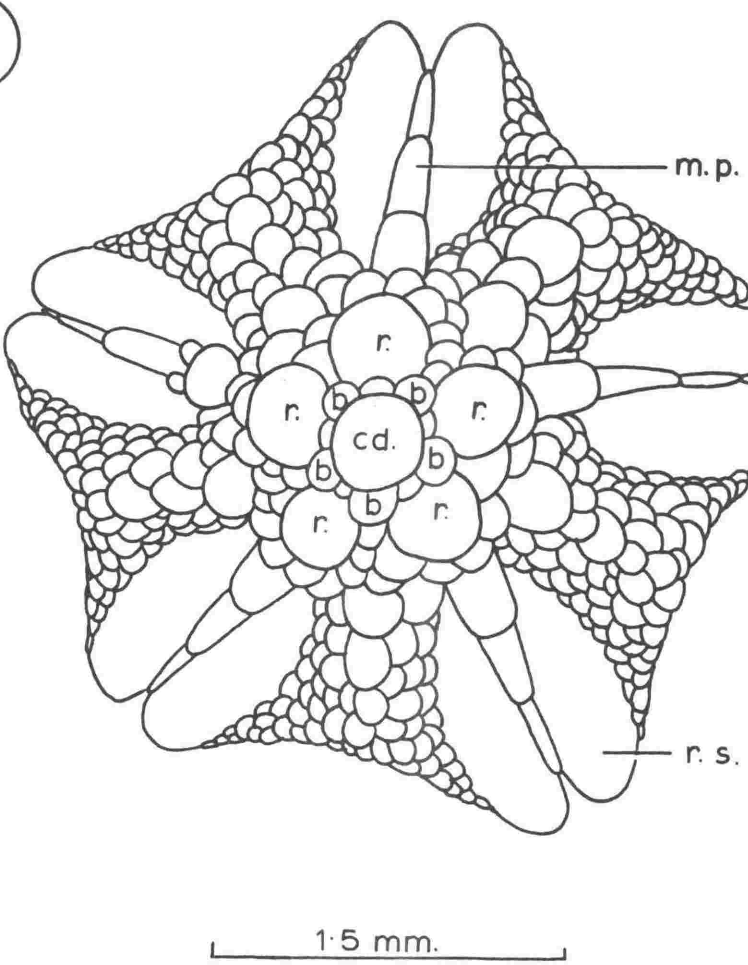

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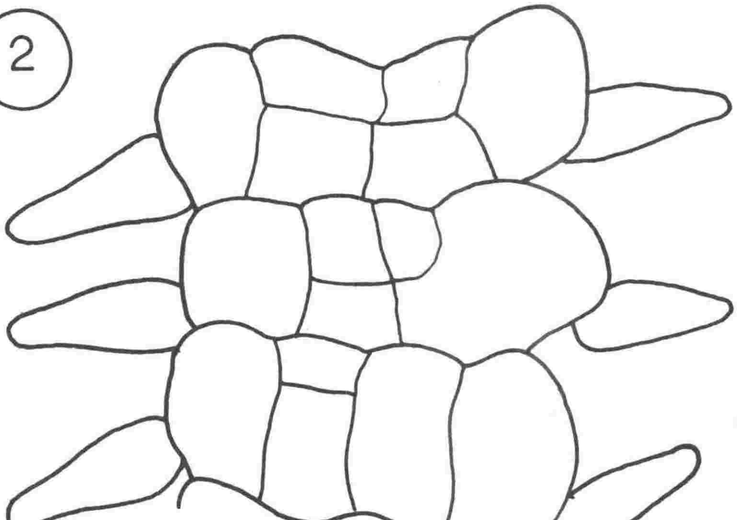

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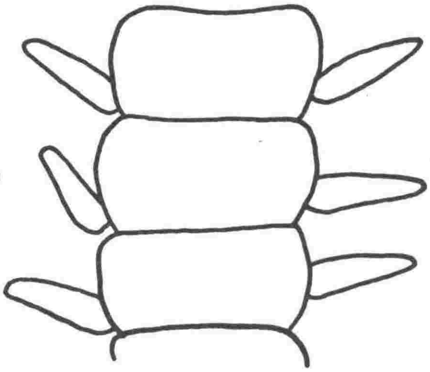

1 mm.
figs. 2,3.

extends the bathymetric range, but the species appears to be restricted to the shelf.

Family Ophiocomidae Ljungman, 1867

Ophiocoma bollonsi Farquhar

Ophiocoma bollonsi Farquhar, 1908, p.108.

Material Examined: ca. 750 specimens.

Remarks: It is indeed remarkable that this large number of specimens was taken from a single station. Obviously O. bollonsi is the dominant macro-organism in the area sampled. Hurley (1959) has already described large populations of this species in Cook Strait, and underwater photographs of the sea-floor in nearby areas of Cook Strait at depths between 162 metres and 254 metres are shown in the same paper. In several of the photographs large numbers of Ophiocoma bollonsi are seen, together with aggregations of the white brachiopod, Liothyrella neozelanica Thomson. This same brachiopod species is also particularly numerous in the present collection.

O. bollonsi ranges the entire New Zealand region in depths between 9 metres and 630 metres.

Family Ophiochitonidae Matsumoto, 1915

Ophionereis fasciata Hutton

Ophionereis fasciata Hutton, 1872, p.2.

Material Examined: 1 specimen.

Remarks: A typical specimen of the species. O. *fasciata* is extremely common in the intertidal zone about the coast of Wellington. The species ranges from North Cape to Stewart Island, and previously the greatest depth at which the species was found is 36 metres. Its occurrence in 151-180 metres is therefore unexpected. Mortensen (1936) described *O. novaezealandiae* from 98 metres in Cook Strait, and thus the present material was at first thought to represent that species. However, the upper arm plates are twice as broad as long, the character of *O. fasciata*, and not as broad as long as in *O. novaezealandiae*.

Family Ophiactidae Matsumoto, 1915

Ophiactis resiliens Lyman

Pl.XX, figs.2, 3.

Ophiactis resiliens Lyman, 1882, p.115, Pl.XX, figs.7-9.

Material Examined: 1 specimen.

Remarks: The single specimen is quite large for the species, R = 37 mm, r = 4 mm. Clark (1946) notes that the arms may exceed 40 mm in length. Colour in alcohol, disc light brown, arms darker. In Farquhar's (1907) specimens of *O. nomentis* (= *O. resiliens*), some of the dorsal armplates were broken into several small irregular plates. Mortensen (1924) examined fourteen specimens of the species, and none have subdivided dorsal armplates, although such occur not uncommonly in Australian specimens of the species. The present specimen displays both complete (Pl.XVIII, fig.3) and subdivided (Pl.XVIII, fig.2) dorsal armplates, the subdivided plates being most common in the proximal part of the arm.

In all other respects the specimen agrees with the illustrations and description given by Mortensen (1924).

O. resiliens is known from southern Australia, where it ranges from the coast of New South Wales (and Lord Howe Island) south and west to Rottnest Island (Western Australia). In New Zealand the species is known from north of Cape Maria van Diemen to Cook Strait. Bathymetric range, intertidal to 210 metres. Mortensen (1924) notes that the eggs are "very small and numerous ... this species has a typical Ophiopluteus-larva". This species probably completed a trans-Tasman crossing as a larval stage, and has colonised especially the northern part of the North Island, spreading south to Cook Strait.

Family Ophiodermatidae Ljungman, 1867

Pectinura maculata (Verrill)

Pectinura maculata Verrill, 1869

Material Examined: 6 specimens.

Remarks: This well-known species is particularly common in certain areas, especially in the oyster beds of Foveaux Strait (Fleming, 1952). Large populations are known from shallow waters at Island Bay, Wellington, particularly where the seafloor is densely clothed with green algae (Ulva spp.). Analysis of stomach contents of specimens from these areas indicates that here this species is a predator and a scavenger. Fell (1952) has reported selective feeding on terrestrial plant material in specimens of this species from Dusky Sound in the southwest of the South Island.

P. maculata is distributed about the South Island of New Zealand, the southern portion of the North Island, and the Chatham Islands, ranging from the intertidal zone to depths of approximately 180 metres. No specimens have been taken from the bathyal zone.

Pectinura gracilis Mortensen

Pectinura gracilis Mortensen, 1924, p.173, figs.35.3-5, 36.

Material Examined: 40 specimens.

Remarks: Although this species is never found in great numbers in Cook Strait, it is common, being represented here in five of the nine stations. In the smallest specimen, R = 12.5 mm, r = 1.5 mm; ratio R/r, 8. In the largest specimen, R = 55, r = 6, ratio R/r, 9. The ratio R/r changes little with growth. The colour is typical, disc mottled grey and brown, arms banded grey and dark grey, lighter ventrally. Underside of disc and arms pale cream. Distributed about the South Island, Cook Strait and Auckland Islands. Bathymetric range, intertidal to 180 metres.

Family Ophiuridae Lyman, 1865

Ophiozonoida picta Clark

Ophiozonoida picta Clark, 1915, p.340, Pl.18, figs.3-4.

Material Examined: 4 specimens.

Remarks: Dimensions of smallest specimen R = 14.5 mm, r = 2 mm; ratio R/r, 7. Largest specimen R = 21 mm, r = 3 mm, ratio R/r, 7. Colour in alcohol, uniformly greyish-brown. Mortensen (1924) notes that this species probably has direct development.

O. picta ranges from North Cape south to Cook Strait, in depths ranging between the intertidal zone and 117 metres. The species is probably restricted to the shelf.

Subclass ASTEROIDEA

Family Luidiidae

Luidia neozelanica Mortensen

Luidia neozelanica Mortensen, 1925, p.278, Pl.XII, fig.5.

Material Examined: 1 specimen.

Remarks: The specimen is broken into numerous fragments. The disc is complete, r = 15 mm. Mortensen (1925) gives the ratio R/r as ca. 10, therefore the arms in the present specimen were probably approximately 135 mm in length. Colour uniformly brown. The inferomarginal plates have 2-3 spines, a character which distinguishes this species from the uncommon northern species L. varia Mortensen.

L. neozelanica is distributed from the vicinity of Auckland to east Marlborough in depths ranging from 63 metres to 270 metres.

Family Astropectinidae

Psilaster acuminatus Sladen

Psilaster acuminatus Sladen, 1888, p.225, Pl.XL, figs.1-2, Pl.XLII, figs.7-8.

Material Examined: 6 specimens.

Remarks: The specimens are typical of the species, which is abundant in some parts of Cook Strait. Fell (1952) records 377 specimens from a single haul near Cape Campbell at a depth of 90 metres.

P. acuminatus is widespread in southern latitudes, having been recovered from off South Africa, South Australia, Tasman Sea, and New Zealand. Within the New Zealand region it is known from Napier south to Cook Strait. Bathymetric range 36-1710 metres.

Family Odontasteridae

Odontaster benhami (Mortensen)

Peridontaster benhami Mortensen, 1925, p.288, Pl.XII, figs.12-13.

Material Examined: 20 specimens.

Remarks: Smallest specimen R = 4 mm, r = 2 mm; ratio R/r, 2. Largest specimen R = 20 mm, r = 10 mm; ratio R/r, 2. In all specimens the colour is bright orange, lighter on the actinal surface of the body. *C. benhami* ranges from Cook Strait to Foveaux Strait, in depths of 36-450 metres.

Family Goniasteridae

Pseudarchaster sp.

Material Examined: 2 specimens.

Remarks: The two specimens are of equal size, R = 49 mm, r = 13 mm; ratio R/r, 3.8. Fell (1958) has described two species of this widely distributed genus from Cook Strait. The present material differs from both these species in carrying a very small number of mucronate spines on the inferomarginal plates. The abactinal paxillae are somewhat similar to those in *P. garricki* Fell, but they are somewhat smaller. The species seems closely related to the type of the genus, *P. parelii* (Duben and Koren) which is known from the North Atlantic and North Pacific in depths of 15-2500 metres (Mortensen, 1927). Fell (pers. comm.) is at present reviewing the genus *Pseudarchaster*, and thus the specific identification of this material should be deferred until the review is completed. It is likely that these specimens represent the third species of the genus to be known from New Zealand.

Family Asteriidae

Sclerasterias mollis (Hutton)

Asterias mollis Hutton, 1872, p.4.

Material Examined: 5 specimens.

Remarks: Colour in life and in spirit deep orange. The specimens are typical, and in most cases the arms are detached from the disc.

S. mollis is common in Cook Strait, and is distributed from Cook Strait south to Foveaux Strait in depths ranging from 36 metres to 540 metres.

Coscinasterias calamaria (Gray)

Asterias calamaria Gray, 1840, p.179.

Material Examined: 1 specimen.

Remarks: The single specimen is small (R = 40 mm), light brown in colour. The species ranges the Indo-Pacific from the intertidal zone to about 90 metres. The present recorded depth, 151-180 metres, is consequently somewhat surprising, leading to the suggestion that the specimen may have accidentally strayed to the outer shelf.

In Wellington Harbour, C. calamaria grows to a large size (R = 200 mm), and is particularly common near wharves on a sandy bottom.

Allostichaster insignis (Farquhar)

Stichaster insignis Farquhar, 1895, p.203, Pl.XIII, fig.1.

Material Examined: 8 specimens.

Remarks: The collection includes four juveniles of R =

3 mm. A. insignis ranges from Cook Strait south to Foveaux Strait, and is also known from Auckland Islands, Chatham Islands and the Snares, in depths between the intertidal zone and 45 metres. As is the case in Coscinasterias calamaria, the present depth of 151-180 metres does not represent the normal habitat for this species. Fell (1958) has described A. insignis var. gymnoplax from off Otago in 216 metres, but this may in fact represent a separate species.

Class ECHINOIDEA

Family Temnopleuridae

Pseudechinus novaezealandiae (Mortensen)

Notechinus novaezealandiae Mortensen, 1921, p.153, Pl.VI, figs. 7-10, Pl.VII, figs.4, 5, 7-11.

Material Examined: 9 specimens.

Remarks: All specimens are juveniles, the largest having a h.d. of 11 mm. The test is light yellowish, green medially in ambs and interambs. Apical system light green, radioles yellowish to light green.

P. novaezealandiae ranges from Cook Strait south to Stewart Island, and the species is also known from the southern islands of New Zealand, and Macquarie Island (see p. 201). Bathymetric range 10-306 metres.

Family Spatangidae

Echinocardium cordatum (Pennant)

Echinus cordatus Pennant, 1777, Brit.zool., (4), p.69.

Material Examined: 2 specimens.

Remarks: This virtually cosmopolitan species has a pelagic larval stage. In New Zealand the species is recorded from Auckland south to Stewart Island, in depths ranging from 6 metres to 234 metres. Recent benthic investigations in Wellington Harbour revealed the presence of extremely large populations of this species, especially in a sandy-muddy bottom at a depth of ca. 15 metres.

Class HOLOTHUROIDEA

Family Phyllophoridae

Pentadactyla longidentis (Hutton)

Thyone longidentis Hutton, 1872, p.16.

Material Examined: 1 specimen.

Remarks: The specimen is partially digested, having been removed from the gut of a snapper (Chrysophrys auratus Forster). In the New Zealand region, holothurians do not appear to be extensively eaten by fish. This is the first record of P. longidentis from a fish stomach. Paracaudina chilensis Muller has also been taken from the gut of a snapper in Cook Strait. Bottom feeders such as the snapper may ingest small numbers of holothurians, but apparently holothurians are not a major part of their diet.

P. longidentis ranges from Cape Egmont to Christchurch, in depths between 6 metres and 720 metres.

Family Stichopodidae

Stichopus mollis (Hutton)

Holothuria mollis Hutton, 1872, p.15.

Material Examined: 4 specimens.

Remarks: The largest specimen is strongly contracted and autoeviscerated, with a total length of 68 mm. In all specimens the colour is dark brown dorsally, lighter ventrally. S. mollis is common on the coasts of south and west Australia, and in New Zealand ranges from Cook Strait south to Stewart Island. Bathymetric range intertidal to 270 metres.

DISCUSSION

The echinoderm fauna of Cook Strait has been studied by several workers, including Mortensen (1921, 1924, 1925), Fell (1952, 1958) and Pawson (1963). Although the fauna may be regarded as well known, it is indeed remarkable that such a small collection as the one described here can add so much to our knowledge of the fauna.

From the single station east of Tory Channel in 151-180 metres, four species previously known from depths of 117 metres or less, were taken. They are:

Monamphiura spinipes (usual depth range 22-117 metres)
Ophionereis fasciata (0-36 metres)
Coscinasterias calamaria (0-90 metres)
Allostichaster insignis (0-45 metres)

As a consequence of the steep marine profines in the area, these specimens may have accidentally strayed into deeper water.

The large populations of Ophiocoma bollonsi in Cook Strait as first recorded by Hurley (1959) are of great interest, and further ecological work should be undertaken here, as it has been done elsewhere (e.g. Thorson, 1957). The technique of underwater photography as applied by Hurley (1959) to the Cook Strait environment is of great value as a tool for ecological investigations.

Undoubtedly, there is still very much to learn about the Cook Strait echinoderms. The presence of what is probably a third Cook Strait species of the Atlantic-Pacific genus Pseudarchaster is also of great interest, and further points to the distinctly cosmopolitan aspect of the genera in the bathyal region of Cook Strait.

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THE ECHINOZOA COLLECTED BY THE ROYAL SOCIETY EXPEDITION TO SOUTHERN CHILE, 1958-9 - ECHINOIDEA

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ABSTRACT

The collection comprises the species *Arbacia dufresnei* (Blainville), *Pseudechinus magellanicus* (Philippi), and *Loxechinus albus* (Molina). Typical temnopleurid epistroma is now known to be present in juveniles of *Pseudechinus magellanicus*, and the disposition of the ocular plates in the apical system in this species is determined by the position of the anal aperture. The shallow water echinoid fauna of southern Chile includes the endemic genera *Loxechinus* and *Tetrapygus*, and genera with antarctic (*Tripylus*) and circumpolar (*Pseudechinus*) affinities.

INTRODUCTION

During late 1958 and early 1959, an expedition sponsored by the Royal Society carried out marine and terrestrial investigations in southern Chile. Littoral marine stations were established in three separate areas, namely:

1. Isla Chiloe (approx. 42°S.).
2. Puerto Eden to Punta Arenas (approx. 49°S. to 52°S.).

3. Isla Navarino and southern regions (approx. 55°S.).

These three areas, considered together, were expected to provide a good picture of the changes in flora and fauna along the Patagonian coastline. The present paper contains an account of the Echinoidea collected in the intertidal and sub-littoral zones by the marine biologist to the expedition, Professor G.A. Knox, of Canterbury University, Christchurch.

The collection contains 243 specimens, which represent three genera and three species. The three species are common in southern Chile and are typical of that area. Pseudechinus magellanicus (Philippi) is conspicuous in the collection, and is an interesting species of a southern genus which apparently originated in Australasia, and has spread to various subantarctic localities with the aid of the west wind drift. Loxechinus albus (Molina) is a large urchin with green test and green spines, and it is used extensively as food in the areas in which it occurs. The third species, Arbacia dufresnei (Blainville), has a characteristic green test and purple spines.

The echinoid fauna of southern Chile is not large, and the present collection represents a fair cross section of the known shallow water fauna.

I am grateful for the opportunity to study this collection, and would like to thank Professor G.A. Knox and the Royal Society for material collected during the Royal

Society Expedition to Southern Chile 1958-59.

MATERIAL EXAMINED

Echinoids were collected at the following stations:

Stn. 19. Puerto Eden, Isla Wellington, the point to the north of the FACh base, 49°08'20"S., 74°26'55"W.; intertidal granitic gneiss rocks, sheltered; hand collecting, also collection from Macrocystis fronds and holdfasts and sublittoral collection by diving; 29,30/11/1958.

Pseudechinus magellanicus (Philippi) 8 specimens.

Stn. 21. Puerto Eden, 49°08'30"S., 74°26'52"W; depth 16-18 metres, grey sand; dredge; 2/12/1958.

Pseudechinus magellanicus (Philippi) 5 specimens.

Stn. 22. Puerto Eden, off the mouth of the river to the south of the FACh base, 49°08'48"S., 74°26'48"W.; depth 6-8 m., grey sand with small stones; dredge; 3/12/1958.

Arbacia dufresnei (Blainville) 1 specimen

Pseudechinus magellanicus (Philippi) 8 specimens

Stn. 24. Puerto Eden, 49°08'41"S., 74°26'48"W.; depth 10-12 m., grey sand; dredge; 4/12/1958.

Pseudechinus magellanicus (Philippi) 2 specimens

Stn. 27. Isla Carlos, 49°09'35"S., 74°25'24"W.; collection from Macrocystis fronds and holdfasts;

5/12/1958.

Arbacia dufresnei (Blainville) 1 specimen

Pseudechinus magellanicus (Philippi) 67 specimens

Stn. 29. Isla Carlos, Puerto Eden, 49°08'38"S., 74°25'32"W.; intertidal gneiss rocks, semi-exposed; hand collecting; 6/12/1958.

Pseudechinus magellanicus (Philippi) 1 specimen

Stn. 33. Puerto Eden, 49°09'28"S., 74°26'06"W.; depth 11-12 m., sandy mud with *Mytilus* shell; dredge; 8/12/1958.

Pseudechinus magellanicus (Philippi) 17 specimens

Stn. 37. Caletta Lackawana, 49°10'32"S., 74°25'52"W.; depth 18 m., sand, rock, shell; dredge; 9/12/1958.

Pseudechinus magellanicus (Philippi) 1 specimen

Stn. 39. Puerto Eden, west side of Canal Sur, 49°09'52"S., 74°26'08"W.; intertidal boulder beach of granitic gneiss; hand collecting and collection from *Macrocystis* fronds and holdfasts; 9,11/12/1958.

Arbacia dufresnei (Blainville) 6 specimens

Pseudechinus magellanicus (Philippi) 9 specimens

Loxechinus albus (Molina) 5 specimens

Stn. 40. Isla Dulce and Isla Levinson, Puerto Eden, 49°09'02"S., 74°25'10"W.; intertidal and sublittoral granitic gneiss rocks; hand collecting; 12,13/12/1958.

Pseudechinus magellanicus (Philippi) 5 specimens

Stn. 44. Puerto Eden, 49°08'16"S., 74°25'34"W.; depth 3-5 m., sand; 18/12/1958.

<u>Pseudechinus magellanicus</u> (Philippi) 7 specimens

Stn. 49. Bahia Munoz Gomera, 52°20'S., 73°32'W.; intertidal basaltic rock; hand collecting and collection from <u>Macrocystis</u> holdfasts; 26/12/1958.

<u>Pseudechinus magellanicus</u> (Philippi) 1 specimen

Stn. 50. Puerto Williams, Isla Navarino, 54°55'40"S., 67°39'W., intertidal boulder beach; hand collecting; 7/1/1958.

<u>Pseudechinus magellanicus</u> (Philippi) 1 specimen

Stn. 51. Puerto Williams, Isla Navarino, 54°55'30"S., 67°34'30"W.; intertidal argillite rocks; hand collecting and collection from <u>Macrocystis</u> fronds and holdfasts; 8,24,31/1/1959.

<u>Pseudechinus magellanicus</u> (Philippi) 6 specimens

<u>Loxechinus albus</u> (Molina) 2 specimens

Stn. 52. Puerto Robalo, Isla Navarino, 54°55'50"S., 67°41'40"W.; intertidal argillite rock; hand collecting and collection from <u>Macrocystis</u> fronds and holdfasts; 10,16,23,30/1/1959.

<u>Arbacia dufresnei</u> (Blainville) 3 specimens

<u>Pseudechinus magellanicus</u> (Philippi) 17 specimens

Stn. 57. Isla Hermite, Caleta San Martin, 55°51'S., 67°32'W.; intertidal granitic rock; hand collecting; 13/1/1959.

<u>Loxechinus albus</u> (Molina) 1 specimen

Stn. 66. Puerto Williams, Isla Navarino, 54°55'35"S., 67°36'50"W.; depth 2-4 m., grey mud with boulders; dredge; 22/1/1959.

<u>Pseudechinus magellanicus</u> (Philippi) 7 specimens

Stn. 68. Puerto Williams, Isla Navarino, 54°55'40"S., 67°36'50"W.; depth 0-5 m., collection by diving; 29/1/1959.

<u>Pseudechinus magellanicus</u> (Philippi) 34 specimens

Stn. 70. Isla Bertrand, 55°14'30"S., 67°55'40"W.; intertidal granitic rock, very exposed; hand collecting; 4/2/1959.

<u>Loxechinus albus</u> (Molina) 8 specimens

Stn. 73. Seno Grandi, small island opposite Puerto Grandi, 55°15'S., 67°56'W.; collection from <u>Macrocystis</u> fronds and holdfasts; 5/2/1959.

<u>Pseudechinus magellanicus</u> (Philippi) 12 specimens

Stn. 74. Seno Grandi, peninsula on Isla Navarino opposite Puerto Grandi, 55°11'20"S., 67°56'W.; collection from <u>Macrocystis</u> fronds and holdfasts; 5/2/1959.

<u>Pseudechinus magellanicus</u> (Philippi) 5 specimens

Stn. 75. Seno Grandi, point on Isla Navarino east of Rio Grande, 55°11'20"S., 67°52'30"W.; intertidal volcanic rocks, sheltered; hand collecting; 5/2/1959.

Pseudechinus magellanicus (Philippi) 1 specimen

Stn. 77. Puerto Grandi, Isla Bertrand, to the west of the wharf, 55°12'S., 67°55'30"W.; intertidal granitic rocks and boulder beach, semi-sheltered, hand collecting; 7/2/1959; collection by diving among *Macrocystis*; 8/2/1959.

Pseudechinus magellanicus (Philippi) 2 specimens

ECHINOIDEA

Family ARBACIIDAE Gray, 1855

Arbacia Gray, 1835

Diagnosis: Test of medium size, solid, low hemispherical or subconical, flattened adorally. Amb plates compound, trigeminate, pore zones straight, narrow above the ambitus, conspicuously widened adorally. Primary amb tubercles in regular series throughout. Interamb primaries numerous, arranged in vertical and horizontal series. A conspicuous naked space adapically in the interambs. No secondary tubercles. Epistroma may be conspicuously developed. Apical system dicyclic, or with one to three of the oculars insert.

Type Species: *Arbacia lixula* (Linnaeus)

Remarks: This well defined genus contains seven species, of which Arbacia dufresnei (Blainville) and A. spatuligera (Valenciennes) are known with certainty from southern Chile. The latter species is unfortunately not represented in the present collection.

Arbacia dufresnei (Blainville) Pl.XXI, fig.1

Arbacia dufresnei Mortensen, 1935, p. 579 (complete list of references); Mortensen, 1936, p. 215; Mortensen, 1952, p. 8; Bernasconi, 1953, p. 13, Pl. V, Pl.VI, figs. 8-10, Pl.VII fig.4., Pl.VIII, figs.7-11.

Diagnosis: Denuded test green, radioles purple.

Material Examined: Stn.22, 1 specimen; Stn.27, 1 specimen; Stn.39, 6 specimens; Stn.52, 3 specimens.

Remarks: These are typical representatives of this well known and attractive species. The largest specimen has a horizontal diameter of 42 mm., and a height of 23 mm., while the smallest is 16 mm. h.d. and 7 mm. high. Two specimens (both from station 52) carry reproductive products on the aboral side of the test. In one case they are eggs, and in the other, sperms. This condition has been observed by others, including Studer (1880), and Mortensen (1936), the latter author noting that the occurrence is not uncommon. A specimen from station 39 is unusual in possessing seven anal valves (fig.1), while members of the family Arbaciidae characteristically have four. This single variant is apparently normal in all other respects. Jackson (1927) has reported considerable variation in the anal valves in *Arbacia punctulata*, at least 10% of the 10,000 specimens he examined having more or less than four anal valves. It is possible that a similar degree of variation exists in *A. dufresnei*.

The characteristic green colour of the test is darker in smaller specimens.

Distribution: *A. dufresnei* is known from the southern end of South America, from Rio de la Plata in the east to Puerto Montt in the west, Antarctica (Booth Wandel Island), and the Falkland Islands, in depths ranging from the intertidal zone to 315 metres.

Family TEMNOPLEURIDAE Agassiz, 1872

Pseudechinus Mortensen, 1903

Diagnosis: Test small to moderate, hemispherical to subconical. Amb plates trigeminate, pore arcs more or less erect. Each amb plate with a primary tubercle. Tubercles conspicuous in both areas; on the interamb plates larger secondaries may form horizontal series. Primaries in some species weakly crenulate. Apical system dicyclic, or with one or two oculars insert. Suranal plate distinct, anal aperture excentric.

Type Species: Pseudechinus albocinctus (Hutton)

Remarks: The genus Pseudechinus contains twelve species, all of which have a southern distribution. Six of the species are apparently restricted to the New Zealand region.

Fell (1958, 1962) has discussed the systematic position of this genus, consequent upon his discovery of weakly developed epistroma in three of the New Zealand species, namely *P. flemingi* Fell, *P. albocinctus* (Hutton) and *P. novaezealandiae* (Mortensen). As the presence of epistroma is an important temnopleurid character, there is therefore strong evidence for the retention of the genus in the Family Temnopleuridae. Mortensen (1943) had supplied some independent evidence in favour of this systematic position. No larval stages are yet known for this genus, but they should prove to be of the characteristic temnopleurid type.

Pseudechinus magellanicus (Philippi) Pl. XXI figs.2,3.

Pseudechinus magellanicus Mortensen, 1943, p. 232, figs. 125, 126a (complete list of references); Mortensen, 1952, p. 9; Bernasconi, 1953, p. 17, Pl.VII, figs.2-3, Pl.VIII, figs.1-6, Pl.XVIII, figs.3-4.

Diagnosis: Denuded test faintly red, radioles light red. Tubercles finely crenulate. Valves of globiferous pedicellariae each with one to two lateral teeth. Apical

PLATE XXI

Arbacia dufresnei (Blainville), *Pseudechinus magellanicus* (Philippi)

Arbacia dufresnei (Blainville)

Fig.1. Abnormal apical system with seven anal valves.

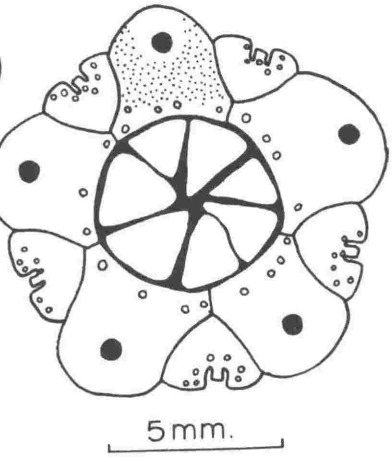
Pseudechinus magellanicus (Philippi)

Fig.2. Adapical surface of test of juvenile, showing epistromal ridges adapically in an amb.

Fig.3. Abnormal apical system, with ocular IV insert.

Abbreviation: OC.III, ocular III.

1



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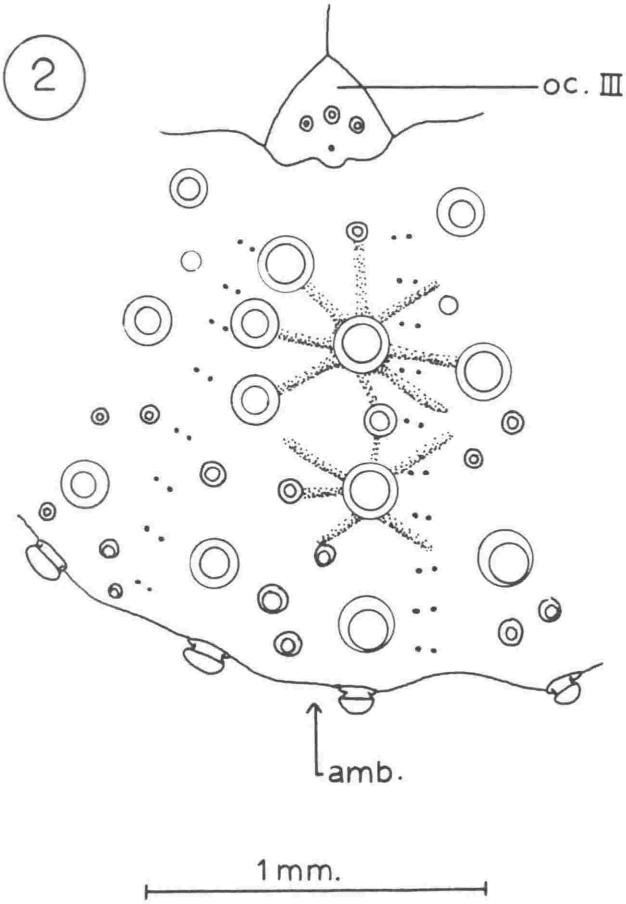

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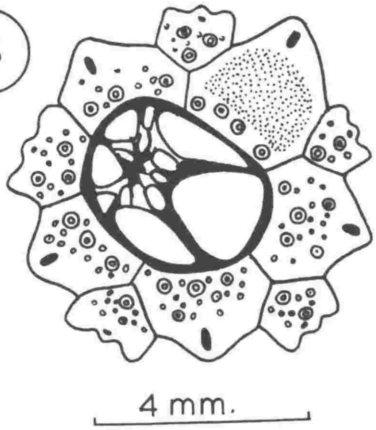

system with Ocular I insert. Suranal plate large, naked.

Material Examined: 216 specimens from the following stations: Stn.19, 8 specimens; Stn.21, 5 specimens; Stn. 22, 8 specimens; Stn. 24, 2 specimens; Stn.27, 67 specimens; Stn.29, 1 specimen; Stn.33, 17 specimens; Stn.37, 1 specimen; Stn.39, 9 specimens; Stn.40, 5 specimens; Stn.44, 7 specimens; Stn.49, 1 specimen; Stn.50, 1 specimen; Stn.51, 6 specimens; Stn.52, 17 specimens; Stn.66, 7 specimens; Stn.68, 34 specimens; Stn.73, 12 specimens; Stn.74, 5 specimens; Stn.75, 1 specimen; Stn.77, 2 specimens.

Remarks: The smallest specimen has a horizontal diameter of 4 mm, while the largest is 29 mm in diameter. Two distinct size groups are represented, the first comprising those specimens with a diameter of 4-10 mm, and the second those with a diameter of 17-29 mm. These probably represent two year-groups. Mortensen (1952) reported two size groups in a collection examined by him, but the groups comprised juveniles 2-5 mm in diameter and adults 12-15 mm in diameter.

The apical systems of fifty specimens were examined. A 6 mm h.d. specimen has two large suranal plates instead of the usual one, and these plates almost fill the periproctal space. In almost all cases, the anterior ocular plate (oc. III) is strongly exsert and oc. I is insert, while the anus tends to occupy a position posterior in the periproct, near oc. I. Some specimens show other ocular plates near the posterior end of the apical system to be almost insert (namely oc. II and V), while in a 27 mm h.d. specimen oc. I and II are broadly insert and oc. V is almost insert. The fact that oc. III remains the most strongly exsert of all the ocular plates agrees with the observations made by Fell (1963) on the tendency for the anus to migrate posteriorly, and the effects of this tendency on the plates of the apical system. In this context it is of some interest to note that a 23 mm h.d. specimen has an unusual apical system (fig.3), in which oc. IV only is insert, and while the anus is as usual ex-centric, it does not lie in its normal posterior position, but lies nearest oc. IV. Oculars I, II, III and V are here strongly exsert.

Small specimens were examined for traces of temno-pleurid epistroma, which has already been found in some other members of the genus Pseudechinus (see above). Epi-stroma are definitely present in P. magellanicus, at least in juvenile specimens. The smallest specimen in the col-lection (4 mm h.d.) showed weakly developed ridges radiating from the areoles of primary and secondary tubercles, esp-ecially in the ambulacra, near the apical system (fig.2). The remainder of the area is sculptured, so that in this aboral region the median sutures of the ambulacral plates cannot be seen. Slightly larger specimens show faint traces of epistroma, but these soon disappear as the animal grows. This parallels the situation in P. novae-zealandiae and P. albocinctus, where the epistroma disappears before maturity is reached (Fell, 1958, p. 36).

The stomach contents of several specimens consisted almost entirely of fragments of a brown alga, probably Macrocystis. This species appears to be a predominantly vegetarian browser.

Distribution: P. magellanicus is well known from the southern end of South America. To the east the northern limit of its range is about 35°S. (Rio de la Plata) and to the west the northern limit is about 41°S. (Puerto Montt). The species also occurs at Tristan da Cunha. It is extremely common in some areas, and appears to favour life in the Macrocystis zone, where it may be found in large numbers on the fronds of Macrocystis.

Family STRONGYLOCENTROTIDAE Gregory, 1900

Loxechinus Desor, 1856

Diagnosis: Test strong, large, hemispherical. Amb plates polyporous, 7-10 pore pairs to each arc; pore zones broad, not widened adorally. A primary tubercle to each amb plate. Tuberculation coarse, secondaries well developed. Apical system dicyclic, or with oculars I and V insert.

Type Species: Loxechinus albus (Molina)

Remarks: This genus is monotypic.

<u>Loxechinus albus</u> (Molina)

<u>Loxechinus albus</u> Mortensen, 1943, p. 172 (complete list of references), Pl.LVII, figs.18-19; Mortensen, 1952, p. 10; Bernasconi, 1953, p. 23, Pl.VII, fig.1, Pl. XI, Pl.XII, figs.1-9.

Diagnosis: As for the genus.

Material Examined: Stn.39, 5 specimens; Stn.51, 2 specimens; Stn.57, 1 specimen; Stn.70, 8 specimens.

Remarks: The largest specimen has a horizontal diameter of 82 mm and a height of 40 mm, and the smallest has a diameter of 23 mm and height 13 mm. In all cases the radioles are green, and the denuded test is faintly purple admedially in the ambs and interambs, green elsewhere.

Distribution: This species is known to occur on the west coast of southern South America, Callao in Peru being the northern limit of its range. While its depth range is 0-340 metres, it is most commonly found in the littoral zone, where it may be extremely common.

DISCUSSION

In area 1 (Isla Chiloe, stns. 1-19), no echinoids were collected, although Professor Knox (pers.comm.) notes the presence of a common sea urchin (probably *Loxechinus albus*) on rocky coasts. Isla Chiloe lies near the northern limit of the range of *Pseudechinus magellanicus*, and it is possible tl that this species is not particularly common there.

The three species in the collection were taken from the other two areas, namely Puerto Eden to Punta Arenas (stns. 19-49) and Isla Navarino (stns. 50-78), where they are all represented in the rocky infralittoral zone.

Species not represented in the collection, but known to occur in southern Chile include the arbaciid *Tetrapygus niger* (Molina), and the schizasterids *Tripylus excavatus* Philippi and *Tripylaster philippi* (Gray).

The known echinoid fauna of this region is related to the faunas of other subantarctic or cold temperate localities at the generic level. *Pseudechinus* is a southern genus, with species on many subantarctic islands. *Arbacia* appears to have the west coast of South America as its home, whence species have spread to the east coast, presumably by way of pre-Pliocene Panama sea-routes, and to the Atlantic coast of Africa (Mortensen, 1935).

The genera *Loxechinus* and *Tetrapygus* are monotypic, and their species are known only from the southwestern coast of South America. *Tripylus* is a genus which has three species in the Antarctic seas, and a single species is known from the southern end of South America. Northern genera are not conspicuous in the shallow water fauna.

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A NEW CIDAROID FROM NEW ZEALAND WATERS

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ABSTRACT

A new species of Goniocidaris is described from specimens collected near Three Kings Islands, New Zealand, at a depth of 135 metres. It is nearly related to G. tubaria (Lmk.), falling in the typical subgenus Goniocidaris s.s., in which no basal disc is developed on the radioles.

INTRODUCTION

Two species of Goniocidaris have hitherto been reported from New Zealand. One, G. umbraculum Hutton, having a terminal disc on apical radioles and basal spurs, falls in the typical subgenus Goniocidaris s.s. The other, G. parasol Fell, having terminal and basal discs on the radioles, falls in the subgenus Aspidocidaris.

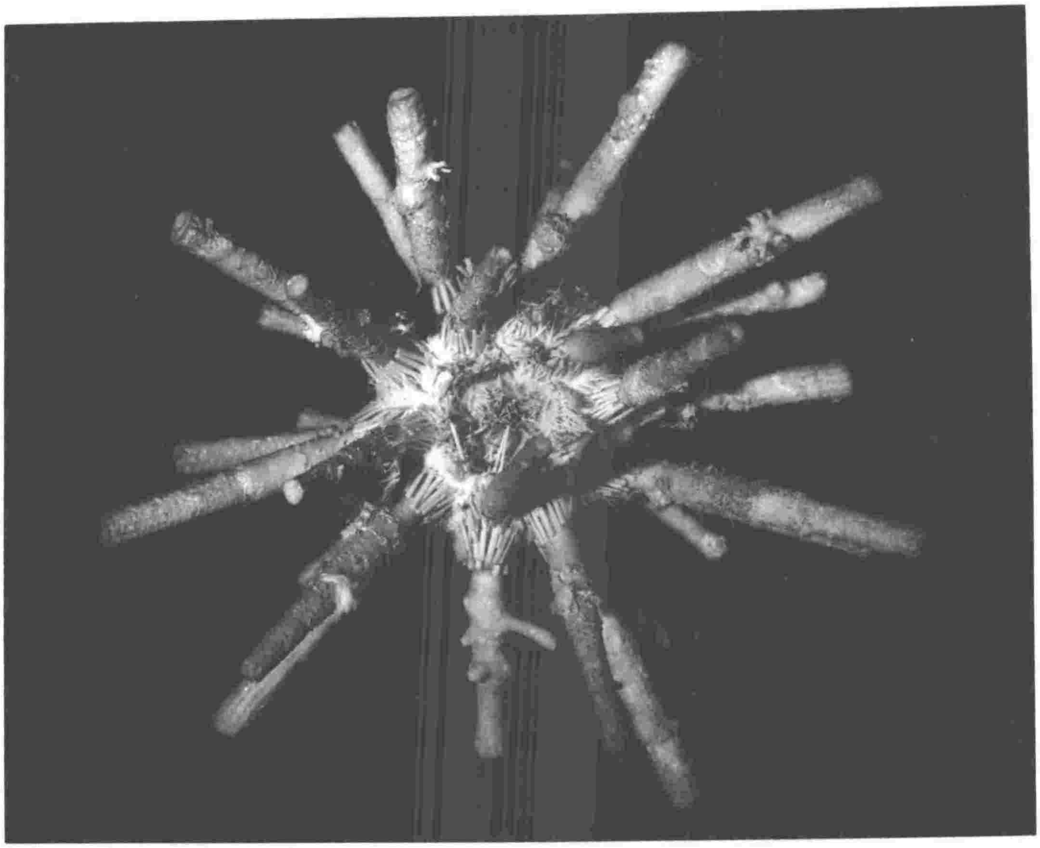
During the course of routine investigations of the benthos of the New Zealand shelf, the New Zealand Oceanographic Institute trawled a benthic sample from 135 metres near Three Kings Islands. This sample contained ten specimens of what proves to be a new species of Goniocidaris. The character of the adapical radioles

PLATE XXII

Goniocidaris magi n.sp.

Upper: Holotype, aboral aspect.

Lower: Paratype, denuded test, lateral aspect.



indicates near affinity to the Australian species Gonio-cidaris tubaria (Lamarck).

Family Cidaridae Gray, 1825

Goniocidaris Agassiz & Desor, 1846

Type Species: Cidarites tubaria Lamarck.

Goniocidaris magi n.sp. (Pls XXII, XXIII)

Description: Test flattened above and below, strongly arched. Ambitus rounded. Apical system slightly less than half h.d. Peristome half h.d. Ambs weakly sinuate, almost straight, ca. 25% as broad as interambs. Five to six amb plates to each interamb plate (Pl.XXIII fig.1). The interporiferous area ca. four times broader than poriferous area. Pores oblique, sunken, but not conjugate. Marginal tubercles in vertical linear series, separated by spaces approximately equal to their diameters. A small internal tubercle is situated medial to the marginal tubercle and below it, lying near the lower suture. Internal tubercles well developed at the ambitus, tending to decrease in size adapically and adorally. Median ambulacral area sunken, naked, forming a continuous furrow.

Interambs with seven plates to each vertical series. Primary tubercles perforate, noncrenulate. The boss of each primary tubercle arises smoothly from the floor of the areole (Pl.XXIII fig.1). Areoles circular aborally, oval at the ambitus, tending to become confluent adorally.

Scrobicular tubercles of varying size, reduced along the horizontal sutures. Secondary tubercles present in small numbers, confined to the admedian border of the scrobicular ring. The remainder of the admedian area sunken and naked. The admedian upper and lower borders of the plates are also sunken, so that the zigzag median vertical furrow subtends short horizontal furrows at the levels of the horizontal sutures.

Primary radioles of variable form, with a length of 80-130% h.d. Adapical radioles cylindrical, finely spinous, in most cases covered by a layer of thin glass-like hairs. The hairs are elongate, tapering to a sharp point. The shaft is expanded distally as a weakly developed crown (Pl.XXIII fig.2). Adoral radioles short (ca. 6.0 mm), flattened, blade-like (Pl.XXIII fig.3), smooth on one surface, spinous on the other. Scrobicular spines elongate, weakly curved, broadening slightly towards the distal extremity, which is flat, not convex or excavate. Paired basal spurs mostly lacking, when present more common on adoral primaries than elsewhere (Pl.XXIII fig.4).

Test and scrobicular spines creamy-white, primary radioles white.

Variation: The smallest specimens (6.5 mm and 7 mm h.d.) carry basal spurs on many of their primary radioles. These spurs appear to be lost as the animals grow, until the radioles in the largest specimen (13 mm h.d.) virtually lack basal spurs.

Holotype: The holotype and two paratypes are lodged in the collection of the New Zealand Oceanographic Institute, Wellington. Dimensions - Holotype: horizontal diameter 13 mm, height 7 mm. Paratypes - (1) h.d. 13 mm, height 7 mm, (2) h.d. 19 mm, height 10 mm.

Material Examined: NZOI Stn. B93 22/9/1958. Off Three Kings Islands, 33°59' S., 172°21' E.; 75 fathoms; beam trawl; 10 specimens.

Affinities of the species: Goniocidaris magi is apparently related to the Australian species G. tubaria (Lamarck) and the New Zealand species G. umbraculum Hutton.

The test of G. magi most closely resembles that of G. umbraculum, the differences between the two species being that G. umbraculum has 8-9 interamb plates to each vertical series and 6-7 amb plates to each interamb plate (Fell, 1954) whereas G. magi has 7 interamb plates to each vertical series, and 5-6 amb plates to each interamb plate. Also, there are two internal tubercles in G. umbraculum (Fell, 1954) and only one in G. magi. These differences in test structure are not reliable, as smaller specimens of G. umbraculum may have but one internal tubercle (Fell, 1954), and it is probable that relative

PLATE XXIII

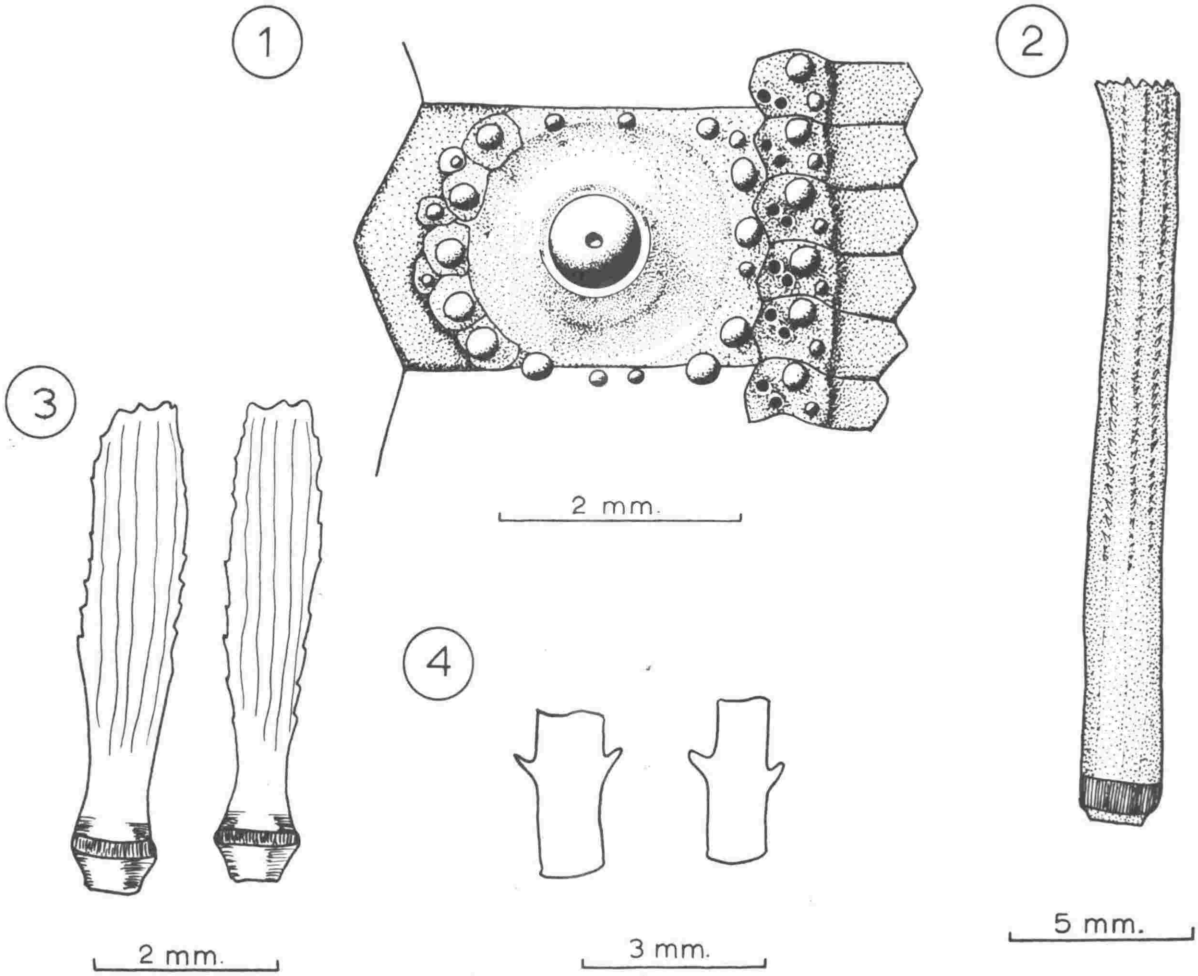
Goniocidaris magi n.sp.

Fig.1. Ambital interamb plate with adjacent amb plates.

Fig.2. Adapical primary radiole.

Fig.3. Adoral primary radioles.

Fig.4. Portions of adoral primaries with basal spurs.


1
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2 mm.
3
4
2 mm.
3 mm.
5 mm.

numbers of plates may change with growth. The chief distinguishing characters lie in the adapical primary radioles, which have terminal discs in _G. umbraculum_, while in _G. magi_ there are no terminal discs, merely weakly developed crowns. Basal spurs, normally present in _G. umbraculum_, tend to be lacking in _G. magi_.

In _G. tubaria_ the marginal tubercles are contiguous, and there are 3-5 internal tubercles (Mortensen, 1928). Secondary tubercles are more numerous in _G. tubaria_ than in _G. magi_. Also, the interporiferous area is wider in _G. tubaria_ than in _G. magi_. The primary radioles in _G. magi_ lack the conspicuous thorns which are so characteristic of _G. tubaria_, and the distal extremity of the scrobicular spines in the former species is flat, not excavate, as it is in _G. tubaria_.

It is evident that the species here described is distinct from the two species with which it has been compared, but it is interesting to consider the similarities between the species. _G. magi_ has spines which more closely resemble _G. tubaria_ (except for the presence of basal spurs in young specimens), yet the test is almost identical to that in _G. umbraculum_. Colour also provides a base for distinction between the three species, for the creamy-white test in _G. magi_ is totally unlike the light to dark brown tests characteristic of _G. tubaria_ and _G. umbraculum_.

