SYSTEMATIC STUDIES ON THE HOLOTHUROIDEA OF THE NEW ZEALAND REGION

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Thesis presented for the Degree of Master of Science in Zoology

1961

I N D E X   T O   P L A T E S

A B S T R A C T

A systematic account of the holothurians of the New Zealand region is given, together with diagnoses of orders, families, sub-families, genera and species. The report is based on a total of 970 specimens, which comprise 18 genera, including Mensamariella n.g., and 25 species, including Protankyra rigida, Chiridota alleni, Chiridota mortenseni, Neothyonidium armatum, and Trachythyone squamata, spp.nov. Genera and species known in the fauna, but not encountered during the course of the present study, are diagnosed, and their systematic positions and distribution patterns are briefly considered.

The distribution of known holothurians within the New Zealand region is discussed, as also are the external relationships and ultimate derivation of the group. The taxonomic state of the Class as a whole is indicated, and comments are made on the reliability of systematic characters within each group, together with some suggestions for modification and possible improvement of the present-day situation.

INTRODUCTION

Holothurians or sea-cucumbers form a conspicuous part of the fauna of the sea-floor. They are particularly well-adapted to life in muddy or sandy habitats, although many species live on rocks or seaweeds in the littoral zone. As a consequence of specialisation towards a detritus-eating habit, many holothurians have a pronounced bilateral symmetry, superimposed on an underlying radial symmetry. The reduction of the calcareous plates in the skin to microscopic spicules has resulted in a soft-bodied group of animals, admirably suited to burrowing activity.

In general, holothurians are worm-like in shape, and are not particularly attractive in appearance. These properties, together with secretive habits, usually discourage collectors from gathering holothurians. Thus, the holothurians of the littoral zone to depths of about 5 fathoms are not well known in New Zealand, and there is an urgent need for collecting in these regions. There is no doubt that many hitherto undescribed forms await the attentions of a careful and observant collector.

At the present time, the holothurians from depths between 5 fathoms and 200 fathoms are becoming increasingly well-known as a result of organised dredging in these waters by various institutions. However, there are still large areas of the New Zealand coastline as yet unexplored.

The Class Holothuroidea has not been as intensively studied as other groups within Phylum Echinodermata. This hiatus is unfortunate, as it is known that the holothurians comprise a very significant percentage of the total biomass in the sea. The reason for the shortage of workers in the field of holothurian systematics possibly lies in the difficulties involved in studying the group. Soft-bodied holothurians cannot be dried for study as can other echinoderms, and the number of reliable systematic characters is relatively small compared with those in Ophiuroidea, Echinoidea, Asteroidea and Crinoidea. The shortage of holothurian systematists has led to the accumulation of large collections of holothurians in many museums in New Zealand and overseas.

The almost exclusively benthic way of life and the degree of stenobathy in many members of the Class make the holothurians of special interest to students of zoogeography.

The general biology of New Zealand holothurians, including physiology, behaviour and life history, is an aspect which has been sadly neglected, and studies in this direction should prove very rewarding.

All of the Orders within the Class have representatives in the New Zealand region, particularly the Dendrochirota and Apoda which are especially well represented. Order Aspidochirota has but two species recorded from New Zealand; one is rare, the other is very common. The deeper water orders Molpadonia and Elasipoda are each known in New Zealand from three species. It is probable that further dredging will reveal many more deeper water species.

I would particularly like to thank Professor H.B. Fell for his careful guidance and constructive criticism throughout the course of this study. Without his help, this work would never have been completed. Thanks are also due to Professor L.R. Richardson and Miss P.M. Ralph for their many thoughtful suggestions; to Professor G.A. Knox of Canterbury University for kindly forwarding to me the Chatham Islands (1954) Expedition holothurians; to Dr. R.A. Falla for the Cape Expedition holothurians and for giving me access to the fine collection of holothurians in the Dominion Museum, Wellington, and to Dr. E. Batham of the Portobello Marine Biological Station for sending me specimens from the collection of that institution.

I am grateful to Dr. Elisabeth Deichmann of the Museum of Comparative Zoology, Harvard, for suggestions regarding the classification of the molpadids, and to Mr. W.H. Dawbin of the Department of Zoology, Sydney University, for notes on the holothurians collected by the Cape Expedition.

Finally, I would like to thank Mrs. D. Freed for the care she exercised in typing this thesis, Mr. M.D. King for his patience and skill in photographing the plates, and Miss M. Tobin for proof-reading the final copy.

H I S T O R I C A L   N O T E

Hutton (1872) was the first to record any holothurians from New Zealand. He described 8 species, all of which were new to science: Holothuria mollis, Thyone longidentis, Thyone brevidentis, Thyone caudata, Synapta uncinata, Synapta inaequalis, Chiridota ? alba, and Molpadia coriacea. Later Hutton (1878) added 3 more species to the list: Cucumaria thomsoni, Labidodesmus turbinatus, and Holothuria robsoni. Thyone longidentis Hutton was placed in a new genus Pentadactyla, and Chiridota ? alba was placed into genus Echinocucumis. Unfortunately Hutton's descriptions were hopelessly inadequate, and many of his species, namely Synapta inaequalis, Thyone caudata, Labidodesmus turbinatus, and Holothuria robsoni, are no longer recognisable, and the type specimens are either lost or have deteriorated to such an extent that they are useless.

Parker (1881) described Chiridota dunedinensis from New Zealand, and later in the same decade Theel (1882, 1886) described Stichopus sordidus, Thyonidium rugosum, Ankyroderma marenzelleri, Trochostoma violaceum, Holothuria lactea, Enypniastes eximia, and Pannychia moseleyi, mainly deep-water species from near New Zealand.

Dendy (1896) published the first paper of any real worth on New Zealand holothurians, and in this paper 4 new species were described: Cucumaria huttoni, Colochirus ocnoides, Colochirus calcarea, and Psolus macquariensis. Stichopus sordidus Theel was synonymised with Holothuria mollis Hutton, and the species became Stichopus mollis (Hutton). Also Thyone caudata

Hutton was declared a synonym of *Pentadactyla longidentis* (Hutton). Many of Hutton's type specimens were examined by Dendy, and most of them were found to have deteriorated beyond recognition.

Ludwig (1898b) was of the opinion that *Colochirus brevidentis* (Hutton) and *Colochirus calcarea* Dendy were synonymous. *Colochirus calcarea* then disappeared from the list of New Zealand holothurians, until it was re-established by Mortensen in 1925. Mortensen (1925) gave an account of the disappearance of *Labidodesmus turbinatus* Hutton from the holothurian fauna in 1903.

Remy Perrier (1903) described 2 new species, *Cucumaria filholi* and *Thyonidium anatinum*. Two years later Perrier (1905) described another new species, *Caudina pulchella*, and a new variety, var. *brevicauda*, of *Caudina coriacea* (Hutton).

Dendy and Hindle (1907) made a valuable contribution to our knowledge of New Zealand holothurians. They described 6 new species: *Stichopus simulans*, *Phyllophorus dearmatus*, *Pseudocucumis bicolumnatus*, *Chiridota gigas*, *Chiridota geminifera*, and *Rhabdomolgus novae-zealandiae*. A very thorough account of the microscopic anatomy of *Rhabdomolgus novae-zealandiae* was given. In the same paper, all of the new species described by Perrier (1903, 1905) were synonymised with species already recognisable from Hutton's (1872, 1878) descriptions.

Clark (1907) did not recognise Hutton's (1872) *Synapta uncinata* and *Synapta inaequalis*, as the original descriptions had been inadequate. In the same paper, Clark declared *Caudina coriacea* (Hutton) a synonym of *Caudina chilensis* (Muller).

Becher (1909) established a new genus Kolostoneura to accommodate Rhabdomolgus novae-zealandiae Dendy and Hindle. Dendy (1909) described a new species Chiridota benhami, and a new variety, var. carnleyensis of Cucumaria brevidentis (Hutton), from the Auckland Islands. Cucumaria leonina Semper var. was also recorded from the Auckland Islands for the first time. This species was later named Cucumaria leoninoides by Mortensen (1925). In the same year, Benham (1909) gave an account of a new species Molpadia dendyi, and recorded Molpadia marenzelleri (Theel) from Hawke Bay.

Between 1909 and 1925, little or nothing was added to our knowledge of New Zealand holothurians, apart from records of the presence in Australia of some New Zealand species by Erwe (1913), Joshua (1914) and Joshua and Creed (1915).

Mortensen (1925) published an excellent and comprehensive paper on the then known holothurians of New Zealand, based on material collected from New Zealand waters during his 1914-1916 Pacific Expedition. In this paper, Mortensen described 10 new species: Holothuria neozelanica, Cucumaria amokurae, Cucumaria farquhari, Cucumaria bollonsi, Cucumaria leoninoides, Psolidella nigra, Psolus neozelanicus, Chiridota nigra, Chiridota carnleyensis, and Trochodota dendyi. A new variety, var. microurna of Trochodota dunedinensis (Parker) was described, and Pseudopsolus macquariensis was added (with some doubt) to the New Zealand fauna.

In the same paper, Stichopus simulans Dendy and Hindle was declared synonymous with Stichopus mollis (Hutton), and Chiridota benhami Dendy and Chiridota geminifera Dendy and Hindle were synonymised with Trochodota dunedinensis (Parker). Synapta inaequalis was synonymised with Protankyra uncinata (Hutton). Cucumaria calcarea (Dendy) and Caudina coriacea (Hutton) were re-established as distinct species. A new genus (monotypic at the time), Psolidiella, was described. Holothuria robsoni was stated to be a species delenda, no longer to be taken into account.

Between 1925 and the present day, no further work was done on the New Zealand holothurians as a group, apart from Dawbin's (1950) key to the then known species. No new species were described until the present time, and thus the list of species had not increased. However, there have been a number of name changes since 1925.

Caudina coriacea (Hutton) was placed into Heding's (1932) new genus Paracaudina, and later synonymised with Paracaudina chilensis (Muller) (Clark, 1935). The complex history of this species is outlined on p. 94.

Molpadia marenzelleri has also a rather complex history (p. 82). Deichmann (1960) suggested that Molpadia dendyi Benham is a synonym of Molpadia marenzelleri (Theel).

Clark (1946) diagnosed a new genus Mensamaria, and included the New Zealand species Pseudocucumis bicolumnatus Dendy and Hindle. Another new genus, Lipotrapeza, was erected in the same paper, and in this genus Phyllophorus dearmatus Dendy and Hindle was placed.

Panning (1949), in a revision of the Family Cucumariidae, distributed the 10 species listed under the genus Cucumaria by

Mortensen (1925) into 6 genera. This re-assessment of the Cucumariidae is discussed throughout the following systematic account.

Heding and Panning (1954) revised Family Phyllophoridae. Hutton's (1872) species Phyllophorus longidentis (Hutton) was restored to genus Pentadactyla Hutton, 1878, Mensamaria thomsoni was transferred to genus Amphicyclus Bell, and Lipotrapeza dearmatum was placed into the genus Neothyonidium Deichmann.

Thus, when this study was commenced, 19 genera and 30 species were known from New Zealand.

MATERIALS AND METHODS

Care of specimens: All of the material examined was preserved in 70% alcohol, either isopropyl or ethyl. Any higher concentration of alcohol tends to extract moisture from specimens and they shrink and become hard, thus being rendered virtually useless for dissection. Care was taken to ensure that the alcohol was not acidic, as acid alcohol causes deterioration and eventual dissolution of the small spicules in the skin, which are so important as systematic characters.

Formalin is absolutely useless as a preservative for holothurians, as it dissolves the calcareous structures in a very short time, leaving a shapeless mass of soft flesh. Specimens in such a condition are virtually impossible to identify with any certainty.

The small number of specimens collected alive were narcotised with a saturated solution of Epsom Salts (magnesium sulphate, $MgSO_4$). The specimens were placed in a small jar of seawater and the Epsom Salts were added slowly. After a brief initial period of contraction, the specimens tend to relax completely. Specimens were left in narcotising solution for periods up to 2 hours, depending on their size, then transferred to 70% alcohol. Without preliminary narcotising, holothurians almost invariably die in a state of complete contraction, and their identification is thus rendered more difficult. Other anaesthetics were employed with varying success. Soneryl Sodium, a medical anaesthetic, proved quite effective, even when used in small quantities.

Specimens deteriorate over long periods of time, until they are virtually unrecognisable. Perhaps regular changing of alcohol may avoid some deterioration.

Dissection: Most specimens were dissected from the dorsal side where possible. A longitudinal incision was made from the anterior extremity to the posterior extremity. Extreme care was required near the anterior end, as delicate structures such as the calcareous ring, genital duct, stone canal and Polian vesicle are all located in that small area. The two flaps of the body wall were pinned back, revealing the internal structures.

All dissections were carried out in deep petri dishes containing layers of black rubberised wax. The black wax formed an excellent contrasting background for the light coloured internal structures. Drawings of dissections were made with the aid of proportional dividers. A camera lucida was employed when specimens were particularly small.

Treatment of calcareous material:

1. Calcareous ring: The complete calcareous ring was removed from the specimen and most of the soft tissues were carefully dissected away. Then the ring was placed in a small tube containing a 10% colution of caustic soda (sodium hydroxide, NaOH). The tube was firmly corked and heated gently in a beaker of water. After a short time the soft tissues completely dissolved away, and the ring broke up into its component radial and interradial pieces. If a whole calcareous ring was required for examination, the ring was immersed in a cold solution of 10% caustic soda for a short period of time, carefully watched,

and removed when most of the soft tissue had dissolved away, and dried. Dried calcareous rings tend to shrink somewhat, but still retain their relative proportions and details.

2. <u>Spicules:</u> Two separate techniques were employed for isolation of calcareous deposits.

The first technique was employed on thin body walls (up to 1 mm in thickness). A small piece of the skin was placed on a glass microscope slide, and covered with Eau de Javelle solution. Eau de Javelle is prepared by dissolving 10 grams of potassium carbonate (K_2CO_3) in 200 cc. of distilled water, and then adding 5 grams of tropical chloride of lime in 25 cc of distilled water. The white flocculent precipitate was allowed to settle, and the resulting clear solution was decanted into a small bottle and tightly corked. Eau de Javelle has a relatively short shelf life, and is fully effective for only 2 months. Addition of Eau de Javelle to a fragment of skin containing spicules caused the dissolution of the skin, and the spicules remained.

The second technique was employed for pieces of skin greater than about 1 mm in thickness. Small pieces of skin were warmed in 10% caustic soda solution in the same manner as the calcareous ring. The skin was permitted to dissolve completely away. Then the small tube was allowed to stand for a time, and most of the solution was drawn off with a pipette. The spicules remained in the bottom of the tube, together with a small amount of caustic soda. The spicules themselves were then pipetted off and placed on a slide.

Mounting of spicules: Spicules which were isolated in Eau de Javelle or caustic soda were treated in the same manner, with equal success. The spicules were washed with a few drops of glacial acetic acid (CH_3COOH), and left to stand for 4 minutes. Then the acid was washed off with 50% alcohol for another 4 minutes. Two washes of 100% alcohol, each of 4 minutes duration, were folled by xylol for 4 minutes. The calcareous deposits were then mounted in canada balsam. It is imperative that all the acetic acid is removed from the spicules, as the presence of acid conditions causes deterioration of the mounted deposits in a very short time.

M A T E R I A L   E X A M I N E D

A total of 970 specimens were examined during the course of this study. Material was supplied by the Department of Zoology, Victoria University of Wellington (250 specimens); the Dominion Museum, Wellington (262 specimens); the New Zealand Oceanographic Institute, Wellington (409 specimens); and the Portobello Marine Biological Station, Dunedin (6 specimens). The holothurians collected by the Cape Expedition (27 specimens) were kindly supplied by the Dominion Museum, Wellington, and Professor G.A. Knox of Canterbury University kindly loaned the holothurians of the Chatham Islands (1954) Expedition (15 specimens). Miss J. Hope Macpherson, curator of molluscs at the National Museum of Victoria, forwarded a single specimen collected by her at Macquarie Island.

Specimens taken during the course of organised marine investigations are listed below with their appropriate station numbers. Many specimens were taken by private collectors and placed in the Dominion Museum, Wellington, or the collection of the Department of Zoology, Victoria University of Wellington. These are recorded below, under the heading "Miscellaneous Collections" (p. 26).

DEPARTMENT OF ZOOLOGY, VICTORIA UNIVERSITY OF WELLINGTON

The stations listed below were worked in Wellington Harbour and Cook Strait, at depths between 2-4 fathoms and 600 fathoms.

VUZ 10 Palliser Bay, 5/2/1955, 41°28'30"S, 174°59'30"E, 200-250 fms, green mud.

Molpadia marenzelleri (Theel) 1 specimen

VUZ 15 Palliser Bay, 13/5/1955, 41°29'S, 175°0'15"E, 100-150 fms, mud.

Molpadia marenzelleri (Theel) 16 specimens

Paracaudina chilensis (Muller) 2 specimens

Pentadactyla longidentis (Hutton) 1 specimen

Heterothyone alba (Hutton) 1 specimen

Stichopus mollis (Hutton) 3 specimens

VUZ 21 Palliser Bay, 13/5/1955, 41°32'S, 175°8'30"E, 38 fms, mud.

Molpadia marenzelleri (Theel) 1 specimen

VUZ 30 Off Somes Island, 16/1/1956, 41°15'48"S, 174°52'6"E, 5-10 fms, mud.

Heterothyone alba (Hutton) 13 specimens

VUZ 32 Off Petone Beach, 16/1/1956, 41°14'30"S, 174°52'6"E, 8 fms, mud.

Protankyra uncinata (Hutton) 3 specimens

Pentadactyla longidentis (Hutton) 2 specimens

VUZ 35 Off Days Bay, 16/1/1956. From 41°16'42"S to 41°17'24"S, from 174°54'6"E to 174°53'48"E, 8-9 fms, mud.

Stichopus mollis (Hutton) 1 specimen

VUZ 37 Off Shelly Bay, 18/1/1956, 41°18'30"S, 174°48'42"E, 10-11 fms, mud.

Protankyra uncinata (Hutton) 8 specimens

Pentadactyla longidentis (Hutton) 1 specimen

VUZ 40 Off Ward Island, 18/1/1956, from 41°18'18"S to 41°17'42"S, from 174°52'18"E to 174°52'36"E, 2-4 fms, mud and sand.

Protankyra uncinata (Hutton) 2 specimens

VUZ 62 Opposite Worser Bay, 2/4/1956, 41°18'24"S, 174°51'36"E, 4-5 fms, green sand.

Stolus huttoni (Dendy) 1 specimen

VUZ 64 Off Point Howard Wharf, 2/4/1956, 41°15'28"S, 174°54'E, 5 fms, blue mud.

Protankyra uncinata (Hutton) 10 specimens

Mensamariella bicolumnata (Dendy and Hindle) 1 specimen

Pentadactyla longidentis (Hutton) 6 specimens

VUZ 69 Somes Island to Days Bay, 16/5/1956, 41°16'24"S, 174°53'21"E, 11 fms, mud.

Pentadactyla longidentis (Hutton) 1 specimen

Heterothyone alba (Hutton) 1 specimen

VUZ 87 South of Cape Palliser, 20/4/1957, approx. 41°44'S, 175°12'E, 400 fms, mud, rock and gravel.

Molpadia marenzelleri (Theel) 1 specimen

Molpadia violacea (Studer) 1 specimen

Paracaudina chilensis (Muller) 2 specimens

Pentadactyla longidentis (Hutton) 2 specimens

VUZ 96 Off Palliser Bay, 29/8/57, 41°31'S, 174°55'E, C380 fms, mud, stone and rock.

Molpadia marenzelleri (Theel) 13 specimens

VUZ 101 Off Palliser Bay, 29/8/57, 41°38'S, 174°53'30"E, C550 fms, mud.

Molpadia violacea (Studer) 6 specimens

Paracaudina chilensis (Muller) 135 specimens

VUZ 109 Off Palliser Bay, 19/12/1957, 41°50'S, 175°5'E, 600 fms, mud.

*Elpidiogone ? n. sp. 1 specimen

Elpidiogone ? n. sp. 1 specimen

DOMINION MUSEUM, WELLINGTON

The Dominion Museum holothurian collection includes specimens from a large number of points around the coasts of the North and South Islands, and Stewart Island.

B.S.22 Doubtful Sound, Fiordland, 2/5/1950, 4-10 fms.

Mensamariella bicolumnata (Dendy and Hindle) 5 specimens

B.S.130 Across entrance to Pelorus Sound, 27/12/1951, 30 fms.

Kolostoneura novae-zealandiae (Dendy and Hindle) 1 specimen

Amphicyclus thomsoni (Hutton) 2 specimens

Mensamariella bicolumnata (Dendy and Hindle) 2 specimens

Pentadactyla longidentis (Hutton) 8 specimens

B.S.135 3 miles southeast of Tonga Cove, Tasman Bay, 1/1/1952, 15 fms.

Protankyra uncinata (Hutton) 1 specimen

Pentadactyla longidentis (Hutton) 1 specimen

Heterothyone alba (Hutton) 1 specimen

B.S.141 Immediately north of South Point, Kaipipi Bay, Paterson Inlet, Stewart Island, 12/1/1952, 5 fms.

Chiridota nigra Mortensen 26 specimens

Trochodota dunedinensis (Parker) 31 specimens

Amphicyclus thomsoni (Hutton) 29 specimens

B.S.142 In channel between Ulva Island and Bradshaw Peninsula, Paterson Inlet, Stewart Island, 12/1/1952, 18 fms.

Amphicyclus thomsoni (Hutton) 17 specimens

B.S.144 Hawke Bay, 20/5/52, 39°31.5'S, 177°13'E, 25 fms.

Paracaudina chilensis (Muller) 1 specimen

B.S.148 Hawke Bay, 21/5/52, 39°17'S, 177°11'E, 25 fms.

Stolus huttoni (Dendy) 3 specimens

B.S.150 Hawke Bay, 21/5/52, 39°13.5'S, 177°10.5'E, 15 fms.

Mensamariella bicolumnata (Dendy and Hindle) 1 specimen

B.S.154 Hawke Bay, 21/5/52, 39°29'S, 176°57.5'E, 10 fms.

Heterothyone ocnoides (Dendy) 3 specimens

B.S.155 Hawke Bay, 21/5/52, 39°27.5'S, 176°54'E, 8 fms.

Paracaudina chilensis (Muller) 11 specimens

Heterothyone ocnoides (Dendy) Fragments

B.S.156 Hawke Bay, 21/5/52, 39°27'S, 176°53.5'E, 5 fms.

Paracaudina chilensis (Muller) 1 specimen

Heterothyone alba (Hutton) 1 specimen

B.S.157 Hawke Bay, 22/5/52, 39°31'S, 176°7.5'E, 8 fms.

Paracaudina chilensis (Muller) 20 specimens

Heterothyone ocnoides (Dendy) 7 specimens

B.S.158 Hawke Bay, 22/5/52, 39°33.5'S, 176°59'E, 7 fms.

Paracaudina chilensis (Muller) 4 specimens

Heterothyone ocnoides (Dendy) 3 specimens

B.S.174 Off Petone, Wellington Harbour, 26/5/53, 41°14.6'S, 174°51.5'E, 9 fms.

Protankyra uncinata (Hutton) 5 specimens

B.S.180 Cook Strait, 21/3/1954, 41°28.5'S, 174°50'E, 150 fms, sand and mud.

Chiridota nigra Mortensen 3 specimens

Neothyonidium armatum n.sp. 2 specimens

B.S.181 Off Palliser Bay, 6/2/1955, 41°27'S, 175°03'E, 100 fms.

Molpadia marenzelleri (Theel) 2 specimens

Pentadactyla longidentis (Hutton) 1 specimen

B.S.194 Off Somes Island, 2/1/1957, 41°16.1'S, 174°50.2'E, 11 fms.

Protankyra uncinata (Hutton) 7 specimens

Pentadactyla longidentis (Hutton) 1 specimen

B.S.202 N66 E of Tairoa Head, Otago, 23/1/1957, 45°44'S, 171°2'E.

Heterothyone alba (Hutton) 3 specimens

B.S.209 Off Mayor Island, 27/2/1957, 37°20.5'S, 176°26.5'E, 270 fms.

Laetmogone violacea Theel 1 specimen

Cape Expedition Material.

Waterfall Inlet, Auckland Islands, 25/3/1943, among rocks, in mud. Collected by W.H. Dawbin.

Trochodota dunedinensis (Parker) 2 specimens

No.1 Station Inlet, Auckland Islands, 8/8/1943, in rock pool. Collected by E.F. Doley.

Ocnus brevidentis (Hutton) 1 specimen

No.1 Station Inlet, Auckland Islands, 20/8/1943, in mud under boulders. Collected by W.H. Dawbin and J. Jones.

Kolostoneura novae-zealandiae (Dendy and Hindle) 1 specimen

Crozier Point, Auckland Islands, 9/8/1943, in mud between boulders at low tide. Collected by W.H. Dawbin.

Trochodota dunedinensis (Parker) 3 specimens

Crozier Point, Auckland Islands, 18/8/1943, in mud-gravel under sheltered gravel at low tide. Collected by W.H. Dawbin.

Trochodota dunedinensis (Parker) 2 specimens

Tagua Bay, Auckland Islands, 18/9/1943, in mud under boulders. Collected by W.H. Dawbin.

Trochodota dunedinensis (Parker) 6 specimens

Tagua Bay, Auckland Islands, 30/9/1943, in rock crevices at low-tide level. Collected by W.H. Dawbin.

Stereoderma leoninoides (Mortensen) 8 specimens

Opposite Passage Island, Auckland Islands, 24/3/1943, in sediment of rock pools. Collected by J. Jones.

Trochodota dunedinensis (Parker) 4 specimens

NEW ZEALAND OCEANOGRAPHIC INSTITUTE, WELLINGTON

At the present time the New Zealand Oceanographic Institute are engaged in a systematic survey of areas off the west coast of New Zealand. This survey has brought forth many holothurians, some of which are treated in this account. The large collection of holothurians from Hawke Bay has been examined, and is considered in the present list.

B 2 (sample 4), Hawke Bay, 25/8/1956, 39°08'S, 177°13.5'E, 10 fms, fine green sand.

Heterothyone ocnoides (Dendy) 1 specimen

B 6 (sample 5), Hawke Bay, 25/8/56, 39°10'S, 177°22'E, 21 fms, grey-green sandy mud.

Heterothyone ocnoides (Dendy) 1 specimen

B 8 (sample 1), Hawke Bay, 26/8/56, 39°06'S, 177°23'E, 15.5 fms, fine grey sand.

Paracaudina chilensis (Muller) 326 specimens and fragments.

Heterothyone ocnoides (Dendy) Fragments.

B 9 (sample 2), Hawke Bay, 26/8/1956, 39°10.5'S, 177°31 E, 18 fms, sand.

Heterothyone ocnoides (Dendy) 4 specimens

B 10 (sample 6), Hawke Bay, 26/8/1956, 39°13.5'S, 177°35.5'E, 30 fms, sand.

Heterothyone alba (Hutton) 1 specimen

B 11 (sample 1), Hawke Bay, 26/8/1956, 39°18'S, 177°39'E, 35 fms, fine sandy cloggy mud.

Molpadia marenzelleri (Theel) 1 specimen

(sample 8)

Heterothyone alba (Hutton) 3 specimens

B 13 (sample 4), 27/8/1956, 39°07'S, 177°36'E, 18.5 fms, blue sandy mud and grey mud in 2 layers.

Heterothyone ocnoides (Dendy) 1 specimen

B 14 (sample 8), 27/8/1956, 39°04'S, 177°42'E, 13.5 fms, very sloshy sand.

Heterothyone ocnoides (Dendy) 1 specimen and fragments

B 15 (sample 6), 27/8/1956, 39°09.5'S, 177°46.5'E, 19.5 fms, fine grey sand.

Heterothyone ocnoides (Dendy) Fragments

(sample 8)

Heterothyone ocnoides (Dendy) 3 specimens

B 16 (sample 6), 27/8/1956, 39°11'S, 177°41'E, 22 fms, slushy sandy grey mud.

Heterothyone alba (Hutton) 1 specimen

B 18 (sample 4), 27/8/1956, 39°18.5'S, 177°48'E, 24 fms, sand.

Heterothyone ocnoides (Dendy) Fragments

(sample 7)

Heterothyone ocnoides (Dendy) 5 specimens

B 19 (sample 6), 27/8/1956, 39°22.5'S, 177°52'E, 38 fms, grey sandy mud and green stones.

<u>Heterothyone</u> <u>ocnoides</u> (Dendy) 2 specimens

B 21 (sample 3), 28/8/1956, 39°22'S, 177°33.5'E, 49.5 fms, pumice and fine black stones.

<u>Protankyra</u> <u>uncinata</u> (Hutton) 1 specimen

B 25 (sample 4), 28/8/1956, 39°25.5'S, 177°46'E, 46 fms, fine grey, sandy, sloshy mud.

<u>Heterothyone</u> <u>alba</u> (Hutton) 2 specimens

B 37 Hawke Bay, 2/9/1957, 39°25'S, 176°57'E, 10.5 fms, sand.

<u>Paracaudina</u> <u>chilensis</u> (Muller) 2 specimens

<u>Heterothyone</u> <u>alba</u> (Hutton) 4 specimens

B 41 (sample 1), Hawke Bay, 2/9/1957, 39°11'45"S, 177°08'30"E, 11 fms., shell, gravel and stones.

<u>Amphicyclus</u> <u>thomsoni</u> (Hutton) 3 specimens

<u>Mensamariella</u> <u>bicolumnata</u> (Dendy and Hindle) 1 specimen

(sample 3)

<u>Mensamariella</u> <u>bicolumnata</u> (Dendy and Hindle) 1 specimen.

B 44 (sample 9), Hawke Bay, 3/9/1957, 39°28'45"S, 177°01'15"E, 14 fms, fine sandy mud.

<u>Molpadia</u> <u>marenzelleri</u> (Theel) 1 specimen

B 45 Hawke Bay, 3/9/1957, 39°25'45"S, 177°06'30"E, 22 fms, fine sandy mud.

<u>Heterothyone</u> <u>alba</u> (Hutton) 1 specimen

B 46 Hawke Bay, 3/9/1957, 39°22'30"S, 177°11'15"E, 32 fms, fine grey sandy glutinous mud.

Heterothyone alba (Hutton) 3 specimens

B 47 (sample 1), Hawke Bay, 3/9/1957, 39°19'30"S, 177°15'16"E, 36 fms, fine grey green sandy glutinous mud; stones and pumice.

Heterothyone alba (Hutton) 2 specimens

(sample 4)

Heterothyone alba (Hutton) 1 specimen

B 49 Hawke Bay, 3/9/1957, 39°23'15"S, 177°20'E, 44 fms, fine grey-green sandy glutinous mud; pebbles and pumice.

Molpadia marenzelleri (Theel) 1 specimen

Heterothyone alba (Hutton) 2 specimens

B 53 Hawke Bay, 3/9/1957, 39°35'S, 177°01'15"E, 8 fms, rock, shell and gravel.

Mensamariella bicolumnata (Dendy and Hindle) 1 specimen

B 54 Hawke Bay, 4/9/57, 39°36'15"S, 177°09'30"E, 29 fms, grey-green mud.

Protankyra uncinata (Hutton) 2 specimens

Heterothyone alba (Hutton) 1 specimen

B 224 21/5/1960, 46°45'S, 168°16.8'E, 15 fms, coarse shelly sand.

Amphicyclus thomsoni 3 specimens

A 435 2/10/1958, 40°30'S, 174°33'E, 64 fms, sandy mud, grading down into muddy shingle.

Molpadia marenzelleri (Theel) 1 specimen

Pentadactyla longidentis (Hutton) 2 specimens

A 445 5/10/1958, 41°7.9'S, 174°22.2'E, 12 fms.

Pentadactyla longidentis (Hutton) 1 specimen

C 166 39°37'S, 171°58'12"E, 100-150 fms, soft grey sloppy mud.

Protankyra rigida n.sp. 1 specimen

Heterothyone alba (Hutton) 2 specimens

C 175 39°40'S, 173°44'E, 50 fms, sandy mud.

Molpadia marenzelleri (Theel) 1 specimen

C 183 39°50'S, 173°44'E, 40 fms, muddy shell.

Protankyra uncinata (Hutton) 1 specimen

Paracaudina chilensis (Muller) 2 specimens

C 184 39°50'S, 173°32'E, 50 fms, sandy mud.

Protankyra uncinata (Hutton) 5 specimens

Pentadactyla longidentis (Hutton) 1 specimen

C 185

Molpadia marenzelleri (Theel) 1 specimen

C 186 40°40'S, 173°03'E, 20 fms, soft mud.

Molpadia marenzelleri (Theel) 1 specimen.

C 187 40°50'S, 173°03'E, 12 fms, soft mud (*Echinocardium* community).

Pentadactyla longidentis (Hutton) 1 specimen

C 188 40°50'S, 173°16'30"E, 25 fms, soft mud and dead shell.

Heterothyone alba (Hutton) 3 specimens

C 189 40°40'S, 173°16'30"E, 30 fms, soft mud.

Molpadia marenzelleri (Theel) 1 specimen

C 218 41°08'18"S, 174°14'E, 20 fms, soft grey mud.

Pentadactyla longidentis 1 specimen

CP 27 41°23'S, 174°25'30"E, 78 fms, pebbly shelly mud.

Mensamariella bicolumnata 1 specimen

M 7 Off Dale Point, Milford Sound, soft grey mud.

Heterothyone alba 1 specimen

PORTOBELLO MARINE BIOLOGICAL STATION, DUNEDIN

Off Hooper's Inlet, 8-10 fms, mud.

Paracaudina chilensis (Muller) 1 specimen

Portobello

Kolostoneura novae-zealandiae (Dendy and Hindle) 3 specimens

Chiridota mortenseni n.sp. 1 specimen

North-east Otago

Stolus huttoni (Dendy) 1 specimen

CHATHAM ISLANDS (1954) EXPEDITION HOLOTHURIANS

Stn.9 Glory Bay, Pitt Island, shore collection, 25/1/1954, stony.

Ocnus brevidentis (Hutton) 2 specimens

Stn.15 Hanson Bay, 27/1/1954, 43°56'S, 176°18.5'W, 30 fms, fine grey sand.

Ocnus brevidentis (Hutton) 1 specimen

Stn.34 East of the Forty Fours, 1/2/1954, 44°04'S, 175°23.5'W, 130 fms, fine sandy gravel.

Ocnus brevidentis (Hutton) 6 specimens

Stn.41 S.E. of Pitt Island, 3/2/1954, 44°35.5'S, 176°04'W, 330 fms, fine green mud and sand.

Heterothyone alba (Hutton) 1 specimen

Stn.44 N.30°E of Kaingaroa, 7/2/1954, 43°35'S, 176°03.5'W, 125 fms, fine green muddy sand.

Heterothyone alba (Hutton) 1 specimen

Stn.46 Kaingaroa, 7/2/1954, 3 fms, fine grey sand.

Heterothyone alba (Hutton) 3 specimens

Stn.52 Chatham Rise, 10/2/1954, 44°04'S, 178°04'W, 260 fms, fine green mud and sand.

Heterothyone alba (Hutton) 1 specimen

MISCELLANEOUS COLLECTIONS

DOMINION MUSEUM, WELLINGTON

Protankyra uncinata (Hutton)

Foveaux Strait, middle ground, 40 fms. 1 specimen

Tasman Bay, 15 fms. 1 specimen

Wellington Harbour 2 specimens

Kolostoneura novae-zealandiae (Dendy and Hindle)

Menzies Bay, Banks Peninsula 2 specimens

Chiridota nigra Mortensen

North Port, Chalky Inlet, 10 fms. 2 specimens

Trochodota dunedinensis (Parker)

Preservation Inlet, Fiordland. 3 specimens

Molpadia marenzelleri (Theel)

Cook Strait, 40 fms, Coll.F.Abernethy, 14/11/1952. 2 specimens.

Off Foxton, 50 fms. 1 specimen.

Paracaudina chilensis (Muller)

Port Gore 1 specimen

Menzies Bay, Banks Peninsula 3 specimens

Cape Campbell, 40 fms. 1 specimen.

Cook Strait, in gut of fish 1 specimen

New Brighton 1 specimen

East Cape, 60 fms. 1 specimen

New Plymouth, in gut of snapper (*Chrysophrys auratus* Forster) 1 specimen

Amphicyclus thomsoni (Hutton)

Off Stephen's Island 1 specimen

Cook Strait, 100 fms. 1 specimen

North-east Otago, 40 fms, coll. W.H. Dawbin, 13/2/1951 1 specimen

Mamakau Rock Foveaux Strait, 15-20 fms. 1 specimen

Muck Rock, Foveaux Strait, 10 fms. 1 specimen

North of Kapiti Island, 30 fms. 1 specimen

Off Foxton, 50 fms. 2 specimens

Pentadactyla longidentis (Hutton)

Cook Strait, 40 fms. 1 specimen

Wellington Harbour, 10 fms, mud. 1 specimen.

Tasman Bay, coll. by M. Young, Nov.1934 1 specimen

Akaroa Harbour, 3 fms, mud. 1 specimen

Psolidiella nigra Mortensen

Sandfly Bay, Otago Peninsula 2 specimens

Menzies Bay, Banks Peninsula 2 specimens

Ocnus brevidentis (Hutton)

Mamakau Rock, Foveaux Strait, 15-20 fms. 4 specimens

Muck Rock, Foveaux Strait 1 specimen

Ulva Island, Paterson Inlet, Stewart Island 5 specimens

Beach Harbour, Dusky Sound, 6-10 fms, coll. 5/5/1950 1 specimen

Takapuna, Auckland, 6-10 fms (attached to *Carpophyllum* sp. holdfast, coll.18/11/1958 1 specimen

Stolus huttoni (Dendy)

Menzies Bay, Banks Peninsula	1 specimen

Heterothyone alba (Hutton)

Tasman Bay, intertidal zone	1 specimen
Wellington Harbour, 11 fms.	1 specimen

Heterothyone ocnoides (Dendy)

Off Karitane, Otago, 10 fms, sand	3 specimens
Blueskin Bay, Otago, 10 fms, sand	Fragments
Purakanui, Otago, 11 fms, sand	Fragments

Stichopus mollis (Hutton)

Farewell Spit, coll. by S. Gamby, Nov.1952	1 specimen

DEPARTMENT OF ZOOLOGY, VICTORIA UNIVERSITY OF WELLINGTON

Kolostoneura novae-zealandiae (Dendy and Hindle)

Ahuriri, Napier	3 specimens
Island Bay, Wellington	1 specimen

Chiridota alleni n.sp.

Ahuriri, Napier, tidal rock pool, coll. by A.D. Allen 26/5/1959	1 specimen

Trochodota dunedinensis (Parker)

Island Bay, Wellington, intertidal rock pool, coll. by G.W.Gibbs, 11/7/1960	1 specimen

Psolidiella nigra Mortensen

Menzies Bay, Banks Peninsula, coll. by H.B. Fell and E. Percival, 25/4/1959	2 specimens

Heterothyone alba (Hutton)

Kau Bay, Wellington Harbour, 20 fms, mud	1 specimen

<u>Stichopus mollis</u> (Hutton)

Island Bay, coll. by A.D. Allen, 3/6/1959 3 specimens

Balaena Bay, Wellington Harbour, coll. by D.L. Pawson, 21/8/1960 1 specimen.

* Specimens marked thus are not treated in the present account.

CHECKLIST OF NEW ZEALAND HOLOTHURIANS

Order APODA Brandt.

