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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BULLETIN 201

The Marine Fauna of New Zealand: Sea Cucumbers (Echinodermata: Holothuroidea)

by

DAVID L. PAWSON

New Zealand Oceanographic Institute

Memoir No. 52

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FOREWORD

Since the early nineteenth century there has been continuous marine biological research in New Zealand. Up to 1900 over 850 papers on the marine zoology of New Zealand had been published. Most of this and later work has appeared as discrete papers, there being relatively few monographic or serial comprehensive treatments of particular taxonomic groups. Despite some substantial contributions in this form, the lack of detailed accounts enabling the ready recognition of species in many other groups has hampered the development of ecological work dependent on such identification.

Since 1955 the N.Z. Oceanographic Institute has been developing a programme of research in benthic ecology in the New Zealand region and the effects of this scarcity of systematic monographs of the marine fauna have been particularly evident. However, the opportunities that have arisen in the course of sampling programmes have provided additional material for systematic consideration, and a number of specialists in systematic groups have interested themselves in working on the New Zealand fauna.

In this memoir the author has utilised large collections of holothurians made by the Institute and additional material from the Dominion Museum, Wellington. The resulting analysis of the holothurian fauna is a substantial addition to our knowledge of New Zealand marine animals.

The work is a contribution to the studies on the Marine Fauna of New Zealand published in this memoir series.

The preliminary editing of this manuscript was carried out by Miss B. Davison, N.Z. Oceanographic Institute.

J. W. Brodie, Director
N.Z. Oceanographic Institute
Wellington

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The Marine Fauna of New Zealand: Sea Cucumbers (Echinodermata: Holothuroidea)

by

DAVID L. PAWSON

Smithsonian Institution, Washington, D.C., U.S.A.

ABSTRACT

The New Zealand holothurian fauna now comprises 49 species belonging to 36 genera. All orders of the Class Holothuroidea occur in New Zealand, and the Dendrochirotida, Elasipodida, and Apodida are particularly well represented. The fauna is reviewed here, the report being based upon a total of 1,121 specimens in the collections of the New Zealand Oceanographic Institute, the Dominion Museum, and other institutions. Keys are given to all taxa, and a general key to the species is given. One new family is diagnosed, to accommodate the New Zealand genus *Heterothyone*.

Notable features of the fauna are the high incidence of primitive (U-shaped) species and the presence of only one conspicuous species (*Stichopus mollis* (Hutton)) in the intertidal zone. The holothurians do not demonstrate provincial distribution patterns as convincingly as do the asteroids and echinoids. Twelve species have been collected in the intertidal zone; of these seven extend to the continental shelf or slope. Of the 27 species known from the continental shelf, 14 range into bathyal depths. In the bathyal zone 31 species occur, of which 17 are apparently restricted to those depths.

Relationships and origin of the fauna are difficult to determine in the absence of a fossil record. At the species level 83% of the shelf holothurians are restricted to the New Zealand region. Four species are shared with Australia, and one with Juan Fernandez Island. In contrast, approximately 45% of the shelf echinoids are shared with Australia. The genera represented in the fauna are mainly widespread in world seas, and thus offer no conclusive evidence of affinities of the New Zealand fauna. It is concluded that, as many other invertebrate groups in the New Zealand fauna are obviously derived chiefly from the Australian-Indo-Pacific region, the holothurians also were probably derived from the same source.

INTRODUCTION

Holothurians are generally inconspicuous, limp, soft-bodied animals, often of unattractive appearance. They have been neglected by many students of echinoderms in favour of more aesthetically pleasing groups, and thus today they form one of the less well known classes of echinoderms. They do not exhibit to such a striking degree the pentamerous symmetry so typical of other extant echinoderms; rather the body generally has a pronounced bilateral symmetry externally. Many species have five rows of tube feet externally, but others have none and appear superficially rather like annelids. In contrast to other echinoderms, the endoskeleton is usually reduced to a layer of scattered, minute, calcareous deposits which appear to have no regular arrangement.

Holothurians are generally benthonic, although a few bathypelagic species are known. They are exclusively marine, and only two species are known to inhabit brackish waters. They range from the intertidal zone to the deepest trenches, in which latter habitat they may comprise up to 90% of the total biomass. The general form of the body often provides some indication of the habitat preferred, and habitats range from mud to rock. Many species, particularly in the southern oceans, live attached to seaweeds.

Among extant echinoderms, the closest relatives of the holothurians appear to be the echinoids (*see* Fell, 1965), but the holothurians have some remarkable primitive features, the most striking being the presence of a single gonad, a character that was widespread in Paleozoic echinoderms. Some living genera of holothurians may possibly be survivors of archaic groups (Pawson, 1966), but the poor fossil record does little to strengthen speculations about the evolution of the group. Such speculations must be based largely on structure of recent forms, coupled with interpretation of the known fossil history of other echinoderms.