At the present time, three species of the genus

Goniocidaris are known to be living in New Zealand waters. They may be distinguished as follows:

1 (2) Primary radioles with a more or less developed basal disc . . . *G.*(*Aspidocidaris*) *parasol* Fell

2 (1) Basal disc lacking, but paired basal spurs may be present.

3 (4) Adapical primary radioles with well developed distal discs . . *G.*(*Goniocidaris*) *umbraculum* Hutton

4 (3) Adapical primary radioles lacking distal discs, but having weakly developed crowns . . . . *G.*(*Goniocidaris*) *magi* Pawson

I am grateful to Professor H.B. Fell of this Department for his advice, and for access to comparative material, also to Mr. M.D. King for photographing the specimens.

Literature Cited:

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FELL, H. BARRACLOUGH, 1954. Tertiary and Recent Echinoidea of New Zealand. Cidaridae. *N.Z. Geol. Surv. Pal. Bull.* 23.

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THE ECHINOID GENUS <u>CAENOPEDINA</u> IN NEW ZEALAND

By D.L. Pawson

Department of Zoology, Victoria University of Wellington

ABSTRACT

A new species of the genus *Caenopedina* is described from a specimen collected in the Bay of Plenty, New Zealand, at a depth of 324-426 metres.

INTRODUCTION

The genus *Caenopedina* is the sole extant member of the family Pedinidae (Subcl. Euechinoidea, Order Echinothurioida), whose fossil representatives were wide ranging from Jurassic to Miocene in the Northern Hemisphere. In the Southern Hemisphere, two fossil species are known, one from Madagascar (Upper Jurassic) and one from Patagonia (Miocene). *Caenopedina* is not a large genus, containing ten species, of which eight are known from the Indo-Pacific, one from the Atlantic Ocean, and one from the Gulf of Panama (Mortensen, 1940). These species are all deep sea forms, and some have a wide geographic range. In spite of this mode of life, no representatives of the genus are known from near Australia, and none have hitherto been recorded from New Zealand.

A small collection of echinoderms was recently obtained in the Bay of Plenty, New Zealand, by a commercial fishing vessel. Through the courtesy of Mr. J. Costello of the Union Fish and Ice Co., Tauranga, a member of the Marine Department Fisheries Laboratory, Mr. D. Arthur, was on board the vessel, and he collected and preserved the echinoderms and kindly forwarded them to this laboratory for identification. The collection contained a handsome regular echinoid, which upon closer examination proves to be a new species of the genus Caenopedina.

I am grateful to the Marine Department for allowing me to examine this specimen, to Professor H.B. Fell of this Department for his advice, and to Mr. M.D. King for his care in photographing the specimen.

Caenopedina A. Agassiz, 1869

Type Species: Caenopedina cubensis A. Agassiz.

Caenopedina novaezealandiae n.sp. (Pls. XXIV, XXV)

Description: Test circular at the ambitus, flattened aborally, the sides strongly arched. Horizontal diameter 30 mm, height 16 mm. Apical system 15 mm (50% h.d.), peristome 12 mm (40% h.d.).

Ambs with fifteen plates to each column. At the ambitus, the ambs are approximately 30% of the width of the interambs. Amb plates trigeminate throughout, the pore pairs arranged in distinct arcs of three. The plate components are of approximately equal size. The middle component of each plate carries a conspicuous large primary

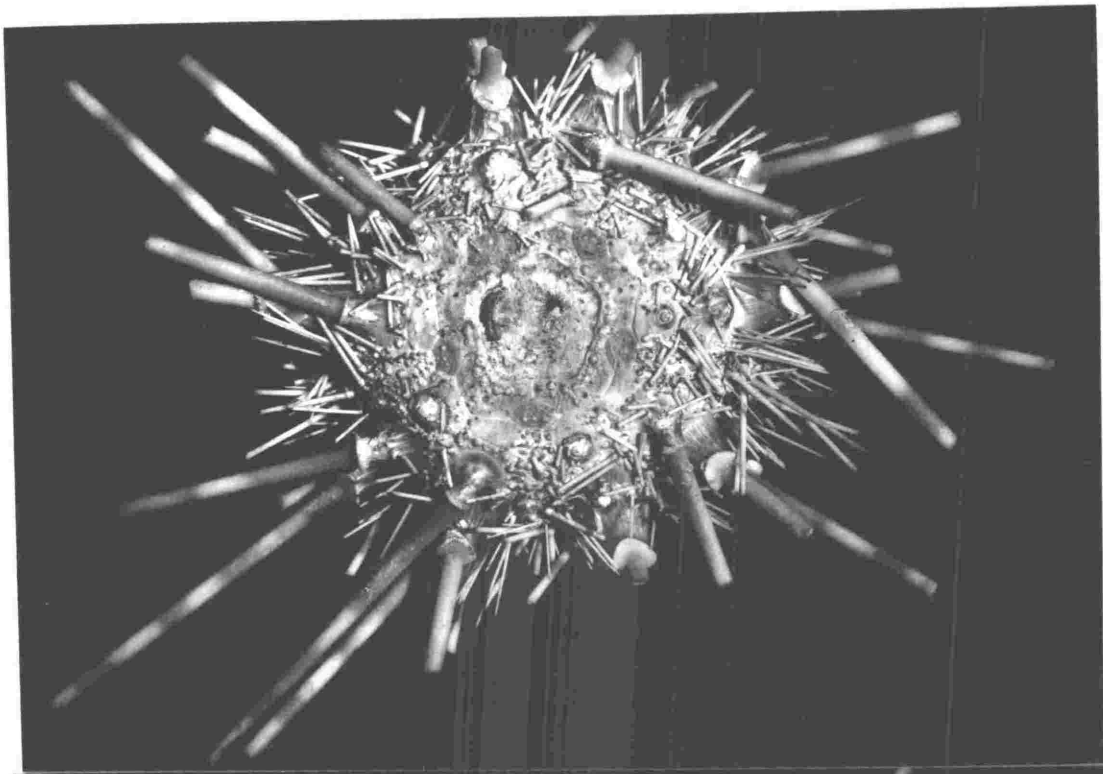
PLATE XXIV

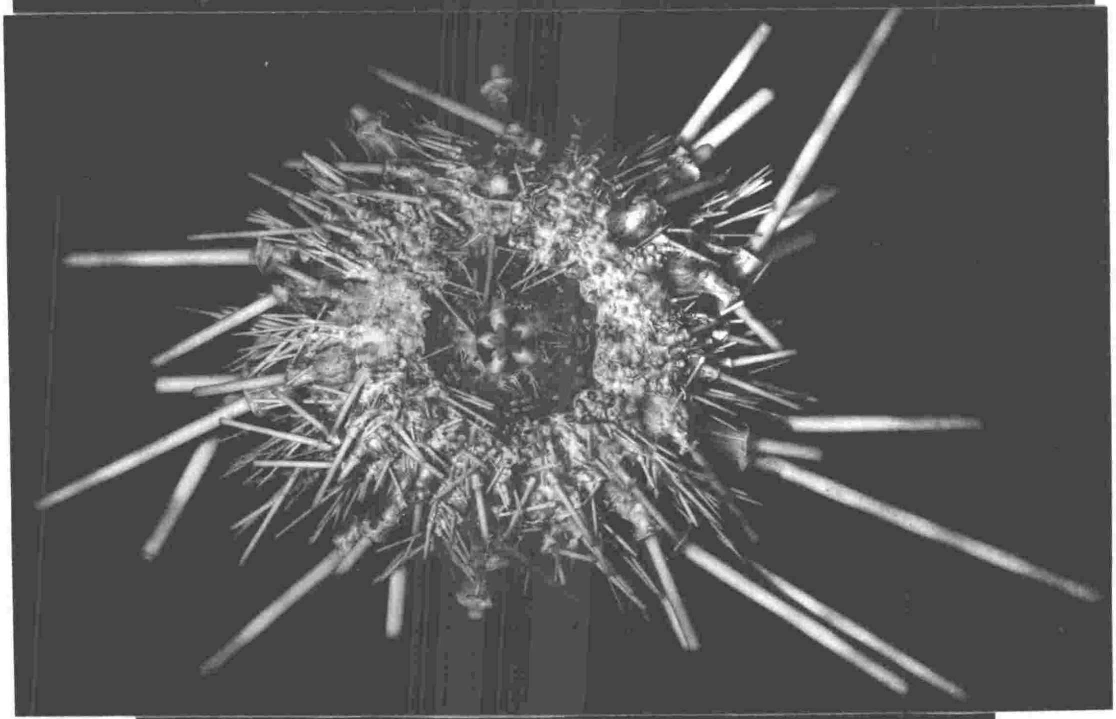
Caenopedina novaezealandiae n.sp.

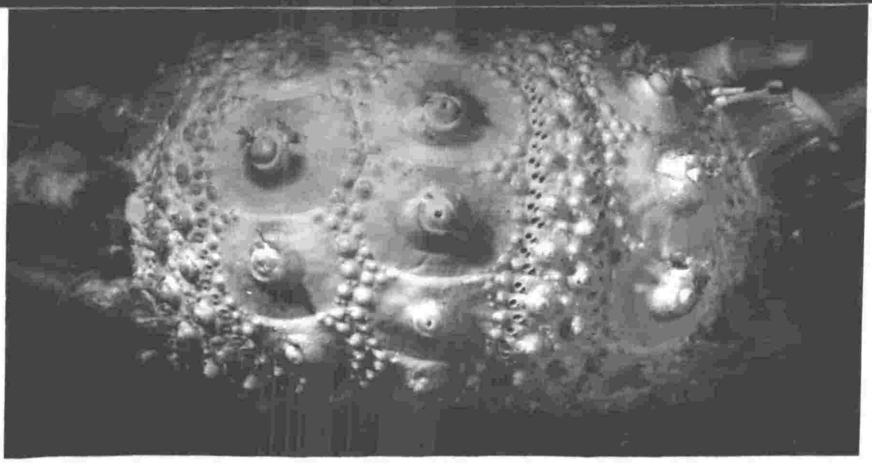
Upper: Holotype, aboral aspect.

Middle: Holotype, oral aspect.

Lower: Holotype, denuded test, lateral aspect.







tubercle, which has a broad areole. The tubercles are perforate, noncrenulate, in a regular vertical series in each column, decreasing gradually in size adapically. Secondary tubercles small, perforate, placed on the lower admedian edge of each plate, thus forming an inconspicuous zigzag line in the middle of the area. Smaller tubercles are sparingly scattered elsewhere (Pl.XXVfig.4).

Interambs with a single series of large primary tubercles in each column. The areoles are large and broadly confluent, so that secondary tubercles are confined to the admedian and adradial edges of the interamb plates. Primary and secondary tubercles perforate, noncrenulate. The areoles of the primary tubercles have a series of weak ridges extending from some secondary tubercles towards the primary tubercle. These ridges are more conspicuous on some plates than on others, and are more commonly present on the adradial side of the primary tubercle than on the admedian side. The median interamb suture is bordered by a conspicuous zigzag row of numerous secondary tubercles, and there is also a continuous row of secondary tubercles at the adradial edge of each column (Pl.XXV fig.4).

The apical system is large (50% h.d.), dicyclic, oculars all widely exsert. The genital pores are small, the madreporite compact. The genital plate carrying the madreporite is not conspicuously enlarged. The periproctal edge of the ring of genital plates is pentagonal in shape, bordered by a ring of closely aggregated tubercles. Some tubercles are placed outside this ring, and on three of the genital plates there is a single tubercle near the genital pore. Smaller tubercles which apparently carried pedicellariae are scattered on ocular and genital plates. The ocular plates characteristically have two tubercles, one to each side of the ocular pore. The periproct is covered by a large number of small plates, and carries fifteen scattered tubercles. The anal aperture is slightly excentric, posteriorly placed (Pl.XXV fig.1).

Primary radioles are long (the longest is 31 mm +), slender, smoothly tapering, longitudinally striated, densely clothed in small spinelets. The milled ring is broad, conspicuous, approximately twice the diameter of the spine at the base (Pl.XXV fig.2). Secondary radioles long (up to 11 mm), tapering, longitudinally striated, carrying numerous spinelets. The milled ring is conspicuous, but not as large in proportion as that of the primary radioles, nor as elegantly shaped (Pl.XXV fig.3).

The spicules in the tubefeet are very closely packed perforated plates of average length 0.2 mm, which have spinose marginal projections and a ridged surface (Pl.XXV fig.5).

The test is white, light brownish green near the apical system. The apical system is conspicuous, uniformly green, the tubercles lighter in colour; periproct grey. Primary radioles have broad, poorly defined bands of colour, the colours being definitely lighter on the oral sides of the radioles. Radioles green for approximately the first 10 mm of their length, darker green near the base. Following this there are bands of white, green and reddish brown in no particular order, the bands being up to 5 mm wide. Secondary radioles are white, sometimes faintly tinged with green at the tips.

Material Examined: 4/8/1963, 16 miles south-east of Mayor Island, Bay of Plenty, 180-240 fathoms, prawn net, 1 specimen.

Holotype: The holotype is lodged in the collection of the Dominion Museum, Wellington, New Zealand. Dimensions: horizontal diameter 30 mm; height 16 mm.

Remarks: Caenopedina novaezealandiae appears to be related to the species C. indica (De Meijere) of the Malay region and to C. mirabilis (Doderlein) from Japanese waters. Differences in test, apical system and colour characters can be used to separate these three species.

The ambs are narrow in C. novaezealandiae, being only 30% the width of the interambs, whereas in C. indica and C. mirabilis they are broader (40% and 50% respectively). The areoles of the primary tubercles are striated in C. novae-

PLATE XXV

Caenopedina novaezealandiae n.sp.

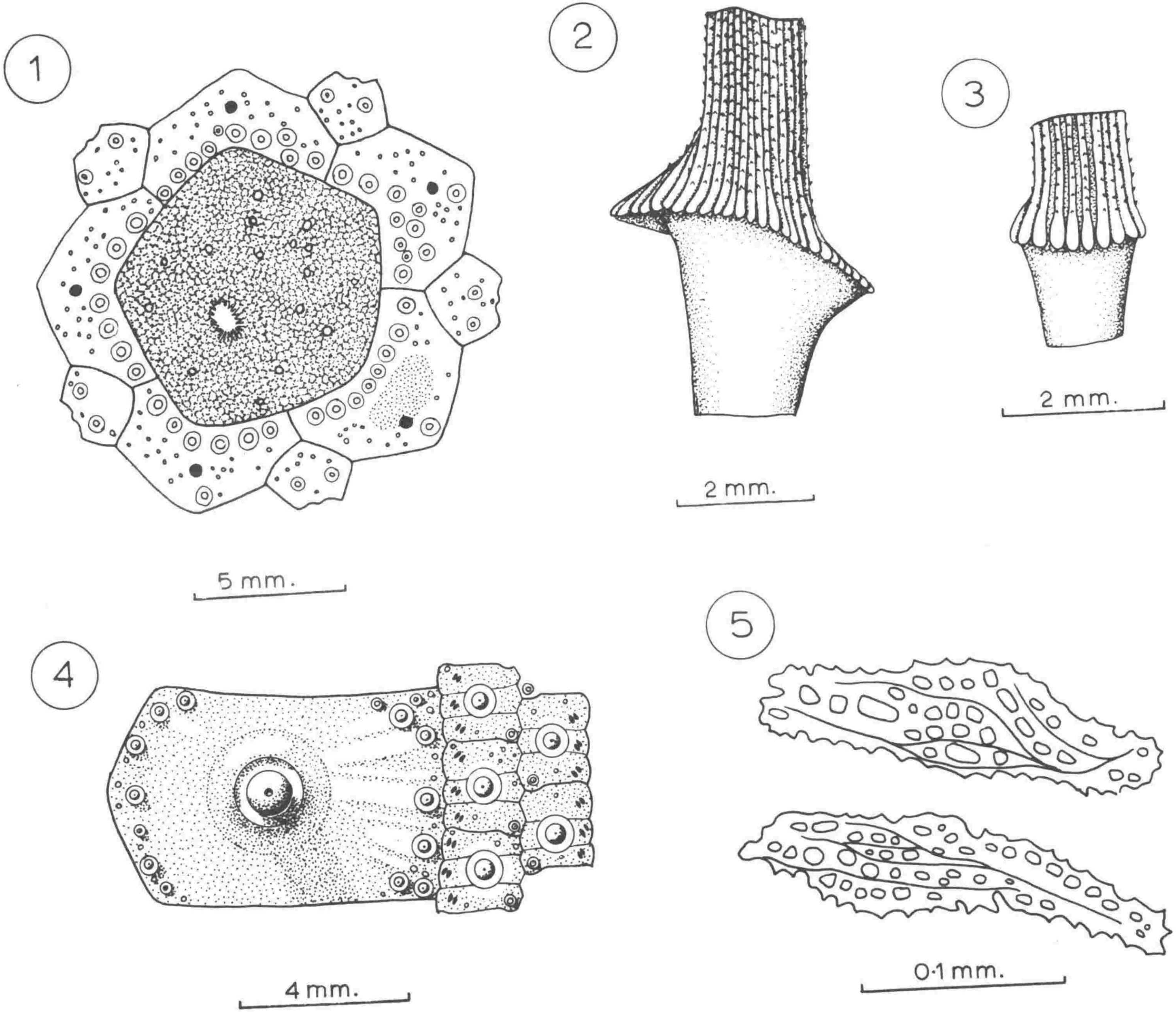
Fig.1. Apical system.

Fig.2. Milled ring of primary radiole.

Fig.3. Milled ring of secondary radiole.

Fig.4. Ambital interamb plate with adjacent amb plates.

Fig.5. Tubefoot deposits.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zealandiae and in C. mirabilis, but not conspicuously so in C. indica (Mortensen, 1940).

In the apical system, the tuberculation of the genital plates in C. novaezealandiae resembles that in C. indica, both species having a ring of closely aggregated tubercles near the periproctal edge. However, C. novaezealandiae has some tubercles outside this ring, while C. indica usually has none. C. mirabilis on the other hand has numerous tubercles scattered over the genital plates. The periproct carries tubercles in C. novaezealandiae, but periproctal tubercles are lacking in C. indica. The colour of the apical system in C. novaezealandiae is a most distinctive green, while in C. indica and C. mirabilis it is usually reddish brown.

When considered together, these distinguishing features seem to justify the erection of a new species to accommodate the New Zealand specimen. Future investigations and a richer material should give a better indication of the variability of this species, and of C. indica and C. mirabilis. If the concept of a polytypic species gains ground in the Echinoidea, then C. novaezealandiae and C. indica may eventually come to be regarded as subspecies of C. mirabilis. For the present, however, it is preferable to regard the differences that exist between C. novaezealandiae and the other two species as specific, and not subspecific.

PHOTOGRAPHS OF ELASIPOD HOLOTHURIANS IN THE SAN DIEGO TRENCH

by D.L. Pawson

Zoology Department, Victoria University of Wellington

The United States Navy Electronics Laboratory is currently photographing the seafloor of the San Diego Trench, using the Bathyscaphe Trieste. Through the generous co-operation of Dr. Eugene LaFond and Dr. Eric G. Barham, a series of photographs were sent to Professor H.B. Fell for study. They show dense populations of ophiuroids of at least two genera. Two remarkable photographs of the seafloor at a depth of 700 fathoms also show three holothurians, all apparently of the same species. The species may be the same as that illustrated by LaFond (1962). The photographs of the holothurians have been enlarged and are included here (Pl. XXVI); locality and bathymetric details are given on the facing-page to that plate.

Specimens of the ophiuroids were also forwarded to Fell, yielding approximate dimensions of the ophiuroids visible in the photographs, and consequently enabling the size of the holothurians to be determined also. The specimen in the middle photograph of Pl. XXVI is approximately 74 mm in length, while that in the lower photograph has a total length of approximately 66 mm. The specimen in the upper photograph was in the foreground of the original photograph, consequently appearing much larger than the other two specimens, which were near the middle of the field; the actual length of this specimen cannot be determined, but it is probably of the same size as the others.

The following description of the holothurians may be given:

Body elongate, cylindrical, approximately 2.5 times as long as broad. Mouth ventrally turned, anus terminal. Lateral ventral radii each with five (perhaps more ?) pedicels, regularly spaced, lighter in colour than the remainder of the body. Dorsal surface with two pairs of elongate processes which lie on the radii. The anterior pair are placed near the extreme anterior end of the body, and are approximately 16 mm in length; the posterior pair are approximately 30 mm in length, placed in the middle of the dorsal surface of the body.

These data clearly show that the holothurians all belong to the elasipod genus Scotoplanes. Specific identification is, however, difficult. If in fact there are only five lateral ventral pedicels, then it is possible that the specimens represent the widespread Pacific species S. murrayi Theel. However, it is equally possible that there are some small pedicels placed near the anus which are not visible in the photographs, and if this is so the specimens may represent the species S. globosa Theel, another widespread Pacific species, which is also known to occur off Hawaii (Hansen, 1956).

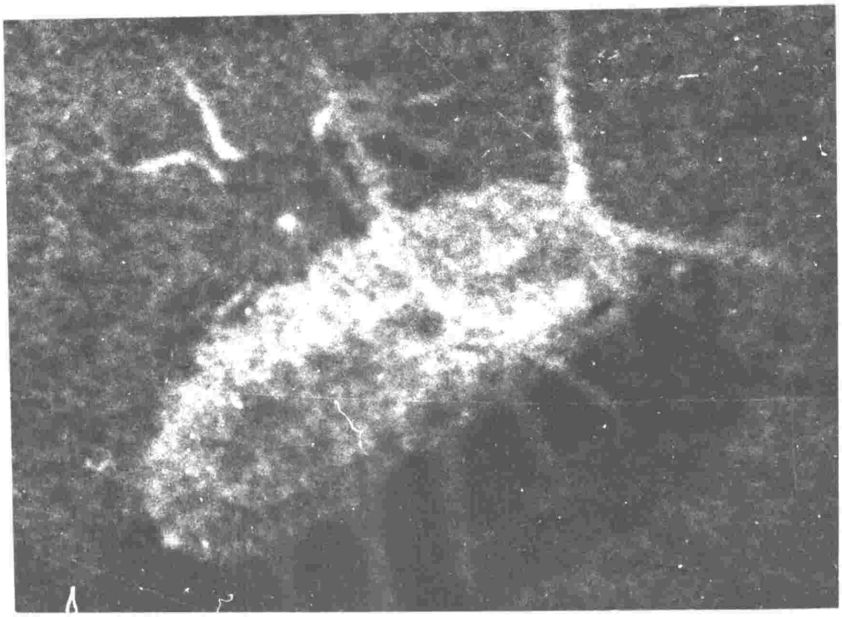
PLATE XXVI

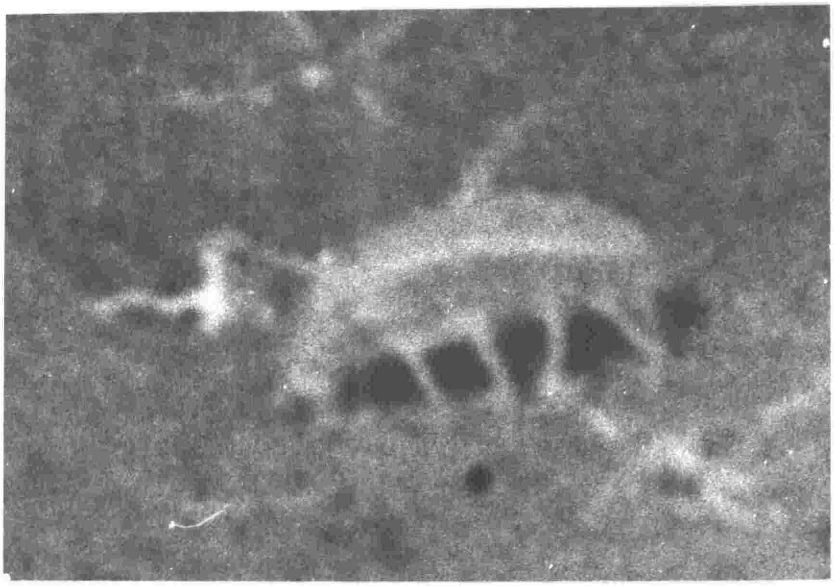
Scotoplanes sp.

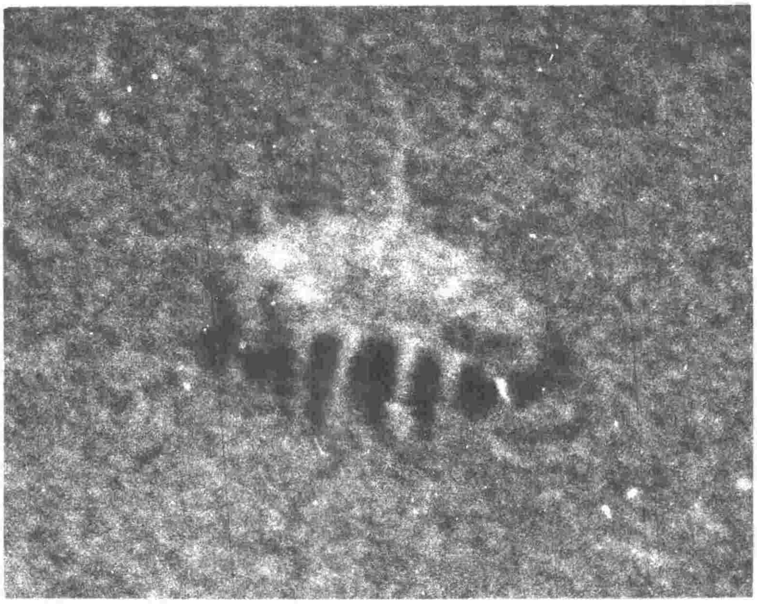
Upper: Specimen in dorsal view. Note ophiuroid at top left. Locality:- 32°32'N, 117°26'W, dive 110, 9/7/62, depth 700 fathoms (1260 metres). (U.S.Navy)

Middle: Specimen in lateral view. This specimen is apparently feeding, and moving forwards. Note ophiuroids at top left, left centre and bottom right.
Locality:- 32°32'N, 117°26'W, dive 110, 9/7/62, depth 700 fathoms (1260 metres). (U.S.Navy)

Lower: Specimen in left postero-lateral view. Apparently feeding.
Locality:- 32°32'N, 117°26'W, dive 110, 9/7/1962, depth 700 fathoms(1260 metres). (U.S.Navy)







The disposition of the dorsal papillae is of little importance as a diagnostic character, as their arrangement can vary considerably within at least one species, as has been demonstrated by Hansen (1956) in the case of S. globosa. It is likely that the specimens represent one of these two species, but without examination of actual specimens the specific status must remain indeterminate.

All three specimens appear to be actively feeding (Pl. XXVI), with the tentacles investigating the benthos. Clearly, these are not burrowing holothurians, for they are "standing" on the extremities of their ventrolateral pedicels. The position of the pedicels of the specimen in the middle figure of Plate XXVI indicates that it may be actually walking across the seafloor. The true function of the dorsal processes is not as yet known, but they are probably sensory, as they are well extended in all specimens.

Scattered about the field of the original photographs are a large number of faecal castings, presumably of holothurians. They were almost invariably U-shaped, present in such large numbers that it is probable that elasipod holothurians are very common in the area photographed. The area of seafloor included in each photograph was approximately 2.25 metres. As three holothurians were found in the two photographs it may be inferred that the population density of elasipod holothurians may reach the order of 6.0×10^5 per km^2 in similar areas of the sea-floor in the San Diego Trench.

Acknowledgment: I am particularly grateful to the United States Navy, and to Dr. Eugene LaFond and Dr. Eric G. Barham for allowing me to examine these most interesting photographs.

LITERATURE CITED:

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ECHINOIDEA FROM NORTH OF NEW ZEALAND

By D.L. Pawson,

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ABSTRACT

The echinoids collected by the "Tui" Expedition in July 1962 are described. The collection comprises 27 specimens and fragments, representing 16 genera and 16 species. New records for the New Zealand region are Stereocidaris sceptriferoides (Doderlein), Prionocidaris australis (Ramsay), Salenocidaris hastigera (Agassiz) and Oligopodia epigonus (v. Martens) and Coelopleurus sp. All of these species are of Indo-west-Pacific distribution, while Coelopleurus is largely an Indo-west-Pacific genus.

Temnopleuroid epistroma is now known to be present in Pseudechinus variegatus Mortensen.

An annotated list is given of all echinoids known from immediately to the north of New Zealand.

INTRODUCTION

The waters to the north of New Zealand are of the transitional warm temperate type, as described by Knox (1960), under the influence of the warm westward flowing trade wind drift. It follows then that the fauna of this region should reflect the attendant physical conditions, and be of a warm temperate type, parallelling the warm temperate faunas of nearby areas, and showing some differences from the fauna of the remainder of the New Zealand region, which is characterised by cold temperate mixed waters and subantarctic cold temperate water.

This area is of the greatest interest zoogeographically, especially in view of the fact that several Australian echinoderm species are known from the northern part of the New Zealand mainland (see p.343), and that the portal of entry of these species is probably from the north. Unfortunately, however, current knowledge of this important northern area is fragmentary, as very little biological sampling has been carried out there, apart from a small number of stations worked by such expeditions as the "Challenger", "Terra Nova", "Discovery II" and "Galathea". Until very recently, no particular study has been made of the benthic fauna between northern New Zealand and Kermadec Islands. During July 1962, a deepwater research cruise was undertaken by H.M.N.Z.F.A. "Tui", north of New Zealand, in the area bounded by Auckland, Norfolk Island and the Kermadec Islands. This expedition was led by Dr. J.B. Gilpin-Brown of the University of Auckland. More than 125 biological stations were occupied, several of these yielding benthic samples, some from depths in excess of 1,500 fathoms (2700 metres). As expected, the hauls of echinoderms were exceedingly rich. The Asterozoa have yet to be described, while the present paper is an account of the Echinoidea. The Holothuroidea have been described elsewhere in this work (p. 55).

I am particularly grateful to Dr. J.B. Gilpin-Brown of the Department of Zoology, University of Auckland for access to the "Tui" echinoids for study, and to Dr. C.A. Fleming, New Zealand Geological Survey, for the loan of specimens of Echinocyamus polyporus Mortensen, collected by him at the Kermadec Islands. I am indebted to Professor H.B. Fell of this department for his continued advice, and for the loan of some comparative material.

MATERIAL EXAMINED

Echinoids were collected at 14 stations, as follows. The approximate positions of the stations are given in Plate XXVII.

Station 3 — 34°20'S., 175°12'E., 990 fathoms (1782 metres)

Salenocidaris hastigera (Agassiz) 1 specimen

Station 9 — 34°45'S., 173°51'E., 294-298 fathoms (529-536 metres).

Goniocidaris magi Pawson — 1 primary radiole

Echinocyamus polyporus Mortensen — 1 test

Station 11 — 30°45'S., 175°51'E., 294-370 fathoms (531-666 metres)

Stereocidaris sceptriferoides (Doderlein) — 3 specimens

Station 12 — $30°37.5'$S., $173°53.5'$E., 1380-1520 fathoms (2486-2736 metres).

<u>Brissopsis</u> <u>oldhami</u> Alcock — fragments

Station 21 — Steel's Point (Norfolk Island), 310-400 fathoms (558-720 metres)

<u>Brissopsis</u> <u>oldhami</u> Alcock — 1 specimen

Station 22 — Steel's Point (Norfolk Island), 52-57 fathoms (94-104 metres).

<u>Peronella</u> <u>hinemoae</u> Mortensen — 4 tests

<u>Echinocyamus</u> <u>polyporus</u> Mortensen — 1 test

Station 24 — Steel's Point (Norfolk Island), 32 fathoms (58 metres).

<u>Prionocidaris</u> <u>australis</u> (Ramsay) — 1 specimen

Station 26 — Steel's Point (Norfolk Island), 30 fathoms

Station 103 At anchor, Raoul Island (Kermadecs).

<u>Laganum depressum</u> var <u>tonganense</u> (Quoy and Gaimard) 2 specimens

Station 107 (Raoul Island), west side of Meyer Island, shore collection.

<u>Heliocidaris tuberculata</u> (Lamarck) 2 specimens

<u>Tripneustes gratilla</u> (Linnaeus) 2 specimens

<u>Echinometra mathaei</u> (Blainville) 2 specimens

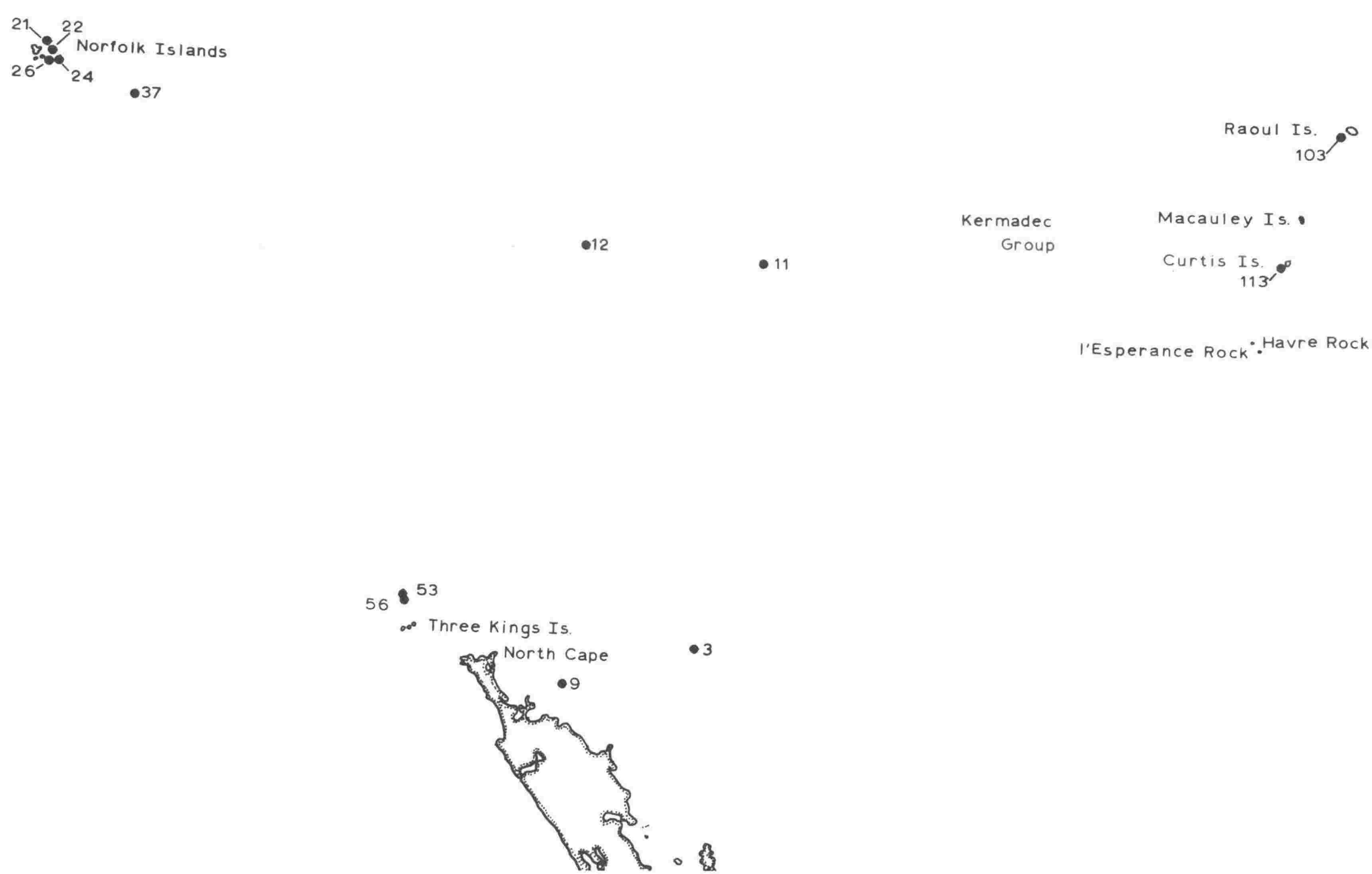
Station 113 30°30'S., 178°33'W., (Curtis Island, Kermadecs).

<u>Peronella hinemoae</u> Mortensen 1 test

PLATE XXVII

"Tui" Stations at which echinoids were collected.

"TUI" STATIONS AT WHICH ECHINOIDS WERE COLLECTED



ORDER CIDAROIDA

Stereocidaris sceptriferoides (Doderlein)

Plate XXVIII

Cidaris (Stereocidaris) sceptriferoides Doderlein, 1887, p.5, Pl. II, figs.12-17, Pl.III, fig.3a-e.

Stereocidaris sceptriferoides Mortensen, 1903, pp.23, 29; Doderlein, 1906, p.102; Mortensen, 1928, p.274, figs.85-6, Pls. XXIX, figs.5-7, LXVII, figs.1-3, 13, LXXXI, figs.1-4.

Cidaris japonica Yoshiwara, 1906, Pl.I, figs.4-5; Agassiz and Clark, 1907, p.112.

Phalacrocidaris japonica Lambert and Thiery, 1910, p.150.

Stereocidaris grandis Clark, 1925, p.26 (partim).

Material Examined: Station 11, 30°45'S., 173°51'E., 294-370 fathoms (531-666 metres), 3 specimens.

Remarks: All specimens are dried in perfect condition. Dimensions:

	1.(female)	2.(male)	3.(male)
Horizontal diameter	39 mm	38 mm	33 mm
Height	22 mm	26 mm	20 mm
Apical system	19.5 mm	18 mm	15.5 mm
Peristome	11 mm	12 mm	8 mm
Longest primary radiole	59 mm	57 mm	64 mm

The large size of the longest primary radiole in the smallest specimen indicates that the figures given for the radioles of larger specimens may be a little low, and the radioles may reach a length of ca. 70 mm.

Test circular, flattened ventrally, the sides strongly arched. Apical system flat in female specimen, slightly raised in the males. Sutures between plates in interambs and apical system sunken, so that plates are sharply delimited.

Ambs strongly sinuate, 55-60 plates in each series. Approximately 17-19 plates to each ambital interamb plate. Pores in single series, not conjugate, of equal size, separated by a low wall. Pore pairs separated by a high ridge. Marginal tubercles not contiguous; between each of them lies the stalk of a globiferous pedicellaria. Median area of amb flat, not sunken, internal tubercles numerous, tending to form series parallel to the marginal tubercles (Pl. XXVIII, fig.3).

Interambs are broad (amb = 22% interamb), with 5-6 plates in each column. At the ambitus the plates are high, as broad as they are long, tumid, with a dense coat of secondary tubercles outside the areoles. Primary tubercles large, perforate, non-crenulate, arising smoothly from the floor of each areole. The first aboral tubercle in each column is rudimentary, lacking a radiole, or absent. Areoles not confluent, well separated, deep, circular at the ambitus, transversely oval below it.

The apical system is large (ca. 50% h.d.), the component plates densely tuberculate, the tubercles of the genital plates generally larger toward the periproctal edge (Pl. XXVIII, figs.1, 2). Periproct slightly displaced into a postero-sinistral position; periproctal plates numerous, tuberculate. Genital pores subcentral, conspicuously larger in the female (Pl. XXVIII, fig.1) than in the male (Pl. XXVIII, fig.2). The smaller male specimen has a dicyclic apical system, with all oculars exsert. In the larger male and female specimens ocular I is narrowly exsert, oculars II, III and IV are broadly exsert, and ocular V is narrowly insert.

Primary radioles are long (ca. twice h.d.), cylindrical, gently tapering. The complete radioles are bluntly pointed distally, or very slightly expanded. The shaft lacks lamellae, but carries numerous low inconspicuous ridges, beset with short blunt spines. The milled ring is inconspicuous, collar short (1 mm), neck long (3-4 mm). Large primary radioles are carried at the ambitus and above it. Subambital radioles are short (10-17 mm in length), slender.

Adoral primaries are ca. 7 mm in length, flattened, with the edges serrate (Pl. XXVIII, fig.4). The radioles are bluntly pointed or truncated. Generally one of the flat sides of each radiole carries a double row of spines. These are occasionally lacking.

Miliary radioles are slender, erect, not appressed to the test. The scrobicular radioles form a sheathing ring around the base of each primary radiole. They are flat, spatulate, with a rounded distal extremity; some radioles have a broad low ridge along the midline. Average length of these radioles is 4 mm (Pl. XXVIII, fig.7).

Colour when dried, test yellowish-white overall. Primary radioles greyish-yellow, tinged with pink; the neck a bright shining pink, collar dull light brown. Subambital and adoral primaries white, with white collars. Secondary radioles yellowish-white, of a similar colour to the test.

Globiferous pedicellariae are particularly common. In general the valves are long and narrow (Pl. XXVIII, fig.5), with a small single end tooth or with none. The terminal opening is narrow, while the edges of the blades are finely serrate. The stalk varies considerably in length, but it is longest on the pedicellariae with extremely narrow blades (Pl. XXVIII, fig.6). The stalk is never globular. No tridentate pedicellariae were found.

The tubefeet contain rods and perforated plates (Pl. XXVIII, fig.8). The perforated plates lie near the terminal disc of each foot, while the rods lie nearer the middle of the foot, transverse to its longitudinal axis.

Epizoans are rare on the radioles, although two carry on their undersides the tubes of tubicolous annelids, composed of aggregations of foraminiferal skeletons and shells of minute gastropod molluscs.

As the female genital pores are very large (1.5 mm diameter) it is probable that this species has large yolky eggs, and lacks a pelagic larval stage.

These specimens are undoubtedly representatives of the species <u>Stereocidaris sceptriferoides</u> Doderlein, agreeing in

PLATE XXVIII

Stereocidaris sceptriferoides (Doderlein)

Fig.1. Apical system of female.

Fig.2. Apical system of male.

Fig.3. Amb plates.

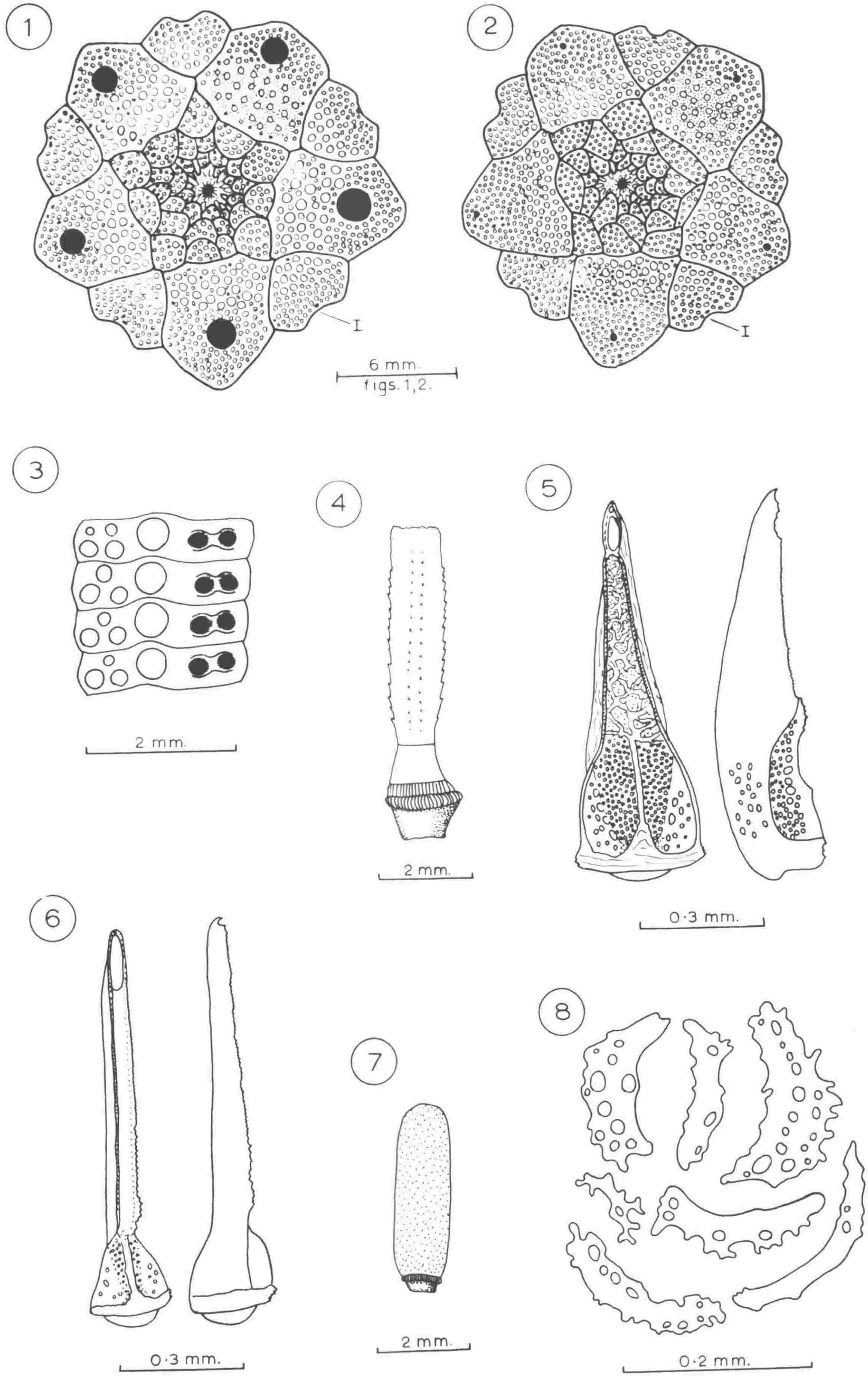
Fig.4. Adoral primary radiole.

Fig.5. Valves of globiferous pedicellariae.

Fig.6. Valves of narrow globiferous pedicellariae.

Fig.7. Scrobicular radiole.

Fig.8. Tubefoot deposits.


1
2
I
I
6 mm.
figs. 1,2.
3
2 mm.
4
2 mm.
5
0·3 mm.
6
0·3 mm.
7
2 mm.
8
0·2 mm.

most respects with the description given by Mortensen (1928). However, in present material the midline of each amb is not sunken, while Mortensen (1928) notes that it is "more or less distinctly sunk". In the apical system some slight differences are found. Mortensen's material comprised five specimens, in which all but one specimen has a dicyclic apical system; the single variant has ocular I narrowly insert. The present material differs slightly in that the two larger specimens have ocular V narrowly insert. But this can probably be explained as a growth change, for Mortensen's largest specimen was of 33 mm h.d., while present material exceeds that measurement by 5-6 mm. These then are the largest known specimens of S. sceptriferoides. The typical form of this species characteristically has primary spines which are gently tapering, "... the point rather conspicuously flaring" (Mortensen, 1928, p.276). Few of the radioles are complete in these specimens, but those that are show only a very weak distal expansion, while some taper to a blunt point. Adoral primaries, scrobicular radioles, pedicellariae and tubefoot deposits are more or less identical to those described by Mortensen (1928).

Fell (1954) has described Stereocidaris hutchinsoni Fell from Nukumaruan (Pliocene) beds in New Zealand, and S. striata (Hutton) from the Duntroonian (Lower Oligocene).

Both of these fossil species differ from S. sceptriferoides in having primary radioles with more conspicuous flutings and ridges. It is of great interest that the genus should be represented by an extant species near New Zealand. (Station 11 is approximately 230 miles NNE of North Cape).

S. sceptriferoides is known from off Japan, 360-700 metres. The variety lamellata Mortensen of this species is known from the Philippines (1040 metres) and the Kei Islands (370-400 metres). The present record shows the species to be a wide-spread Indo-west-Pacific form and the depth (531-666 metres) from which material was taken near New Zealand is consistent with its known bathymetric range. The species has probably achieved its present-day distribution by spreading across the deep-sea floor.

Goniocidaris magi Pawson

Goniocidaris magi Pawson, in press (p. 255).

Material Examined: Station 9, 34°45'S., 173°51'E., 294-298 fathoms (529-536 metres), 1 primary radiole.

Remarks: The radiole is of total length 26 mm, light yellowish-brown in colour, with the distal extremity slightly widened to form a weakly developed crown, as is typical of this species.

The holotype and paratypes were taken from near Three Kings Islands at a depth of 135 metres. The present record (approximately 50 miles east of North Cape) shows that the species is probably distributed about the northern portion of New Zealand. Present known bathymetric range, 135-536 metres.

<u>Prionocidaris</u> <u>australis</u> (Ramsay)

Pl. XXIX, figs.1-3

<u>Prionocidaris</u> <u>australis</u> Mortensen, 1928, p.456, figs.140 (2), 141, Pls. LII, LIII, fig.12, LXXIII, figs.17-19, LXXXVII, figs.6-8. (Complete synonymy).

Material Examined: Station 24, off Steel's Point, Norfolk Island, 32 fathoms (58 metres), 1 specimen; Station 37, 29°20'S., 169°09'E., 110 fathoms (198 metres), fragment of radiole.

Remarks: A juvenile cidarid is included in the collection. The horizontal diameter is 10 mm, height 5 mm.

The primary radioles at the ambitus and above it are elongate, slightly flattened. The shaft reaches its greatest width about 1/3 of its length from the base, then tapers gradually toward the distal extremity. In some radioles the distal extremity is very slightly expanded to form a weak crown. The largest radiole is 16 mm in length, collar 2 mm. All are beset with regularly arranged spines, which are largest at the sharp edges of the flattened radioles. The milled ring is not prominent; the collar is usually long (ca. 1/8 the total radiole length), and carries serially arranged conspicuous white spots, against a brownish-red background. These radioles are light red, with a greenish tinge. (Pl. XXIX, fig.1).

Adoral radioles flattened, approximately 2.5 mm in length.

The collar is long, almost the same length as it is on the ambital primaries. Thus the cortex is restricted to the distal end of the adoral radioles, forming a "cap". This cortex "cap" carries a small number of regularly arranged blunt spines (Pl. XXIX, fig.2).

Secondary spines are flat, slightly curved, ca. 1.5 mm in length. They are bluntly pointed, the point being minutely serrate.

Globiferous pedicellariae of the large type are lacking. Small globiferous pedicellariae with a valve length of up to 0.4 mm are especially common aborally. The valves are slender, and carry a single end tooth (Pl. XXIX, fig.3). The opening of the poison duct is also surrounded by a ring of teeth, of which two pairs, one at the top of the opening and one at the bottom, are the largest. Each edge of the valve is finely serrate for its entire length.

Tridentate pedicellariae have extremely long and narrow valves up to 2 mm in length. The edges of the blade in each valve are irregularly serrated and thorny. The valves are of the same type as those figured by Mortensen (1928).

As this is the only specimen in the collection, no examination of the test has been made.

On the basis of the structure of the globiferous pedicellariae and the primary radioles, this specimen has been assigned to the species Prionocidaris australis. Juvenile cidarids are often extremely difficult to place, as the primary radioles, an important taxonomic character, change greatly with growth. This is well known, and also applies to the New Zealand species <u>Goniocidaris umbraculum</u> (see p. 180). However, the present specimen has primary radioles with a large collar, bearing white spots, also adoral radioles with a cortex "cap". Both these features are combined in <u>P. australis</u>, according to Mortensen (1928). The valve of a small globiferous pedicellaria of <u>P. australis</u> figured by Mortensen (1928, Pl. LXXXVII, fig.6) agrees in all respects with that figured here (Pl. XXIX, fig.3). Also the colour of the juvenile radioles is exactly the same as that in adult specimens.

The primary radioles in this species change with growth and become coarsely thorny. The largest specimen of the species recorded has a h.d. of 70 mm, and the average size seems to be approximately 50 mm h.d. In these full-grown specimens there is some variation in colour, Mortensen (1928) noting that "fully-formed primaries are light greenish, more or less distinctly banded with purplish". Clark (1946) states that the primaries are deep brown.