1. *Protankyra uncinata* (Hutton)
2. *Protankyra rigida* n.sp.
3. *Kolostoneura novae-zealandiae* (Dendy and Hindle)
4. *Chiridota alleni* n.sp.
5. *Chiridota mortenseni* n.sp.
6. *Chiridota gigas* Dendy and Hindle
7. *Chiridota nigra* Mortensen
8. *Chiridota carnleyensis* Mortensen
9. *Trochodota dunedinensis* (Parker)
10. *Trochodota dunedinensis* (Parker) var. *microurna* Mortensen
11. *Trochodota dendyi* Mortensen

Order MOLPADONIA Haeckel

12. *Molpadia marenzelleri* (Theel)
13. *Molpadia violacea* (Studer)
14. *Paracaudina chilensis* (Muller)

Order DENDROCHIROTA

15. *Amphicyclus thomsoni* (Hutton)
16. *Mensamariella bicolumnata* (Dendy and Hindle)
17. *Neothyonidium armatum* n.sp.
18. *Neothyonidium dearmatum* (Dendy and Hindle)
19. *Pentadactyla longidentis* (Hutton)
20. *Psolus neozelanicus* Mortensen
21. *Psolidiella nigra* Mortensen
22. *Cucumaria macquariensis* (Dendy)
23. *Stereoderma leoninoides* (Mortensen)

24. *Trachythyone amokurae* (Mortensen)

25. *Trachythyone bollonsi* (Mortensen)

26. *Ocnus farquhari* (Mortensen)

27. *Ocnus brevidentis* (Hutton)

28. *Ocnus brevidentis* (Hutton) var. *carnleyensis* Dendy

29. *Ocnus calcareus* (Dendy)

30. *Stolus huttoni* (Dendy)

31. *Heterothyone alba* (Hutton)

32. *Heterothyone ocnoides* (Dendy)

Order ASPIDOCHIROTA Grube

33. *Stichopus mollis* (Hutton)

34. *Holothuria neozelanica* Mortensen

Order ELASIPODA Theel

35. *Enypniastes eximia* Theel

36. *Pannychia moseleyi* Theel

37. *Laetmogone violacea* Theel

38. *Trachythyone squamata* n. sp. (Known only from Macquarie Island.)

S Y S T E M A T I C S

CLASS H O L O T H U R O I D E A

Diagnosis: Free-living echinoderms (Eleutherozoa), which are elongated in the oral-aboral axis. Mouth surrounded by tentacles which are connected with the water-vascular system. Endoskeleton reduced to microscopic plates or spicules of complex form, sometimes totally lacking. Water-vascular system varies in development from well-developed with numerous tubefeet to almost complete reduction.

The holothurians or sea-cucumbers are typically bottom-dwelling forms, very common in shallow water in the Tropics, and rarer in the Arctic and Antarctic shallow waters. A number inhabit the great depths of the sea, both in the Tropics and in the Polar regions. The Class contains over 1,000 species at the present time.

For identification of holothurians, the systematist must depend partly on internal and external characters, but chiefly on the microscopic spicules, which are rarely totally absent.

External characters: The shape and number of the tentacles are the first characters to be considered. The various Orders in Class Holothuroidea are diagnosed on the basis of differences in tentacle structure and numbers. Tentacles in juvenile specimens may differ in some respects from those in adults.

Body shape is a useful character if used carefully, as the majority of holothurians can change their shape to a considerable degree when they contract.

The arrangement of the feet, whether confined to the radii, scattered in the interradii, restricted to a ventral sole, etc. is of importance, as also is their development into sucking tubefeet, pedicels, processes or wart-like protruberances.

The thickness of the body wall depends to a certain extent on the degree of contraction and also on the age of the animal.

Colour in life and in alcohol is a character which can often be misleading, particularly when a systematist does not state whether the specimen before him is the same colour in life and in alcohol, or whether the colour in life differs from the colour in alcohol, as is so often the case. Many holothurians vary greatly in colour, even when living in the same area. This is exemplified by the common New Zealand aspidochirote, Stichopus mollis (Hutton). Specimens of S. mollis taken from the same rock pool may be dark brown, blackish, or light brown, or some combination of these colours.

Internal characters: The degree of development of the water-vascular system and the organs connected with it are of prime importance. Such characters as presence or absence of tentacle ampullae, whether the stone canal is connected to the body wall or is free, and numbers of Polian vesicles are quite stable, although the Polian vesicles do vary in number, even within the species. This is particularly noticeable in Order Apoda, where Polian vesicle numbers are useless for systematic purposes, unless it is expressly stated that the number of Polian vesicles varies between certain limits.

The calcareous ring is also of prime importance in certain groups, especially in Order Dendrochirota, where the features of the calcareous ring vary to such an extent that the ring can be used for separation at the level of the family, sub-family and genus. In the Elasipoda, Dendrochirota, Molpadonia and Apoda the calcareous ring is fairly stable. However, some workers attach great importance to the calcareous ring in the latter groups, and attempt to revise whole taxa using minute differences in the calcareous rings as a basis. This has unfortunately resulted in much confusion, especially when one realises that during the life of a holothurian, the proportions, shape and sculpture of the calcareous ring change, sometimes drastically, so that juveniles and adults of the same species are often placed into different species when the calcareous ring is used alone as a diagnostic character.

The course of the intestine seems to be of importance only when taken in conjunction with other characters. In most species, the intestine describes an S-shaped loop, but in others it is coiled, or straight.

The 5 radial longitudinal muscles may be divided (as in Orders Molpadonia and Aspidochirota), or simple (as in Orders Dendrochirota, Elasipoda and Apoda). Retractor muscles are present in Dendrochirota, but are absent from the other groups, despite statements to the contrary.

Respiratory trees are absent in some groups (Elasipoda and Apoda), and present in others (Dendrochirota, Aspidochirota and Molpadonia).

The structure of the gonad, its arrangement into 1 or 2 tufts, the length of the common genital duct, and the nature of the branching in the genital tubules are of considerable use, but it must be remembered that the structure of the gonad varies within a species, depending on the time of the year and the age of the specimen.

The details of the internal structures, when considered together in a single species, constitute a very useful set of diagnostic characters. Each small character may be present in various other species, but a particular combination of characters is usually found only in other members of the same species.

Microscopical characters: The spicules are of the greatest importance in identifying holothurians, especially at the level of the genus and species. The spicules present a great variety of shape and size, and they are present in many areas of the body, including the skin, tentacles, tubefeet, anal papillae (where present), introvert (especially in dendrochirotes) and in the madreporite and associated structures.

An attempt has been made in the following account to figure a large selection of spicules for each species, where practical. Many workers in the field of holothurian systematics tend to figure only 1 or 2 spicules for each species. The writer is of the opinion that confusion could arise, and in fact has arisen, as a result of inadequate illustration of such important characters as calcareous deposits. The deposits themselves are subject to much variation in such features as size and shape, and the true range of variation should be illustrated where possible. The size of calcareous deposits is a character of some worth, but it is preferable to note the size range for a particular type of deposit within a species, or the average size, based on a random sample of spicules from different individuals.

Many closely related species have skin deposits which appear to be identical, but their tentacle deposits, tubefeet deposits or introvert deposits (in the dendrochirotes) may differ. Although the deposits in the skin are most often employed for separation at the species level, it is necessary that deposits from other areas should be considered.

As a holothurian grows, its spicules change in size and shape. In the Molpadonia, Family Molpadiidae, most species have their calcareous deposits transformed into phosphatic material as they advance in age. Careful attention must be paid to the changes in deposits with growth, and a thorough examination of juvenile spicules should be made where possible.

Spicules of various types are classified into groups, and given names, such as buttons (see Pl.XV, fig.2), cups (Pl.XV, fig.6), tables (Pl.VIII, fig.7), anchors (in Orders Molpadonia and Apoda) (Pl.I, fig.1; Pl.V, fig.9), and plates (Pl.XI, fig.1). Many other spicules such as rods, anchor-plates, wheels and endplates are easily recognised and named. The names are not rigidly defined, and one finds, for example, plates which may just as well be called rods. But if one bears in mind the limitations of the spicule names, they prove to be a very convenient method of labelling the great variety of spicules which are encountered.

Key to the Orders in Class Holothuroidea

1 (6) Tubefeet well developed. Tentacles shield-shaped or profusely branched.

2 (5) Tentacles shield-shaped. No retractor muscles present.

3 (4) Respiratory trees absent. Mesentery of the posterior loop of the intestine attached in the right dorsal interradius . . . . Order ELASIPODA Theel (p.168)

4 (3) Respiratory trees present. Mesentery of the posterior loop of the intestine attached in the right ventral interradius . . . . .Order ASPIDOCHIROTA Grube (p.163)

5 (2) Tentacles profusely branched. Retractor muscles present . . . . Order DENDROCHIROTA Grube (p. 98)

6 (1) Tubefeet lacking. Tentacles pinnate or digitate.

7 (8) Anal papillae, tentacle ampullae, and respiratory trees present. Body usually ending in a caudal prolongation . . . . Order MOLPADONIA Haeckel (p. 72)

8 (7) Anal papillae, tentacle ampullae, respiratory trees absent. Worm-shaped, without a caudal prolongation . . . . .Order APODA Brandt (p. 38)

Order A P O D A Brandt, 1835

Diagnosis: Modified vermiform holothurians with smooth, rough or warty surface. Podia 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.

Members of this Order are widely distributed in all seas, but are most common in the Indo-West-Pacific. Three distinct families are included here, and they are easily distinguished by the differences in their calcareous deposits.

The Order Apoda is represented in New Zealand by 10 species, which are placed into 4 genera.

Key to the Families in the Order Apoda

1 (2) Deposits in the form of perforated plates accompanied by anchors . . . . .Fam. SYNAPTIDAE (p. 39).

2 (1) Deposits include wheels.

3 (4) Wheels with 6 spokes together with sigmoid or C-shaped rods. Wheels arranged in papillae, or scattered in the body wall . . . . . . Fam. CHIRIDOTIDAE (p.47).

4 (5) Wheels complex, with 8 or more spokes . . . . .Fam. MYRIOTROCHIDAE

Up to the present time, no members of the Family Myriotrochidae have been recorded from New Zealand waters.

Family SYNAPTIDAE

Diagnosis: Calcareous deposits in the form of anchors and anchor-plates. Tentacle-stalk cylindrical or terete, not becoming widened distally, either with digits along each side for most of its length (pinnate), or with only one or two digits along each side near the tip (digitate).

The Synaptidae are represented in New Zealand by the single genus *Protankyra* Ostergren.

Genus *Protankyra* Östergren, 1898

Diagnosis: Arms of the anchors usually serrate, sometimes smooth. Vertex without knobs. Anchor-plates irregular, with numerous holes (Pl.I, figs.2,8).

Two species of *Protankyra* are now known from New Zealand, one of them new to science.

Key to the New Zealand Species of *Protankyra*

1 (2) Anchors small (0.3-0.5 mm long), anchorplates with large perforations . . . . . .*Protankyra uncinata* (Hutton)

2 (1) Anchors large (1-1.2 mm long), anchorplates with many small perforations . . .*Protankyra rigida* n.sp.

Protankyra uncinata (Hutton)

Plate I, figs.3, 5-12.

Synapta uncinata Hutton, 1872, p.16; Theel, 1886, p.27; Dendy, 1896, p.25; Farquhar, 1898, p.325.

Synapta inaequalis Hutton, 1872, p.17.

<u>Protankyra</u> <u>uncinata</u> Mortensen, 1925, p.367, figs.48-51; Heding, 1928, p.252; Dawbin, 1950, p.40.

<u>Material examined:</u> Forty-nine specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 32, off Petone Beach, 8 fms, mud, 3 specimens; VUZ 37, off Shelly Bay, 10-11 fms, mud, 8 specimens; VUZ 40, off Ward Island, 2-4 fms, mud, 2 specimens; VUZ 64, off Point Howard Wharf, 5 fms, blue mud, 10 specimens.

Dominion Museum, Wellington:- B.S:135, Tonga Cove, Tasman Bay, 15 fms, 1 specimen; B.S.174, Petone, 9 fms, 5 specimens (with commensal <u>Scintillona</u> sp.); B.S.194, Somes Island, 11 fms, 7 specimens; Foveaux Strait, 40 fms, 1 specimen; Tasman Bay, 15 fms, 1 specimen; Wellington Harbour, 2 specimens.

New Zealand Oceanographic Institute, Wellington:- B 21 (sample 3), Hawke Bay, 50 fms, 1 specimen; B 54, Hawke Bay, 29 fms, grey-green mud, 2 specimens; C 183, Wanganui, 40 fms, mud and shell, 1 specimen; C 184, Wanganui, 50 fms, sand and mud, 5 specimens.

<u>Diagnosis:</u> Tentacles twelve, with sensory cups and four terminal digits. Colour white transparent to reddish-brown. Anchors small (0.3-0.5 mm long), usually symmetrical, with unbranched finely toothed stock; arms with few serrations or none. Anchor-plates oval or rectangular with many large perforations. Ciliated funnels slipper-shaped, numerous.

<u>Description:</u> Many of the specimens are in a state of complete contraction. Others are partially contracted. In the extended

specimens, the body wall is semi-transparent, and through the skin the radial muscles can easily be seen. The body is cylindrical, tapering sharply to the terminal anus.

Colour in alcohol varies between white transparent and reddish-brown. A brown pigment spot lies at the base between each pair of tentacles.

The skin is often quite prickly to touch. This prickly sensation is caused by the presence of projecting anchor arms, which can be seen with the naked eye.

The tentacles are elongate and more or less cylindrical in shape. Four long unbranched digits arise from the terminal part of the tentacle stem. The stem carries numbers of small sensory cups on its inner margin (Pl.I, fig.11). These cups are usually arranged in two rows along the margins of the stem, but often a more haphazard distribution is seen. No theory has as yet been put forward to explain the exact function of the cups. They occur in other members of this genus, and also in species of the genus Leptosynapta Verrill.

When in a state of contraction, 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 five soft fleshy lumps. This method of contraction was not observed in any other species, and may be characteristic of Protankyra uncinata (Pl.I, fig.10).

The calcareous ring is composed of twelve small square pieces. The five radial pieces are perforated for the passage of the radial nerves. (Mortensen, 1925).

The oesophagus is thin-walled and short, leading into a well-defined stomach which has a thick, muscular wall (Pl.I, fig.9). Mortensen (1925) stated that the stomach is indistinguishable from the intestine. The writer dissected 10 specimens of <u>Protankyra</u> <u>uncinata</u>, and all of the specimens possessed muscular stomachs. The intestine takes a small loop and runs into an undifferentiated cloaca and thence to the anus.

Polian vesicles number 4-5, 2 or 3 of which are conspicuously longer than the rest (Pl.I, fig.9). They are tubular, with lengths varying between 3 mm and 25 mm. 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 0.2 mm in diameter, terminating in a small irregular madreporite.

Genital tubules are moniliform and sparsely branched, arranged into two bunches which extend for about half of the length of the body cavity. The common genital duct lies in the dorsal mesentery, and opens to the exterior as a definite genital pore in the middorsal interradius, immediately posterior to the ring of tentacles (Pl.I, fig.9).

Longitudinal muscles are well developed, and are thick and firm in contracted specimens. Transverse muscles are represented as bunches of very fine fibres.

Deposits of four kinds were found:

1. Anchors:- The anchors are approximately symmetrical, although some asymmetrical examples are often encountered, especially near the posterior end (Pl.I, fig.5). Total length of the anchors varies between 0.3 and 0.5 mm. The arms have 3-7 irregular serrations on their upper edges, or none at all. However, smooth

arms are the exception rather than the rule. The stock is unbranched and carries a number of fine teeth, irregularly arranged (Pl.I, fig.6).

2. Anchor-plates:- The anchor-plates are rectangular or oval in shape, with many large angular to circular perforations. Average length of the anchor-plates along the long axis is about 0.3 mm. The narrower end of the anchor-plate is reflected to form a bridge for the support of the anchor stock (Pl.I, figs.6, 8). Fig.6 shows the way in which an anchor-plate and anchor are associated in the skin. The anchor is supported in such a way that the arms project above the surface of the skin.

Stages in the development of anchor-plates were found near the extreme posterior end of the body (Pl.I, fig.7). The anchors develop before the plates.

3. Tentacle-deposits:- Curved and dumb-bell-shaped rods are present in the tentacles in great numbers. The curved rods are C- or bracket-shaped, 0.03-0.06 mm long, and are confined to the digits of the tentacles, where they form an investing layer (Pl.I, fig.3). Dumbbell-shaped rods invest the tentacle stems. They are 0.02-0.04 mm long.

4. Lenticular bodies:- Radial muscles contain oval to dumb-bell-shaped lenticular bodies in small clumps. They are about 0.02-0.05 mm in length. (Pl.I, fig.12).

Mortensen (1925) figured small irregular perforated plates which he found "in the anterior end ... more or less sparsely". None of these small irregular plates were found in any of the specimens examined by the present writer.

Distribution: The new localities, together with Mortensen's (1925) localities Wellington Harbour, Colville Channel and Tiritiri, Auckland, lead to the supposition that *Protankyra uncinata* has a very wide distribution around the coasts of New Zealand, from Stewart Island in the south to the Hauraki Gulf in the north. However, the species is endemic, at the present time known only from the New Zealand mainland.

Ecology: *P. uncinata* prefers a sandy or muddy bottom in comparatively sheltered areas. No specimens have been taken from depths below 50 fathoms, so this species may be regarded as a member of the littoral holothurian fauna of New Zealand.

Discussion: Hutton (1872) gave an inadequate description of his *Synapta uncinata* and *Synapta inaequalis*. As a consequence, Clark (1907) did not include these 2 species in his excellent monograph. Mortensen (1925) established the validity of *uncinata* and transferred it to the genus *Protankyra*. Hutton's *inaequalis* was synonymised with *uncinata*, as *inaequalis* was based on a single specimen which possessed some asymmetrical anchors. However, many specimens of *uncinata* have asymmetrical anchors, and *inaequalis* was probably an individual variant.

The presence of a commensal mollusc, *Scintillona* sp., on a specimen from Wellington Harbour is an interesting phenomenon. Unfortunately, the mollusc was removed from the specimen before the relationship between the two animals was ascertained.

A degree of individual variation is noticeable in colouration, specimens from the same area being very differently coloured in many cases.

P. uncinata appears to have no very close relatives, either

P L A T E   I

Protankyra rigida n.sp.

Fig.1. Anchors.

a. Whole anchor from the middle of the body.

b. Anchor fluke, showing serrations.

c. Anchor stock.

Fig.2. Anchor plates.

Fig.4. Lenticular bodies from radial muscles.

Protankyra uncinata (Hutton)

Fig.3. Tentacle deposits.

Fig.5. Portion of an anchor from the posterior of the body.

Fig.6. Anchor and anchor-plate in situ.

Fig.7. Developing anchor-plates.

Fig.8. Fully developed anchor-plate.

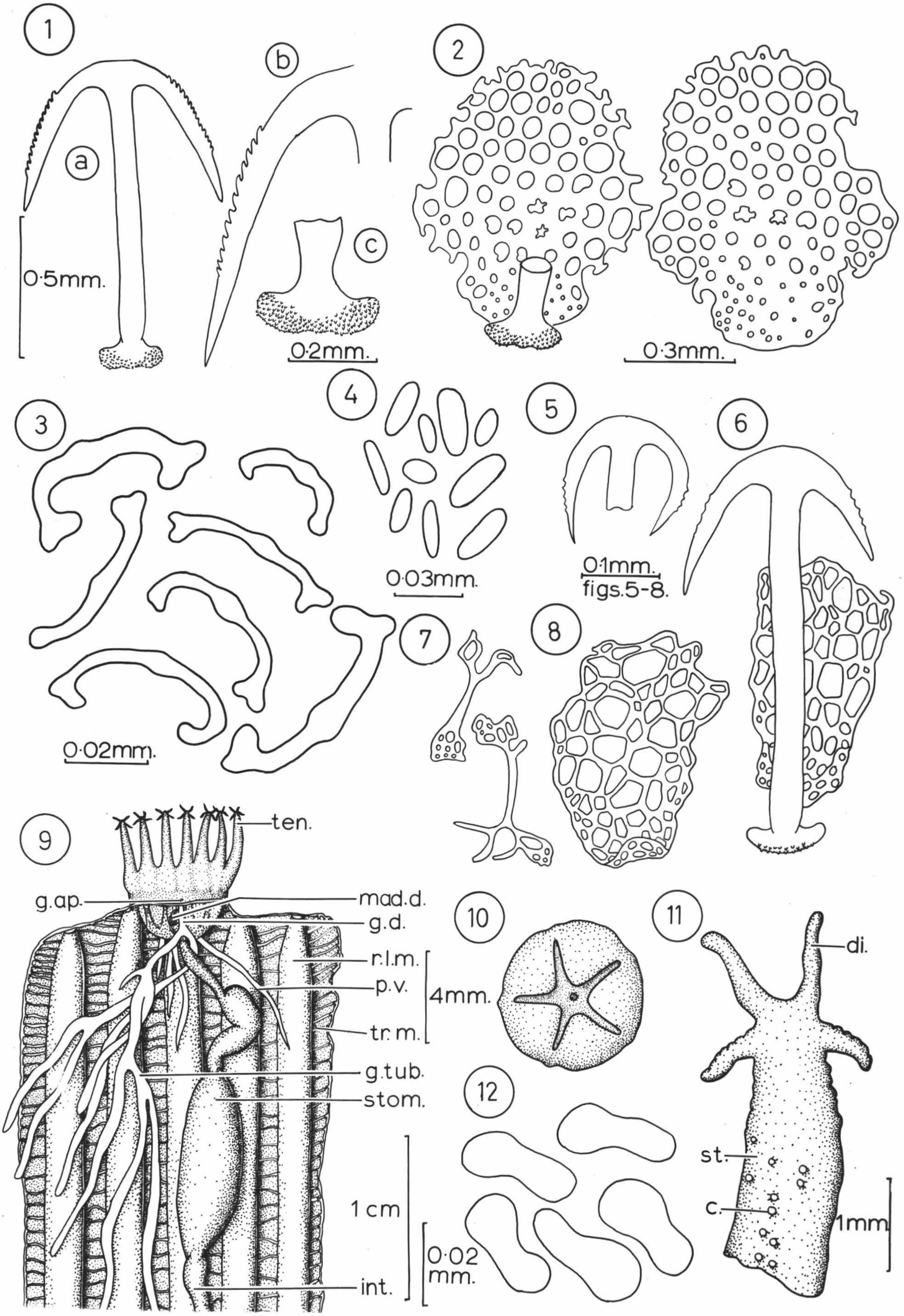
Fig.9. Internal anatomy of adult dissected from the dorsal side. (Portions of gonad removed.)

Fig.10. Anterior end of a contracted specimen.

Fig.11. Tentacle.

Fig.12. Lenticular bodies from radial muscles.

Abbreviations: c., sensory cup; di., tentacle digit; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; mad.d., madreporic duct or stone canal; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; st., tentacle stem; stom., stomach; ten., tentacles; tr.m., transverse muscles.


1
a
b
c
0·5mm.
0·2mm.
2
0·3mm.
3
0·02mm.
4
0·03mm.
5
0·1mm.
figs.5-8.
6
7
8
9
ten.
g.ap.
mad.d.
g.d.
r.l.m.
p.v.
4mm.
tr.m.
g.tub.
stom.
1 cm
0·02
mm.
int.
10
11
di.
12
st.
c.
1mm

in New Zealand or overseas, and is therefore a very distinct species.

Protankyra rigida n.sp.

Plate I, figs.1,2,4.

Material examined: In the collection of the New Zealand Oceanographic Institute, Wellington:- Stn.C 166, off Cape Egmont, 100-150 fms, grey mud, 1 specimen.

Diagnosis: Body elongate, approximately cylindrical. Colour in alcohol buff, with numerous large white spots. Anchors very large (1-1.2 mm long) and symmetrical; arms with 10-14 serrations; stock unbranched and finely toothed. Anchor-plates also large, oval, with numerous small perforations.

Description: The single specimen is completely contracted, and the body wall is very stiff and rough to touch. The interradial areas are raised and carry numerous conspicuous white spots. The radii are completely naked, and the buff-coloured body wall is clearly visible. Each white spot is an anchor-plate with an attached anchor. The anchors are supported in such a way that they project through the skin of the specimen and can be seen with the naked eye. There are as many as 60 anchor-plates to each interradius. The anchor-plates tend to decrease in size toward the posterior end of the body, and they are absent from the anterior and posterior extremities.

As the specimen is in a state of contraction, the structure of the tentacles could not be ascertained.

Deposits of three kinds were found:

1. Anchors:- The anchors are rather larger than those from other members of the genus Protankyra. Their length almost invariably exceeds 1 mm. They are quite symmetrical, with long sharply pointed arms, which have 10-14 serrations on their upper edges. The stock is simple, unbranched, and carries a number of fine teeth, irregularly arranged. (Pl.I, fig.1, a-c.)

2. Anchor-plates:- The anchor-plates are approximately oval in shape, 0.7-1.0 mm long and 0.5-0.7 mm broad (Pl.I, fig.2). The perforations are small, round, and numerous (60-110). Some perforations near the middle of the plate have 1-5 small inpushings. There is no true bridge for the support of the anchor; the area of attachment is marked by a number of scattered smaller perforations. As is the case in P. uncinata, the anchor is supported in such a way that the arms and a small portion of the shaft project from the skin.

3. Lenticular bodies:- The radial muscles contain large numbers of oval to elongate granules 0.015-0.03 mm in length. These lie in irregular rows, parallel to the longitudinal axes of the radial muscles. (Pl.I, fig.4).

Discussion: Protankyra rigida is an interesting addition to the holothurian fauna of New Zealand. Its nearest relative appears to be Protankyra denticulata Koehler and Vaney (1905), which is known from a single specimen taken from a depth of 738 metres off Madras, India. There is, however, no doubt that the specimen described above is a member of a different species. The following differences between the two species have been observed:

1. In both species, the anchors exceed 1 mm in total length, but the anchors of P. denticulata are in general more massive.

The ratio shaft width : total length of anchor serves to demonstrate this feature. P. denticulata ratio = 1 : 6; P. rigida ratio = 1 : 10. The stock of the anchor shows weak but definite branching in P. denticulata. There is no evidence of such branching in the New Zealand species.

The anchor arms are broader and shorter in proportion in P. denticulata, and carry fewer serrations. Koehler and Vaney (1905, Pl.XV, fig.37) illustrate a portion of an anchor which has serrations from one arm tip to another. No such serrations were found in P. rigida.

2. Differences were also observed in the anchor plates. They are approximately the same size and shape in both species, although the plates of P. denticulata tend to be more regularly rectangular, with the larger perforations near the centre of the plate. In P. rigida this situation is reversed, the larger perforations being most common near the edge of the plate.

3. P. denticulata was described from a specimen 70 mm long and 12 mm in diameter. Thus there is also a considerable discrepancy in size between the two species.

Holotype: The holotype lies in the collection of the New Zealand Oceanographic Institue, Wellington.

Dimensions of holotype: Total length 39 mm; diameter at anterior end 9 mm.

Family CHIRIDOTIDAE

Diagnosis: Calcareous deposits in the form of 6-spoked wheels and/or sigmoid or C-shaped rods. 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.

This family has a world-wide distribution and contains mainly small holothurians. Three genera and 8 species are now known from New Zealand. Two of the species are new to science.

Key to the New Zealand Genera of Family Chiridotidae

1 (2) Calcareous deposits wanting in the body wall . . . . . .
. . . . Kolostoneura Becher, 1909

2 (1) Calcareous deposits always present.

3 (4) Sigmoid rods absent. Wheels arranged in small heaps . . . .
. . . . Chiridota Eschscholtz, 1829

4 (3) Sigmoid rods present. Wheels scattered or arranged in loose heaps, or sometimes so scattered as to be easily overlooked . . . . . . Trochodota Ludwig, 1892

Genus Kolostoneura Becher, 1909

Diagnosis: Calcareous deposits absent from the body wall. Tentacles 10. General features of anatomy similar to those in genus Trochodota Ludwig.

Kolostoneura is, up to the present time, a monotypic genus, the single representative, K. novae-zealandiae (Dendy and Hindle) being endemic to the New Zealand region.

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; H.L. Clark, 1921, p.164; Mortensen, 1925, p.383; Dawbin, 1950, p.40.

Material examined: Eleven specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- Ahuriri, Napier, muddy tide pool, 3 specimens, coll. D.L. Pawson 20/5/59; Island Bay, intertidal rock pool, 1 specimen, coll. A.D. Allen.

Dominion Museum, Wellington:- B.S.130, Pelorus Sound, 1 specimen; Portobello, Otago, 3 specimens; Menzies Bay, Lyttelton Harbour, 2 specimens.

Dominion Museum, Cape Expedition material:- No.1 Station Inlet, Auckland Islands, in mud under boulders, 1 specimen, coll. W.H. Dawbin and J.Jones 20/8/43.

Diagnosis: Colour in life pinkish-brown and transparent. White and transparent in alcohol. Tentacles pinnate, occasionally containing calcareous deposits.

Description: All of the specimens are white and transparent in alcohol, and approximately cylindrical in shape. The radial muscles are clearly visible through the body wall. Total length varies between 15 mm and 40 mm. The ten tentacles each give rise to 5 pairs of pinnately arranged branches which increase in length towards the distal extremities of the tentacles.

Dendy and Hindle (1907) gave a very complete description of the internal anatomy of K. novae-zealandiae. Mortensen (1925) agreed with Dendy and Hindle's account in all respects and added his observations on the almost invariable presence of calcareous deposits in the tentacles. Of the 24 specimens available to Mortensen, all but two contained calcareous deposits in the tentacles. The present writer examined the tentacles of 9 specimens and calcareous deposits were found in only one of them. Eighteen of Mortensen's specimens were from Plimmerton, near Wellington, and many of these also contained scattered spicules in the skin, so presumably most of these specimens possessed tentacle deposits. Mortensen (1925) believed that the presence of deposits in the skin of some of his specimens was induced somehow by the presence of ectoparasitic snails. Perhaps Mortensen's statement, "the tentacles contain, almost invariably, calcareous spicules", may not be quite true for specimens of K. novae-zealandiae living under normal conditions without ectoparasites. The statement could be modified to read, "the tentacles occasionally contain calcareous spicules".

Distribution: Dendy and Hindle's (1907) specimens were taken from New Brighton Beach, Kaikoura, and Ouenga in the Chatham Islands. Mortensen (1925) found specimens at Akaroa, Plimmerton, Takapuna Beach and Stewart Island. The new localities Menzies Bay, Pelorus Sound, Portobello, Island Bay, Napier, and the Auckland Islands lead to the inference that K. novae-zealandiae is a common member of the littoral holothurian fauna of New Zealand. Its presence at the Auckland Islands is also interesting from the zoogeographical point of view. This species is endemic to the New Zealand region.

Ecology: K. novae-zealandiae is restricted to the littoral zone, lying hidden under rocks in sand or mud.

Discussion: Becher's (1909) genus Kolostoneura at present contains only one species. The name Kolostoneura was employed as Dendy and Hindle (1907) had stated that the radial nerve disappears even before reaching the level of the calcareous ring. The use of the name Kolostoneura in preference to Rhabdomolgus eliminates any suggestion of a genetic relationship between K. novae-zealandiae and Rhabdomolgus ruber Keferstein, which is known from deep water off Hawaii. Becher (1909) proved that there was no genetic relationship between the two species. Clark (1921) agreed fully with Becher, 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 infected specimens from Plimmerton lends much support to Clark's theory.

The genus 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 Ostergren without deposits.

Genus Chiridota Eschscholtz 1829

Diagnosis: Tentacles 12, digits 3-10 on each side, the terminal pair being the longest. Polian vesicles numerous (3-20). Deposits in the form of 6-spoked wheels collected into small papillae containing varying numbers of wheels of diverse sizes. No sigmoid deposits, but small curved rods with enlarged ends may be present, and minute lenticular bodies often occur in the longitudinal muscles.

The genus Chiridota is represented in New Zealand by 5 species, 2 of which are new to science. All except 1 are endemic to the New Zealand region. Chiridota gigas Dendy and Hindle is known from New Zealand and Western Australia.

Key to the New Zealand Species of Chiridota

1 (6) Thick rods with spinous extremities present in the skin.

2 (5) Radial pieces of the calcareous ring perforated anteriorly for the passage of the radial nerve.

3 (4) Great numbers of spinous rods present in the radii, and many in the interradii. Rods also found in numbers associated with wheel papillae. Wheel papillae with 80-120 wheels. Colour in alcohol white transparent . . . . C. alleni n.sp.

4 (3) Spinous rods scattered, and mainly confined to the radial areas. Wheel papillae with 20-60 wheels. Colour in alcohol orange . . . . . . C. mortenseni n.sp.

5 (2) Radial pieces of the calcareous ring not perforated. Interradials ovoid in shape . . C. gigas Dendy and Hindle

6 (1) Thick spinous rods absent.

7 (8) Lenticular bodies present in radial muscles. Colour black with whitish spots . . . C. nigra Mortensen

8 (7) Lenticular bodies absent. Colour white transparent . . . . C. carnleyensis Mortensen

Chiridota alleni n.sp.

Plate II, figs.1-5

Material examined: Ahuriri, Napier, under stones at lowtide level, 1 specimen, coll. A.D. Allen, 26/3/59.

Diagnosis: Short curved spinous rods present in the skin in great numbers, and also associated with wheels in the wheel papillae. Calcareous ring fragile. Radials perforated, interradials with

P L A T E II

Chiridota alleni n.sp.

Fig.1. Tentacle.

Fig.2. Lenticular bodies from radial muscles.

Fig.3. Spinous rods from the skin.

Fig.4. Typical wheel from a wheel-papilla.

Fig.5. Pieces of the calcareous ring.

Chiridota mortenseni n.sp.

Fig.6. Lenticular bodies from radial muscles.

Fig.7. Rods from the tentacle digits.

Fig.8. Spinous rods from the skin.

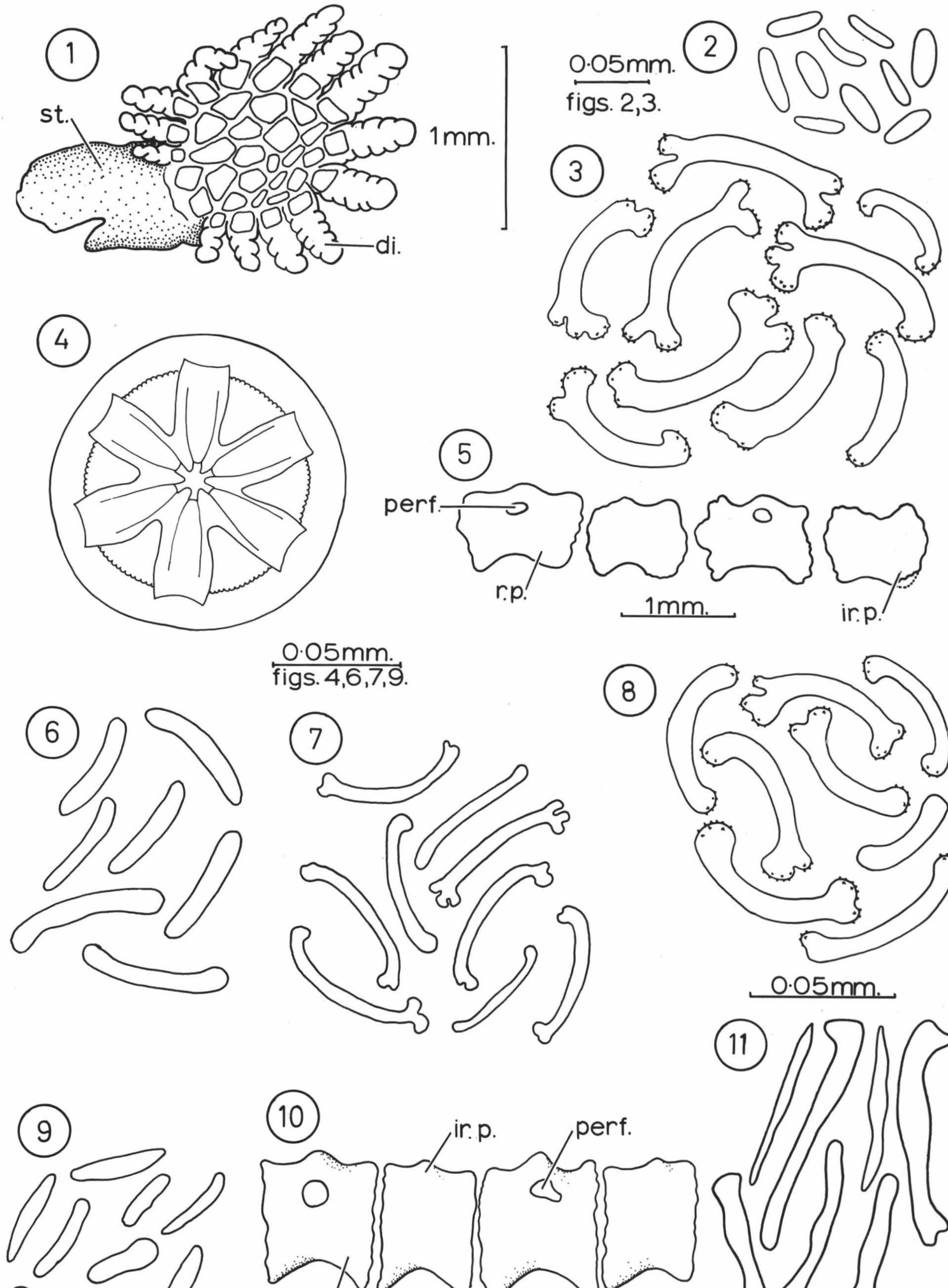
Fig.9. Rods from the tentacle stems.

Fig.10. Pieces of the calcareous ring.

Trochodota dunedinensis (Parker)

Fig.11. Rods from the tentacles.

Abbreviations: di., tentacle digit; ir.p., interradial piece; perf., perforation; r.p., radial piece; st., tentacle stem.


1
st.
di.
1mm.
2
0·05mm.
figs. 2,3.
3
4
5
perf.
r.p.
1mm.
ir.p.
0·05mm.
figs. 4,6,7,9.
6
7
8
0·05mm.
9
10
ir.p.
perf.
r.p.
1mm.
11
0·02mm.

no anterior projection. Colour in life, light red; in alcohol, white transparent.

Description: The single specimen is cylindrical in shape, and tapers gently towards the posterior end. In life the colour is pink-red, while in spirit the colour disappears and the skin becomes white and translucent. The radial muscles are visible through the body wall as five broad bands. The skin is beset with numerous circular papillae (about 0.7 mm diameter), which are light coloured in the living animal. Most of these papillae lie on the dorsal surface, concentrated mainly in the dorsal interradii. Ventrally, there are a few papillae, scattered over radii and interradii.

The mouth takes the form of a dorsoventral slit, and is surrounded by a single ring of peltato-digitate tentacles. Each tentacle carries seven pairs of digits arranged around the margin of a central disc (Pl.II, fig.1). The digits tend to increase in length toward the distal extremity. The tentacle disc carries a peculiar pattern of slightly raised polygonal areas on its inner surface (Pl.II, fig.1). Between the tentacle bases, brown pigment spots are found.

The calcareous ring is composed of twelve small fragile pieces, five radials and seven interradials. The two extra interradials lie in the left and right lateral interradii. The radial pieces are perforated anteriorly for the passage of the radial nerves, and have a shallow notch posteriorly. Anteriorly, the radials have a blunt projection, while the interradials have a shallow notch (Pl.II, fig.5).

Deposits of four kinds were found:-

1. Wheels:- The numerous papillae on the skin are actually heaps of wheels. They are symmetrical, varying in size, and have 6 spokes (Pl.II, fig.4). In this species the papillae contain an average of 100 wheels each. The wheel diameter ranges between 0.075 mm and 0.16 mm, with an average of 0.13 mm. The wheels are very similar to those found in other members of this genus.

2. Spinous rods:- Short curved rods with enlarged spinous extremities are present in the wheel papillae and scattered in the skin in great numbers, especially along the radii. The enlarged extremities of the rods tend towards bifurcation to a greater or lesser degree. Average length of rods is 0.17 mm (Pl.II, fig.3).