Most of the New Zealand species are off-shore forms, and few species can be found between the tides. Only one large species, *Stichopus mollis* (Hutton), is common in shallow water; other shallow-water species are small, and live attached to seaweed, buried in sandy mud, or concealed under rocks. Our knowledge of the biology and ecology of New Zealand holothurians is regrettably scanty. Apart from the studies by Dawbin (1949a, 1949b) on autovisceration and regeneration in *Stichopus mollis*, no published reports on the biology of local species have appeared. Virtually nothing is known of the feeding habits, behaviour, and reproductive biology of New Zealand holothurians. Investigations along these lines should be rewarding. Many species are obtainable by dredging in shallow water.

SCOPE OF THIS REPORT

This bulletin is a survey of the New Zealand holothurian fauna, based on 1,121 specimens in collections made by the New Zealand Oceanographic Institute between 1956 and 1963, the Dominion Museum, the Cape Expedition to the Auckland Islands, and the Chatham Islands (1954) Expedition. Several species are described and illustrated; others have been described elsewhere (*see* Mortensen (1925) and Pawson (1962 *et seq.*)), and it has not been considered necessary to describe them fully again here. However, all species are diagnosed and their distribution is discussed.

Probably few new shallow-water or shelf species remain undiscovered, but the bathyal and abyssal areas around New Zealand are rich sources for new and interesting taxa. Almost every deep-sea sample of New Zealand holothurians that has come to my attention has revealed new material or new records, and it is obvious that this experience is shared by workers on other echinoderm groups (*see* Fell, 1958 and McKnight, 1967).

Bathymetric ranges cited are derived from earlier records of the species and from collections dealt with in this report. The distribution of each species is not considered in very great detail, for very large recent collections from the New Zealand area are at present being studied by the writer, and undoubtedly the range of several species will be extended. Where possible, preferred habitats are given for each species, with the exception of the Order Elasipodida. As the elasipodids are exclusively deep-sea species, the habitat is almost invariably mud or ooze.

Keys are given for all taxa, together with a general key to the New Zealand species, which should aid in identification. The New Zealand region as defined throughout this series extends to the 2,700 m line, and thus includes the Chatham, Auckland, Campbell, Bounty, and Antipodes Islands (Bennett, 1964).

PREVIOUS WORK

Hutton (1872) was the first to describe holothurians from New Zealand. His report included eight species, all of which were new to science: *Holothuria mollis*, *Thyone longidentis*, *T. brevidentis*, *T. caudata*, *Synapta uncinata*, *S. inaequalis*, *Chiridota* ? *alba*, and *Molpadia coriacea*. Later Hutton (1878) described three further species: *Cucumaria thomsoni*, *Labidodesmus turbinatus*, and *Holothuria robsoni*. *Thyone longidentis* was referred to a new genus, *Pentadactyla*, and *Chiridota* ? *alba* to *Echinocucumis*. Many of Hutton's descriptions were inadequate, and several of his species are either no longer recognisable or have been reduced to synonymy.

Parker (1881) described *Chiridota dunedinensis* from New Zealand, and later Theel (1882, 1886) described *Stichopus sordidus*, *Thyonidium rugosum*, *Ankyroderma marenzelleri*, *Trochostoma violaceum*, *Holothuria lactea*, *Enypniastes eximia*, and *Pannychia moseleyi*, most of which were deep-water species, collected by HMS "Challenger".

Dendy (1896) described four new species: *Cucumaria huttoni*, *Colochirus ocnoides*, *C. calcarea*, and *Psolus macquariensis*. *Stichopus sordidus* Theel was synonymised with *Holothuria mollis* Hutton, and the name changed to *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 (1896), and most were found to have deteriorated beyond recognition. Ludwig (1898b) was of the opinion that *Colochirus brevidentis* (Hutton) and *Colochirus calcarea* Dendy were synonymous. Perrier (1903) described two new species, *Cucumaria filholi* and *Thyonidium anatinum*, and 2 years later (1905) described another new species, *Caudina pulchella*, and a new variety, var. *brevicaudata*, of *Caudina coriacea* (Hutton).

Dendy and Hindle (1907) described six new species: *Stichopus simulans*, *Phyllophorus dearmatus*, *Pseudocucumis bicolumnatus*, *Chiridota gigas*, *C. geminifera*, and *Rhabdomolgus novaezealandiae*. In the same paper all 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 *S. inaequalis*, as the original descriptions had been inadequate. In the same paper Clark declared *Caudina coriacea* (Hutton) a synonym of *C. chilensis* (Müller). Becher (1909) established a new genus *Kolostoneura* to accommodate *Rhabdomolgus novaezealandiae* 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. *C. leonina* Semper var. was also recorded from the Auckland Islands (this species was later named *C. leoninoides* by Mortensen (1925)). Benham (1909) described a new molpadid species, *Molpadia dendyi*.