The species was hitherto known only from the southeastern coast of Australia, from Fraser Island Queensland to Bass Strait, and Lord Howe Island (Clark, 1946). Thus its presence at Norfolk Island in 58 metres and 198 metres is surprising. This species appears to have a short bathymetric range of 10-85 metres, according to Mortensen (1928). The record here of a radiole fragment from 198 metres certainly does not prove that the species lives at that depth. *P. australis* probably has a pelagic larval stage (Mortensen, 1928), and has achieved its distribution through drift in the plankton.

PLATE XXIX

<u>Prionocidaris australis</u> (Ramsay), <u>Salenocidaris hastigera</u> (Agassiz)

<u>Prionocidaris australis</u> (Ramsay)

Fig.1. Ambital primary radiole.

Fig.2. Adoral primary radiole.

Fig.3. Valve of globiferous pedicellaria.

<u>Salenocidaris hastigera</u> (Agassiz)

Fig.4. Secondary radioles, plan view.

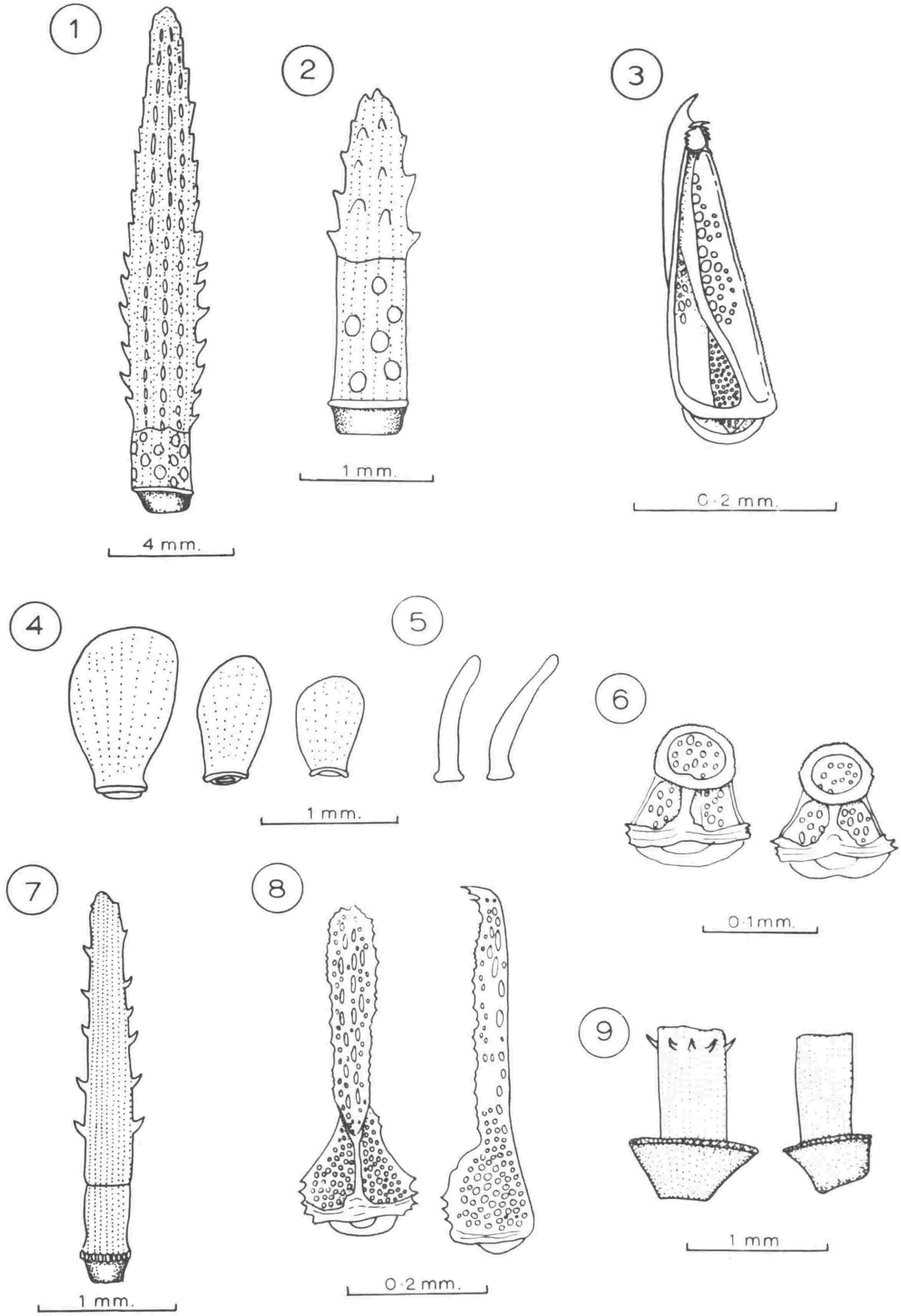
Fig.5. Secondary radioles, profile view.

Fig.6. Valves of ophicephalous pedicellariae.

Fig.7. Adoral primary radiole.

Fig.8. Valves of tridentate pedicellariae.

Fig.9. Bases of primary radioles.


1
2
3
1 mm.
0·2 mm.
4 mm.
4
5
6
1 mm.
0·1 mm.
7
8
9
1 mm
0·2 mm.
1 mm.

Order HEMICIDAROIDA

<u>Salenocidaris</u> <u>hastigera</u> (Agassiz)

Plate XXIX, figs.4-9

<u>Salenia</u> <u>hastigera</u> Agassiz, 1879, p.198; Agassiz, 1881, p.54, Pl. IV, figs.3-17, Pl. XXXVIII, fig.10; Agassiz, 1904, Pl.20, fig.8; De Meijere, 1904, p.43 (partim); Doderlein, 1906, p.177, Pl. XXI, fig.1, Pl. XXII, fig.1, Pl. XLV, fig.3; Mortensen, 1935, p.360, Pl. LXVI, figs.1-2, Pl. LXXXV, figs.5-7, Pl. LXXXVI, figs.17-20.

<u>Salenocidaris</u> <u>profundi</u> Clark, 1925, p.66 (partim).

<u>Salenia</u> <u>hastigera</u> var. <u>acuminata</u> Mortensen, 1934, p.166.

Material Examined: Station 3, 34°20'S., 175°12'E., 990 fathoms (1782 metres), 1 specimen.

Remarks: The single specimen is complete, the test circular, flattened adorally. Dimensions, horizontal diameter 10.5 mm, height 6 mm, peristome 4 mm, apical system 6.5 mm.

The aboral surface of the test is beset with numerous short and stout papillae, which are scattered, but may tend to be arranged in rows, radiating from the periproct. Between the papillae are large numbers of almost spherical ophicephalous pedicellariae.

The primary radioles are cylindrical, long (longest radiole is 23 mm, broken), slender, gently tapering towards the distal extremity, carrying whorls of small sharp spines (the longest radiole has 38 such whorls). Ambital primaries are slightly curved, with the convexity turning upwards. Collar very short and inconspicuous, milled ring well developed, elegantly shaped (Pl. XXIX, fig.9). Adoral primaries are flattened, resembling cidarid adoral primaries, averaging 3 mm in total length. The collar is here long (0.5 mm), slightly narrower than the flattened shaft. The edges of the shaft each carry a single row of sharp spines (Pl. XXIX, fig.7). The milled ring is prominent but not as conspicuously developed as it is on the ambital primaries.

Secondary radioles are short, spatulate (Pl. XXIX, figs. 4, 5), slightly curved, approximately 1 mm in total length.

When dried, the test is white adorally and at the ambitus. The close-set papillae of the aboral surface are light violet. Primary radioles white, collar and milled ring with light violet striae. Secondary radioles with longitudinal violet striae, otherwise white.

Ophicephalous pedicellariae (Pl. XXIX, fig.6) have very short and broad valves, and are typical of those found in the genus. Tridentate pedicellariae are uncommon, and have long and slender valves (Pl. XXIX, fig.8), up to 0.6 mm in length. The edges of the blades are irregularly serrated.

Although the test has not been cleaned, it can be clearly seen that the areoles are confluent, and that the adoral interamb tubercles increase gradually in size toward the ambitus.

The species in the genus Salenocidaris are rather difficult to distinguish. Mortensen (1935) distinguishes the eight species which he recognises on the basis of such characters as position of ocular I, shape of secondary radioles, and relative length of valves of tridentate pedicellariae.

For the purposes of specific identification, the important characters of this specimen are as follows:

Areoles confluent, interamb tubercles increase gradually in size toward the ambitus. Secondary radioles broad, thin, slightly curved. Papillae of apical plates arranged in no definite order. Tridentate pedicellariae with long slender valves.

On the basis of these characters, the specimen falls closest to S. hastigera (Agassiz), but differs from that species in some minor respects.

Some of the secondary radioles are slightly broader than they are in S. hastigera, and curved, while Mortensen does not indicate whether or not they are curved in S. hastigera. The presence of strongly curved secondary radioles is a key character of S. pacifica (Doderlein) from off Japan, but in that species the radioles are considerably thicker than they are in the present material, thus clearly distinguishing the two forms. The conspicuous milled ring on the primary radioles is identical to that in S. hastigera (and S. profundi (Duncan) from the Atlantic Ocean). Valves of the tridentate pedicellariae of S. hastigera illustrated by Mortensen (1935) greatly resemble those figured here (Pl. XXIX, fig.8), but they do not show as many irregular serrations on the edges of the blade.

These differences are considered slight, and the specimen has therefore been placed into S. hastigera. Further sampling in the area may produce more material and perhaps stronger evidence for the erection of a new species to accommodate this southern Pacific form.

Salenocidaris is wide-ranging in the Atlantic and Pacific Oceans, and three of the eight species are recorded from the Indo-west-Pacific Ocean. One other species, S. brachygnatha Mortensen, is known from 28°33'S., 177°50'W., a short distance NE of the Kermadec Islands, in 1080 metres. This specimen was collected by the "Challenger", and Agassiz (1881) referred it to his new species S. hastigera. Mortensen established a separate species for this specimen, which, as its specific name suggests, has tridentate pedicellariae with short valves, the blades of which are widened distally. In all other respects, the species S. brachygnatha resembles S. profundi and S. hastigera, but in the shape of the tridentate pedicellariae a similarity is shown to S. varispina Agassiz from the Atlantic Ocean.

Thus there are now two species of Salenocidaris known from the vicinity of New Zealand; the present record (approximately 120 miles east of North Cape) establishes S. hastigera in the deepsea echinoderm fauna of New Zealand, and the known

Order ARBACIOIDA

Coelopleurus sp.

Material Examined: Station 56, 33°58'S., 172°07'E., 140-190 fathoms (252-342 metres), five fragments of primary radioles.

Remarks: The collection includes five fragments of primary radioles which appear to belong to a representative of genus Coelopleurus. Members of this genus are characterised by possessing slender, slightly curved primary radioles, which are triangular in cross-section, with a median keel on the upper side. The shaft is smooth, shining, due to the presence of a well developed cortex layer. On some of the uppermost radioles the cortex is apparently never developed (Mortensen, 1935).

The largest radiole here is 145 mm in length, with a base triangular in cross-section, each side of the triangle being 4 mm across. The radiole tapers gradually, and at its distal extremity (where it is broken) is approximately oval in cross-section. Two smaller fragments of length 110 mm and 76 mm are similar to that described, but the smallest fragments (70 mm and 52 mm) differ in that they appear to lack the smooth, shining cortex. Apparently these are the "uppermost radioles" to which Mortensen (1935) refers, which lack a cortex.

All but the smallest fragments are heavily encrusted in epizoans, including serpulid worms, bryozoans, and cirripedes.

The radioles are white, those without a cortex layer yellowish-white.

These radioles cannot be assigned to a known species, but their great length serve as a guide for future investigations. The only species which has radioles approaching the size of the present fragments is C. floridanus Agassiz, in which, according to Rathbun (1886) the primary radioles may exceed 130 mm in total length. This species is known from the West Indies north to Cape Hatteras on the American east coast. In the Indo-west-Pacific, no species have primary radioles which exceed 100 mm in length. Probably the present material represents a new species, which is a matter of great interest. While most species are centred about Japan and the East Indian region, a single extant species, C. australis Clark, is known from Australia. The present record, off Three Kings Islands, adds another northern genus to the bathyal fauna of the New Zealand region.

Order TEMNOPLEUROIDA

Pseudechinus variegatus Mortensen

Plate XXXI, fig.1

Pseudechinus variegatus Mortensen, 1921, p.167, figs.12, 14, 16, Pl.VI, figs.20-21, Pl.VII, figs.19-23; Lambert & Thiery, 1925, p.672; Mortensen, 1943a, p.243, fig.131.

Material Examined: Station 53, 33°56'S., 172°E., 440-450 fathoms (792-810 metres), 2 naked tests.

Remarks: The two tests are small, with the aboral surfaces damaged, so that no details of the apical system can be given. Dimensions:

	Horizontal diameter	height	peristome
1.	13 mm	8.5 mm	6.5 mm
2.	8 mm	5 mm	4 mm

The sides of the test are strongly arched, while the test is scarcely sunken toward the peristome. The tuberculation is as described by Mortensen (1921), coarse, with secondary tubercles of small size, with no regular arrangement. Primary tubercles form a regular single series in each column. The primary tubercles are distinctly crenulate (Pl. XXXI, fig.1). The pores are, as usual, in slightly oblique arcs of three.

The rediscovery of this species is of considerable interest, but of greater importance is the fact that there are distinct epistromal ridges in ambs and interambs. Mortensen (1921) made no mention of this although the epistroma is rather conspicuous on the present 8 mm h.d. specimen, and Mortensen has material of the same size at his disposal. The larger specimen in the present collection is badly eroded, and no traces of epistroma can be found. Epistroma is best developed adorally, where it takes the form of ridges radiating from the primary tubercles toward the adjacent secondary tubercles (Pl. XXXI, fig.1), together with some ridges which run between the secondary tubercles. Small "tubercles" are also to be seen on the epistromal ridges.

Particularly in the interambs, the areoles of the primary tubercles are separated by low ridges, such as are found adorally in Pseudechinus novaezealandiae. These ridges are not developed in the ambs. The test is light green, apart from the poriferous areas which are white. The tubercles are also light green. The species is aptly named, as in the smaller specimen the green varies considerably in shade, giving a mottled effect.

Only P. albocinctus (Hutton) and P. variegatus Mortensen have distinctly crenulate tubercles. Fell (1962) gives an account of the epistroma in P. flemingi Fell, P. albocinctus (Hutton) and P. novaezealandiae (Mortensen). Recent investigations by the writer (p.250) show that epistroma is also present in the Magellanic species P. magellanicus (Philippi). Including the present species, five of the eleven known species of Pseudechinus are known to have epistroma, at least in their young stages. It is expected that eventually all Pseudechinus species will be found to possess this important temnopleuroid character.

Mortensen (1921) states that P. variegatus is most closely related to P. albocinctus on the basis of the crenulation of tubercles and similarities in their pedicellariae. Later, Mortensen (1943a) contends that the species is related to P. huttoni, but differs in its more dense tuberculation, its size, and colour.

The type material was collected from off Three Kings Islands, 65 fathoms (117 metres), and 10 miles NW of Cape Maria van Diemen, 50 fathoms (90 metres). A further two specimens were taken from west of Cuvier Island (near Auckland, New Zealand) in 35 fathoms (63 metres) (Mortensen, 1921). The present locality, approximately 20 miles north of Three Kings Is., does not affect the known distribution of the species. The depth of this station (792-810 metres) is very great compared with the depths from which the other material of the species is known, and it may be suggested that the dead tests were carried into deep water from the shelf. It is possible, however, that the species may live at that depth, as Pseudechinus magellanicus ranges from 0-820 metres, while P. marionis (Mortensen) may be found in 100-ca. 3,000 metres.

Tripneustes gratilla (Linnaeus)

Tripneustes gratilla Mortensen, 1943a, p.500, figs.306-307, Pls. XXXIII, figs.1-3, XXXIV, figs.2-6, XXV, figs.3-4, XXVII, figs.1-2, 4-10, XXXVIII, figs.1-4, LVI, fig. 11. (Complete synonymy).

Material Examined: Station 107 (Raoul Island), west side of Mayer Island, shore collection, 2 specimens.

Remarks: The two specimens have the following dimensions:

h.d.	height	peristome	apical system
110 mm	55 mm	27 mm	15 mm
105 mm	60 mm	25 mm	14 mm

The largest specimen available to Mortensen (1943) was 106 mm h.d. Clark (1946) notes that full-grown specimens are 140-145 mm h.d.

The spines are short as usual, greyish-white in colour. These contrast sharply with the black covering of the test. The cleaned test is strikingly coloured, the poriferous areas white, while the interambs and median areas of the ambs are light violet. The colour of this species can vary quite remarkably, as has been pointed out by Mortensen (1943a) and Clark (1946).

T. gratilla is widely distributed over the Indo-Pacific region from East Africa to the South Sea Islands, from Norfolk and the Kermadec Islands to the Marquesas and Hawaii, and from Australia to southern Japan (Mortensen, 1943a). The species is as yet unknown from the northern coast of Australia (Clark, 1946), or from New Zealand. Bathymetric range 0-75 metres.

Order ECHINOIDA

Heliocidaris tuberculata (Lamarck)

Heliocidaris tuberculata Mortensen, 1943b, p.338, figs.164-166, 167c, Pls. XXXVI, figs.1-4, XXXVII, fig.8, XXXVIII, fig.8, LXIII, figs.2-6, 9, 10. (Complete synonymy).

Material Examined: Station 107 (Raoul Island), west side of Meyer Island, shore collection, 2 specimens; Station 26, off Steele's Point, Norfolk Island, 30 fathoms (54 metres), 1 specimen.

Remarks: The two specimens from Station 107 have the following dimensions:

	h.d.	height	peristome	apical system
1.	90 mm	45 mm	21 mm	12 mm
2.	98 mm	47 mm	24 mm	13 mm

The largest size recorded for this species is 106 mm h.d. (Clark, 1938), and thus it is probable that the present specimens are near their maximum size.

The freshly cleaned test is light green aborally, even lighter on the oral side. Adorally the poriferous areas are very light brown. The primary radioles are dark brown generally, with a greenish tinge near the base. The tips of the radioles are brownish red. The adoral radioles are often uniformly light green, with reddish brown tips. This colour description agrees with that of Benham (1911) and Mortensen (1943b). Clark (1938) has noted that the colour in life is "bright brown, with a red tinge to test and pedicels, and greenish tips to the spines, very marked".

A small juvenile echinoid from Station 26 apparently also belongs to this species. The test is 8 mm in horizontal diameter and 5 mm in height. Colour dried, light orange-brown, radioles light brown.

This species is known from the coasts of New South Wales and Victoria, although its occurrence there is apparently erratic (Clark, 1946). Also recorded from Lord Howe Island where it is common, the Kermadec Islands and Northern New Zealand (Mortensen, 1943b).

The Norfolk Island record of the juvenile specimen is new.

<u>Echinometra mathaei</u> (Blainville)

<u>Echinometra mathaei</u> Mortensen, 1943b, p.381, figs.185-194, Pls. XLII, figs.1-10, XLVII, figs.1-4, LXV, figs. 16-26. (Complete synonymy).

Material Examined: Station 107 (Raoul Is.), west side of Meyer Island, shore collection, 2 specimens.

Remarks: The two specimens have the following dimensions:

h.d.	height	peristome	apical system
41-32 mm	20 mm	17 mm	9 mm
61-51 mm	33 mm	22 mm	11 mm

As is usual in this species, the test is elongate, not sunken at the peristomial edge. Mortensen (1943b) notes that circular specimens are rare, although very young stages are circular, and change shape with growth. The largest recorded specimen is one of 76 mm greatest length (Agassiz, 1872).

The colour of the radioles is extremely variable, ranging from white to black (Mortensen, 1943b). In present material they are faintly green basally, grey elsewhere. The test is almost white.

The species occurs all over the Indo-west-Pacific, and has elsewhere (Farquhar, 1897; Benham, 1911) been recorded from the Kermadec Islands, but is as yet unknown from New Zealand. Bathymetric range 0-139 metres.

Order CASSIDULOIDA

Apatopygus recens (Milne-Edwards)

Plate XXX, figs.4-6

For synonymy, see p.

Material Examined: Station 53, approximately 33°56'S., 172°E., 440-450 metres (792-810 metres) 1 naked test.

Remarks: The single specimen is a naked test, which has the following dimensions: length, 9.5 mm, greatest breadth, 8 mm, height 4.5 mm. The test is broadly oval in outline (Pl. XXX, figs.4, 5), flat ventrally, but slightly sunken towards the peristome. The dorsal side is arched, the sides of the test smoothly rounded. The periproct is placed on the posterodorsal side of the test, in a deep groove (Pl. XXX, figs.5, 6). Four genital pores are present, the posterior pair being the larger. The mouth is ventral, in a slightly anterior position. There is no evidence of petals or pores.

There is little doubt that this specimen represents the genus Apatopygus, but its specific placement is rendered difficult because of the lack of pedicellariae and radioles. Mortensen (1921) has described some growth stages of A. recens (M.-Edwards), noting that the petals begin to form rather early, at a size of 8-9 mm. The lack of forming petals in present material seems consistent with Mortensen's evidence. Unfortunately Mortensen (1921) does not refer to the shape of the peristome in young stages of _A. recens_, but in a later publication (Mortensen, 1948) employs the shape of the peristome as a feature by which the two species _A. recens_ and _A. occidentalis_ Clark may be distinguished. In _A. recens_ the peristome is transversely elongate, while in _A. occidentalis_ it is circular.

In the present specimen the peristome is definitely circular (Pl. XXX, fig.4), and moreover, the posterior genital pores are distinctly larger than the anterior pores, as they are in _A. occidentalis_, while in _A. recens_ they are approximately equal. On the basis of these characters the specimen appears to lie rather closer to _A. occidentalis_ than to _A. recens_. Both the characters (peristome shape and genital pore size) probably change with growth.

A. occidentalis is known so far only from Western Australia in depths of 18-40 metres, while _A. recens_ ranges from the South Island of New Zealand and the southern islands in depths of 10-162 metres, but has not been collected further north than the Wellington area, where it is rare.

It seems the best course to assign the specimen to the New Zealand species for the present, at least until further material becomes available. The range of _A. recens_ is thus extended to the north by approximately 450 miles.

Oligopodia epigonus (v. Martens)

Pl. XXX, figs.7-10

Oligopodia epigonus Mortensen, 1948, p.228, figs. 211-216, Pl. I, figs.5-13, Pl. XII, figs.13, 14, 17, 19, 24. (Complete synonymy).

Material Examined: Station 37, 29°20'S., 169°09'E., 110 fathoms (198 metres), 1 naked test.

Remarks: The single test is not in good condition, and the position and numbers of the ambulacral pores cannot be determined exactly. But the shape of the test provides enough evidence for the inclusion of this specimen in the genus *Oligopodia*.

The test is ovoid (Pl. XXX, figs. 7, 8), moderately high and vaulted. Total length 12.5 mm, greatest breadth (at level of apical system) 10 mm, height 7 mm. The posterior interamb is slightly raised to form a very weak keel (Pl. XXX, fig.9), which is almost flat, sunken toward the peristome, which is pentagonal in shape. The periproct is terminal, dorsally placed in the truncated posterior end of the test, at the upper end of a narrow groove, and deeply sunken (Pl. XXX, fig.10). Apparently the ambs are petaloid dorsally, but their exact configuration is impossible to determine.

Both the apical system and the peristome are slightly anteriorly placed. There are four very large genital pores (Pl. XXX, fig.7); apparently this is a female specimen. Only

PLATE XXX

Echinocyamus polyporus Mortensen; Apatopygus recens (Milne-Edwards); Oligopodia epigonus (v. Martens)

Echinocyamus polyporus Mortensen

Fig.1. Dorsal aspect of naked test.

Fig.2. Ventral aspect.

Fig.3. Lateral aspect.

Apatopygus recens (Milne-Edwards)

Fig.4. Ventral aspect of naked test.

Fig.5. Dorsal aspect.

Fig.6. Posterior aspect.

Oligopodia epigonus (v. Martens)

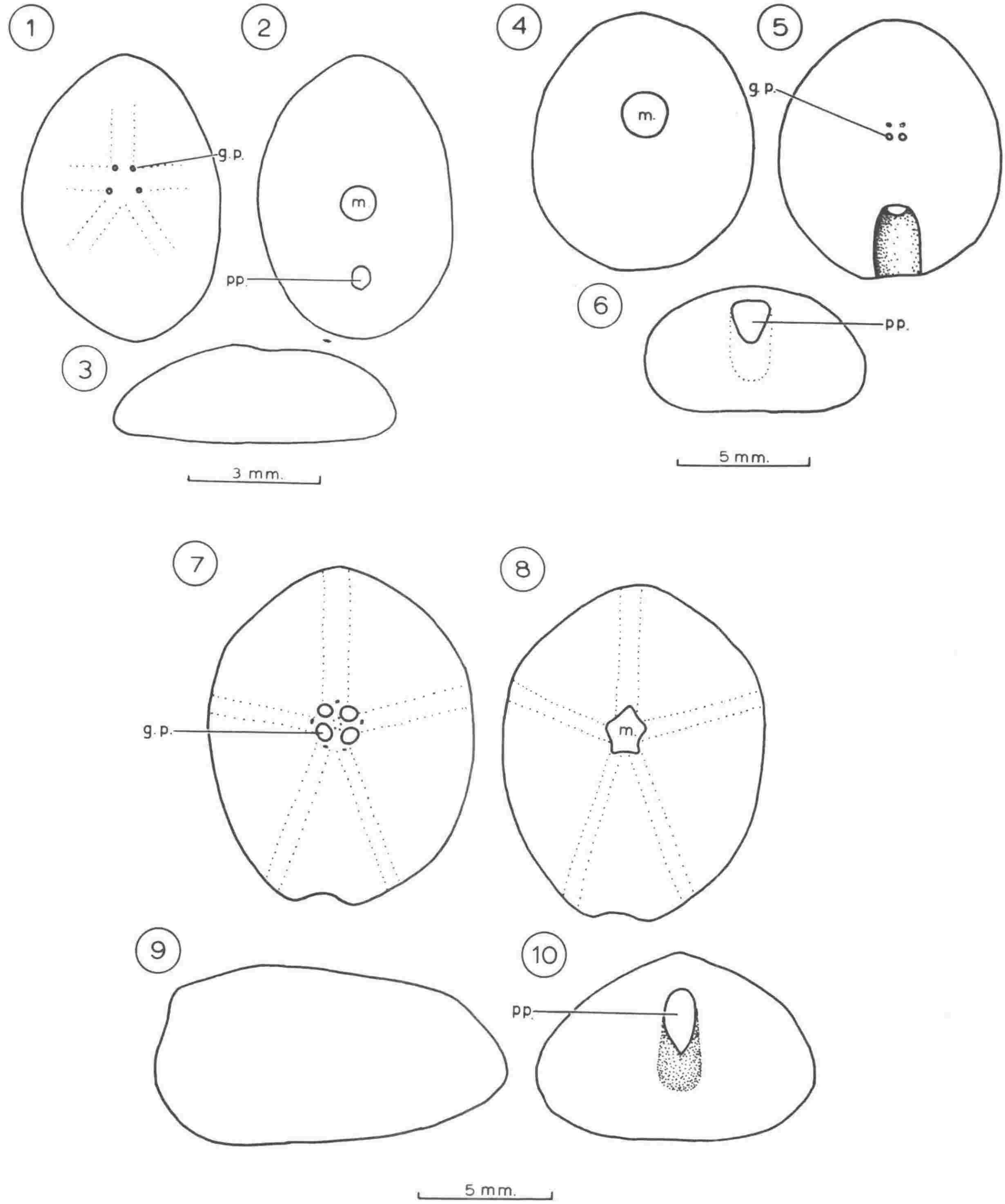
Fig.7. Dorsal aspect of naked test.

Fig.8. Ventral aspect.

Fig.9. Lateral aspect.

Fig.10. Posterior aspect.

Abbreviations: g.p., genital pore; m., mouth (peristome); pp., periproct.



1
2
3
4
5
6
7
8
9
10
g.p.
m.
pp.
3 mm.
5 mm.
5 mm.

five hydropores were seen, scattered between the genital pores. The ocular pores are barely visible.

Colour of denuded test, white.

It is possible that this specimen represents a different species from the only surviving species of this genus, O. epigonus. The specimen has a pentagonal peristome, while Mortensen (1948) notes that in O. epigonus the peristome is elongate oval. But because of the lack of a richer material it is felt best to leave the specimen in this known species, which can vary considerably in the shape of the test (Mortensen, 1948), although no mention has been made of variation in the shape of the peristome.

The largest specimen recorded is 20 mm in total length, and thus the present specimen is probably almost full-grown.

Mortensen (1948) suggests that the centre of distribution of this species is the Malay region, and records its occurrence at the Kei Islands, Jolo, off Natal, between depths of 35 and 141 metres. The "Siboga" took a specimen at a depth of 390 metres, but it is unknown whether this specimen was dead or alive. Clark (1925) described specimens from Lord Howe Island, but later (Clark, 1946) indicates that this record must be regarded with some doubt. The present record, off Norfolk Island, is new, and indicates that the species does in fact also occur at Lord Howe Island.

Order CLYPEASTROIDA

Clypeaster australasiae (Gray)

Clypeaster australasiae Mortensen, 1948, p.79, figs.49-50, Pls. XIX, figs.1-2, XX, figs.1-3, XXI, figs.1-7, LXV, figs.3, 6, 10, 17-19. (Complete synonymy).

Material Examined: Station 26, off Steele's Point, Norfolk Island, 30 fathoms (54 metres), 1 specimen.

Remarks: The single specimen is typical of this large species. Its dimensions are as follows:

Total length 119 mm, width 98 mm, height 40 mm, thickness of margin 10 mm.

The test is elongate oval in outline, with slight emarginations in the posterolateral interambs. The posterior end of the body is smoothly rounded, while the anterior end is slightly sharper. The petaloid region is elevated to form a broad convexity in the middle of the dorsal side. The ventral side is concave, sloping gradually toward the peristome, which is deeply sunken.

Colour in formalin (with spines attached) dark brown. Denuded petals also dark brown, with a narrow lighter brown band medially in each petal.

Mortensen (1948) has given some indication of the considerable variation in shape which may be found in this species.

C. australasiae is distributed about the east and south coasts of Australia, Tasmania, Lord Howe Island, in depths of 0-220 metres, and Fell (1949) describes specimens taken from New Zealand (East Cape and Parengarenga) in 70-157 metres. The occurrence of the species at Norfolk Island is consistent with the hitherto known distribution, but constitutes a new record.

Echinocyamus polyporus Mortensen

Plate XXX, figs.1-3

Fibularia australis Benham, 1911, p.162.

Echinocyamus polyporus Mortensen, 1921, p.176, Pl.VI, figs.28-31; Mortensen, 1925, p.390, fig.67; Clark, 1925, p.163; Mortensen, 1948, p.200, fig.115b.

Fibularia polypora Lambert & Thiery, 1925, p.577.

Material Examined: Station 9, 34°45'S., 173°51'E., 294-298 fathoms (529-536 metres) 1 naked test; Station 22, off Steel's Point, 52-57 fathoms (94-99 metres), 1 naked test.

Denham Bay, Kermadec Islands, shore collection, 3 naked tests, collected by C.A. Fleming.

Remarks: All five specimens are typical of the species. The specimen from Station 9 is heavily encrusted with bryozoans. The largest specimen is 12 mm in total length, while the smallest is 7 mm in length. The test is elongate oval (Pl. XXX, figs.1, 2), broadest at the level of the peristome, low arched, slightly higher toward the posterior end (Pl. XXX, fig.3). The apical system is central, with four genital pores. The petals are long, but not reaching the ambitus. The anterior petal is exactly similar to that figured by Mortensen (1948, p.198). The peristome is distinctly, but not deeply, sunken, with the periproct lying half-way between the peristome and the posterior edge of the test. Colour of test, greyish-white.

E. polyporus has been previously recorded from Cook Strait at a depth of 40 metres (Mortensen, 1921), and the Kermadec Islands 9-18 metres (Benham, 1911, as *Fibularia australis*). At this latter locality the species is very common. The present Norfolk Island record is new, and the occurrence of the species approximately 50 miles east of North Cape is not unexpected. The bathymetric range may now be given as 9-536 metres. Whether or not the species actually lives at a depth of 536 metres cannot as yet be established; it may well be that the dead test taken from that depth was carried there by bottom currents. It is notable, however, that several species of this genus have a wide bathymetric range (e.g. *E. pusillus* (Muller) 0-1250 metres), and this may also be the case in *E. polyporus*.

Peronella hinemoae Mortensen

Laganum sp. Bell, 1917, p.6.

Peronella hinemoae Mortensen, 1921, p.177, Pls. VI, figs.22, 23, VII, figs.31-36; Clark, 1925, p.159; Mortensen, 1948, p.284.

Echinodiscus hinemoae Lambert & Thiery, 1925, p.581.

Material Examined: Station 22, off Steele's Point, Norfolk Island, 52-57 fathoms (94-104 metres), 4 naked tests; Station 113, 30°30'S., 178°33'W. (Curtis Island), 1 naked test.

Remarks: In his key to the species in the genus Peronella, Mortensen (1948) gives the following diagnosis for P. hinemoae:

> Genital pores placed within the apical system. Periproct naked, central, round or transversely oval. Oral ambulacral furrows not at all distinct.

The present material is more or less in accord with this diagnosis, but differs in some small respects. The statement "periproct central" refers to the position of the periproct relative to the peristome and posterior margin of the test. Thus in this species the periproct lies midway between the peristome and the posterior margin.

The dimensions of the present specimens are as follows:

	A	B	C	D	E
Length	29 mm	21 mm	9 mm	9 mm	5 mm
Breadth at peristome	28 mm	19 mm	8 mm	8 mm	4.5 mm
Height	5.5 mm	4 mm	2 mm	2 mm	1 mm
Peristome (distance from posterior margin)	14 mm	11 mm	5 mm	4.5 mm	2.5 mm
Periproct (distance from posterior margin)	5.5 mm	4 mm	2 mm	2 mm	1.2 mm

The above table shows that all specimens are almost circular in outline. The distance between the periproct and the posterior margin is approximately 20% less than that between the periproct and the peristome, showing that the periproct is slightly posteriorly placed, while it should be "central" if these specimens are in fact representatives of P. hinemoae. Professor H.B. Fell of this Department has kindly permitted my examination of comparative material of P. hinemoae, and it is found that among eight specimens examined, three have the periproct in a position exactly midway between the peristome and the posterior margin, while in the remaining five specimens the periproct is slightly posterior to this midpoint. In view of such variation, although slight, and the otherwise complete resemblance of the "Tui" specimens to P. hinemoae, they have been assigned to that species.

In all cases the test is quite white, while the colour of the test can vary, from light green to light red or white.

A very closely related species, P. pellucida Doderlein, is known from Japanese seas between 75 metres and 550 metres (Mortensen, 1948).

The species has been recorded from the north and east of northern New Zealand from depths of 70-128 metres. Fell (1952) reports specimens from Fiordland in the southwest of New Zealand, 18-28 metres, and later (Fell, 1958) from the Bay of Plenty from depths up to ca. 225 metres. Within New Zealand the species appears to have a discontinuous distribution, the Fiordland record being some 700 miles south of its nearest northern locality, as pointed out by Fell (1952). The present records, Norfolk Island and Kermadec Islands, are new, and considerably extend the known range of the species.

Laganum depressum var. tonganense (Quoy & Gaimard)

Laganum tonganense Agassiz, 1841, p.114, Pl. 26, figs.7-19. (Synonymy).

Laganum depressum var. tonganense Mortensen, 1948, p.323, Pl. LIV, figs.1-4, 7-9. (Complete synonymy).

Material Examined: Station 103, at anchor, Raoul Island, 2 specimens.

Remarks: Mortensen (1948) regards the species Laganum tonganense as a variety of L. depressum, characterised by the slightly more anterior periproct and the shorter oral ambulacral furrows than those in the typical form. Also the typical form has more or less developed shallow emarginations of the ambitus in the posterior and posterolateral interambs, while L. depressum var. tonganense has none. It is also pointed out (Mortensen, 1948) that there is considerable variation in the outline of the test, and smaller specimens of the species may not with certainty be placed in any of the currently accepted varieties.

The two specimens in the present collection are complete and in excellent condition. They have the following dimensions:

	Specimen A	Specimen B
Length	62 mm	61 mm
Greatest breadth	57 mm	58 mm
Height	11 mm	10 mm
Petaloid area	37 mm	33 mm
Oral furrows (anterior)	13 mm	13 mm
Oral furrows (posterior)	15 mm	17 mm
Peristome (distance from posterior end)	32 mm	31 mm
Periproct (distance from posterior end)	13 mm	13 mm

As can be seen from the above table the ambitus is almost circular in outline, and the specimens are low, the height being approximately 18% of the breadth. The periproct is slightly posteriorly placed, the distance from the periproct to the posterior margin (13 mm, 13 mm) being less than that between the periproct and the peristome (19 mm, 18 mm). The peristome and apical system are slightly anterior. The posterior oral furrows are longer than the anterior furrows, and all furrows extend from the peristome to a point approximately halfway between the peristome and the ambitus.

Thus in the above characters these specimens agree with the variety <u>tonganense</u> of <u>L. depressum</u>, rather than with the typical form.

The test is light yellowish-brown in colour when denuded. The primary and secondary spines are light yellow.

In describing the echinoids of New Zealand, Mortensen (1921) records L. depressum from off the Hen and Chicken Islands (in the northern part of the North Island) at a depth of 55 metres, and the single test he describes has the characters of the specimens in the present collection. At that time Mortensen placed his specimen into L. depressum, with some hesitation. More recently Mortensen (1948) has referred this specimen to the variety tonganense. The occurrence of the present specimens at the Kermadec Islands is not surprising, but represents a new record for the species. Mortensen (1948) gives its distribution as "South Sea, from the Tonga, Gilbert and Fiji Islands, New Caledonia, Admiralty Islands, Queensland, and New Zealand". A widespread southern Pacific species, with a bathymetric range of 0-40 metres.

Order SPATANGOIDA

Brissopsis oldhami Alcock

Brissopsis oldhami Mortensen, 1951, p.409, fig.198a, Pls. XXI, fig.10, LVIII, figs.1-3, 5-20 (complete synonymy); Fell, 1958, p.38.

Brissopsis zealandiae Mortensen, 1921, p.193, Pl. 6, figs.33-34.

Material Examined: Station 21, off Steele's Point, Norfolk Island, 310-400 fathoms (558-720 metres), 1 specimen; Station 12, 30°37'S., 173°53'E., 1380-1520 fathoms (2484-2736 metres), fragments.

Remarks: Fell (1958) has established the presence of B. oldhami in New Zealand, and has reduced Mortensen's (1921) species B. zealandiae to synonymy with B. oldhami. The present (fragmented) specimen appears to represent B. oldhami. The test is greyish-white, radioles very light green. Total length 20 mm.

B. oldhami ranges the Indo-west-Pacific in depths of 1040-2140 metres. Within New Zealand the species is known from the northern part of the North Island to the Chatham Rise in depths of 75-1980 metres. Its occurrence near Norfolk Island and north of New Zealand is therefore not unexpected, but the bathymetric range of B. oldhami is now 75-2736 metres.

This species appears to be closely related to B. lyrifera (Forbes) which is wide-ranging in the Atlantic Ocean.

LIST OF ECHINOIDS KNOWN FROM NORTH OF NEW ZEALAND

The following list is intended to include all echinoids so far known from the area bounded by the Kermadec Islands, Norfolk Island and northern New Zealand (at latitude approximately 35°S.), with information on their distribution and bathymetric ranges. With regard to their distribution, special attention is paid to the presence of species in Australia, New Zealand, and northern islands.

Bathymetric ranges (in brackets) are given in metres.

Abbreviations: A., Australia; I.P., Indo-west-Pacific; K., Kermadecs; L.H., Lord Howe Island; N., Norfolk Island; N.Z., New Zealand (including Three Kings Islands).

Order Cidaroida

Prionocidaris australis (Ramsay) A., N., L.H. (10-85)

Goniocidaris magi Pawson N.Z. (135)

Stereocidaris sceptriferoides (Doderlein) Japan, near N.Z. (360-700)

Phyllacanthus parvispinus Tenison-Woods A., K. (0-28)

Order Lepidocentroida

Araeosoma thetidis (Clark) A., N.Z. (ca. 125-360)

Order Hemicidaroida

Salenocidaris hastigera (Agassiz) N.Z., I.P. (370-2565)

Salenocidaris brachygnatha Mortensen K. (1080)

Order Arbacioida

Coelopleurus sp. (chiefly an I.P. genus)

Order Diadematoida

Centrostephanus rodgersi (Agassiz) A., K., L.H., N.Z. (0)

Aspidodiadema tonsum Agassiz K., I.P. (180-1135)

Order Temnopleuroida

Holopneustes inflatus Lutken A., N., N.Z. (11-27)

Pseudechinus variegatus Mortensen N.Z. (65-120)

Pseudechinus grossularia (Studer) N.Z. (179)

Orechinus monolini (Agassiz) K., I.P. (ca. 450-2300)

Tripneustes gratilla (Linnaeus) A., N., K., I.P. (0-75)

Order Echinoida

Echinus multidentatus Clark K. (1135)

Evechinus chloroticus (Valenciennes) K., N.Z. (0-20)

Heliocidaris tuberculata (Lamarck) A., K., L.H., N., N.Z. (0-54)

Echinometra mathaei (Blainville) A., K., L.H., I.P. (0-139)

Order Holectypoida

Echinoneus cyclostomus Leske A., K., L.H. (0-120)

Order Cassiduloida

Apatopygus recens (Milne-Edwards) N.Z. (10-162)

Oligopodia epigonus (v. Martens) L.H., N., I.P. (35-141)

Order Clypeastroida

Clypeaster australasiae (Gray) A., K., L.H., N., N.Z. (0-220)

Echinocyamus polyporus Mortensen K., N., N.Z. (9-536)

Peronella hinemoae Mortensen K., N., N.Z. (70-ca.225)

Laganum depressum var. *tonganense* (Quoy & Gaimard) A., K., N.Z. (0-40)

Order Spatangoida

Brissopsis oldhami Alcock N.Z., I.P. (75-2736)

Brissus latecarinatus (Leske) A., K., L.H., I.P. (0-ca. 45)

Brissus gigas Fell N.Z. (ca. 20)

DISCUSSION

The distribution of each species has been considered in detail in the systematics section, but some general remarks about the area sampled may be made.

Stations 3, 9, 53 and 56 were occupied close to the New Zealand mainland, yielding six species, of which two, *Salenocidaris hastigera* and *Coelopleurus* sp., are new additions to the New Zealand fauna. As both of these species were collected from relatively deep water (1782 metres and 252-342 metres respectively), they probably also occur further south at similar depths.

New records for the broad area bounded by New Zealand, Norfolk Island and the Kermadec Islands are as follows:

Prionocidaris australis

Stereocidaris sceptriferoides

Salenocidaris hastigera

Coelopleurus sp.

Oligopodia epigonus

All of the above species (except the indeterminate *Coelopleurus* species) are widely distributed in the Indo-west-Pacific, while *Coelopleurus* is primarily an Indo-west-Pacific genus. Fell (1953) has analysed the generic content of the Tertiary and Recent echinoderm faunas of Australia and New Zealand, and concludes that New Zealand and Australia have derived many faunal elements from the northern Indo-Pacific region, and consequently Australia and New Zealand have many elements in common at the generic level.

Previously, Fell (1949) had reported on the occurrence of Australian echinoids in New Zealand waters, and in view of the additional knowledge provided by the present collection, it must be concluded that a substantial number of Australian or Indo-west-Pacific echinoids are yet to be discovered north of New Zealand, and there may in fact be a continuity in the deeper water faunas of Australia and New Zealand, the establishment of this continuity being facilitated by:

1. Trans-Tasman larval drift.

2. Benthic migration across the Lord Howe Rise and the Norfolk Island Ridge.

It is likely that species found in deeper waters as Australia and north of New Zealand also occur on the Lord Howe Rise.

Oligopodia epigonus, Salenocidaris hastigera and Stereocidaris sceptriferoides are now recorded from several localities in the Indo-west-Pacific and from north of New Zealand; they are as yet unknown from Australia, but undoubtedly they occur there. Owing to the very small amount of deepwater sampling which has been carried out in Australian waters, the fauna is very poorly known, and thus its content must be deduced on the basis of knowledge of the faunas of nearby areas, as has already been pointed out (p. 138).

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NEW RECORDS OF ECHINODERMS FROM THE SNARES ISLANDS

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ABSTRACT

A collection of 170 echinoderms from the Snares Islands comprises 13 genera and 13 species, of which ten are new records. Seventeen species of echinoderms are now known from the Snares, and the fauna is closely related to that of the New Zealand mainland.

INTRODUCTION

Although the faunas of the Auckland, Campbell, Bounty and Antipodes Islands echinoderms are now regarded as being well known, the Snares Islands, lying only 65 miles to the south of Stewart Island, have until recently been neglected by biological expeditions. Farquhar (1898) recorded a species of the asteroid Henricia from the Snares, and Fell (1953) reported four further genera of asteroids, which were collected by Dr. C.A. Fleming in 1947. In January and February of 1961, Professor G.A. Knox of Canterbury University, Christchurch, carried out a thorough investigation of the intertidal zone at the Snares Islands, and collected several echinoderms, which were forwarded to this Department for examination.

The collection greatly enhances our knowledge of the area, and I am grateful to Professor Knox for allowing me to examine it.

CLASS ASTEROIDEA

Calvasterias suteri (de Loriol)

Stichaster suteri de Loriol, 1894, p.477, Pl.23, fig.2.

Material Examined: 1/1/1961, barnacle zone, 1 specimen; 4/1/1961, Durvillea holdfast, 3 specimens; 26/1/1961, Durvillea holdfasts, 3 specimens; 30/1/1961, in pools, Durvillea zone, 2 specimens

Remarks: The largest specimen is R = 24 mm, r = 8 mm (R/r, 3), while the smallest is R = 9 mm, r = 3 mm (R/r, 3). The colour of these alcohol preserved specimens ranges from light fawn to dark brown, the aboral paxillae lighter in colour, forming a conspicuous lighter coloured band along the middle of each arm. The species is known on the New Zealand mainland from Wellington (see p.337), south to Stewart Island, and Fell (1953) records it from Auckland and Campbell Islands, the Snares and (with doubt) the Antipodes Islands.

Asterodon dilatatus (Perrier)

Pentagonaster dilatatus Perrier, 1875, p.217.

Material Examined: 26/1/1961, Durvillea holdfasts, 3 specimens.

Remarks: The largest specimen is R = 55 mm, r = 25 mm (R/r, 2.2), the smallest R = 30 mm, r = 15 mm (R/r, 2). Colour when dried, pale fawn. Fell (1953) has given a thorough account of the variation and colour of this species. Known from Cook Strait south to Stewart Island, also from the Snares.

Sclerasterias mollis (Hutton)

Asterias mollis Hutton, 1872, p.4.

Material Examined: 26/1/1961, Durvillea holdfasts, 2 specimens; 30/1/1961, in pools, Durvillea zone, 1 specimen.

Remarks: Largest specimen, R = 44 mm, r = 8 mm (R/r, 5.5), smallest specimen R = 28 mm, r = 6 mm (R/r, 4.6). Colour when dried, light orange brown. These are small specimens of a species which reaches an arm-spread of up to 330 mm. This is the first record of the species outside of the New Zealand mainland. On the New Zealand coast, it ranges from Cook Strait to Otago, in 12-130 fathoms (22-234 metres).

Coscinasterias calamaria (Gray)

Asterias calamaria Gray, 1840, p.179.

Material Examined: 26/1/1961, Durvillea holdfasts, 5 specimens.

Remarks: All specimens are young, the largest having the dimensions R = 69 mm, r = 10 mm (R/r, 7). Colour when dried, light brown, oral surface fawn. This wide-ranging Indo-west-Pacific species is known in New Zealand from North Cape to Stewart Island, and it is not unexpected that the species should occur at the Snares.

<u>Allostichaster insignis</u> (Farquhar)

<u>Stichaster insignis</u> Farquhar, 1895, p.203, Pl.13, fig.1.

Material Examined: 5-6/1/1961, <u>Lessonia</u> holdfasts, 9 specimens; 26/1/1961, <u>Durvillea</u> holdfasts, 4 specimens; 30/1/1961, in pools, <u>Durvillea</u> zone, 9 specimens; 4/2/1961, rock pool, <u>Durvillea</u> zone, 1 specimen; 6/2/1961, <u>Lessonia</u> holdfasts, 1 specimen.

Remarks: This fissiparous species is apparently common at the Snares, especially in the holdfasts of brown algae. Mortensen (1925) reports it from the Auckland Islands, while Fell (1953) describes further material from the Auckland Islands and the Snares. On the New Zealand mainland, <u>A. insignis</u> ranges from Cook Strait south to Stewart Island in 0-125 fathoms (0-225 metres).

CLASS OPHIUROIDEA

Ophiomyxa brevirima Clark

Ophiomyxa brevirima Clark, 1915, p.169, Pl.1, figs.3-4.

Material Examined: 26/1/1961, Durvillea holdfasts, 1 specimen; 30/1/1961, in pools, Durvillea zone, 11 specimens; 6/2/1961, in pool, Durvillea zone, 1 specimen; 5-6/1/1961, Lessonia holdfasts, 1 specimen.

Remarks: These are typical specimens of this species, which ranges the entire New Zealand coast in depths ranging from 0-300 fathoms (0-540 metres).

Pectinura gracilis Mortensen

Pectinura gracilis Mortensen, 1924, p.172, figs.35, 36.

Material Examined: 30/1/1961, in pools, Durvillea zone, 1 specimen.

Remarks: P. gracilis ranges from Cook Strait south to the Snares, with a bathymetric range of 0-100 fathoms (0-180 metres).

Amphipholis squamata (Delle Chiaje)

Asteria squamata Delle Chiaje, 1828, p.74.

Material Examined: 30/1/1961, in pools, Durvillea zone, 5 specimens; 2/2/1961, Marginariella holdfasts, 4 specimens;

3/2/1961, in algae from *Durvillea* zone; in sponges, 1 specimen.

Remarks: This is a cosmopolitan species, with a bathymetric range in the New Zealand region of 0-300 fathoms (0-540 metres).

Amphioplus basilicus (Koehler)

Amphiura basilica Koehler, 1907, p.307, Pl.11, figs.17-18.

Material Examined: 4/1/1961, deep pool, *Durvillea* zone, 1 specimen; 5-6/1/1961, *Lessonia* holdfasts, 19 specimens; 3/2/1961, *Lessonia* and *Marginariella* holdfasts, 5 specimens.

Remarks: Known from off East Cape, New Zealand (Koehler, 1907) and from the South Island of New Zealand (Fell, 1953). Fell (1953) also records the species from the Auckland, Campbell and Antipodes Islands. This species is almost exclusively intertidal, and lacks a pelagic larval stage.

Ophiocoma bollonsi Farquhar.

Ophiocoma bollonsi Farquhar, 1908, p.108.

Material Examined: 5-6/1/1961, *Lessonia* holdfasts, 1 specimen; 26/1/1961, *Durvillea* holdfasts, 1 specimen.

Remarks: The single specimen is dark greyish-brown on the aboral surface, light reddish-brown adorally. *O. bollonsi* ranges the entire New Zealand coast in 5-350 fathoms (9-630 metres), and is now known to occur in the intertidal zone at the Snares.

Ophiopteris antipodum Smith

Ophiopteris antipodum Smith, 1877, p.305, Pl.15.

Material Examined: 26/1/1961, Durvillea holdfasts, 3 specimens.

Remarks: While this species is nowhere particularly common, it ranges on the New Zealand coast from Auckland to Otago in 0-40 fathoms (0-70 metres).