3. Tentacle rods:- Numerous rods are present scattered in the tentacles. They are rather similar to those in the skin, but are in general slightly smaller.

4. Lenticular bodies:- Oval to elongate lenticular bodies are found in 2 rows in the radial muscles, along the whole length of the body. They have their long axes parallel to the longitudinal axes of the muscles. Average length of the lenticular bodies is about 0.04 mm (Pl.II, fig.2).

Discussion: *C. alleni* is quite distinct from other members of the genus *Chiridota*. Its nearest relative appears to be the Australasian species *C. gigas* Dendy and Hindle. However, the present species differs from *C. gigas* in the following respects:

1. Each radial piece of the calcareous ring in *C. alleni* is perforated, and has a pronounced posterior notch, whereas in

C. gigas the radials are not perforated, and lack a posterior notch in the strict sense.

2. In C. alleni, the curved spinous rods are often associated with wheels in the papillae. This is not the case in C. gigas. The papillae of C. alleni are round and of approximately the same size all over the skin. "Larger aggregations of somewhat vermiform shape ..." (Dendy and Hindle, 1907), present in C. gigas are absent in C. alleni as also are the "few wheels . . . isolated in the body wall" (Dendy and Hindle, 1907).

Holotype: The holotype lies in the collection of the Department of Zoology, Victoria University of Wellington.

Dimensions of holotype: Total length 60 mm; diameter at anterior end 5 mm.

Chiridota mortenseni n.sp.

Plate II, figs.6-10; Plate III.

Material examined: In the collection of Portobello Marine Biological Station, Dunedin:- Little Papanui, Otago, under stones on sand at low tide level, 1 specimen, collected 17/9/57.

Diagnosis: Spinous rods present in small numbers in the radii. Radial pieces of calcareous ring perforated, interradials with anterior processes. Colour in life, light red; in alcohol, orange-brown. Tentacles each with 6 pairs of digits.

Description: The specimen is approximately cylindrical and elongate, and the skin is thin and firm, but opaque. When alive, C. mortenseni is light red in colour with numerous paler spots, while in alcohol the body is orange-brown and the tentacles are light orange.

PLATE III

Chiridota mortenseni n. sp., viewed from the ventral side. (x 2).

The skin carries a number of small regular circular papillae which are present in great numbers on the dorsal side, but are more scattered ventrally (Pl.III). These papillae lie in the interradii, but are not strictly confined to them, so that on superficial examination they appear to be scattered over the whole of the dorsal surface. Near the anterior and posterior extremities the papillae are more closely packed together.

The mouth is circular, and surrounded by a single ring of 11 tentacles which vary slightly in size. Each tentacle carries 6 or 7 pairs of digits, the terminal pair being the longest in each case. The anus is terminal.

The calcareous ring is composed of 12 small rectangular pieces, 5 radials and 7 interradials. The 2 extra interradials lie dorsally, 1 in each lateral dorsal interradius. Radials are perforated for the passage of the radial nerve, and are slightly larger than the interradials, being about 0.6 mm wide and 0.7 mm long, while the interradials are 0.5 mm wide and 0.6 mm long. Anteriorly, each piece carries a single projection which is more pronounced in the radial pieces (Pl.II, fig.10). Each piece has a shallow notch posteriorly.

The oesophagus is short, narrow and thin-walled and runs into the intestine, which takes a short loop in the middle of the body, and then proceeds to the undifferentiated cloaca which opens to the outside as the anus.

The water-vascular ring lies immediately behind the calcareous ring and gives rise to the tentacular canals anteriorly and the Polian vesicles and stone canal posteriorly. There are 7 Polian vesicles, each about 3-4 mm in length. Also present on the ring vessel are 3 small nodules which might well be interpreted as developing Polian vesicles. The stone canal arises on the dorsal side of the ring and runs anteriorly for a short distance in the dorsal mesentery, terminating in an oval flattened madreporite.

Gonads consist of 2 small bunches of long, sparsely branched caecae which lie to the right and left of the dorsal mesentery, and join to form the common genital duct at the level of the water-vascular ring. The genital duct runs anteriorly in the dorsal mesentery (together with the stone canal), and opens to the exterior as the genital pore in the mid-dorsal interradius, immediately posterior to the ring of tentacles.

Ciliated funnels occur in the left dorsal interradius in large numbers. They are wide-mouthed and trumpet-shaped, with a long stalk. Longitudinal muscles are 5 broad bands.

Deposits of 4 kinds are present in this species:

1. Wheels:- The majority of the skin papillae are composed entirely of aggregations of 6-spoked wheels in varying numbers (20-60). Wheel diameter ranges between 0.05 mm and 0.1 mm. The inturned margins of the wheels are finely serrated, the average number of serrations being about 70 to each wheel. The wheels are confined to the papillae, and none were found elsewhere.

2. Spinous rods:- Curved rods with spinous ends occur in small numbers in the skin, mainly overlying the radial muscles. They are C- or bracket-shaped, and their ends are occasionally weakly bifurcated. Average length of these rods is 0.1 mm. (Pl.II, fig.8.)

3. Tentacle-rods:- Two types of tentacle-rods can be distinguished. Rods from the digits are curved, 0.04-0.07 mm long and about 0.005 mm wide. Their ends are frequently slightly enlarged and occasionally bifurcating (Pl.II, fig.7). They are closely packed together into two rows in each digit. The stem rods are scattered, of irregular shape and variable size (Pl.II, fig.9).

4. Lenticular bodies:- These are smooth, elongate (0.04-0.08 mm long), narrow rods with smooth rounded ends. They lie in the radial longitudinal muscles in double rows, with their long axes parallel to the longitudinal axis of each muscle. (Pl.II, fig.6.)

Discussion: The usual number of tentacles in members of this genus is 12, but frequently the number varies between 10 and 14 (Clark, 1907), so the 11 tentacles in this specimen is of no great systematic significance, and cannot be regarded as a character of the species.

C. mortenseni resembles C. gigas Dendy and Hindle in some respects, but the two species are separable on the basis of differences in the calcareous ring. In contrast to the radials of C. mortenseni, the radial pieces of C. gigas are not perforated, are ovoid in shape, and have no posterior notch. Also, C. gigas is scarlet alive and has at least 19 Polian vesicles.

C. alleni and C. mortenseni differ also in features of the calcareous ring. The interradial pieces of C. mortenseni have an anterior projection, while those in C. alleni have none. In fact, they each have a shallow notch.

C. mortenseni seems to have C. rigida Semper as its nearest relative. C. rigida is known from the East Indian region. There are numerous differences between these 2 species, especially in the spinous rods and features of the calcareous ring.

Holotype: The holotype lies in the collection of the Department of Zoology, Victoria University of Wellington.

Dimensions of holotype: Total length, 95 mm; diameter at middle of body, 5 mm.

Chiridota gigas Dendy and Hindle

Chiridota gigas Dendy and Hindle, 1907, p.110, Pl.12, figs.9-11; Joshua, 1914, p.7; Mortensen, 1925, p.370, fig.53; Clark, 1946, p.457; Dawbin, 1950, p.40, Pl.2, fig.22.

Material examined: None.

Diagnosis: Elongate, cylindrical, body wall with many papillae which are circular anteriorly and posteriorly, but form vermiform prominences near the middle of the body. Calcareous ring containing 12 pieces, the radials rounded anteriorly, interradials ovoid. No perforation for passage of radial nerve. (Dendy and Hindle, 1907.)

Discussion: C. gigas is not a very conspicuous member of the New Zealand holothurian fauna. Dendy and Hindle (1907) described the species from 1 specimen, and Mortensen (1925) gave a brief account of a single specimen from the Chatham Islands. Joshua (1914) reported the occurrence of this species on the coast of Victoria. Clark (1946) recorded the presence of C. gigas on the northeastern coast of Tasmania, and later stated that there is not a firm enough basis for discussion about the distribution of C. gigas, as the species is insufficiently well known. At the present time this situation has not altered.

Chiridota nigra Mortensen

Plate IV, figs.1-5

Chiridota gigas Benham, 1909, p.73.

Chiridota nigra Mortensen, 1925, p.371, figs.54-57; Dawbin, 1950, p.40, Pl.2, fig.21.

Non: Chiridota gigas Dendy and Hindle, 1907, p.110.

Material examined: Thirty-one specimens from the following stations:

In the collection of the Dominion Museum, Wellington:- B.S.141, Kaipipi Bay, Stewart Island, 5 fms, 26 specimens; B.S.180, Cook Strait, 150 fms, 3 specimens; North Port, Chalky Inlet, 10 fms, 2 specimens.

Diagnosis: Elongate, cylindrical. Dorsal surface black with white spots; ventral surface greyish-white. Dorsal skin peels off in small rags revealing white undersurface. Wheel papillae few, large, and confined to the 3 dorsal interradii, visible as white spots. Spinous rods absent.

Description: All of the specimens are quite large, the largest being 180 mm long and 8 mm in diameter at the anterior end. They are elongate and approximately cylindrical in shape. The 2 specimens from Chalky Inlet are uniformly wine-coloured, but the rest are black with white spots dorsally and greyish-white ventrally. In contracted specimens, the skin is quite thick and has a number of transverse wrinkles, while in relaxed forms the skin is quite thin and smooth. The white spots are wheel papillae, and they are arranged in single irregular rows in the 3 dorsal interradii.

The mouth is circular, lying in the centre of a small funnel-shaped depression, and is surrounded by a single ring of 12 tentacles. The stems of the tentacles are greyish-black while the digits are quite white. Each tentacle has 5 pairs of digits which increase in length toward the distal extremity of the tentacle, the terminal pair being about twice as long as the proximal pair. The outer surface of the tentacle disc has a pattern of small polygonal areas which seem to be quite distinctive (Pl.IV, fig.2).

The calcareous ring is composed of 12 almost square pieces which are firmly blonded together. Separation of the pieces with sodium hydroxide is rather difficult. The radials are perforated for the passage of the radial nerve, have a sharp anterior projection and a shallow posterior notch. The anterior projection is more pronounced on the interradials.

The oesophagus is short and nonmuscular. The intestine, which has a rugose surface, describes a very short loop in the middle of the body and runs undifferentiated to the terminal anus.

There are 15-20 Polian vesicles in C. nigra, arising from the ventral side of the water-vascular ring (Pl.IV, fig.1). Length varies between 0.5 mm and 9 mm. The single stone canal arises from the dorsal side of the water-vascular ring, is loosely coiled, and runs anteriorly in the dorsal mesentery, terminating in an irregular madreporite (Pl.IV, fig.1).

P L A T E   IV

Chiridota nigra Mortensen

Fig.1. Internal anatomy of the anterior end of an adult. (Portions of the gonad removed.)

Fig.2. Tentacle.

Fig.3. Lenticular bodies from radial muscles.

Fig.4. Bracket-shaped tentacle rods.

Fig.5. Ciliated funnels.

Molpadia violacea (Studer)

Fig.6. Fusiform rod from the anterior end of the body.

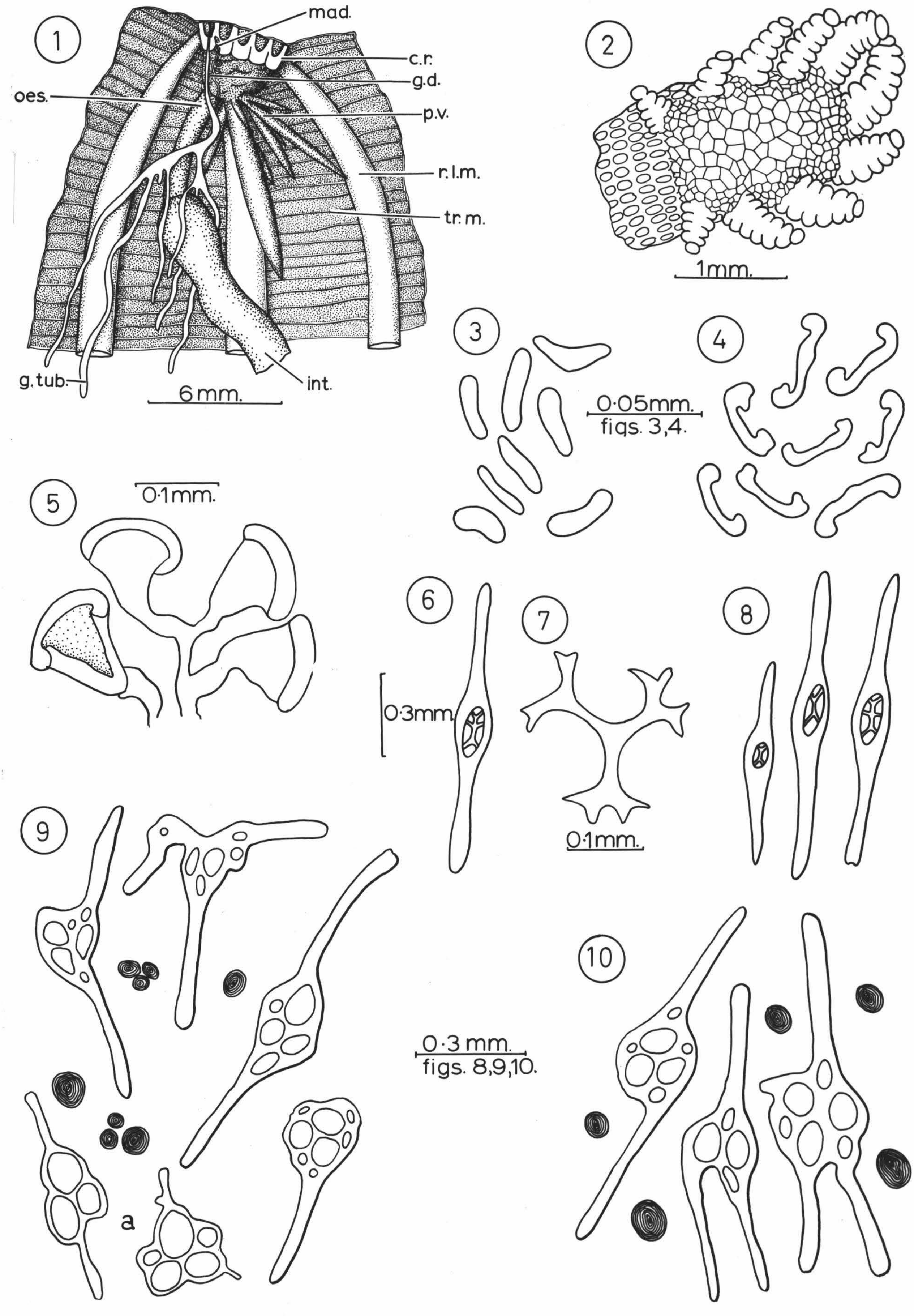
Fig.7. A stage in the development of a small perforated plate.

Fig.8. Fusiform rods from the tail.

Fig.9. Fusiform rods, perforated plates and phosphatic deposits from the middle of the body.

Fig.10. Fusiform rods and phosphatic deposits from the posterior end of the body, near the tail.

Abbreviations: c.r., calcareous ring; g.d., genital duct; g.tub., genital tubule; int., intestine; mad., madreporite; oes., oesophagus; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; tr.m., transverse muscles.


1
mad.
c.r.
g.d.
oes.
p.v.
r.l.m.
tr.m.
g.tub.
int.
6 mm.
2
1mm.
3
4
0·05mm.
figs. 3,4.
5
0·1mm.
6
0·3mm.
7
0·1mm.
8
9
a
10
0·3 mm.
figs. 8,9,10.

The gonads consist of two small bunches of long unbranched caecae, each bunch being about 30 mm in length. (The length of the bunch varies considerably, depending on the age of the specimen examined.) The common genital duct runs anteriorly in the dorsal mesentery and opens to the exterior in the mid-dorsal interradius, between the two dorsal tentacles as a poorly defined genital pore or gonoporus. (Pl.IV, fig.1.)

The longitudinal muscles take the form of 5 broad straps. Transverse muscles are well defined. (Pl.IV, fig.1.)

Ciliated funnels (Pl.IV, fig.5) are present in numbers in the left dorsolateral and the left ventrolateral interradii. They are bell-shaped, with wide mouths and short stalks.

Deposits of 3 kinds were found:

1. Wheels:- The dorsal papillae are circular, 1-2 mm in diameter, and each contains up to 250 wheels of varying size. The largest wheel encountered by the writer had a diameter of 0.2 mm. In structure, the wheels resemble those from other species of Chiridota.

2. Tentacle rods:- Bracket-shaped rods are scattered in the tentacle stems and arranged in double rows in the digits. The rods are 0.03-0.05 mm long and have enlarged ends. (Pl.IV, fig.4.)

3. Lenticular bodies:- The radial muscles contain elongate lenticular bodies with rounded ends. They are slightly curved and lie scattered in the muscles. Length of the bodies varies between 0.02 mm and 0.04 mm (Pl.IV, fig.3).

Distribution: Mortensen (1925) described specimens of *C. nigra* from 15 fathoms in Paterson Inlet, Stewart Island, and 45 fathoms in Carnley Harbour, Auckland Islands. The two new localities recorded here indicate that *C. nigra* is confined to the southern half of New Zealand and the Auckland Islands.

Ecology: This species prefers a muddy bottom, and has been taken from depths between 0 fathoms and 150 fathoms.

Discussion: Mortensen (1925) stated that *C. nigra* has 8 Polian vesicles. The present writer dissected 10 specimens, and there were no fewer than 15 Polian vesicles in each. The number of Polian vesicles probably depends on the age of the specimens. In many species of *Chiridota* the water-vascular ring often carries a number of small vesicles, which may be interpreted as Polian vesicles in the process of development. If this is the case, then it is very difficult to ascertain the exact number of Polian vesicles in any one species in this particular genus. It may perhaps be a wise course to state that the number of Polian vesicles is, for example, "no less than 15". A procedure such as this would tend to avoid much confusion. Polian vesicle numbers are obviously not a reliable character for separation at the species level in the genus *Chiridota*.

Mortensen (1925) described the intestine as "sinuate, with a large loop. Its course otherwise not to be made out exactly". The writer found that in fact the intestine described a short loop which is confined to the middle part of the body.

In his discussion, Mortensen (1925) suggested that *C. nigra* may be related in some way to *C. discolor* Eschscholtz. The only differences between the two species lie in the colour, and the shape and arrangement of ciliated funnels. C. discolor varies considerably in colour, but grey and shades of red are usually present. The two wine-coloured specimens from Chalky Inlet seem to be nearer C. discolor than C. nigra on the basis of external appearances. But examination of the deposits and ciliated funnels show that they are exactly the same in the corresponding structures in the black or "normal" form of C. nigra. More complete descriptions of C. discolor are needed before any final decision can be reached. Their geographic isolation from each other (C. discolor is common on the northwest coast of America and the northeast coast of Asia) tends to support the theory that C. discolor and C. nigra are different species. But C. discolor has been taken from depths of 500 fms or more (Clark, 1907), and the limits of its distribution have not as yet been established. So, in a negative sense, support is also lent to the premise that the two species are synonymous. However, the weight of evidence is against the latter view, and the writer feels that C. nigra should be maintained.

Chiridota carnleyensis Mortensen

Chiridota carnleyensis Mortensen, 1925, p.374, fig.58; Dawbin, 1950, p.40.

Material examined: None.

Diagnosis: Colour in alcohol white transparent. Deposits in the skin wheels only, collected into diffuse round heaps. Lenticular bodies absent from the radial muscles. Radial pieces of the calcareous ring perforated. (Mortensen, 1925).

Discussion: Mortensen (1925) described C. carnleyensis from several specimens taken from Carnley Harbour, Auckland Islands. Later collecting in Carnley Harbour has failed to reveal any further specimens of this interesting species.

Genus Trochodota Ludwig, 1892

Diagnosis: Tentacles 10. Digits 2-6 on each side. Polian vesicle single; stone canal 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.)

The genus Trochodota is cosmopolitan and represented in New Zealand by 2 endemic species.

Key to the New Zealand Species of Trochodota

1 (2) Skin smooth, not papillate, with numerous scattered sigmata and wheels . . . . . . .T. dunedinensis (Parker), 1881

2 (1) Skin distinctly papillate. Sigmata arranged into groups in the papillae. Wheels numerous or scarce . . . . T. dendyi Mortensen, 1925

Trochodota dunedinensis (Parker)

Plate II, fig.11

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, 1898a, p.87; Perrier, 1905, p.123; H.L. Clark, 1907, p.124; H.L. 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.VI, fig.3a-31.
Trochodota benhami Clark, 1921, p.166.
Non: Trochodota dunedinensis Allan, 1911, p.325 (= Trochodota allani Joshua); Ohshima, 1914, p.478 (= Trochodota diasema H.L. Clark).
Non: Chiridota australiana Theel, 1886, p.16.

Material examined: Fifty-two specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- Island Bay, intertidal rock pool, 1 specimen, coll. G.W. Gibbs 11/7/60.

Dominion Museum, Wellington:- B.S.141, Paterson Inlet, Stewart Island, 5 fms, 31 specimens; Preservation Inlet, Fiordland, 3 specimens.

Dominion Museum, Cape Expedition material:- Waterfall Inlet, Auckland Island, among rocks in mud, 2 specimens, coll. W.H. Dawbin 25/3/43; Crozier Point, Auckland Islands, in mud between boulders at lowtide level, 3 specimens, coll. W.H. Dawbin 9/9/43; Crozier Point, Auckland Islands, in mud-gravel under sheltered boulder at low-tide, 2 specimens, coll. W.H. Dawbin 18/8/43; Togua Bay, Auckland Islands, in mud under boulders, 6 specimens, coll. W.H. Dawbin 18/9/43; opposite Passage Island, Auckland Islands, in sediment of rock pools, 4 specimens, coll. J. Jones 24/3/43.

Diagnosis: Colour in life reddish-brown. Body elongate, cylindrical, skin smooth, without papillae. Deposits sigmoid hooks and wheels scattered loosely in the skin. Radials and interradials irregular in shape, and notched anteriorly and posteriorly.

Description: As a consequence of poor preservation, very few of the specimens are in good condition. A single live specimen was examined and found to be quite cylindrical in shape, tapering abruptly toward the anus at the posterior end. When contracted, the specimen assumed a pear shape. Colour in life reddish-brown, darker near the extremities. Tentacles transparent, with numerous dark spots. Colour in alcohol yellowish-white, semi-transparent, with the well-developed radial muscles clearly visible through the skin.

The calcareous ring is composed of 10 unsymmetrical pieces. Each piece is about 1 mm in length and narrow, with shallow notches anteriorly and posteriorly. The radials are scarcely distinguishable from the interradials, as they are not perforated. Mortensen (1925) stated that the oral disc is "distinctly oblique in dorso-ventral section" and "the calcareous ring is distinctly oblique, parallel to the oral disc". The calcareous ring is no doubt asymmetrical as a consequence of its oblique position.

The oesophagus is short and thin-walled and enters into the intestine which describes a variable course to the anus. In some of the specimens dissected, the intestine is quite straight, while in others it is looped or S-shaped. Dendy (1909) proposed a new species, benhami, for a specimen of dunedinensis which possessed an S-shaped intestine. Mortensen (1925) detected Dendy's error and included benhami in dunedinensis.

The Polian vesicle is single, lying ventrally. The stone canal is very small and convoluted, lying in the dorsal mesentery, and terminating in a minute nodular madreporite.

The sexes are separate (Dendy, 1896) and the gonads consist of a few long and slender tubes which often extend to the posterior extremity of the body. T. dunedinensis is viviparous (John, 1939).

Deposits of 3 kinds are present:-

1. Wheels:- The dorsal side contains variable numbers of wheels. Diameters range between 0.06 mm and 0.16 mm, the average diameter being 0.1 mm. The wheels are 6-spoked and they are almost identical to the wheels in members of the genus Chiridota.

2. Sigmoid hooks:- Among the wheels on the dorsal side are found large numbers of sigmoid hooks of varying shape and size. They lie transverse to the longitudinal axis of the body (Perrier, 1905.)

3. Tentacle-rods:- The tentacles contain very large numbers of small rods 0.02-0.06 mm in length. They are irregular in shape, and frequently have enlarged ends (Pl.II, fig.11). 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 deep petri dish, the bottom of which was partly covered by a layer of sandy mud. Its behaviour was observed for several minutes.

1. Feeding:- The tentacles were pushed into the mud in turn. Small particles of mud, sand and organic material adhered

to the outer surfaces of the tentacles, which were apparently 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, or pushed into the mouth, and the particles were ingested. The specimen was fully extended while feeding, 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 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 did not take place continuously, but at irregular intervals.

3. Locomotion:- The specimen literally pulled itself around the walls of the petri dish by means of its sticky tentacles. This may be its chief means of locomotion, as T. dunedinensis is usually found in stony localities.

Distribution: Parker (1881) described the type specimen from Otago Harbour. Since 1881, specimens of T. dunedinensis were found in many parts of the South Island of New Zealand, including Stewart Island and Cook Strait, and the Auckland and Campbell Islands (Mortensen, 1925).

Ecology: T. dunedinensis prefers to live in the littoral zone concealed under stones on sand. No specimens have been taken from depths exceeding 5 fathoms.

Discussion: There is apparently some variation in the number of wheels in the skin. This has been the cause of much confusion. Dendy and Hindle (1907) described a new species Chiridota geminifera which resembled T. dunedinensis in most respects except for the fact that wheels were absent from the skin. The present writer found only two wheels in the skin of a specimen from the Auckland Islands, and less than 10 wheels in another, while some had many hundreds of wheels. Clark (1921) was therefore quite correct in assuming that C. geminifera was a synonym of T. dunedinensis.

Trochodota dunedinensis (Parker) var. microurna Mortensen

Trochodota dunedinensis (Parker) var. microurna Mortensen, 1925, p.381, figs.59c, 60c.

Material examined: None.
Diagnosis: As for the typical form, but the tentacles have 12-14 digits, the calcareous ring is larger and of a slightly different form, and the ciliated funnels are distinctly smaller.
Discussion: This variety is known from 2 specimens taken from off Moko Hinau in 5 fathoms. Close examination of the available specimens of T. dunedinensis has revealed no further specimens of var. microurna.

Trochodota dendyi Mortensen

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

Material examined: None.
Diagnosis: Colour white or faint purple. Skin papillate, each papilla containing 3-6 sigmoid hooks. Wheels numerous or absent. Tentacle deposits with bifurcating ends.

Discussion: Mortensen (1925) was furnished with 9 specimens of this most interesting species. In his discussion he stated that *T. dendyi* is closely related to *T. japonica* (v. Marenzeller) from Port Jackson, Australia. Heding (1928) instituted a new genus *Scolioraphis theeli*, which includes *T. japonica*. Wheels are absolutely absent from the body wall in members of the monotypic genus *Scolioraphis*, whereas members of the genus *Trochodota* should possess wheels invariably. However, Mortensen (1925) found only one wheel (and that abnormal in structure!) in one of his specimens of *T. dendyi*. It seems that the gap between *Trochodota* and *Scolioraphis* is not a very well-defined one. More material of *T. dendyi* must be studied before any conclusive statements can be made regarding its systematic position.

Order M O L P A D O N I A Muller, 1850

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.

This group is cosmopolitan, and most abundant in the Indo-West-Pacific. Members have a bathymetric range from a little below low water mark to at least 2,000 fathoms. An exclusively subterranean life is led in a sandy or muddy bottom. Species which live in shallow water are often disturbed by storms and cast ashore. Dendy (1898) stated that after a storm Paracaudina chilensis (Muller) was washed ashore "in enormous numbers".

The Order comprises 3 families, 2 of which are represented in New Zealand, with 3 species in 2 genera.

Key to the Families in Order Molpadonia

1 (4) Tentacle ampullae present.

2 (3) Tentacles with 1-3 pairs of digits and a terminal digit . . . . Fam. MOLPADIIDAE (p. 73)

3 (2) Tentacles with 2 pairs of digits and no terminal digit . . . . Fam. CAUDINIDAE (p. 87)

4 (1) Tentacle ampullae absent . . . Fam. EUPYRGIIDAE

Up to the present time, no members of the Family Eupyrgiidae have been recorded from New Zealand waters.

Family MOLPADIIDAE

Diagnosis: Tentacles each with lateral digits and a terminal digit. Tentacle ampullae long. Spicules derived from tri-radiate tables with solid or 3-pillared spire. Tail with tables with round to oblong discs, or long fusiform rods. Dark red egg-shaped phosphatic bodies often present. In some species anchors and racquet-shaped plates may be present in young individuals. Mostly large forms 6-15 cm long. (Deichmann, 1960 in part.)

At the present time the Family Molpadiidae is in a state of confusion. This confusion is caused by the fact that as a molpadid grows, its calcareous deposits change their character, and are transformed into phosphatic material. The phosphatic material is déposited as small orange or wine-coloured spherules, superficially resembling starch grains. As a result of this phenomenon, juveniles and adults of the same species are often placed in different species because of the fact that they differ in the character of their deposits. This unfortunate state of affairs can only be remedied by an intensive comparative study of juveniles and adults of all the known species in the group. Deichmann (1960) is engaged in a revision of the Molpadonia of the Indo-Pacific region, and with this revision many problems may be solved.

The Family Molpadiidae is represented in New Zealand by 2 species, both of which are incorporated in the genus Molpadia Cuvier.

Genus Molpadia Cuvier, 1817

Diagnosis: Radial pieces of the calcareous ring with rather long bifurcated posterior processes. Exterior side of the calcareous ring deeply sculptured in mature specimens. Deposits of the body wall include tables, anchors and rosettes of racquet-shaped plates, and large fusiform rods. Those of the caudal appendage are small and fusiform.

H.L. Clark (1907) referred all the then known species of the Family Molpadidae to the genus Molpadia. Heding (1932) did not agree with Clark's work and separated the species into 5 genera. However, Deichmann (1936) pointed out that Heding's work was inaccurate and inconsistent with the known facts, and suggested that the single generic name Molpadia Cuvier be retained, and that the species be arranged, according to the type of the deposits, into the musculus-group, the roretzii-group, and others until the life histories had been worked out completely, at least in a few typical cases. The juveniles must be examined before specific status can be given to doubtful specimens. Calcareous rings have proved unsatisfactory for systematic purposes in this group as they change drastically with growth. The spicules are the only safe criteria, even though they are also subject to much change. Deichmann (1960) states that some workers are separating some species of Molpadia on the basis of differences in blood spectra. This technique is of little use to the systematist who is working with preserved material. Sturtevant (1954) maintained that species should be identifiable from museum specimens. This should be the case, especially in lesser-known groups such as Class Holothuroidea.

Key to the New Zealand Species of Molpadia

1 (2) Juvenile deposits in the form of large fusiform rods with few tables . . . . . . M. violacea (Studer)

2 (1) Juvenile deposits anchors and anchorplates, and tables with 3 perforations . . . . M. marenzelleri (Theel)

Molpadia marenzelleri (Theel)

Plate V

Ankyroderma marenzelleri Theel, 1886, p.41, Pl.III, fig.1, a-g.

Molpadia marenzelleri Clark, 1907, p.171, Pl.X, fig.23; Benham, 1909, p.70, Pl.XI, 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.XI, figs.1-3.

Pseudomolpadia marenzelleri Heding, 1932, p.280.

Material examined: Forty-five specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 10, Palliser Bay, 200-250 fms, green mud, 1 specimen; VUZ 15, Palliser Bay, 100-150 fms, mud, 16 specimens; VUZ 21, Palliser Bay, 38 fms, mud, 1 specimen; VUZ 87, south of Cape Palliser, 400 fms, mud rock and gravel, 1 specimen; VUZ 96, off Palliser Bay, 380 fms, mud, 13 specimens; Cook Strait, 40 fms, 2 specimens, coll. F. Abernethy 14/11/52; off Foxton, 50 fms, 1 specimen.

Dominion Museum, Wellington:- B.S.181, off Palliser Bay, 100 fms, 2 specimens.

New Zealand Oceanographic Institute, Wellington:- B 11, Hawke Bay, 35 fms, mud, 1 specimen; B 44, Hawke Bay, 14 fms, sandy mud, 1 specimen; B 49, Hawke Bay, 44 fms, fine grey green mud, 1 specimen; A 435, off Foxton, 64 fms, sandy mud, 1 specimen; C 175, off Opunake, 50 fms, sandy mud, 1 specimen; C 185, off Wanganui, 25 fms, mud, 1 specimen; C 186, off Wanganui, 20 fms, soft mud (Echinocardium community), 1 specimen; C 189, entrance to Tasman Bay, 30 fms, soft mud, 1 specimen.

Diagnosis: Deposits in the form of spired tables with 3 large perforations, anchors, and irregular perforated anchor-plates. No large fusiform rods. No rosettes of racquet-shaped plates. Tail deposits lozenge-shaped.

Description: Most of the specimens examined by the writer are in excellent condition. A number of stages in development are represented, there being numerous juveniles as well as adult and senescent individuals. The smallest specimen is 15.0 mm in length, with a tail length of 6 mm. The largest senescent individual is 101.0 mm long, with a tail length of 12.0 mm. The tail is more pronounced in some specimens than in others, and is longer in proportion in the juvenile.

A distinct gradation in colour is seen between the juveniles and senescent individuals. The juveniles are uniformly greyish-white in colour, and are very rough to touch. Adult specimens are dark red, with many lighter greyish spots. The tail and circum-oral regions still retain the grey colour of the juvenile. Senescent individuals are smooth to touch, and are more or less uniformly dark red in colour, with grey extremities. Some transverse wrinkling is seen in the senescent individuals. The

P L A T E V

<u>Molpadia</u> <u>marenzelleri</u> (Theel)

Fig.1. Internal anatomy of adult dissected from the dorsal side. (Portions of the gonad removed.)

Fig.2. Tail deposits.

Fig.3. Anchor-plates.

a. Typical anchor-plate. A stage in its transformation into phosphatic material.

b. Anchor-plate with a three-pillared spire and two large perforations.

c. Anchor-plate from a juvenile specimen.

Fig.4. Deposits from the extreme anterior end of the body.

Fig.5. Phosphatic deposits.

Fig.6. Mid-body tables from a young specimen.

a. Table with an anchor-like outgrowth.

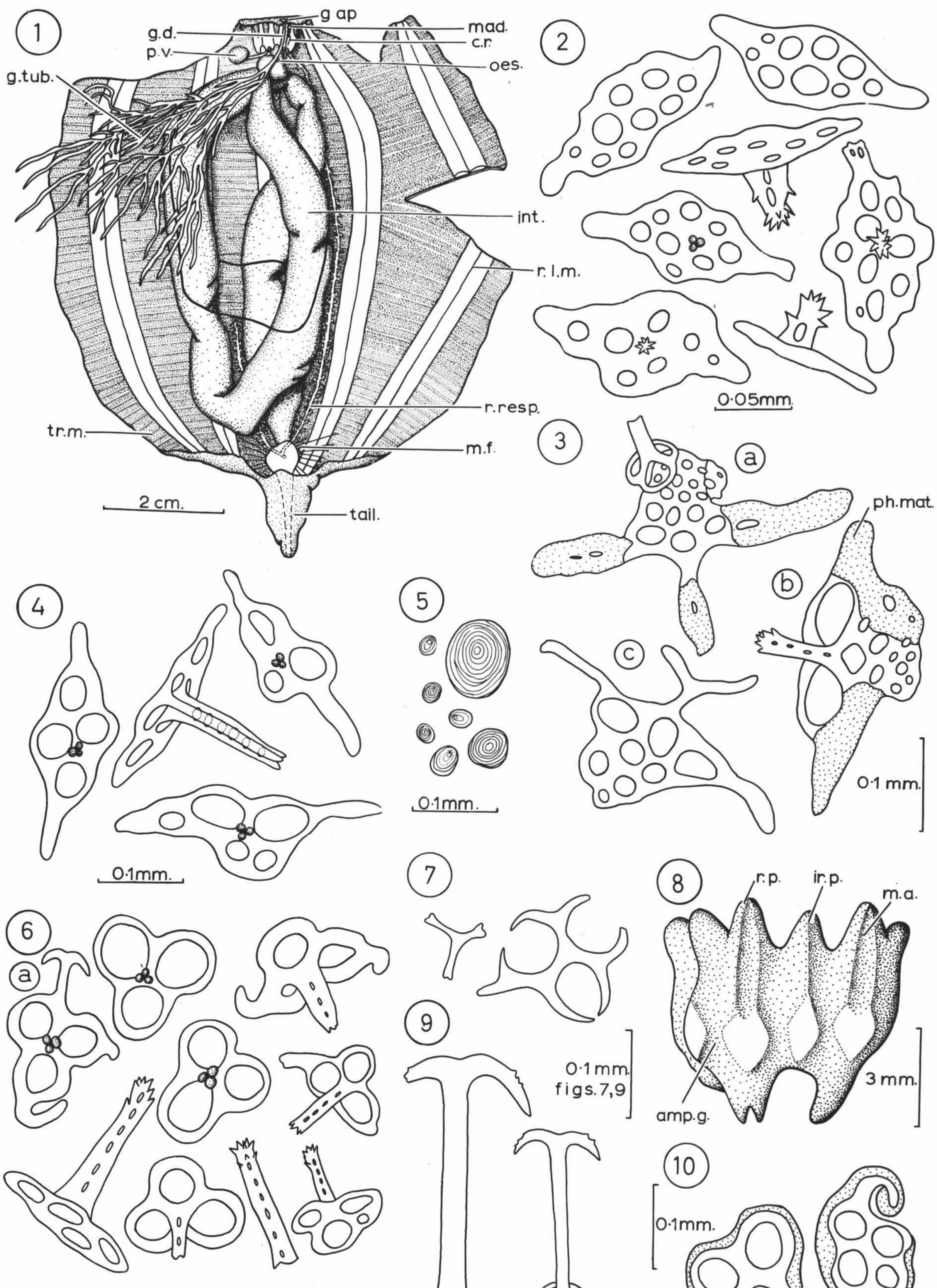
Fig.7. Stages in the development of a mid-body table.

Fig.8. Calcareous ring of an adult specimen.

Fig.9. Anchors.

Fig.10. Mid-body tables of a young specimen. A stage in their transformation into phosphatic material.

<u>Abbreviations:</u> amp.g., groove for the passage of a 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., attachment 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.


1
g ap
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2 cm.
tail.
2
0·05mm.
3
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ph.mat.
b
c
0·1 mm.
4
0·1mm.
5
0·1mm.
6
a
0·1mm.
7
8
r.p.
ir.p.
m.a.
amp.g.
3 mm.
9
0·1 mm.
figs. 7,9
10
0·1mm.

juvenile and adult specimens are frequently covered with particles of mud, which adhere easily to the rough surface of the skin.

The general appearance of the specimens is typical of that shown by other members of the genus. Tentacles 15, retracted in all cases. The mouth is a circular aperture, lying in the centre of the oral disc.

The calcareous ring is composed of 10 large sculptured pieces, joined to form a solid ring (Pl.V, fig.8). Each radial piece has 2 rounded anterior projections, and a slightly bifurcated posterior projection. The radial pieces are grooved for the attachment of radial muscles. Interradials carry a sharp ridge and have 1 anterior projection, and no posterior projection. The ring has 15 grooves for the tentacle ampullae (Pl.V, fig.8). There are differences between the calcareous rings in juvenile and adult specimens. In the juvenile, the bifurcations of the posterior prolongations are long and fragile, while those in the senescent individuals are short and strong. The sculpture of the ring varies from specimen to specimen.

The oesophagus is thin-walled and leads into the intestine which takes a very large loop (Pl.V, fig.1), 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.

The 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 (Pl.V, fig.1). The stone canal lies in the dorsal interradius and is a short, loosely coiled white tube, which terminates in a small nodular madreporite (Pl.V, fig.1).

Two respiratory trees arise from the cloaca. Each consists of a single flattened tube which gives rise to a number of short side branches. The left tree extends about one-third of the way along the body cavity (Pl.V, fig.1). The right tree is considerably longer, and runs to the anterior end of the body, attaching to the dorsal segments of the calcareous ring (Pl.V, fig.1).