Between 1909 and 1925 little or nothing was added to our knowledge of the 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 a comprehensive account of the then known holothurians of New Zealand, based on material he collected in the area during his 1914–16 Pacific Expedition. He described 10 new species: *Holothuria neozelanica*, *Cucumaria amokurae*, *C. farquhari*,

C. bollonsi, *C. leoninoides*, *Psolidiella nigra*, *Psolus neozelanicus*, *Chiridota nigra*, *C. carnleyensis*, and *Trochodota dendyi*. A new variety, var. *microurna* of *Trochodota dunedinensis* (Parker), was described. In the same paper *Caudina coriacea* (Hutton) and *Colochirus calcarea* (Dendy) were re-established, *Stichopus simulans* Dendy and Hindle was declared synonymous with *Stichopus mollis* (Hutton), *Chirodota benhami* Dendy and *C. geminifera* were synonymised with *Trochodota dunedinensis* (Parker), and *Synapta inaequalis* Hutton was synonymised with *Protankyra uncinata* (Hutton). *Holothuria robsoni* Hutton and *Labidodesmus turbinatus* Hutton were deleted from the faunal list.

Heding (1931) referred *Caudina coriacea* (Hutton) (= *C. chilensis* (Müller)) to his new genus *Paracaudina*. Clark (1946) diagnosed a new genus, *Mensamaria*, and referred to it the New Zealand species *Pseudocucumis bicolumnatus* Dendy and Hindle. Another new genus, *Lipotrapeza*, included *Phyllophorus dearmatus* Dendy and Hindle. In a revision of the family Cucumariidae, Panning (1949) distributed the 10 species listed under the genus *Cucumaria* by Mortensen (1925) into 6 genera. Heding and Panning (1954) revised the family Phyllophoridae. In this revision Hutton's (1872) species *Phyllophorus longidentis* was restored to the genus *Pentadactyla* Hutton, *Mensamaria thomsoni* was transferred to the genus *Amphicyclus* Bell, and *Lipotrapeza dearmatum* was referred to *Neothyonidium* Deichmann.

Until the writer began working on the New Zealand holothurians in 1959, no publications devoted to the New Zealand forms had been produced since Mortensen's (1925) report, apart from a key to the New Zealand species by Dawbin (1950). Nomenclatural changes introduced by the writer in previous publications are incorporated into the following systematic account and need no further discussion here.

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For sending me comparative material of certain species and for advice on classification I thank Miss Elizabeth Pope of the Australian Museum; Dr B. Hansen of the Universitetets Zoologiske Museum, Copenhagen; Dr Elizabeth Deichmann of the Museum of Comparative Zoology, Harvard University; and Dr W. H. Dawbin, Zoology Department, University of Sydney.

Thanks are also due to colleagues at the U.S. National Museum for reading parts of this manuscript and for offering valuable suggestions, and to the photographic staff of the museum for the photographic work involved.

STATION DATA

Throughout the following station list the following abbreviations are employed: bl., black; f., fine; frag(s)., fragment(s); gr., grey; gn, green; m, metres; med., medium; sd, sand; sdy, sandy; sp., specimen(s).

LIST OF STATIONS

NEW ZEALAND OCEANOGRAPHIC INSTITUTE

These collections comprise some 816 specimens, representing 24 species, taken during cruises about the New Zealand coast from August 1956 to February 1963.

A 327, 28 Jan 1957, Off Dale Point, Milford Sound, 44° 36′ S, 167° 49.2′ E, 113 m, gr. mud.
Heterothyone alba (Hutton) 1 sp.

A 435, 2 Oct 1958, Taranaki Bight, 40° 30′ S, 174° 33′ E, 115m, sdy mud.
Heteromolpadia marenzelleri (Theel) 1 sp.
Pentadactyla longidentis (Hutton) 2 sp.

A 445, 5 Oct 1958, Cook Strait, 41° 7′ S, 174° 22.2′ E, 21m.
Pentadactyla longidentis (Hutton) 2 sp.

B 2, 25 Aug 1956, Hawke Bay, 39° 08.8′ S, 177° 13′ E, 17m, f. gr. sd.
Placothuria huttoni (Dendy) 1 sp.

B 6, 25 Aug 1956, Hawke Bay, 39° 09.9′ S, 177° 21.7′ E, 33m, gr. gn sdy mud, 13.1°C.
Heterothyone ocnoides (Dendy) 1 sp.