Ophiactis resiliens Lyman

Ophiactis resiliens Lyman, 1882, p.115, Pl. 20, figs.7-9.

Material Examined: 5-6/1/1961, Lessonia holdfasts, 32 specimens; 26/1/1961, Durvillea holdfasts, 5 specimens; 30/1/1961, 9 specimens.

Remarks: The largest specimen has a disc diameter of 9 mm and an armlength of 52 mm. The smallest is 3 mm in disc diameter, with arms 11 mm in length. The central portion of the disc in large specimens is covered in small circular overlapping plates (Pl. XXXI, fig.2). Toward the edge of the disc the plates carry numerous small spines which tend to obscure them. At the edge of the disc the plates disappear and the spines are carried on the leathery dark brown skin. The radial shields are conspicuous, the members of each pair separated by up to eight polygonal platelets, which are not overlapping.

In a juvenile specimen with disc diameter of 2 mm the primary embryonic plates can be seen in their original positions (Pl. XXXI, fig.5). The centrodorsal and radial plates are of approximately equal size, while the basals are much smaller, and appear to have arisen later than the centrodorsal and radials, becoming interpolated between them.

The ventral surface of the disc carries spines in the interradii (Pl. XXXI, fig.4); there are no plates in the ventral interradii. The ventral spines are slightly larger and more scattered than those on the dorsal side of the disc.

Oral shields are approximately rectangular in shape, broader than long. Adoral plates are large, carrying lateral wings which meet in the midline of each radius. There are two oral papillae to each oral plate, and a single terminal infradental papilla which resembles a tooth. The oral papillae are approximately rectangular, with the outer edges irregular, but not serrate.

The arms are widest some distance from the nodes (Pl.XXXI, fig.2). There is a single broad rectangular dorsal armplate, which may be fragmented into smaller pieces (see Pl. XX fig. 2). The lateral armplates each carry four to six arm-spines, which are short, stout and blunt, the uppermost and lowermost spines being smaller than the rest (Pl.XXXI, fig.3). Ventral armplates are elongate, rounded at their free edges (Pl. XXXI, fig.4). The tentacle-pores are large, each with

PLATE XXXI

Pseudechinus variegatus Mortensen; Ophiactis resiliens Lyman

Pseudechinus variegatus Mortensen.

Fig.1. Primary tubercle, showing radiating epistromal ridges extending towards secondary tubercles.

Ophiactis resiliens Lyman

Fig.2. Aboral surface: portion of disc and arm.

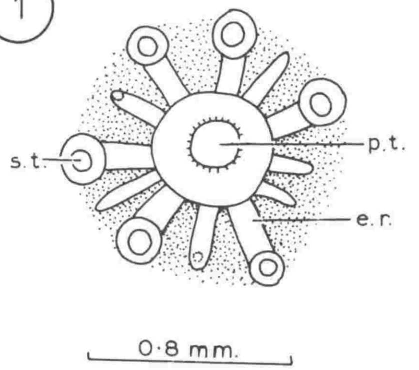
Fig.3. Lateral armplates with armspines.

Fig.4. Adoral surface: jaws and arm.

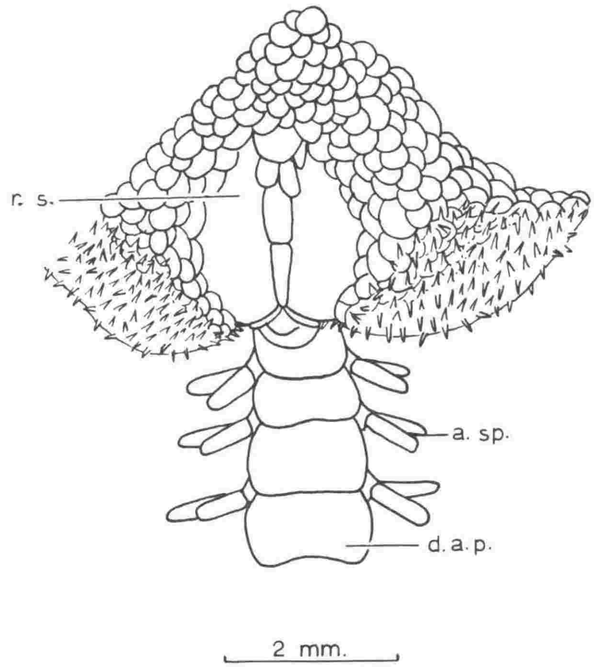
Fig.5. Aboral surface of disc of juvenile, showing embryonic primary plates.

Abbreviations: a.p., adoral plate; a.sp., armspine; b.p., basal plate; cd., centrodorsal plate; d.a.p., dorsal armplate; e.r., epistromal ridge; l.a.p., lateral armplate; o.pap., oral papilla; o.pl., oral plate; o.s., oral shield; p.t., primary tubercle; r.p., radial plate; r.s., radial shield; s.t., secondary tubercle; t.s., tentacle scale; v.a.p., ventral armplate.

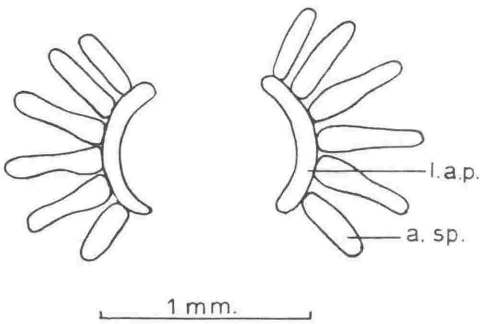
1


s.t.
p.t.
e.r.
0·8 mm.

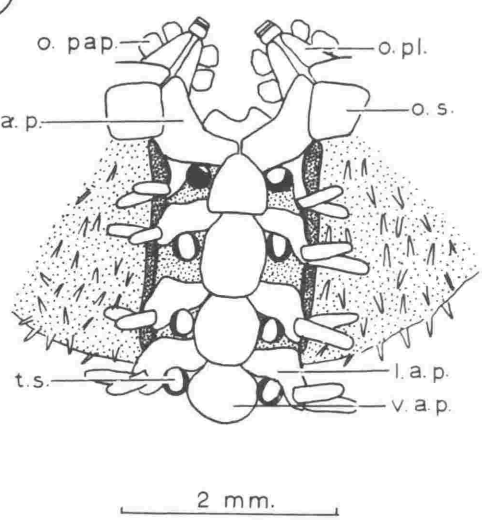
2


r. s.
a. sp.
d. a. p.
2 mm.

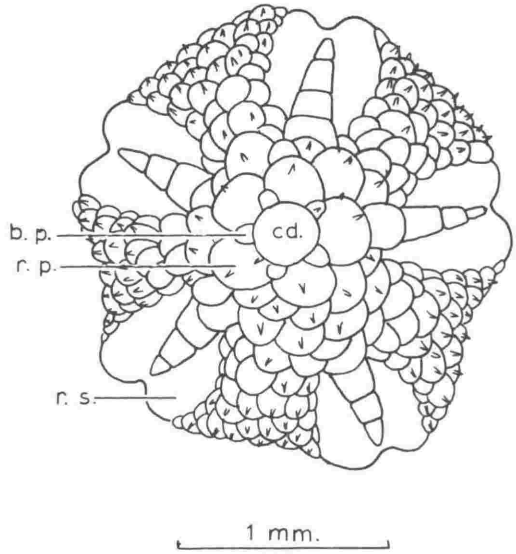
3


l. a.p.
a. sp.
1 mm.

4


o. pap.
o. pl.
a. p.
o. s.
t. s.
l. a. p.
v. a. p.
2 mm.

5


b. p.
cd.
r. p.
r. s.
1 mm.

a single large tentacle scale.

Colour when dried is variable. Upper side of disc orange-brown to greenish-grey, mottled with darker and lighter shades. Near the ambitus and below it, where scales are lacking, the skin is light to dark brown. Arms greenish-grey above, often with a longitudinal light orange band along each lateral margin of the dorsal armplates, yellowish-white to light brown below.

Remarks: These specimens differ in some small respects from those described by Farquhar (1907) and Mortensen (1924). In his description of _O. nomentis_, Farquhar (1907) notes the presence of four armspines, and his description was based on " ... a number of specimens" (Farquhar, 1907). In the present material the armspine numbers vary considerably, there being four to six on each lateral armplate, at least half of the specimens having four armspines. This character is not of diagnostic importance. The adoral plates, according to Farquhar (1907) and the present material, have their inner edges bent at an acute angle (Pl. XXXI, fig.4), but Mortensen's (1924) figure shows the adoral plates to have an almost straight inner edge. It is doubtful whether much importance can be attached to this feature, for many of the present specimens show some variation in the shape of the adoral valves. Mortensen (1924) has also described some variation in the structures on the oral side, and it seems evident that this species, though distinct from all other _Ophiactis_ species, is highly variable. Variation in colour is also evident.

The radial oral plates are conspicuous in this species (Pl.XXXI, fig.4). Fell (1963) has commented upon the significance of these plates, suggesting that they must function as valvate structures helping to close the jaw; these plates evidently develop "as the first sign of a mid-ventral gradient ..." (Fell, 1963).

Ophiactis resiliens is known in New Zealand from near Cape Maria van Diemen in the extreme north of the North Island to the Snares, between the shore and 120 fathoms. The species is also known from Australia, where it is "... a characteristic member of the temperate fauna of South Australia" (Clark, 1946), and from Lord Howe Island.

CLASS ECHINOIDEA

Pseudechinus novaezealandiae (Mortensen)

Notechinus novaezealandiae Mortensen, 1921, p.153, figs.6-8, Pl.6, figs.7-10, Pl.8, figs.4-5, 7-11.

Material Examined: 4/2/1961, rock pool, Durvillea zone, 1 specimen.

Remarks: The single specimen is 25 mm in horizontal diameter. The radioles are light green in colour, with white or light red tips. The distribution of this species is given on p. 185 ; the Snares record is new.

ECHINODERMS NOW KNOWN FROM THE SNARES ISLANDS

(New records are marked with an asterisk)

Class Asteroidea

Asterodon dilatatus (Perrier)

*_Sclerasterias mollis_ (Hutton)

*_Coscinasterias calamaria_ (Gray)

Henricia sp. (possibly _H. compacta_ (Sladen))

Stichaster australis (Verrill)

Allostichaster insignis (Farquhar)

Calvasterias suteri (de Loriol)

Class Ophiuroidea

*_Ophiomyxa brevirima_ Clark

*_Ophiocoma bollonsi_ Farquhar

*_Ophiopteris antipodum_ Smith

*_Ophiactis resiliens_ Lyman

*_Amphioplus basilicus_ (Koehler)

*_Amphipholis squamata_ (Delle Chiaje)

*_Pectinura gracilis_ Mortensen

Class Echinoidea

*_Pseudechinus novaezealandiae_ (Mortensen)

Evechinus chloroticus (Valenciennes)

Class Holothuroidea

*_Stereoderma_ leoninoides (Mortensen)

DISCUSSION

On the basis of the four genera then known from the Snares Islands, Fell (1958) was led to the conclusion that the fauna of the Snares is more closely related to that of the New Zealand mainland than to the other southern islands. The present records support this conclusion, for of the 17 species now known from the Snares, all but one are also present in the New Zealand mainland fauna, while seven of these 17 are shared between New Zealand and the Snares, but are unknown from the other southern islands.

The single species as yet unknown from New Zealand is the holothurian *Stereoderma leoninoides*, and in view of its present known distribution (see p.164), it is expected that the species will eventually be discovered off New Zealand.

Notable absentees from the Snares fauna are *Patiriella regularis* (Verrill), *Pectinura maculata* (Verrill), *Stichopus mollis* (Hutton) and *Trochodota dunedinensis* (Parker). All of these species are wide-ranging on the New Zealand coast, but are as yet unrecorded from the Snares.

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THE ASTEROID, *Calvasterias suteri* (de Loriol) IN COOK STRAIT

The brood-protecting New Zealand representatives of the genus *Calvasterias*, namely *C. suteri* (de Loriol) and *C. laevigata* (Hutton), are known to occur among the southern islands of New Zealand, while the former species is also known from the New Zealand mainland, south of Banks Peninsula, and the Snares Islands (Fell, 1959).

Recently (May, 1963), Mr. R.A. Fordham of this Department collected a single juvenile specimen of this species from the holdfast of a brown seaweed (*Durvillea antarctica* (Chamisso)), washed ashore at Palliser Bay, near Wellington. The specimen was still alive when collected. This represents the most northerly record known of this species, and thus considerably extends its range of distribution.

Mortensen (1925) has also reported on a specimen of this species taken from a piece of floating seaweed (*Lessonia* sp.) 1 mile to the east of Auckland Island. It appears that the present specimen was carried from the south across Cook Strait. It would be of great interest to discover whether the species has settled anywhere on the northern side of Cook Strait.

The specimen is a juvenile, R = 10 mm, r = 4 mm, R/r, 2.5. Colour when dried, aboral surface dark brown, spinules fawn, aboral surface uniformly yellowish-white.

It has been stated elsewhere that Cook Strait appears to present no barrier to northward migration of southern species (p.345), and the present record lends additional support to this statement, showing that migration from the south, perhaps with the aid of the northward-flowing Canterbury Current, is definitely taking place.

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A RECORD OF THE HOLOTHURIAN *Stichopus mollis* (Hutton) FROM NORTHERN NEW ZEALAND

A small collection of intertidal animals from a rock pool at Cape Karikari (approximately 35 miles southeast of North Cape) was recently made by Mr. L.J. Paul of the Marine Department, Wellington. This collection comprised four species of echinoderms:

Patiriella regularis (Verrill)	4 specimens
Ophiomyxa brevirima Clark	2 specimens
Ophionereis fasciata Hutton	1 specimen
Stichopus mollis (Hutton)	1 specimen

All of the specimens are typical of the species. The small specimens of *Patiriella regularis* range in colour from dark green to light brown. *Ophiomyxa brevirima* is, as usual, deep brownish-red dorsally, light red ventrally.

The most important feature of the collection is the presence of *Stichopus mollis*. This species has been well known in New Zealand for over ninety years. During that time it has never been recorded from further north than Plimmerton (approximately 20 miles north of Wellington), although, because the species is also widespread in southern and western Australia, and Tasmania, it was expected to occur in northern New Zealand. Now its presence there is established with the present record, and it may now be stated that *S. mollis* ranges the entire coast of New Zealand, in depths between the intertidal zone and 270 metres.

THE DISTRIBUTION OF ECHINODERMS TO THE EAST OF NEW ZEALAND

by D.L. PAWSON

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Since the publication of an article on distribution patterns of New Zealand echinoderms (Pawson, 1961), Dell (1962) has reviewed New Zealand marine provinces in the light of additional knowledge of the distribution of some Mollusca. In his paper, Dell notes that many mollusc species previously regarded as "typical" of the provinces defined by Finlay (1925) do in fact have a wider distribution than formerly supposed, and on the basis of such evidence, favours a more dynamic approach to the distribution problems. Thus Dell (1962) discards the molluscan provinces, and rather envisages the Mollusca as being composed of three groups, namely:

1. A group extending throughout New Zealand.
2. A group essentially northern in origin.
3. A group essentially southern in origin.

Dell (1962) suggests that more work should be concentrated on compiling full distribution data for all species, rather than attempting to define "... rather nebulous province boundaries" (Dell, 1962).

In response to this recommendation for a more realistic approach to the distribution of New Zealand marine animals, a more detailed analysis is given here of the distribution of echinoderms to the east of New Zealand.

Distribution data for the elements in the fauna have been derived chiefly from publications by Mortensen (1921-1925), Fell (1949a, 1949b, 1952, 1953a, 1958, 1960), Pawson (1963) and others, together with some data as yet unpublished.

At the present time, 215 species of echinoderms are known from the coasts of New Zealand. The east coast, an area which has been more intensively sampled than the west, supports a known fauna of 210 species. Thus, only five of the New Zealand echinoderm species are unknown from the east coast; of these, four have been recorded only from the south-western coast of the South Island, while the other has a bathyal distribution, and is expected to occur in east coast waters. To the east of New Zealand, a good cross-section of the fauna is displayed.

The accompanying figure (Pl. XXXII) shows some typical latitudinal distributions of stenobathic shelf species. In the following text, the number in brackets following the species mentioned refers to the number given the species in the figure. Code-number (1) is intended to include all those species which range the entire New Zealand coast.

SHELF FAUNA

The east coast shelf supports a known echinoderm fauna of 145 species, representing 92 genera. Species restricted to the shelf (presumed to be stenobathic species) number 83 (56 genera). The stenobathic shelf species thus represent about 58% of the total shelf fauna. This percentage might possibly be a little higher as there are some species which, while they are generally regarded as restricted to the shelf, have been taken from deeper waters. These include Pentagonaster pulchellus, Heterothyone alba, Stichopus mollis and Chiridota nigra. There is some evidence to show that these species may have accidentally fallen from the shelf into the bathyal depths in which they were found.

Speciation is not far advanced in the stenobathic fauna, except in a few cases such as the widespread holothurian genus Chiridota, which has five species in New Zealand.

The generic structure of the stenobathic fauna indicates strong affinities with the Indo-west-Pacific region and the number of endemic genera is small. It is probable that the bulk of the fauna in question was initially and recently (in the geological sense) derived principally from the Indo-west-Pacific region. At the specific level, the situation becomes rather more complex. There are a large proportion of endemic species, and of the 83 stenobathic shelf species 70 (83%) are endemic; 12 (15%) have warmer-water distribution (especially in Australia), and 2 (3%) are circumpolar. There are no true cosmopolitan elements in this stenobathic fauna; most of the cosmopolitan elements in the echinoderm fauna of New Zealand are eurybathic forms.

The high percentage of endemic species needs no further discussion here, as this is a characteristic of the shallow water fauna of New Zealand, implying some isolation from adjacent land-masses. The two circum-polar elements are <u>Ocnus calcareus</u> and <u>Monamphiura magellanica</u> (30). Both of these species are commonly found in the holdfasts of seaweeds, e.g. <u>Macrocystis</u>. Transport epiplanktonically with the aid of the west-wind-drift has been suggested to account for the distribution of species such as these (Mortensen, 1925; Fell, 1953b). Recently, Fell (1962) has elaborated this theory on a quantitative basis.

There remain for consideration twelve "immigrant" species, which are known from the Australian-Indo-Pacific region, and warmer northern waters. Two of these species, namely <u>Allostichaster polyplax</u> (1) and <u>Coscinasterias calamaria</u> (1) are widely distributed along our coasts. The other ten species have what appears to be a restricted distribution on the east coast of New Zealand. They are:

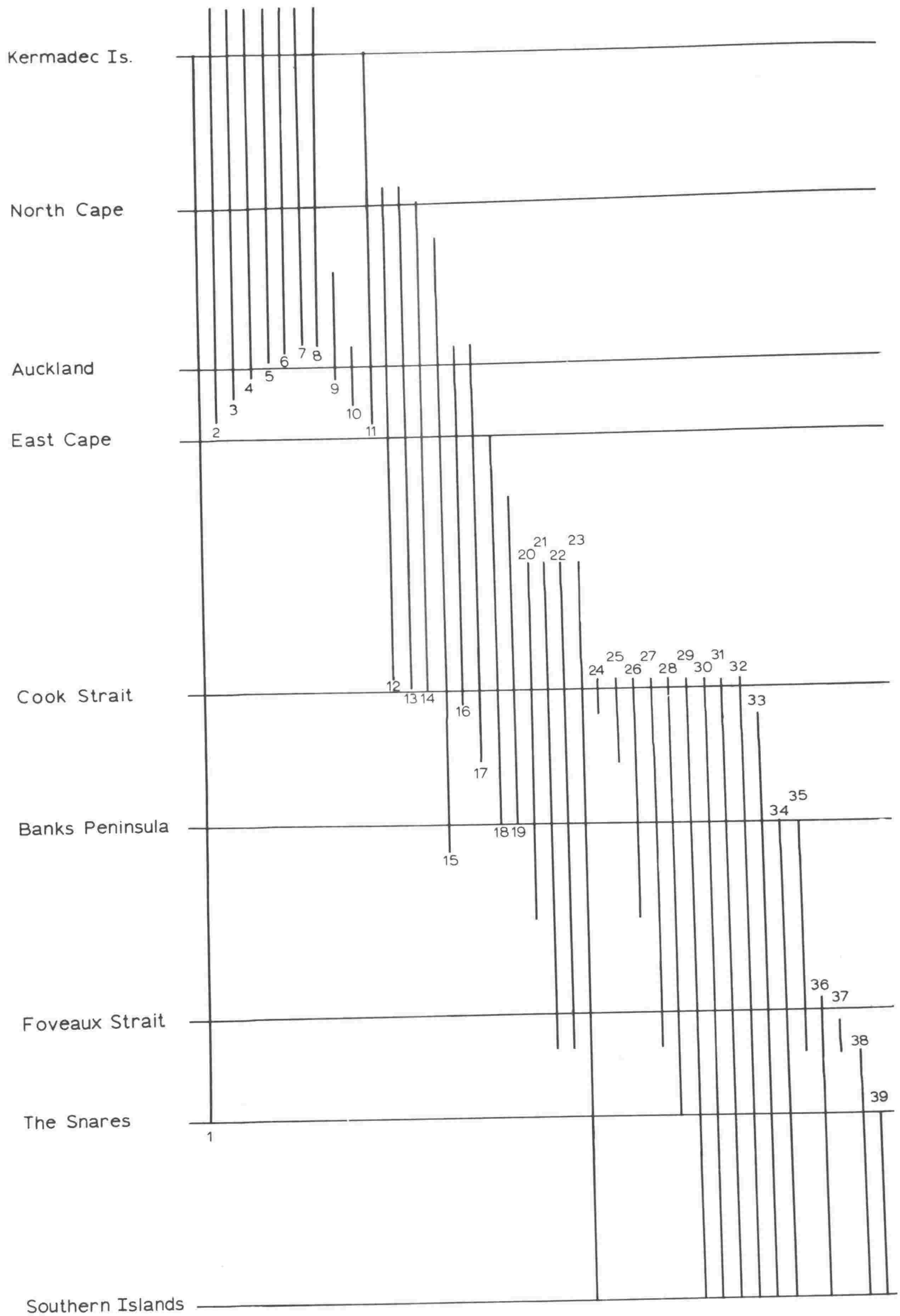
<u>Luidia varia</u> (10)
<u>Astropecten polyacanthus</u> (2)
<u>Ophidiaster kermadecensis</u> (11)
<u>Asterodiscus truncatus</u> (4)
<u>Ophiocentrus pilosa</u> (3)
<u>Centrostephanus rodgersi</u> (7)
<u>Heliocidaris tuberculata</u> (6)
<u>Holopneustes inflatus</u> (5)
<u>Laganum depressum</u> var. <u>tonganense</u> (8)
<u>Brissus gigas</u> (9)

The last species on the above list, <u>Brissus gigas</u>, although unknown elsewhere, is very closely related to <u>B.</u>

PLATE XXXII

Latitudinal distribution of stenobathic shelf echinoderms to the east of New Zealand.

(For explanation, see text.)


Kermadec Is.
North Cape
Auckland
East Cape
Cook Strait
Banks Peninsula
Foveaux Strait
The Snares
Southern Islands
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39

latecarinatus, an Indo-Pacific species. None of the above species have been taken from further south than East Cape. It is clear that the warmer-water elements in our stenobathic shelf echinoderm fauna are entering from the north, and the greater proportion of these "immigrants" appear to be remaining there. The area north of East Cape is therefore notable for the presence of these ten species, and thus differs faunistically from the remainder of the New Zealand shelf region. Together with these species are some endemic forms which have a restricted distribution, including *Astropecten dubiosus* and *Vaneyothuria neozelanica*. (The latter species is New Zealand's sole representative of a large tropical and subtropical family of holothurians, the Holothuriidae).

Underlying this immigrant fauna, there is an assemblage of 13 stenobathic species which range from the northern part of New Zealand to the southern part of the South Island, in some cases as far as the Snares and the other southern islands. These are:

Patiriella regularis
Allostichaster polyplax
Stichaster australis
Coscinasterias calamaria
Ophionereis fasciata
Monamphiura spinipes
Monamphiura alba
Amphiura amokurae
Evechinus chloroticus

Ocnus calcareus

Protankyra uncinata

Trochodota dendyi

Kolostoneura novaezealandiae

The above assemblage is represented in Plate XXXII by column 1.

In addition there are several species which are so far known from but a single record. They must of necessity be neglected when distributions are being considered, until more data is forthcoming.

South of East Cape, the fauna assumes a different aspect. Its most notable features include the presence of some southern species, virtual absence of stenobathic northern immigrants, and an overlap of endemic species which have either a northern or a southern distribution within New Zealand, but whose individual ranges do not cover the entire coast. In addition there are restricted stenobathic species such as *Eurygonias hylacanthus* (25), *Heterothyone ocnoides* (18), *Neothyonidium dearmatum* (26), *Astrostole scabra* (19), *Stolus huttoni* (20), and peak populations of rather more widespread species, such as *Psilaster acuminatus*, *Persephonaster neozelanicus* and *Pentadactyla longidentis*.

It is interesting to note that the Cook Strait area is an important point of overlap of northern and southern species, giving the fauna a "mixed" aspect. Cook Strait itself appears to present no barrier to northward migration of southern species.

Southern elements in the Cook Strait area include *Monamph-*

iura magellanica (30), a circumpolar species, Asterodon dilatatus (22), known from the Snares Islands north to Cook Strait, Amphioplus basilicus (33), Calvasterias suteri (31), both recorded from the southern islands north to Cook Strait.

Northern elements include Stegnaster inflatus (15), Ophiozonoida picta (13), Ophioceres huttoni (14), Pectinura cylindrica (12) and Amphiura rosea (16).

Further south, along the east coast of the South Island, the northern endemics tend to disappear, and a rather uniform southern group is encountered, especially toward the southern extremity of the South Island, in the Foveaux Strait region.

Foveaux Strait has an echinoderm fauna which resembles that of Cook Strait in some respects, for many of the species known from Cook Strait are also known from Foveaux Strait. But Foveaux Strait differs in possessing the following features:

1. Presence of some restricted species which are not known further north.

2. Peaking of populations in several species.

3. Impoverishment of some families which are well represented in the Cook Strait fauna.

In addition, the remarkable overlap of northern and southern species, a characteristic of Cook Strait, is lacking here.

1. Presence of restricted species: Ophionephthys stewartensis (37) is known from Foveaux Strait and is unknown elsewhere. Of the two Foveaux Strait spatangids recently described

by Fell (1963), namely _Spatangus thor_ and _S. beryl_, the latter is as yet unknown from elsewhere, while the former has been taken from the Chatham Rise and south of New Zealand (see p.190). _Pseudopsolus macquariensis_ (38), a monotypic genus, is recorded from Stewart Island and Macquarie Island. _Trachythyone amokurae_ (36) ranges from the Auckland Islands to Foveaux Strait. _Stereoderma leoninoides_ (39), a species previously known from the Auckland and Campbell Islands, is now recorded from the Snares, and is expected to occur in southern New Zealand.

2. Peaking of populations: It is true that Foveaux Strait and Cook Strait have many species in common, and straight lines indicating known limits of distribution show this, but such lines (as on Plate XXXII) give no indication of population density. As yet, there are not enough data to make a satisfactory quantitative study of the populations but it is known that for some species, the peak population lies in Foveaux Strait, with specimen numbers falling off, either abruptly, or gradually with spread northwards. _Apatopygus recens_ (32) can be obtained in large numbers in Foveaux Strait, but off Oamaru, some 140 miles north of Foveaux Strait, only a single specimen has been collected by Graham (1962), and from Cook Strait, where the species is also known to occur, no more than about 12 specimens have been taken. This property is shared also by _Asterodon dilatatus_ (28), _Pseudechinus novaezealandiae_, _Goniocidaris_

umbraculum, Calvasterias suteri and Pentagonaster pulchellus (21).

3. Impoverishment of Families: The family Luidiidae extends from North Auckland to south of Cape Campbell, while Family Astropectinidae show a marked reduction in number of representatives towards southern New Zealand. Astropecten polyacanthus (2) and A. dubiosus are northern species, A. primigenius ranges from North Auckland to east Otago, while Psilaster acuminatus and Persephonaster neozelanicus tend to diminish in numbers south of Cook Strait.

The brief summary given above is intended to represent the state of our knowledge of the distribution of New Zealand shelf echinoderms. This knowledge is still very lacunar, for there is yet much to be learned about the habits, vagility, and interrelationships of these shelf species. Undoubtedly, with further sampling of the shelf, the distributional data given here will need considerable modification in the light of new discoveries. Four important facts emerge from the present study:

1. There are 13 species which extend throughout New Zealand.

2. Of the 12 Australian-Indo-Pacific elements in the stenobathic shelf fauna, 10 are unknown from south of the East Cape region. Thus the area north of East Cape is notable for the unique nature of its echinoderm fauna.

3. Between East Cape and the southern part of the South Island, the fauna is mixed, showing an overlap of northern

endemics and southern endemics, together with circumpolar species.

4. The fauna of the Foveaux Strait region is notable for possessing the three characters discussed above(p.346).

Three distinct faunal assemblages may therefore be recognised off the east coast of New Zealand, namely a northern assemblage, a middle (mixed) assemblage and a southern assemblage.

The areas containing these assemblages have previously been labelled "provinces" for the purposes of convenience and the provincial faunal patterns of the echinoderms have been discussed by Fell (1949b) and Pawson (1961).

Dell (1962) has analysed the use of the word "province" in relevant molluscan literature, and concludes that the term has been defined by several authors, the definitions given being at variance, and in some cases almost mutually exclusive. Provinces must have boundaries, and these should be capable of definition, in terms of physical factors, which act in some way to prevent or restrict the movements or spread of certain species.

It is felt that the East Cape region constitutes an important barrier to southward movement of some echinoderm species. The writer (Pawson, 1961) has discussed physical factors which may contribute to the formation of this barrier. As a result of the southward flow of the East Auckland Current a counter-clockwise swirl is established in the Bay of Plenty, and this should have some effect on the plankton of the area, tending to carry it away from East Cape rather than towards it. In this context it is interesting to note that most of the Australian-Indo-Pacific species known from north of East Cape have pelagic larval stages. The East Cape region may then be interpreted as a "filter" zone, with the pattern of the coastal currents dictating the spread of species. Dell (1963) notes that some archibenthal (bathyal) molluscs are not yet known south of East Cape, and considers that this may later prove to have some significance, when more intensive sampling has been carried out.

No satisfactory line of demarcation appears to exist between the faunas of the Cook Strait region and the Foveaux Strait region. This has already been pointed out (Pawson, 1961).

Although the term "province" may not be wisely chosen, it seems necessary that the areas containing the three distinct echinoderm assemblages should be labelled, and for the echinoderms these areas may be aptly termed northern, middle mixed, and southern.

BATHYAL (ARCHIBENTHAL) FAUNA

The bathyal echinoderm fauna comprises 100 species, which are distributed as follows: restricted species 57 (57%), Australian-Indo-Pacific 27 (27%), cosmopolitan 12 (12%), southern 4 (4%). The presence of 27 Australian-Indo-Pacific species points to that area as a source for many of our deeper water elements, as has already been pointed out by Fell (1953). The percentage of endemic species has dropped from 83% on the shelf to 57% on the slope, indicating the ability of the deeper water species to spread more widely. This archibenthal fauna may be subdivided into four categories:

1. Species common to shelf and slope: There are 33 of these species, of which seven (27%) are known from elsewhere.

2. Species common to the shelf, slope, and abyss: Of the 30 such species, 14 (46%) are endemic, but because of their eurybathic habit have achieved a wide distribution to the east of New Zealand. These include Heteromolpadia marenzelleri, Ognocidaris benhami. Of the 16 species (54%) known from elsewhere, some have a very wide bathymetric range. Ophiactis profundi is known from 50-900 fathoms (90-1620 metres), Molpadia violacea from 20-700 fathoms (36-1260 metres) and Paracaudina chilensis from 0-750 fathoms (0-1350 metres). Species such as these have probably achieved their distribution by spreading across the deep-sea floor, with shallower waters having little effect as a barrier.

3. Species common to slope and abyss: Twenty-four species fall into this category, and of these 18 (75%) are known from elsewhere. Of the six remaining species, four are so far known from one record. In this category, the Indo-west-Pacific influence is becoming overshadowed by more pan-Pacific and

cosmopolitan elements, such as <u>Laetmogone violacea</u>, <u>Enypniastes eximia</u>.

(In the three categories listed above the percentage of immigrants is seen to rise from 27% through 54% to 75%, indicating how the fauna loses its "New Zealand character" with increase in depth.)

4. Species restricted to the bathyal zone: Eleven species are so restricted, and of these, two (18%) are known from elsewhere. They are <u>Cosmasterias dyscrita</u>, which is a wide-ranging species, and <u>Ophiacantha abyssicola</u>, a deep-sea species which is expected to occur in our abyssal zone, thus falling into category (3) above. The remaining nine species (82%) are all known from but one record each.

It seems evident that there is no restricted bathyal fauna as such; rather the fauna appears to be derived in part from the shelf and in part from the abyss. The bathyal zone is mixed, carrying an ascending and descending traffic. An example of the ascending species is <u>Spatangus multispinus</u>, which in Cook Strait is decidedly a deep-water form, reaching peak populations in abyssal depths. Occasional specimens taken from the shelf in Cook Strait almost certainly represent derivatives from a deep-water population living nearby. Descending traffic is exemplified by <u>Ophiocoma bollonsi</u>, which is represented by large local populations on the Cook Strait shelf (see p. 225), but a few specimens have been collected from depths in excess of 350 fathoms (630 metres).

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A CLASSIFICATION OF THE DENDROCHIROTE HOLOTHURIANS

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Recent studies on some unusual dendrochirote holothurians, coupled with inferences drawn by Fell (in press) as to pelmatozoan trends in these forms, has prompted a re-examination of their currently accepted classification. There is palaeontological evidence indicating that some extant dendrochirote holothurians may be primitive types, and the current classification appears to conceal certain important evolutionary trends.

At the present time, three dendrochirote families are recognised. These may be distinguished as follows:

1 (4) Body cylindrical or fusiform, without a well-defined sole.

2 (3) Tentacles 10 . . . . Cucumariidae

3 (2) Tentacles more than 10, up to 30 in number . . . . .Phyllophoridae

4 (1) Body flattened, with a well-defined ventral sole. Mouth and anus dorsal . . . . .Psolidae

In this article, a classification of dendrochirote holothurians is proposed in which tentacle numbers are abandoned as criteria for major taxa, and importance is attached to the shape of the tentacles, the calcareous deposits of the body-wall and the shape of the calcareous ring.

Unusual dendrochirote holothurians

A review of the Order Dendrochirotida discloses that a number of included genera exhibit characters which are incompatible with the diagnosis of the order. Deichmann (1931) gives the following diagnosis for the Dendrochirotida:

Tubefeet present, tentacles tree-shaped, profusely branched. Retractor muscles present. Mesentery of the posterior loop of the intestine in the right or left ventral interradius. Gonads on both sides of the dorsal mesentery. Respiratory trees present. Deposits usually irregular fenestrated plates, sometimes tables.

The above characters are not fully exhibited in the genera Ypsilothuria Perrier, 1886; Echinocucumis Sars, 1859; Ypsilocucumis Panning, 1949; Mitsukuriella Heding and Panning, 1954; Vaneyella Heding and Panning, 1954; Rhopalodina Gray, 1853; Rhopalodinopsis Heding, 1937. All of these genera include species with relatively simple tentacles which may be digitiform, digitate, or weakly branched. In sharing this character, these genera are sharply distinguished from those with "richly branched" tentacles.

A study of the genera referred to above revealed that they share two other very interesting features. Firstly, in all genera, the body is more or less U-shaped, with mouth and anus directed dorsally. Secondly, all have the body completely invested in a test of overlapping or contiguous skeletal plates approximately 1 mm in diameter.

A U-shaped body may not be of very great importance, but the genera listed above may be arranged in a series, showing progressive shortening of the mid-dorsal interradius. In Vaneyella and Mitsukuriella the body is usually U-shaped, but may be almost fusiform. In Echinocucumis, Ypsilothuria and Ypsilocucumis the body is rigid, permanently U-shaped (Pl. V, fig.3). In the genera Rhopalodina and Rhopalodinopsis this tendency has progressed further, so that the body becomes flask-shaped, with the anus and mouth close together at the top of the "neck". Heding (1937) notes that Rhopalodinopsis has a distinct "dorsal side", where mouth and anus are well separated, while in Rhopalodina the mouth and anus are placed very close together, with the mid-dorsal interradius virtually lacking.

Each of the plates which form the test in these genera comprises a single layer or several layers of calcareous material. Spires may be present or absent.

Vaneyella Heding and Panning contains two species, V. dactylicus (Ohshima) which has 15 tentacles, and V. digitata (Koehler & Vaney) which has (apparently) 18 tentacles. Mitsukuriella Heding and Panning was placed near Vaneyella in a recent revision of the Phyllophoridae (Heding and Panning, 1954); Mitsukuriella contains the species M. inflexa (Koehler & Vaney) and M. squamulosa (Mitsukuri). When these two species were originally described, it was stated in both descriptions (Koehler and Vaney, 1905; Mitsukuri, 1912) that ten tentacles are present. However, on the basis of the structure of the calcareous ring, Heding and Panning (1954) inferred that 15 tentacles are present in both species. Thus these two genera were included in the Phyllophoridae.

The unusual genera Rhopalodina and Rhopalodinopsis each have about 20 tentacles (Heding, 1937). Heding (1937) noted that these flask-shaped holothurians cannot be placed close to Echinocucumis and Ypsilothuria as Perrier (1902) maintained, but should rather be placed close to, or within, the "subfamily Phyllophorinae". Heding (1937) was of the opinion that the two genera deserved a separate subfamilial status, contending that "... the only important difference between the Rhopalodininae and the Phyllophorinae is the presence of large plates in the former ... the peculiar body shape is (not) of any higher taxonomic value". Thus Heding (1937) attached some importance to the presence of large plates in the body-wall, but apparently did not investigate further.

The Ypsilothuriidae as herein interpreted (see p.79) contain the genera Ypsilothuria Perrier, Ypsilocucumis Panning and Echinocucumis Sars. The tentacle numbers range from eight to ten.

It is here maintained that all the above genera, because of the important characters they share, should be grouped together, irrespective of the number of tentacles they possess. Formerly these genera were scattered among the Cucumariidae (10 tentacles) and the Phyllophoridae (15-30 tentacles).

A revised classification of the "dendrochirote" holothurians is therefore required in which a new taxon, Order Dactylochirotida nov., is erected to accommodate the genera discussed above. It may be briefly diagnosed as follows:

Tentacles digitiform or digitate, sometimes weakly branched, 8-30 in number. Body completely invested by overlapping scales. Calcareous ring simple, lacking complex posterior processes.

The Order Dendrochirotida is thereby restricted to include only those genera with richly branched tentacles. As both orders are closely related, they may be united into a Superorder Dendrochirotacea. These taxa are formally diagnosed on p.369. Throughout the remainder of this discussion, the term "dendrochirote" refers only to truly dendrochirote holothurians, and does not include dactylochirote forms.

The presence of large plates in the bodywall is not, of course, a character restricted to the dactylochirotes; several dendrochirote taxa are also characterised by possessing large plates which form a more or less rigid test.

Dendrochirotes with large plates

Mortensen (1925) has described Paracucumis, an unusual Antarctic dendrochirote holothurian which is not only U-shaped, but apparently lacks tubefeet. There are 12-15 richly branched tentacles, and the body is invested in large plates, which imbricate, and form a close mail when the body is contracted. The genus is unique among dendrochirotes in possessing this combination of characters, and hence warrants the erection of a new family, Paracucumidae nov., having the characters of the genus.

The holothurian fauna of New Zealand includes two remarkable genera, in both of which the body is U-shaped and is invested by large plates. One of these genera is Heterothyone Panning, restricted to New Zealand and comprising the two species alba (Hutton) and ocnoides (Dendy).

A second genus is evidently represented by two other species which have hitherto been nominally assigned to the genus Stolus; these are Cucumaria huttoni Dendy and Stolus squamatus Pawson. However, the type species of the genus Stolus, S. sacellus (Selenka) does not possess the large plates which are so characteristic of the two New Zealand species cited. It is considered that these species should be assigned to a new genus, of which a diagnosis is given here.

Placothuria n.g.

Tentacles ten, richly branched. Body U-shaped, completely invested by large overlapping plates, which lack spires in any form. Sole lacking. Calcareous ring long, with posterior processes composed of a mosaic of small pieces.

Type species: Cucumaria huttoni Dendy.

Also included: Stolus squamatus Pawson.

It is here proposed that Heterothyone and Placothuria should be placed together in a new taxon, Family Placothuriidae nov., distinguished by the body being completely enclosed by a test comprising conspicuous imbricate plates, sole lacking. The calcareous ring is long, with long posterior processes.

The psolids (Family Psolidae) are characterised by possessing a body only partly invested by plates, with a soft thin ventral sole sharply defined from the plated dorsal side of the body. No recent attempt has been made to revise the Psolidae; a revision is urgently required.

H.L. Clark (1946) has already remarked on the unfortunate choice of the species Holothuria phantapus Strussenfeldt as the type of Psolus. Many Psolus species are of the "squamatus-type", with a flattened body almost as broad as long, while P. phantapus, according to Mortensen (1927), is "... rather high and vaulted; anterior and posterior ends prominent; especially the posterior end produced into a long conical tail-like prolongation". The flattened psolids differ so conspicuously from the type of the genus that they should be assigned to separate taxa. It is desirable, then, to resurrect the generic name Lepidopsolus Bronn, type species Psolus antarcticus (Philippi), for those psolids with a flattened body, only five oral and anal valves, and with the mid-ventral radius lacking tubefeet, except at the anterior and posterior ends. The "squamatus-type" differs from Lepidopsolus in having a variable number of anal and oral valves, except in very young stages. In adult specimens the oral aperture is surrounded by irregularly arranged scales, which differ conspicuously from the large valves of Lepidopsolus. Clark (1946) stated that the generic name Cuvieria is available for the flattened forms, type species Psolus squamatus (Koren); however, Cuvieria is preoccupied, and a new generic name for those psolids with irregularly arranged oral and anal valves must eventually be proposed.

The genus Psolidium includes species which greatly resemble Psolus species, but differ in having tubefeet on the dorsal side of the body, whereas they are lacking in Psolus. Psolus and Psolidium have ten tentacles; another psolid, Stolinus, on the other hand, has 15 tentacles.

Apart from the taxa discussed above, the rest of the dendrochirotes have small non-imbricating deposits in the bodywall, although some genera (e.g. Pseudocnus) have a rather rigid body owing to the presence of numerous small plates.

The fossil record

In general, echinoderms are well-known as fossils, for their calcareous exoskeleton is readily preserved. However, very few entire holothurian fossils are known. Several Cambrian fossils discovered and described by Walcott (1911, 1918) as holothurians should now be interpreted as coelenterates and annelids in the opinion of Madsen (1956, 1957).

The calcareous deposits of holothurians have been studied by micropaleontologists for at least eighty years. These fossil deposits are referred to as "sclerites" and recently, Frizzell and Exline (1955) have compiled a monograph of fossil holothurian sclerites. Such sclerites are known as far back as the Ordovician. The published illustrations of these early Palaeozoic fossils are of extreme interest, for several of these almost exactly match the plates of extant Dactylochirotida and Dendrochirotida. For example, the lattice-plates of the middle Ordovician genus Thuroholia Gutschick are strongly reminiscent of the single-layered plates of the genera of Dactylochirotida, namely Echinocucumis and Rhopalodina. Furthermore, structures which can be interpreted as chiridotid wheels occur in the Carboniferous, so it may be suggested that the major holothurian orders had already differentiated by that time. The holothurian wheels figured by Etheridge (1881, Pl. VI, figs.1-8) from the Carboniferous of Scotland, if they had been observed in a living holothurian would surely lead to the inference that the specimen must be classified as an elasipod of the family Laetmogonidae.

Further investigations along these very promising lines are now planned, and should lead to a clarification of the fossil history of the Holothuroidea.

In all probability holothurians and echinoids are related, constituting the subphylum Echinozoa (Fell, 1963, p.487-8). As the primitive Ordovician echinoids Aulechinus, Ectechinus and Eothuria had a test comprising irregularly arranged imbricating plates, it is also likely that a similar test of imbricating plates occurred in early holothurians.

The recent discovery of the Helicoplacoida (Durham and Caster, 1963) in lower Cambrian deposits is of prime importance, for these earliest known echinozoans had a fusiform body and a plated test, the plates sometimes carrying an erect rigid spine.

Paleontological evidence implies then that early holothurians were heavily plated forms. It follows that the extant plated holothurians are probably persistent archaic forms. It is highly significant that only the Superorder Dendrochirotacea includes such heavily plated forms. Probably, then, the Dendrochirotacea are the most ancient holothurians, and the other major holothurian groups have been derived from them.

Further to this discussion, Fell (in press) has deduced that the ambulacral plate system of edrioasteroids is probably homologous with the calcareous ring of holothurians; and in the large calcareous ring such as occurs in the dendrochirote genus Placothuria, the inferred homology is very striking. Fell believes that the paired posterior radial series of ossicles in the calcareous ring of such dendrochirotes are homologues of edrioasteroid ambulacral plates, and the analagous interradial series if present represent either the lateral cover-plates or adradial interamb plates. Fell infers that the calcareous ring arose as a consequence of the evolution of the introvert, the original ambulacral plates telescoping inside the bodywall, leaving the radial water vessel behind. This theory seems very plausible, and serves to explain:

1. The absence of any evidence of external ambulacral plates in holothurians, despite the presence of well developed radial water vessels and tubefeet in most groups.

2. The origin of the complex calcareous ring as found in such genera as <u>Placothuria</u>.

If this hypothesis is true, it follows that a large calcareous ring with long posterior projections is more primitive than a ring which lacks posterior projections, the latter having presumably undergone secondary reduction.

The fossil record, then, suggests that primitive holothurians may have possessed both a complex calcareous ring and large plates in the bodywall.

The calcareous ring

All members of the Order Dactylochirotida have simple calcareous rings, but within the Order Dendrochirotida the ring displays an extraordinary diversity in shape and size. The work of Heding and Panning (1954) on the Phyllophoridae demonstrates admirably the variation in the calcareous ring. The subfamilies proposed by these workers are based chiefly on the structure of the calcareous ring, as also are the subfamilies proposed in the revision of the Cucumariidae by Panning (1949). In the classification proposed here the taxa employed by Panning (1949) and Heding and Panning (1954) will remain substantially unaltered.

If tentacle numbers are disregarded, the dendrochirote subfamilies may be arranged as follows (this list excludes the Psolidae, Paracucumidae and Placothuriidae, whose positions are discussed elsewhere):

1. Calcareous ring with long radial and interradial posterior processes composed of a mosaic of minute pieces - Thyoninae, Phyllophorinae, Semperiellinae.

2. Calcareous ring with radial and interradial or radial only posterior processes short or long, not composed of a mosaic of minute pieces - Sclerodactylinae, Cladolabinae.

3. Calcareous ring without posterior processes, or with rudimentary posterior processes - Cucumariinae, Colochirinae, Thyonidiinae.

The boundary between groups 2 and 3 above is not clearly defined, and suggests a gradual evolutionary sequence. The fact that the posterior radial series persists irrespective of whether interradial series are present, is further evidence supporting the hypothesis that the radial series do represent ambulacral plates. Future work will aim at determining the limits of these groups.

Origin of the psolids

The psolids possess large plates in the bodywall, a feature regarded as primitive. No psolid is known to possess a complex calcareous ring, this structure having therefore probably suffered secondary reduction, as in group 3 above. Psolids exhibit strong bilateral symmetry, which is manifest even in young stages. Internal anatomy, however, reflects a former radial symmetry, and it is probable that the ancestor of the psolids was a radially symmetrical holothurian. The sole has developed simply by reduction of the calcareous deposits on the ventral side, in response to the adoption of a sedentary way of life, a palmatozoan tendency, as inferred by Fell (in press).

The Placothuriidae

If the assumptions made in this memoir are correct, it follows that the Placothuriidae are the most primitive holothurians living today, for they possess a plated body and a complex calcareous ring. This applies particularly to the genus Placothuria which has a very complex calcareous ring (see Pawson, 1963, Pl. VII, fig. 2). Heterothyone, also included in the Placothuriidae, has a plated body, and a long calcareous ring, but the ring is not composed of a mosaic of pieces.

Dendrochirote tentacles

So complex a structure as the dendrochirote tentacle could scarcely have arisen *de novo*, without previous simpler stages. Such stages would probably be tentacles resembling relatively unmodified oral tubefeet. Thus it would appear reasonable to regard the genera with fingerlike tentacles as representing an earlier grade of differentiation than those with dendrochirote tentacles. Branched tentacles may have arisen from a fingerlike archetype in response to a change from non-selective to selective microphagous feeding.

The forms here regarded as the most primitive holothurians, the Placothuriidae, have well-branched tentacles. Although the dendritic tentacle may initially have arisen from a digitiform tentacle, it would of course be unwise to regard the extant dactylochirotes as exactly matching the ancestors of the dendrochirotes. Digitiform and digitate tentacles, such as occur in extant dactylochirotes, could equally well be interpreted as primitive, or as secondarily derived from a dendrochirote tentacle. On the other hand, the evidence supplied by skeletal morphology seems to be decisive, and indicates that the extant Placothuriidae, despite their dendritic tentacles, are more archaic than any known dactylochirote family. Hence in the following classification the Dendrochirotida are placed before the Dactylochirotida. The tentacles of molpadids and apodids may similarly be interpreted as secondarily simplified, though there is as yet no available evidence to prove this.

Summary

On the evidence discussed here, it is proposed to discard tentacle numbers as the basis for distinguishing major taxa within the Dendrochirotacea. Such characters as tentacle-shape

(dactylochirote or dendrochirote), presence or absence of large plates in the bodywall, and degree of complexity of the calcareous ring, are regarded as more significant diagnostic characters.

The following classification is therefore proposed:

Superorder DENDROCHIROTACEA Grube, 1840
(*Nomen translatum* Pawson, herein, ex. fam. Dendrochirotae Grube, 1840)

Introvert (with retractor muscles) always present. Tube-feet and respiratory trees usually present. Madreporite free in the body cavity. Mesentery of the posterior loop of the intestine in the right or left ventral interradius. Free tentacle ampullae lacking. Gonad in two tufts, one tuft to each side of the dorsal mesentery.

Order DENDROCHIROTIDA Grube, 1840 (restr.)

Tentacles richly branched, 10-30 in number.

Key to included families

1 (6) Body partly or completely invested by plates.

2 (5) Body enclosed by a test comprising conspicuous imbricate plates; sole lacking.

3 (4) Calcareous ring complex, with long paired posterior processes . . . . . Placothuriidae fam. nov.
(Included extant genera *Placothuria* Pawson; *Heterothyone* Panning, 1949).

4 (3) Calcareous ring simple, lacking posterior processes
. . . . Paracucumidae fam. nov.
(Included extant genus Paracucumis Mortensen, 1925)

5 (2) Body invested dorsally by conspicuous plates; sole present . . . . Psolidae Perrier, 1902
(Included extant genera Psolus Oken, 1815; Lepidopsolus Bronn, 1860; Stolinus Selenka 1868; Psolidium Ludwig, 1886; Thyonepsolus Clark, 1901).

6 (1) Body more or less naked, not enclosed by a test, calcareous deposits small and inconspicuous.

7 (10) Calcareous ring complex, with paired or unpaired posterior processes.

8 (9) Processes composed of a mosaic of small pieces . . . .
. . . . Phyllophoridae Ostergren, 1907
(emend. herein.)
(Included subfamilies Phyllophorinae Ostergren, 1907; Semperiellinae Heding and Panning, 1954; Thyoninae Panning, 1949)

9 (8) Posterior processes entire . . . .
. . . . Sclerodactylidae Panning, 1949.
(Nomen translatum Pawson, herein, ex. Scleridactylinae Panning, 1949).
(Included subfamilies Sclerodactylinae Panning, 1949; Cladolabinae Heding and Panning, 1954).