The gonads are vesicular and extensively branched. They reach about two-thirds of the way along the body cavity, and their branches are spread around and over the intestine and the right respiratory tree. The 2 bunches ofcaecae unite to form the common genital duct which runs forward in the dorsal mesentery to open to the exterior as a well-defined genital aperture in the mid-dorsal interradius (Pl.V, fig.1), immediately posterior to the ring of tentacles.

Longitudinal muscles are well developed as five broad strap-like double bands (Pl.V, fig.1). Transverse muscles can be seen as fine white fibres (Pl.V, fig.1).

Calcareous deposits may be divided into 4 groups:

1. Tail deposits (Pl.V, fig.2):- The tables in the tail have elongate discs (0.1-0.17 mm long) and carry short three-pillared spires. The discs have 7-12 perforations. The 3 pillars of the spire are joined by 1 or sometimes 2 cross-bars, and the pillars meet at their ends and give rise to a few short spines. Some tables lack spires and merely take the form of flat plates. The juvenile tables are not markedly different from those in adults.

2. Anchors and anchor-plates (Pl.V, figs.3, 9):- These are found in numbers in juvenile specimens, while in adults and senescent individuals they are absent, due to their absorption and displacement by phosphatic material (see below). The anchors are of varying sizes, lengths ranging from 0.2 mm to 0.3 mm. The stock is saucer-shaped and has 3 perforations. The shaft is long and cylindrical. The arms are short, curved and usually have 2 to 5 small serrations (Pl.V, fig.9).

The anchor-plates are of an irregular shape, but the basic design is a central disc with no spire which gives rise to 2 or 3 elongate marginal projections. The disc carries a number of perforations, large and small (Pl.V, fig.3). The anchor-plates support the anchors, which project from the body wall. Because of this, many anchors are broken, or lie on the surface of the body, separated from their plates. Plates from adult individuals show various stages in their transformation into phosphatic material (Pl.V, fig.3, a, b). Juvenile anchor-plates show no traces of phosphatic material (Pl.V, fig.3, c). One anchor-plate was found to possess a spire composed of 3 rods joined by crossbars (Pl.V, fig.3, b). The disc of this plate has 2 large perforations and 12 smaller ones. The arrangement of the perforations and the presence of a spire leads to the suggestion that perhaps this anchor-plate was derived from a mid-body table of the type described below. If the anchor-plates are in fact derived from mid-body tables, they must arise very early in the life of an individual, as the smallest specimen examined was found to have large numbers of well-developed anchor-plates. The derivation of anchors from mid-body tables might also be postulated, as a mid-body table from a juvenile specimen carries a projection which resembles part of the shaft and flukes of an anchor (Pl.V, fig.6, a). This deposit could conceivably have given rise to an anchor in time, with the 3 disc perforations forming the 3 perforations in the stock of the anchor.

3. Mid-body tables (Pl.V, fig.6):- These tables are small (about 0.15 mm across), and typically have 3 perforations. A 3-pillared spire arises from the centre of the table. The pillars have spinous ends and are joined by 3-7 crossbars. Stages in the development of tables are common, especially in juvenile specimens (Pl.V, fig.7). The tables are present in large numbers in the juveniles, scattered among the anchor-plates. Their numbers decrease as a specimen grows older, as they also become transformed into phosphatic material. The spires of the tables project from the body wall, and these, together with the anchors, make the younger specimens very rough to touch. As the specimens grow older, and the deposits are absorbed by phosphatic material, the body wall becomes progressively smoother.

4. Tables from the anterior of the body (Pl.V, fig.4):- Tables from this area are elongate to fusiform and have 3-7 perforations. They carry a 3-pillared spire with crossbars. These spicules are also eventually transformed into phosphatic material.

Phosphatic deposits:- It is an interesting fact that in most members of the genus Molpadia the calcareous spicules of the juvenile are gradually transformed into small round phosphatic bodies, until the senile individual has few calcareous deposits or none. This phenomenon has been observed by many workers (Theel, 1886, Ludwig, 1894, et al.). M. marenzelleri is no exception in this respect, and, apart from the tail deposits which remain virtually unaffected, the anchors, anchor-plates, mid-body tables, and anterior tables respectively become transformed into phosphatic spherules. It is therefore possible to encounter specimens of M. marenzelleri which lack anchors, anchors and anchor-plates, or anchors, anchor-plates and tables. Transformation of calcareous deposits into phosphatic bodies is a gradual process, and spicules which are half calcareous and half phosphatic are often encountered (Pl.V, figs.3,a, 3,b, 10). Eventually the calcareous deposits dissolve into oval to round phosphatic bodies (Pl.V, fig.5). The phosphatic bodies are amber to red in colour.

Knowledge of the changes in the deposits with growth serves to explain the differences in colour between juvenile, adult, and senile individuals. The greyish-white juveniles have few phosphatic bodies and many calcareous spicules. The adults, red with white spots, have clusters of phosphatic bodies, and the white spots represent areas where calcareous deposits still remain. The uniformly dark red senile individuals have great numbers of phosphatic bodies and few calcareous deposits or none at all.

Distribution: Theel (1886) described the type from east of East Cape at a depth of 700 fathoms. Benham (1909) recorded specimens of M. marenzelleri from 38 fathoms in Hawke Bay, and M. dendyi (= M. marenzelleri) "from deeper water off the coast of the North Island". The localities recorded herein show that M. marenzelleri is a common holothurian in the deeper waters around the southern half of the North Island of New Zealand, as far north as East Cape to the east, and Opunake to the west. As the species is eurybathic, it probably has a wider distribution.

Ecology: This species prefers a mud bottom, lying buried, with the anus projecting above the surface of the mud for the purpose of respiration.

Discussion: The specific status of M. marenzelleri has been in doubt for some time, owing to insufficient knowledge of the juvenile individuals. The present findings leave no doubt that M. marenzelleri is quite a distinct species, as the following discussion serves to point out.

M. marenzelleri was described under the name Ankyroderma marenzelleri (Theel, 1886). Clark (1907) placed this species into the genus Molpadia Risso. Heding (1932), in his attempt to subdivide the genus Molpadia, instituted a new genus Pseudomolpadia and included the species marenzelleri. The diagnosis of Pseudomolpadia was as follows:- "Ankyroderma-like molpadids which have the anchors either united with a single fenestrated plate, or supplied with more than 2 arms." Deichmann (1936) replaced marenzelleri in the genus Molpadia. Deichman (1960) stated that M. marenzelleri is an untypical form of M. roretzii v. marenzeller, and that M. dendyi Benham and M. marenzelleri are identical. The latter part of Deichmann's statement is evidently quite correct. The single specimen described by Benham (1909) as M. dendyi showed no ewidence of anchors or anchor-plates, but the mid-body tables were present in numbers. It appears that Benham (1909) has described a specimen of M. marenzelleri whose anchors and anchor-plates had already been transformed into phosphatic material.

M. marenzelleri shows no trace of the rosettes of racquet-shaped plates which are so typical of many other species in this genus. The absence of racquet-shaped plates, together with the unique shape of the anchor-plates and anchors, shows quite definitely that this species is not related to M. roretzii and similar species. M. marenzelleri may possibly be placed in a separate genus. However, more work is required in the group as a whole before this step should be taken, as knowledge of many key species is still rather lacunar.

Molpadia violacea (Studer), 1876 (Theel),1886

Plate IV, figs.6-10

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, 1932, p.280.

Molpadia violacea Deichmann, 1960.

Material examined: Seven specimens from the following stations: In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 87, south of Cape Palliser, 400 fms, mud, 1 specimen; VUZ 101, off Palliser Bay, 550 fms, mud, 6 specimens.

Diagnosis: Deposits in the form of large fusiform rods up to 1.1 mm in length, together with a small number of smooth perforated plates. No anchors or anchor-plates. No rosettes. Tail deposits fusiform.

Description: All of the specimens are elongate and fusiform, the posterior end being attenuated to form a distinct caudal appendage which occupies up to 20% of the total body length. Length of the specimens varies between 47 mm and 78 mm. The degree of contraction is variable. In most cases, the anterior and posterior portions of the body are contracted, while the central portions of the body are relaxed.

Colour in alcohol ranges from a light brownish-red to a dark brick-red. The anterior extremity and the tail are greyish-white. Close examination of the skin enables detection of a number of discrete brick-red spots on a greyish-white background. This arrangement of small spots gives the overall effect of a uniform brick-red colour on superficial examination. The skin is quite thin and rough to touch. The radial longitudinal muscles can be seen through the skin as broad flat straps.

Tentacles 15, in a single ring, fully retracted in all cases. The mouth is circular, and lies in the middle of a circular oral disc.

The calcareous ring is composed of 10 large pieces, 5 radials and 5 interradials, joined to form a solid ring. Anteriorly, the radials have 2 processes, one of which is perforated for the passage of the radial nerve. Interradials have 1 anterior process and no perforation. Posteriorly the radials each carry a bifurcated piece, which is absent from the interradial pieces. The exterior of the ring is sculptured.

The oesophagus is short and thin-walled, and leads into the thin-walled intestine, which takes a very large loop, and runs to an enlarged cloaca. The cloaca is attached to the body wall by a number of fine muscle fibres.

The right respiratory tree is longer than the left, and extends anteriorly to attach to the dorsal side of the calcareous ring. The left tree extends about one-third of the way along the body cavity.

There is a single small Polian vesicle. The stone canal is tubular, about 4 mm long, terminating in a bulbous madreporite about 1.5 mm in diameter. Tentacle ampullae number 15, and they vary in length, maximum length being about 1 cm.

The gonads consist of tangled masses of branching caecae. The genital duct runs forward in the dorsal mesentery and opens to the exterior in the dorsal interradius immediately posterior to the ring of tentacles.

The internal anatomy is very similar to that in _Molpadia marenzelleri_ (Theel) (p. 77, Pl.V, fig.1).

Calcareous deposits:- There are two kinds of calcareous deposits in the skin.

1. Large fusiform rods of varying sizes and shapes:- These are found over the whole of the body wall, especially in the tail, where they occur in great profusion. They are more scattered over other parts of the body. Length of the rods varies up to a maximum of 1.1 mm. The central regions of the rods carry a few perforations.

a. Rods from the tail (Pl.IV, fig.8):- Tail rods are in general smaller (average length 0.6-0.7 mm) than those from other regions, and have fewer perforations. Usually the rods have a single central perforation traversed by a number of thin crossbars. The ends of the rods project above the level of the skin, and can be seen with the naked eye. There are no phosphatic bodies in the tail.

b. Rods from the extreme anterior end of the body (Pl.IV, fig.6):- These are rather similar to those from the tail, but are not nearly as numerous. There are only a few scattered phosphatic bodies near the ring of tentacles.

c. Rods from the posterior of the body, near the tail (Pl. IV, fig.10):- These are quite massive spicules, with an average length of 1 mm. The central portion of a rod carries 4-8 perforations. Many of the rods from this area have 3 arms, while others have 2. Usually the rods are grouped into small clusters, together with a number of small phosphatic deposits.

d. Rods from the middle of the body (Pl.IV, fig.9):- Mid-body spicules closely resemble those from the posterior of the body in general features, but even more variability in shape is apparent. In the middle of the body the rods are more scattered and not aggregated into clumps.

2. Small perforated plates (Pl.IV, fig.9, a):- Small plates, with few (3-6) perforations and a tendency to assume a fusiform shape are present in the middle of the body. They are not numerous, however, and are easily overlooked. Lengths range between 0.3 mm and 0.6 mm. Stages in the development of these plates were found. One typical example is illustrated (Pl.IV, fig.7).

<u>Distribution:</u> Theel (1886) described specimens taken from Kerguelen Islands 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, Palliser Bay, 550 fms, and south of Cape Palliser, 400 fms, are rather interesting and lead to the suggestion that M. violacea has a rather wide distribution and may perhaps be a circumpolar species. Deichmann (1960) would prefer to "eliminate M. violacea from all regions, except the waters around Kerguelen and immediately south of that island group". But this is not possible (see Discussion below).

Ecology: Like most other Molpadids, M. violacea is eurybathic and prefers a muddy bottom.

Discussion: M. violacea is a very well-defined species, one of the few in Family Molpadiidae. There is a complete absence of deposits such as racquets and rosettes, even in smaller specimens. Usually some traces of these deposits are seen in those species which possess them. Deichmann (1960) could find no trace of anchors and racquets in the specimens of M. violacea at her disposal, "in spite of hunting eagerly ..." (Deichmann, 1960). Deichmann believes that M. violacea is an extreme form of M. musculus (Risso), with narrow rods and lacking the anchor and racquet stage completely.

There is no doubt that the specimens from Cook Strait are in fact M. violacea, exactly the same species as that described by Theel (1886) from Kerguelen Island and east of East Cape. Therefore, Deichmann (1960) must include the New Zealand area when considering the distribution of M. violacea.

Family CAUDINIDAE

Diagnosis: Tentacles with 1-2 pairs of digits, but no terminal digit. Spicules as large tables or plates, or small cross-cups or irregular bodies. No phosphatic bodies, but discolouration of the skin may occur in older individuals of some species. (Deichmann, 1960.)

The Family Caudinidae is cosmopolitan, with representatives in all seas, and at depths from a little below low tide mark to at least 1500 fathoms. The New Zealand holothurian fauna contains a single species, Paracaudina chilensis (Muller).

Genus Paracaudina Heding, 1932

Diagnosis: Tentacles with 2 pairs of digits. Caudal appendage usually long and slender. Deposits not tables, but cups (buttons), perforated plates or irregular rods. (Heding, 1932, in part.)

H.L. Clark (1907) placed all but one of the then known species of Caudinidae into the single genus Caudina. Heding (1932) placed 7 species of Caudina into a new genus Pseudocaudina which he later changed to Paracaudina, after finding that Pseudocaudina was preoccupied. Heding's new genus has survived to the present day, with a slightly modified diagnosis.

Paracaudina chilensis (Muller)

Plate VI.

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, 54, Pl.III, fig.4; Dendy, 1896, p.28, Pl.3, figs.9-18; Dendy, 1897, p.456, Pl.29;

Farquhar, 1898a, 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 (Muller) H.L.Clark, 1907, p.175; Benham, 1909, p.28; Hozawa, 1928, p.363; Ohshima, 1929, p.39.

Pseudocaudina coriacea Heding, 1932, p.283.

Paracaudina coriacea Heding, 1932a, p.455; Heding, 1933, p.127; Pl.VI, 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 forma coriacea Deichmann, 1960.

Material examined: Five hundred and sixteen specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 15, Palliser Bay, 100-150 fms, mud, 2 specimens; VUZ 87, south of Cape Palliser, 400 fms, mud, 2 specimens; VUZ 101, off Palliser Bay, 550 fms, mud, 135 specimens.

Dominion Museum, Wellington:- B.S.144, Hawke Bay, 25 fms, 1 specimen; B.S.155, Hawke Bay, 8 fms, 11 specimens; B.S.156, Hawke Bay, 5 fms, 1 specimen; B.S.157, Hawke Bay, 8 fms, 20 specimens; B.S.158, Hawke Bay, 7 fms, 4 specimens; Port Gore, 1 specimen; Menzies Bay, 3 specimens; Cape Campbell, 40 fms, 1 specimen; East Cape, 60 fms, 1 specimen; New Brighton, 1 specimen; New Plymouth, in gut of snapper (Chrysophrys auratus Forster), 1 specimen; Cook Strait, gut of fish, 1 specimen.

New Zealand Oceanographic Institute, Wellington:- B 8, Northern Hawke Bay, 15.5 fms, mud, 326 specimens; B 37, Hawke Bay, 10.5 fms, sand, 2 specimens; C 183, off Opunake, 40 fms, muddy shell, 2 specimens.

Portobello Marine Biological Station, Dunedin:- Off Hooper's Inlet, 8-10 fms, 1 specimen.

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 if any being low and rounded. Cups, especially in young specimens, are approximately octagonal in shape, the points of the octagon being obscured in older specimens.

Description: Total length of largest specimen 115.0 mm, tail 44.0 mm, diameter at widest point 37.0 mm. Total length of a juvenile specimen 15.0 mm, tail 6.0 mm, diameter at widest point 6.0 mm. It can be seen that the tail : body proportion changes little during growth.

The body in most of the specimens is in the form of an approximate cylinder, and is attenuated posteriorly to form a long tail. The body wall is quite thin but firm, and is marked by numerous transverse striations. In juveniles, the body wall is semi-transparent, and the internal organs can be seen as a dark coloured mass. The colour varies quite considerably, but usually shades of white and light yellow are found. Some senescent individuals have a light brown tinge. Anal papillae are present. Dendy (1897) recorded their presence and gave a very complete account of their structure.

P L A T E   VI

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 canal and madreporite of adult.

Fig.6. Developmental stages of "crossed cups".

a. A "cross".

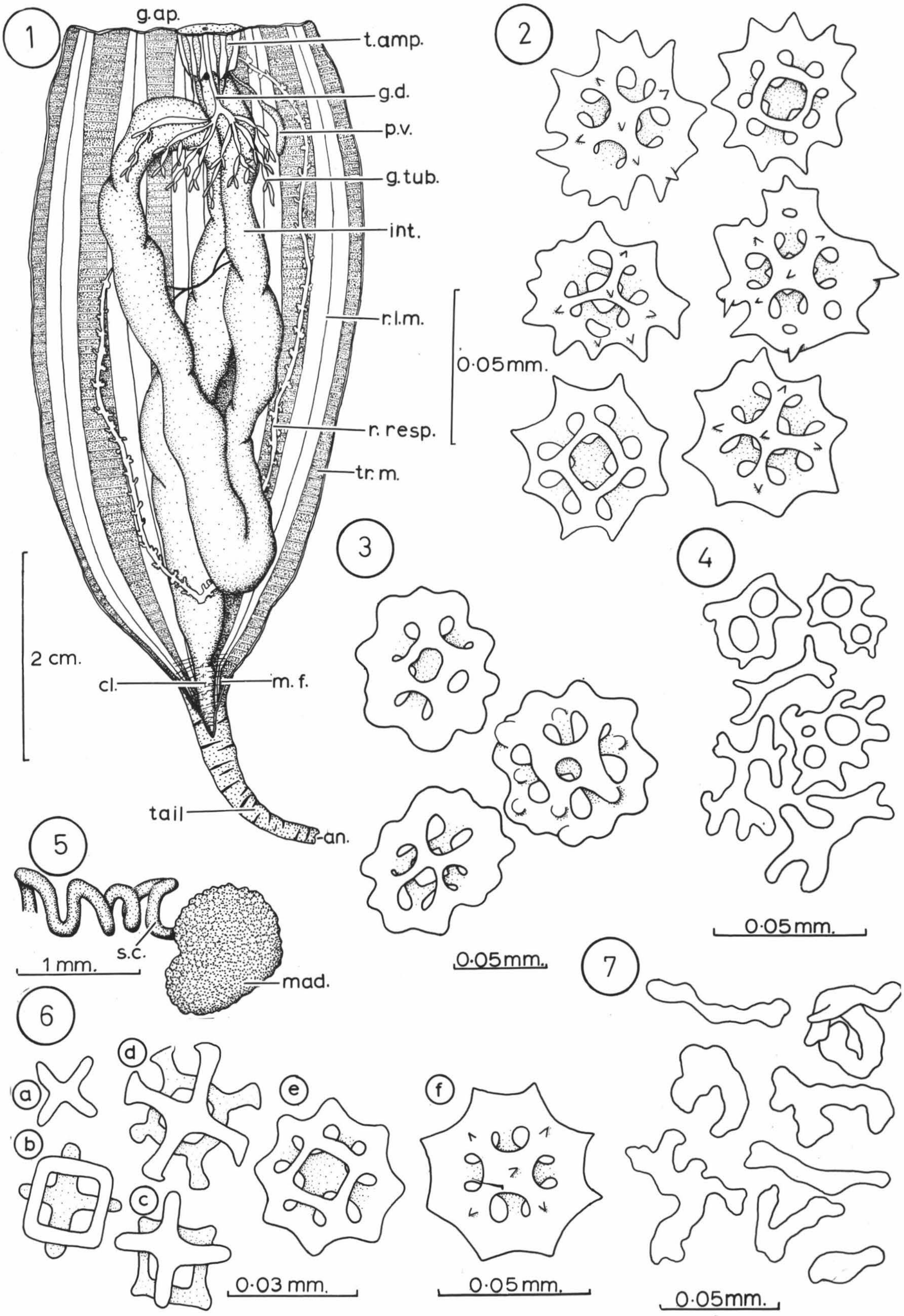
b, c. "Crosses" and "squares".

d. Extremities undergoing lateral expansion.

e, f. "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.


1
g.ap.
t.amp.
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0·05 mm.
5
1 mm.
s.c.
mad.
6
a
b
c
d
e
f
0·03 mm.
0·05mm.
7
0·05mm.

The calcareous ring is composed of 10 pieces, 5 radials and 5 interradials. The radials each have a pronounced bifurcated posterior projection, and 3 anterior projections. Interradials have no posterior projections, and 1 anterior projection. The calcareous ring has been well described by a number of workers (Hozawa, 1928; Heding, 1933; Clark, 1935 et al.) and needs no further discussion here.

The oesophagus is short and thin-walled, and the stomach is not differentiated from the intestine. The intestine is transparent and takes a very large loop (Pl.VI, fig.1). The cloaca is also thin-walled, and attached to the body wall by a large number of fine muscle fibres. These fibres fill the cavity of the tail. The anus is terminal. In the juvenile, the intestine fills the entire body cavity and the cloaca carries very few muscle strands.

Gonads consist of 2 bunches of irregularly branched vesicular caecae (Pl.VI, fig.1). The bunches join to form the common genital duct which runs forward in the dorsal mesentery, and between the dorsal radial pieces of the calcareous ring to open to the exterior at a virtually invisible genital aperture. The juveniles show no evidence of gonads.

The Polian vesicle is large, bulbous and elongate, about 5.0 mm in length, and has a patch of dark brown pigment at its distal extremity. A short and coiling stone canal lies in the dorsal mesentery, terminating in a madreporite which takes the form of a compressed sphere (Pl.VI, fig.5), The madreporite has a sculptured surface, due to the presence of an investing layer of irregular intertwining deposits (Pl.VI, fig.7). The madreporite in the juvenile is very small, its greatest diameter being 0.2 mm, but it has the same shape as that of the adult. The stone canal is correspondingly small and short. Madreporite deposits are essentially the same as those in the adult, but they do not constitute a full enveloping network.

Respiratory trees consist of 2 main trunks which carry numerous small side branches (Pl.VI, fig.1). The right tree is considerably longer than the left, and runs anteriorly to join to the calcareous ring, while the left tree extends about half way along the body cavity. In some specimens the left trunk gives rise to lesser trunks which tangle around the intestine and form a connection with the intestinal vessels. The condition in the juvenile is similar, but the trunks give off fewer small side branches.

Longitudinal muscles take the form of 5 double bands (Pl.VI, fig.1). There is no evidence whatsoever of the presence of retractor muscles. In the juvenile, the muscle bands are very thin and straplike. Between each member of a pair of muscle bands, the radial longitudinal nerve is clearly visible. As a specimen grows older, the nerve becomes buried and is no longer visible. Transverse muscles are visible as fine lines (Pl.VI, fig.1).

Calcareous deposits:- In adult specimens the deposits are "crossed cups" of slightly varying shapes. These are crowded together in vast numbers in the skin, from the extreme anterior end to the tip of the tail. The "crossed cups" are 0.08-0.1 mm across. They each consist of a "cross" which overlies a "square" (Pl.VI, fig.3). The "square" has a single large perforation which is usually rectangular, with a tendency towards roundness. The margin of the "crossed cup" is approximately octagonal in shape, but in the adult this shape is often obscured, and the points of the octagon become rounded. Marginal projections are often present as low rounded knobs. Near the tail, the cups are slightly more irregular than those from the middle of the body.

The juvenile deposits are "sharper" than the adult deposits, and are rather more scattered. The typical "crossed cup" structure is more readily observed (Pl.VI, fig.2). The rounded adult deposits are not present in the juvenile, but half-grown specimens show a mixture of "sharp" deposits and rounded deposits.

An interesting series of developing deposits can be seen in the juveniles (Pl.VI, fig.6). The "cross" is the first to form (Pl.VI, fig.6, a). It is a simple four-armed cross, each arm measuring about 0.008 mm in length. A perforated square then develops on the cross (Pl.VI, fig.6, b, 6, c). The "cross" is invariably the starting point in the development of skin deposits in this species. The extremities of the "cross" and the corners of the "square" begin to expand laterally (Pl.VI, fig.6, d), and these lateral expansions gradually meet to form the "young" deposit, which has smooth rounded edges (Pl.VI, fig.6, e). The "young" deposits then assumes the "classical" deposit form (Pl.VI, fig.6, f), which has 8 sharp projections regularly spaced around the margin and a few small spines (3-8) on the "cross" side of the spicule. In most cases the cross faces the outside of the skin, and the short sharp projections project slightly above the level of the body wall. The tail deposits of the juvenile are slightly more irregular than those from the middle of the body, but the basic pattern is the same.

Anal papilla deposits of the juvenile are similar to those of the adult. They are small, irregular spicules, and take the form of branched rods or perforated plates (Pl.VI, fig.4).

Discussion: Clark (1907) placed many 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 specimen, colour, and texture of the body wall, all of which are 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) took Clark to task for his synonymy, and declared that C. coriacea from New Zealand, C. australis from Australia and C. chilensis from Chile were different species, and he used 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 members of 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 in his new genus Paracaudina. 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 also employed additional characters such as body form, "retractor muscles", genital papillae, and presence or absence of "Cuvierian organs" as additional evidence. Thus Paracaudina coriacea was reestablished as a species, but not for long, as Clark (1935) "reentered the lists" in his own words, after having examined 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. He agreed with Heding's (1932) new genus Paracaudina, but agreed only in part with his diagnosis.

As a result of his thorough studies, Clark (1935) compiled a key to the members of the genus Paracaudina, and named the New Zealand form Paracaudina chilensis var. coriacea, adding that Deichmann was in agreement with him. Deichmann (1960), however, suggested that the New Zealand form be termed P. chilensis forma coriacea, as, in the words of W.K. Fisher, "it does not protest too much".

Only the New Zealand specimens of the genus Paracaudina were encountered during the course of this study, but in this collection much variation was seen in the body wall deposits, even in juvenile specimens. Examination of these deposits and those figured by Hozawa (1928) and Heding (1933) has served to convince the present writer that the calcareous deposits 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. H.L. 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. Thus, 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 specimens may have reached South America via New Zealand. Fell (1953a) 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 a means of dispersal 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. This gap may be caused by unfavourable environmental conditions. As _P. coriacea_ is a eurybathic species, there are no depth barriers to dispersal.

Ecology: _P. chilensis_ has been taken from muddy and sandy localities to depths of at least 550 fathoms. The two specimens herein recorded from fish stomachs indicate that the species may be used as food by some fish. But these are burrowing holothurians, and should not be extensively troubled by predators.

Order DENDROCHIROTA Grube

Diagnosis: Tubefeet present, tentacles tree-shaped, profusely branched. Retractor muscles usually present. Respiratory trees present. Mesentery of the posterior intestinal loop in the right or left ventral interradius. Gonads on both sides of the dorsal mesentery. Deposits usually more or less irregular, fenestrated plates, sometimes tables.

The order is cosmopolitan, and members are found in all depths. The numerous species within the order feed on plankton or detritus, which they catch by means of their sticky and extensile tentacles.

The Order Dendrochirota is divided into 3 families, all of which are represented in New Zealand waters.

Key to the families in Order Dendrochirota

1 (4) Body cylindrical or fusiform, without a well-defined ventral sole.

2 (3) Tentacles 10 . . . . Fam. CUCUMARIIDAE (p. 122).

3 (2) Tentacles 15-30 . . . . Fam. PHYLLOPHORIDAE (p. 98)

4 (1) Body flattened, with a well-defined ventral sole. Mouth and anus dorsal. . . . . . . Fam. PSOLIDAE (p. 121)

Family PHYLLOPHORIDAE

Diagnosis: Tentacles 15-30, usually in 2 or even 3 circles, the inner circles having smaller tentacles. Calcareous ring well-developed, with or without forked posterior processes.

Members of this family are common in tropical and temperate areas, usually living on muddy bottoms, in all depths.

Heding and Panning (1954) made a thorough revision of the Phyllophoridae, and diagnosed 5 subfamilies. Of these subfamilies, 2 are represented in New Zealand.

Key to the New Zealand 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 small 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. Of these genera, one is represented in New Zealand waters, and another new genus is described herein. These two New Zealand genera are distinguished quite easily from each other.

Key to the New Zealand Genera in Subfamily Thyonidiinae

1 (2) Tentacles 25. Spicules wanting in the body wall . . . . Genus Amphicyclus Bell

2 (1) Tentacles 20. Spicules present in large numbers . . . . Genus Mensamariella n. g.

Genus Amphicyclus Bell, 1884

Diagnosis: Tentacles 25. Tubefeet confined to the radii, lacking in the interradii and introvert. Calcareous ring simple; interradials somewhat irregular. Spicules wanting in the body wall and in the feet apart from the endplates in the sucking-discs. The introvert contains small numbers of two-columned tables of variable form. (Heding and Panning, 1954, in part.)

In their revision of the Phyllophoridae, Heding and Panning (1954) include 3 species in the genus Amphicyclus Bell. Two of these 3 species may be synonymous (see p. 104).

Amphicyclus thomsoni (Hutton)

Plate VII, figs.1,2,6,7.

Cucumaria thomsoni Hutton, 1878, p.307; Dendy, 1896, p.34; Farquhar, 1898, p.324.

Pseudocucumis thomsoni Mortensen, 1925, p.355, figs.38-40.

Mensamaria thomsoni H.L. Clark, 1946, p.406; Dawbin, 1950, p.38.

Amphicyclus thomsoni Heding and Panning, 1954, p.88, abb. 29 figs. a-f.

Non: Pseudocucumis thomsoni H.L.Clark, 1938, p.484.

Material examined: Sixty-two specimens from the following localities:

In the collection of the Dominion Museum, Wellington:- B.S.130, Entrance to Pelorus Sound, 30 fms, 2 specimens; B.S.141, Paterson Inlet, Stewart Island, 5 fms, 29 specimens; B.S. 142, Paterson Inlet, Stewart Island, 18 fms, 17 specimens; B.S.169, off Stephen's Island, 110 fms, 1 specimen; Cook Strait, 100 fms, 1 specimen; Northeast Otago, 40 fms, 1 specimen; Mamakau Rock, Foveaux Strait, 15-20 fms, 1 specimen; Muck Rock, Foveaux Strait, 10 fms, 1 specimen; north of Kapiti Island, 30 fms, 1 specimen; off Foxton, 50 fms, 2 specimens.

New Zealand Oceanographic Institute, Wellington:- B.41, Hawke Bay, 11 fms, shell and stones, 3 specimens; B.224, Foveaux Strait, 15 fms, shelly sand, 3 specimens.

Diagnosis: Large holothurians, approximately pentagonal in cross-section. Colour light brown; tubefeet white. Deposits in the introvert only. The introvert deposits are irregular tables with short spires. Table perforations greatly variable in number. Calcareous ring typical of the genus. Interradials of varying shape, needlelike.

Description: The body is fusiform in shape, approximately pentagonal in cross-section. Total length ranges between 10 mm and 75 mm. Living and preserved specimens are yellowish to light brown in colour. The tubefeet and tentacles are white. The body wall carries a large number of transverse wrinkles.

Tubefeet are very numerous, confined to the radii. They are arranged in simple double rows on the introvert, but on the rest of the body the radial areas are packed with tubefeet, the rows being 8-10 tubefeet wide.

There are 25 tentacles arranged in 2 concentric rings. The outer ring is composed of 15 large tentacles, of which the dorsal pair are the smallest. The inner ring has 10 small tentacles, all more or less equal in size. The mouth lies at the base of a funnel-shaped depression.

The calcareous ring is quite complex in structure. There are 5 radial pieces and 5 slender, almost needle-like, interradials. The radials are long and broad, and each has a conspicuous median anterior notch and 2 lesser notches, 1 to each side of the large notch (Pl.VII, fig.6). The shape of the interradials (Pl.VII, fig.6) varies from specimen to specimen. Both radials and interradials have a shallow posterior notch.

The oesophagus is broad and muscular (Pl.VII, fig.1), narrowing rapidly to merge with the intestine. At the junction of oesophagus and intestine, there is invariably a ring of small papillae whose function is unknown. The intestine is quite narrow and thin-walled, describes a poorly defined loop, and runs to the enlarged cloaca, thence to the terminal anus. In some specimens the intestine runs straight to the cloaca (Pl.VII, fig.1). There are no fine muscle fibres supporting the cloaca.

Two tubular Polian vesicles arise from the ventral side of the water vascular ring. They are long and quite transparent (Pl.VII, fig.1). The single stone canal is straight, supported by the dorsal mesentery, and terminates in an oval madreporite (Pl.VII, fig.1). The stone canal tends to run posteriorly in the dorsal mesentery.

The gonad consists of a bunch of long unbranched intertwining caecae. These caecae are bright yellow or orange in colour, and in many specimens they almost fill the anterior half of the body cavity. The genital duct is long (Pl.VII, fig.1), and runs along the dorsal interradius quite close to the body wall, opening to the exterior at the tip of a well-defined genital papilla. The genital papilla lies between the 2 middorsal tentacles in the outer ring.

The respiratory trees are feebly developed, and arise from the anterior end of the cloaca on the ventral side. There are 2 main trunks of equal length extending about two-thirds of the way along the body cavity. Respiratory tubules are well-branched (Pl.VII, fig.1).

Longitudinal muscles are thick and broad in the contracted areas of the body. Elsewhere they are thin and narrow. Retractor muscles are well developed, originating from the longitudinal muscles half way along the body cavity, and inserting into the anterior notches of the radial pieces of the calcareous ring. Transverse muscles are also prominent in contracted areas. All of the muscles are light orange in colour, in contrast to the overall white colour of the peritoneum.

Deposits of 4 kinds are known from Amphicyclus thomsoni:-

1. Tables (Pl.VII, fig.7). Although absent from most of the body wall, many tables are to be found in the extreme anterior and posterior parts of the body. The disc of the table is irregular in outline, and the number of perforations is very variable. Each table is surmounted by a spire composed of two columns joined at the top by a single cross-piece. The diameter of the table disc ranges from 0.04 mm to 0.08 mm.

2. Tentacle deposits (Pl.VII, fig.2). The tentacles contain a large number of spicules in the digits, but none in the stems. The spicules are rod-like, and have few (no more than 8) perforations, which are largely confined to the enlarged extremities of the rods. Many of the tentacle spicules have no perforations at all. Average length of tentacle deposits is about 0.08 mm.

3. Mortensen (1925) described finely branched elongate spicules from small papillae around the mouth.

4. Well-developed end-plates are present in the tubefeet.

Distribution: Hutton (1878) and Mortensen (1925) described specimens from Stewart Island. The new localities Hawke Bay, Kapiti Island, Cook Strait, Foxton, and Foveaux Strait indicate that *A. thomsoni* is extremely common in relatively shallow water about Foveaux Strait, and is present in lesser numbers in Hawke Bay and the Cook Strait region.

Ecology: *A. thomsoni* may be described as a shallow-water holothurian which prefers a sandy or muddy bottom. No specimens have been taken from depths greater than 110 fms.

Discussion: There is some variation in the number of tentacles in this species. No doubt 25 tentacles is the usual number in mature specimens, but smaller specimens have as few as 17 tentacles. Mortensen (1925) noted that the tentacles of the outer ring are the first to form.

H.L. Clark (1946), instituted a new genus, *Mensamaria*, and included the species *thomsoni* (Hutton) from New Zealand. Previously H.L. Clark (1938) had recorded *thomsoni* from Western Australia and Tasmania, but he indicated that perhaps the Australian form might represent a different species. The New Zealand and Australian forms differ in external appearances, but Clark (1938) could find no differences in their calcareous rings or spicules. Again Clark (1946) suggested that "at least 2 and possibly 3 species may be confused under the one name" (*thomsoni*).

The situation remained unchanged until Heding and Panning (1954) published a revision of the Phyllophoridae. In this revision, the New Zealand form and the Australian form were placed as different species into the genus *Amphicyclus* Bell. The Australian form became known as *Amphicyclus mortenseni* Heding and

P L A T E VII

<u>Amphicyclus thomsoni</u> (Hutton)

Fig.1. Internal anatomy of adult dissected from the dorsal side. (Portions of the gonad removed.)

Fig.2. Tentacle deposits.

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

Fig.7. Tables from the anterior end of the body.

<u>Mensamariella bicolumnata</u> (Dendy and Hindle)

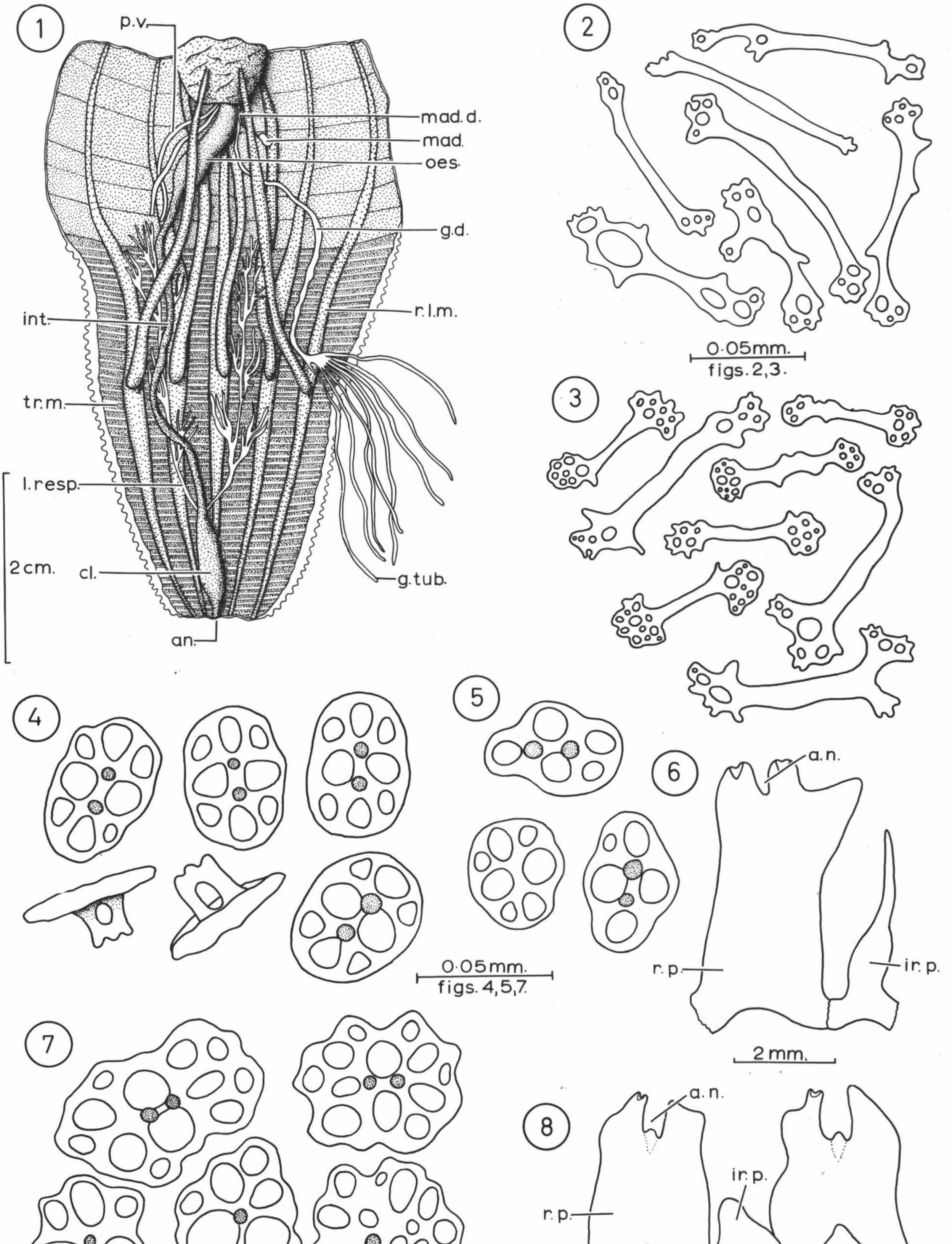
Fig.3. Tentacle deposits.