10 (7) Calcareous ring simple, lacking posterior processes . .
. . . . Cucumariidae Ludwig, 1894 (emend. herein.)

(Included subfamilies Cucumariinae Ludwig, 1894; Colochirinae Panning, 1949; Thyonidiinae Heding and Panning, 1954).

Order DACTYLOCHIROTIDA nov.

Tentacles digitiform or digitate, the digits sometimes bifurcate, 8-30 in number. Body enclosed by a test comprising imbricate plates. Calcareous ring simple, lacking complex posterior processes.

Key to included families

1 (4) Anus and mouth at opposite ends of the body, which is fusiform or U-shaped.

2 (3) Plates with a prominent spine. Tentacles 8-10 in number . . . . Ypsilothuriidae Heding, 1942 (Included extant genera Ypsilothuria Perrier, 1886; Echinocucumis Sars, 1859; Ypsilocucumis Panning, 1949).

3 (2) Plates with small spires, or none. Tentacles 10-20 in number. . . . . .Vaneyellidae fam. nov. (Included extant genera Vaneyella Heding & Panning, 1954; Mitsukuriella Heding & Panning, 1954).

4 (1) Body flask-shaped, with anus and mouth opening close together . . . . . . Rhopalodinidae Perrier, 1902 (Included extant genera Rhopalodina Gray, 1853; Rhopalodinopsis Heding, 1937).

The above arrangement of taxa is believed to reflect phylogenetic relationships more satisfactorily than that hitherto current, although it may require considerable modification as a result of planned future work, which will be directed towards its elaboration.

Other holothurian groups

In view of the above proposed revision of the Dendrochirotacea, it is desirable to consider briefly the arrangement of the remaining holothurian groups, the Molpadida, Apodida, Aspidochirotida and Elasipodida.

Aspidochirotida and Elasipodida

Both the aspidochirotes and elasipods have tentacles which terminate in an approximately circular disc. The body is usually bilaterally symmetrical in both groups, with the dorsal tubefeet modified into papillae or warts (Aspidochirotida) or into elongate sensory processes (Elasipodida). The two groups are distinguishable on the basis of several features, which are included in their diagnoses below. Both orders may be conveniently grouped within a single superorder, the Aspidochirotacea, on the basis of their shared characters, as follows:

Superorder Aspidochirotacea Grube, 1840
(Nomen translatum Pawson, herein, ex Family Aspidochirotae Grube, 1840)

Tubefeet present. Tentacles shield-shaped, 10-30 in number. No introvert, hence retractor muscles lacking. Body with conspicuous bilateral symmetry.

Included Orders

Respiratory trees present. Mesentery of the posterior loop of the intestine attached in the right ventral interradius . . . . ASPIDOCHIROTIDA Grube, 1840

Respiratory trees lacking. Mesentery of the posterior loop of the intestine attached in the right dorsal interradius . . . . ELASIPODIDA Theel, 1882

Theel (1882) has discussed the possible antiquity of the elasipod holothurians and concluded that they are certainly not representatives of an ancestral holothurian stock; rather they are secondarily adapted to deep-sea life. In elasipods, and in some aspidochirotes, the madreporite opens to the exterior, and does not hang free in the body cavity. This can be regarded, not as a primitive feature, but as a logical compensatory consequence of the absence of respiratory trees. The extremely fragile calcareous ring in elasipods is apparently secondarily reduced.

Apodida and Molpadida

The important character shared by apodids and molpadids is the almost complete absence of tubefeet. Also both groups have simple, digitate, or pinnate tentacles. It is possible that the orders Apodida and Molpadida bear no close relation to each other, and that the characters they have in common may have arisen through parallel evolution and convergence.

Superorder APODACEA Brandt, 1835

(Nomen translatum Pawson, herein, ex Apodes Brandt, 1835)

Tentacles simple, digitate or pinnate. Tubefeet markedly reduced or, more usually, lacking altogether. No introvert, hence muscles lacking. Deposits may include anchors and anchor-plates.

Included Orders

Body cylindrical. Respiratory trees and anal papillae lacking. Deposits often include wheels . . . . APODIDA Brandt, 1835

Body fusiform, often with a tapering caudal portion. Respiratory trees and anal papillae present. Wheels lacking . . . . MOLPADIDA Haeckel

It is remarkable that some members of both Apodida and Molpadida have anchors and anchor-plates in the bodywall. The anchors and their plates differ morphologically in the two orders, but presumably have the same functional significance as accessory locomotor organs, since the anchors project through the bodywall.

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THE DISTRIBUTION OF HOLOTHURIANS IN THE SOUTHERN OCEANS

by D.L. Pawson

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Up to the present time, no attempts have been made to consider the derivation and relationships of the major holothurian groups in the larger southern land-masses, although some thorough summaries have been given of the relationships of the echinoderms of Australia (Clark, 1946) and South Africa (Clark, 1923). Ekman (1925) has discussed the holothurian fauna of the west Antarctic region, and its relationship to other nearby areas. The present brief survey of the holothurians of the southern oceans has been undertaken in the hope that some inferences may be drawn as to the areas from which these faunas were derived, and that the influence, if any, of the west-wind-drift upon the faunas may be determined.

The physical environment in the southern oceans has been discussed in detail by Sverdrup et al. (1942) and Ekman (1953). More recently, Knox (1960) has given an important account of the littoral ecology and biogeography of the southern oceans.

The distribution of only the essentially shallow-water holothurian groups has been studied; deep-sea holothurians are generally wide-ranging by virtue of the fact that they are capable of spreading across the great areas of abyssal seafloor. Therefore, the elasipods and some molpadids and aspidochirotes are omitted from this survey.

Throughout the following discussion, the term "South Africa" is intended to refer only to that part of South Africa which lies south of approximately 32°S.; while the Magellanic region is regarded as that part of South America south of 42°S., together with the adjacent island archipelagoes, but excluding the Palmer Peninsula.

A. Southern distribution of major groups

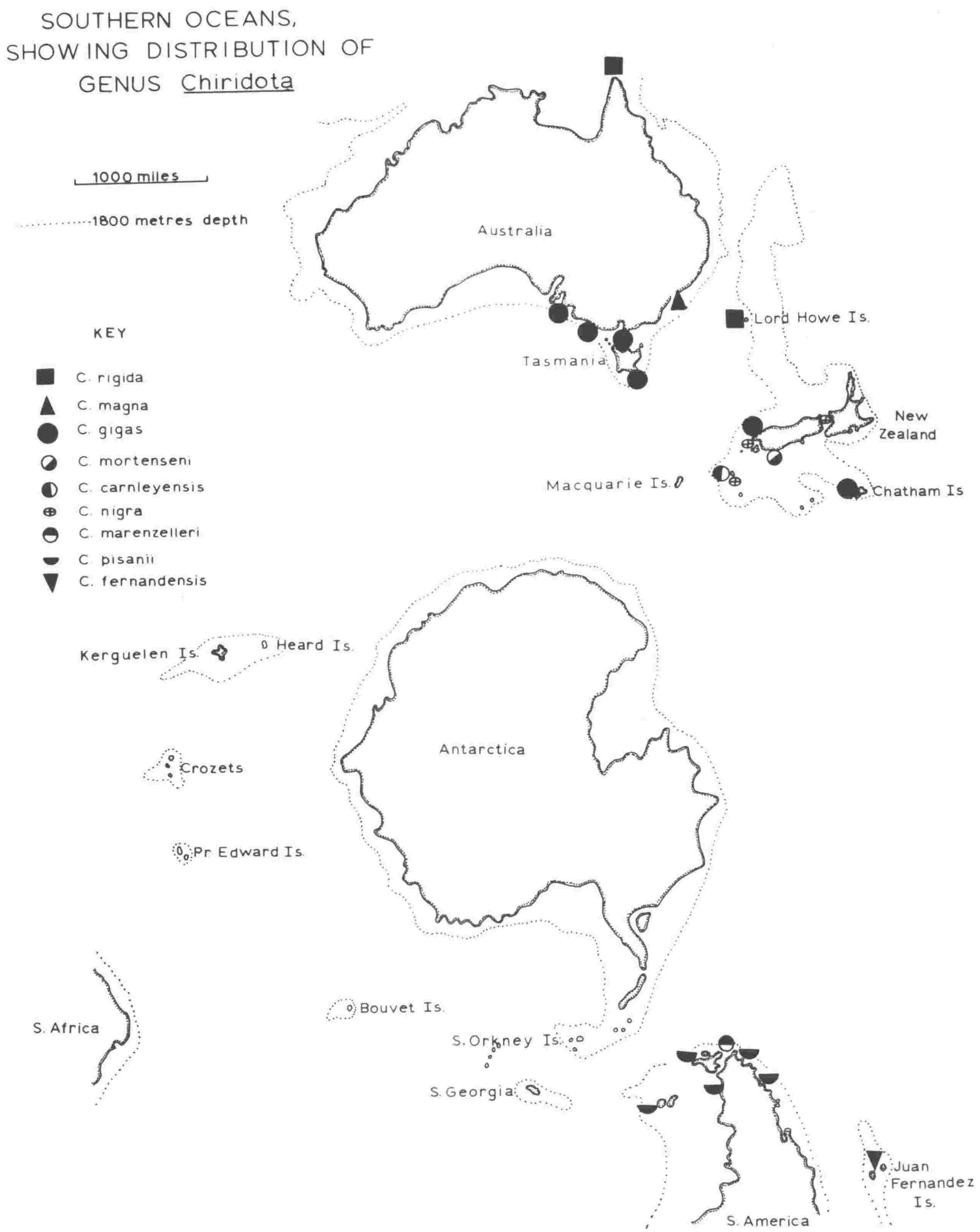
1. Order Apodida

The systematic status of the Apodida is relatively stable, the genera for the most part being clearly defined. Most apodous genera are widely distributed. Only three genera, _Synapta_, and the monotypic genera _Scoliorhapis_ (Australia) and _Kolostoneura_ (New Zealand) are unknown in the Northern Hemisphere.

A widespread genus is _Chiridota_, which contains approximately 30 species; the southern distribution of this genus is shown on Plate XXXIII. Most _Chiridota_ species have only a limited bathymetric and geographic range, and they are more commonly found in the intertidal zone. _C. gigas_ Dendy and Hindle is remarkable in that it ranges from southeast Australia and Tasmania to New Zealand and the Chatham Islands. Australia supports three _Chiridota_ species, while New Zealand has four. One species of doubtful status, _C. fernandensis_ Ludwig, is known from Juan Fernandez, while two species, _C. pisanii_ Ludwig and _C. marenzelleri_ Theel, occur in the Magellanic region. _Chiridota_ is unknown in Antarctic seas, and has not as yet been

PLATE XXXIII

Southern oceans, showing distribution of the genus *Chiridota*.


SOUTHERN OCEANS,
SHOWING DISTRIBUTION OF
GENUS Chiridota
1000 miles
1800 metres depth
KEY
C. rigida
C. magna
C. gigas
C. mortenseni
C. carnleyensis
C. nigra
C. marenzelleri
C. pisanii
C. fernandensis
Australia
Tasmania
Lord Howe Is.
New Zealand
Macquarie Is.
Chatham Is
Kerguelen Is.
Heard Is.
Crozets
Pr Edward Is.
Antarctica
S. Africa
Bouvet Is.
S. Orkney Is.
S. Georgia
S. America
Juan Fernandez Is.

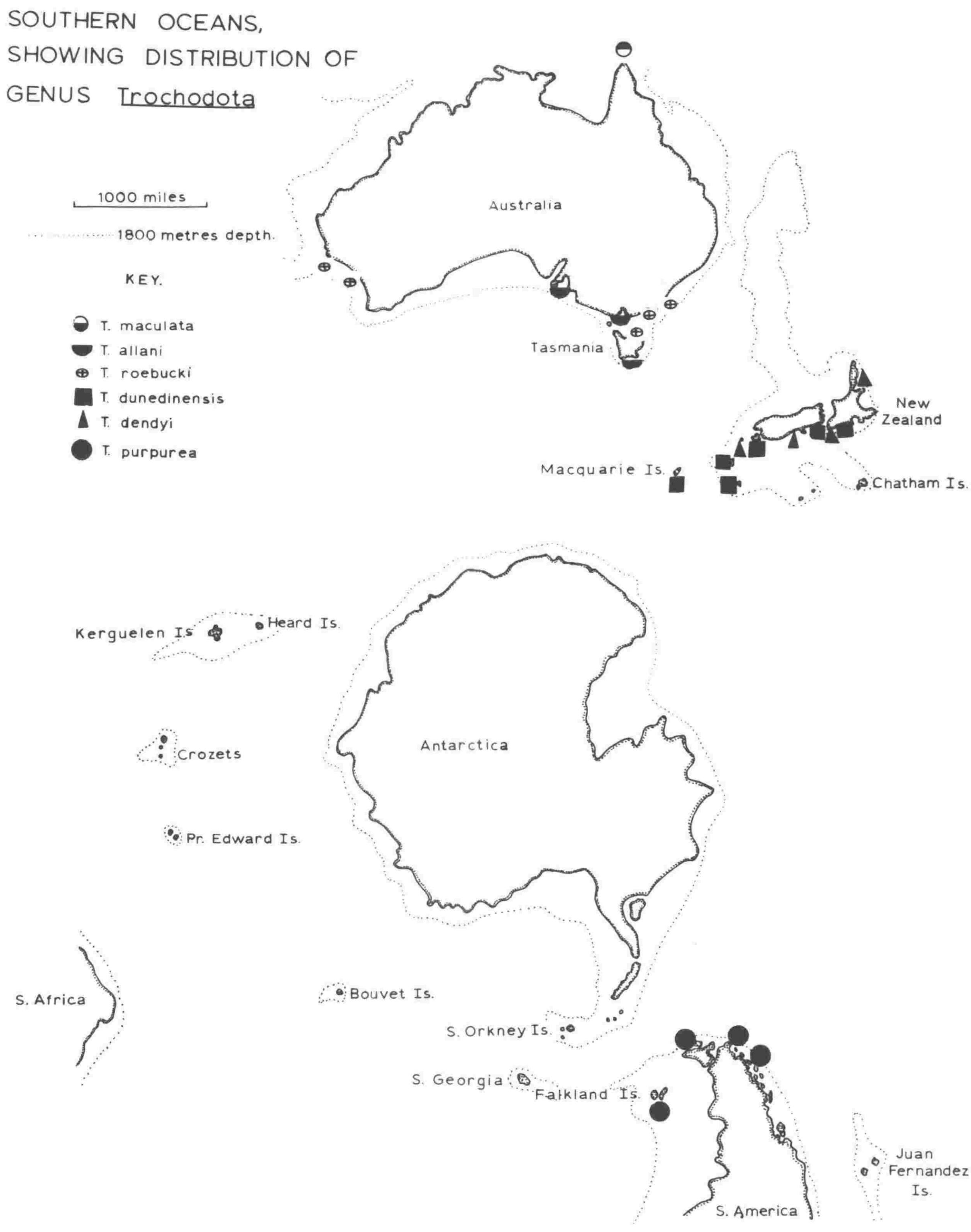
described from South Africa or any of the islands between South Georgia and Kerguelen inclusive. In the Northern Hemisphere, the genus is represented off Japan, Hawaii, Alaska, Greenland, in the Gulf of Mexico, off West Africa, but by far the greatest number of species are present in the Indo-west-Pacific. A single deepwater species, C. abyssicola v. Marenzeller, is known from the Atlantic Ocean.

The distribution of Chiridota is closely paralleled by that of Trochodota, a small genus, containing ten species. Three species occur in Japan, one in the Mediterranean Sea, and the remainder are of southern distribution, as shown in Plate XXXIV. All of the species are of restricted distribution. Three species occur in Australia (Clark, 1946), while two of these also occur in Tasmania (Hickman, 1962). New Zealand has two species, of which one, T. dunedinensis (Parker), extends south to Macquarie Island (see p.174). One species, T. purpurea (Lesson) is known from the Magellanic region; it is of considerable interest here that T. purpurea appears to be very closely related to T. dunedinensis (Parker) from New Zealand. No Trochodota species are known from South Africa, nor from the islands between South Georgia and Kerguelen inclusive.

Consideration of the distribution of the two genera discussed above prompts enquiry into their possible area of origin. The data suggest that Chiridota arose in the Indo-west-Pacific region, where the greatest concentration of its species lies. From this area the genus has presumably spread northwards to Japan, and via the Aleutians to Alaska. Migration through the

PLATE XXXIV

Southern oceans, showing distribution of the genus *Trochodota*.



SOUTHERN OCEANS,
SHOWING DISTRIBUTION OF
GENUS Trochodota
1000 miles
1800 metres depth.
KEY.
T. maculata
T. allani
T. roebucki
T. dunedinensis
T. dendyi
T. purpurea
Australia
Tasmania
New Zealand
Macquarie Is.
Chatham Is.
Kerguelen Is
Heard Is.
Antarctica
Crozets
Pr. Edward Is.
S. Africa
Bouvet Is.
S. Orkney Is.
S. Georgia
Falkland Is.
Juan Fernandez Is.
S. America

Arctic Ocean would presumably have established the genus off Greenland. Spreading southward in the Indo-Pacific, the genus has speciated in Australia and New Zealand. It is of great interest that one species of Chiridota is known north-east of the Magellanic region, namely C. rotifera (Pourtales) which has been recorded from Brazil (Deichmann, 1954). This suggests an almost exactly comparable pattern of migration to that recorded for the asteroid Allostichaster (Fell, 1962). On the west coast of the Americas, no Chiridota species are known from between Juan Fernandez and 47°29'N. (Deichmann (1947)). It therefore seems probable that the Magellanic species C. pisanii and C. marenzelleri were derived not from the north but from the west, and probably from Australasia, through the agency of the west-wind-drift.

Trochodota, also, appears to have arisen in the Indo-west-Pacific and spread north to Japan (three species) and south to Australasia. As the genus is unknown from the Americas apart from the single Magellanic species T. purpurea, it is probable that this species was contributed to the Magellanic fauna by Australasia. The presence of a single species T. venusta (Semon) in the Mediterranean indicates that this genus may have been widespread during the existence of the Tethys Sea in early Tertiary times, and T. venusta may be regarded as a "Tethys relict" (sensu Ekman, 1953).

Both Trochodota and Chiridota have either been unsuccessful in colonising the islands in the South Atlantic and Indian Oceans, or they may never have arrived there.

Taeniogyrus contains eight species, of which three are known from Australia, four are known from Indonesia, and the remaining species, *T. contortus* Ludwig, is widespread in southern oceans (see Plate XXXV). As can be seen, *T. contortus* ranges from the Magellanic region through to Kerguelen, and is known in Antarctica. Fisher (1907) has described a Hawaiian species of *Taeniogyrus* which is very closely related to *T. contortus*. As with the genera discussed above, *Taeniogyrus* has probably arisen in the Indonesian region, spread south to Australia, and contributed *T. contortus* to the Magellanic region, whence this species has spread to the southern circum-polar islands. The presence of *Taeniogyrus* in Hawaii is doubtless explicable by the views of A.H. Clark (1949), who regards the Hawaiian echinoderm fauna as "... an attenuated peripheral Indo-Pacific fauna in which a number of component types have become locally modified so as to form endemic species".

Of the southern land-masses, Australia has by far the largest fauna of apodous holothurians, for here 12 genera and 30 species are known (Clark, 1907; Clark, 1946). New Zealand supports four genera and eight species (four of these species are of the genus *Chiridota*). The Magellanic region has four genera and five species. South Africa has two genera and two species.

All of the New Zealand apodid genera (except the peculiar monotypic genus *Kolostoneura*) are shared with Australia. All

Magellanic genera are shared with Australia, and (apart from Taeniogyrus) with New Zealand. The two South African apodid genera Leptosynapta and Patinapta are also known from Australia, but are unknown from the other southern land-masses.

It is concluded that all the land-masses in the southern oceans have apodid faunas which were initially derived from the Indo-west-Pacific region. The portal of entry of all of the apodid genera into the southern oceans was probably Northern Australia, as inferred for asteroids by Fell (1962) from analogous data. The history of the apodid faunas may be outlined as follows.

Apodid genera spread via Indonesia to Australia from the north and speciated there. During Tertiary and Recent times three of these genera have somehow crossed the Tasman Sea to New Zealand, where they have speciated to a greater or lesser degree, some species penetrating as far south as the southern islands of New Zealand and Macquarie Island. From the New Zealand region some genera have evidently reached the Magellanic region. Trochodota and Chiridota, well established in Australia and New Zealand, and hence by inference able to perform a trans-Tasman crossing, were apparently also capable of completing the much longer journey from New Zealand to South America, since related species occur at both ends. Taeniogyrus, which is represented in Australia by three species (Plate XXXV) but is unknown from New Zealand, is represented in the Magellanic region and on several southern islands. On the evidence afforded by the genera Trochodota and Chiridota, it appears likely that

Taeniogyrus will eventually be discovered in the New Zealand region. Several genera known in Australia but as yet unknown in New Zealand do not appear to have completed the trans-Tasman crossing. Among these are Euapta, Opheodesoma, Polyplectana, Synapta, Chondrocloea, Leptosynapta, Polycheira and Scoliorhapis.

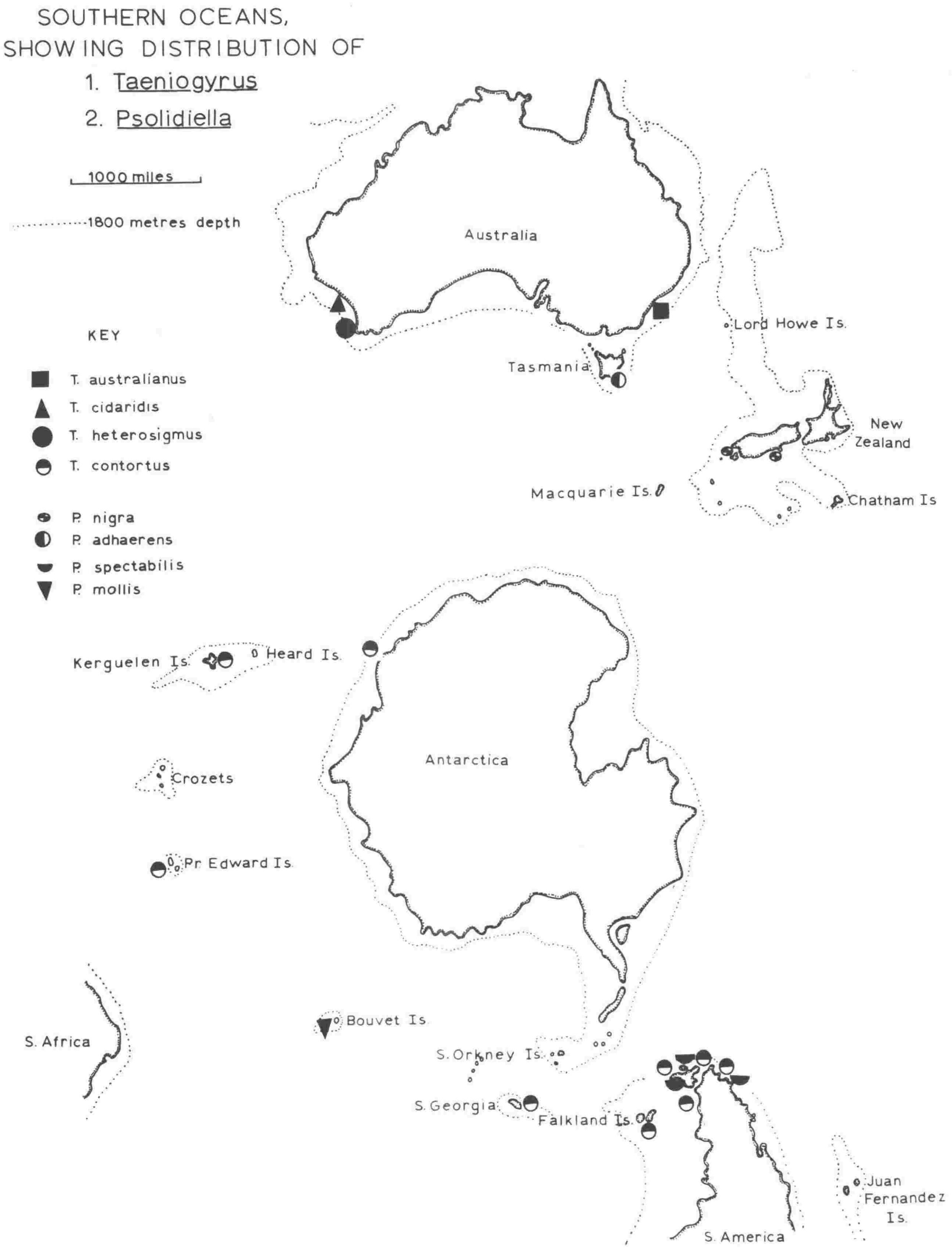
It is inferred that New Zealand has been of great importance as a contributor to the apodous fauna of the Magellanic region and the southern islands.

2. Order Aspidochirotida

Two aspidochirote genera, Holothuria (s.l.) and Stichopus, are conspicuous in the shallow-water faunas of many areas. Holothuria is tropicopolitan, and contains approximately 90 species. Deichmann (1958) has begun a revision of this very large genus. For the purposes of the present discussion the generic name Holothuria is employed sensu lato. Holothuria is especially well represented in the Pacific Ocean. Australia supports 38 species of the genus, but only one species, H. hartmeyeri Erwe, is known from the south coast of Australia (32-35°S.). No species are known from Tasmania (41-44°S). Despite its small area, Lord Howe Island (30°S.) has at least six species. A single species, H. neozelanica Mortensen, is known from northern New Zealand (35°S.). Although apparently no species are as yet recorded from Norfolk Island or the Kermadecs, they must be expected to occur there, particularly the more widespread Pacific forms such as H. atra Jaeger,

PLATE XXXV

Southern oceans, showing distribution of the genera *Taeniogyrus* and *Psolidiella*.


SOUTHERN OCEANS,
SHOWING DISTRIBUTION OF
1. Taeniogyrus
2. Psolidiella
1000 miles
1800 metres depth
KEY
T. australianus
T. cidaridis
T. heterosigmus
T. contortus
P. nigra
P. adhaerens
P. spectabilis
P. mollis
Australia
Tasmania
Lord Howe Is.
New Zealand
Macquarie Is.
Chatham Is
Kerguelen Is.
Heard Is.
Antarctica
Crozets
Pr. Edward Is.
S. Africa
Bouvet Is.
S. Orkney Is.
S. Georgia
Falkland Is.
Juan Fernandez Is.
S. America

H. impatiens (Forskal) and H. argus (Jaeger). From South Africa, Deichmann has described species occurring as far south as Durban, but none are known south of about 31°S.

The Magellanic region supports no species of Holothuria in its western regions, but to the east, H. patagonicus Perrier has been described from Santa Cruz, Argentina, at a latitude of 50°S.

Apparently the genus Holothuria is rarely found in latitudes higher than 35°S. This arbitrary figure is not universally applicable, for in South Africa the area in the region of 34°S. is one of cold temperate mixed waters (Stephenson, 1948; Knox, 1960), and the southward spread of Holothuria is there prevented. The limiting factor is evidently thermal. However, the presence of H. patagonicus at a latitude of 50°S. is anomalous, for waters off the east Magellanic coast are cooled by the northward flowing Falkland Current, which extends up to about 30°S. (Knox, 1960). The southward flowing warm Brazil Current has a variable influence on the Falkland Current. H. patagonicus is apparently a species which can tolerate far lower temperatures than other Holothuria species. This temperature tolerance is also exhibited by a species of Stichopus, namely S. mollis.

It is probably because Holothuria displays a preference for warmer waters that its distribution in the southern oceans has not been influenced by the west-wind-drift. The genus has spread southwards to a varying degree off the larger land-masses, the extant species in each southern area being derived in each case from the relevant populations living immediately to the north.

The genus Stichopus, like Holothuria, is wide-ranging in the tropics but contains fewer species (approximately 25). In East Africa, S. chloronotus Brandt is found at Mozambique, but so far no species have been recorded from further south, although another member of the same family, Neostichopus grammatus (Clark) was described by Deichmann from East London (33°S.), and that species ranges to Cape Agulhas (35°S.). In Australia, seven species of Stichopus are known (Clark, 1946), of which three, S. mollis (Hutton), S. ludwigi Erwe and S. variegatus Semper occur along southern Australian coasts. S. mollis is widespread in southern Australia, and has also been recorded from Tasmania (Clark, 1946; Hickman, 1962). The latter species ranges the entire New Zealand coast, as far south as Foveaux Strait (46-47°S.).

Ludwig (1874) described S. fuscus from a locality given as "Patagonia". Clark (1922) was of the opinion that this species is unrecognisable, but Deichmann (1947, 1958) contends that the species is valid, placing it in a distinct genus, Isostichopus; however, there is still some doubt as to whether this species occurs in the Magellanic region. The diligent collecting carried out by the Royal Society Expedition to Southern Chile 1958-9 failed to reveal any stichopodids (see p. 9).

The distribution patterns of Stichopus and Holothuria are closely similar, although Stichopus appears to tolerate a greater range of temperature than Holothuria. These genera do not contribute greatly to the faunas of the southern oceans, although admittedly they are conspicuous in the shallow water fauna of large areas of the Australian coast; in Torres Strait, species of Stichopus and Holothuria once formed the bulk of holothurians collected by the Beche-de-mer fishery.

Although Stichopus mollis is apparently a derivative of the Australian fauna, the remainder of the southern aspidochirotes appear to be derived from warmer northern regions, and not from other southern land-masses.

3. Order Dendrochirotida

By far the largest and most diverse group of holothurians are the dendrochirotes. They are found in all seas, and some occur in great depths. For the most part, however, they are shallow-water forms. The very size of the group and the perplexing systematics of some taxa preclude an exhaustive study of the distribution of the dendrochirotes, but some analysis of the dendrochirote faunas of the southern land-masses is given. The classification here employed is that set out on pp. 369-371.

Within the family Psolidae, all included genera except Thyonepsolus are represented in the southern oceans. The following list comprises the genera (with number of species in brackets) of Psolidae known from the larger southern land-masses:

1. Australia (including Tasmania); Psolus (2), Psolidium (3, possibly 4), Stolinus (1).

2. South Africa: Psolus (3), Psolidium (1).

3. New Zealand: Psolus (1), Pseudopsolus (monotypic).

4. Magellanic region: Psolus (2), Lepidopsolus (1), Psolidium (2), Neopsolidium (1).

5. Antarctica: Psolus (6), Lepidopsolus (1), Psolidium (6).

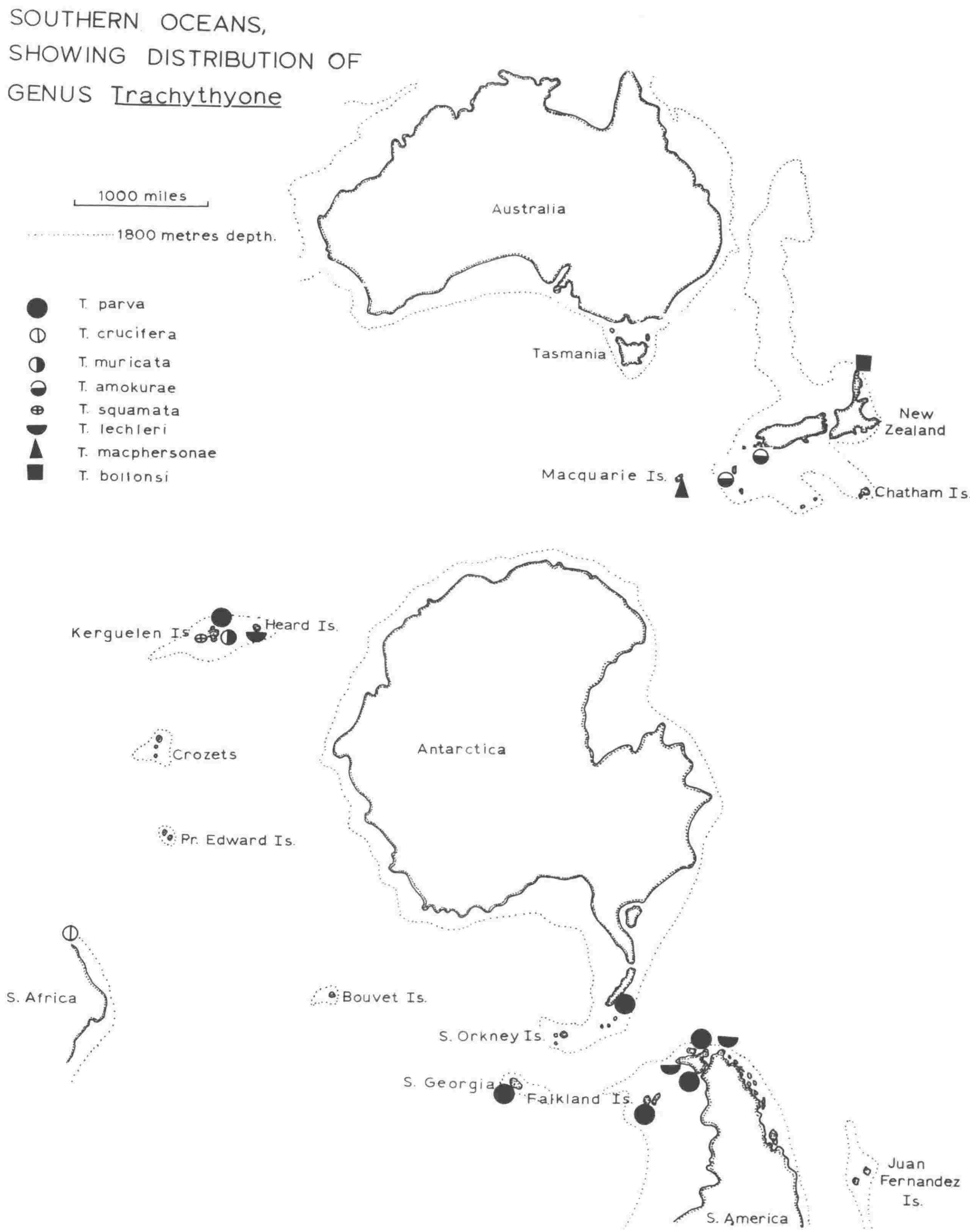
Antarctica is notable for the large number of psolids (13 species) represented in its fauna. Most of the Antarctic psolids are of restricted distribution, except Psolus antarcticus (Philippi) which ranges from Antarctica and the Magellanic region to Macquarie Island (see p. 160), and has a bathymetric range of 35-1080 metres. The family as a whole, however, has a very wide distribution. The psolids are virtually sedentary animals, and a high percentage of the southern species have direct development; consequently their vagility is reduced.

The family Placothuriidae contains two genera, Heterothyone and Placothuria, both of which are so far known only from New Zealand; but probably they are not restricted to New Zealand. Family Paracucumidae, containing the single monotypic genus Paracucumis, is known only from Antarctica.

The family Phyllophoridae is well represented in the southern oceans, especially in Australia, where eight genera are known. The following list comprises the genera (with numbers of species in brackets) of Phyllophoridae known from

PLATE XXXVI

Southern oceans, showing distribution of the genus *Trachythyone*.


SOUTHERN OCEANS,
SHOWING DISTRIBUTION OF
GENUS Trachythyone
1000 miles
1800 metres depth.
T. parva
T. crucifera
T. muricata
T. amokurae
T. squamata
T. lechleri
T. macphersonae
T. bollonsi
Australia
Tasmania
New Zealand
Macquarie Is.
Chatham Is.
Kerguelen Is.
Heard Is.
Antarctica
Crozets
Pr. Edward Is.
S. Africa
Bouvet Is.
S. Orkney Is.
S. Georgia
Falkland Is.
Juan Fernandez Is.
S. America

the larger southern land-masses:

1. Australia (including Tasmania): Phyllophorus (4), Phyrella (2), Neothyonidium (1), Lipotrapeza (2), Stolus (1), Havelockia (1), Hemithyone (1).

2. South Africa: Pentamera (1), Stolus (1), Havelockia (1).

3. New Zealand: Neothyonidium (2), Pentadactyla (1).

4. Magellanic region: Pentamera (1).

5. Antarctica: Havelockia (1).

Neothyonidium dearmatum (Dendy and Hindle) is common to the faunas of New Zealand and Australia, but apart from this species, no others are widely distributed. Havelockia is represented in Antarctica, South Africa and Australia, but is so far unknown from New Zealand, where it may be expected to occur. Stolus evidently arose in the Indo-west-Pacific whence it has spread to Australia and South Africa.

The family Sclerodactylidae is not known from any southern land-masses in the higher latitudes, but is represented by four genera in Australia and South Africa. The following list comprises the genera (with numbers of species in brackets) of Sclerodactylidae known from the southern land-masses:

1. Australia: Afrocucumis (1), Cladolabes (4), Pentathyone (1), Pseudothyone (1).

2. South Africa: Afrocucumis (1), Cladolabes (1), Ohshimella (1), Neothyone (1).

3. New Zealand: None.

4. Magellanic region: None.

5. Antarctica: None.

Clearly this group comprises mainly warm-water forms, for all of the species known in Australia are confined to the east coast north of Sydney, and the west coast north of Shark Bay. This is apparently another Indo-west-Pacific assemblage, but with a lower range of temperature tolerance than other dendrochirote groups.

The family Cucumariidae, the largest in the Order Dendrochirotida, is represented around all southern land-masses. The following list comprises the genera (with numbers of species in brackets) of Cucumariidae known from the southern land-masses:

1. Australia: Actinocucumis (4), Mensamaria (1), Neocucumella (1), Amphicyclus (1), Neocucumis (1), Neoamphicyclus (1), Leptopentacta (1), Pentacta (= Colochirus) (9), Thyonacta (1), Pseudocolochirus (1), Plesiocolochirus (monotypic), Cucumaria (1), Psolidiella (1), Orbithyone (monotypic), Staurothyone (3), Thyone (11).

2. South Africa: Cucumella (1), Cucumaria (2), Trachythyone (1), Pseudocnus (1), Ocnus (1), "Ludwigia" (2), Pentacta (1).

3. New Zealand: Amphicyclus (1), Neocucumella (1), Psolidiella (1), Stereoderma (1), Trachythyone (2), Ocnus (4).

4. Magellanic region: Athyonidium (monotypic), Pattalus (monotypic), Cladodactyla (1), Pseudocnus (1), Stereoderma (2), Trachythyone (2), Psolidiella (1).

5. Antarctica: Cucumaria (5), Cladodactyla (1), Staurocucumis (monotypic), Ekmocucumis (7), Stereoderma (1), Trachy-

thyone (1), "Ludwigia" (2).

Australia has the best developed cucumariid fauna, with 16 genera and 39 species. The New Zealand fauna is closely related to that of Australia, for three of the New Zealand genera are shared with Australia, and in the case of Neocucumella, only a single shared species N. bicolumnata (Dendy and Hindle) is involved.

Several cucumariid genera are widely distributed in the southern oceans, and their distribution has probably been achieved with the aid of the west-wind-drift. Psolidiella (Plate XXXV) is restricted to the southern oceans and is of circumpolar distribution. Trachythyone (Plate XXXVI), with three species in New Zealand, two in the Megallanic region (one of which is also known from Graham Land, Antarctica), and four species at Kerguelen is another circumpolar species. These genera, together with such other circumpolar forms as Stereoderma, Cladodactyla and Ocnus, are frequently found inhabiting the fronds and holdfasts of brown algae. The large number of holothurians collected from Macrocystis fronds and holdfasts by the Royal Society Expedition to Southern Chile included the genera Stereoderma, Cladodactyla and Pseudocnus.

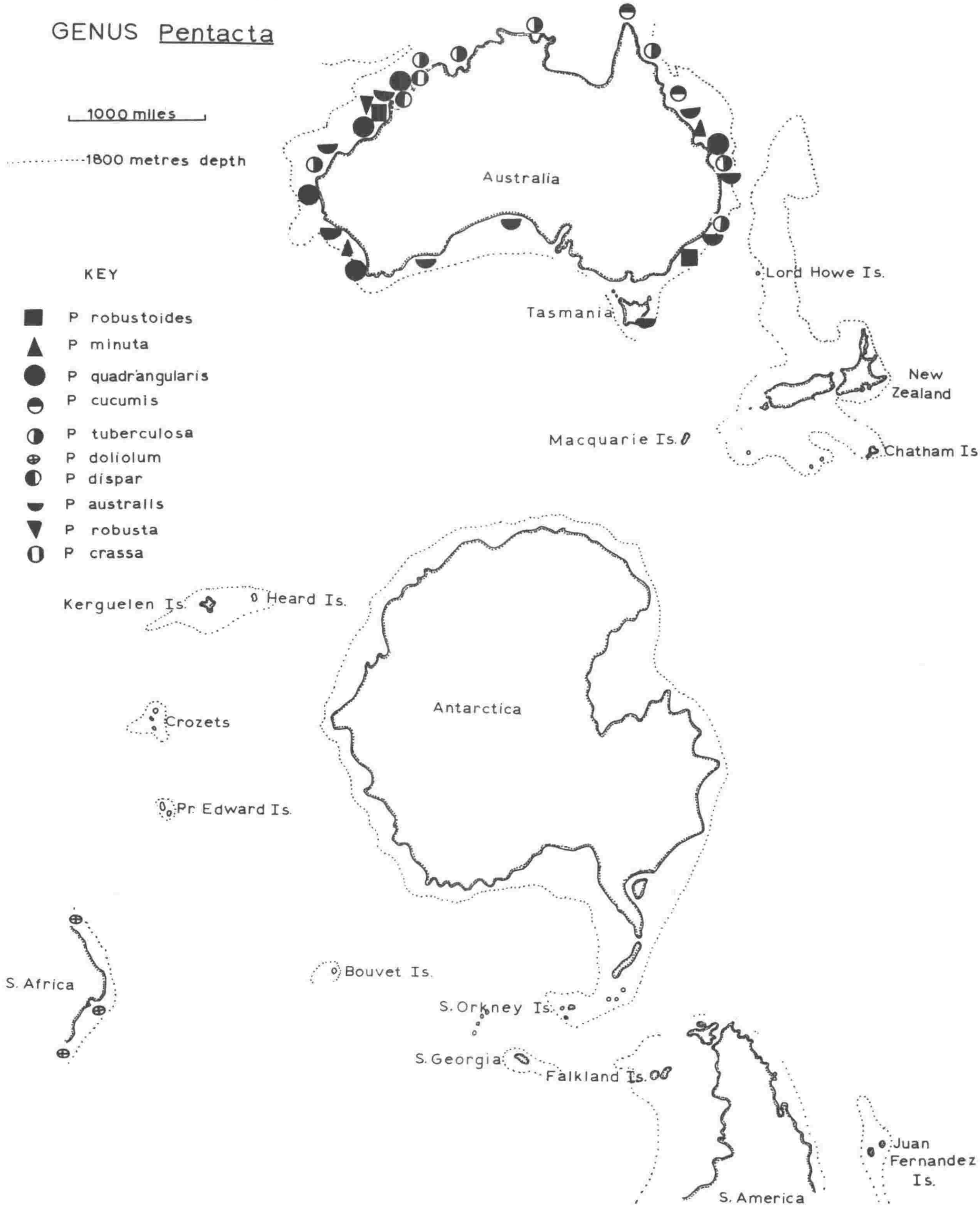
A genus such as Pentacta (= Colochirus), known from Indonesia, Australia and South Africa, has an Indo-west-Pacific distribution (Plate XXXVII) and has evidently not yet come under the action of the west-wind-drift. Similar examples are Afrocucumis and Cladolabes.

It is evident that, with the exceptions noted, the west-

PLATE XXXVII

Southern oceans, showing distribution of the genus *Pentacta.*

SOUTHERN OCEANS, SHOWING DISTRIBUTION OF GENUS *Pentacta*



wind-drift has played a very conspicuous part in shaping the pattern of distribution of southern dendrochirotes. The area of origin for most genera is usually indeterminate, although Thyone and Actinocucumis are predominantly Indo-west-Pacific forms, and therefore presumably originated in this region.

4. Order Dactylochirotida

The family Ypsilothuriidae comprise mainly deep-sea forms. The family Vaneyellidae is confined to the Indo-west-Pacific region, while the Rhopalodinidae are confined to South Africa.

5. Order Molpadida

As most molpadids are deep-water forms, they are widely distributed. The molpadid genera known from the southern land-masses (numbers of species in brackets) are as follows:

1. Australia (including Tasmania); Molpadia (3), Paracaudina (4), Acaudina (2).
2. South Africa: None.
3. New Zealand: Molpadia (3, possibly 4), Heteromolpadia (2), Paracaudina (1), Hedingia (1).
4. Magellanic region: Molpadia (3), Paracaudina (1), Hedingia (1).
5. Antarctica: Molpadia (1).

Very little sampling of the bathyal zone has been carried out off South Africa and Australia, and consequently few genera are recorded. Nonetheless, it is probable that the molpadid faunas of these areas will eventually be found to exceed that of New Zealand, where expeditions are active. It seems likely, in view of the known distribution of the group, that molpadids will be found off South Africa; indeed, the north-east Indian Ocean supports a rich molpadid fauna, as has been demonstrated by Koehler and Vaney (1905), and presumably the same applies elsewhere in the Indian Ocean.

The single molpadid known from Antarctica is Molpadia antarctica (Theel), which is also known from New Zealand and southern South America, and is also widespread in the Pacific Ocean. Paracaudina chilensis (Muller) is a circum-Pacific species, as already discussed elsewhere (Pawson, 1963).

B. Relationships of the faunas of the southern land-masses

1. Australia

There is little to add to the thorough discussion given by Clark (1946), except that Fell (1949a, 1953) has demonstrated that a much closer relationship exists between the faunas of Australia and New Zealand than Clark (1946) supposed. Australia has clearly derived its fauna from the Indonesian region. Tasmania has 15 known holothurian species (Hickman, 1962), and the Tasmanian fauna is clearly related to that of southern Australia, for eleven of the species are found on the south Australian coast. The remaining four species were described as new by Hickman (1962). Two of these represent genera also known from southern Australia, while another is *Psolidiella adhaerens* Hickman, a circum-polar element in the Tasmanian fauna, related to *P. nigra* Mortensen from New Zealand.

2. South Africa

Clark (1923, 1924, 1926), Mortensen (1933), Deichmann (1948) and Stephenson (1948) have analysed zoogeographic affinities of the South African echinoderm fauna, the holothurians being discussed by Clark (1923) and Deichmann (1948). On the basis of the entire shallow-water echinoderm fauna, it was apparent that the fauna includes a large percentage of endemic species, and an almost equally large percentage shared with the Indo-west-Pacific region, together with some species having other affinities.

The 28 holothurian species known from South Africa have the following relationships: endemic species 20 (72%), Indo-west-Pacific 4 (14%), northern (to Red Sea and Mediterranean Sea) 4 (14%). Clark (1946) stated that 12 of the 28 South African species occur also on the Australian coast, but he included in his survey of the South African fauna those forms known from Natal and further north. The fauna of that region is tropical to subtropical, containing approximately 15 aspidochirote species, most of them widespread. South of Natal, only four aspidochirotes are known, and two of these, *Holothuria cinerascens* (Brandt) and *H. leucospilota* (Brandt) are also known from Australia. South Africa is notable for the paucity of its apodid fauna, such widespread genera as

Chiridota and *Protankyra* being as yet unknown from the region. The structure of the extant South African holothurian fauna indicates a derivation from the north and east. Stephenson (1948) notes that the deeper water (bathyal and abyssal) echinoderm fauna of South Africa shows very slight Indo-Pacific affinities, the faunal elements being mainly Atlantic or cosmopolitan.

3. New Zealand

The relationships of the New Zealand echinoderm fauna have been discussed by Mortensen (1925), Fell (1949b, 1953, 1962) and Pawson (1961 and present work, p. 340). No more than a summary is necessary here. It is evident that New Zealand has a holothurian fauna derived chiefly from the Indo-west-Pacific region, but containing two endemic genera (*Kolostoneura*, *Heterothyone*). New Zealand is apparently important as a donor to the fauna of the Magellanic region, and has received elements from Australia, the presumed portal of entry into the southern oceans of such apodid genera as *Trochodota* and *Chiridota*. Probably some dendrochirote genera, including *Psolidiella* and *Trachythyone*, have been distributed in a similar manner.

4. The Magellanic region

Elsewhere in this work (p. 46) a discussion of the relationships of the Megallanic holothurian fauna has been given. At the specific level, the Magellanic fauna is not closely related to that of New Zealand, but several genera are shared by the two areas, as has already been shown. The taxa shared with Antarctica are discussed below. The Magellanic region has evidently also contributed elements to the faunas of the circumpolar islands.

5. Antarctica

Ekman (1953) states, " ... no other large faunal region in the world can match the Antarctic in the sharpness of its boundaries", and he notes that the fauna is remarkably independent. Of all the echinoderm groups, the holothurian fauna is the least known, for reports on the Holothuroidea collected by several recent expeditions have not as yet been published. Of the 13 holothurian genera now known from Antarctica, 2 (18%) are endemic. The remaining genera (82%) (with the exception of Ekmocucumis, discussed above), are widespread, none of them being confined to the southern oceans.

Of the 36 shallow water Antarctic species, 23 (65%) are endemic; 12 (33%) also occur in South Georgia; 4 (11%) occur in the Magellanic region; 5 (14%) on other southern islands.

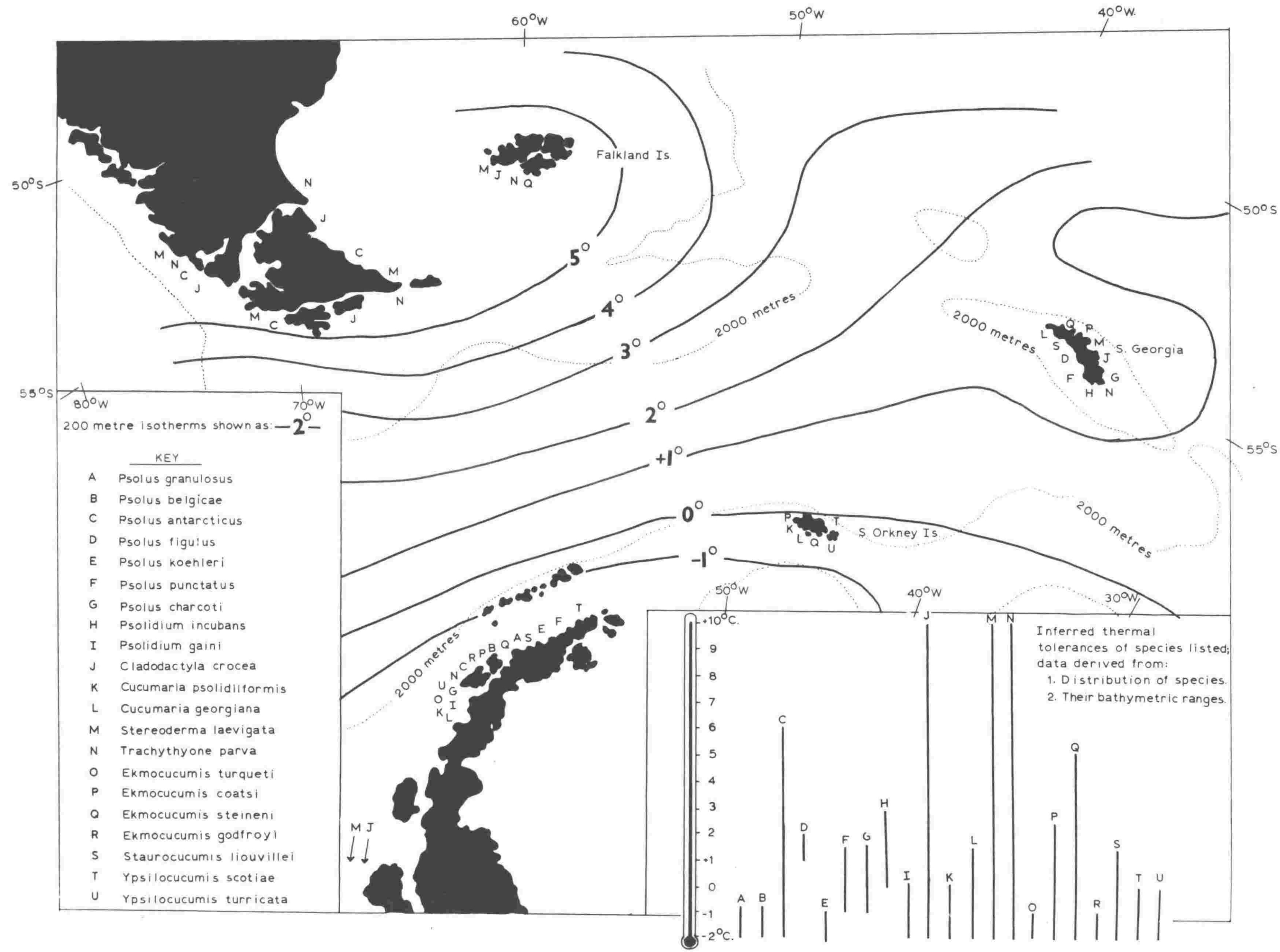
The presence of four species both in Antarctica and the Magellanic region is of considerable zoogeographic interest. Fell (1961, fig.8), has analysed the inferred thermal tolerances of 20 species of ophiuroids which are known from west Antarctica and the Magellanic region, and a similar treatment may be given here of the holothurians. Plate XXXVIII shows the distribution of all holothurians recorded from west

Antarctica. Two species, Cladodactyla crocea (Lesson) and Stereoderma laevigata (Verrill) are recorded from the Ross Sea, but they are as yet unknown from west Antarctica; these species may, however, be expected to occur there, as they are common in the Magellanic region and at South Georgia. The 200 metre isotherms shown on Plate XXXVIII are derived from Sverdrup et al. (1942). The known distributions of the species listed are plotted, and knowledge of their distribution and bathymetric ranges enables approximate temperature tolerances to be inferred. It is immediately apparent that five species are strongly eurythermal, and three of these tolerate a range of temperatures between -2°C. and 10°C. Such species should have a wide distribution, and this in fact proves to be the case; Psolus (Lepidopsolus) antarcticus (Philippi) ranges from Antarctica and the Magellanic region to Macquarie Island, while Cladodactyla crocea, Stereoderma laevigata and Trachythyone parva are all widely distributed.

The widespread species discussed above may have entered the Magellanic region from Antarctica, or conversely, may have spread southward from the Magellanic region to enter the Antarctic fauna. This latter alternative seems more feasible when the distribution of the genera concerned is considered. Trachythyone is essentially a circum-polar genus, but is represented in Antarctica by only one species, T. parva. Cladodactyla comprises two species, C. crocea and C. senegalensis Panning, the latter known from west Africa. Stereoderma, like Trachythone, has most of its representatives in the Southern

PLATE XXXVIII

Distribution and inferred thermal tolerances of holothurian species which occur both in the west Antarctic region and in the Magellanic region.


60°W
50°W
40°W.
50°S
55°S
80°W
70°W
30°W
Falkland Is.
S. Georgia
S. Orkney Is.
2000 metres
5°
4°
3°
2°
+1°
0°
-1°
200 metre isotherms shown as: —2°—
KEY
A Psolus granulosus
B Psolus belgicae
C Psolus antarcticus
D Psolus figulus
E Psolus koehleri
F Psolus punctatus
G Psolus charcoti
H Psolidium incubans
I Psolidium gaini
J Cladodactyla crocea
K Cucumaria psolidiiformis
L Cucumaria georgiana
M Stereoderma laevigata
N Trachythyone parva
O Ekmocucumis turqueti
P Ekmocucumis coatsi
Q Ekmocucumis steineni
R Ekmocucumis godfroyi
S Staurocucumis liouvillei
T Ypsilocucumis scotiae
U Ypsilocucumis turricata
Inferred thermal tolerances of species listed; data derived from:
1. Distribution of species.
2. Their bathymetric ranges.
+10°C.
9
8
7
6
5
4
3
2
+1
0
-1
-2°C.

Hemisphere, but only one species, S. laevigata, is known from Antarctica. It seems then, that the so-called "Antarctic holothurian elements" in the Magellanic fauna should rather be interpreted as Magellanic and circum-polar elements which have entered the Antarctic fauna.

The southern islands

The faunas of some southern islands and their possible origins are discussed elsewhere in this work as follows: Macquarie Island (p.201), southern islands of New Zealand (p.205), Falkland Islands (p.47), Kerguelen (p.47).

The South Orkney Islands lie close to Graham Land, and as is expected, all of the species known from the South Orkneys are shared with Antarctica; these islands may be aptly termed "high Antarctic", according to Ekman (1925).

South Georgia is of interest in this context, for it lies almost equidistant from the Magellanic region and Graham Land. On the basis of its geographic position, lying to the east of these areas, it may be predicted that the holothurian fauna of South Georgia is of mixed derivation, containing both Antarctic and Magellanic species. Of the 14 known species 2 (14%) are endemic; 5 (36%) are known also in the fauna of Graham Land and the South Orkney Islands, though unknown elsewhere; 7 species (50%) are common to the Magellanic region and South Georgia, but of these, 4 also occur in the Graham Land fauna. Thus 9 (64%) species are common to Antarctica and South Georgia. Ekman (1925, 1953) regards South

Georgia as a "low Antarctic" region.

In general, it may be stated that the circum-polar islands have holothurian faunas which are very similar to that of the Magellanic region, and it is probable that these faunas were derived directly from the Magellanic region through the action of the west-wind-drift. These islands, then, each have a west-wind-drift holothurian fauna.

Summary

1. It is evident that all the land-masses in the southern oceans have apodid faunas which were initially derived from the Indo-west-Pacific region. The apodid faunas of the Magellanic region and the circumpolar islands were probably derived from that of New Zealand, through the agency of the west-wind-drift.

2. The distribution of the aspidochirote genera Holothuria and Stichopus in the southern oceans has not been influenced by the west-wind-drift. Rather, extant species of the southern land-masses have been derived from relevant populations living further north.

3. While the areas of origin of many dendrochirote genera are not readily determinable, it is evident that the west-wind-drift has contributed greatly toward the distribution of these genera in the southern oceans.

4. The holothurian fauna of Australia is clearly derived from the Indonesian region, while that of South Africa is part of the same generalised Indo-west-Pacific fauna. New Zealand

has a fauna which is apparently of Australian-Indo-Pacific origin. The Magellanic region has chiefly a west-wind-drift fauna, though it includes some elements derived from further north. The so-called "Antarctic elements" in the Magellanic fauna may more reasonably be interpreted as Magellanic elements which have spread into Antarctica.

5. The faunas of the circum-polar islands were apparently derived mainly from the Magellanic region through the agency of the west-wind-drift, although it has already been noted (p. 201) that the fauna of Macquarie Island is more closely related to that of New Zealand than formerly supposed.

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The Holothurian Fauna of Cook Strait, New Zealand

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The Holothurian Fauna of Cook Strait, New Zealand

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Abstract

The fauna is now known to comprise 13 genera, of which one is new, and 15 species. *Heteromolpadia* n.g., type species *Ankyroderma marenzelleri* Theel, has tri-radiate anchor-plates and spired tables, but lacks rosettes of racquet-shaped plates. New records are *Neocucumella bicolumnata* (Dendy and Hindle), *Stolus huttoni* (Dendy), *Heteromolpadia marenzelleri* (Theel), and *Molpadia violacea* (Studer). A second new genus is proposed for the Australian species currently known as *Heterothyone semperi* (Bell) and the Arabian Sea species *Heterothyone pigra* (Koehler and Vaney).

The 12 species from the shelf have essentially a restricted distribution, although four are also known from Australia. The three deep water species are more widely distributed.

Introduction

Since 1954, a marine research team led by Professor L. R. Richardson has investigated the benthic and pelagic fauna of Cook Strait to depths in excess of 1,000 fathoms, and of Wellington Harbour. Analysis of benthic samples revealed 235 specimens of holothurians, which represent eleven genera and eleven species, of which four species are new records for the area. In addition, there are four more species, also known from Cook Strait, but not represented in the collections. These are diagnosed and briefly discussed here.

Throughout this report, the Cook Strait region is taken to comprise Cook Strait including Palliser Bay, and Wellington Harbour.

Farquhar (1898) recorded seven valid holothurian species from the Cook Strait region. Mortensen (1925) later added four species, bringing the total to eleven. No further records were made between 1925 and the present time. It is probable that the list of species is still far from complete; the shelf fauna is as yet imperfectly known, and deeper waters should yield many more species.

Perhaps the only Cook Strait holothurian to attract the attention of the casual collector is *Stichopus mollis* (Hutton), known locally as the " brown sea squirt " or " sea sausage ". It is by far the largest and most common shallow water form. Other intertidal species are rather more secretive in their habits, and may be found only by assiduous digging and overturning of rocks in sandy or muddy pools. The apodous species *Trochodota dunedinensis* (Parker) frequently inhabits tufts of the red alga *Corallina*. Dendy (1898) noted that the dentrochirote *Ocnus calcareus* occurs ". . . . not uncommonly on seaweed in Cook Straits near Wellington, where it may be collected at lowtide ". Beyond the intertidal zone, the shelf and deep water species may be taken by dredging and trawling.

I am grateful to Professor H. B. Fell of this department for his careful guidance and constructive criticism throughout the course of this study. My thanks are also due to Professor L. R. Richardson for access to collections and for many valuable suggestions and discussions, and to Mr J. W. Brodie, Director of the New Zealand Oceanographic Institute, for making available to me specimens of *Heteromolpadia marenzelleri* (Theel) and *Paracaudina chilensis* (Muller).

Publication of this paper has been assisted by a grant from the Victoria University Publications Fund.

CHECKLIST OF COOK STRAIT HOLOTHURIANS

INTERTIDAL SPECIES

Kolostoneura novae-zealandiae (Dendy and Hindle)
Trochodota dunedinensis (Parker)
**Trochodota dendyi* Mortensen
**Ocnus calcareus* (Dendy)

SHELF SPECIES

Protankyra uncinata (Hutton)
Neocucumella bicolumnata (Dendy and Hindle)
**Neothyonidium dearmatum* (Dendy and Hindle)
Pentadactyla longidentis (Hutton)
Heterothyone alba (Hutton)
**Heterothyone ocnoides* (Dendy)
Stolus huttoni (Dendy)
Stichopus mollis (Hutton)

BATHYAL SPECIES

Heteromolpadia marenzelleri (Theel)
Molpadia violacea (Studer)
Paracaudina chilensis (Muller)
Pentadactyla longidentis (Hutton)
Heterothyone alba (Hutton)
Stichopus mollis (Hutton)

Note: Species marked with an asterisk were not represented in the collections examined.

MATERIAL EXAMINED

The holothurians forming the basis of this account were taken from Cook Strait and Wellington Harbour. The depths worked ranged between 5–10 fathoms and approximately 1300 fathoms. Benthic collections were made with dredge, otter trawl, beam trawl, Petersen grab, or a cone net fished on the bottom. Specimens of two species were kindly loaned to me by the New Zealand Oceanographic Institute, and supplementary intertidal species were collected by my colleagues and myself.

Victoria University of Wellington, Department of Zoology collections.

Coll. VUZ 10 (Station SAS): Palliser Bay, 41° 28′ 30″ S., 174° 59′ 30″ E., 5/2/55, 200–250 fathoms, green mud, dredge.
Heteromolpadia marenzelleri (Theel)—1 specimen.

Coll. VUZ 15 (Station SEB): Palliser Bay, 41° 29′ S., 175° 8′ 30″ E., 13/5/55, 100–150 fathoms, mud, otter trawl.
Heteromolpadia marenzelleri (Theel)—16 specimens.
Paracaudina chilensis (Muller)—2 specimens.
Pentadactyla longidentis (Hutton)—1 specimen.
Heterothyone alba (Hutton)—1 specimen.
Stichopus mollis (Hutton)—3 specimens.

Coll. VUZ 21 (Station CUC): Palliser Bay, 41° 32′ S., 175° 8′ 30″ E., 13/5/55, 38 fathoms, mud, beam trawl.
Heteromolpadia marenzelleri (Theel)—1 specimen.

Coll. VUZ 30 (Station W.REH): Wellington Harbour, south of Somes Island, 41° 15′ 48″ S., 174° 52′ 6″ E., 16/1/56, 5–10 fathoms, mud, rock trawl.
Heterothyone alba (Hutton)—13 specimens.

Coll. VUZ 32 (Station W.KEH): Wellington Harbour, off Petone Beach, 41° 14′ 30″ S., 174° 52′ 6″ E., 16/1/56, 8 fathoms, mud, dredge.
Protankyra uncinata (Hutton)—3 specimens.
Pentadactyla longidentis (Hutton)—2 specimens.

Coll. VUZ 35 (Station W.GOP): Wellington Harbour, off Days Bay, from 41° 16′ 42″ S., 174° 48′ 24″ E., to 41° 17′ 24″ S., 174° 53′ 48″ E., 16/1/56, 8–9 fathoms, mud, beam trawl.
Stichopus mollis (Hutton)—1 specimen.

Coll. VUZ 37 (Station W.LIJ): Wellington Harbour, off Shelly Bay, 41° 18′ 30″ S., 174° 48′ 42″ E., 18/1/56, 10–11 fathoms, mud, beam trawl.
Protankyra uncinata (Hutton)—8 specimens.
Pentadactyla longidentis (Hutton)—1 specimen.

Coll. VUZ 40 (Station W.JOJ): Wellington Harbour, off Ward Island, from 41° 18′ 18″ S,. 174° 52′ 18″ E., to 41° 17′ 42″ S., 174° 52′ 36″ E., 18/1/56, 2–4 fathoms, mud and sand, beam trawl.
Protankyra uncinata (Hutton)—2 specimens.

Coll. VUZ 62 (Station W.QOF): Wellington Harbour, east side, opposite Worser Bay, 41° 19′ 24″ S., 174° 51′ 36″ E., 2/4/56, 4–5 fathoms, gravel and sand, small beam trawl and dredge.
Stolus huttoni (Dendy)—1 specimen.

Coll. VUZ 64 (Station W.PEQ): Wellington Harbour, off Point Howard wharf, 41° 15′ 28″ S., 174° 54′ E., 2/4/56, 5 fathoms, blue mud, small beam trawl.
Protankyra uncinata (Hutton)—10 specimens.
Neocucumella bicolumnata (Dendy and Hindle)—1 specimen.
Pentadactyla longidentis (Hutton)—6 specimens.

Coll. VUZ 69 (Station W.BON): Wellington Harbour, Somes Island to Days Bay, 41° 16′ 24″ S., 174° 53′ 21″ E., 16/5/56, 11 fathoms, mud, Petersen grab, 3 hauls.
Pentadactyla longidentis (Hutton)—1 specimen.
Heterothyone alba (Hutton)—1 specimen.

Coll. VUZ 87 (Station KUJ): South of Cape Palliser, approximately 41° 44′ S., 175° 12′ E., 20/4/57, ca. 400 fathoms, mud, rock, gravel, 1 metre cone net fished on the bottom.
Heteromolpadia marenzelleri (Theel)—1 specimen.
Molpadia violacea (Studer)—1 specimen.
Paracaudina chilensis (Muller)—2 specimens.
Pentadactyla longidentis (Hutton)—2 specimens.

Coll. VUZ 96 (Station BOQ): Off Palliser Bay, 41° 31′ S., 174° 55′ E., 28/8/57, ca. 380 fathoms, mud, beam trawl.
Heteromolpadia marenzelleri (Theel)—13 specimens.

Coll. VUZ 101 (Station GOP): Off Palliser Bay, 41° 38′ S., 174° 53′ 30″ E., 29/8/57, ca. 550 fathoms, mud, beam trawl.
Molpadia violacea (Studer)—6 specimens.
Paracaudina chilensis (Muller)—135 specimens.

Order APODIDA

DIAGNOSIS: Modified vermiform holothurians with smooth, rough or warty surface. Tubefeet totally lacking, except for the tentacles. Anal papillae, tentacle ampullae, and respiratory trees absent. Tentacles 10 to 20 or even more in number, simple, digitate or pinnate. Characteristic deposits anchors and wheels, though some species lack deposits altogether.

The Order Apodida contains three well defined families, of which two have representatives in Cook Strait.

KEY TO THE FAMILIES IN ORDER APODIDA

1 (2) Deposits in the form of perforated plates accompanied by anchors ...... Fam. SYNAPTIDAE

2 (1) Deposits include wheels.

3 (4) Wheels with six spokes, together with sigmoid or C-shaped rods. Wheels arranged in papillae, or scattered in the body wall .... Fam. CHIRIDOTIDAE

4 (3) Wheels complex, with eight or more spokes .... Fam. MYRIOTROCHIDAE

Family SYNAPTIDAE

DIAGNOSIS: Tentacles with the stalks cylindrical or terete, not becoming widened distally, either with digits along each side for most of their length (pinnate), or with only one or two digits along each side near the tip (digitate), or without digits at all (simple). Calcareous deposits usually anchors and perforated plates often accompanied by irregular curved rods or minute particles (miliary granules), but any or all of these may be wanting. (Clark, 1907.)

The presence of distinctive anchors and anchor-plates appears to be the most important character for distinguishing this family. However, where calcareous deposits are lacking, the tentacles must be examined. Anchors are also found in the Family Molpadiidae, Order Molpadida, but reference to Plate I, fig. 4

(*Protankyra uncinata*) and Plate II, fig. 9 (*Heteromolpadia marenzelleri*) will show that the two types of anchors are readily distinguishable.

Family Synaptidae contains in excess of 120 species, the majority of which are littoral. There are a few species which live at depths below 250 fathoms. The family is especially well represented in the Indo-Pacific region, where more than half of the known species occur. A single species is at present known from New Zealand waters.

Protankyra Ostergren, 1898

DIAGNOSIS: Tentacles digitate, 10–12, rarely 13 or 14. Digits two on each side. Cartilaginous ring wanting. Polian vesicles 2–10 or rarely only one. Stone canal usually single. Stocks of the anchors more or less branched, but only finely toothed; arms usually serrate; vertex without knobs. Anchor-plates without handles, with numerous perforations, and with a more or less imperfectly developed bow across the outer surface of the posterior end. The anchor-plates and their perforations have either smooth or dentate margins.

Type Species: *Protankyra abyssicola* (Theel).

The genus *Protankyra* is a large and perplexing one. Most of the species are distinguishable on the basis of differences in the shape and size of the anchors and anchor-plates and their ornamentation. Heding (1928) stated ". . . . the ciliated funnels are of the greatest value as specific characters in *Protankyra*". It is felt, however, that the calcareous deposits should be regarded as of primary importance in diagnosing species of this genus, and such variable structures as the ciliated funnels should be used with caution.

The single New Zealand representative of this genus is quite distinct from the other known *Protankyra* species.

Protankyra uncinata (Hutton) Plate I, figs. 2–10

Synapta uncinata Hutton, 1872, p. 16; Theel, 1886, p. 27; Dendy, 1896, p. 25; Farquhar, 1898, p. 325.
Synapta inaequalis Hutton, 1872, p. 17.
Protankyra uncinata Mortensen, 1925, p. 367, figs. 48–51; Heding, 1928, p. 252; Dawbin, 1950, p. 40.

MATERIAL EXAMINED: VUZ 32, off Petone Beach, 8 fathoms, mud, 3 specimens; VUZ 37, off Shelly Bay, 10–11 fathoms, mud, 8 specimens; VUZ 40, off Ward Island 2–4 fathoms, mud, 2 specimens; VUZ 64, off Point Howard Wharf, 5 fathoms, blue mud, 10 specimens.

DIAGNOSIS: Tentacles 12, with sensory cups and four terminal digits. Colour white transparent to reddish brown. Anchors small (0.3–0.5mm long), usually symmetrical, with unbranched finely toothed stocks. Arms with few serrations or none. Anchor-plates oval or rectangular, smooth, with large smooth polygonal perforations of average diameter 0.025mm. Ciliated funnels slipper-shaped, numerous.

DESCRIPTION: The body is smooth, approximately cylindrical in shape, tapering abruptly to the terminal anus. Many of the specimens are completely contracted and carry a number of transverse wrinkles. In extended specimens the skin is semi-transparent. Length of largest extended specimen 100m; diameter at anterior end, 5mm. In alcohol, the colour varies between white transparent and reddish brown.

The skin is prickly to touch, the prickly sensation being caused by the sharp-pointed anchor arms which project above the level of the body wall. These arms can be seen with the naked eye. When completely contracted, the anterior end of the body folds inward and the tentacles disappear from view. If the animal is viewed end on, the five interradial areas between the radial muscle bands appear as soft fleshy lumps. This method of contraction may be a characteristic of the species. (Plate I, fig. 8.)

Twelve elongate, cylindrical tentacles surround the mouth, which lies in a shallow depression. There is a brown pigment spot at the base between each pair of tentacles. Each tentacle carries a terminal claw composed of two pairs of digits, and the stems carry a number of sensory cups on their inner margins (Plate I, fig. 9). The true function of these cups has apparently not been determined.

The calcareous ring is composed of twelve small, square pieces. The five radial pieces are each perforated for the passage of the radial nerves.

PLATE I

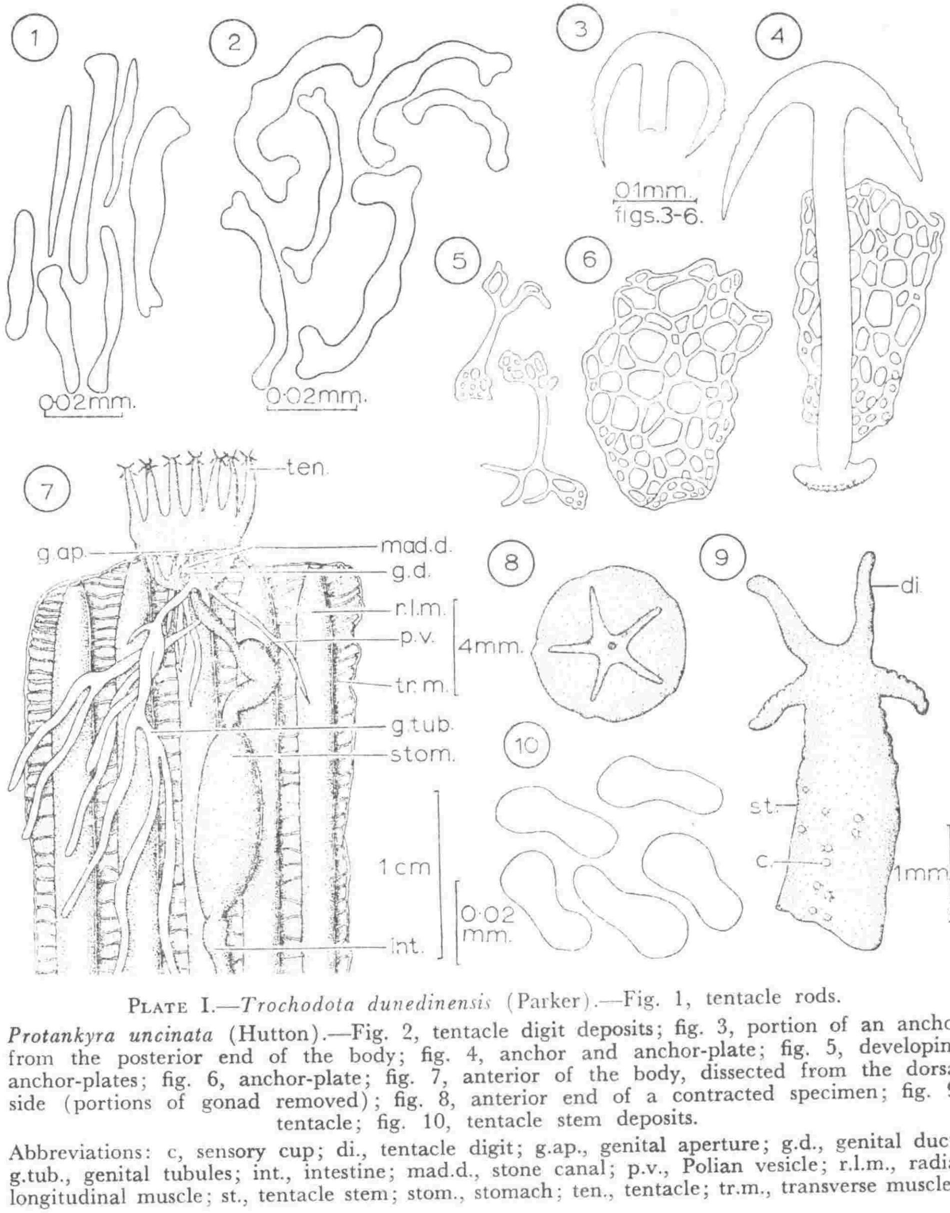

PLATE I.—*Trochodota dunedinensis* (Parker).—Fig. 1, tentacle rods.
Protankyra uncinata (Hutton).—Fig. 2, tentacle digit deposits; fig. 3, portion of an anchor from the posterior end of the body; fig. 4, anchor and anchor-plate; fig. 5, developing anchor-plates; fig. 6, anchor-plate; fig. 7, anterior of the body, dissected from the dorsal side (portions of gonad removed); fig. 8, anterior end of a contracted specimen; fig. 9, tentacle; fig. 10, tentacle stem deposits.

Abbreviations: c, sensory cup; di., tentacle digit; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; mad.d., stone canal; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; st., tentacle stem; stom., stomach; ten., tentacle; tr.m., transverse muscles.

A short, thin-walled oesophagus leads into a well-defined stomach which has a thick muscular wall (Plate I, fig. 7). The intestine takes a short loop and terminates in an undifferentiated cloaca.

There are 4–5 Polian vesicles, two or three of which may be longer than the rest (Plate I, fig. 7). They are tubular, and their length varies between 3mm and 25mm. The single stone canal leaves the water-vascular ring on the dorsal side, and runs anteriorly in the dorsal mesentery as a short loosely coiled tube 0.2mm in diameter, terminating in a small madreporite of an irregular shape.

The genital tubules are moniliform and sparsely branched, arranged in two bunches, extending for about half of the length of the body cavity in mature specimens. The common genital duct lies in the dorsal mesentery, and opens to the exterior as a minute genital pore in the mid-dorsal interradius, immediately posterior to the ring of tentacles (Plate I, fig. 7). Longitudinal muscles are well developed, and transverse muscles are represented as bunches of fine fibres.

Calcareous deposits of four types were found:

1. Anchors: The anchors are approximately symmetrical, although some asymmetrical examples were found, especially near the posterior extremity of the body (Plate I, fig. 3). The total length of each anchor varies between 0.3mm and 0.5mm. The arms have 3–7 irregular serrations on their upper edges, or none at all, but smooth anchor arms are not common. The stock is unbranched, and carries a number of fine teeth, irregularly arranged (Plate I, fig. 4).

2. Anchor-plates: The anchor-plates lie in association with anchors in the skin. They are rectangular to oval in shape, with an average length of 0.3mm, and have many large and small polygonal to circular perforations (Plate I, fig. 6). The narrower end of the anchor-plate is reflected to form a bridge for the support of the anchor stock. The anchor is supported in such a way that the arms can project above the level of the skin. Anchors develop before anchor-plates, and stages in the development of anchor-plates (Plate I, fig. 5) are commonly found near the extreme posterior end of the body.

3. Tentacle Deposits: Curved and dumbbell shaped rods are present in great numbers in the tentacles. The curved rods are C- or bracket-shaped, 0.03–0.06mm long, and they are confined to the tentacle digits, where they form an investing layer (Plate I, fig. 2). Dumbbell shaped rods invest the tentacle stems. Thy are 0.02–0.05mm in length (Plate I, fig. 10).

DISTRIBUTION: *Protankyra uncinata* is now known from Auckland, Colville Channel (Mortensen, 1925), and Wellington Harbour, and may yet prove to have a wider distribution pattern. This species is restricted to the New Zealand region.

ECOLOGY: Mortensen's (1925) specimens were taken from muddy or sandy bottoms at depths ranging between 5 and 35 fathoms. The present collection contains specimens taken from a muddy bottom at depths ranging between 2 and 11 fathoms. This species is then a member of our sub-littoral fauna, and may eventually come to be known from other sheltered muddy localities.

DISCUSSION: Mortensen (1925) figured small irregular perforated buttons which he found ". . . . in the anterior end . . . more or less sparsely". These were not found in the specimens on hand. He also commented on the small size of the eggs in this species (approximately 0.1mm in diameter), and suggested that *Protankyra uncinata* may possess a typical auricularia larva.

Hutton (1872) gave a very inadequate description of his two new species *Synapta uncinata* and *Synapta inaequalis*. As a consequence Clark (1907) declared that the two species were absolutely unrecognisable on the basis of Hutton's descriptions. Mortensen (1925) established the validity of *P. uncinata* and reduced *P. inaequalis* to synonymy with that species. *P. inaequalis* was based on a fragment of skin containing asymmetrical anchors, but Mortensen (1925) suggested that this was probably an individual variant of *P. uncinata*.

Family CHIRIDOTIDAE

DIAGNOSIS: Calcareous deposits in the form of six-spoked wheels; sigmoid or C-shaped rods may be present. Tentacles with short stalks, becoming widened distally, where they bear 3–10 digits on each side. The digit-bearing portion forms a disc and the tentacles are therefore peltato-digitate.

Clark (1907) noted that the sexes are separate in many species. Sigmoid rods have each end curved in opposite directions, often in planes at right angles to each other. Rods in which the ends are curved inward towards each other are C-shaped or bracket-shaped.

This family comprises mainly small holothurians. The group is world-wide, and most of the species live in the littoral zone. Three genera and six species of Chiridotidae are known from New Zealand, of which three species are found in the Cook Strait region.

KEY TO THE COOK STRAIT GENERA IN FAMILY CHIRIDOTIDAE

1	(2) Calcareous deposits absent from the body wall	*Kolostoneura* Becher, 1909
2	(1) Wheels present, scattered or arranged into loose heaps, or sometimes so scattered as to be easily overlooked. Sigmoid rods also present in numbers	*Trochodota* Ludwig, 1892

Kolostoneura Becher, 1909

DIAGNOSIS: Calcareous deposits absent from the body wall. Tentacles ten. General features of anatomy similar to those in *Trochodota* Ludwig.

Type Species: *Kolostoneura novae-zealandiae* (Dendy and Hindle).

The genus *Kolostoneura* is monotypic, and Dendy and Hindle (1907) originally placed the species in genus *Rhabdomolgus*. Becher (1909) proposed a new genus for the New Zealand species to eliminate any suggestion of a genetic relationship with *Rhabdomolgus ruber* Keferstein, which is known from deeper waters in the Northern Hemisphere. Clark (1921) fully agreed with Becher's decision, and stated that *Kolostoneura* was probably derived from *Trochodota* by loss of (1) wheels and (2) sigmoid hooks. Mortensen's (1925) discovery of sigmoid hooks in some specimens from Plimmerton infected by ectoparasitic snails lends support to Clark's thesis.

Kolostoneura forms a parallel to *Anapta* Semper, which is described as a *Leptosynapta* Verrill without deposits in the skin, and *Achiridota* Clark, which is a *Chiridota* Eschscholtz without deposits (Clark, 1921).

Kolostoneura novae-zealandiae (Dendy and Hindle)

Rhabdomolgus novae-zealandiae Dendy and Hindle, 1907, p. 113, Pl. 11, figs. 1–4; Pl. 13, figs. 16–17; Pl. 14, figs. 22–29.

Kolostoneura novae-zealandiae Becher, 1909, p. 35; Clark, 1921, p. 164; Mortensen, 1925, p. 383; Dawbin, 1950, p. 40.

MATERIAL EXAMINED: Island Bay, intertidal rock pools, 11 specimens, collected by A. D. Allen and D. L. Pawson, 15/7/1959; Napier, muddy tide pool, 3 specimens, collected by D. L. Pawson, 20/5/1959.

DIAGNOSIS: Colour in life pinkish brown to white transparent. White and transparent in alcohol. Tentacles pinnate, occasionally containing calcareous deposits.

DESCRIPTION: Small holothurians, approximately cylindrical in shape, white transparent in alcohol. The radial longitudinal muscles can be clearly seen through the skin. Total length varies between 15mm and 40mm. Each of the ten tentacles gives rise to five pairs of pinnately arranged digits, which increase in length toward the distal extremities of the tentacles.

Dendy and Hindle (1907) gave a very thorough description of the internal anatomy of this species. Mortensen (1925) added that he almost invariably found calcareous deposits in the tentacles.

DISTRIBUTION: Dendy and Hindle's (1907) specimens were taken from New Brighton Beach, Kaikoura, and Owenga in the Chatham Islands. Mortensen (1925) found specimens at Akaroa, Plimmerton, Takapuna Beach and Stewart Island. The new locality, Napier, leads to the suggestion that *K. novae-zealandiae* may prove to be present around the entire New Zealand coast. The species is endemic to the New Zealand region.

ECOLOGY: This species has only been taken from the intertidal zone, where it lies concealed under rocks in mud or sand.

DISCUSSION: Examination of the tentacles of all the specimens on hand showed that only two were found to possess calcareous deposits in the tentacles.

K. novae-zealandiae appears to have no near relatives in New Zealand or overseas.

Trochodota Ludwig, 1892

DIAGNOSIS: Tentacles 10. Digits 2–6 on each side. Polian vesicle single. Calcareous ring of 10 pieces, the radial not perforated. Calcareous deposits sigmoid hooks, scattered, or arranged into groups, and wheels, scattered, never grouped into papillae (Clark, 1907).

Type Species: *Trochodota purpurea* (Lesson).

This well-defined genus contains in excess of 15 species at the present time. The species are separated on the basis of differences in average wheel size, in the size and arrangement of sigmoid rods, and the size and shape of the tentacle deposits. Some of the known species are closely related to each other and may yet prove to be synonyms.

The greatest concentration of species lies in the Indo-West Pacific region. Two species are known from New Zealand, and both are members of the Cook Strait Holothurian fauna.

KEY TO THE NEW ZEALAND SPECIES OF *Trochodota* LUDWIG

1	(2)	Skin smooth, not papillate, with numerous scattered sigmata and wheels	*T. dunedinensis* (Parker)
2	(1)	Skin distinctly papillate. Sigmata arranged into groups in the papillae. Wheels numerous or scarce	*T. dendyi* Mortensen

Trochodota dunedinensis (Parker) Plate I, fig. 1

Chiridota dunedinensis Parker, 1881, p. 418; Theel, 1886, p. 34; Dendy, 1896, p. 26, Pl. 3, figs. 1–8; Farquhar, 1898, p. 323.
Trochodota dunedinensis Ludwig, 1898, p. 87; Perrier, 1905, p. 123; Clark, 1907, p. 124; Clark, 1921, p. 166; Mortensen, 1925, p. 376, figs. 59b, 60b, 61; John, 1939, p. 315; Dawbin, 1950, p. 40, fig. 19.
Chiridota geminifera Dendy and Hindle, 1907, p. 112, Pl. 14, fig. 30.
Chiridota benhami Dendy, 1909, p. 151, Pl. 16, fig. 3a-1.
Trochodota benhami Clark, 1921, p. 166.
Non. *Trochodota dunedinensis* Allan, 1911, p. 325 (= *Trochodota alleni* Joshua); Ohshima, 1914, p. 478 (= *Trochodota diasema* Clark).
Chiridota australiana Theel, 1886, p. 16.

MATERIAL EXAMINED: Island Bay, intertidal rock pool, 1 specimen, collected by G. W. Gibbs, 11/7/1960.

DIAGNOSIS: Colour in life reddish-brown, darker near the posterior and anterior extremities of the body. Body elongate, cylindrical, smooth, without papillae. Deposits wheels and sigmoid hooks, scattered in the skin. Radials and interradials irregular in shape, notched anteriorly and posteriorly.

DESCRIPTION: These are small holothurians, rarely more than 50mm in length when fully extended. The single specimen in the collection is 35mm in total length; the diameter at the anterior end is 3mm. Colour in life reddish-brown, deepening to a dark brown at the anterior and posterior extremities of the body; the tentacles are transparent, with numerous dark brown spots. Colour in alcohol, yellowish-white and semi-transparent.

The calcareous ring is composed of 12 unsymmetrical pieces. Each piece is narrow, about 1mm in length, with an anterior and a posterior notch. The radials are not perforated and are virtually indistinguishable from the interradials.

The oesophagus is short and thinwalled and enters the intestine which describes an S-shaped loop and runs to the anus. The single Polian vesicle arises from the ventral side of the water-vascular ring. The stone canal is very small and convuluted, lying in the dorsal mesentery, terminating in a minute nodular madreporite.

Gonads consist of a few long and slender tubes which extend almost to the posterior end of the body cavity.

Calcareous deposits of three kinds were found:

1. Wheels: The dorsal side of the body contains numerous six-spoked wheels in the skin, whose diameters range between 0.06mm and 0.16mm, the average diameter being 0.1mm.

2. Sigmoid Hooks: Sigmoid hooks, with an average length of 0.1mm are scattered among the wheels on the dorsal surface of the body. They lie transverse to the longitudinal axis of the body.

3. Tentacle Rods: The tentacles contain large numbers of small rods 0.02–0.06mm in length. They are irregular in shape and frequently have enlarged extremities (Plate I, fig. 1). The rods are scattered in the stems of the tentacles, but in the digits they are arranged in narrow double rows.

BEHAVIOUR OF A LIVING SPECIMEN: A living specimen of *T. dunedinensis* was placed in a dish of seawater, the bottom of which was partly covered by a thick layer of sandy mud. The general behaviour of the specimen was observed for some time.

1. *Feeding*: The tentacles were pushed into the mud and sand in turn. Small particles of the substrate adhered to the outer surfaces of the tentacles which apparently were covered by a sticky secretion. No particles of sand adhered to the inner surfaces of the tentacles. The tentacles were then rapidly wiped across the mouth one at a time, or pushed into the mouth, and the adhering particles were removed and ingested. While feeding, the specimen was fully extended, and waves of contraction passed along the body from time to time. The feeding process took place almost continuously during the time of observation.

2. *Defaecation*: The anal aperture of the body was completely closed, and the posterior half of the body contracted. Then the anus opened suddenly and egesta emerged in small lumps. No vermiform "casts" were seen. Defaecation took place at irregular intervals.

3. *Locomotion*: The specimen pulled itself around the walls of its dish by means of its sticky tentacles. There was no tendency to burrow away from strong light, although the animal was photosensitive.

DISTRIBUTION: Parker (1881) described the type specimen from Otago Harbour. Since that time specimens of this species have been found in many parts of the South Island of New Zealand, the Cook Strait region, Stewart Island, and the Auckland and Campbell Islands (Mortensen, 1925).

ECOLOGY: *T. dunedinensis* appears to favour comparatively sheltered sandy to muddy localities where it conceals itself under stones or by burrowing.

DISCUSSION: Mortensen (1925) stated that the oral disc is "distinctly oblique in dorso-ventral section" and "the calcareous ring is . . . parallel to the oral disc". The calcareous ring is no doubt asymmetrical owing to its oblique position.

There appears to be some variation in the course of the intestine in this species. Dendy's *T. benhami* possessed an S-shaped intestine. However Mortensen (1925) noted that in some of the specimens at his disposal the intestine ran straight to the anus, while in others it looped twice, or described an S-shaped path to the anus. He also showed that the other characters for *T. benhami* given by Dendy (1909) fell within the range of variation of *T. dunedinensis*.

Dendy (1896) noted that the sexes are separate in this species, and John (1939) observed that the females are viviparous.

Trochodota dunedinensis has certain characters in common with other species of the same genus. Clark (1921) pointed out that it is almost impossible to make an accurate key to the species of the genus without re-examining many of the species. To the writer's knowledge, this has not been done as yet.

Trochodota dendyi Mortensen

Trochodota dendyi Mortensen, 1925, p. 381, figs. 62–63a; Dawbin, 1950, p. 40.

DIAGNOSIS: Colour white or faint purple. Skin papillate, each papilla containing 3–6 sigmoid hooks. Wheels numerous or absent. Tentacle deposits with bifurcating ends.

DISTRIBUTION: The type specimen was from Plimmerton. The species is also known from Waikeke (Auckland Harbour), and Paterson Inlet (Stewart Island) (Mortensen, 1925). Restricted to the New Zealand region.

ECOLOGY: Known only from the intertidal zone.

DISCUSSION: Mortensen examined nine specimens of this interesting species and after giving a very careful description, he stated that the species is nearly related to *Trochodota japonica* (v. Marenzeller) but differs in colour, number of sigmoid hooks in each papilla, and in the shape of the tentacle deposits.

Order MOLPADIDA

DIAGNOSIS: Stout, sausage-shaped holothurians, usually possessing a caudal prolongation or tail. Tentacles 15, digitate. Anal papillae, tentacle ampullae, respiratory trees present. Radial muscles in the form of double bands. Deposits commonly in the form of tables, fusiform rods, or perforated plates. Anchors sometimes occur, but wheels and sigmoid hooks do not. Phosphatic bodies often present.

The Order Molpadida is cosmopolitan, most abundant in the Indo-West Pacific, and its members have a bathymetric range from a little below low-water mark to at least 2,000 fathoms, where an almost exclusively subterranean life is led in a sandy or mud bottom. Most of the known species have been taken in deep water, and consequently, many species have a wide geographic distribution.

There are three families in Order Molpadida, of which two are represented in New Zealand waters, species from both having been taken in the Cook Strait region.

KEY TO THE FAMILIES IN ORDER MOLPADIDA

1	(4)	Tentacle ampullae present.	
2	(3)	Tentacles with 1–3 pairs of digits and a terminal digit	Fam. MOLPADIIDAE
3	(2)	Tentacles with 2 pairs of digits and no terminal digit	Fam. CAUDINIDAE
4	(1)	Tentacle ampullae absent	Fam. EUPYRGIIDAE (unknown in New Zealand)

Family MOLPADIIDAE

DIAGNOSIS: Tentacles with lateral digits, or claw-shaped. Tentacle ampullae long (reduced in one deep-water species). Spicules derived from triradiate tables with solid three-pillared spire; tail with tables with round to oblong disc, or long fusiform rods. In one species large fusiform plates or rods develop in the skin of the body wall with advancing age. Dark red egg-shaped phosphatic bodies often present. In some species anchors and racquet-shaped plates present in young individuals. Mostly large forms, 6–15cm long (Deichmann, 1960).

The members of this family are unique in that the calcareous deposits of the juvenile may be transformed into phosphatic material with the passage of time. The phosphatic material is deposited as small orange or red concentrically laminated granules. As a consequence of this phenomenon, juveniles, half-grown specimens, and adults of the same species have often been placed in different species, because of the differences in their spiculation. Clark (1907) referred all of the then known species of the family Molpadiidae to the genus *Molpadia* Risso. Heding (1931) attempted a revision of the family, listing the known species under five genera, one of which (*Pseudomolpadia*) was a new genus. Later, Heding (1935) erected another new genus (*Eumolpadia*). Deichmann (1936), pointed out a number of inconsistencies in Heding's reasoning, and suggested a return to Clark's (1907) idea that all of the species be placed under the single generic name *Molpadia* in the meantime, until the life histories of at least a few typical cases be worked out.

Heding (1931, 1935) used differences in structure and sculpture of the calcareous ring, in certain features of internal anatomy, and (to a lesser extent) in calcareous deposits, as criteria for separation at the generic level. It appears that these criteria may be rather unreliable, and subject to more or less drastic changes with growth. The calcareous deposits of the tail are relatively unaffected by deposition of phosphatic material and these deposits are thus reliable criteria for identification of juvenile and adult specimens alike. The deposits in the body wall should be used only when the life history of the species is fairly well known, and a series of specimens have been examined, or when the body wall deposits are so distinctive as to belong to a certain species. The calcareous ring should supply characters of secondary importance only.

Two genera of Molpadiidae are represented in the Cook Strait collections.

KEY TO THE COOK STRAIT GENERA IN FAMILY MOLPADIIDAE

1 (2)	Deposits include anchors and three-armed anchor-plates, and spired tables with three perforations	*Heteromolpadia* n.g.
2 (1)	Deposits in the form of large fusiform rods and scattered irregular tables	*Molpadia* Risso

Heteromolpadia n.g.

DIAGNOSIS: Molpadids whose calcareous deposits include two-armed anchors associated with single perforated anchor-plates of varying shapes, usually having three marginal projections. No rosettes of racquet-shaped plates; no fusiform rods. Phosphatic bodies present, at least in adult specimens.

Type Species: *Ankyroderma marenzelleri* Theel.

Also included here: *Ankyroderma tridens* Sluiter.

DISCUSSION: Heding (1931) in his subdivision of the genus *Molpadia* proposed a new genus *Pseudomolpadia* for those species which have the anchors either united with a single fenestrated plate, or supplied with more than two arms. In this genus Heding placed the following species:

1. *brevicaudata* (Koehler and Vaney) 1905 type species.
2. *marenzelleri* (Theel) 1886.
3. *tridens* (Sluiter) 1901.
4. *inflata* (Augustin) 1914.

Subsequently, Deichmann (1936) pointed out that it is only in *tridens* and *marenzelleri* that the anchor-plates are definitely known to be "not united in rosettes". Thus *brevicaudata* and *inflata* do not belong with the two other species unless it is proved that they have single anchor-plates. As *brevicaudata* is the type of *Pseudomolpadia,* this generic name cannot be used here, and it is necessary to propose a new genus, *Heteromolpadia,* with *H. marenzelleri* (Theel) as the type species.

KEY TO THE SPECIES OF *Heteromolpadia*

1 (2)	Deposits in the body wall include tables, typically with three perforations	*H. marenzelleri* (Theel)
2 (1)	No such tables present	*H. tridens* (Sluiter)

Heteromolpadia marenzelleri (Theel) Plate II

Ankyroderma marenzelleri Theel, 1886, p. 41, Pl. 3, fig. 1 a-g.
Molpadia marenzelleri Clark, 1907, p. 171, Pl. 10, fig. 23; Benham, 1909, p. 70, Pl. 11, fig. 4, a-d; Deichmann, 1936, p. 464; Dawbin, 1950, p. 39, Pl. 2, fig. 17; Deichmann, 1960.
Molpadia dendyi Benham, 1909, p. 71, Pl. 11, figs. 1-3.
Pseudomolpadia marenzelleri Heding, 1932, p. 280.

MATERIAL EXAMINED: VUZ 10, Palliser Bay, 200–250 fathoms, green mud, 1 specimen; VUZ 15, Palliser Bay, 100–150 fathoms, mud, 16 specimens; VUZ 21, Palliser Bay, 38 fathoms, mud, 1 specimen; VUZ 87, South of Cape Palisler, 400 fathoms, mud, rock and gravel, 1 specimen; VUZ 96, off Palliser Bay, 380 fathoms, mud, 13 specimens; Cook Strait, 40 fathoms, 2 specimens, collected by F. Abernethy, 14/11/1952; off Foxton, 50 fathoms, 1 specimen.

New Zealand Oceanographic Institute, Wellington: B 11, Hawke Bay, 35 fathoms, mud, 1 specimen; B 44, Hawke Bay, 14 fathoms, sandy mud, 1 specimen;

B 49, Hawke Bay, 44 fathoms, fine grey-green mud, 1 specimen; A 435, off Foxton, 64 fathoms, sandy mud, 1 specimen; C 185, off Wanganui, 25 fathoms, mud, 1 specimen; C 186, off Wanganui, 25 fathoms, mud, 1 specimen; C 189, entrance to Tasman Bay, 30 fathoms, soft mud, 1 specimen.

DIAGNOSIS: Deposits in the body wall comprise spired tables with 3 large perforations, and anchors associated with single three-armed perforated anchor-plates up to 0.4mm in length. Tail deposits lozenge-shaped, 0.1–0.16mm in length.

DESCRIPTION: Short-tailed, fat-bodied holothurians which are greyish-white as juveniles, and gradually become red in colour with growth, until the largest specimens are almost uniformly dark red. The calcareous deposits comprise distinctive anchors, anchor-plates and tables. The tables in the tail persist unchanged throughout life, and are always readily usable as a diagnostic character. The deposits in the rest of the body become gradually transformed into phosphatic bodies with age, and thus they range from well-formed anchors, anchor-plates and tables in smaller specimens to simple, small, concentrically laminated ovoidal red phosphatic granules in larger specimens. Large specimens of the species often lack calcareous deposits altogether, except in the tail, and are dark red is colour, due to the presence of great numbers of phosphatic deposits.

Three groups, based mainly on colour of specimens, may be recognised:

1. Small specimens: 15–30mm in total length. The smallest specimen on hand is 15mm in total length, with a tail length of 6mm. The ratio tail : body in this group is about 1 : 3. The body is about twice as long as it is broad. These animals are uniformly greyish-white in colour, and the body wall is quite thin, but opaque. The body is often clothed in particles of mud and sand, which are caught on the arms of anchors and the spires of the tables, as they project above the level of the skin. When touched, the skin gives the sensation of carrying a number of short sharp spines. The inadequate development of the gonads indicates that the specimens in this group may not be sexually mature, and they may be regarded as juveniles.

2. Medium Specimens: 30–70mm in total length. The shape is approximately the same as that in the juvenile, but the tail : body ratio has now become 1 : 6. These specimens are orange to dark red in colour, with many greyish spots. The tail and circum-oral regions still retain the grey colour of the juvenile. At this stage in growth, many of the calcareous deposits have been transformed into red phosphatic material, and thus there are but small numbers of anchor arms and table spires projecting from the skin.

3. Large Specimens: 70–101mm in total length. The largest specimen is 101mm in total length, with a tail length of 12mm. The tail : body ratio is here 1 : 8. In these specimens the body is uniformly dark red, while the tail is grey. In these large specimens, virtually all of the calcareous deposits have been transformed into phosphatic bodies. No anchor arms project above the skin, and the skin is quite smooth and leathery to touch.

The calcareous ring is made up of 10 sculptured pieces, 5 radials and 5 interradials, which are joined to form a solid ring (Plate II, fig. 8). Each radial piece has two rounded anterior projections and a slightly bifurcated posterior projection. There are no perforations for the passage of the radial nerves. The radial pieces each carry a groove for attachment of the radial muscle. Each interradial has a single anterior process, carries a sharp ridge, and has no posterior process. The ring has 15 grooves for tentacle ampullae. Sculpture of the ring varies considerably in this species. The calcareous ring in the juvenile has long and slender posterior projections.

A short thin-walled oesophagus leads into the intestine, which takes a very large loop and runs to the cloaca, which is undifferentiated, save for the numerous very fine muscle strands attaching it to the body wall. These strands also fill the cavity in the tail.