Fig.4. Normal tables from the skin.

Fig.5. Irregular tables from the skin.

Fig.8. Radial and interradial pieces of calcareous ring.

<u>Abbreviations:</u> a.n., anterior notch; an., anus; cl., cloaca; 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; oes., oesophagus; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.p., radial piece; tr.m., transverse muscles.


1
p.v.
mad.d.
mad.
oes.
g.d.
int.
r.l.m.
tr.m.
l.resp.
2 cm.
cl.
g.tub.
an.
2
0·05 mm.
figs. 2,3.
3
4
5
6
a.n.
r.p.
ir.p.
0·05 mm.
figs. 4,5,7.
2 mm.
7
8
a.n.
ir.p.
r.p.
2 mm.

Panning. There is no really significant difference between the calcareous rings and spicules of A. thomsoni and A. mortenseni (Clark, 1938). The present distribution of A. thomsoni in New Zealand suggests its recent derivation from Australia.

This problem needs the most careful attention, and more work is required before any definite conclusion can be reached. If the 2 species do prove to be synonymous, then the distribution pattern of the species would be approximately equal to that of Stichopus mollis (Hutton), which is also known from Western Australia, is common in Tasmania, and is present in southern New Zealand. This similarity of pattern is very interesting from the zoogeographical point of view.

Genus Mensamariella n.g.

Diagnosis: Tentacles 20 in a single ring. Calcareous ring simple; radials each with a pronounced anterior notch; interradials small, with short blunt anterior projections. Deposits tables of a regular shape. Tables take the form of a disc with 8 perforations, 4 large and 4 small, surmounted by a short two-pillared spire. Tubefeet confined to the radii, where they are arranged into double rows.

Type species: Mensamariella bicolumnata (Dendy and Hindle).

This genus is so named to indicate its similarity to Mensamaria Clark. Although the calcareous deposits in the two genera are superficially similar, they have one very important distinguishing feature. Mensamariella has 20 tentacles, while Mensamaria has 30.

At present the genus is monotypic, the single species M. bicolumnata being known from New Zealand and Australia.

Mensamariella bicolumnata (Dendy and Hindle)
Plate VII, figs.3,4,5,8.

Pseudocucumis bicolumnatus Dendy and Hindle, 1907, p.106, Pl.11, fig.6, Pl.12, figs.13-14; Joshua and Creed, 1915, p.19.
Mensamaria bicolumnata H.L.Clark, 1946, p.406; Dawbin, 1950, p.38.
Non: Amphicyclus thomsoni Heding and Panning, 1954, p.88.

Material examined: Thirteen specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 64, off Point Howard Wharf, 5 fms, blue mud, 1 specimen.

Dominion Museum, Wellington:- B.S.22, Doubtful Sound, Fiordland, 4-10 fms, 5 specimens; B.S.130, entrance to Pelorus Sound, 30 fms, 2 specimens; B.S.150, Hawke Bay, 150 fms, 1 specimen.

New Zealand Oceanographic Institute, Wellington:- B.41 (sample 1), Hawke Bay, 11 fms, shell and stones, 1 specimen; B.41 (sample 3), Hawke Bay, 11 fms, shell and stones, 1 specimen; B.53, Hawke Bay, 8 fms, rock and shell, 1 specimen; CP.27, Cook Strait, pebbly shelly mud, 1 specimen.

Diagnosis: Shape fusiform; radial areas prominent. Colour brick red to light brown. Tentacles red to dark brown. Tentacles 20 in a single ring, 10 large and 10 small, arranged in alternating pairs. Each radial piece of the calcareous ring has a deep posterior notch.

<u>Description:</u> Many of the specimens on hand are completely relaxed, with their tentacle crowns finely expanded. Total length varies between 20 mm and 90 mm. The body is fusiform in shape, attenuated posteriorly to form a more or less distinct tail region. The anterior end narrows as an introvert, which is surmounted by a crown of 20 tentacles. In many specimens the body is flexed into a distorted U-shape. The body wall is quite thin, but opaque. There are only a few transverse wrinkles near the posterior end.

Colour ranges from light brown to brick red. The tentacles are light red to dark brown in colour.

The tubefeet are confined to the 5 well-defined ambulacra, where they are arranged in double rows. There are no tubefeet on the introvert. Near the anus, the tubefeet are more scattered, and the rows are not clearly distinguishable.

The 20 tentacles are arranged in a single ring, 5 pairs of large tentacles alternating with 5 small pairs. The large tentacles are present in the interradii, while the small are in the radial position. All of the tentacles are very richly branched. The middorsal pair of tentacles are conspicuously smaller than the rest.

The calcareous ring is composed of 5 radial pieces and 5 interradial pieces. Each radial is rectangular in shape, and has a deep posterior notch and a narrow anterior notch (Pl.VII, fig. 8). Interradials take the form of an inverted Y, with the tail of the Y directed anteriorly (Pl.VII, fig.8). Length of radial piece - about 2.2 mm. Length of interradial piece - about 1 mm.

The internal anatomy of this species was well described by Dendy and Hindle (1907). In general, the structures are rather similar to those in Amphicyclus thomsoni. The following differences between the two species are worthy of note:

1. M. bicolumnata has only 1 Polian vesicle. It is quite long and tubular.

2. The cloaca in M. bicolumnata is not as conspicuously dilated as it is in A. thomsoni.

3. The respiratory tubules in M. bicolumnata are short and sparsely branched, whereas those in A. thomsoni are sinuous and copiously branched.

Deposits of 3 types were found:

1. Tables (Pl.VII, figs.4, 5): The skin contains very large numbers of tables. The disc is of a regular shape, usually oval, and has 8 perforations, 4 large and 4 small. Departures from this basic pattern are rare, but 3 tables of unusual shape were found (Pl.VII, fig.5). The disc is surmounted by a spire composed of 2 short columns joined at the top by a single crossbar. Average dimensions of disc - length 0.05 mm; breadth 0.03 mm. Average height of the spire is 0.02 mm. The dimensions of the tables are subject to some variation.

2. Tentacle deposits (Pl.VII, fig.3). The tentacle digits contain large numbers of rod-like deposits. The extremities of the rods are usually expanded, and have a number of perforations (up to 20 in each rod). Average length of these spicules is 0.06 mm. No unperforated rods were found.

3. Tubefoot deposits: The tubefeet carry well-developed endplates in their sucking discs.

Distribution: The type specimen was taken from Akaroa Harbour at a depth of 6 fathoms (Dendy and Hindle, 1907). H.L. Clark (1946) states that Joshua and Creed (1915) had examined a very typical specimen of this species in the South Australian Museum. Unfortunately, Joshua and Creed gave no indication of the colour or size of their specimen, nor did they name the locality from which it was taken.

The new localities, Fiordland, Pelorus Sound, Cook Strait, and Hawke Bay indicate that the species is not particularly common in New Zealand, as no more than 5 specimens were taken at one time. Its distribution in New Zealand is strongly indicative of derivation from Australia, and it is quite probable that the single specimen in the South Australian Museum is *Mensamariella bicolumnata*.

Ecology: *M. bicolumnata* has been taken from muddy and shelly bottoms in depths between 5 fathoms and 150 fathoms.

Discussion: Up to the present time, this species was known in New Zealand from but a single specimen. Mortensen (1925) had no opportunity of examining *M. bicolumnata*. Thus, the original generic name *Pseudocucumis* was retained until Clark (1946) instituted the genus *Mensamaria*, and included *bicolumnata*. Heding and Panning (1954) had no specimens of *bicolumnata* at their disposal and decided that the species was synonymous with *Amphicyclus thomsoni*. This was not warranted, however, as Dendy and Hindle's description served to indicate that *bicolumnata* is distinct from *thomsoni*. As *bicolumnata* has 20 tentacles, it does not have a place in the genus *Amphicyclus* Bell, nor in *Mensamaria* Clark.

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) include 5 genera in this subfamily. Two of these genera are represented in the New Zealand holothurian fauna.

Key to the New Zealand genera in Subfamily Semperiellinae

1 (2) Deposits small tables with short, blunt, two-pillared spires . . . . Genus Neothyonidium Deichmann.

2 (1) Deposits tables, each with a sharp spire composed of two long rods fused together . . . . Genus Pentadactyla Hutton.

Genus Neothyonidium Deichmann, 1938

Diagnosis: Dendrochirote holothurians with 20 tentacles which are arranged in pairs. Calcareous ring complex. Radials with long posterior processes. Spicules tables with two columns. (Heding and Panning, 1954, in part.)

Hitherto, only 1 species of Neothyonidium, N. dearmatum (Dendy and Hindle) was known from New Zealand. The present account contains a description of a new species, N. armatum. The two species are readily recognisable.

Key to the New Zealand species in Genus Neothyonidium

1 (2) Deposits absent from the skin, apart from the anal extremity . . . . . . Neothyonidium dearmatum (Dendy and Hindle)

2 (1) Deposits present in the skin in very large numbers . . . .
. . . . *Neothyonidium armatum* n.sp.

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; H.L.Clark, 1938, p.494

Lipotrapeza dearmatus H.L. Clark, 1946, p.411.

Neothyonidium dearmatum Heding and Panning, 1954, p.191, Abb.93.

Material examined: None.

Diagnosis: Spicules absent from the skin, apart from the anal extremity, where two-pillared deposits appear in small numbers. Average length of two-pillared tables is 0.07 mm. Tables typically have 8 perforations.

Discussion: This interesting but fairly rare species has been reported from Akaroa Harbour (Dendy and Hindle, 1907), and Wellington Harbour (Mortensen, 1925). Joshua (1914) noted that *N. dearmatus* occurs in numbers on the coast of Victoria, Australia. The species may be a comparatively recent contribution to the New Zealand holothurian fauna from Australia.

Neothyonidium armatum n.sp.

Plate VIII.

Material examined: Two specimens in the collection of the Dominion Museum, Wellington - B.S.180, off Wellington Harbour, 150 fms, grey sand and mud, 2 specimens.

Diagnosis: Spicules present in the skin in great numbers. They take the form of two-pillared tables, with a varying number of

P L A T E VIII

Neothyonidium armatum n.sp.

Fig.1. Pharynx and calcareous ring.

Fig.2. Tables from the extreme anterior end of the body.

Fig.3. Tubefoot deposits.

Fig.4. Endplate of tubefoot.

Fig.5. A small portion of the gonad, showing branching genital tubules.

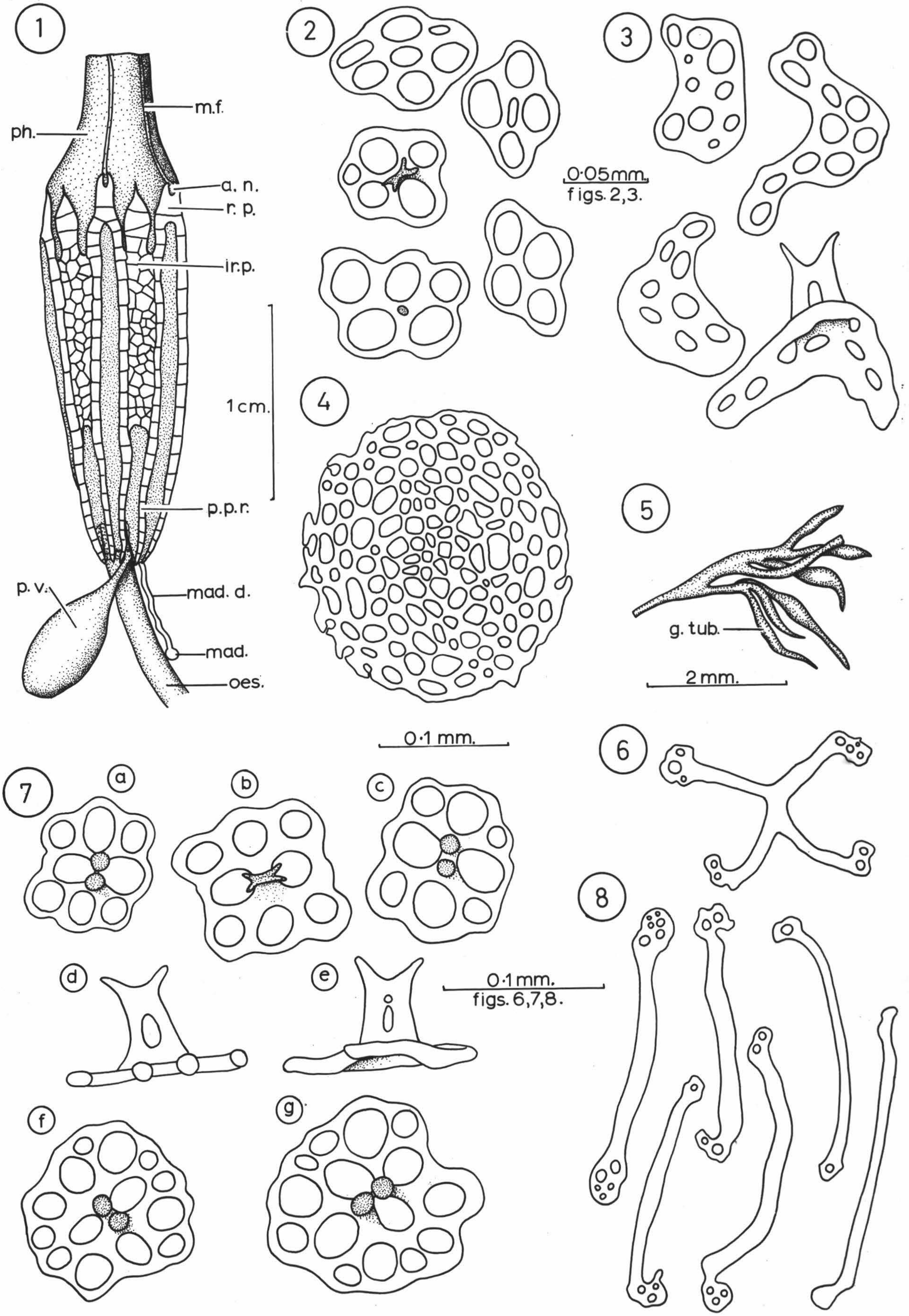
Fig.6. Cruciform deposit from tentacle stem.

Fig.7. Tables from the skin.

- a, b, c. Typical tables with 8 perforations.
- d. Table, showing columns joined by a single crossbar.
- e. Table, showing columns joined by two crossbars.
- f, g. Irregular tables with many perforations.

Fig.8. Deposits from tentacle digits.

Abbreviations: a.n., anterior notch; g.tub., genital tubule; ir.p., interradial piece; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; oes., oesophagus; ph., pharynx; p.p.r., posterior process of the radial; p.v., Polian vesicle.


1
m.f.
ph.
a. n.
r. p.
ir.p.
1 cm.
p.p.r.
p. v.
mad. d.
mad.
oes.
2
3
0·05 mm.
figs. 2,3.
4
5
g. tub.
2 mm.
0·1 mm.
6
7
a
b
c
d
e
f
g
0·1 mm.
figs. 6,7,8.
8

perforations. Average length of tables is 0.1 mm. Colour in alcohol greyish-white, with numerous brown patches.

Description: The 2 specimens on hand are both completely contracted. The shape of both is rather similar to that in Pentadactyla longidentis (Hutton). The larger of the specimens has a distinct tail region which is 4 mm in length. The middle of the body is fat and round, tapering near the anterior end to form the bluntly rounded anterior extremity. The smaller specimen is rather more cylindrical in shape, and the tail is 1.5 mm long. The skin is firm but not thick, and is rough to touch.

Tubefeet are present, scattered all over the body, and are particularly numerous on the ventral surface near the middle of the body. They appear as small round white spots in the skin.

On the dorsal side the specimens are white, with numerous light brown patches, giving the skin a mottled appearance. The ventral surface has many longitudinal wrinkles, and is grey, with a few small scattered brownish patches. The brown patches merge towards the posterior end, where they form an almost continuous ring of brown pigment. The tail is greyish-white. The tentacles are grey, liberally speckled with small dark brown spots.

There are 20 tentacles arranged in 2 rings. The outer ring is composed of 5 pairs of long-stemmed large tentacles, each pair occupying an interradius. The inner ring has 5 pairs of small tentacles, which lie in a radial position.

The calcareous ring is massive, barrel-shaped, and composed of a number of small pieces. There are 5 radial pieces and 5 interradials. The radials have a deep anterior notch (Pl.VIII, fig.1), and long posterior processes, but the interradials are sharply pointed anteriorly, and have no posterior processes. The small components of the radials are approximately rectangular in shape, while those of the interradials are polygonal (Pl.VIII, fig.1).

There is a single large and bulbous Polian vesicle arising from the ventral side of the calcareous ring (Pl.VIII, fig.1). The stone canal is almost straight, and terminates in a small nodular madreporite (Pl.VIII, fig.1).

Gonads consist of a large bunch of branching genital caecae (Pl.VIII, fig.5), which are filled with small eggs of varying sizes.

Calcareous deposits are present in the body wall, tentacles and tubefeet.

1. Body wall deposits: The body wall contains very large numbers of two-pillared tables (Pl.VIII, fig.7, a-g), which show some variation in shape. Most of the tables have 8 perforations (Pl.VIII, fig.7, a-c), but some have a large number of perforations and are irregular in outline (Pl.VIII, fig.7, f-g). Average length of the tables is 0.1 mm. The disc of the table is surmounted by 2 short columns joined by a crossbar (Pl.VIII, fig.7, d). In some of the spicules the columns are joined by 2 crossbars (Pl.VIII, fig.7, e). Near the extreme anterior end of the body the tables are consistently irregular in shape, and many of them are merely flat plates with no spire (Pl.VIII, fig.2). Average length of these deposits is 0.08 mm.

2. Tentacle deposits: The digits of the tentacles contain numbers of long and narrow rods with enlarged perforated extremities (Pl.VIII, fig.8). Many of the rods have no perforations. Average length of tentacle rods is 0.16 mm. The tentacle stems

contain scattered deposits, many of which are cruciform in shape (Pl.VIII, fig.6).

3. Tubefoot deposits: The tubefeet have well-developed endplates (Pl.VIII, fig.4), surrounded by irregular perforated plates (Pl.VIII, fig.5), some of which have a two-pillared spire. Average length of the plates is 0.09 mm.

<u>Holotype:</u> The holotype lies in the collection of the Dominion Museum, Wellington. Dimensions of holotype - total length 35 mm; greatest diameter 17 mm.

Dimensions of paratype - total length 17 mm; greatest diameter 9 mm.

<u>Discussion:</u> It is obvious from the foregoing description that this species is quite closely related to <u>Neothyonidium</u> <u>dearmatum</u> (Dendy and Hindle). There is no doubt, however, that they are distinct species. <u>N. dearmatum</u> is characterised by a total absence of deposits in the skin, apart from a few near the extreme posterior end of the body (Mortensen, 1925), while the present species has very large numbers of deposits all over the body wall. Average length of two-pillared tables in <u>N. dearmatum</u> is 0.07 mm. Average length of tables in <u>N. armatum</u> is 0.1 mm. Thus there is a difference in relative sizes of deposits in the skin, even though the deposits are very similar in other features.

The Polian vesicle in the present species is bulbous, while in <u>N. dearmatum</u> it is long and tubular (Mortensen, 1925).

Of the tentacle deposits in <u>N. dearmatum</u>, Mortensen (1925) says: "The tentacles contain rather numerous spicules, thin rods with a hole or two in each end." The tentacle rods in <u>N. armatum</u>

often have 6 or more holes in each end, and are larger than those in N. dearmatum (length ratio of tentacle rods, N. dearmatum: N. armatum = 1:2).

Unfortunately, Dendy and Hindle (1907) and Mortensen (1925) gave no indication of the colour of their specimens of N. dearmatum. Dendy and Hindle (1907) note that the tentacles have a number of deep red-brown spots.

N. armatum appears to have no near relatives overseas, and constitutes an interesting addition to the dendrochirote holothurian fauna of New Zealand.

Genus Pentadactyla Hutton, 1879

Diagnosis: Medium sized dendrochirotes with 20 tentacles in 2 rings. Tubefeet distributed evenly over the body. Spicules in the skin either spired tables of irregular shape with rough tapered spires, or smooth shiny lattice-plates.

Only 1 species, P. longidentis (Hutton) is known from New Zealand.

Pentadactyla longidentis (Hutton)

Plate IX

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.

<u>Phyllophorus</u> <u>longidentis</u> Ludwig, 1898a, p.49; Dendy and Hindle, 1907, p.101, Pl.13, fig.18, a-d; Benham, 1909, p.28; Mortensen, 1925, p.352; Dawbin, 1950, p.39, Pl.2, fig. 15.

<u>Thyonidium</u> <u>anatinum</u> Perrier, 1903, p.142.

<u>Phyllophorus</u> <u>anatinus</u> Perrier, 1905, p.112, Pl.V, figs.1-9.

<u>Material examined:</u> Thirty-four specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 15, Palliser Bay, 100-150 fms, mud, 1 specimen; VUZ 32, off Petone Beach, 8 fms, mud, 2 specimens; VUZ 37, off Shelly Bay, 10-11 fms, 1 specimen; VUZ 64, off Point Howard Wharf, 5 fms, blue mud, 6 specimens; VUZ 69, Somes Island to Days Bay, 11 fms, mud, 1 specimen; VUZ 87, south of Cape Palliser, 400 fms, mud, rock, gravel, 2 specimens.

Dominion Museum, Wellington:- B.S.130, entrance to Pelorus Sound, 30 fms, 8 specimens; B.S.135, 3 miles southeast of Tonga Cove, Tasman Bay, 15 fms, 1 specimen; B.S.181, off Palliser Bay, 100 fms, 1 specimen; B.S.194, off Somes Island, 11 fms, mud, 1 specimen; Cook Strait, 40 fms, 1 specimen; Wellington Harbour, 10 fms, mud, 1 specimen; Tasman Bay, 1 specimen, coll. M. Young, 11/1934; Akaroa Harbour, 3 fms, mud, 1 specimen.

New Zealand Oceanographic Institute, Wellington:- A.435, off Otaki, 64 fms, sandy mud, 2 specimens; A.445, off Titahi Bay, 12 fms, mud, 1 specimen; C.184, off Opunake, 50 fms, sandy mud, 1 specimen; C.187, entrance to Tasman Bay, 12 fms, soft mud, <u>Echinocardium</u> community, 1 specimen; C.218, Port Gore, 20 fms, soft grey mud, 1 specimen.

P L A T E IX

Pentadactyla longidentis (Hutton)

Fig.1. Internal anatomy of adult dissected from the dorsal side. (Portions of the gonad removed.)

Fig.2. Pharynx and calcareous ring of a senile specimen.

Fig.3. Deposits from a tubefoot.

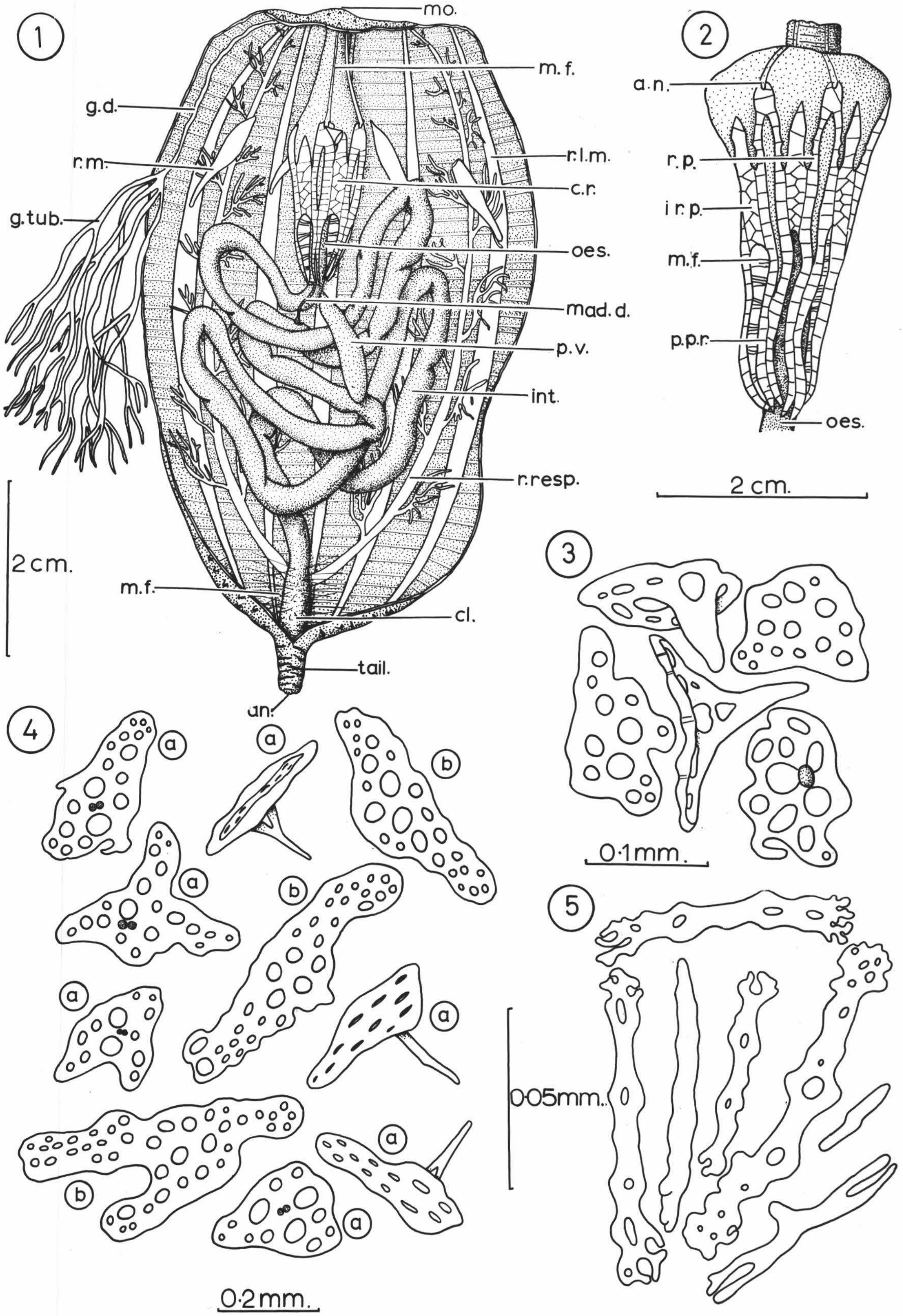
Fig.4. Body-wall deposits.

a. Spired tables.

b. Large smooth plates.

Fig.5. Rods from the tentacles.

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.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.



1
mo.
m. f.
g.d.
r.m.
r.l.m.
c.r.
g.tub.
oes.
mad. d.
p.v.
int.
r.resp.
2 cm.
m.f.
cl.
tail.
an.
2
a.n.
r.p.
i r. p.
m.f.
p.p.r.
oes.
2 cm.
3
0·1 mm.
4
a
b
0·2 mm.
5
0·05 mm.

Diagnosis: Colour dark brown in life and in alcohol. Calcareous deposits in the form of cruciform and oval spired tables 0.3 mm long, together with smooth perforated plates 0.5 mm in length. One bulbous Polian vesicle.

Description: All but one of the specimens on hand are completely contracted. Total length varies between about 20 mm and 70 mm. The shape is approximately cucumiform, but a great deal of variation of this pattern can be seen. Some specimens have pronounced "tails", while others have none. This variation in body form has led to some confusion, and Theel's (1886) species Thyonidium caudatum was based on a tailed form of the species Pentadactyla longidentis. The body carries many scattered spinous projections, which contain aggregations of calcareous deposits.

The colour is usually dark brown in life and in alcohol. The extremities are lighter coloured. The tentacles are greyish-white, with small red-brown spots.

A distinct introvert carries a crown of 20 tentacles, which are disposed in two rings. The outer ring has 5 pairs of large tentacles placed in the interradii; the inner ring has 5 pairs of small tentacles lying in the radii. In the single expanded specimen the large tentacles are 4 mm long and the small tentacles are 1-2 mm in length. The mouth lies in a shallow depression in the centre of the oral disc. The introvert is thin-walled and transparent, and carries double rows of tubefeet on the radii.

The calcareous ring is massive and has 10 pieces, each piece being composed of a complex mosaic of polygonal pieces (Pl.IX, fig.2). Dendy (1896) and Dendy and Hindle (1907) described the calcareous ring in this species. The calcareous ring from a large, possibly senile specimen (Pl.IX, fig.2) differs from the ring figured by Dendy (1896) in a number of respects. The notched anterior ends of the radials have become slightly more rounded, the splits in the radial pieces are much wider and more pronounced, and the anterior projections of the interradials are more angular in outline.

Dendy (1896) stated that the interradial pieces of the calcareous ring contribute to the strong posterior projections (Pl.IX, fig.2), but later (1907) amended this statement, and showed that the radials contribute to the posterior processes.

The small fragments composing the radial pieces tend towards a rectangular shape, while the fragments in the interradials are polygonal (Pl.IX, fig.2).

The oesophagus is thin-walled, and runs into a long coiled intestine (Pl.IX,fig.1). The rectum is thin-walled and transparent and leads into the cloaca, and thence to the anus.

The single Polian vesicle is quite large, transparent and bulbous (Pl.IX, fig.1). The stone canal is short, runs anteriorly in the dorsal mesentery, and terminates in a small madreporite (Pl.IX, fig.1).

The left and right respiratory trees arise from the ventral side of the anterior end of the rectum, and both extend to the anterior end of the body, where they attach to the pharynx (Pl.IX, fig.1).

Gonads consist of a large mass of dichotomously branching filiform caecae. The genital duct is long, runs forward in the dorsal mesentery close to the body wall (Pl.IX, fig.1), and opens to the exterior in the dorsal interradius immediately posterior to the outer ring of tentacles. The genital caecae contain large yolky eggs, indicating that this species lacks a pelagic larva, and may perhaps be viviparous. Viviparity has been reported in Phyllophorus urna Grube (Mortensen, 1927, p.409).

Longitudinal muscles are represented as 5 broad flat straps (Pl.IX, fig.1), and they extend on to the pharynx as 5 pairs of thin strands (Pl.IX, fig.2). Retractor muscles arise from the longitudinal muscles one third of the way along the body cavity, and are inserted into the anterior notches of the radial pieces of the calcareous ring (Pl.IX, fig.1). Transverse muscles are visible, but not conspicuous.

Calcareous deposits of two kinds may be distinguished:-

1. Body wall deposits: The body wall is completely invested in calcareous spicules, many of which have a central spire. The spired tables (Pl.IX, fig.4, a) are usually oval to round in adult specimens. In juveniles and some adults, the spired deposits are cruciform in shape. This was first observed by Dendy (1896). Average greatest diameter of spired tables is 0.3 mm. The spire is usually centrally placed on the disc, and is composed of 2 projecting rods which are fused together. The spired deposits are so placed in the skin that the sharp spires project above the level of the body wall.

Larger plates without a central spire are also rather common in the skin. Dendy and Hindle (1907) state that a few of the deposits in this species have no spire at all. The present writer has found that in adult specimens at least half of the skin deposits are without spires, and these flat plates are quite distinct from the spired tables. They are larger than the tables (average length 0.5 mm), and are more elongate. (Pl.IX, fig.4, b).

The tubefeet do not appear to have endplates in the strict sense, but they contain large numbers of deposits, mainly spired tables (Pl.IX, fig.3).

There are no deposits in the introvert.

2. Tentacle deposits: The tentacles contain numerous small, elongate (0.02-0.1 mm long) rods, some of which are perforated. (Pl.IX, fig.5.)

Distribution: *Pentadactyla longidentis* is a prominent member of the holothurian fauna of the Cookian region of New Zealand. Specimens have been taken from as far north as Egmont to the west of the North Island, and no doubt the species is present in the same latitudes to the east. *P. longidentis* is very common in Wellington Harbour and also in the Marlborough Sounds.

Ecology: Preference is shown for a muddy bottom, and depths between 3 fathoms and 400 fathoms are tolerated. The presence of specimens in 400 fathoms leaves room for the suggestion that *P. longidentis* may prove to have a wider distribution than formerly supposed.

It is interesting to note that *Echinocardium cordatum* (Pennant) is also very common in Wellington Harbour and Tasman Bay. *P. longidentis* may play a prominent part in the *Echinocardium* communities in the same areas.

Discussion: Because of its colour, shape, and rough texture, *P. longidentis* is one of the most easily recognised of the New

Zealand holothurians, distinguishable from Neothyonidium dearmatum (Dendy and Hindle) by the roughness of its body wall.

Family PSOLIDAE

Diagnosis: Body flattened, with a sharply defined ventral sole. Dorsal side covered by thick imbricating scales; sole thin-walled. Mouth and anus dorsal. Posterior loop of the intestine lies in the right ventral interradius. Tentacles 10-15.

The family Psolidae is a small group containing only a few genera, and is represented in New Zealand by a single species. Members of this family are usually small, living on hard bottoms.

Genus Psolus Oken, 1815

Diagnosis: Tentacles 10. Dorsal surface without pedicels.

Psolus neozelanicus Mortensen

Psolus neozelanicus Mortensen, 1925, p.362, figs.44-45; Dawbin, 1950, p.35, Pl.1, fig.2.

Material examined: None.

Diagnosis: Tubefeet of the ventral sole arranged in a double series around the whole edge of the sole; no tubefeet in the midventral interradius. Dorsal surface with a few very large imbricating scales. Colour white.

Discussion: No further specimens of this very interesting little psolid have been taken in New Zealand waters.

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 holothurians are placed in this very large family. Panning (1949) revised the family and diagnosed 5 subfamilies. Three of these subfamilies are represented in the New Zealand region.

Key to the New Zealand Subfamilies of Family Cucumariidae

1 (4) Calcareous ring composed of 10 solid pieces.

2 (3) Calcareous deposits merely plates. No cups or tables . . .
. . . . .Subfam. CUCUMARIINAE

3 (2) Calcareous deposits cups and plates . . . .
. . . . .Subfam. COLOCHIRINAE

4 (1) Calcareous ring long and slender, the entire ring composed of a complex mosaic of minute pieces . . . .
. . . . .Subfam. THYONINAE

Subfamily CUCUMARIINAE

Diagnosis: Calcareous ring simple, without bifurcated processes, or at the most moderately deep, with short undivided processes. Radials and interradials undivided. Merely plates in the skin. No cups or tables. (Panning, 1949.)

The Subfamily Cucumariinae is represented in New Zealand by 3 genera and 3 species.

Key to the New Zealand Genera in Subfamily Cucumariinae

1 (4) Calcareous deposits in the form of smooth plates, scattered in the skin.

2 (3) Tubefeet present over the entire dorsal surface. Colour black and white . . . . Genus Psolidiella Mortensen

3 (2) Tubefeet absent from the dorsal surface. Colour whitish, or with purplish tinge. Genus Cucumaria Blainville

4 (1) Calcareous deposits in the form of overlapping knobbed buttons . . . . Genus Stereoderma Ayres

Genus Psolidiella Mortensen, 1925

Diagnosis: Psolus-like, with a ventral sole which is, however, not limited from the rest of the body through a sharp edge. Outside the sole the body is all over provided with tubefeet which do not show any serial arrangement. Calcareous deposits not in the shape of overlapping scales. (Mortensen, 1925).

The single New Zealand species of this genus is P. nigra Mortensen. Panning (1949) includes the species spectabilis (Ludwig) and mollis (Ludwig and Heding) in this formerly monotypic genus. It is of some interest to note that the genus has a Sub-antarctic distribution, P. mollis being known from Bouvet Island, and P. spectabilis from Magellan Straits.

Psolidiella nigra Mortensen

Plate X

Psolidiella nigra Mortensen, 1925, p.360, figs.42-43; Dawbin, 1950, p.35, pl.1, fig,3; Panning, 1949, p.424.

P L A T E X

Psolidiella nigra Mortensen.

Fig.1. Internal anatomy of adult dissected from the dorsal side.

Fig.2. Pharynx and calcareous ring.

Fig.3. Tentacle deposits.

Fig.4. Plates from the ventral sole.

Fig.5. Endplate from a ventral tubefoot.

Fig.6. Stages in the development of a dorsal tubefoot endplate.

Fig.7. Endplates from dorsal tubefeet.

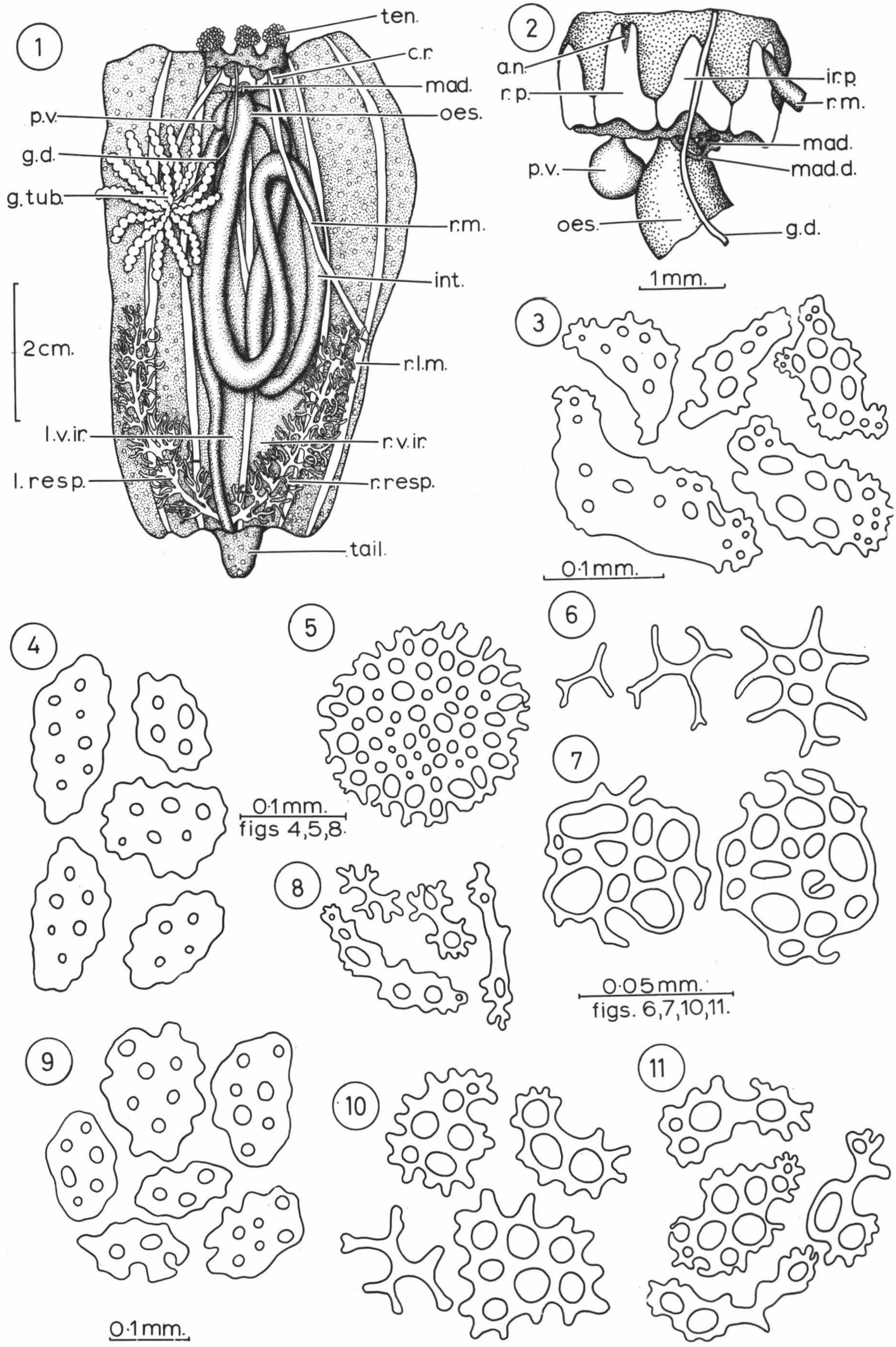
Fig.8. Irregular deposits from ventral tubefeet.