A single Polian vesicle leaves the water vascular ring in the left ventral interradius. It consists of a short narrow tube which carries a dark brown bulbous extremity (Plate II, fig. 1). The stone canal lies in the mid-dorsal interradius, runs anteriorly and dorsally into

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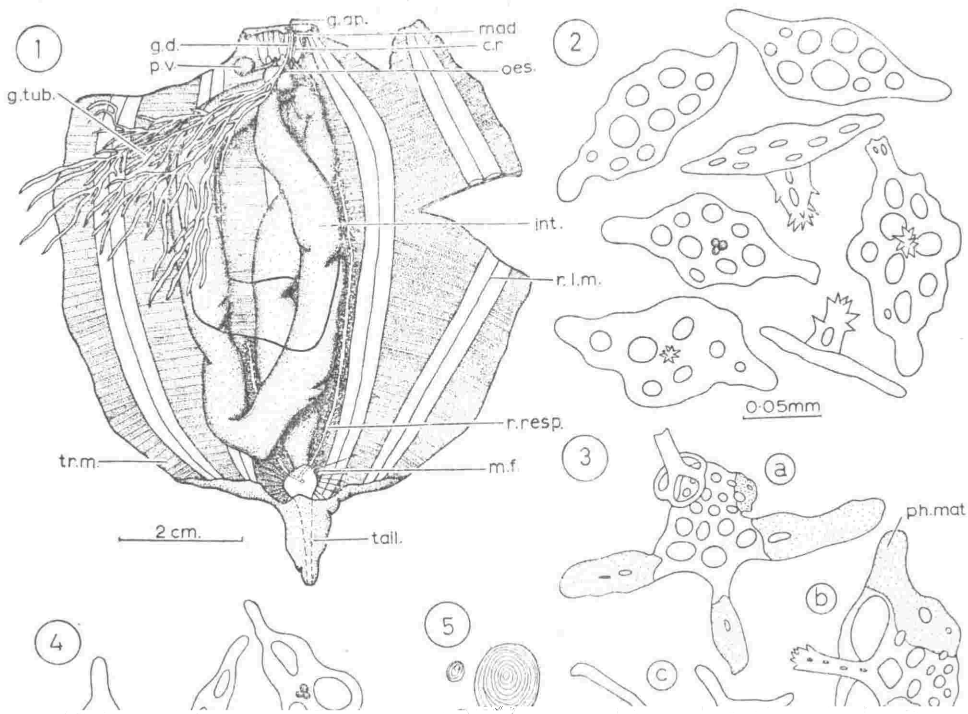
fig. 6, mid-body tables; fig. 7, stages in development of a mid-body table; fig. 8, calcareous ring of an adult specimen; fig. 9, anchors; fig. 10, mid-body tables showing phosphatic material.

Abbreviations: amp.g., groove for passage of tentacle ampulla; c.r., calcareous ring; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., interradial piece; m.a., attchmeant area for radial muscles; mad., madreporite; m.f., muscle fibres; oes., oesophagus; ph.mat., phosphatic material; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.p., radial piece; r.resp., right respiratory tree; tr.m., tranverse muscles.

PLATE II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the centre of a spherical madreporite. The madreporite is joined to a pore-canal which opens to the exterior near the anterior end of the body, posterior to the gonopore.

Two respiratory trees arise from the cloaca. Each consists of a single flattened tube which gives rise to a number of short side branches (Plate II, fig. 1). The left tree extends about one third of the way along the body cavity. The right is considerably longer, and runs to the anterior end of the body, attaching to the dorsal pieces of the calcareous ring (Plate II, fig. 1).

The gonads are represented in the mature specimens as extensively branched vesicular caeca, which are arranged in two bunches, lying one to each side of the dorsal mesentery. The caeca are loosely intertwined around and over the intestine and the right respiratory tree. The common genital duct runs anteriorly in the dorsal mesentery to open to the exterior as a well-defined genital aperture in the mid-dorsal interradius, immediately posterior to the ring of tentacles.

The longitudinal muscles are five broad strap-like double bands (Plate II, fig. 1). No "retractor muscles" were seen. Transverse muscles are visible as fine white fibres against the dark coloured background of the body wall (Plate II, fig. 1).

Four types of calcareous deposits are known in this species:

1. Tail Deposits (Plate II, fig. 2): The tail contains a large number of very closely aggregated tables which have elongate discs (0.1–0.16mm long), and carry short three-pillared spires. The discs each have 7–12 perforations. The three pillars of the spire are joined by one or sometimes two crossbars, and the pillars at their distal extremities give rise to a few short spines. Some tables were seen to lack spires and they merely took the form of flat perforated plates. The tail deposits in the juvenile differ little from those in adult specimens. The anus is surrounded by a small number of irregular and distorted tables.

2. Mid-body Tables (Plate II, fig. 6): These tables are small (about 0.15mm across), and they typically have three large perforations. A three-pillared spire with a spinous distal extremity arises from the centre of each table and the pillars are joined to each other by 3–7 crossbars. The tables lie so that the spires project through the skin. Developing tables are common in small specimens (Plate II, fig. 7). In juveniles, the tables are present in large numbers, closely aggregated together, but their numbers decrease with growth of the animals as they become transformed into phosphatic deposits. Medium-sized specimens have scattered tables, while large specimens have very few tables or none.

3. Tables from the extreme anterior end of the body (Plate II, fig. 4): These are elongate tables which often tend towards a fusiform shape, and have 3–7 perforations. The disc is surmounted by a three-pillared spire with crossbars.

4. Anchors and Anchor-plates (Plate II, figs. 3, 9): Anchors with anchor-plates are present in numbers in juveniles, while in large specimens they are absent, due to their dissolution into phosphatic bodies. Medium-sized specimens may still possess anchors and anchor-plates, but when present, they are commonly in the process of dissolution.

The anchors are of varying sizes, lengths ranging between 0.2mm and 0.3mm. The attaching portion of the anchor is saucer-shaped and has 3 perforations. The shaft is straight and cylindrical. The arms are short and curved, and each has two to five small serrations (Plate II, fig. 9).

The very characteristic anchor-plates are not all the same shape, but the basic form is an irregular plate having three (sometimes two) elongate marginal projections. The plate is freely perforated, while the projections each have one or two perforations or none at all (Plate II, fig. 3). Each anchor-plate supports one anchor in such a manner that part of its shaft and arms lie outside the skin. The method of support is simple (Plate II, fig. 3a), so that the anchors are easily detached from their plates. Some anchors were found on their own, holding to the surface of the body by the ends of their arms or by their serrations.

Anchor-plates from medium-sized specimens show various stages in their transformation into phosphatic material (Plate II, figs. 3a, 3b), while juvenile anchor-plates show no trace of phosphatic material (Plate II, fig. 3c). One anchor-plate was found to possess a spire composed of three rods joined by crossbars (Plate II, fig. 3b). This plate had two large perforations and 12 smaller ones. A mid-body table from a juvenile specimen carried a marginal process which showed some resemblance to part of the shaft and arms of an anchor (Plate II, fig. 6a).

Phosphatic Deposits: Apart from the tail deposits which remain unaffected, the anchors, anchor-plates and tables in turn become transformed into phosphatic spherules with advancing age. It is therefore possible to encounter specimens which lack anchors, anchors and anchor-plates, or anchors anchor-plates and tables. Transformation into phosphatic material is a gradual process and one often sees deposits which are in the process of dissolution (Plate II, figs. 3a, 3b, 10).

The resulting phosphatic bodies are amber or red, ovoid to spherical, and they superficially resemble starch grains (Plate II, fig. 5).

Knowledge of the changes in deposits with growth serves to explain clearly the differences in colour between small, medium and large individuals of this species. The greyish-white juveniles have very few phosphatic bodies and many calcareous deposits. The medium-sized specimens, dark red with greyish spots, have clusters of phosphatic bodies, and the greyish patches represent areas where calcareous deposits still remain. The uniformly dark red large individuals have great numbers of phosphatic bodies and very few calcareous deposits.

DISTRIBUTION: Theel (1886) described the type specimen from east of East Cape in 700 fathoms. Benham (1909) recorded specimens of *H. marenzelleri* from 38 fathoms in Hawke Bay, and *Molpadia dendyi* from deeper water off the coast of the North Island. The new localities recorded here indicate that *H. marenzelleri* is a common species about the deeper waters of the southern half of the North Island. As the species is eurybathic, it probably has a wider distribution.

ECOLOGY: This species lives on a muddy or sandy bottom.

DISCUSSION: The status of this species has been in doubt for some time, owing to insufficient knowledge of the juvenile and its deposits. The present findings indicate that *H. marenzelleri* is a valid species, characterised by the peculiar anchor-plates.

Molpadia Risso, 1826

DIAGNOSIS: Molpadids whose calcareous deposits include tables, anchors, and rosettes of racquet-shaped plates and large fusiform rods in various combinations. Tail deposits fusiform.

Type Species: *Molpadia musculus* Risso.

The single Cook Strait representative of this perplexing genus is *Molpadia violacea* (Studer), which is probably related to the type species of the genus, but the relationship is not absolutely clear, as *M. violacea* seems to lack the characteristic rosettes of racquet-shaped plates and anchors which are found in *M. musculus*.

Molpadia violacea (Studer) Plate III, figs. 4–8

Trochostoma violaceum Studer, 1876; Theel, 1886, p. 42, Pl. II, fig. 4; Pl. XI, fig. 1.
Molpadia musculus H. L. Clark, 1907, p. 165, Pl. XI.
Haplodactyla violacea Heding, 1931, p. 280.
Molpadia violacea Deichmann, 1960.

MATERIAL EXAMINED: VUZ 87, South of Cape Palliser, 400 fathoms, mud, 1 specimen; VUZ 101, off Palliser Bay, 550 fathoms, mud, 6 specimens.

DIAGNOSIS: Deposits in the form of large fusiform rods with two to three arms, up to 1.1mm in length. No anchors or anchor-plates. No rosettes of racquet-shaped plates. Tail deposits two-armed fusiform rods up to 0.8mm in length. One anterior process on each radial piece of the calcareous ring perforated for the passage of the radial nerve.

DESCRIPTION: The smallest specimen has a total length of 47mm; the largest is 78mm in length. The specimens are approximately cylindrical in shape, elongate, with the posterior end attenuated to form a distinct caudal appendage which occupies up to 20% of the total body length.

Colour in alcohol ranges from a light-brownish red to a dark brick-red. The anterior extremity of the body and the tail are greyish-white. The skin is quite thin and coarse to touch.

The calcareous ring is composed of 10 pieces, five radials and five interradials, joined to form a solid ring. Anteriorly, the radials each have two short and blunt processes, one of which carries a small perforation for the passage of the radial nerve. The interradials each have one anterior process and no perforation. The radials have a forked posterior process, while the interradials have none. The ring is sculptured on its outer surface, and the sculpture varies within the species.

The internal anatomy is similar to that in *Heteromolpadia marenzelleri*.

Two types of calcareous deposits are present in the skin:

1. Fusiform Rods: These are found everywhere in the body wall, especially in the tail, where they occur in great numbers, closely aggregated together, lying transverse to the longitudinal axis of the body. The rods vary in length up to a maximum of 1.1mm, and they have an expanded central portion which carries a small number of perforations.

(a) Rods from the tail (Plate III, fig. 6): The tail rods are in general smaller (average length 0.7mm) than those from other areas, and have fewer perforations. The ends of the rods tend to project above the level of the skin, and they can be seen with the naked eye.

(b) Rods from the posterior third of the body, near the tail (Plate III, fig. 8): These are massive deposits, with an average length of 1.0mm. Many of the rods have three arms, while others have two, and there are four to eight central perforations. The rods are grouped into small clusters.

(c) Rods from the middle of the body (Plate III, fig. 7): Mid-body deposits closely resemble those from the posterior third of the body in general features, but even more variability in shape is displayed.

(d) Rods from the extreme anterior end of the body (Plate III, fig. 4): These are similar to those from the tail, and are of a comparable size.

2. Perforated tables (Plate III, fig. 7a): Tables (length 0.3–0.6mm) with short central spires and 3–6 perforations are scattered sparsely in the skin. The spire is composed of a single column, and in many cases it is absent. Developmental stages are occasionally seen (Plate III, fig. 5).

Red phosphatic deposits are present, grouped together in small clumps. They are similar to those in *Heteromolpadia marenzelleri* (Theel).

DISTRIBUTION: Theel (1886) described specimens taken from the vicinity of Kerguelen Island at depths between 20 and 120 fathoms, and from about 50 miles east of East Cape, New Zealand in 700 fathoms. The two new localities recorded here, Palliser Bay, 550 fathoms, and south of Cape Palliser, 400 fathoms, indicate that this species may be relatively common in deeper waters about New Zealand, and probably elsewhere, achieving its distribution by spreading across the seafloor in deep water.

DISCUSSION: The specimens described here are similar in most respects to those described and figured by Theel (1886). There appears to be a complete lack of anchors and rosettes, even in smaller specimens. Thus the species is sharply distinguished from *M. musculus* (Risso). Deichmann (1960) believes that *M. violacea* is an extreme form of *M. musculus* with narrow rods and lacking the anchor and racquet stage completely.

Family CAUDINIDAE

DIAGNOSIS: Tentacles with one to two pairs of digits, but no terminal digit. Spicules large tables or plates, or small crossed cups or irregular bodies. No phosphatic bodies, but discolouration of the skin may occur in older individuals of some species (Deichmann, 1960).

The genera within this family, in contrast to those in the family Molpadiidae, are clearly defined, the calcareous deposits of the skin being particularly useful as criteria for separation. The deposits are not transformed into phosphatic material as are those of so many species in the family Molpadiidae, although in some cases the deposits are known to change shape with growth and age, but this change is by no means a dramatic one.

Four genera are recognised at the present time. *Acaudina* Clark is readily distinguishable from the rest as its tentacles have one pair of digits, while the other genera have two pairs of digits per tentacle. *Paracaudina* Heding has characteristic deposits in the form of "crossed cups" (Plate IV, fig. 2). *Caudina* Stimpson has deposits which usually take the form of spired tables and knobbed buttons. *Hedingia* Deichmann has distinctive tables and plates of considerable size.

PLATE III

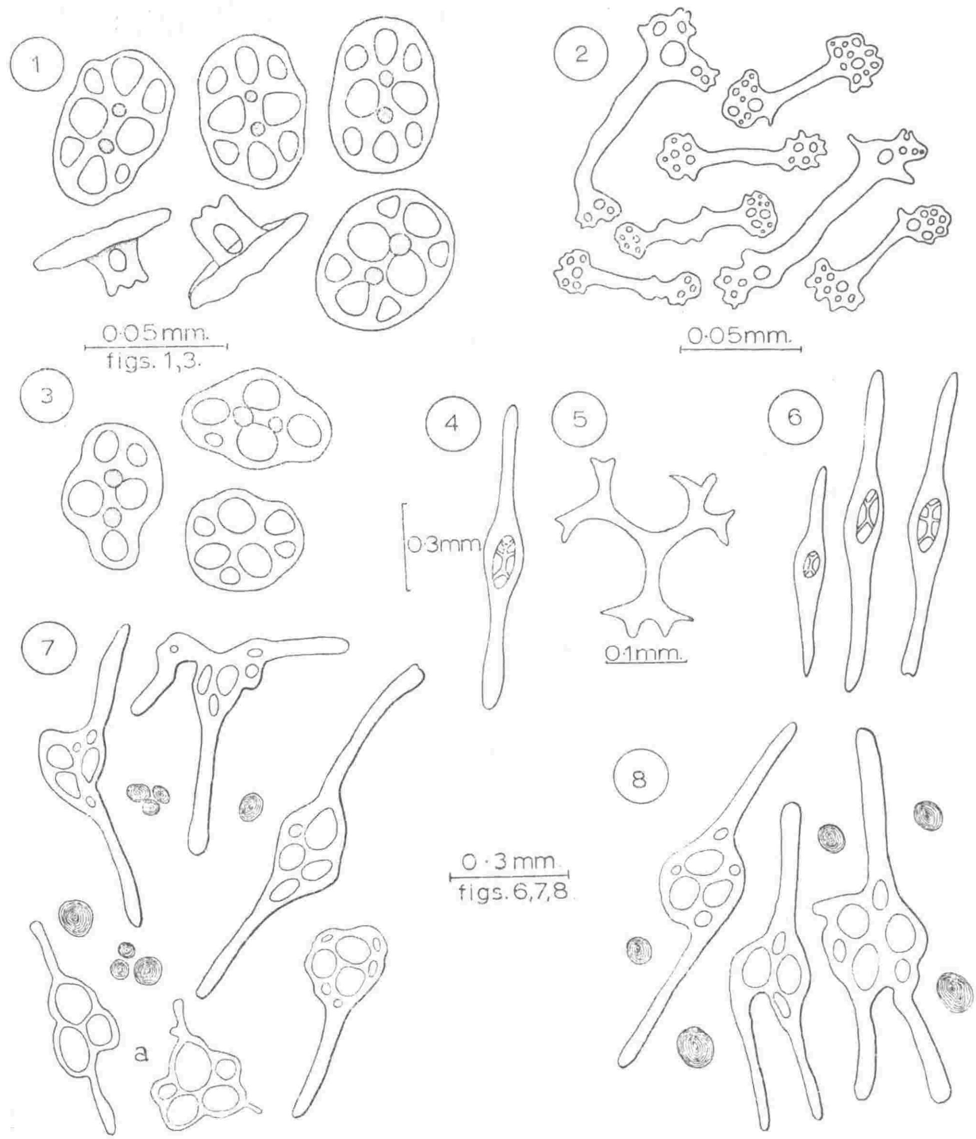

PLATE III.—*Neocucumella bicolumnata* (Dendy and Hindle).—Fig. 1, tables; fig. 2, tentacle deposits; fig. 3, abnormal tables.

Molpadia violacea (Studer).—Fig. 4, rod from anterior end of body; fig. 5, developmental stage of perforated plate; fig. 6, rods from the tail; fig. 7, deposits from the middle of the body; fig. 8, rods from the posterior of the body, near the tail.

The family is cosmopolitan, with representatives in all seas. Most species are known from moderate depths, although *Hedingia albicans* has been taken from depths in excess of 1500 fathoms.

Genus *Paracaudina* Heding is represented in the Cook Strait region by a single species.

Paracaudina Heding, 1931

Diagnosis: Tentacles with two pairs of digits. Caudal appendage usually long and slender. Deposits not tables but cups (buttons), perforated plates or irregular rods (Heding, 1931, in part).

Type Species: *Paracaudina chilensis* (Muller).

Heding (1931) diagnosed this genus and listed seven species, one of which (*pigmentosa* Perrier) was included with some doubt. Clark (1935) agreed with Heding's new genus, but did not agree with the part of Heding's diagnosis which stated "retractor muscles more or less well developed". After examination of many specimens of *Paracaudina,* Clark found no true retractor muscles.

Paracaudina chilensis (Muller) Plate IV

Molpadia chilensis Muller, 1850, p. 139; 1854, Pl. VI, fig. 14, Pl. IX, fig. 1.
Molpadia coriacea Hutton, 1872, p. 17; Hutton, 1878, p. 307.
Caudina meridionalis Bell, 1883, p. 58, Pl. XV, fig. 1.
Caudina coriacea Theel, 1886, p. 47, Pl. III, fig. 4; Dendy, 1896, p. 28, Pl. 3, figs. 9–18; Dendy, 1897, p. 456, Pl. 29; Farquhar, 1898, p. 324; Ludwig, 1898, p. 63; Dendy and Hindle, 1907, p. 108; Mortensen, 1925, p. 363, figs. 46–47.
Caudina pulchella Perrier, 1905, p. 117, Pl. V, figs. 14–17.
Caudina coriacea var. *brevicauda* Perrier, 1905, p. 121.
Caudina chilensis H. L. Clark, 1907, p. 175; Benham, 1909, p. 28; Hozawa, 1928, p. 363; Ohshima, 1929, p. 39.
Pseudocaudina coriacea Heding, 1931, p. 283.
Paracaudina coriacea Heding, 1932, p. 455; Heding, 1933, p. 127, Pl. IV, figs. 8–13, Pl. VII, figs. 6–7, Pl. VIII, fig. 4; Dawbin, 1950, p. 39, Pl. 1, fig. 5, Pl. 2, fig. 16.
Paracaudina chilensis var. *coriacea* H. L. Clark, 1935, p. 267.
Paracaudina chilensis forms *coriacea* Deichmann, 1960.

Material Examined: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 2 specimens; VUZ 87, South of Cape Palliser, 400 fathoms, mud, 2 specimens; VUZ 101, off Palliser Bay, 550 fathoms, mud, 135 specimens.

New Zealand Oceanographic Institute, Wellington: Stn. B 8, Hawkes Bay, 39° 06′ S., 177° 23′ E., 15.5 fathoms, 26/8/56, fine grey sand, 326 specimens.

Diagnosis: Body cylindrical, attenuated posteriorly into a long tail. Colour in alcohol white; old specimens frequently light brown. Calcareous deposits in the form of thick, solid crossed cups with small perforations, the marginal projections when present being low and rounded. The cups, especially in young specimens, approximately octagonal in shape, while the points of the octagon may be obscured in old specimens. Diameter of cups 0.06–0.1mm.

Description: These are caudinids whose tail length is about 40% of the total body length. Total length of largest specimen 115.0mm, tail 44.0mm, diameter of body at widest point 37.0mm. Total length of a juvenile specimen 15.0mm, tail, 6.0mm, diameter at widest point 6.0mm.

In all specimens the body is cylindrical, tapering abruptly to form a long tail. The body wall is thin and firm, and is marked by numerous transverse striations. In juveniles the body wall is semi-transparent, and through it the gut can be seen as a dark coloured mass. Colour in life and in alcohol varies from white to light yellow or brown. Anal papillae are present. The mouth is circular, lying in the middle of a circular oral disc. Tentacles 15, usually retracted.

The calcareous ring comprises ten pieces, five radials and five interradials. The radials each have a bifurcated posterior projection and three anterior projections. The interradials each have no posterior projection and one anterior projection. Many workers (Hozawa, 1928; Heding, 1933; Clark, 1935) have described the calcareous ring in detail.

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canal and madreporite; fig. 6, developmental stages of crossed cups; fig. 7, madreporite deposits.

Abbreviations: an., anus; cl., cloaca; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.resp., right respiratory tree; t.amp., tentacle ampulla; tr.m., transverse muscles.

PLATE IV

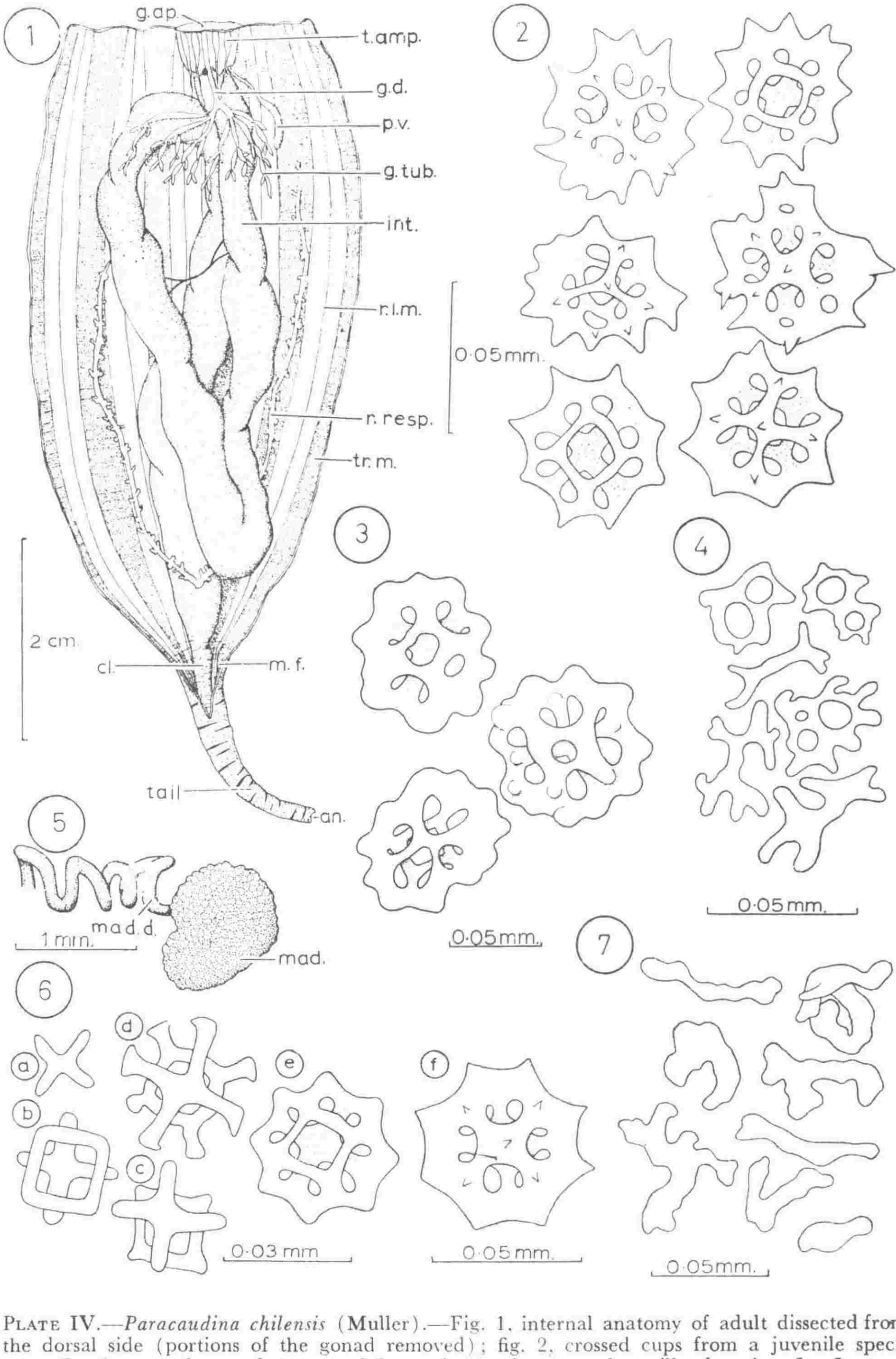

PLATE IV.—*Paracaudina chilensis* (Muller).—Fig. 1, internal anatomy of adult dissected from the dorsal side (portions of the gonad removed); fig. 2, crossed cups from a juvenile specimen; fig. 3, crossed cups from an adult specimen; fig. 4, anal papilla deposits; fig. 5, stone

A short thinwalled oesophagus meets the intestine which takes a large loop (Plate IV, fig. 1), and joins the cloaca, which is attached to the body wall by fine muscle strands which also fill the cavity in the tail. In the juvenile the intestine fills most of the body cavity, and the cloaca has a small number of muscle strands.

The gonad consists of two bunches of irregularly branching vesicular caeca (Plate IV, fig. 1). The bunches join to form the common genital duct which runs anteriorly in the dorsal mesentery, and opens to the exterior as a minute genital pore. The juveniles show no trace of gonads.

A single bulbous and elongate Polian vesicle, up to 10mm in length arises from the right or left ventral side of the water vascular ring. The vesicle has a small patch of dark brown pigment at its distal extremity. A short coiling stone canal lies in the dorsal mesentery, terminating in a madreporite which takes the form of a depressed sphere (Plate IV, fig. 5). The madreporite has a sculptured surface, due to the presence of an investing layer of irregular intertwining deposits (Plate IV, fig. 7). In the juvenile the madreporite has a diameter of about 0.2mm, and the deposits are essentially the same as those in the adult, but they do not constitute a full enveloping network.

Respiratory trees are composed of two main trunks which carry numerous small side branches (Plate IV, fig. 1). The right tree is considerably longer than the left, and extends to the level of the calcareous ring, to which it is attached, while the left tree extends about half way along the body cavity. In most specimens the left tree gives rise to lesser trunks which tangle about the intestine, and lie in association with the rete mirabile.

The longitudinal muscles take the form of five double bands (Plate IV, fig. 1). There are no retractor muscles. In juvenile specimens, the muscle bands are very thin and strap-like, and between each member of a pair of double bands the radial longitudinal nerve can be clearly seen as a thin white line. Transverse muscles are visible as fine lines (Plate IV, fig. 1).

Calcareous deposits: In adult specimens the deposits are "crossed cups" of varying shapes. These are crowded together in vast numbers in the skin, from the extreme anterior end of the body to the end of the tail. These cups are 0.06–0.1mm across. They each consist of a "cross" which overlies a "square" (Plate IV, fig. 2). The "square" has a single large perforation which is usually rectangular, with a tendency to become circular. The margin of the "crossed cup" is approximately octagonal in shape, but in adult specimens this shape is often obscured, as the points of the octagon become rounded off. Marginal projections are usually present as low rounded knobs. In the tail the cups are slightly more irregular in shape than those in the rest of the body wall.

The cups in the juvenile are more angular in outline (Plate IV, fig. 2) than those in the adult (Plate IV, fig. 3), and the typical "crossed cup" structure is more readily observed. Half-grown specimens show a mixture of angular and rounded deposits.

Stages in the development of "crossed cups" are readily observed in juveniles. The "cross" is the first to form (Plate IV, fig. 6a). It is a simple four-armed cross, each arm measuring about 0.008mm in length. A perforated square then develops on the cross (Plate IV, fig. 6b). The cross is invariably the starting point in the development of crossed cups. The extremities of the cross and the corners of the square then begin to expand laterally, and these lateral expansions eventually meet to form the "young" deposit which has smooth rounded edges (Plate IV, fig. 6e). The "young" deposits then assume the "classical" form (Plate IV, fig. 6f), with eight sharp projections regularly spaced around the margin, and a few small spines (3–8) on the cross side. In most cases the cross faces the outside of the body, and the short sharp spines project slightly above the level of the skin.

The anal papilla deposits of the juvenile are similar to those in the adult. They are small, irregular spicules, and take the form of branched rods or perforated plates (Plate IV, fig. 4).

ECOLOGY: *Paracaudina chilensis* has been taken in the New Zealand region from muddy and sandy localities to depths of at least 550 fathoms. Some specimens have been recorded from fish stomachs, but it is not known how extensively the species is used as food by bottom-feeding fish.

DISCUSSION: Dendy (1897) gave a very thorough account of the structure and disposition of the anal papillae in this species.

Clark (1907) placed eight species of *Caudina* Stimpson into the single species *Caudina chilensis* (Muller), as many of the original species descriptions had been inadequate, based as they were on such characters as size of the specimens, colour, texture of the body wall, all of which are known to be subject to much individual variation. In this synonymy Clark included Hutton's (1872) species *coriacea* from New Zealand and *australis* (Semper) from Australia.

Mortensen (1925) criticised Clark's synonymy and declared that *C. coriacea* from New Zealand, *C. australis* from Australia and *C. chilensis* from Chile were different species, and he used apparent differences in spiculation and calcareous rings as his evidence. At the present time, *C. australis* is still regarded as a distinct species. But the history of *C. coriacea* is rather more complex.

Hozawa (1928) regarded *C. chilensis* and *C. coriacea* as the same species using Clark (1907) as his authority. He may not have seen Mortensen's (1925) paper. Ohshima (1929) agreed with Clark (1907) and Hozawa (1928), and criticised the work of Mortensen, stating that his figures were inadequate. Heding (1932) accepted Mortensen's view and included *C. coriacea* as a separate species in his new genus *Paracaudina,* together with *C. chilensis.* Later Heding (1933) vigorously opposed Ohshima's (1929) opinion, and used the same characters as Mortensen (1925) for distinguishing the species *coriacea* and *chilensis,* but on a much more elaborate scale. He used characters such as body form, "retractor muscles", genital papillae, and presence or absence of "Cuvierian organs" as additional evidence. Thus *Paracaudina chilensis* was re-established as a separate species, but Clark (1935) "re-entered the lists" in his own words, after examining a great number of specimens of *Paracaudina.* His paper shows that he disagreed with Mortensen (1925) and Heding (1933). He discarded body form, "retractor muscles", "Cuvierian organs", genital papillae and the calcareous ring as bases for classification, and stated that the spicules were the only safe criterion for separation at the species level. As a result of his thorough studies Clark compiled a key to the species in genus *Paracaudina*, and named the New Zealand form *Paracaudina chilensis* var. *coriacea,* adding that Deichmann was in agreement with him. Deichmann (1960) suggested that the New Zealand form be named *P. chilensis* forma *coriacea* as, in the words of W. K. Fisher, "it does not protest too much".

I have examined only the New Zealand specimens of the genus *Paracaudina* and they display some considerable variation in their calcareous deposits. Comparison of these deposits with those figured by Hozawa (1928) and Heding (1933) has served to convince me that they resemble each other in so many features, and show such diversity of form, that the subdivision of the species *chilensis* into subspecies or even "forms" is unwarranted. Clark (1935) himself stated that if he had a specimen from Chile mixed with specimens from another area he would not be able to identify the Chile specimen with certainty.

Thus the suggestion lies at hand that *P. chilensis* is a circum-Pacific species, having possibly the Indo-West-Pacific region as its centre of distribution. Near the centre of distribution, the genus *Paracaudina* gave rise to *tetrapora* and *australis,* now in Australia, and to *chilensis,* which spread north to Japan, and to California and Florida via the Aleutian Islands, and south to New Zealand, leaving a remnant in North-west Australia. The Chilean representatives may have reached South America via New Zealand. Fell (1953) states that it is quite likely that New Zealand supplied contributions to the fauna of southern South America. He does not propose an Antarctic shoreline as does Deichmann (Clark, 1935), but indicates that the west to east circum-polar current may be responsible for this New Zealand affinity in certain elements of the South American fauna. The gap in the distribution of *P. chilensis* lies between California in the north and Chile in the south. The gap may possibly be due to unfavourable environmental conditions, or the species may still be undiscovered there. As *P. chilensis* is eurybathic to a certain degree, there should be few depth barriers to dispersal.

Order DENDROCHIROTIDA

Diagnosis: Tubefeet present, tentacles tree-shaped, profusely branched. Retractor muscles usually present. Mesentery of the posterior loop of the intestine in the right or left ventral interradius. Gonads on both sides of the dorsal mesentery. Respiratory trees present. Deposits usually irregular fenestrated plates, sometimes tables.

The Order Dendrochirotida is cosmopolitan, containing predominantly shallow water forms, but a number of species are found in deeper waters, especially in the Arctic region. The numerous species in this order feed selectively on planktonic organisms or detrital material.

There are three families, of which two are represented in Cook Strait. The third family (Psolidae) has two representatives in the New Zealand region, namely *Psolus neozelanicus* Mortensen which is known from off North Cape, and *Pseudopsolus macquariensis* (Dendy) recorded from Macquarie Island and Stewart Island.

Key to the Families in Order Dendrochirotida

1	(4)	Body cylindrical or fusiform, without a well-defined ventral sole.	
2	(3)	Tentacles 10	Fam. CUCUMARIIDAE
3	(2)	Tentacles 15 to 30	Fam. PHYLLOPHORIDAE
4	(1)	Body flattened, with a well-defined ventral sole. Mouth and anus dorsal	Fam. PSOLIDAE

Family PHYLLOPHORIDAE

Diagnosis: Tentacles 15–30, usually in two or even three circles, the inner circles having smaller tentacles. Calcareous ring well developed, with or without forked processes.

Heding and Panning (1954) revised the Phyllophoridae and diagnosed five subfamilies. Of these subfamilies, two have representatives in Cook Strait.

Key to the Cook Strait Subfamilies in Family Phyllophoridae

1	(2)	Calcareous ring without posterior processes. The individual pieces of the ring are undivided	Subfamily Thyonidiinae
2	(1)	Calcareous ring complex, composed of a mosaic of minute pieces	Subfamily Semperiellinae

Subfamily Thyonidiinae

Diagnosis: Calcareous ring without posterior processes. The individual pieces of the ring are undivided.

Heding and Panning (1954) listed 13 genera in this subfamily. A new genus was described from Cook Strait by the writer (Pawson, 1962), thus increasing the number of genera to 14.

Neocucumella Pawson, 1962

Diagnosis: Tentacles 20 (outer ring with five pairs of larger tentacles, interradial; inner ring with five pairs of smaller tentacles, radial). Tubefeet confined to the radii, arranged in double rows. Radial pieces of the calcareous ring each with a deep median anterior notch. Interradials rounded anteriorly. Calcareous deposits numerous two-pillared tables, with symmetrical circular or elliptical bases, 0.05mm in average length, perforated by four large and four small (alternating) holes.

Neocucumella bicolumnata (Dendy and Hindle) Plate III, figs. 1–3

Pseudocucumis bicolumnatus Dendy and Hindle, 1907, p. 106, Pl. 11, fig. 6, Pl. 12, figs. 13–14; Joshua and Creed, 1915, p. 19; Engel, 1933, p. 36.
Mensamaria bicolumnata Clark, 1946, p. 406; Dawbin, 1950, p. 38.
Neocucumella bicolumnata Pawson, 1962, p. 65, figs. 1–2.
Non: *Amphicyclus thomsoni* (Hutton).

MATERIAL EXAMINED: VUZ 64, off Point Howard Wharf, 5 fathoms, blue mud, 1 specimen.

DIAGNOSIS: Shape fusiform. Colour light brown. Tubefeet dark brown. Tentacles reddish-brown.

DESCRIPTION: The single specimen is 30mm in total length, and the body is attenuated posteriorly to form a more or less distinct "tail" region. The anterior end narrows as an introvert which carries the crown of 20 tentacles. The body wall is quite thin but opaque, and there is some transverse wrinkling near the posterior end.

Colour in alcohol light brown. The tubefeet are dark brown and the tentacles are dark reddish-brown. The tubefeet are confined to the five ambulacra, where they are arranged in double rows. There are no tubefeet on the introvert. Near the extreme posterior end of the body they are more scattered, and the double row arrangement is lost.

Two rings of richly branched tentacles surround the mouth. The outer ring has five pairs of large tentacles 4–5mm in length, lying in an interradial position, while the inner ring has five pairs of small tentacles, 1mm in length, radially placed. The mid-dorsal pair of larger tentacles are smaller than the other outer ring tentacles.

The calcareous ring is composed of ten simple pieces. Each radial piece is approximately rectangular in shape and has a wide and deep posterior notch and a pronounced median anterior notch. There are no anterior processes on the radials. Interradials are Y-shaped, with the tail of the "Y" directed anteriorly. This anterior projection is bluntly rounded. Length of each radial piece 2.0mm; length of each interradial piece 1.0mm.

The internal anatomy has been described by Dendy and Hindle (1907).

Calcareous deposits of three types were found:

1. Tables: The skin contains very large numbers of tables, closely aggregated together. In general the table disc is oval in shape, and has eight perforations, four large (approximately 0.013mm diameter) and four small (approximately 0.007mm diameter). Average table length is 0.05mm, breadth 0.03mm (Plate III, fig. 1). Departures from this basic pattern are so rare that only three tables of unusual shape were found (Pl. III, fig. 3). At its centre the disc of each table carries two short pillars, which are joined at the top by a single crossbar. Average height of pillars is 0.02mm.

2. Tentacle deposits: The digits of the tentacles contain large numbers of rod-like deposits (Pl. III, fig. 2). The extremities of the rods are expanded and carry a number of perforations (up to 20 in each rod). Average length of the tentacle rods is 0.06mm. No unperforated rods were found.

3. Tubefoot deposits: The tubefeet carry well developed endplates in their sucking discs.

DISTRIBUTION: The type specimen was recorded from "off Dunedin" (Dendy and Hindle, 1907). Joshua and Creed (1915) recorded a specimen from Australia, probably collected near Adelaide. The new record, Wellington Harbour, enlarges the distribution area of the species, but *N. bicolumnata* is still a rare species.

DISCUSSION: Dendy and Hindle (1907) described an S-shaped intestine, feebly developed respiratory trees, a single Polian vesicle, and gonads consisting of two bunches of very long filaments in their specimen of this species..

The systematic history of *N. bicolumnata* has already been outlined (Pawson, 1962).

Subfamily SEMPERIELLINAE

DIAGNOSIS: Calcareous ring tube-shaped with long processes; both radials and interradials are composed of a complex mosaic of small pieces.

Heding and Panning (1954) included five genera in this group, of which two are represented in the Cook Strait region.

KEY TO THE COOK STRAIT GENERA IN SUBFAMILY SEMPERIELLINAE

1	(2) Deposits (when present) small tables, typically with eight perforations, and a short blunt two-pillared spire	*Neothyonidium* Deichmann
2	(1) Deposits perforated plates, with a long, sharp spire composed of two long rods fused together	*Pentadactyla* Hutton

Neothyonidium Deichmann, 1938

DIAGNOSIS: Dendrochirote holothurians with 20 tentacles which are arranged in pairs. Calcareous ring complex. Radials with long posterior processes. Deposits tables with two columns. (Heding and Panning, 1954, in part.)

Type Species: *Neothyonidium hawaiiense* (Fisher).

A single species, *N. dearmatum* is known from New Zealand at the present time.

Neothyonidium dearmatum (Dendy and Hindle)

Phyllophorus dearmatus Dendy and Hindle, 1907, p. 103, Pl. 11, figs. 7–8, Pl. 12, fig. 15, Pl. 13, fig. 20; Joshua, 1914, p. 4; Mortensen, 1925, p. 353, figs. 36–37; Clark, 1938, p. 494.
Lipotrapeza dearmatus Clark, 1946, p. 411.
Neothyonidium dearmatum Heding and Panning, 1954, p. 191, fig. 93.

DIAGNOSIS: Calcareous deposits usually absent from the skin, apart from the anal extremity, where they take the form of two-pillared tables (average length 0.07mm), typically with eight perforations, four large alternating with four small.

DISCUSSION: This interesting species has been recorded from Akaroa Harbour (Dendy and Hindle, 1907), and Wellington Harbour (Mortensen, 1925). Joshua (1914) reported the presence of specimens at various points along the south coast of Australia.

Pentadactyla Hutton, 1878

DIAGNOSIS: Medium-sized dendrochirotes with 20 tentacles in two rings. Tubefeet distributed evenly over the body. Deposits in the skin either spired tables of irregular shape with rough tapered spires, or smooth, shiny lattice-plates.

Pentadactyla longidentis (Hutton) Plate V

Thyone longidentis Hutton, 1872, p. 16; Theel, 1886, p. 141.
Thyone caudata Hutton, 1872, p. 16.
Pentadactyla longidentis Hutton, 1878, p. 307; Heding and Panning, 1954, p. 199.
Thyonidium rugosum Theel, 1886, p. 95, Pl. V, fig. 5.
Thyonidium caudatum Theel, 1886, p. 147.
Thyonidium longidentis Dendy, 1896, p. 42, Pl. VI, figs. 62-69; Farquhar, 1898, p. 326.
Phyllophorus longidentis Ludwig, 1898, p. 49; Dendy and Hindle, 1907, p. 101, Pl. 13, fig. 18 a-d; Benham, 1909, p. 28; Mortensen, 1925, p. 325; Dawbin, 1950, p. 39, Pl. 2, fig. 15.
Thyonidium anatinum Perrier, 1903, p. 142.
Phyllophorus anatinus Perrier, 1905, p. 112, Pl. V, figs. 1–9.

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 1 specimen; VUZ 32, off Petone Beach, 8 fathoms, mud, 2 specimens; VUZ 37, off Shelly Bay, 10–11 fathoms, 1 specimen; VUZ 64, off Point Howard Wharf, 5 fathoms, blue mud, 6 specimens; VUZ 69, Somes Is. to Days Bay, 11 fathoms, mud, 1 specimen; VUZ 87, South of Cape Palliser, 400 fathoms, mud, rock, gravel, 2 specimens.

DIAGNOSIS: Colour dark brown in life and in alcohol. Calcareous deposits in the form of very numerous oval to cruciform spired plates 0.3mm long, together with smooth plates 0.5mm in length. Polian vesicle single, bulbous.

DESCRIPTION: These are stout holothurians, with a total length varying between 20mm and 70mm. The body tapers abruptly posteriorly to form a more or less distinct tail. There is, however, considerable variation in shape, depending on the degree of contraction of specimens. The body carries a number of short (1–3mm long) spinous projections scattered over its surface. These projections render the skin prickly to touch.

The colour is dark brown in life and in alcohol. The anterior and posterior extremities are lighter in colour, and the tentacles are greyish-white, with small brown-red spots.

An introvert, usually retracted, is present, and carries a crown of 20 tentacles which are disposed in two circles. The outer ring has five pairs of large (4mm long) interradial tentacles, while the inner ring has five pairs of small (1–2mm long) radial tentacles. The mouth lies in a shallow depression in the centre of an oral disc. The introvert is thin-walled and transparent, and carries double rows of tubefeet on the radii.

PLATE V

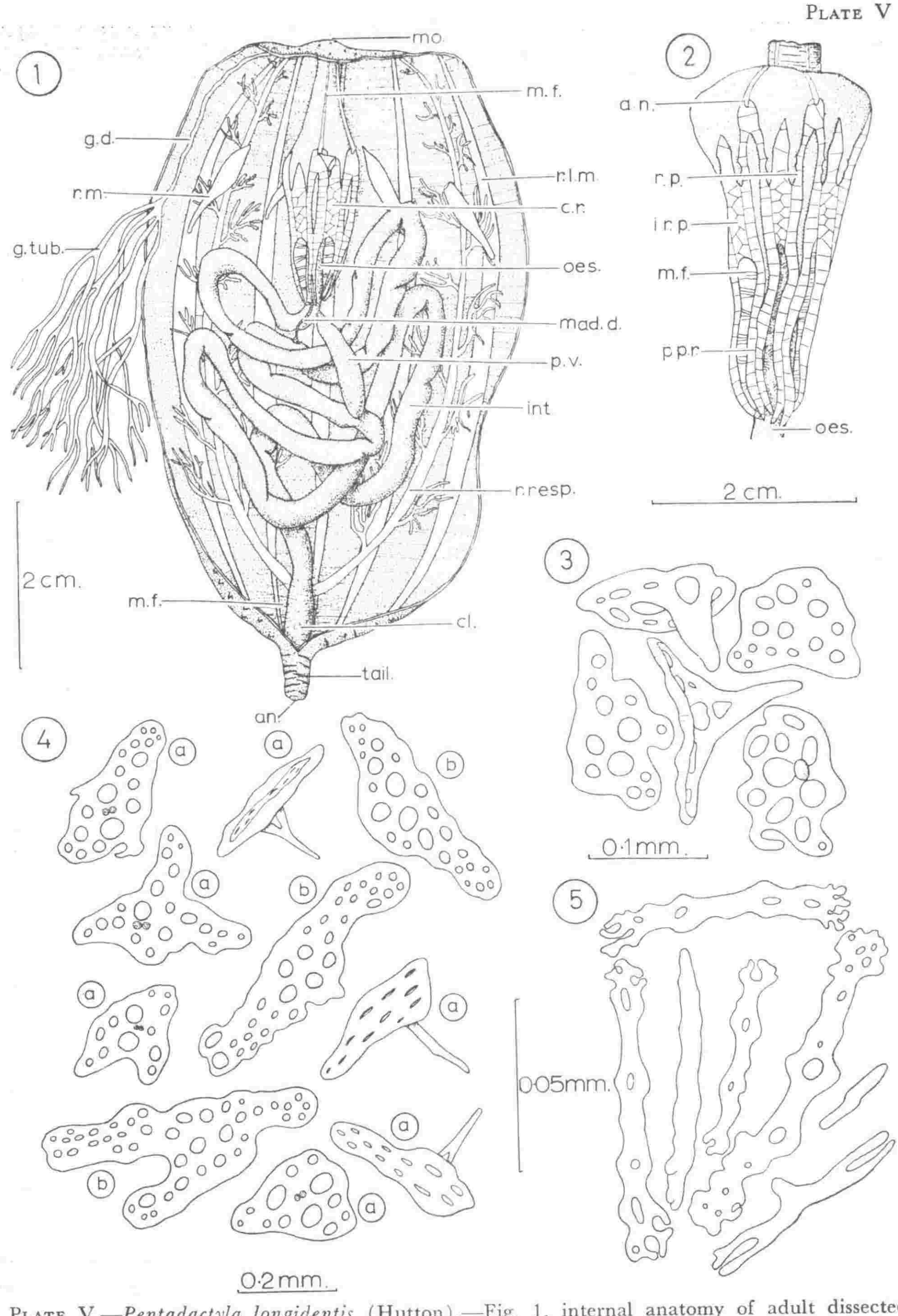

PLATE V.—*Pentadactyla longidentis* (Hutton).—Fig. 1, internal anatomy of adult dissected from the dorsal side (portions of gonad removed); fig. 2, pharynx and calcareous ring of a large specimen; fig. 3, deposits from a tubefoot; fig. 4, bodywall deposits; fig. 5, tentacle rods. Abbreviations: a.n., anterior notch; an., anus; a.p.r., anterior process of radial; cl., cloaca; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., inter-radial piece; mad.d., stone canal; mo., mouth; m.f., muscle fibres; oes., oesophagus; p.p.r., posterior process of the radial; P.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; r.p., radial piece; r.resp., right respiratory tree.

The calcareous ring is large, composed of ten pieces, each piece comprising a complex mosaic of small fragments (Pl. V, fig. 2). This ring has been well described by Dendy (1896) and Dendy and Hindle (1907). The ring from the largest specimen differs from that figured by Dendy in some respects. The notched anterior ends of the radial pieces are more rounded (Pl. V, fig. 2), the splits in the radial pieces are much wider in proportion and better defined, and the anterior projections of the interradial pieces are more irregular in outline. The small fragments which are aggregated to form the radial pieces tend toward a rectangular shape, while those in the interradials are polygonal.

A thinwalled oesophagus runs into a long coiled intestine (Pl. V, fig. 1). The rectum is thinwalled and transparent. The cloaca is attached to the inside of the body wall by numerous muscle strands.

The single Polian vesicle is elongate, transparent and bulbous (Pl. V, fig. 1). The stone canal runs anteriorly in the dorsal mesentery, terminating in a nodular madreporite.

Left and right respiratory trees arise from the ventral side of the anterior end of the cloaca, and both extend to the anterior end of the body cavity, where they are attached to the pharynx.

A large mass of dichotomously branching genital caeca lies at the level of the middle of the body. The genital duct is long, and runs anteriorly in the dorsal mesentery close to the body wall (Plate V, fig. 1), opening to the outside in the dorsal interradius, immediately posterior to the outer ring of tentacles. The genital caeca contain large yolky eggs.

Longitudinal muscles are represented as five broad flat straps (Pl. V, fig. 1). Retractor muscles arise from the longitudinal muscles one-third of the way along the body cavity from the anterior end, and they are inserted into the anterior notches of the radial pieces of the calcareous ring (Pl. V, fig. 1). Transverse muscles are visible as fine fibres, but they are not conspicuous.

Calcareous deposits:

1. Body wall deposits: The body wall is completely invested in perforated plates, many of which possess a central spire.

The spired plates (Pl. V, fig. 4a) are usually round to oval in adult specimens. In juveniles and some adults the spired deposits tend towards a cruciform shape. Average greatest diameter of the spired plates is 0.3mm. The spire is usually centrally placed on the plate, and is composed of two rods which fuse together near the base. These deposits are so placed in the skin that the spires project above the level of the body wall.

Larger plates which lack spires are also common in the skin. They are elongate (average length 0.5mm), and have larger numbers of perforations than the spired plates (Plate V, fig. 4b).

2. Tubefoot deposits: The tubefeet do not appear to have endplates in the strict sense, but they contain large numbers of deposits, mainly spired plates of varying shape (Plate V, fig. 3).

3. Tentacle deposits: The tentacles contain numerous small rods, some of which are perforated (Plate V, fig. 5). Rod length varies between 0.02mm and 0.1mm.

There are no deposits in the introvert.

DISTRIBUTION: This species is a prominent member of the holothurian fauna of New Zealand, especially in the Cook Strait region, where it is known to occur in numbers. Specimens have been taken from as far north as Cape Egmont to the west of the North Island, and it is likely that the species is present in the same latitudes to the east. Mortensen (1925) recorded a specimen from Akaroa Harbour in the South Island. *Pentadactyla longidentis* may yet prove to have a wider distribution than formerly supposed.

ECOLOGY: Preference is shown for a muddy bottom, and specimens have been taken from depths ranging between 3 fathoms and 400 fathoms.

DISCUSSION: The variability of body shape has led to some confusion in the past, some new species having been based on specimens of unusual shape. However this error was rectified by Dendy and Hindle (1907) and Mortensen (1925). The presence of large yolky eggs in the genital caeca leads to the suggestion that this species lacks a pelagic larva and has direct development.