Fig.9. Plates from the dorsal skin.

Fig.10. Button-like deposits from the ventral sole.

Fig.11. Irregular deposits from dorsal tubefeet.

Abbreviations: a.n., anterior notch; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., interradial piece; l.resp., left respiratory tree; l.v.ir., left ventral interradius; mad., madreporite; mad.d., stone canal; 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.v.ir., right ventral interradius; ten., tentacles.


1
ten.
c.r.
mad.
p.v.
oes.
g.d.
g.tub.
r.m.
int.
2cm.
r.l.m.
l.v.ir.
r.v.ir.
l.resp.
r.resp.
tail.
2
a.n.
r.p.
ir.p.
r.m.
mad.
mad.d.
p.v.
oes.
g.d.
1mm.
3
0·1mm.
4
5
0·1mm.
figs 4,5,8.
6
7
8
0·05mm.
figs. 6,7,10,11.
9
10
11
0·1mm.

<u>Material examined:</u> Six specimens from the following stations:-

In the collection of the Department of Zoology, Victoria University of Wellington:- Menzies Bay, Banks Pensinula, intertidal rock crevices, 2 specimens, coll. H.B. Fell and E. Percival 25/4/59.

Dominion Museum, Wellington:- Sandfly Bay, Otago Peninsula, intertidal rock crevice, 2 specimens; Menzies Bay, 2 specimens.

<u>Diagnosis:</u> Ventral tubefeet in each radius arranged into 4 rows. Dorsal surface black; ventral surface white. Calcareous deposits small, irregular smooth plates, numerous ventrally but widely scattered on the dorsal surface.

<u>Description:</u> All but 2 of the specimens on hand are contracted. The body is <u>Psolus</u>-like, with a ventral sole. The mouth is ventrally turned and the anus is subdorsal, at the tip of a distinct posterior "tail". The skin is soft and thin, but opaque.

The ventral sole and tubefeet are white, while the dorsal surface of the body is black. The numerous dorsal tubefeet appear as small white spots, scattered over the entire dorsal surface. Tentacles are black, with a few white spots.

The sole is delimited by the tubefeet of the lateral ventral radii, which are arranged in 4 crowded rows in each radius. The tubefeet of the mid-ventral radius are in a double row.

A ring of 10 tentacles surrounds the circular mouth. The mid-ventral pair of tentacles are slightly smaller than the rest.

The calcareous ring is simple and well-developed. Radial pieces each have a long and broad anterior process which is notched at its anterior extremity (Pl.X, fig.2). Posteriorly, the radials each have a shallow notch. Interradial pieces have broad, blunt anterior projections and V-shaped posterior notches (Pl.X, fig.2).

A single spherical Polian vesicle arises from the water-vascular ring in the left ventral interradius (Pl.X, fig.2). The stone canal is short and straight, terminating in a rather flocculate madreporite (Pl.X, fig.2).

The oesophagus is thin-walled and dilated (Pl.X, fig.1), narrowing into the intestine, which takes 2 S-shaped loops and runs to the terminal anus. The posterior loop of the intestine lies in the left ventral interradius (Pl.X, fig.1). Respiratory trees are short and copiously branched (Pl.X, fig.1). The left trunk is slightly longer than the right.

The gonad consists of a small number of short tubular caecae which are filled with large eggs (Pl.X, fig.1). Average diameter of the eggs is 1.4 mm. The genital duct runs anteriorly in the dorsal mesentery and opens to the exterior in the mid-dorsal interradius, near the ring of tentacles. On the inside of the body wall, the tubefeet can be seen as small white spots.

A variety of calcareous deposits are present:-

1. Skin deposits:- The sole contains large numbers of plates and button-like deposits, which are very closely crowded together but do not overlap. The plates are small (0.1-0.15 mm in length), oval to elongate, and have a small number of perforations (Pl.X, fig.4). Intermingled with the plates are button-like deposits, which are irregular in shape and have 3-10 large perforations (Pl.X, fig.10). Various developmental stages of the button-like deposits are also present.

The dorsal area of the skin has deposits similar in most respects to the plates in the sole. They are, however, smaller than the sole plates, their average length being 0.11 mm (Pl.X, fig.9).

2. Tubefoot deposits:- Deposits in the dorsal tubefeet differ quite conspicuously from those in the ventral tubefeet. The dorsal tubefeet have endplates with a small number of perforations, and they tend to be angular in shape (Pl.X, fig.7). Stages in the development of the dorsal endplates can be seen (Pl.X, fig.6). The endplates are surrounded by irregular perforated rods and plates (Pl.X, fig.11).

The ventral tubefeet have circular endplates with numerous small perforations (Pl.X, fig.5), surrounded by irregular deposits rather similar to those in the dorsal tubefeet, but with fewer perforations (Pl.X, fig.8).

3. Tentacle deposits:- The tentacles contain many perforated plates of irregular shape. Average length of the plates is 0.12 mm. (Pl.X, fig.3).

Distribution: Mortensen (1925) described the holotype from Paterson Inlet, Stewart Island. The new localities, Menzies Bay and Sandfly Bay, Otago Peninsula, indicate that Psolidiella nigra may be present along the entire East Coast of the South Island of New Zealand, its habitat preferences limiting its wider distribution.

Ecology: Psolidiella nigra is known only from the intertidal region, where it clings to rocks, or lodges in small crevices. The remarks of Mortensen (1925) may be appropriate at this juncture - "The black colour must make this species very difficult to observe on the dark rocks, where it lives, and thus afford it a most effective protection."

Discussion: Mortensen (1925) illustrated pieces of the calcareous ring of this species. His figure did not show the definite anterior notch possessed by each radial piece. As his specimens were completely contracted, the posterior "tail" was not in evidence.

Genus Cucumaria Blainville, 1834

Diagnosis: Calcareous ring simple, without prolongations. In the body wall thin plates, sometimes with large perforations, flat, or with some isolated spines. (Panning, 1949.)

New Zealand has a single representative of this genus.

Cucumaria macquariensis (Dendy)

Psolus macquariensis Dendy, 1896, p.41, Pl.7, figs.70-72; Farquhar, 1898, p.325.

Pseudopsolus macquariensis Ludwig, 1898a, p.49; Perrier, 1905, p.111; Mortensen, 1925, p.357, fig.41; Dawbin, 1950, p.35.

Material examined: None.

Diagnosis: Body flattened ventrally to form a creeping sole. Skin very thin, containing very sparingly scattered small oval reticulate plates. Tentacles and tubefeet entirely devoid of deposits. Calcareous ring rudimentary, reduced to aggregations of granules.

Discussion: This species has been recorded from Macquarie Island (Dendy, 1896) and Stewart Island (Mortensen, 1925). Dawbin (1950) includes Pseudopsolus macquariensis in the family Psolidae, but there is no doubt that the species is a cucumariid.

Genus Stereoderma Ayres, 1851

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

Stereoderma is represented in New Zealand waters by a single species.

Stereoderma leoninoides (Mortensen)
(Plate XI, figs. 4,5,8,9.)

Cucumaria leonina Semper var. Dendy, 1909, p.146, Pl.VI, fig.1, a-c.

Cucumaria leoninoides Mortensen, 1925, p.338, fig.27, a-b; Dawbin, 1950, p.38.

Stereoderma leoninoides Panning, 1949, p.422.

Non: Pseudocnus leonina (Semper).

Material examined: Eight specimens in the collection of the Dominion Museum, Wellington (Cape Expedition material):- Tagua Bay, Auckland Islands, in rock crevices at lowtide level, 8 specimens, coll. W.H. Dawbin 30/9/43.

Diagnosis: Deposits oval to rectangular perforated plates beset with knobs. Average length of plates is 0.1 mm. One end of the plate is narrow and dentate; the other is smooth and rounded. Each plate has four large perforations and many smaller perforations.

Description: Unfortunately, all of the specimens on hand are damaged, apparently as a result of sudden contraction when being preserved. In most of the specimens portions of the viscera project through the body wall, and the bodies are so twisted and deformed that successful dissection is not possible.

The body is more or less cucumiform, tapering abruptly to the anus at the posterior end. The crown of tentacles is carried on a transparent introvert. The skin is thick, rough and coriaceous, and carries a number of deep transverse wrinkles. Total length of largest specimen is 15 mm.

In alcohol, the body is bright yellow in colour, while the tentacles are orange. Dawbin (1960, private communication) states that "the bright strawberry red Cucumaria was abundant in Carnley Harbour ..." (Tagua Bay lies in Carnley Harbour.) As there were no other specimens of "Cucumaria" in the Cape Expedition collection, it is assumed that Stereoderma leoninoides is in fact strawberry red when alive. Dendy (1909) makes no mention of the colour of his specimens in life, while Mortensen (1925) writes: " ... I have made no notice of the colour of the living specimens ... I seem to remember fairly clearly that it was yellowish white."

The anus is surrounded by 5 small anal teeth which are virtually invisible in many of the specimens examined.

Tubefeet are present on the introvert in 5 irregular rows, but are not visible elsewhere due to the condition of the body wall. Dendy (1909) states that the tubefeet are arranged in 5 well-marked, irregularly double, ambulacral bands.

There are 10 short, much-branched tentacles arranged in a single ring around the circular mouth. The 2 ventral tentacles are slightly smaller than the rest. A brownish spot lies at the base between each pair of tentacles.

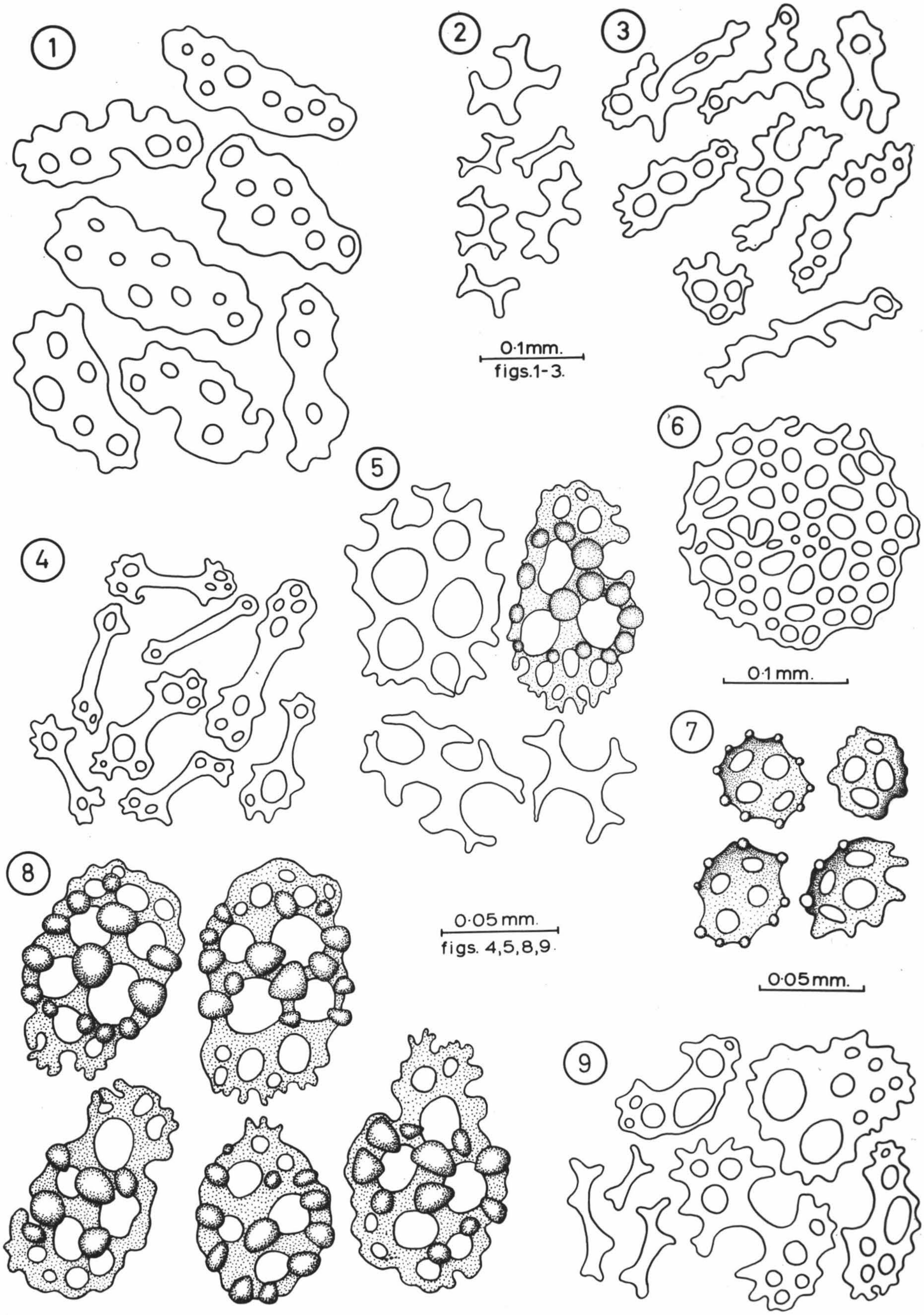
Calcareous deposits are present in the skin, introvert, tentacles and tubefeet.

1. Skin deposits:- The skin contains great numbers of small knobbed perforated plates. The plates are oval to rectangular in shape, and have an average length of 0.1 mm (Pl.XI, fig.8). The plates are usually narrower at one end than at the other, and the narrow end is serrated, while the broad end is quite smooth. In the skin, the plates overlap closely, and their narrow dentate extremities point outward and project above the level of the skin. Thus, specimens of S. leoninoides feel grainy when handled. Each plate has 4 large perforations and some smaller perforations, but many variations of this basic pattern are found (Pl.XI, fig. 8), and some of the spicules are very atypical.

Near the posterior extremity of the body, the plates tend to become even more irregular in pattern, and stages in the development of plates can be seen (Pl.XI, fig.5).

2. Introvert deposits:- The introvert has a number of irregular plates with 3-10 perforations (Pl.XI, fig.9). Average length of the introvert deposits is 0.07 mm. Also present in the introvert are a small number of slightly branched unperforated rods.

3. Tentacle deposits:- The tentacles contain a large number of small rods which rather resemble dumbbells. The enlarged extremities of these rods have varying numbers of small perforations. Average length of the tentacle rods is 0.05 mm. (Pl.XI, fig.4.)


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

4. Tubefoot deposits:- The well-developed endplates in the tubefeet are surrounded by deposits which are similar to those from the introvert and tentacles.

Distribution: Dendy (1909) described specimens from Carnley Harbour in the Auckland Islands. Mortensen (1925) described numerous specimens from Carnley Harbour, 5 specimens from Perseverance Harbour, Campbell Island, and 2 specimens taken from a piece of floating Lessonia sp., 1 mile east of the Auckland Islands. It appears, then, that this species is especially common in Carnley Harbour in the Auckland Islands, and is present in numbers in Campbell Island. No specimens have as yet been taken from the New Zealand mainland.

Ecology: This species has only been found in intertidal areas, concealed in rock crevices. The presence of a specimen on Lessonia sp. indicates that the species may also live on fronds of algae.

Discussion: Dendy (1909) stated that 1 of the 2 specimens at his disposal was badly damaged by rupture. This may therefore be a commonplace phenomenon in this species.

Dendy (1909) also noted the fact that his specimens bore a strong resemblance to the South American species Cucumaria leonina Semper. But he did recognise some differences and suggested that the Auckland Islands forms might constitute a variety of the South American species. Mortensen (1925) agreed with Dendy, but went a step further, and placed his Auckland and Campbell Islands material into a new species Leoninoides, the name "hinting both at its history and its affinity with the South American species" (Mortensen, 1925). Mortensen also indicated that the species bears "distinct relations to the Kerguelen form, Cuc. laevigata (Verrill) ...".

The chief difference between leoninoides and leonina lies in the fact that the skin in leonina contains large numbers of small, smooth perforated buttons, which are completely lacking in leoninoides. But the peculiar knobbed plates in leonina and leoninoides and also in laevigata are strong evidence for the supposition that the species are quite closely related. Their geographic distribution serves to confirm this. It is not too difficult to visualise a parent species being carried alive on floating seaweed to South America, Kerguelen Island, and the Auckland and Campbell Islands, with the assistance of the circum-polar current and west wind drift. Specimens impinging on such widely separated areas could undergo divergent evolution and eventually give rise to separate species as a result of their isolation from each other.

If a theory such as the above has a basis of truth, then it is necessary that the 3 species under discussion should be placed in the same genus. Panning (1949) placed leoninoides and laevigata into the genus Stereoderma Ayres, and leonina into his new genus Pseudocnus.

A rather more thorough investigation of this problem is needed, and zoogeographical considerations should not be neglected in these cases.

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. (Panning, 1949.)

This Subfamily is represented in New Zealand by 2 genera and 5 species.

Key to the New Zealand Genera in Subfamily Colochirinae

1 (2) Calcareous deposits cups and smooth plates . . . .
. . . . Genus Trachythyone Studer

2 (1) Calcareous deposits cups and knobbed plates of two types . .
. . . . Genus Ocnus Forbes and Goodsir, Forbes.

Genus Trachythyone Studer, 1876

Diagnosis: Calcareous ring simple, without posterior processes. In the body wall cups and smooth plates.

There are 2 New Zealand species of this genus. A third species. T. squamata n.sp., is known only from Macquarie Island, but is included in the present account because it is closely related to T. bollonsi (Mortensen), and is therefore of some zoogeographical interest.

Key to the New Zealand species of Trachythyone

1 (4) Deposits include small plates with few perforations.

2 (3) (Plates form an investing layer in the skin. Macquarie Island specimen . . . . Trachythyone squamata n.sp.)

3 (2) Plates scattered in small numbers . . . .
. . . . Trachythyone bollonsi (Mortensen)

4 (1) Deposits include larger plates of variable form with many perforations . . . . . Trachythyone amokurae (Mortensen)

Trachythyone amokurae (Mortensen)

Cucumaria amokurae Mortensen, 1925, p.341, figs.29, 30,a; Dawbin, 1950, p.38, Pl.2, fig.13.
Trachythyone amokurae Panning, 1949, p.425.
Material examined: None.
Diagnosis: Skin thin and delicate. Deposits large plates of various forms with many perforations; plates smooth ventrally, coarse and spinose dorsally. The plates are overlain by small, irregular X-shaped bodies. Small knobbed buttons also present.
Discussion: Mortensen's specimens were taken from Carnley Harbour, Auckland Islands, and Stewart Island. Further collecting in these areas has failed to reveal any further specimens of this species. T. amokurae is therefore not a prominent member of the holothurian fauna of New Zealand.

Trachythyone bollonsi (Mortensen)

Cucumaria bollonsi Mortensen, 1925, p.345, fig.32; Dawbin, 1950, p.38, Pl.2, fig.9.
Trachythyone bollonsi Panning, 1949, p.425.
Material examined: None.
Diagnosis: Skin thin and delicate. Deposits small smooth plates with few perforations. The plates do not overlap, and are rather scattered. Four-holed buttons and characteristic rudimentary cups are present in numbers.
Discussion: See under Trachythyone squamata n.sp. (p.136).

Trachythyone squamata n.sp.

Plate XI, figs.1-3,6,7. Plate XII.

Material examined: Garden Cove, Macquarie Island, amongst sea anemones, 1 specimen, coll. J. Hope Macpherson 26/12/1959.

Diagnosis: Skin thin but firm. Deposits small overlapping plates with few perforations. Cups, typically with four perforations, and small dichotomously branching spicules, are present in numbers. Ventral tubefeet in three crowded rows.

Description: The single specimen is completely contracted, and the tentacles are not visible. The body is approximately cylindrical in shape, bluntly rounded anteriorly, and narrowing gently toward the posterior end to form an upward turned "tail". The skin is thin, but firm and opaque, and has a characteristic grainy appearance when viewed through a lens. There is some transverse wrinkling, especially near the posterior end.

Colour in alcohol, pink. The extremities are greyish-white.

On the ventral side of the body, there are 3 rows of tubefeet (Pl.XII) to each ventral radius. Near the extremities the rows become biserial, and they eventually die out altogether. The last 5 mm of the posterior end of the body are completely naked. The dorsal surface carries a number of scattered papillae which are more numerous laterally, and absent at the extremities.

Skin deposits are of 3 kinds:

1. Plates (Pl.XI, fig.1):- The skin contains great numbers of small perforated plates which are closely aggregated together and overlap in all directions. In general, the plates are oval to elongate and have 2-10 perforations. Average length of plates is 0.2 mm.

PLATE XII

Trachythyone squamata n. sp., viewed from the left ventral side. (x 6).

2. Cups (Pl.XI, fig.7):- Small cups overlie the buttons in the skin, but they are not nearly as numerous. The cups are shallow, approximately circular, and typically have 4 perforations. The cup rim carries about 10 knob-like projections. Average cup diameter is 0.05 mm.

3. Small dichotomously branching spicules (Pl.XI, fig.2):- These characteristic branching spicules are present, overlying the plates and intermingled with the cups.

The tubefeet have well-developed endplates (Pl.XI, fig.6), which are surrounded by irregular perforated rods (Pl.XI, fig.3).

Holotype: The holotype lies in the collection of the National Museum of Victoria.

Dimensions of holotype:- Total length 30 mm; greatest diameter 7 mm.

Discussion: The present species is closely related to *T. bollonsi* (Mortensen), which is known from 6 specimens taken from Cape Maria van Diemen in the northernmost part of New Zealand. They are very similar in external appearances, apart from colour. *T. bollonsi* is blackish dorsally and white on the ventral surface. The differences in spiculation serve to demonstrate that the two species are distinct. The plates in *T. bollonsi* are scattered, not overlapping, as they are in *T. squamata*. The well-developed cups of *T. squamata* are parallelled by rudimentary cups in *T. bollonsi*.

T. parva (Ludwig) is also similar to the Macquarie Island species in a number of respects, but the plates in *T. parva* are larger and more massive, and the ventral tubefeet are not confined to the radii. *T. parva* is a firmly established species, known from Patagonia and Kerguelen Island.

The 3 species under discussion may have arisen from a common source, and as they are all littoral forms, their distribution may have been accomplished on floating seaweed, with the aid of the west wind drift.

T. squamata is an interesting addition to the sparse holothurian fauna of Macquarie Island, and the species may eventually be taken in New Zealand. If this is so, then the case will form an interesting parallel with that of Cucumaria macquariensis (Dendy) (p.127)

Genus Ocnus Forbes and Goodsir, Forbes, 1841

Diagnosis: Calcareous ring simple, without posterior processes. Deposits in the form of knobbed plates and cups. The plates form an investing layer. (Panning, 1949, in part.)

Panning (1949) included 3 New Zealand species in this genus. The 3 species are rather similar in external features, but differ markedly in their calcareous deposits.

Key to the New Zealand species of the Genus Ocnus

1 (2) Deposits include large, coarse, overlapping scales with numerous knobs . . . . Ocnus farquhari (Mortensen)

2 (1) Deposits include small knobbed plates, typically with 4 large perforations.

3 (4) Plates usually with 10 marginal knobs . . . . Ocnus brevidentis (Hutton)

4 (3) Plates usually with 12 marginal knobs . . . . Ocnus calcareus (Dendy)

Ocnus farquhari (Mortensen)

Cucumaria farquhari Mortensen, 1925, p.343, figs.30, b, 31;
Dawbin, 1950, Pl.2, fig.12, p.38.
Ocnus farquhari Panning, 1949, p.437.

Material examined: None.

Diagnosis: Deposits include large, coarse, overlapping scales beset with numerous knobs, spinous cups with thorny edges, and buttons with round knobs. Ventral tubefeet in 3 biserial rows. Dorsal surface black; otherwise white.

Discussion: This species is known only from 2 specimens taken from 55 fms. off North Cape. It seems that O. farquhari is a rare species, possibly part of the subtropical element in the fauna of northern New Zealand.

Ocnus brevidentis (Hutton)

Plate XIII.

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 and 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, p.38.
Colochirus brevidentis Ludwig, 1898b, p.442, Taf.26, figs.22-29.
(= Ocnus calcarea (Dendy).)

Material examined: Twenty-two specimens from the following stations:

In the collection of the Dominion Museum, Wellington:- off Mamakau Rock, Foveaux Strait, 15-20 fms, 4 specimens; off Muck Rock, Foveaux Strait, 10 fms, 1 specimen; Ulva Island, Paterson Inlet, Stewart Island, 5 specimens; Beach harbour, Dusky Sound, 6-10 fms, 1 specimen; Takapuna, Auckland, 6-10 fms, 1 specimen (on *Carpophyllum* sp. holdfast).

Cape Expedition material:- No.1 Station Inlet, Auckland Islands, in rock pool, 1 specimen, coll. E.F. Doley, 8/8/40.

Chatham Islands (1954) Expedition material:- Stn.9, Glory Bay, Pitt Island, shore collection, 2 specimens; Stn.15, Hanson Bay, 30 fms, fine grey sand, 1 specimen; Stn.34, east of the Forty Fours, 130 fms, green sand and mud, 6 specimens (attached to the spines of a large cidarid).

Diagnosis: Deposits include knobbed plates, typically with 4 primary perforations and 10 marginal knobs; knobbed cups and curved perforated rods also present. Skin thick and coriaceous. Colour white.

Description: All but one of the specimens are completely contracted. Total length ranges between 6 mm and 20 mm. The body is sausage-shaped, and bluntly rounded anteriorly and posteriorly. The skin is thick and coriaceous.

Colour in life, pink; in alcohol, some of the specimens are white, while others are light brown. The tentacles are light brown in preserved specimens.

The circular mouth is surrounded by a single ring of 10 dendriform tentacles, the 2 ventral tentacles being considerably

P L A T E XIII

Ocnus brevidentis (Hutton)

Fig.1. Internal anatomy of adult dissected from the left ventral side. (Portions of the gonad removed.)

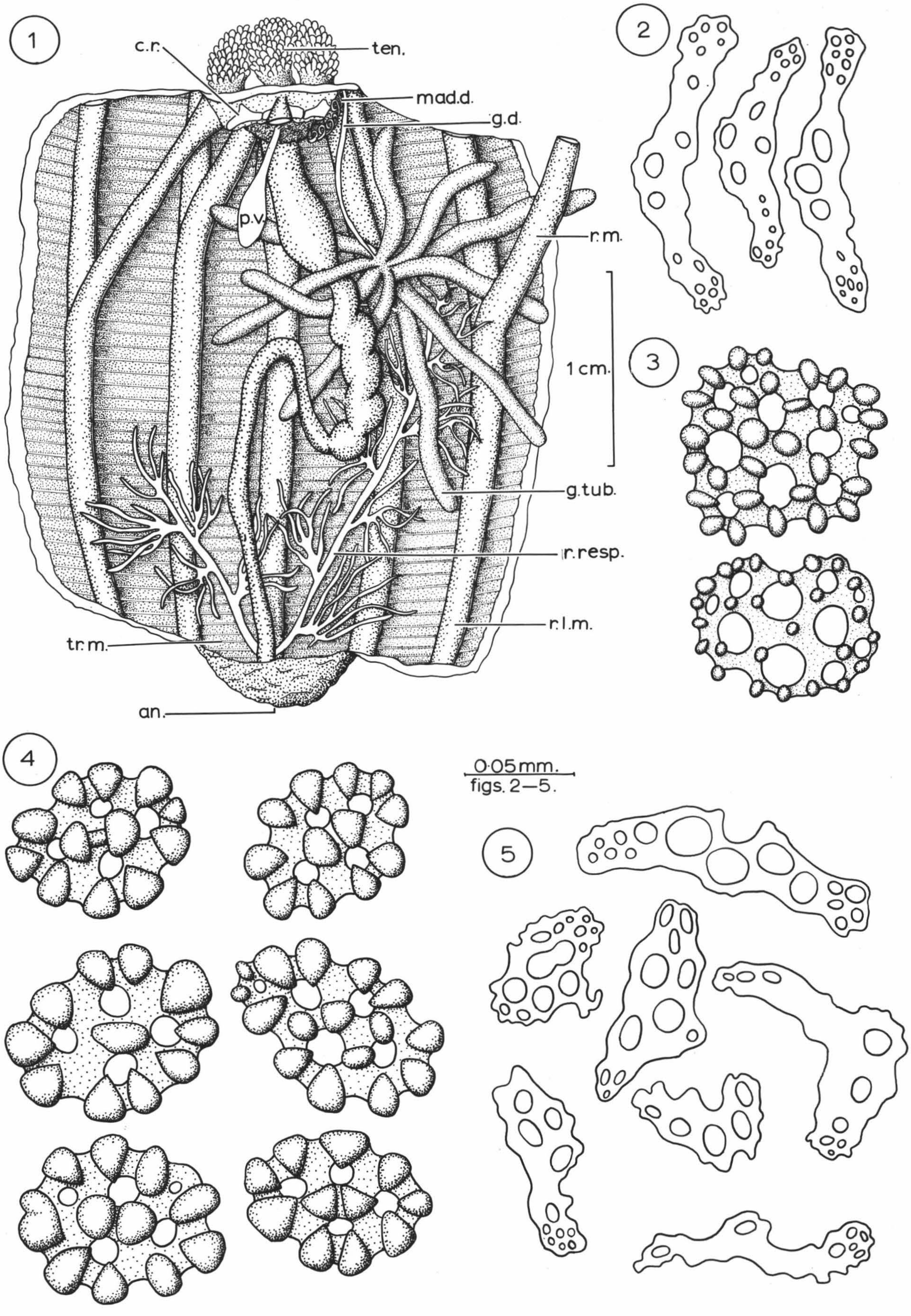
Fig.2. Perforated rods from the skin.

Fig.3. Knobbed cups from the skin.

Fig.4. Knobbed plates from the skin.

Fig.5. Tentacle deposits.

Abbreviations: an., anus; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubule; mad.d., stone canal; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; r.resp., right respiratory tree; ten., tentacle; tr.m., transverse muscles.


1
c.r.
ten.
mad.d.
g.d.
p.v.
r.m.
1 cm.
g.tub.
r.resp.
r.l.m.
tr.m.
an.
2
3
4
0·05 mm.
figs. 2—5.
5

smaller than the rest.

Tube feet and pedicels are present in abundance, the tube-feet being crowded over the whole of the ventral surface, except at the anterior and posterior extremities, while the pedicels are scattered over the dorsal surface.

The calcareous ring is simple, composed of 10 small pieces. The radial pieces are notched anteriorly for the insertion of the retractor muscles. Each interradial has a short blunt anterior process.

The oesophagus is short and thick-walled, narrowing sharply to lead into the convoluted intestine, which takes a short S-shaped loop (Pl.XIII, fig.1) and runs to an undifferentiated rectum, thence to the terminal anus.

A single Polian vesicle arises from the water-vascular ring in the left ventral interradius (Pl.XIII, fig.1). The Polian vesicle is elongate and swollen distally. The loosely coiled stone canal is derived from the water-vascular ring in the dorsal interradius, and runs anteriorly in the dorsal mesentery, terminating in a minute nodular madreporite (Pl.XIII, fig.1).

Respiratory trees are well-developed, and the 2 main trunks each give rise to a small number of long, branching, filamentous respiratory tubules. The right trunk is about twice as long as the left, and extends about two thirds of the way along the body cavity (Pl.XIII, fig.1).

The gonad consists of a bunch of unbranched tubular caecae (Pl.XIII, fig.1) which lie tangled around the oesophagus and intestine. The genital duct lies in the dorsal mesentery, and opens to the exterior at an indistinct genital pore in the dorsal interradius, immediately posterior to the ring of tentacles.

Longitudinal muscles and retractor muscles are represented as strong broad straps. The transverse muscles are also well-developed (Pl.XIII, fig.1).

Calcareous spicules are present in the skin, the tentacles and the tubefeet and pedicels.

1. Skin deposits:- The thick and hard integument contains great numbers of knobbed plates (Pl.XIII, fig.4). The plates are oval in shape, their average length being 0.08 mm. There are typically four primary perforations of equal size in each plate, but some have a few smaller perforations in addition. The margin of each plate is beset with a number of conspicuous knobs. There are usually 10 marginal knobs in this species, but the number varies between 8 and 11. The central portions of the plates have 1-4 knobs.

Small knobbed cups are also present in large numbers in the skin (Pl.XIII, fig.3). They are oval to rectangular in shape, the average length being 0.08 mm. The cups have many perforations, and are knobbed on one side only.

Curved perforated rods (Pl.XIII, fig.2) are found in the skin, but they are rather more scattered than the buttons or cups. Average length of the curved rods is 0.11 mm.

2. Tentacle deposits:- The tentacle digits and stems contain large numbers of irregular perforated plates and rod-like spicules (Pl.XIII, fig.5). The number of perforations varies between 4 and 18.

3. The tubefeet and pedicels have well-developed end-plates, which are surrounded by perforated plates similar to those found

in the skin.

Distribution: Hutton (1872) made no mention of the locality from which the holotype was taken. Dendy and Hindle (1907) recorded specimens from the Chatham Islands, Great Barrier Island and Stewart Island. Mortensen listed specimens from Cape Maria van Diemen, Slipper Island and Carnley Harbour, Auckland Islands. The present localities, Foveaux Strait, Stewart Island, Auckland, Dusky Sound, Chatham Islands, and Auckland Islands indicate that the species is widespread around all coasts in New Zealand, and is also very common on the near islands.

Ecology: *Ocnus brevidentis* has been taken from the intertidal zone to depths of 130 fathoms. The records of previous writers show that the species is most commonly found clinging to seaweed or rock walls. The distribution pattern of this species is readily understood when one considers that specimens can cling to floating seaweed. It is possible that *Ocnus brevidentis* may prove to be more widely distributed in the southern oceans.

Discussion: Mortensen (1925) showed quite conclusively that *Ocnus brevidentis* is distinguishable from *Ocnus calcarea* (Dendy), mainly on the basis of constant differences in their calcareous deposits.

Ocnus brevidentis var. *carnleyensis* (Dendy)

Cucumaria brevidentis (Hutton) var. *carnleyensis* Dendy, 1909, p. 149, Pl.VI, fig.2, a-l; Mortensen, 1925, p.332, figs. 24, 25.

Ocnus brevidentis var. *carnleyensis* Panning, 1949, p.437.

Material examined: None.

Diagnosis: As for the species. Young specimens of the variety have many large plates, forming a close mail (*Psolus*-like). Adults bright red in colour.

Discussion: Mortensen (1925) suggested that perhaps var. *carnleyensis* constitutes a separate species. The chief difference between the adult specimens of the typical form and the variety lies in their colour. Specimens of the typical form are often dark coloured, sometimes black, while specimens of the variety are almost dark red in colour. However, the juveniles of the typical form and the variety differ in a number of characters, and there are strong reasons for the promotion of var. *carnleyensis* to the species level when the juveniles are considered. But a rather more thorough investigation of the problem is needed before a satisfactory decision can be reached.

Ocnus calcareus (Dendy)

Colochirus calcarea Dendy, 1896, p.38, Pl.5, figs.44-53; Farquhar, 1898, p.325.

Colochirus brevidentis Ludwig, 1898b, 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)

Material examined: None.

Diagnosis: Deposits include knobbed plates, typically with 4 primary perforations (2 large and 2 small), and 12 marginal knobs; knobbed cups and perforated plates also present.

Discussion: Although *Ocnus calcareus* is not a common species, it is known from Auckland, Wellington, Stewart Island, and Juan Fernandez Islands. Mortensen (1925) says of this species, "As it is a littoral form, which can be transported on floating algae, the occurrence of the 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".

Subfamily THYONINAE

Diagnosis: Calcareous ring slender, long, with long processes; radials and interradials flat, fused together; the entire calcareous ring often composed of a complex mosaic of minute pieces. (Panning, 1949, in part.)

The subfamily Thyoninae is represented in New Zealand by 2 genera and 3 species. The 2 genera are easily distinguished on the basis of their calcareous rings and skin deposits.

Key to the New Zealand Genera in Subfamily Thyoninae

1 (2) Calcareous ring long and slender, with long processes, composed of a mosaic of minute pieces. Deposits plates . . . . Genus *Stolus* Selenka, Heding

2 (1) Calcareous ring long and broad. Deposits cups and plates. . . . . Genus *Heterothyone* Panning

Genus *Stolus* Selenka, 1867, Heding, 1940

Diagnosis: Calcareous ring with long processes, composed of a mosaic of minute pieces. Deposits large scales with many perforations and smaller plates with few perforations.

The genus Stolus is quite well-defined and contains fewer than 10 species at the present time. The single New Zealand species is a large form, endemic to the New Zealand region.

Stolus huttoni (Dendy)

Plate XIV

Cucumaria huttoni Dendy, 1896, p.32, Pl.3, figs.19-20; Ludwig, 1898a, 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: Six specimens from the following stations:-

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 62, opposite Worser Bay, Wellington Harbour, 4-5 fms, green sand, 1 specimen.

Dominion Museum, Wellington:- B.S.148, Hawke Bay, 25 fms, 3 specimens; Menzies Bay, Lyttelton Harbour, 1 specimen.

Portobello Marine Biological Station, Dunedin:- East Otago, sand, 1 specimen.

Diagnosis: Body U-shaped, completely invested by large overlapping scales. The scales are overlain by numbers of small (0.1-0.3 mm long) perforated plates. Colour grey to yellow.

Description: Of the specimens on hand, 5 are strongly contracted, while the other is well expanded, and the large crown of tentacles can be seen. The body is strongly flexed into an approximate U-shape. The integument is very hard and thick, due to the presence of large numbers of imbricating scales which form an investing layer.

PLATE XIV

<u>Stolus</u> <u>huttoni</u> (Dendy)

Fig.1. Internal anatomy of adult dissected from the dorsal side. (Portions of gonad and retractor muscles removed.)

Fig.2. Pharynx and calcareous ring.

Fig.3. Large scales from the skin (outlines only).

Fig.4. Small plates from the skin.

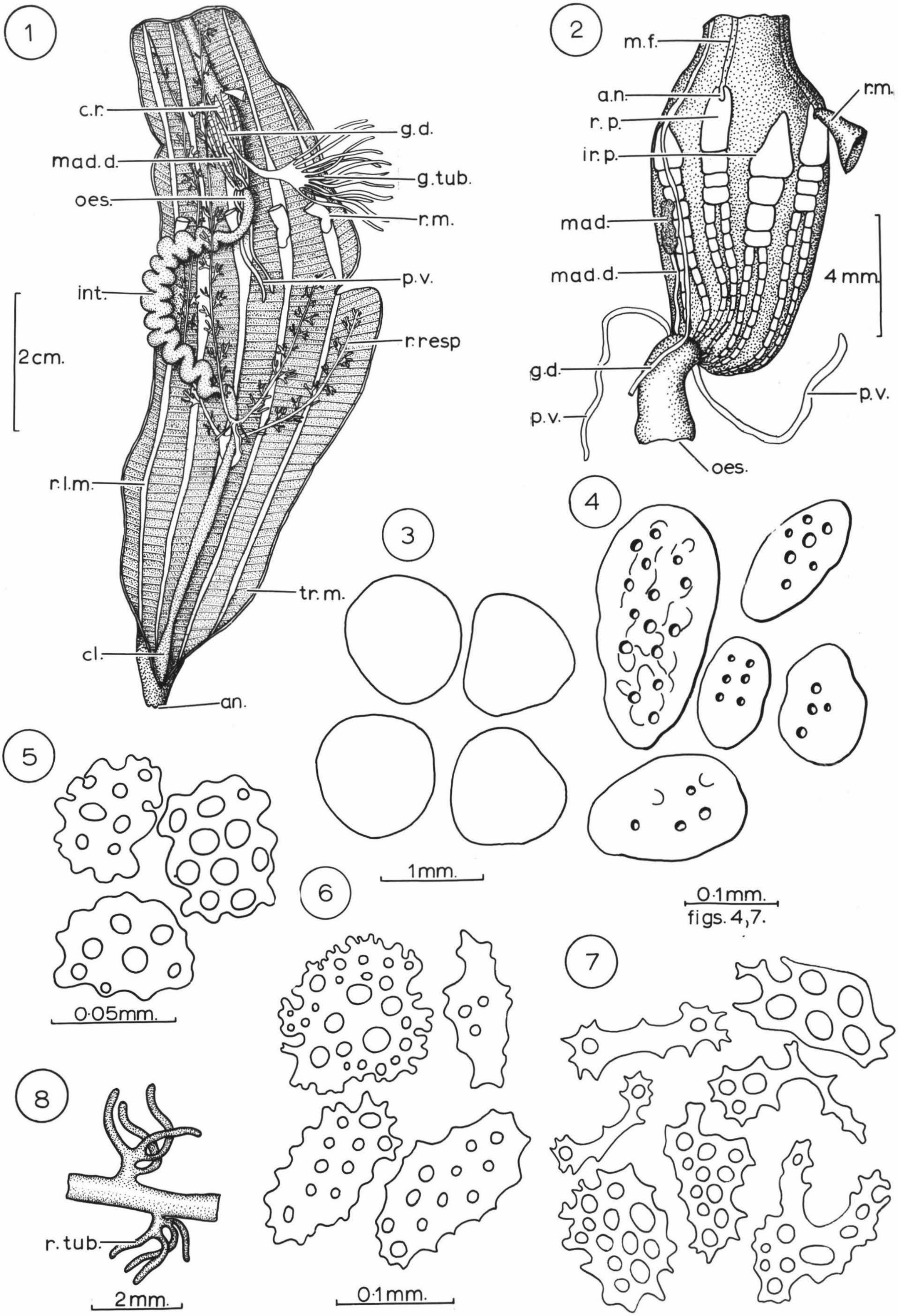
Fig.5. Introvert deposits.

Fig.6. Tubefoot deposits.

Fig.7. Tentacle deposits.

Fig.8. Portion of a respiratory tree.

<u>Abbreviations:</u> 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.



1
c.r.
g.d.
mad.d.
g.tub.
oes.
r.m.
int.
p.v.
2cm.
r.resp
r.l.m.
tr.m.
cl.
an.
2
m.f.
a.n.
r.m.
r.p.
ir.p.
mad.
mad.d.
4 mm.
g.d.
p.v.
p.v.
oes.
3
4
1mm.
0·1mm.
figs. 4,7.
5
0·05mm.
6
7
8
r.tub.
2mm.
0·1mm.

The colour in life and in alcohol varies between grey and yellow. The tentacles are abundantly speckled with brown spots.

Tubefeet are present in all radii, and confined to them. The tubefeet 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 10 extensively branched tentacles. The 2 ventral tentacles are considerably smaller than the rest.

The calcareous ring is quite complex, and contains 10 pieces, 5 radials and 5 interradials. Each piece is composed of a number of small particles (Pl.XIV, fig.2). The radials each have a deep anterior notch and long, narrow posterior processes. The interradials are not notched, but do possess long posterior processes.

The oesophagus is short and muscular (Pl.XIV, fig.1) and joins to the thin-walled convoluted intestine. The rectum is long and straight, and runs to the terminal anus. The cloaca is poorly differentiated.

Two long and slender Polian vesicles are attached to the ventral side of the water-vascular ring (Pl.XIV, fig.2). The stone canal is short, and runs anteriorly in the dorsal mesentery to terminate in a well-defined madreporite (Pl.XIV, fig.2).

The 2 trunks of the respiratory trees arise from near the anterior end of the rectum as flat 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 2 long branches extend anteriorly for a considerable distance and attach to the body wall in the interradii (Pl.XIV, fig.1). The 2 short branches are each about half the length of the long branches, and they also lie in the interradii. Each trunk carries a number of short, sparsely branched respiratory tubules (Pl.XIV, fig.8).

The gonads consist of 2 poorly defined bunches of intertwining, unbranched, filamentous caecae. The genital duct runs forward in the dorsal mesentery, and opens into the introvert in the dorsal interradius (Pl.XIV, fig.1).

The radial muscles are quite 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 retractor muscles. The retractor muscles are well-developed, originating from the longitudinal muscles about a third of the way along the body cavity, and inserting into the anterior notches of the radial pieces of the calcareous ring. Transverse muscles are present as fine bands. All of the muscles are orange coloured in preserved material.

Calcareous spicules were found in the following structures:

1. Body wall:- The body is completely invested by oval to round imbricating scales (Pl.XIV, fig.3). Average diameter of the scales is 1.0 mm. The pattern of perforations on the scales is rather similar to that in <u>Heterothyone</u> <u>alba</u> (Pl.XV, fig.7). The scales overlap in a direction which is transverse to the longitudinal axis of the body. There are no scales on the introvert.

The scales are overlain by large numbers of small perforated plates (Pl.XIV, fig.4). The plates are 0.1-0.3 mm long and the number of perforations varies between 2 and 20. The presence of these thick plates gives the skin a grainy appearance.

The introvert contains a number of small perforated buttons of a different character from those in the rest of the body wall. They are oval or rectangular in shape, and have a small number of large perforations (6-12). Average length of the introvert buttons is about 0.05 mm (Pl.XIV, fig.5).

2. Tubefeet:- The well-developed endplates in the tubefeet are surrounded by irregular perforated deposits 0.1-0.25 mm in length (Pl.XIV, fig.6). They are easily distinguishable from the buttons in the skin, as they are quite thin, and are more irregular in outline.

3. Tentacles:- The digits of the tentacles contain large numbers of irregular perforated buttons and rods. These deposits have sharp edges, and the tentacles are therefore rather prickly to touch. Average length of tentacle deposits is about 0.2 mm. The spicules vary greatly in size. (Pl.XIV, fig.7.)

<u>Distribution:</u> <u>Stolus</u> <u>huttoni</u> has previously been recorded from Oamaru (Dendy, 1896) and Otago Harbour (Mortensen, 1925). The new localities, Hawke Bay, Wellington Harbour, Menzies Bay and East Otago, seem to indicate that this species may eventually be found along the entire east coast of New Zealand.

<u>Ecology:</u> <u>Stolus</u> <u>huttoni</u> prefers a sandy bottom in sheltered shallow areas. The same is true for <u>Heterothyone</u> <u>ocnoides</u> (Dendy), and these 2 species apparently live in close association with each other.

<u>Discussion:</u> Dendy (1896) stated that tubefeet are absent from the dorsal radii. Ludwig (1898a) agreed with Dendy. 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 the presence of tubefeet in all radii, the dorsal tubefeet appearing to be confined to the middle of the body.

There appears to be some variation in the number of Polian vesicles in S. huttoni. Dendy (1896) found 2 in the type specimen. Ludwig (1898) found 1, while Mortensen (1925) noted the existence of "5 long and slender Polian vesicles". All of the specimens on hand have 2 Polian vesicles. It is apparent, then, that no taxonomic importance can be attached to the Polian vesicle number in this species.

Dendy (1896) figured the calcareous ring of the holotype, but his figure did not show the definite anterior notches in the radial pieces, nor the bifurcating posterior ends of the interradials.

Panning (1949) placed the species huttoni into the genus Stolus Selenka.

Stolus huttoni has no very near relatives in New Zealand or overseas.

Genus Heterothyone Panning, 1949

Diagnosis: Calcareous ring compound, with long processes. Deposits plates and cups.

In his new genus Heterothyone Panning included 4 species, among them H. alba (Hutton), which is endemic to the New Zealand region.

Another endemic New Zealand species, formerly known as Cucumaria ocnoides (Dendy) was placed into the genus Ludwigia

Reiffen, in the Subfamily Colochirinae. It seems, however, that the species alba and ocnoides are quite closely related to each other (see p.161). The writer is of the opinion that ocnoides and alba should be placed together in the same genus.

Whether the species alba and ocnoides do in fact belong in the Subfamily Thyoninae is a subject for debate. But an intensive study of this problem is unfortunately beyond the scope of this work. It is to be hoped that the position of the species alba and ocnoides will be clarified in the near future.

For the present it is perhaps the best course to place the 2 species in question into the genus Heterothyone Panning.

Key to the New Zealand Species of Genus Heterothyone

1 (2) Small holothurians (up to 25 mm long), U-shaped, with many small pedicels. Radials without a well-defined anterior notch; interradials with long and narrow anterior processes . . . . Heterothyone alba (Hutton)

2 (1) Larger holothurians (up to 50 mm long), U-shaped, with many pedicels and tubefeet. Radials with a well-defined anterior notch; interradials with short and broad anterior processes . . . . Heterothyone ocnoides (Dendy)

Heterothyone alba (Hutton)

Plate XV

Chiridota ? alba Hutton, 1872, p.17.

Echinocucumis alba Hutton, 1878, p.307.

<u>Colochirus</u> <u>alba</u> Dendy, 1896, p.35, Pl.4, figs.21-32; Farquhar, 1898, p.325.

<u>Cucumaria</u> <u>alba</u> Ludwig, 1898a, p.29; Perrier, 1905, p.85; Dendy and Hindle, 1907, p.98; Mortensen, 1925, p.346; Dawbin, 1950, p.36.

<u>Cucumaria</u> <u>filholi</u> Perrier, 1903, p.144; Perrier, 1905, p.88, Pl.V, figs.10-12.

<u>Heterothyone</u> <u>alba</u> Panning, 1949, p.464, abb.59, figs.a-i.

<u>Material examined:</u> Fifty-six specimens from the following stations

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 15, Palliser Bay, 100-150 fms, mud, 1 specimen; VUZ 30, off Somes Island, 5-10 fms, mud, 13 specimens; VUZ 69, Somes Island to Days Bay, 11 fms, mud, 1 specimen; Kau Bay, 20 fathoms, mud, 1 specimen.

Dominion Museum, Wellington:- B.S.135, 3 miles southeast of Tonga Cove, Tasman Bay, 15 fms, 1 specimen; B.S.156, Hawke Bay, 5 fms, 1 specimen; B.S.202, east of Tairoa Head, Otago, 75 fms, 3 specimens; Tasman Bay, intertidal, 1 specimen; Wellington Harbour, 11 fms, 1 specimen.

New Zealand Oceanographic Institute, Wellington:- B.10, Hawke Bay, 30 fms, 1 specimen; B.11 (sample 8), Hawke Bay, 35 fms, fine sandy mud, 3 specimens; B.16, (sample 6), Hawke Bay, 22 fms, blackish grey mud, 1 specimen; B.25, Hawke Bay, 46 fms, fine grey sandy mud, 2 specimens; B.37, Hawke Bay, 10.5 fms, sand, 4 specimens; B.45, Hawke Bay, 22 fms, fine sandy mud, 1 specimen; B.46, Hawke Bay, 32 fms, fine grey-green sandy glutinous mud, 3 specimens; B.47 (sample 1), Hawke Bay, 36 fms, fine grey green sandy glutinous mud, 2 specimens; B.47 (sample 4), 1 specimen; B.49, Hawke Bay, 44 fms, fine grey-green sandy glutinous mud, 2 specimens; B.54, Hawke Bay, 29 fms, grey-green mud, 1 specimen; C.166, 80 miles west of Cape Egmont, 150 fms, 2 specimens; C.188, Tasman Bay, 5 fms, soft mud and dead shell, 3 specimens; M.7 (sample 8), off Dale Point, Milford Sound, 1 specimen.

Chatham Islands (1954) Expedition material:- Stn.41, south-east of Pitt Island, 330 fms, fine green mud and sand, 1 specimen; Stn.44, N 30°E of Kaingaroa, 120-125 fms, fine green sand, 1 specimen; Stn.46, Kaingaroa, 3 fms, fine grey sand, 3 specimens; Stn.52, Chatham Rise, 260 fms, fine green mud and sand, 1 specimen.

Diagnosis: Small, U-shaped, colour white in life. Radials without a well-defined anterior notch; interradials with long and narrow (almost needle-like) anterior processes. Deposits plates and deep cups. The cup rims have many small projections.

Description: All of the specimens in hand are U-shaped, with the ventral surface occupying the greater curvature. Total length varies between 10 mm and 25 mm. The body is rounded anteriorly, and tapers posteriorly to form a slender tail, which occupies about one third of the total length of the animal. The skin is quite rough to touch, owing to the presence of an investing coat of imbricating scales.

Colour in life and in alcohol, white or grey. The tentacles are liberally sprinkled with brownish spots. In all cases, the tentacles are completely retracted, and their features cannot be ascertained without dissection of the retracted pharynx. The

P L A T E XV

Heterothyone alba (Hutton)

Fig.1. Internal anatomy of adult.

Fig.2. Buttons from the skin.

Fig.3. Tentacle deposits.

Fig.4. Pharynx and calcareous ring.

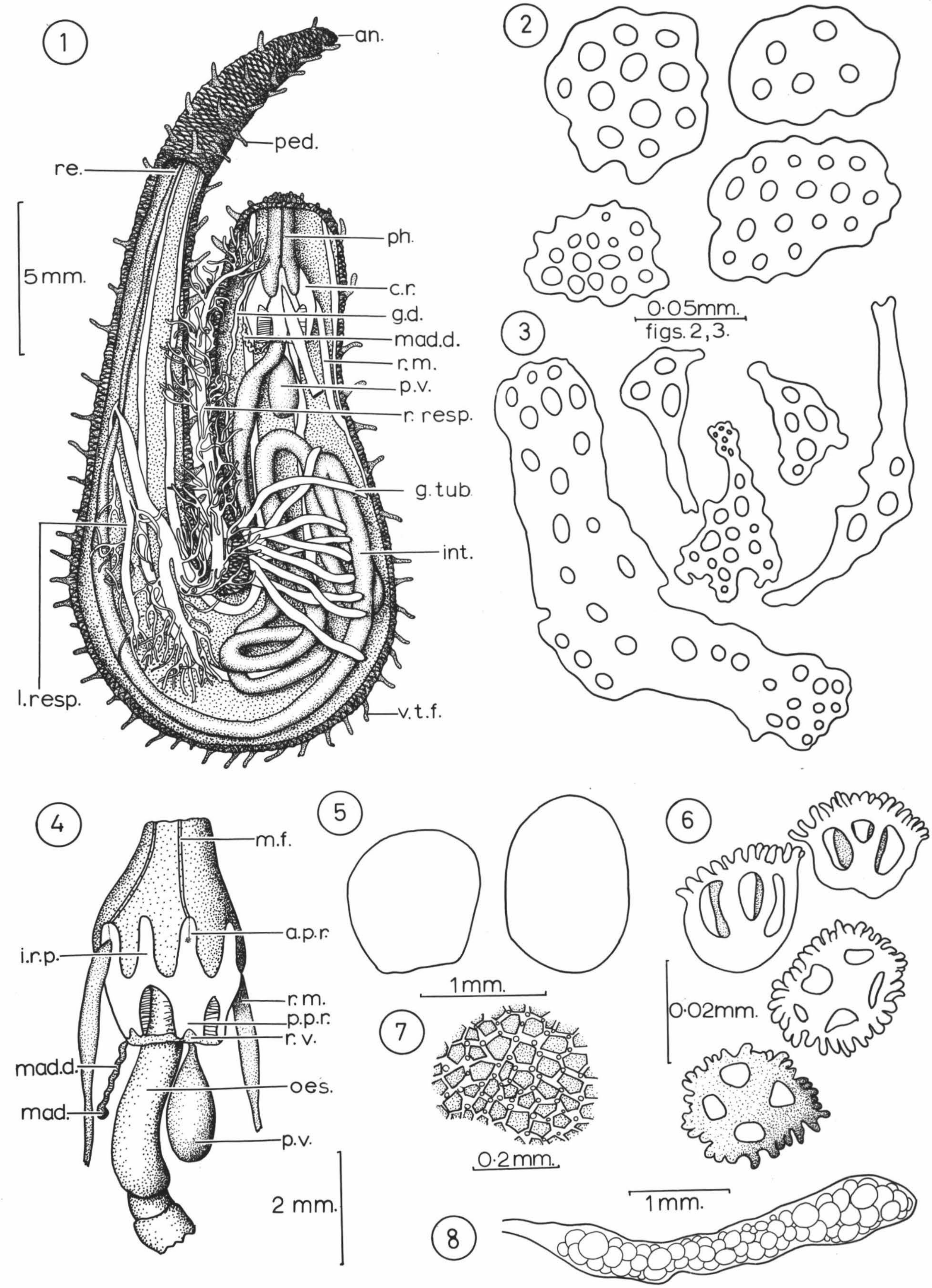
Fig.5. Large plates from the skin (outlines only).

Fig.6. Cups from the skin.

Fig.7. Pattern of perforations on large plates.

Fig.8. A single genital tubule, packed with eggs.

Abbreviations: an., anus; a.p.r., anterior process of the radial; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubule; int., intestine; i.r.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 the 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.


1
an.
ped.
re.
5 mm.
ph.
c.r.
g.d.
mad.d.
r.m.
p.v.
r. resp.
g. tub.
int.
l. resp.
v.t.f.
2
0·05mm.
figs. 2, 3.
3
4
m.f.
a.p.r.
i.r.p.
r.m.
p.p.r.
r.v.
mad.d.
mad.
oes.
p.v.
2 mm.
5
1mm.
6
0·02mm.
7
0·2mm.
1mm.
8

2 ventral tentacles are invariably smaller than the rest. There is a distinct thin-walled introvert.

Tubefeet or pedicels are numerous, confined to the radii anteriorly and posteriorly, but scattered in both radii and interradii near the middle of the body, in greater numbers than elsewhere. The pedicels are stiff and firm, due to the presence of calcareous deposits in their walls.

The calcareous ring consists of 10 pieces, 5 radials and 5 interradials (Pl.XV, fig.4). The ring is well-developed, broad and deep. The radials have a long anterior process, with an attachment area for the retractor muscles. Some specimens have a fine notch in the anterior process of the radial, but the notch is not always present, and therefore cannot be used as a diagnostic character. The posterior processes of the radials are long and broad, and each has a very definite V-shaped notch (Pl.XV, fig.4).

The thin-walled oesophagus leads into a thin-walled intestine, which is extensively coiled near the middle of the body (Pl.XV, fig.1). The intestine joins to the narrow rectum which runs direct to the terminal anus (Pl.XV, fig.1). Both intestine and rectum are dark brown in colour.

The water-vascular ring surrounds the oesophagus immediately posterior to the calcareous ring (Pl.XV, fig.4). The single Polian vesicle is large and bulbous and arises from the ventral side of the ring vessel (Pl.XV, fig.4). The stone canal is convolute and terminates in a scarcely distinguishable madreporite, which is attached to the dorsal mesentery (Pl.XV, fig.4).

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 gives rise to a single subsidiary branch. The left tree is short, about half as long as the right. Respiratory tubules are long and narrow, branching extensively (Pl.XV, fig.1).

The gonad consists of 2 small bunches of unbranched genital caecae (Pl.XV, fig.1). The genital caecae in some specimens are packed with small eggs (Pl.XV, fig.8), of varying sizes (0.05-0.3 mm in diameter). Mortensen (1925) suggested that the small size of the eggs may indicate that H. alba has a typical pelagic larva, though such are otherwise unknown in the Order Dendrochirota. The genital duct is long, and runs anteriorly to open into the introvert in the dorsal interradius (Pl.XV, fig.1).

Radial longitudinal muscles, retractor muscles and transverse muscles are very poorly developed, the radial muscles being represented as thin white straps. The stiff nature of the body wall would prevent change in the body shape with contraction or relaxation, so the radial muscles would serve only to assist in retraction of the pharynx.

Deposits of 4 kinds were found:

1. Large plates (Pl.XV, figs.5, 7):- The body is completely invested in plates which are approximately oval in shape. Average diameter is 1 mm (Pl.XV, fig.5), but considerable size variation is encountered. The surfaces of the plates are reticulate, and the patterning is quite complex (Pl.XV, fig.7). The plates imbricate towards the posterior end in the posterior half of the body, and towards the anterior end in the anterior half.

2. Cups (Pl.XV, fig.6):- Small, deep perforated cups overlie the imbricating plates in large numbers. The basin of the cup has 4 large perforations. The rim has numerous irregular projections. Average diameter of the cup rim is 0.03 mm.

3. Perforated buttons (Pl.XV, fig.2):- Small numbers of perforated buttons are present, intermingled with the cups and perforated plates. The buttons have 5-20 perforations, and are oval to rectangular in shape. The length of the buttons varies between 0.05 mm and 0.1 mm.

4. Tentacle deposits (Pl.XV, fig.3):- The tentacle stems and digits contain great numbers of large and small perforated plates and rods. There is great diversity of size and shape displayed in the tentacle spicules. The perforated plates reach lengths of 0.24 mm.

<u>Distribution:</u> <u>Heterothyone alba</u> is a conspicuous member of the dendrochirote holothurian fauna of New Zealand. It is common along the entire east coast of New Zealand, and is also present in the Chathams. There is no doubt that <u>H. alba</u> is endemic to the New Zealand region.

<u>Ecology:</u> This species prefers to live on a muddy or sandy bottom in comparatively sheltered localities. A degree of eurybathy is displayed, specimens having been taken from the intertidal zone to depths of 150 fms.

<u>Discussion:</u> Dendy and Hindle (1907) also noted the presence of slots in the anterior processes of the radials in the calcareous rings of 4 of the specimens at their disposal.

<u>Heterothyone</u> <u>alba</u> was designated as the type of Panning's

(1949) new genus Heterothyone. This species appears to have no near relatives overseas, but species ocnoides, a dendrochirote endemic to the New Zealand region, appears to be closely related to Heterothyone alba (see p.161).

Heterothyone ocnoides (Dendy)

Plate XVI

Colochirus ocnoides Dendy, 1896, p.36, Pl.4, figs.33-43; Farquhar, 1898, p.325.

Cucumaria ocnoides Ludwig, 1898a, p.30; Perrier, 1905, p.96, Pl.I, 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.

Ludwigia ocnoides Panning, 1949, p.435, abb.30,31.

Material examined: Thirty-four specimens and fragments from the following stations:

In the collection of the Dominion Museum, Wellington:- B.S. 154, Hawke Bay, 10 fms, 3 specimens; B.S.155, Hawke Bay, 8 fms, fragments; B.S.157, Hawke Bay, 8 fms, 7 specimens; B.S.158, Hawke Bay, 7 fms, 3 specimens; off Karitane, Otago, 10 fms, sand, 3 specimens; Blueskin Bay, Otago, 10 fms, sand, fragments; Purakanui, Otago, 11 fms, sand, fragments.

New Zealand Oceanographic Institute, Wellington:- B.2 (sample 4), Hawke Bay, 10 fms, fine green sand, 1 specimen; B.6 (sample 5), Hawke Bay, 21 fms, grey green sandy mud, 1 specimen; B.8 (sample 5) Hawke Bay, 15.5 fms, fine grey sand, fragments; B.9 (sample 2), Hawke Bay, 18 fms, sand, 4 specimens; B.13, (sample 4), Hawke Bay, 18.5 fms, blue sandy mud and grey mud, 1 specimen; B.14 (sample 8), Hawke Bay, 13.5 fms, very sloshy sand, 1 specimen and gragments; B.15 (sample 6), Hawke Bay, 19.5 fms, fine grey sand, fragments; B.15, (sample 8), 3 specimens; B.18, (sample 4), Hawke Bay, 24 fms, sand, fragments; B.18, (sample 7), 5 specimens; B.19, (sample 6), Hawke Bay, 38 fms, grey sandy mud and green stones, 2 specimens.

Diagnosis: Large (up to 50 mm long), U-shaped, colour orange in life. Radials each with a well-defined anterior notch; interradials with short, broad and blunt anterior processes. Deposits plates and deep cups. The cup rims have few (less than 10) projections.

Description: The body is more or less cucumiform, with the posterior end strongly upturned, giving the body a characteristic U-shape. As in *Heterothyone alba* (p.152), the body is approximately divisible into 3 regions. Total length varies between 20 mm and 50 mm. The integument is quite hard, due to the presence of a great number of imbricating scales.

Colour in life and in alcohol, orange to pink. The tentacles are covered with irregular brown spots. The tubefeet are a dark orange in colour.

Tubefeet and pedicels are very numerous. The tubefeet are confined to the 3 ventral radii in the middle of the body, where they are closely crowded in large numbers. Pedicels are also confined to the radii, and the interradii are quite naked, except for the middle of the body, where the stiff pedicels are scattered over the radii and interradii. As the extremities are approached, the pedicels become confined to the radii, and eventually disappear altogether. In most specimens, the pedicels/are completely retracted, and their arrangement cannot be determined with any certainty. The above description is based on a single fully expanded specimen.

The 10 tentacles are well-branched. The 2 ventral tentacles are smaller than the rest.

The calcareous ring is composed of 10 pieces. The radial pieces (Pl.XVI, fig.1) are long and narrow. The anterior projection has a definite notch into which the retractor muscle is inserted. Posteriorly, each radial piece has 2 projections which curve towards each other, but do not meet. The projections enclose a space which is approximately oval in shape. (Pl.XVI, fig.1). Each interradial piece is in the shape of an inverted Y, with the tail pointing anteriorly. The anterior process is short and blunt. Posteriorly, each interradial piece has a shallow notch (Pl.XVI, fig.1).

In general, the internal anatomy of this species is similar to that of Heterothyone alba (Hutton) (p.153). The Polian vesicle in Heterothyone ocnoides is long and tubular (Pl.XVI, fig.1), in contrast to the bulbous Polian vesicle in Heterothyone alba.

Calcareous spicules were found in the following structures:

1. Body wall:- The body is invested by imbricating scales, which are oval to rectangular in shape (Pl.XVI, fig.8). The structure of these scales and their arrangement is rather similar to that in Heterothyone alba. The only difference between them lies in the presence in Heterothyone ocnoides of a dark brown pigment spot in the centre of each scale. These spots are clearly visible when viewed with a hand lens.

Deep cups are present, overlying the scales. They are

PLATE XVI

Heterothyone ocnoides (Dendy)

Fig.1. Pharynx and calcareous ring.

Fig.2. Tubefoot deposits.

Fig.3. Introvert deposits.

Fig.4. Deposits from the tentacle digits.

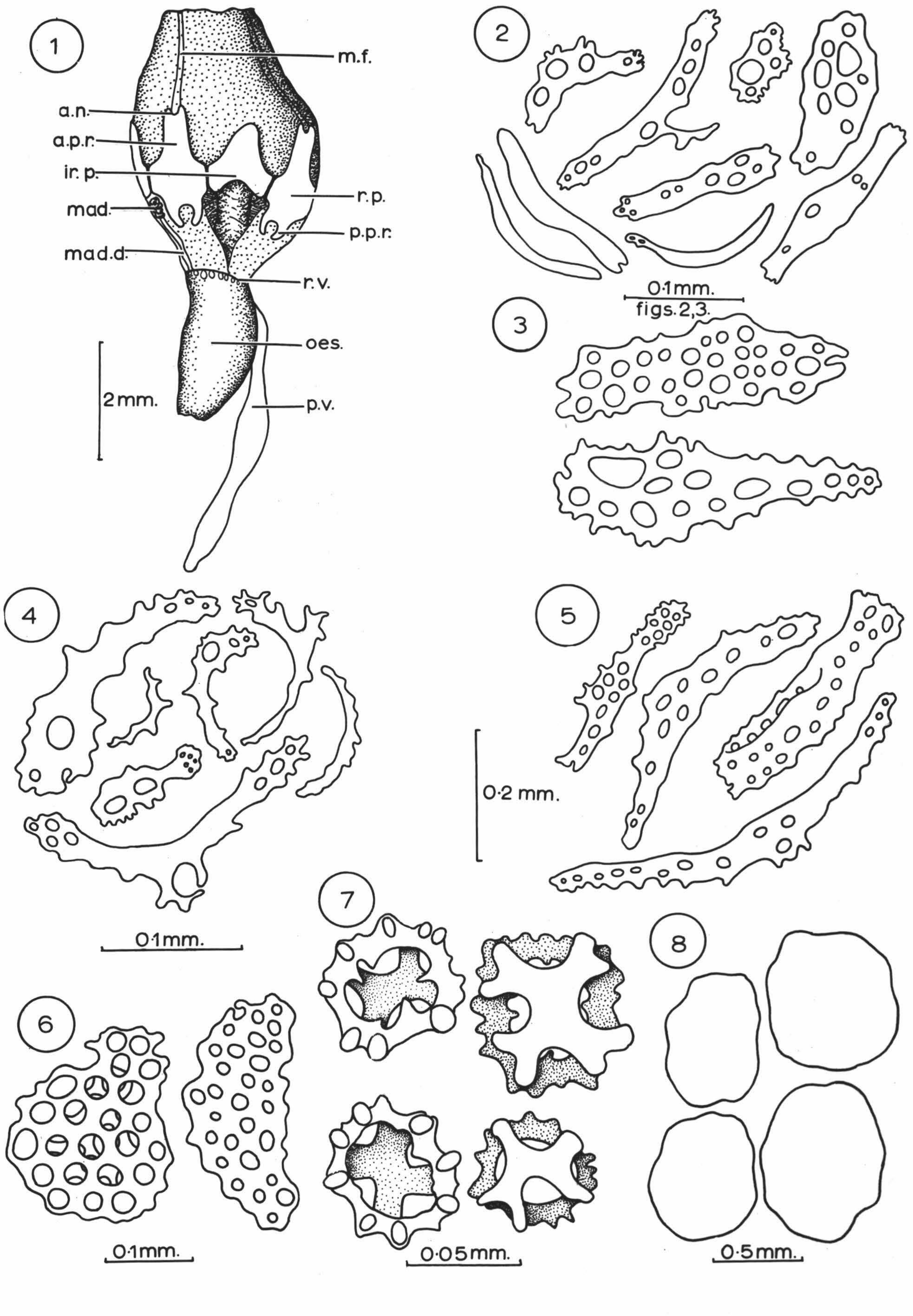
Fig.5. Deposits from the tentacle stems.

Fig.6. Small perforated plates from the skin.

Fig.7. Cups from the skin.

Fig.8. Large plates from the skin (outlines only).

Abbreviations: a.n., anterior notch; a.p.r., anterior process of the radial; ir.p., interradial piece; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; oes., oesophagus; p.p.r., posterior process of the radial; p.v., Polian vesicle; r.p., radial piece; r.v., ring vessel.


1
m.f.
a.n.
a.p.r.
ir. p.
r.p.
mad.
p.p.r.
mad.d.
r.v.
oes.
2mm.
p.v.
2
0·1mm.
figs. 2,3.
3
4
0·1mm.
5
0·2 mm.
6
0·1mm.
7
0·05mm.
8
0·5mm.

easily rubbed off when a specimen is handled. The basin of the cup has 4 large perforations (Pl.XVI, fig.7), and the rim has a number of projections. Average diameter of the cup rim is 0.06 mm.

The integument also contains a few small perforated plates (Pl.XVI, fig.6). They are oval to elongate in shape, and have varying numbers of perforations. These plates are up to 0.3 mm in length.

The introvert also contains perforated plates which are scattered and might easily be overlooked. They are long and narrow, and have many perforations (Pl.XVI, fig.3). Average length of introvert plates is 0.25 mm.

2. Tentacles:- Two types of deposit are found in the tentacles. The tentacle-stems contain many long and narrow perforated rod-like spicules (Pl.XVI, fig.5). Average length of stem deposits is 0.5 mm. The digits of the tentacles have spicules of an entirely different nature. They take the form of irregular rods which vary greatly in size (Pl.XVI, fig.4). Many of the rods have perforations, while others have none. The digits are packed with such spicules, and they are consequently prickly to touch. Length of the digit rods ranges between 0.05 mm to 0.25 mm.

Tubefeet:- Perforated and unperforated rods and small plates surround the well-developed endplates of the tubefeet (Pl.XVI, fig.2).

Distribution: This well-known New Zealand holothurian is endemic to the New Zealand region, and is extremely common in the areas in which it is known to occur. Mortensen's (1925) statement that Heterothyone ocnoides "will prove to have a much wider distribution in New Zealand seas" is quite true. This species is now known from near Otago in the south to Hawke Bay in the north, and is especially common in Hawke Bay and near Christchurch. Dendy (1898) reported that after a storm, "shovelfuls" of this species could be collected from New Brighton Beach.

Ecology: Almost invariably, Heterothyone ocnoides is found in association with dendrochirotes such as Stolus huttoni and Heterothyone alba in a muddy or sandy bottom, in shallow water to depths of at least 38 fms. Fell (1960a) states that in Hawke Bay there is an association between Amphiura aster Farquhar and Echinocardium cordatum (Pennant). It is interesting to note that in Hawke Bay Amphiura aster and Heterothyone ocnoides were taken together at 5 out of 15 stations, and Echinocardium cordatum and Heterothyone ocnoides were taken together at 3 out of 19 stations. There are not enough samples for a statistical investigation of the situation, but it appears that Amphiura aster and Heterothyone ocnoides can tolerate each other on the seafloor, but Echinocardium cordatum and Heterothyone ocnoides are not often found together. There may be a case of exclusion here, as both Echinocardium cordatum and Heterothyone ocnoides are burrowing forms, living just below the surface of the seafloor, while Amphiura aster prefers to live more or less on the surface of the seafloor. Amphiura aster, therefore, is the common factor, living in harmony with both burrowing forms, while the burrowing forms cannot live in harmony with each other.

More intensive investigations into faunal associations are needed, however, to enable a better understanding of the interrelationships between these bottom-dwelling species.

Discussion: In his description of Colochirus ocnoides, Dendy (1896) compared the species with Colochirus alba, and made the following statement: "It is not easy to convey in writing an adequate idea of the distinction between this species and the preceding (= Colochirus alba)." And later in the same paragraph, "It is very interesting to find in two closely allied species . . . a slight difference in external characters accompanied by a slight but well-marked difference in spiculation." Reiffen (1901) established the genus Ludwigia and designated Colochirus ocnoides as the type species of the genus. However, Perrier (1905) and Dendy and Hindle (1907) had cause to disagree with Reiffen's (1901) decision. Mortensen (1925) called attention to the fact that the name Ludwigia had been preoccupied for a longicorn beetle. Therefore, the species remained within the genus Cucumaria (to which it had been referred by Perrier (1905)), until Panning (1949) resurrected the genus Ludwigia Reiffen, and designated species ocnoides as the type species. Panning was in error in this regard, as the name Ludwigia was known to be preoccupied, and thus could never be used again.

Cucumaria alba (Hutton), moreover, became the type species of a new genus Heterothyone Panning. Therefore, Panning (1949) had placed two quite closely related species into separate genera! Mortensen (1925), in discussing Cucumaria ocnoides, states, "It is perfectly evident that this species is closely related to Cucumaria alba ...."

The present investigations have served to convince the writer that the species alba and ocnoides are very closely related. The following list of characters common to both species may be of some use in demonstrating the similarity between the two species:

1. Both are always more or less U-shaped, with a distinct tail region.

2. Both species have large imbricating plates investing the body, and these plates are overlain by deep cups.

3. Internal structures are remarkably similar in both species.

4. The calcareous rings are alike in many respects. In both species the radials have a pronounced posterior notch, and the interradials are Y-shaped.

5. Both live in the same type of habitat.

It can be seen that there is some justification for placing the two species under discussion in the same genus, and as they cannot both be included in genus Ludwigia Reiffen, they must, for the present at least, remain in genus Heterothyone Panning.

Panning (1949) included the following list of species under genus Ludwigia Reiffen, together with species ocnoides: bouvetensis (Heding); ekmani (Heding); gemmata (Pourtales); glacialis (Ljungmann); hedingi (Panning); lactea (Forbes and Goodsir); lutea (Sluiter); pervicax (Dendy); planci (Brandt); punctata (Ludwig); solida (Deichmann); spyridophora (H.L. Clark); suspecta (Ludwig); tetracentriphora (Heding); vicaria (Bell); lefevrei (Barrios).

The species pervicax was named by Theel and not Dendy, as Panning has indicated above. Many of the above species must remain incertae sedis for the present.

Order A S P I D O C H I R O T A Grube

Diagnosis: Tentacles shield-shaped and 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 the tropics. Of the 3 families in this group, 2 are known from the New Zealand region, but it is possible that the Family Synallactidae may be represented in this region, as its members are all deep-water forms, living in association with members of Order Elasipoda.

Key to the Families in Order Aspidochirota

1 (4) Tentacle ampullae present.

2 (3) Gonad in 2 tufts, 1 to each side of the dorsal mesentery . . . . Family STICHOPODIDAE

3 (2) Gonad in 1 tuft, lying on the left side of the dorsal mesentery . . . . .Family HOLOTHURIIDAE

4 (1) Tentacle ampullae absent . . . Family SYNALLACTIDAE

Family STICHOPODIDAE

Diagnosis: Gonads in 2 tufts, 1 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 group contains 4 genera. By far the largest genus is Stichopus Brandt, which contains over 20 species.

Genus Stichopus Brandt, 1835

Diagnosis: Ventral surface flattened, markedly distinct from the dorsal surface; pedicels more or less fully covering 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 Cuvier's organs; no anal teeth or noticeable papillae around cloacal opening; numerous calcareous tables in epidermis; Polian vesicles few, unbranched; madreporic canal single (Clark, 1922).

New Zealand has a single representative of this genus, namely S. mollis (Hutton).

Stichopus mollis (Hutton)

Holothuria mollis Hutton, 1872, p.15; Hutton, 1878, p.308.

Stichopus sordidus Theel, 1886, p.167; Pl.VIII, fig.3.

Holothuria victoriae Bell, 1887, p.534, Pl.XLV, 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; H.L. Clark, 1922, p.60; Mortensen, 1925, p.327; H.L. Clark, 1938, p.511; H.L. 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; H.L. Clark, 1922, p.69.

Stichopus simultans Erwe, 1913, p.388, Taf.VIII, fig.23,a-d.

Material examined: Nine specimens from the following stations:

In the collection of the Department of Zoology, Victoria University of Wellington:- VUZ 15, Palliser Bay, 100-150 fms, mud, 3 specimens; VUZ 35, off Days Bay, 8-9 fms, 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.

Dominion Museum, Wellington:- Farewell Spit, 1 specimen, coll. S. Gamby, 11/1952.

Diagnosis: Large forms, colour light mottled brown to black. Deposits tables with regular spires which are more or less open at the top with 1 or 2 crossbars. Discs of tables square or squarish, 0.055-0.065 mm in diameter, with 4 large holes and 4 smaller ones at the corners.

Discussion: This species is the best known and most easily recognised of the New Zealand holothurians. *S. mollis* is common in the areas in which it occurs, and is known from Western Australia (Erwe, 1913), Tasmania (H.L. Clark, 1946), and New Zealand. Within New Zealand, *S. mollis* is known from Stewart Island in the south to Cook Strait in the north, and is very common in Tasman Bay and Wellington Harbour.

S. mollis is found on bottoms ranging between rock and sand, to depths of at least 150 fathoms. The colour of the body varies greatly but specimens are usually light or dark brown, with lighter spots.

Dawbin (1944) has fully described the anatomy of this species and its autoevisceration.

Family HOLOTHURIIDAE

Diagnosis: Gonads in 1 tuft on the left side of the dorsal mesentery. Tentacle ampullae long and slender. Deposits tables and buttons.

The Family Holothuriidae contains a very large number of tropical forms which inhabit the littoral zone. Few holothuriids are present in temperate regions.

Holothuria neozelanica Mortensen is the sole representative of this family known from New Zealand.

Genus *Holothuria* Linne, 1791

Diagnosis: Tentacles 20, seldom 30. No conspicuous calcified anal teeth. Pedicels not in longitudinal series, but more or less generally scattered, often transformed into papillae. Deposits tables and plates, rods or buttons.