Because of its colour, shape, and the rough texture of the body wall, this species is one of the most easily recognised of the Cook Strait holothurians.

Family CUCUMARIIDAE

DIAGNOSIS: Tentacles 10, equal, or with a smaller ventral pair. Tubefeet confined to the radii or scattered over the body. The mesentery of the posterior loop of the intestine lies in the left ventral interradius.

About 30% of the known New Zealand holothurian species are placed in this very large family. Panning (1949) revised the group, diagnosing five subfamilies on the basis of calcareous rings and calcareous deposits. Two of these subfamilies have representatives in the Cook Strait region.

KEY TO THE COOK STRAIT SUBFAMILIES OF FAMILY CUCUMARIIDAE

1 (2) Calcareous rings composed of 10 solid pieces. Calcareous deposits cups and plates	Subfam. COLOCHIRINAE
2 (1) Calcareous ring long and slender, the entire ring composed of a complex mosaic of minute pieces	Subfam. THYONINAE

Subfamily COLOCHIRINAE

DIAGNOSIS: Calcareous ring simple, without bifurcated processes, or at the most moderately deep, with short undivided processes. Radials and interradials undivided. In the skin plates and baskets; no tables (After Panning, 1949).

KEY TO THE COOK STRAIT GENERA IN SUBFAMILY COLOCHIRINAE

1 (2) Body cucumber-shaped, straight. Deposits cups and knobbed plates of two types	*Ocnus* Forbes
2 (1) Body typically U-shaped. Deposits cups, and large scales of average diameter 1.0mm	*Heterothyone* Panning

Ocnus Forbes, 1841

DIAGNOSIS: Calcareous ring simple, without posterior processes. Deposits in the form of knobbed plates and cups. The cups form an investing layer (Panning, 1949, in part).

Type Species: *Ocnus brunneus* (Forbes).

Of the three species of *Ocnus* known from New Zealand, one, *O. calcareus* has been recorded from the Cock Strait region.

Ocnus calcareus (Dendy)

Colochirus calcareus Dendy, 1896, p. 38, Pl. 5, figs. 44–53; Farquhar, 1898, p. 325.
Colochirus brevidentis Ludwig, 1898, p. 442, taf. 26, figs. 22–29.
Cucumaria calcarea Mortensen, 1925, p. 335, fig. 26 c-d; Dawbin, 1950, p. 38, Pl. 2, fig. 11.
Ocnus calcareus Panning, 1949, p. 437.
Non: *Ocnus brevidentis* (Hutton).

DIAGNOSIS: Deposits include cups, and knobbed plates of two types, one type with four perforations and 12 marginal knobs, the other type with many small perforations and numerous central and marginal knobs.

DISCUSSION: Although *Ocnus calcareus* is not a particularly common species it is known from Auckland, Wellington, Stewart Island, and Juan Fernandez Islands. Mortensen (1925) said of this species " as it is a littoral form, which can be transported on floating algae, the occurrence of this species at Juan Fernandez is not so very surprising. But it is to be expected that it will prove to occur also on the other subantarctic localities ".

O. calcareus is similar to *O. brevidentis* (Hutton) in some respects, but the two species differ markedly in the structure of their calcareous deposits, as pointed out by Dendy (1896) and Mortensen (1925).

Heterothyone Panning, 1949

DIAGNOSIS: Calcareous ring composed of 10 solid pieces; radials each with a more or less well developed posterior notch. Deposits include large scales 1–2mm in diameter, which invest the body, and well developed deep cups, usually with four perforations.

Type Species: *Heterothyone alba.*

Also included here: *H. ocnoides* (Hutton).

Panning (1949) erected the new genus *Heterothyone,* with species ***alba*** as the type, and he also included under this generic name the species ***pigra*** (Koehler and Vaney) and *semperi* (Bell). This genus was placed in Subfamily Thyoninae Panning, which was diagnosed as follows:

" Calcareous ring slender, with long processes; radials and interradials flat, fused together; the entire calcareous ring composed of a complex mosaic of minute pieces " (Panning, 1949).

Dissection of many specimens of the species *alba* showed that the ring is in fact composed of 10 solid yet fragile pieces. Consequently this species belongs in Subfamily Colochirinae Panning.

Descriptions of the species *semperi* (Bell, 1884) and *pigra* (Koehler and Vaney, 1905) point out that the ring in these species is composed of a mosaic of pieces. Thus *semperi* and *pigra* should remain in Subfamily Thyoninae, but a new generic name should be supplied. I propose the name *Hemithyone* for these species, with *Hemithyone semperi* as the type species.

The species *alba* is quite closely allied to another New Zealand species originally described as *Colochirus ocnoides* (Dendy). This has already been pointed out by other workers, including Dendy (1896) and Mortensen (1925). Panning (1949) resurrected Reiffen's (1901) genus *Ludwigia* for species *ocnoides* (Reiffen had designated *ocnoides* as the type of *Ludwigia*). However, *Ludwigia* is preoccupied, and the name cannot be used again. Under this generic name Panning (1949) listed 17 species (including *ocnoides*). Of the 16 species beside *ocnoides,* none appear to possess the large imbricating scales investing the body which are so characteristic of the species *ocnoides* and *alba.* In this respect, and in others, the two New Zealand species are distinct and I have placed them together in genus *Heterothyone*, and transferred the genus to Subfamily Colochirinae.

The 16 species included in *Ludwigia* by Panning (1949) are listed below. These may have to be assigned to new genera in due course. I am not in a position to critically examine these species, but study of the literature shows that they tend to fall into two categories on the basis of their calcareous deposits. It must be pointed out that descriptions of some of these species are inadequate.

" Ludwigia "

Species which have buttons with four holes: *spyridophora* (Clark); *vicaria* (Bell); *lefevrei* (Barrois); *tetracentriophora* (Heding); *punctata* (Ludwig); *solida* (Deichmann); *gemmata* (Pourtales); *pervicax* (Theel); *suspecta* (Ludwig).

Species which have buttons with more than four holes, or none: *lactea* (Forbes); *planci* (Brandt); *glacialis* (Ljungman); *hedingi* (Panning); *lutea* (Sluiter); *bouvetensis* (Heding); *ekmani* (Heding).

KEY TO THE SPECIES IN GENUS *Heterothyone* PANNING

1 (2) Small holothurians (up to 30mm long); radials with a poorly defined anterior notch; interradials with long and narrow anterior processes .... *H. alba* (Hutton)

2 (1) Larger holothurians (up to 60mm long); radials each with a well defined anterior notch; interradials with short and broad anterior processes ...... *H. ocnoides* (Dendy)

Heterothyone alba (Hutton) Plate VI

Chiridota alba Hutton, 1872, p. 17.
Echinocucumis alba Hutton, 1878, p. 307.
Colochirus alba Dendy, 1896, p. 35, Pl. 4, figs. 21–32; Farquhar, 1898, p. 325.
Cucumaria alba Ludwig, 1898, p. 29; Perrier, 1905, p. 85; Dendy and Hindle, 1907, p. 98; Mortensen, 1925, p. 346; Dawbin, 1950, p. 36.
Cucumaria filholi Perrier, 1903, p. 144; Perrier, 1905, p. 88, Pl. V, figs. 10–12.
Heterothyone alba Panning, 1949, p. 464, abb. 59, figs. a-i.

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 1 specimen; VUZ 30, off Somes Island, 5–10 fathoms, mud, 13 specimens; VUZ 69, Somes Island to Days Bay, 11 fathoms, mud, 1 specimen; Kau Bay, 20 fathoms, mud, 1 specimen.

DIAGNOSIS: Small, U-shaped, colour white in life. Radials with a poorly defined anterior notch; interradials with long and narrow (almost needle-like) anterior processes. Deposits scales and deep cups. The cup rims carry many small projections.

DESCRIPTION: These are pure white to grey holothurians, almost invariably U-shaped, with the ventral surface occupying the greater curvature. The total length varies between 10mm and 25mm. The tentacles are retracted in all specimens, and the anterior end of the body is bluntly rounded. Toward the posterior end, the body tapers gently to form a slender tail. The body wall is thick and firm, due to the investing layer of imbricating scales.

There are ten tentacles, the ventral pair being the smallest. They are grey, covered with dark brown spots. The crown of tentacles is carried on a short, thinwalled introvert.

Tubefeet are numerous, confined to the radii anteriorly and posteriorly, but scattered in radii and interradii on the ventral surface of the middle of the body, in greater numbers than elsewhere. These tubefeet are stiff, and not completely retractile, their walls containing large numbers of perforated rods.

The calcareous ring is composed of ten pieces, five radials and five interradials (Plate VI, fig. 4). The radials each have a well developed anterior process with an attachment area for the radial muscle and a poorly defined median split. The posterior process of the radial is long and broad, with a shallow but distinct V-shaped posterior notch. Each interradial piece is Y-shaped, with the tail of the "Y" directed anteriorly.

A short thinwalled oesophagus leads into the thinwalled intestine, which is extensively coiled near the middle of the body (Pl. VI, fig. 1). The rectum runs direct to the terminal anus and the cloaca is undifferentiated. Both intestine and rectum are dark brown in colour.

The water-vascular system surrounds the oesophagus immediately posterior to the calcareous ring (Plate VI, fig. 1), and gives rise to a single bulbous Polian vesicle from its ventral side (Plate VI, fig. 1). The stone canal is a short coiled white tube, terminating in a minute nodular madreporite which is attached to the dorsal mesentery.

The right respiratory tree is considerably longer than the left, and extends to the extreme anterior end of the body. In some specimens the right tree carries a short subsidiary branch. The left tree is about half as long as the right. Respiratory tubules are long and narrow, branching copiously.

The gonad consists of two small bunches of unbranched genital caeca (Plate VI, fig. 1), which lie half way along the body cavity. As a consequence the genital duct is a long and narrow tube, which runs anteriorly on the dorsal mesentery, opening to the exterior in the introvert, in the dorsal interradius. In some specimens the genital caeca are packed with small eggs (Plate VI, fig. 8), which vary considerably in size (0.05—0.3mm diameter).

Radial longitudinal muscles, retractor muscles and transverse muscles are poorly developed, the radial muscles being represented as thin white straps.

Calcareous deposits:

1. Large Scales (Plate VI, figs. 5, 7): The body is completely invested in calcareous scales which are approximately oval in shape. The average greatest length of these scales

PLATE VI

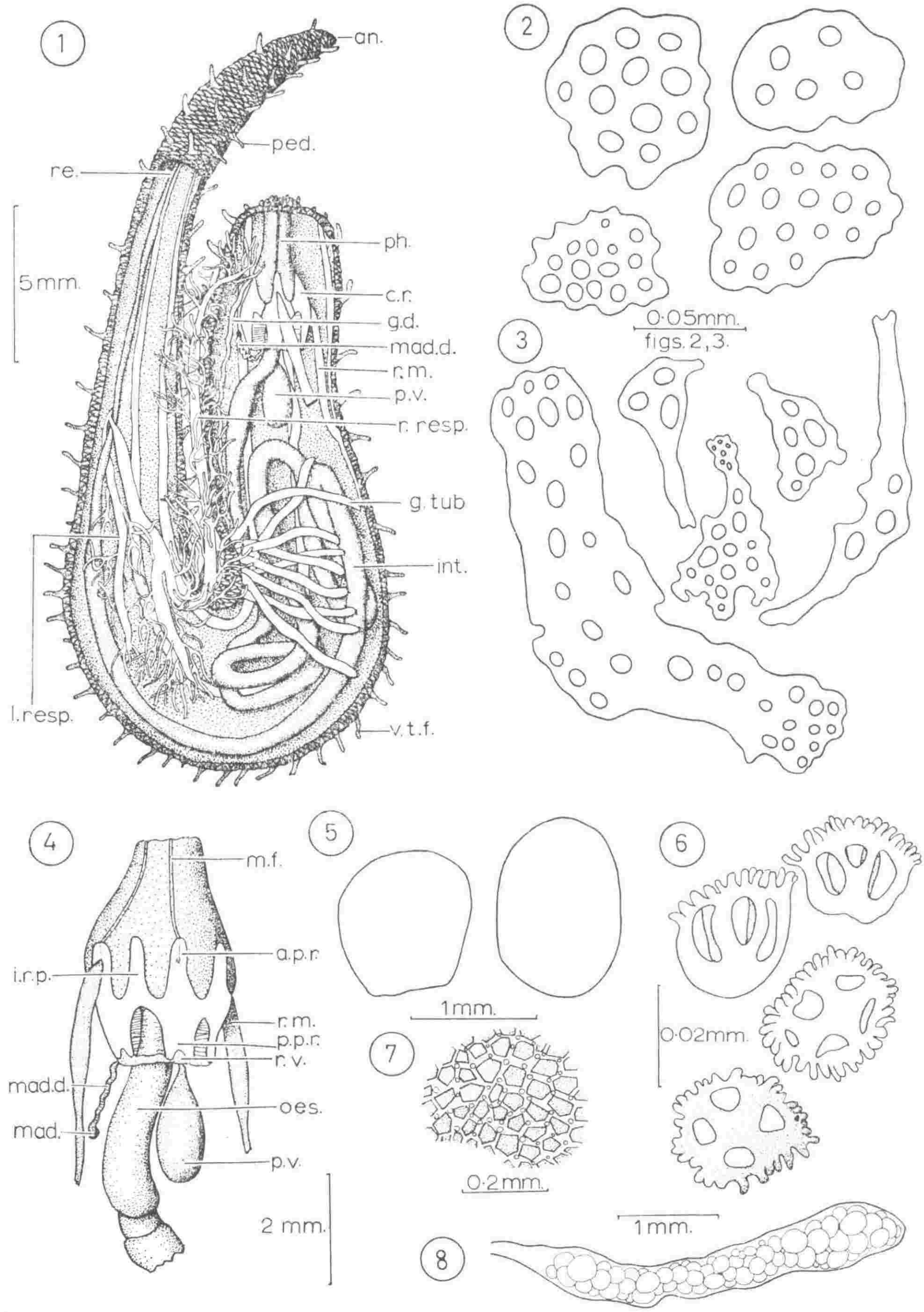

PLATE VI.—*Heterothyone alba* (Hutton).—Fig. 1, internal anatomy of adults; fig. 2, buttons; fig. 3, tentacle deposits; fig. 4, pharynx and calcareous ring; fig. 5, scales from the skin (in outline only); fig. 6, cups; fig. 7, surface features of a scale; fig. 8, genital tubule packed with eggs.

Abbreviations: an., anus; a.p.r., anterior process of radial; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubule; int., intestine; ir.p., interradial piece; l.resp., left respiratory tree; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; oes., oesophagus; ped., pedicel; ph., pharynx; p.p.r., posterior process of radial; P.v., Polian vesicle; re., rectum; r.m., retractor muscle; r.resp., right respiratory tree; r.v., ring vessel; v.t.f., ventral tubefoot.

is 1.0mm, but there is some considerable size variation. The surfaces of the scales are reticulate, and carry small knobs (Plate VI, fig. 7). In general, the free edges of these overlapping scales face the posterior end in the posterior half of the body, and the anterior end in the anterior half of the body.

2. Cups (Plate VI, fig. 6): Deep perforated cups overlie the plates in large numbers. The basin of each cup has four perforations, while the cup rim carries a number of irregular projections. Average diameter of the cups is 0.03mm, and the cups are approximately as deep as they are wide.

3. Buttons (Plate VI, fig. 2): Oval to rectangular smooth buttons, with 5–20 perforations are scattered sparingly among the cups in the body wall. The greatest length of the buttons varies between 0.05 and 0.1mm.

4. Tentacle Deposits (Plate VI, fig. 3): The stems and digits of the tentacles contain large numbers of perforated plates and rods, which show considerable variation in shape and size. The perforated plates reach a length of 0.24mm.

DISTRIBUTION: *Heterothyone alba* is one of our best known dendrochirote holothurians. It is restricted to the New Zealand region, where it has been taken in numbers from many points along the east coast of the North and South Islands. The species has not been recorded from any of the outlying islands.

ECOLOGY: This species prefers a sandy to muddy bottom in comparatively sheltered localities. A degree of eurybathy is displayed, specimens having been taken from lowtide level to depths of 150 fathoms.

DISCUSSION: Mortensen (1925) suggested that the small size of the eggs in this species may indicate indirect development, with the presence of a true pelagic larva.

H. alba has but one close relative, *H. ocnoides* (Dendy), which also has a restricted distribution. The two species differ in size, and in certain features of their calcareous rings and calcareous deposits.

Heterothyone ocnoides (Dendy)

Colochirus ocnoides Dendy, 1896, p. 36, Pl. 4, figs. 33–43; Farquhar, 1898, p. 325.
Cucumaria ocnoides Ludwig, 1898, p. 30; Perrier, 1905, p. 96, Pl. 1, figs. 9–13, Pl. V, fig. 13; Dendy and Hindle, 1907, p. 100; Mortensen, 1925, p. 347; Dawbin, 1950, p. 36.
Ludwigia ocnoides Reiffen, 1901, p. 598, taf. 15; Panning, 1949, p. 435, abb. 30, 31.

DIAGNOSIS: Large (up to 50mm long), U-shaped, colour orange in life. Radials each with a well-defined anterior notch; interradials with short, broad and blunt anterior processes. Deposits scales and deep cups. The cup rims have less than ten projections.

DISCUSSION: This species is known in the Cook Strait region from a single specimen taken in Wellington Harbour at a depth of 5–10 fathoms by Mortensen (1925). Other localities include New Brighton (Dendy, 1896, 1898), Dendy and Hindle (1907), and Cloudy Bay and Akaroa (Mortensen, 1925). Mortensen (1925) suggested that *H. ocnoides* will prove to have a much wider distribution in New Zealand seas.

Subfamily THYONINAE

DIAGNOSIS: Calcareous ring slender, long, with long processes; radials and interradials flat, the entire ring composed of a complex mosaic of minute pieces (Panning, 1949, in part).

The subfamily Thyoninae is represented in Cook Strait by a single species of the genus *Stolus* Selenka.

Stolus Selenka, 1867

DIAGNOSIS: Calcareous ring with long processes, composed of a mosaic of minute pieces. Deposits large scales with many perforations, and smaller buttons with few perforations. No cups.

Type Species: *Stolus sacellus* Selenka.

At the present time, this genus contains less than ten species.

Stolus huttoni (Dendy) Plate VII

Cucumaria huttoni Dendy, 1896, p. 32, Pl. 3, figs. 19–20; Ludwig, 1898, p. 39; Farquhar, 1898, p. 324; Perrier, 1905, p. 93; Mortensen, 1925, p. 384, figs. 33–35; Dawbin, 1950, p. 36.

Stolus huttoni Panning, 1949, p. 463, abb. 58.

MATERIAL EXAMINED: VUZ 62, opposite Worser Bay, 4–5 fathoms, green sand, 1 specimen.

DIAGNOSIS: Body large (up to 180mm total length), U-shaped, completely invested by large overlapping scales, which are overlain by small perforated buttons 0.01–0.03mm long. Colour grey to yellow.

DESCRIPTION: The single specimen is U-shaped, with a total length of 125mm. The integument is very hard and thick, due to the presence of great numbers of calcareous deposits. The colour in alcohol is yellowish-white. The tentacles are abundantly speckled with brown spots on a grey background.

Tubefeet are present in all radii and confined to them. They are more numerous in the mid-ventral portion of the body, where they are arranged in distinct double rows. A semi-transparent introvert is surmounted by a crown of ten richly branched tentacles, of which the ventral pair is the smallest.

The calcareous ring is complex, each piece being composed of a number of fragments (Plate VII, fig. 2). The radials each have a pronounced anterior notch and long, narrow posterior processes. The interradials are not notched, but do possess long posterior processes.

The oesophagus is short and muscular (Plate VII, fig. 1), and joins to the thinwalled convoluted intestine. The rectum is long and straight and runs to the terminal anus. Two long and slender Polian vesicles are attached to the ventral side of the water-vascular ring (Plate VII, fig. 1). The stone canal is short, and runs anteriorly in the dorsal mesentery to terminate in a conspicuous madreporite (Plate VII, fig. 2).

The two trunks of the respiratory trees arise from near the anterior end of the rectum as flattened tubes.. At the level of the junction between the intestine and the rectum, each trunk divides and gives rise to a long and a short branch. The two long branches extend anteriorly for a considerable distance and attach to the body wall in the interradii. Each trunk carries many short, sparsely branched respiratory tubules (Plate VII, fig. 8).

There are two bunches of intertwining, unbranched, filamentous genital caeca. The genital duct opens into the introvert in the dorsal interradius (Plate VII, fig. 1).

The radial muscles are narrow, especially near the posterior end of the body. They thicken in the anterior half, and are thickest at the point of origin of the retractors, which is about one-third of the way along the body from the anterior end. Transverse muscles are present as fine fibres. All of the muscles are orange coloured in preserved material.

Calcareous deposits:

1. Large Scales: The body is completely invested in oval to round imbricating scales (Plate VII, fig. 3), with an average diameter of 1.0mm.

2. Perforated Buttons: Great numbers of perforated buttons overlie the scales (Plate VII, fig. 4). These are 0.1–0.3mm long, and have two to twenty perforations. The presence of these buttons gives the integument a granular appearance.

3. Tubefoot Deposits: The endplate in each tubefoot is surrounded by perforated deposits 0.1–0.25mm in length (Plate VII, fig. 6). They are easily distinguishable from the buttons in the skin as they are not nearly as thick, and are more irregular in outline.

4. Tentacle Deposits: Irregular perforated buttons and rods of varying shape and average length 0.2mm are present in the digits of the tentacles (Plate VII, fig. 7). The tentacles are consequently prickly to touch.

5. Introvert Deposits: The thinwalled introvert contains small perforated buttons of a different character from those in the rest of the body wall (Plate VII, fig. 5). They are oval to rectangular in shape and have few (6–12) perforations. Average length of these buttons is 0.05mm.

DISTRIBUTION: *Stolus huttoni* has previously been recorded from Oamaru (Dendy, 1896) and Otago Harbour (Mortensen, 1925). The new locality Wellington Harbour, somewhat extends the area of distribution of this species.

ECOLOGY: Specimens of *S. huttoni* have been taken from sandy or muddy bottoms in sheltered shallow areas.

PLATE VII

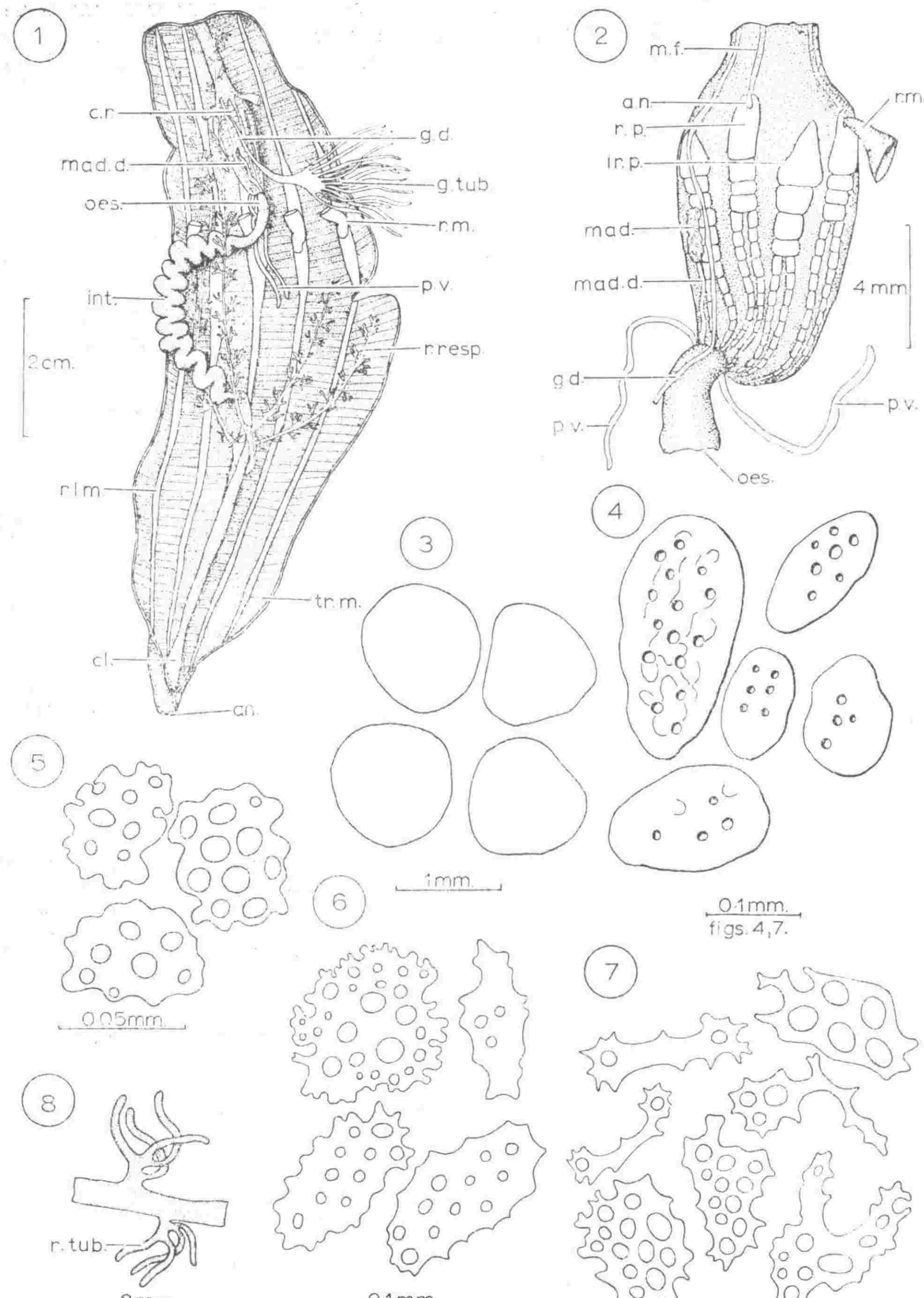

PLATE VII.—*Stolus huttoni* (Dendy).—Fig. 1, internal anatomy of adult dissected from the dorsal side; fig. 2, pharynx and calcareous ring; fig. 3, scales from the skin (in outline only); fig. 4, buttons; fig. 5, introvert deposits; fig. 6, tubefoot deposits; fig. 7, tentacle deposits; fig. 8, portion of a respiratory tree.

Abbreviations: a.n., anterior notch; an., anus; cl., cloaca; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., interradial piece; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; oes., oesophagus; P.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; r.p., radial piece; r.resp., right respiratory tree; r.tub., respiratory tubule; tr.m., transverse muscles.

DISCUSSION: Dendy (1896) stated that the tubefeet are absent from the dorsal radii, and Ludwig (1898) agreed with him. Perrier (1905) found tubefeet on the lateral regions of the dorsal side, and Mortensen (1925) stated that the dorsal tubefeet are inconspicuous "and form only a single irregular zig-zag series". The present writer noted tubefeet in all radii, the dorsal tubefeet appearing to be confined to the middle ⅓ of the body.

There is some variation in the number of Polian vesicles. Dendy (1896) found two in the type specimen. Ludwig (1898) found one, while Mortensen (1925) noted the presence of five long and slender Polian vesicles. The present specimen has two. Therefore no taxonomic importance can be attached to Polian vesicle numbers in this species.

Dendy (1896) figured the calcareous ring of the holotype, but his figure did not show the anterior notches in the radial pieces, nor the bifurcating posterior ends of the interradials.

S. huttoni has no near relatives, either in New Zealand or overseas.

Order ASPIDOCHIROTIDA

DIAGNOSIS: Tentacles shield-shaped, numerous (15 to 30, usually 20). Respiratory trees present. Mesentery of the posterior loop of the intestine attached in the right ventral interradius. Retractor muscles wanting: longitudinal muscles present as five double bands.

The aspidochirotes are mostly large forms, very common in tropical regions. Of the three families in this order, one is represented in the Cook Strait region.

Family STICHOPODIDAE

DIAGNOSIS: Gonads in two tufts, one to each side of the dorsal mesentery. Stone canal connected to the body wall, but not opening to the exterior. Deposits tables and rarely buttons.

This family contains four genera, of which the genus *Stichopus* is by far the largest.

Stichopus Brandt, 1835

DIAGNOSIS: Ventral surface flattened, markedly distinct from the dorsal surface; pedicels more or less fully covering the ventral side; dorsal surface with tubercles or papillae, at least along the lateral margins; tentacles typically 20; gonads in a tuft along each side of the dorsal mesentery; no cuvierian organs; no anal teeth or noticeable papillae around the cloacal opening; numerous calcareous tables in epidermis. Polian vesicles few, unbranched; madreporic canal single (After Clark, 1922).

Type Species: *Stichopus chloronotus* Brandt.

A single species, *Stichopus mollis* (Hutton) is known from New Zealand.

Stichopus mollis (Hutton)

Holothuria mollis Hutton, 1872, p. 15; Hutton, 1878, p. 308.
Stichopus sordidus Theel, 1886, p. 167, Pl. 8, fig. 3.
Holothuria victoriae Bell, 1887, p. 534, Pl. 45, fig. 7.
Stichopus mollis Dendy, 1896, p. 46, Pl. 7, figs. 73–82; Whitelegge, 1897, p. 50; Farquhar, 1898, p. 326; Ludwig, 1898, p. 7; Perrier, 1905, p. 83; Dendy and Hindle, 1907, p. 96, Pl. 12, fig. 12; Erwe, 1915, p. 387, Taf. VII, fig. 22; Joshua, 1914, p. 2; Clark, 1922, p. 60; Mortensen, 1925, p.327; Clark, 1938, p. 511; Clark, 1946, p. 417; Dawbin, 1950, p. 35, Pl. 1, fig. 1.
Stichopus simulans Dendy and Hindle, 1907, p. 97, Pl. 11, fig. 5; Joshua, 1914, p. 3; Clark, 1922, p. 69.
Stichopus simultans Erwe, 1913, p. 388, Taf. VIII, fig. 23 a-d.

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 3 specimens; VUZ 39, off Days Bay, 8–9 fathoms, mud, 1 specimen; Island Bay, intertidal rock pool, 3 specimens, coll. A. D. Allen, 3/6/1959; Balaena Bay, Wellington Harbour, intertidal rock pool, 1 specimen, coll. D. L. Pawson, 21/8/1960.

DIAGNOSIS: Large forms (up to 25cm total length), colour light brown to black. Deposits tables with regular spires, which are more or less open at the top, with one or two crossbars. Discs of tables square or squarish, 0.055–0.065mm in diameter, with four large holes and four smaller holes at the corners.

DISCUSSION: This species is the best known and most easily recognised of the New Zealand holothurians. Previous workers (Dendy, 1896; Erwe, 1915; Clark, 1922; Mortensen, 1925) have described the anatomy and calcareous deposits of *Stichopus mollis* very fully, and Dawbin (1949) has given an account of its autoevisceration and regeneration.

Stichopus mollis is common in the areas in which it occurs, and it is known from central and southern New Zealand, southern and western Australia, and Tasmania, where it lives on coarse sand or mud in sheltered areas to depths of at least 150 fathoms.

GENERAL DISCUSSION

The holothurian fauna of the Cook Strait region is notable for its diversity at the generic level. The Order Dendrochirotida is well represented on the shelf, but only one species, *Ocnus calcareus* may be found intertidally. In contrast, three of the four apodous species appear to be restricted to the intertidal zone where five holothurian species are known to occur.

They are:

Kolostoneura novae-zealandiae — *Trochodota dunedinensis*
Trochodota dendyi — *Ocnus calcareus*
Stichopus mollis

Of the above species, *Trochodota dendyi* and *Ocnus calcareus* are relatively rare, while the remaining three species are common.

The following eight species have been taken from the shelf:

Protankyra uncinata — *Neocucumella bicolumnata*
Neothyonidium dearmatum — *Pentadactyla longidentis*
Heterothyone alba — *Heterothyone ocnoides*
Stolus huttoni — *Stichopus mollis*

All but three of these species are restricted to the shelf. *Pentadactyla longidentis* has been found at 400 fathoms (Station 87), and *Heterothyone alba* and *Stichopus mollis* are known from 100–150 fathoms (Station 15). It is possible that specimens taken from these depths may have strayed accidentally from the shelf into deep water, as a result of the steep marine profiles in the area. Unfortunately it is not known whether the specimens were alive when captured. Probably most of the specimens known so far only from Wellington Harbour occur also on the Cook Strait shelf, but there is a definite need for a more thorough investigation of the shelf and slope.

There are three deep water species known from the area. They are:

Heteromolpadia marenzelleri — *Molpadia violacea*
Paracaudina chilensis

As a result of the greater depth tolerances in the above species, they should have the ability to achieve a wide distribution by spreading across the deep sea floor. Although *Heteromolpadia marenzelleri* is known so far only from New Zealand, *Molpadia violacea* also occurs near Kerguelen (Theel, 1886), and *Paracaudina chilensis* is a circum-Pacific species. It is expected that further deep water investigation in Cook Strait will reveal members of the almost exclusively deep sea group, Order Elasipodida.

Present records indicate that no shelf holothurian species are restricted to the Cookian Province as defined by Finlay (1925) and applied to the echinoderms by Fell (1949) and Pawson (1961). The fauna of Cook Strait contains a mixture of northern and southern New Zealand elements, with southern elements predominating. Cook Strait does not appear to present a barrier to northward dispersal of southern species.

Among the Cook Strait holothurians are four species which are also known in Australia. They are:

Paracaudina chilensis	*Neocucumella bicolumnata*
Neothyonidium dearmatum	*Stichopus mollis*

The above species comprise about 25% of the known fauna. The means by which echinoderms can cross the ocean gap between Australia and New Zealand have been discussed by Mortensen (1925) and Fell (1953). Drift in surface waters across the Tasman Sea in the planktonic larval stage is feasible for those species which possess pelagic larvae (as is probably the case with *Stichopus mollis*). Both *Neothyonidium dearmatum* and *Neocucumella bicolumnata* have yolky eggs, and probably lack a larval stage in their life history. They may have been carried across the Tasman Sea in rafts of seaweed, or perhaps dispersed via the Lord Howe Rise to which Fell (1953) attaches some importance as at least a former, if not a present, dispersal route. More complete information on the life history and bathymetric distribution of such problematical species may assist in revealing their dispersal mechanism.

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Distribution Patterns of New Zealand Echinoderms

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ECHINODERMS appear to be particularly suitable as material for the study of patterns of distribution, owing to their relatively sedentary habits, their aversion to fresh or even brackish water, the brevity or complete absence of a pelagic larval life, and their usually short bathymetric range.

This article deals mainly with patterns of distribution of the shelf fauna, that is, species known to depths of 100 fathoms. The archibenthal and abyssal faunas will also be considered.

Marine Provinces have been defined by Finlay (1925) and Powell (1937) on the basis of Mollusca, and have also been applied to the shelf echinoderms (Fell, 1949, and later references). In this paper an attempt is made to find correlations between the very restricted distribution of some species and physical environmental factors. It would be useful indeed if we could say that some one marine province is bounded to the north by an ocean current and to the south by another current or trench, but with the present state of our knowledge no really definite statements such as this can be made.

The boundaries of the provinces as suggested by the known echinoderms of New Zealand may be at variance with the boundaries indicated by other animal groups, e.g. Mollusca, but this is possibly due to many factors, among them differences in powers of locomotion, mode of reproduction, and others. Probably the most important factor is our lack of a more complete knowledge of the patterns of distribution of the animals concerned.

Of the New Zealand shelf echinoderms, approximately 59% have a scattered distribution pattern, and show no clear provincial pattern. The remaining 41% appear to conform rather well to the provincial system, and may be separated into groups, each group being restricted to a province and typical of that province.

Kermadec Islands

The Kermadec Islands are often excluded from the New Zealand region as they are truly subtropical in position and in the general affinities of their fauna. At first sight the echinoderm fauna of these islands seems to show a generalised Indo-Pacific facies: of the 13 recorded species 6 (46%) are Australian-Indo-Pacific, 5 (39%) are restricted to the Kermadecs, and only 2 (15%) are shared with the New Zealand mainland. This might seem to exclude the Kermadecs from the New Zealand faunal region.

Closer analysis of the echinoderm fauna, however, leads to a different conclusion. One of the restricted species, *Patiriella oliveri*, is very closely related to *Patiriella regularis* of the New Zealand mainland, and the two almost certainly share a common ancestry. Another starfish restricted to the Kermadecs, *Astrostole rodolphi*, is very closely related to *Astrostole scabra* of the New Zealand mainland.

Of the two species shared with New Zealand, *Ophidiaster kermadecensis* ranges the Bay of Plenty and the Kermadecs and is unknown elsewhere in the world. The other is *Evechinus chloroticus* ranging the entire New Zealand mainland and, apart from the Kermadecs, unknown elsewhere in the world; *Evechinus* is known fossil in New Zealand, at least from the Pliocene (Nukumaruan). Of the Australian-Indo-Pacific species, *Astropecten polyacanthus* is also shared with the Aupourian Province of New Zealand.

There is, therefore, good echinoderm evidence for including these islands in the New Zealand region, possibly as a sub-region of the Aupourian Province, but more collecting is obviously required.

Aupourian Province

The Aupourian Province was established for Mollusca to cover Three Kings Islands and all that part of the North Auckland Peninsula above Ahipara on the west and Whangaroa on the east coast (Powell, 1937). It was known then that the province was distinguished by the presence of a number of subtropical molluscs. Powell (1955) subsequently extended the south-eastern boundary of the province to East Cape, and Fell (1952) had found this to be consistent with the echinoderm evidence. So far as the echinoderms are concerned, the south-western boundary of the Aupourian Province cannot fall north of Cape Egmont (Fig. 1), as otherwise certain species with a distinct Australian-Indo-Pacific facies would present an anomalous distribution.

Some typical Aupourian echinoderms are *Asterodiscus truncatus* (Powell, 1937): *Astropecten polyacanthus* (known from as far south as New Plymouth to the west and East Cape to the east); *Centrostephanus rodgersii* (from south of Whangaroa); *Holopneustes inflatus* (from Great Barrier Island); *Clypeaster australasiae* (off Parengarenga and East Cape) (Fell, 1949b). All of these species are also present in the Australian echinoderm fauna and are typical subtropical forms. Another species, *Brissus gigas*, from the Bay of Islands (Fell, 1947), is very closely related to a widespread Indo-Pacific species *Brissus latecarinatus*. At the present time, fifteen species may be named as typical of this province.

If the subtropical forms can only move as far south as Cape Egmont to the west and East Cape to the east, there must be some barrier preventing their dispersal at least to the more southern regions of the North Island. For shallow water species such as these, factors such as temperature, salinity and water movements should act in some way to produce a barrier.

Deacon (1937) suggested that the northern limit of the subtropical convergence to the west of the North Island lies at about 42° S. and 170° W. and strikes towards the coast in the neighbourhood of Cape Egmont. Garner (1959) noted a pronounced drop in the level of the mean surface temperature between the areas off Capes Egmont and Farewell, and thus tended to agree in part with Deacon's premise. We know that most of the subtropical species tend to be stenothermal, and thus Cape Egmont might form a southern boundary for the Aupourian echinoderms of the west coast. The cooler waters of the Westland Current (Fig. 1) flow past Cape Egmont at varying times throughout the year, but the northern limit of the current is variable (Brodie, 1960). The current, however, may play some part in the regulation of distribution on this coast.

To the east the situation is not the same. The northern limit of the subtropical convergence strikes not towards East Cape, but towards Castle Point, some 300 miles further south (Fig. 1) (Deacon, 1937; Garner, 1959). Therefore there should be nothing preventing Aupourian forms from dispersing at least as far south as Castle Point if we use this northern limit of the subtropical convergence as an eastern boundary. But there are two factors which may act to prevent dispersal past East Cape for many echinoderm species:

1. The Canterbury Current, a colder water current, moves northwards near the coast towards East Cape (Fig. 1).
2. Garner (1959) noted a significant drop in water temperature off East Cape at latitude 37.5° S. (Fig. 1), indicating a localised coastal upwelling of colder water.

Taken together, these physical factors might form an excellent barrier. The shelf echinoderms between East Cape and Hawke Bay are unfortunately not very well known, but those of Hawke Bay have been intensively studied in recent years, and no 'strays from the north' have been encountered as yet among the thousands of specimens taken from that region.

Cookian Province

Probably the most important feature of the Cookian Province is the fact that it is an area of mixed waters, the site of the subtropical convergence (Fleming, 1944), and thus it is to be expected that its echinoderm fauna is of mixed composition. This was demonstrated by Fell (1949a). The Cookian Province seems to present a broad section of the New Zealand echinoderm fauna as a whole.

For the echinoderms the northern boundaries of the Cookian Province appear to lie at East Cape and Cape Egmont. The southern boundaries are rather indefinite (Fig. 1), as the shelf echinoderms of certain important areas of the South Island are not very well known. Garner (1959) recognised an area of mixed waters which extended between Cape Egmont and Fiordland. It is possible that northern Fiordland may form a southern boundary to the west. To the east the boundary appears to fall a little to the north of Dunedin. From this province, 85 shelf echinoderms are known. Of these 16 (19%) are of restricted distribution and 3 (3%) are magellanic. This is the northernmost area in which occur shallow-water New Zealand species which are also found in the Magellanic region. All of the three species concerned are often found in the holdfasts of seaweeds (e.g. *Carpophyllum, Macrocystis*). The west wind drift (Fig. 1) has a direct effect on the coastal current patterns in this area (Knox, 1960) and the occurrence of Magellanic elements in the Cookian Province is not so very surprising.

Chatham Islands

The Chatham Islands comprise the Moriorian Province in Finlay's (1925) scheme. These islands lie within the subantarctic mixed water zone and sit astride the subtropical convergence (Knox, 1960). For many other plant and animal groups the distinctiveness of this province lies in the mixed nature of its fauna, which usually contains northern and southern mainland forms, together with elements from the Antipodean Province and a number of forms with restricted distribution patterns.

The echinoderm fauna, Asteroidea, Ophiuroidea, Echinoidea (Fell, 1960) and Holothuroidea (Pawson, 1961) of the Chatham Islands is a mixed fauna in deeper waters, but the shelf fauna shows some remarkable features. The recent (1954) expedition to the Chathams greatly augmented our knowledge of the echinoderm fauna of that island group, and at the present time 56 species are known, 24 of which have been taken from depths less than 100 fathoms. Of these 24 shelf species, 8 (33%) are recorded from the Chathams, the Chatham Rise, and the New Zealand mainland shelf (especially in the Cook Strait region). Two species (8%), *Henricia lukinsii* and *Calvasterias suteri*, are also known in the Antipodean fauna, and clearly show a west-wind-drift distribution pattern. One species (4%) is circum-polar. The remaining 13 species (55%) are recorded from off the New Zealand coast, and are particularly well known in the Cook Strait area, but have not as yet been taken from the Chatham Rise. At the present time no shelf echinoderms appear to be restricted to the Chathams. In other words no species may be stated as being 'typical' of a Moriorian Province. On the basis of this evidence, then, there appear to be no grounds for giving to the Chathams the status of a marine province when the echinoderm fauna is considered. It must be indicated here that the echinoderm fauna of the Chatham Islands is still imperfectly known, but the facts as

Figure 1: New Zealand and outlying islands, showing marine provinces as suggested by the echinoderms. The Aupourian Province includes the northern part of the North Island from East Cape and Cape Egmont, and Three Kings Islands. The indefinite southern boundary of the Cookian Province is indicated by a broken line. The Chatham Islands are regarded as members of the Cookian Province. The Antipodean Province includes the Auckland, Campbell, Bounty and Antipodes Islands, to depths of 100 fathoms. Abbreviations: A, West Auckland Current; B, East Auckland Current; C, East Cape Current; D, Westland Current; E, Canterbury Current.

we know them now lead to the suggestion that the Chatham Islands should best be regarded as a part of the Cook Strait sub-region, members of the Cookian Province. This suggestion was first put forward by Fell (1960). Recent studies on the Holothuroidea by the author lend support to his thesis. The comparatively shallow waters of the Mernoo Bank and the Chatham Rise appear to form an excellent bridge for those forms which are able to migrate between New Zealand and the Chatham Islands.

Forsterian Province

The Forsterian Province is subject to the direct influence of the cold subantarctic waters of the west-wind-drift at certain times of the year and at others to the warmer mixed waters of the Southland Current. This province has some subantarctic affinities in its echinoderm fauna, and appears to form a transitional zone between the subantarctic cold temperate and the cold temperate mixed waters.

Echinoderms suggest that the Forsterian Province includes the southern portion of the South Island from Fiordland in the west and Dunedin in the east, Stewart Island and the Snares Islands. Fell (1953) gave reasons for regarding the Snares as part of the Forsterian Province, and Powell (1955, 1961) has confirmed this conclusion on the basis of Mollusca. Of the four genera of echinoderms known to have species in the Snares, two are represented on the New Zealand mainland by identical species (*Asterodon dilatatus* and *Stichaster australis*) while the other two (*Allostichaster insignis* and *Calvasterias suteri*) occur both in the Antipodean Province and on the New Zealand mainland shelf. All Snares echinoderms which are shared with the other outlying islands are also shared with the New Zealand mainland. Thus, for the echinoderms the northern boundary of the Antipodean Province would fall south of the Snares (Fell, 1953). Support for this view is given by Knox (1961, personal communication), who reports *Evechinus chloroticus* from the Snares. It is interesting to note that the Snares lie on the shallow water plateau which extends southwards beyond Stewart Island. The 100-fathom line (Fig. 1) might suffice as the southern boundary for the Forsterian Province.

In general, the echinoderm fauna of the Forsterian Province resembles the Cookian fauna. Over 60 shelf echinoderms are known from this province. Of these, 6 (10%) are at this time regarded as typical Forsterian species. Subantarctic elements in the province include *Trachythyone amokurae* and *Ocnus brevidentis*.

The echinoderms of Fiordland include some forms which have distinct Australian-Indo-Pacific affinities. The presence of these forms in this part of the New Zealand region may be due to the influence of the East Australian Current, but as yet we have insufficient data. There are also northern New Zealand shallow-water species present in Fiordland, separated by a gap of about

700 miles from their other known localities (Fell, 1952). These include *Peronella hinemoae* and *Amphiura alba*. Another species, *Amphiura hinemoae* was formerly regarded as having a similar distribution pattern, but it was recently found to be an inhabitant of the abyssal zone, and thus, being a eurythermal species, its pattern of distribution is readily explained. It is possible that *Amphiura alba* and *Peronella hinemoae* may also be eurythermal species.

Antipodean Province

The Antipodean Province (formerly termed Rossian) is taken to comprise the Auckland Islands, Campbell Islands, Bounty Islands and Antipodes Islands. Macquarie Island does not stand on the New Zealand submarine plateau, and its shallow-water echinoderm fauna is strikingly different from that of the Antipodean Province islands. The only New Zealand echinoderm in its fauna is *Pseudechinus novae-zealandiae*, which has a pelagic larva. Its presence in Macquarie Island is thus readily explained. Macquarie Island is therefore to be regarded as a member of the Kerguelenian (i.e. Subantarctic) Province.

The islands Auckland, Campbell, Bounty and Antipodes lie in a direct line with the west-wind-drift (Fig. 1), and it is to be expected that a certain percentage of their echinoderm fauna comprises circum-polar species. However, Mortensen (1925) clearly demonstrated that the bulk of the echinoderm fauna of the Auckland and Campbell Islands is of New Zealand derivation, not subantarctic, and Fell (1953) gave similar data for the Antipodes and Bounty Islands. An analysis of the known echinoderms of the Antipodean Province serves to demonstrate these relationships. Of the 27 known shelf species, 6 (22%) are restricted; 18 (66%) are common to the Antipodean Province and the New Zealand mainland, but are endemic to the New Zealand region as a whole; 2 (possibly 3) are circum-polar (8%), and 1 (4%) is cosmopolitan. There are no Australian-Indo-Pacific elements in the fauna as we know it today.

On the basis of the Asteroidea, Ophiuroidea and Echinoidea, Fell (1953) inferred that the echinoderm fauna of the Antipodean Province islands may have been derived from two sources, namely:

1. The greater part of the fauna has been derived from an assemblage of species which has been the common heritage of all parts of the New Zealand submarine plateau. This conclusion is based on the number of species which are common to the mainland and the islands of the Antipodean Province.
2. A small percentage of the fauna has possibly been derived from some originally southern species which have achieved a circum-polar distribution on account of their epiplanktonic habit (on brown seaweed), influenced by the west-wind-drift. In this way they could spread to other southern areas, such as Patagonia, Macquarie Island and Kerguelen Island, and subsequently

speciate there. Examples cited by Fell were *Amphiura magellanica*, *Calvasterias* spp. and *Pseudechinus* spp. Similar conclusions may be drawn from the Holothuroidea (Pawson, 1961). It is interesting to note that the holothurian species *Stereoderma leoninoides* and *Ocnus brevidentis*, like the other echinoderms cited above, are known to inhabit the holdfasts of seaweeds in the eulittoral zone. The seaweed would form an excellent raft for dispersal, and the west-wind-drift the dispersal mechanism. Mortensen (1925) recorded two living specimens of *Stereoderma leoninoides* on a piece of floating *Lessonia*, one mile to the east of the Auckland Islands. This second source of contributions to the Antipodean Province fauna is of no great significance when the fauna as a whole is considered.

The term 'Subantarctic Islands' has been used by New Zealand writers to include the islands of the Antipodean Province, as well as Macquarie Island, Heard, Kerguelen, and many others. But whereas there is obviously a very close echinoderm faunal relationship between New Zealand and the Antipodean Province islands, the echinoderm faunas of the other islands mentioned are of a very different character, comprising mainly circum-polar species, together with some Antarctic genera. The echinoderm fauna of Auckland, Campbell, Antipodes and Bounty Islands is almost entirely New Zealand in character and is extremely dissimilar to that of the other islands under discussion. The two groups of islands are sharply distinguishable, the former belonging to the New Zealand faunal region, the latter belonging to the subantarctic proper. Therefore, so far as the echinoderms are concerned, it is most misleading to use the term 'Subantarctic Islands of New Zealand' to cover Auckland, Campbell, Antipodes and Bounty Islands.

Archibenthal and Abyssal Echinoderms

A total of ninety-nine archibenthal and abyssal echinoderm species are known from the New Zealand region. Fell (1958) regards the archibenthal fauna as a mingling of local and cosmopolitan elements, shelf forms occasionally descending the continental slopes either by accident or design (e.g. *Astropecten primigenius*, *Pentagonaster pulchellus*, *Heterothyone alba*, *Amphyicyclus thomsoni*), and abyssal forms occasionally reaching the shelf. The relatively steep marine profiles facilitate the mingling of deep-water and shallow-water echinoderms, and a number of individual species tend to have a wide bathymetric range. For example, *Paracaudina chilensis* is common in Cook Strait in depths ranging between forty fathoms and 600 fathoms. This species is probably abyssal, and is also known from off Patagonia, Japan, Australia, California and Florida, probably achieving its distribution by spreading across abyssal bottom water.

The 69 known archibenthal species comprise 45 endemic forms (66%): 16 (22%) Australian-Indo-Pacific forms: 7 (10%)

cosmopolitan species, and 1 (2%) magellanic species. The presence of 22% Australian species points to the Australian region as a source for many of our archibenthal elements. Such species as *Araeosoma thetidis, Paramaretia multituberculata, Zoroaster macracantha, Cosmasterias dyscrita* and *Amphicyclus thomsoni* are known from New Zealand and the deeper waters off Australia. More sampling is needed in some critical areas before it can be decided whether the archibenthal echinoderms fit any horizontal distribution pattern. The same is true for the abyssal echinoderms.

In conclusion it may be stated that we are continually reminded of our incomplete knowledge of the New Zealand echinoderm fauna. There are many discoveries to be made, and with these discoveries the apparent distribution patterns which have emerged over recent years will no doubt be modified. Nevertheless, it seems unlikely that there will be any drastic change in our present conception of the fauna.

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