The genus *Holothuria* contains a heterogeneous assemblage of species, and the group is in urgent need of a thorough revision.

Holothuria neozelanica Mortensen

Holothuria neozelanica Mortensen, 1925, p.330, fig.25; Dawbin, 1950, p.35.

Material examined: None.

Diagnosis: Papillae absent from the dorsal side. Tentacles 16. Deposits tables with many perforations and spinous spires, and buttons with 6-8 perforations.

Discussion: *Holothuria neozelanica* is known from a single specimen taken from 2 miles east of North Cape in 55 fathoms. Mortensen (1925) was of the opinion that the presence of 16 tentacles might be used as a specific character. More specimens of this interesting species are needed before it can be decided whether or not the tentacles constantly number 16.

Order E L A S I P O D A Theel, 1882

Diagnosis: Body bilateral, more or less distinctly symmetrical. Lateral and ventral radii with rows of non-retractile pedicels; mid-ventral radius naked, or with a few minute pedicels, or a double row of them. Dorsal surface provided with long non-retractile processes, often disposed in one or two rows along each radius. Deposits include plates, wheels, and branched or simple spicula. Respiratory trees absent; ciliated funnels and retractor muscles absent. (After Theel, 1882.)

The Order Elasipoda is cosmopolitan, inhabiting ocean depths, mostly below 500 fathoms, and specimens have been taken from depths exceeding 3,500 fathoms. The elasipods are of bizarre appearance, and were very little known until Theel (1882) published his report on the holothurians collected during the voyage of the "Challenger". In this report, Theel founded the order and diagnosed 3 families. Since 1882, a great number of new species have been added to the group, and a new family was established by Ekman (1926).

Theel (1882) described 2 species from near New Zealand. Pannychia moseleyi was taken from 700 fathoms about 60 miles east of East Cape, and Enypniastes eximia from about 70 miles east of Cape Turnagain, in 1,100 fathoms. No further specimens of these species have been taken from the New Zealand region.

In the present account, another species of elasipod is recorded from New Zealand for the first time. This species is Laetmogone violacea Theel, a member of Family Deimatidae Theel.

Family DEIMATIDAE Theel

Diagnosis: Body usually rather long, cylindrical or fusiform, seldom shorter, and of an elliptical form. Tentacles 15 or 20. Mouth almost terminal, though more or less distinctly turned towards the ventral surface. The lateral ambulacra of the ventral surface bearing long and wide, cylindrical or conical, slightly retractile pedicels, disposed in a single or a double row along each side of that surface, and sometimes provided with another series of extremely elongated, conical, non-retractile processes placed externally and above the pedicels. The odd ambulacrum generally naked, seldom with a few rudimentary pedicels or with a double row of rather long ones. The dorsal surface with very long, conical, mostly non-retractile processes, disposed in one or more rows all along each of its ambulacra. Calcareous deposits perforated plates, spicula, wheels, cruciform and dichotomously branched bodies. Calcareous ring composed of a rather fragile and imperfect network; no distinct radial and interradial pieces. (Theel, 1882.)

Genus Laetmogone Theel

Diagnosis: Tentacles 15, rather large, non-retractile. The lateral ambulacra of the ventral surface with very large pedicels, disposed in a single row, all along each side of that surface. The odd ambulacrum naked. The dorsal surface with extremely elongated, flexible, cylindrical non-retractile processes disposed in a single row all along each of its ambulacra. Integument with numerous wheels and besides those deposits spicula or cruciform bodies (Theel, 1882).

<u>Laetmogone</u> <u>violacea</u> Theel

Plate XVII

<u>Laetmogone</u> <u>violacea</u> Theel, 1882, p.78, Pl.XIII, Pl.XXXVI, figs. 20-24; Sluiter, 1901, p.62; Perrier, 1902, p.390, Pl. XIX, figs.1-7; Koehler and Vaney, 1905, p.64; Mitsukuri, 1912, p.192-198, Pl.VI, figs.52-54, textfig.36; Deichmann, 1930, p.120; Heding, 1942, p.14, textfig.14.

<u>Material examined:</u> One specimen in the collection of the Dominion Museum, Wellington:- B.S.209, off Mayor Island, Bay of Plenty, 270 fms, 1 specimen.

<u>Diagnosis:</u> Elongate, about twice as long as broad. Mouth anterior, subventral. Anus posterior, terminal, slightly dorsally turned. Tentacles 15, equal, with circular terminal discs. Dorsal radii with long thin processes, 23-27 in each radius. Left and right ventrolateral radii each with 15 pedicels. Midventral radius naked. Deposits wheels of two types, together with four- to six-rayed spinous spicula, numerous on the ventral side, but scattered dorsally.

<u>Description:</u> The single specimen is in excellent condition. Total length 70 mm; greatest breadth 30 mm. The body is approximately cylindrical in shape. The mouth is strongly turned toward the ventral side and is surrounded by a ring of 15 non-retractile tentacles (Pl.XVII, fig.5). A genital papilla 2 mm in length lies in the mid-dorsal interradius, immediately posterior to the ring of tentacles. The dorsal processes vary greatly in length

P L A T E XVII

Laetmogone violacea Theel

Fig.1. Internal anatomy of adult, dissected from the dorsal side.

Fig.2. Anchor-shaped deposit from the dorsal skin.

Fig.3. Spinous spicules from the ventral skin.

Fig.4. Tri-radiate rods from the dorsal processes.

Fig.5. Entire animal, viewed from the ventral side.

Fig.6. Portion of gonad, showing short genital tubules.

Fig.7. Tentacle deposits.

Fig.8. Wheels from the skin.

a, b. Stages in the development of large wheels.

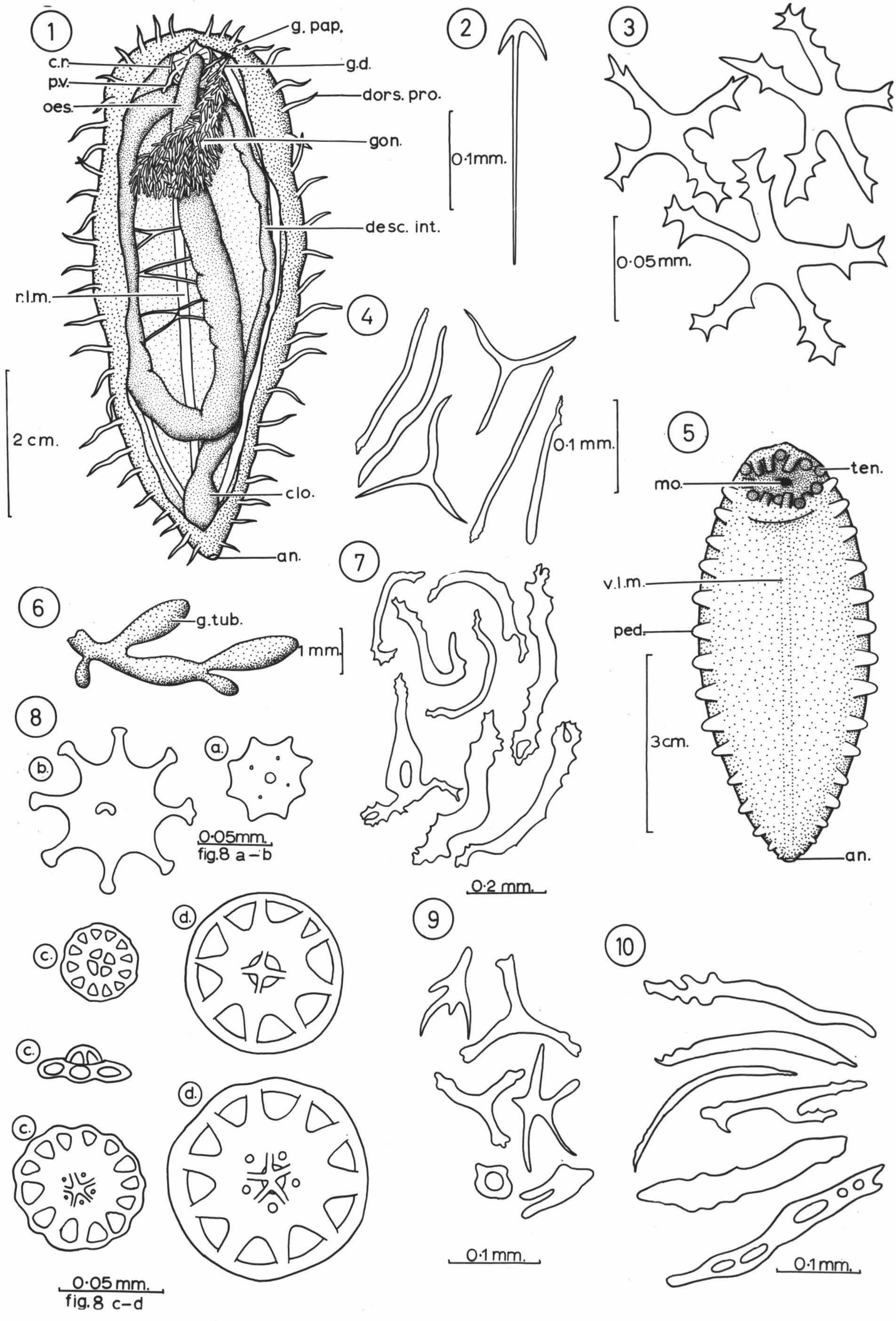
c. Small wheels.

d. Large wheels.

Fig.9. Deposits from the centre of the distal extremity of a pedicel.

Fig.10. Deposits from the perimeter of the distal extremity of a pedicel.

Abbreviations: an., anus; clo., cloaca; c.r., calcareous ring; desc. int., descending loop of the intestine; dors.pro., dorsal process; g.d., genital duct; gon., gonad; g.pap., genital papilla; g.tub., genital tubule; 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.
oes.
dors. pro.
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.

(Pl.XVII, fig.1). The ventral pedicels are short and blunt, and are more or less equal in length. The midventral radius and the rest of the body are completely naked. The anus is subterminal, a circular aperture 3 mm in diameter.

The skin is quite thin and fairly smooth to touch, and through the skin the mid-ventral longitudinal muscle can be clearly seen.

The dorsal region and the dorsal processes are violet in colour. The ventral side and the pedicels are grey. The tentacle stems are violet, while the terminal discs are light brown.

Tentacles are cylindrical, each with a circular leathery terminal disc, 2-3 mm in diameter.

The calcareous ring is fragile, composed of a continuous network of spicules. The radial areas of the ring have faint anterior processes for the attachment of the radial muscles.

The oesophagus is nonmuscular and is indistinguishable from the intestine. The intestine takes a very large loop (Pl.XVII, fig.1), and runs to the enlarged cloaca, which is attached to the body wall by a number of fine muscle fibres. Cloaca and oesophagus are light violet in colour.

The single Polian vesicle is cylindrical in shape, 4 mm long, and arises from the ring vessel in the left ventral interradius (Pl.XVII, fig.1). The stone canal runs dorsally and posteriorly in the dorsal mesentery to the small, nodular madreporite which opens to the exterior near the genital papilla. (Pl.XVII, fig.1.)

A large bunch of copiously branched genital tubules lie over the anterior portion of the intestine (Pl.XVII, fig.1). The tubules are short, branching dichotomously (Pl.XVII, fig.6). The genital duct opens to the exterior in the middorsal interradius at the tip of a prominent genital papilla (Pl.XVII, fig.1).

Longitudinal muscles are present as 5 broad, dark brown bands. Transverse muscle fibres are not visible. Retractor muscles are absent.

Calcareous deposits are present in the skin, the dorsal processes, the pedicels, tentacles and gonads.

1. Skin deposits:- The skin contains a great number of wheels and spinous spicules.

a. Wheels:- Wheels are found in almost every part of the body wall, and are also present in the tentacles, pedicels, and dorsal processes. The wheels may be arbitrarily divided into 2 types, large and small. Large wheels have 8-9 spokes, are about 0.09 mm in diameter and have smooth margins (Pl.XVII, fig.8, d). The small wheels have 13 spokes, are about 0.05 mm in diameter, and have indented margins (Pl.XVII, fig.8, c). All of the wheels are approximately saucer-shaped, and lie in the skin with their concave surfaces facing outwards. The convex surface carries a boss which is made up of 4 or 5 curved rods which meet at a common point. Each wheel has a central perforation, and in some cases this central perforation is surrounded by 5 or 6 smaller perforations.

Stages in the development of large wheels are commonly encountered. The first part of the wheel to form is the central disc (Pl.XVII, fig.8, a). The disc has a single central perforation, and a margin with 8 projections. Another stage (Pl.XVII, fig.8, b) shows that the 8 points have grown out to form spokes, and their ends are expanding laterally. This lateral expansion presumably carries on until the complete wheel rim is formed. The raised boss probably forms at a later stage.

b. Spinous spicules:- Three- to six-armed spinous deposits are numerous in the ventral skin, but are scattered dorsally. The extremities of the arms carry short, sharp spines (Pl.XVII, fig.3). Average length of the spinous spicula is 0.1 mm. The spicules are concave in shape, and lie in the skin with their concave surfaces facing outwards.

2. Tentacle deposits:- In addition to a number of large and small wheels, the tentacles contain aggregations of irregular spinous rods of varying size (Pl.XVII, fig.7). Many of the rods are C- or U-shaped, and some have 1 or 2 perforations. Average length of tentacle rods is 0.4 mm.

3. Deposits of the dorsal processes:- The dorsal processes contain wheels and a large number of rods with slightly spinous extremities (Pl.XVII, fig.4). Small wheels tend to accumulate near the distal extremities of the processes, while the large wheels are found near their bases.

4. Deposits of the pedicels:- The distal extremity of each pedicel has an "endplate" composed of an aggregation of small, smooth, irregular deposits (Pl.XVII, fig.9), which are surrounded by a ring of curved spinous rods (Pl.XVII, fig.10). Wheels are also very numerous in the pedicels.

5. The genital tubules carry numbers of spinous rods. Average length of the rods is 0.2 mm.

A spicule of unusual character was found in the dorsal skin (Pl.XVII, fig.2). It consists of a long rod which is surmounted by a curved piece, and rather resembles an anchor. This deposit is 0.24 mm in length. A small number of long thin rods were found in the dorsal skin, but they were invariably broken. The spicule described above was the only complete example seen by the writer.

Distribution: *Laetmogone violacea* is one of the most widely distributed of the elasipods. Theel (1882) recorded 2 specimens from off Sydney in 950 fathoms. In his description of this species, Theel (1882) also stated that the "Knight Errant" in the summer of 1880 took over 100 specimens from a depth of 550 fathoms between the Faroe Islands and the coast of Scotland. Koehler and Vaney (1905) noted the occurrence of *Laetmogone violacea* near the Chagos Archipelago in the Indian Ocean. Heding (1942) described specimens from various regions in the Arctic, and noted that "*L. violacea* appears to be a cosmopolitic species, originating from the Indo-Pacific ...." (Heding, 1942).

Ecology: *L. violacea* has been recorded from depths between 250 fathoms and 1,000 fathoms. Like other members of the Order

Elasipoda, L. violacea prefers a muddy bottom, where its ventrally turned mouth facilitates detritus feeding.

Discussion: The specimen herein described agrees with those described by Theel (1882) in many respects, and differs in others. Differences were found in the number of ventral pedicels (Theel's (1882) specimens possessed 11 or 12 pedicels along each lateral ventral radius), and in the number of dorsal processes. The simple spicula described by Theel (1882) from the ventral skin in his specimens were not found in the specimen on hand. But Heding (1942) stated that the spiculation and relative numbers of processes and pedicels are variable in character, and that the variations are too slight to be used for distinguishing the numerous forms of this species.

D I S C U S S I O N

The distribution of holothurians within the New Zealand region and the relationships of the known New Zealand holothurians to those of other regions are both topics of considerable zoogeographical interest.

a. Distribution within the New Zealand region: (The New Zealand region as used here includes Auckland and Campbell Islands and Chatham Islands.)

1. The New Zealand Mainland: Finlay (1925) established marine provinces within the New Zealand region to describe the distribution of some marine molluscs. The Aupourian province covered the northern part of the North Island; the Cookian province extended from East Cape in the north to Otago in the south; the Forsterian province covered the lower part of the South Island, Snares Islands, and Stewart Island. The Morioran province comprised the Chatham Islands. The Auckland, Campbell, Antipodes and Bounty Islands comprise the Antipodean province (formerly the Rossian province).

Fell (1949), after a study of the distribution of the then known echinoderms, tended to agree with Finlay's (1925) province boundaries, save for some minor divergences. The list of holothurians regarded as stenotopic in Fell's (1949) paper was based on the results of Mortensen's (1925) work. The present study has revealed that many of the species previously regarded as stenotopic are in fact eurytopic, though other stenotopic species may now be named.

The Aupourian province contains the following stenotopic species (Pl.XVIII, fig.1):

Psolus neozelanicus Mortensen

Trachythyone bollonsi (Mortensen)

Ocnus farquhari (Mortensen)

Holothuria neozelanica (Mortensen).

All of the above species are known from off Cape Maria van Diemen and North Cape, and have not been taken elsewhere.

The Cookian province contains the greatest number of known New Zealand holothurian species. Four species are here regarded as stenotopic (Pl.XVIII, fig.1):

Protankyra rigida n.sp.

Chiridota alleni n.sp.

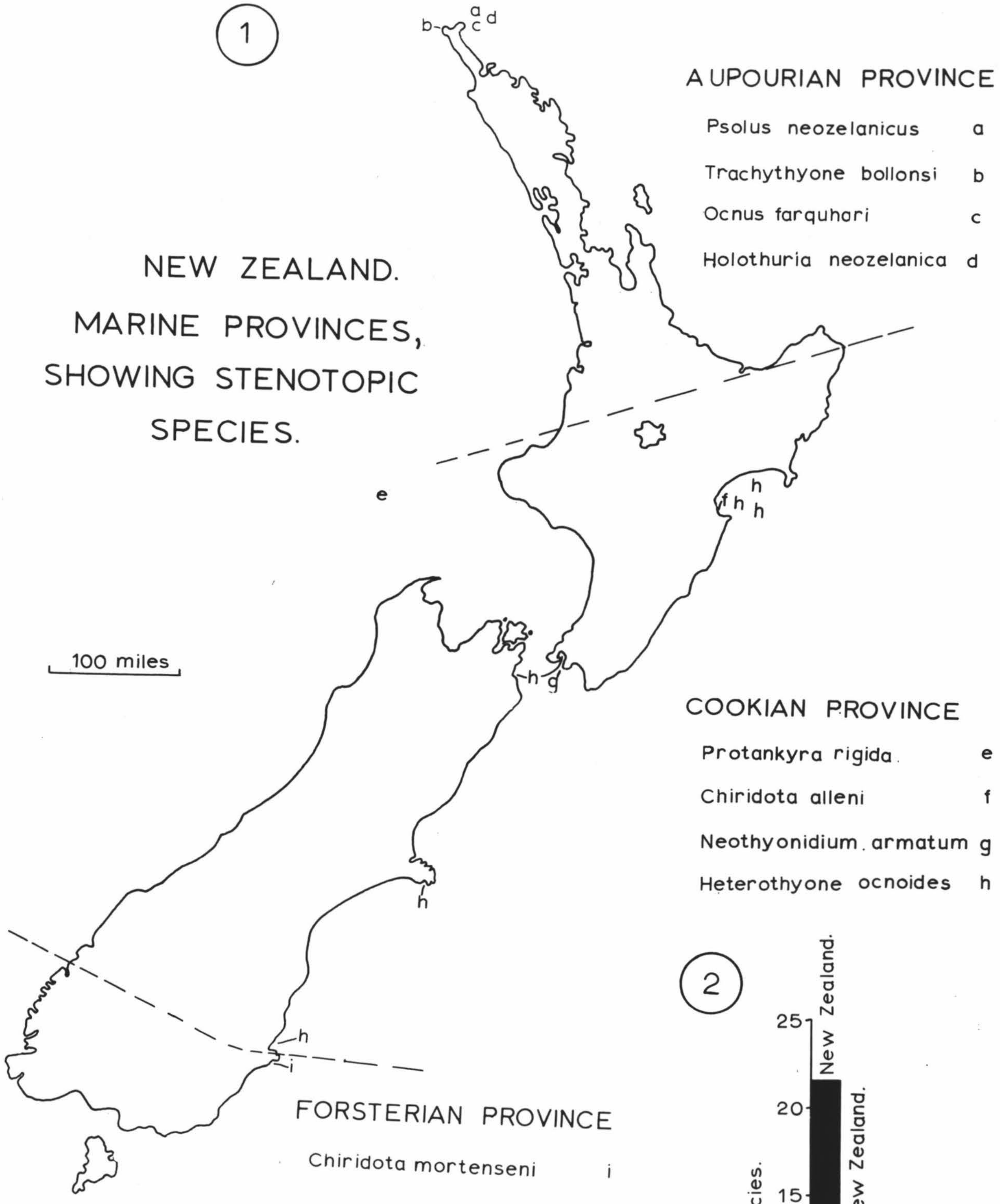
Neothyonidium armatum n.sp.

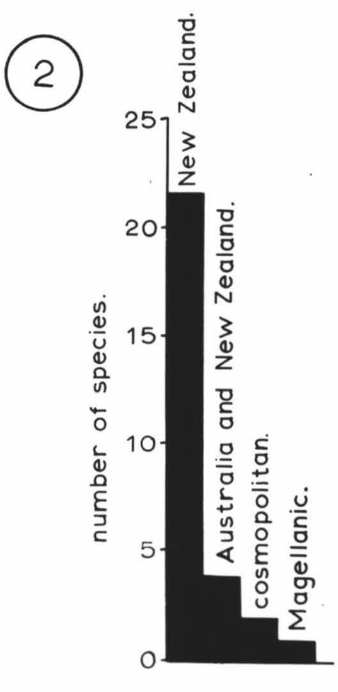
Heterothyone ocnoides (Dendy).

The Forsterian province contains but one species which may be regarded as stenotopic (Pl.XVIII, fig.1):

Chiridota mortenseni n.sp.

The above lists contain only shallow water species, as species from deeper waters are usually eurytopic. A study of the stenotopic species shows that they are either rare forms, or species new to the fauna. *Heterothyone ocnoides* (Dendy) is the sole exception. It is, therefore, possible to point out that holothurians do not exhibit stenotopy to the extent shown by the Mollusca or even by the other echinoderm groups. Most of the known shallow water species have been collected from areas of the coastline which are close to cities, and large areas of the coast still require


1
NEW ZEALAND.
MARINE PROVINCES,
SHOWING STENOTOPIC
SPECIES.
100 miles
AUPOURIAN PROVINCE
Psolus neozelanicus a
Trachythyone bollonsi b
Ocnus farquhari c
Holothuria neozelanica d
COOKIAN PROVINCE
Protankyra rigida e
Chiridota alleni f
Neothyonidium armatum g
Heterothyone ocnoides h
FORSTERIAN PROVINCE
Chiridota mortenseni i


2
number of species.
0
5
10
15
20
25
New Zealand.
Australia and New Zealand.
cosmopolitan.
Magellanic.

investigation. With further collecting in these vital areas, a more stable pattern may emerge, but at the moment, speculation on the distribution of holothurians within the provinces of the New Zealand mainland is unwarranted. There is no doubt that the list of eurytopic species will enlarge as the group becomes better known.

2. Chatham Islands: The Chatham Islands (1954) Expedition greatly augmented our knowledge of the fauna of that region. The holothurian fauna of the Chathams is now available for discussion from the point of view of zoogeography, but some reservations must be made, as the fauna of that region is still by no means well known. The species now known from the Chatham Islands are as follows:

Ocnus brevidentis (Hutton)
Heterothyone alba (Hutton)
Chiridota gigas Dendy
Trochodota dunedinensis (Parker).

All of the above species are present on the coasts of New Zealand, and all but *Chiridota gigas* Dendy are common species. *Heterothyone alba* and *Trochodota dunedinensis* are especially common in the Cook Strait region (or Cookian province), while *Ocnus brevidentis* is common in Foveaux Strait (in the Forsterian province). *Chiridota gigas* is known in New Zealand from but a single specimen taken from Dusky Sound, Fiordland (Mortensen, 1925). A study of the above list, and the areas of most frequent occurrence of the species concerned, leads to the conclusion that the known holothurian fauna of the Chatham Islands is derived from the southern half of New Zealand, especially from the Cook Strait region. The Chatham Rise would suffice as a shallow-water bridge from the Cook Strait region to the Chatham Islands. This supposition is supported by the studies of Fell (1960b) on the Asterozoa and Echinoidea of the Chatham Islands. Fell concluded that "the area is best regarded as part of the Cook Strait sub-region ...." I agree with Fell's (1960b) statement that he was "no longer able to recognise a distinctive Chatham Islands fauna ...."

3. Auckland and Campbell Islands: Mortensen visited the Auckland and Campbell Islands in 1916, and in 1925 he recorded 6 species and 1 variety of holothurians from these islands. Auckland and Campbell Islands lie within the Antipodean province.

Members of the Cape Expedition 1941-1943 collected many holothurians in the Auckland Islands. Examination of the specimens from this expedition has now led to the inclusion of *Kolostoneura novae-zealandiae* (Dendy and Hindle) in the known holothurian fauna of the Auckland Islands. The list of holothurians taken from the Rossian province now contains the following species:

Chiridota nigra Mortensen

Chiridota carnleyensis Mortensen

Trochodota dunedinensis (Parker)

Kolostoneura novae-zealandiae (Dendy and Hindle)

Stereoderma leoninoides (Mortensen)

Trachythyone amokurae (Mortensen)

Ocnus brevidentis (Hutton)

Ocnus brevidentis (Hutton) var. carnleyensis Dendy.

Of the above species, Stereoderma leoninoides and Chiridota carnleyensis are at present believed to be stenotopic, being known only from the Auckland and Campbell Islands, while the other species are known from the coasts of New Zealand.

The evidence afforded by the admittedly sparse holothurian fauna of these islands indicates that their fauna may have been derived from two sources:

(i) The greater part of the holothurian fauna is derived from the same stock as the holothurian fauna of the New Zealand mainland. This conclusion is based on the number of species common to both regions.

(ii) A small element of the fauna has possibly been derived from some originally circum-polar species, which have given rise to other species in other southern areas, including Patagonia, Kerguelen Island, and Macquarie Island. Stereoderma leoninoides is endemic to this Rossian province, but has a close relative in Patagonia (the species leonina Semper), and exemplifies this second source of supply. This second source, however, has little significance when the fauna as a whole is considered.

Auckland and Campbell Islands, together with Snares, Antipodes, and Bounty Islands are popularly known as "Subantarctic Islands". Fell (1953b) states, "... the subantarctic islands of New Zealand have received their echinoderm fauna from an assemblage of species which has been the common heritage of all parts of the New Zealand submarine plateau". This conclusion arose from a study of Echinoidea and Asterozoa from the islands under discussion. Unfortunately, no holothurians or crinoids are known from the Snares or Bounty Islands, but the evidence afforded by the holothurians of Auckland and Campbell Islands supports the above opinion. If, therefore, such a close faunal relationship exists between New Zealand and these outlying islands, then as far as the echinoderms are concerned, there are no grounds for referring to the islands as "subantarctic" islands, especially when localities such as Macquarie Island, Kerguelen and Heard Islands, and many others are included in the same term. This relationship was already apparent to Mortensen (1925). The holothurian faunas of the latter islands are of a very different character, derived mainly from circum-polar species, and in part from Antarctic genera, but each island also has a significant percentage of endemic species.

4. Macquarie Island: Mortensen (1925) gave an excellent account of the then known echinoderm fauna of Macquarie Island, and his remarks on the affinities and origins of the fauna of that island are still upheld at the present time. It is apparent that the echinoderm fauna of Macquarie Island contains a pronounced endemic element, the endemic species being derived from genera which have a wide distribution in both the Antarctic and temperate regions of the South Sea (Ekman, 1953). The relationships with New

New Zealand are remote. Mortensen (1925) notes that the two holothurian species common to the New Zealand region and Macquarie Island, namely Cucumaria macquariensis Dendy and Cucumaria brevidentis (Hutton) var. carnleyensis Dendy are "easily explained as being due to transport on floating algae". Fell (1953a) maintains that a shallow water route is more effective for echinoderm dispersal than a narrow deep-water gap. The deep trench (2,000 fathoms) separating Macquarie Island from the Auckland and Campbell Island group forms an effective barrier, and has prevented Macquarie Island from receiving the fauna typical of the New Zealand submarine plateau. Thus Macquarie Island is able to supply elements of its fauna to the New Zealand region with the assistance of the west wind drift, but no typical New Zealand species (shallow water stenobathic species) are able to traverse the deep trench in the opposite direction. Trachythyone squamata n.sp. known only from Macquarie Island has close relatives in Trachythyone bollonsi (Mortensen) from New Zealand and Trachythyone parva (Ludwig) from Patagonia and Kerguelen Islands. These 3 species clearly illustrate a typical "west wind drift distribution".

b. Relationships of the New Zealand holothurian fauna: At the outset it may be stated that the external relationships of the New Zealand holothurians are very closely paralleled by those of the other echinoderm groups. There is a rather high percentage of endemic species (Pl.XVIII, fig.2), amounting to approximately

80% of the total known species in New Zealand. A significant Australian-Indo-Pacific element is present (approximately 14%), together with 2 cosmopolitan species and a single species common to the magellanic region and New Zealand (Ocnus calcareus (Dendy)).

1. The Australian element: The following species are present in Australia and in the New Zealand region:

Chiridota gigas Dendy and Hindle
Mensamariella bicolumnata (Dendy and Hindle)
Neothyonidium dearmatum (Dendy and Hindle)
Stichopus mollis (Hutton).

Fell (1949) estimated that 16% of the then known species of New Zealand echinoderms were also present in the Australian-Indo-Pacific region. At that time 4 species of holothurians were common to both areas, and the number has not changed. The slight reduction in the percentage from 16% to 14% is not significant as only small numbers of holothurian species are concerned.

The problems concerning the difficulties involved in making the trans-Tasman crossing have been carefully discussed by Mortensen (1925) and Fell (1953a). Mortensen (1925) observed that Stichopus mollis and Chiridota gigas would no doubt possess pelagic larvae which could be carried across the Tasman Sea by means of any favourable currents. Fell (1953a) discussed the possibility of larval transportation across the Tasman Sea, and states, "we cannot dismiss the possibility that genera like Heliocidaris may make the trans-Tasman crossing in the larval stage".

Mortensen (1921) observed that in tropical echinoderm species larval life varies between 3 and 58 days, with a most common larval life of about 35 days. Thorson (1950) states that many larval forms can prolong their pelagic life until they find a suitable substratum on which to settle. At this juncture it may be of some interest to note that none of the four holothurian species common to the New Zealand and Australian regions have been taken from below 100 fathoms, and they may be safely regarded as shallow water forms. A study of the arguments presented above shows that trans-Tasman crossings by larval holothurians are well within the bounds of possibility. Further evidence in favour of this theory is supplied by the fact that the East Australian current flows southward along the east coast of Australia, encounters the west wind drift, and the resulting counter-clockwise swirl strikes towards New Zealand (Fell, 1953a). *Stichopus mollis*, *Chiridota gigas*, *Mensamariella bicolumnata* and *Neothyonidium dearmatum* are most common in Southeast Australia and Tasmania, and are thus in direct line with the East Australian current.

Neothyonidium dearmatum and *Mensamariella bicolumnata* present difficulties, as they do not appear to possess pelagic larvae. Two possible means of dispersal may be involved here:

(i) Migration along the present shallow-water New Zealand Ridge through the Lord Howe Rise during the late Tertiary and Pleistocene lowerings of the sea-level. Fell (1953a) has discussed the possibilities of this route, and attaches "... some importance to the Lord Howe Rise as at least a former, if not a present, dispersal route".

(ii) The second alternative appears to be transport on floating seaweed across the Tasman Sea. Clark's (1946) contention that only dead tests of certain Australian species of echinoids were carried across the Tasman Sea was disproved by Fell (1953a) when he recorded living specimens from North Auckland. The chance of a bottom-dwelling species becoming associated with a raft of seaweed and drifting to New Zealand from Australia is indeed remote, but not intolerably so. Two holothurian species (Neothyonidium dearmatum and Mensamariella bicolumnata) may have arrived at New Zealand in this manner. Many other species may have arrived on New Zealand shores and died out as a result of unfavourable environmental conditions, or survived and have not as yet been collected. Many more species may never have completed the journey.

2. The Magellanic element: Species common to New Zealand and the magellanic region have presented students of zoogeography with ample room for speculation, reasonable or otherwise. The older view entertained by such workers as Hutton and Oliver is that the faunas of the southern extremity of South America and New Zealand and Australia achieved their present distribution via a bridge formed by the Antarctic continent. However, the facts which have accrued since have led to the

inference that the older theory may be incorrect. The echinoderms have been studied from this point of view by many workers, including Mortensen (1925), Fell (1949, 1953a), and Ekman (1953). All of the above maintain that the New Zealand species have arrived in South America purely by chance, and there is no evidence of a former connection between the two regions. Ekman (1953) lists three methods of dispersal available to benthic animals:

(i) Spreading through abyssal bottom waters.

(ii) Transport on drifting seaweeds.

(iii) Drifting with surface ocean currents during the planktonic larval stage.

The first method (above) applies to eurybathic species. In the Holothuroidea of New Zealand, Molpadia violacea (Studer) may have achieved its distribution in this manner (p.86). There is no doubt that most elasipods spread through abyssal bottom waters.

The second and third methods are quite reasonable, when one considers the presence of the west wind drift. The large number of circum-polar species serves as testimony to the ability of the west wind drift to transport larvae or rafting adults to remote land masses. It is of particular interest to note that the single holothurian species common to New Zealand and the magellanic region (Ocnus calcareus (Dendy)) is almost invariably found in the holdfasts of littoral seaweeds on exposed shores. Mortensen (1925) also noted the seaweed-inhabiting species among other echinoderm groups, and observed that many of the species are present in

South America. Such facts as these speak for themselves.

A statement made by Mortensen (1925) concerning magellanic elements in the New Zealand fauna is often quoted, and is well worth repetition here: "Thus, we need not have recourse to any former land or shallow water connection between New Zealand and South America (Patagonia) in order to explain the similarity in their echinoderm faunas. It may rather be maintained, on the contrary, that the echinoderm faunas of the two regions bear witness against such former connection in post-mesozoic times".

Therefore, the magellanic region has little or no significance when the origins and derivation of the New Zealand holothurian fauna is considered. It is probable that New Zealand played a part, and is no doubt still playing a part in the building up of the holothurian fauna of the magellanic region. With reference to the other echinoderm groups, Fell (1953a) writes, "... South America is more likely to have been a recipient of occasional offshoots from the New Zealand stock".

c. General biology: There is a regrettable lack of information on the physiology, habits and life history of New Zealand holothurians. Autoevisceration and regeneration in Stichopus mollis has been studied by Dawbin (1944), while the life history, growth, and general physiology of Paracaudina chilensis has been investigated in Japan by many workers, including Hozawa, Inaba, Kawamoto, Kitao, Ohshima and Heding. John (1939) reported viviparity in the common synaptid Trochodota dunedinensis, and suggested that the complete life history of this species may be worked out. Nothing more has been done about this, or any other species in New Zealand. A better understanding of the relationship between closely similar species is achieved when a comparative study of their life histories is carried out, and there is an urgent need for investigation in this direction.

d. Systematics: Perhaps one of the most important conclusions arising from this study concerns the systematics of the Holothuroidea as a whole.

Orders Apoda and Elasipoda are fairly stable, although in recent years a large number of new species have been described in these orders, and the validity of some of these species is in some doubt.

Order Dendrochirota has been studied by a number of specialists, but unfortunately for systematics, there appears to have been little agreement and co-operation between the authors concerned. There is great confusion at the generic level, and the revisions made by Panning (1949) of the Cucumariidae and Heding and Panning (1954) of the Phyllophoridae have solved many problems, but have unfortunately posed many more. Inadequate diagnoses of genera and use of already preoccupied generic names are some regrettable errors in the above revisions.

The Orders Aspidochirota and Molpadonia are not well represented in New Zealand. However, workers in both groups disagree on a number of important points, especially where members of the genus *Molpadia* are concerned. A period of upset followed Heding's unsuccessful attempt at a new subdivision of the molpadids. Heding's work, however, tended to stimulate a closer investigation of the genus Molpadia and its species, and at the present time some order is being restored within this genus.

One is led to ask why such disagreement and chaos has arisen. It is apparent that different workers are at variance regarding characters which are useful for systematics. A typical example of this is found in the history of the species Paracaudina chilensis (Muller) (see p.94). It has been proved in recent years that many characters are useful for classification in some groups and worthless in others. The calcareous ring is unreliable in Order Molpadonia but is of prime importance in Order Dendrochirota. Whether the shape of the ciliated funnels and the number of Polian vesicles in the Apoda are reliable characters is a very debatable point. Deichmann does not rely particularly on ciliated funnels, but Heding places great stress on them and has described many new species, using ciliated funnels as a basis.

The calcareous deposits still remain the most important and reliable characters available for separation at the specific level, and they are also of great value at the level of the higher taxa. Although the deposits do change with growth of the animals concerned, the changes are not particularly drastic, apart from those in the species of Molpadia. Such gross spicule changes as those in Molpadia species are unparallelled in the other echinoderm groups.

A thorough evaluation of all the systematic characters used within each group is required, and the limits of variation of said characters must be made known. As many characters as possible must be used when a species is being described for the first time. The characters stated to be "diagnostic" for a group, whether it is a family, genus, or species must be used for the other groups at the same level. For example, if the calcareous ring is used to diagnose genera within a family, the ring characters must be used in every genus, including new genera described later. A new basic pattern should be established if order is to be restored to Class Holothuroidea, and the taxa should be arranged according to that pattern. There is no doubt that the pattern will change to some extent with increased knowledge of the group, but if the systematic characters used are reliable, there will be no drastic changes. Because groupings into genera, subfamilies and families are mostly artificial groupings, there is naturally room for some disagreement. Specialists within the field of holothurian systematics should make their ideas known, so that the unsatisfactory state of affairs existing at the present time may be remedied.

CONCLUSIONS

1. With regard to the holothurians, the marine provinces as established by Finlay (1925) and applied to the echinoderms by Fell (1949) are of little significance. Most of the species known from the New Zealand mainland are eurytopic or very rare. A more definite distribution pattern may emerge with further collecting in shallow waters around the New Zealand coasts.

2. The Chatham Islands holothurian fauna is derived from the Cook Strait region and the southern part of the South Island, the Chatham Rise forming the necessary shallow water bridge.

3. The holothurian fauna of the Antipodean region was derived chiefly from the same stock as that of the New Zealand region, and in part from former circum-polar species. The name"Sub-antarctic Islands" is inappropriate if used to indicate faunal affinities.

4. Macquarie Island has Antarctic and circum-polar affinities when its holothurian fauna is considered. The presence of Macquarie Island elements in the New Zealand fauna is a consequence of rafting in one direction, namely west to east.

5. The New Zealand holothurian fauna contains a significant Australian element. Evidence indicates, therefore,that the fauna was derived from the Indo-West-Pacific region. It is probable that Australia is still supplying elements to the New Zealand holothurian fauna,either as larvae or rafting adults.

6. Affinities with the South American region are negative if is seeking the area of origin of the New Zealand holothurian fauna. The single species common to New Zealand and South America is known to inhabit seaweeds in the littoral zone. It is probable that this species was carried to South America on rafts of seaweed, with the aid of the west wind drift.

7. There is a lack of information regarding the general biology of New Zealand holothurians, and more research is required in this field.

8. Many of the taxa within the Class holothuroidea are in a state of disorder at the present time. It appears that there has been an over-emphasis on characters which tend to be unreliable, and inadequate use of known reliable characters.

9. The calcareous deposits still remain the best single criterion for separation at the species level, and,to a lesser extent, at the level of the genus.

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