B 8, 26 Aug 1956, Hawke Bay, 39° 06.6′ S, 177° 27.3′ E, 27m, f. gr. sd, 13.1°C.
Paracaudina chilensis (Muller) 326 sp. + frags
Heterothyone ocnoides (Dendy) frags

B 9, 26 Aug 1956, Hawke Bay, 39° 10.9′ S, 177° 30.8′ E, 33m, sd, 13.0°C.
Heterothyone ocnoides (Dendy) 4 sp.

B 10, 26 Aug 1956, Hawke Bay, 39° 13.9′ S, 177° 35.4′ E, 55m, f. sdy cloggy mud, 12.9°C.
Heterothyone alba (Hutton) 1 sp.

B 11, 26 Aug 1956, Hawke Bay, 39° 18.4′ S, 177° 39.1′ E, 66m, f. sdy cloggy mud, 13.1°C.
Heteromolpadia marenzelleri (Theel) 1 sp.
Heterothyone alba (Hutton) 3 sp.

B 13, 27 Aug 1956, Hawke Bay, 39° 07.4′ S, 177° 36′ E, 29m, sdy mud, 12.9°C.
Heterothyone ocnoides (Dendy) 1 sp.

B 14, 27 Aug 1956, Hawke Bay, 39° 04.4′ S, 177° 41.3′E, 20m, sloshy sd, 12.5°C.
Heterothyone ocnoides (Dendy) 1 sp. + frags

B 15, 27 Aug 1956, Hawke Bay, 39° 09.8′ S, 177° 46.6′ E, 35m, f. gr. sd, 12.6°C.
Heterothyone ocnoides (Dendy) 3 sp. + frags

B 16, 27 Aug 1956, Hawke Bay, 39° 11.3′ S, 177° 40.6′ E, 40m, gr. mud and f. sdy mud, 13.2°C.
Heterothyone alba (Hutton) 1 sp.

B 18, 27 Aug 1956, Hawke Bay, 39° 19′ S, 177° 48 .2′ E, 46m, sd, 13.4°C.
Heterothyone ocnoides (Dendy) 5 sp. + frags

B 19, 27 Aug 1956, Hawke Bay, 39° 23′ S, 177° 52′ E, 41m, gr. sdy mud, gn stones, 13.3°C.
Heterothyone ocnoides (Dendy) 2 sp.

B 21, 28 Aug 1956, Hawke Bay, 39° 22.4′ S, 177° 33.4′ E, 91m, pumice and f. bl. stones, 13.1°C.
Rynkatorpa uncinata (Hutton) 1 sp.

B 25, 28 Aug 1956, Hawke Bay, 39° 25.6′ S, 177° 45.9′ E, 82m, f. gr. sdy sloshy mud.
Heterothyone alba (Hutton) 2 sp.

B 37, 2 Sep 1957, Hawke Bay, 39° 25.4′ S, 176° 56.2′ E, 17 m, sd.
Heterothyone ocnoides (Dendy) 4 sp. + frags
Paracaudina chilensis (Muller) 2 sp.
Heterothyone alba (Hutton) 4 sp.

B 41, 2 Sep 1957, Hawke Bay, 39° 12′ S, 177° 08.1′ E, 17m, shell, gravel and stones.
Amphicyclus thomsoni (Hutton) 3 sp.
Neocucumella bicolumnata (Dendy & Hindle) 2 sp.

B 44, 3 Sep 1957, Hawke Bay, 39° 29.3′ S, 177° 00.8′ E, 22m, f. sdy mud.
Heteromolpadia marenzelleri (Theel) 1 sp.

B 45, 3 Sep 1957, Hawke Bay, 39° 27.1′ S, 177° 06.2′ E, 35m, f. sdy mud.
Heterothyone alba (Hutton) 1 sp.

B 46, 3 Sep 1957, Hawke Bay, 39° 23′ S, 177° 10.8′ E, 53m, f. gr. sdy mud.
Heterothyone alba (Hutton) 3 sp.

B 47, 3 Sep 1957, Hawke Bay, 39° 20.0′ S, 177° 16′ E, 62m, f. gr. gn sdy mud.
Heterothyone alba (Hutton) 3 sp.

B 49, 3 Sep 1957, Hawke Bay, 39° 23.8′ S, 177° 19.8′ E, 68m, f. gr. gn sdy mud.
Heteromolpadia marenzelleri (Theel) 1 sp.
Heterothyone alba (Hutton) 2 sp.

B 53, 3 Sep 1957, Hawke Bay, 39° 35.6′ S, 177° 00.6′ E, 13m, rock shell gravel.
Neocucumella bicolumnata (Dendy & Hindle) 1 sp.

B 54, 4 Sep 1957, Hawke Bay, 39° 36.8′ S, 177° 08.7′ E, 51m, gr. gn mud.
Heterothyone alba (Hutton) 1 sp.
Rynkatorpa uncinata (Hutton) 1 sp.

B 217, 20 May, 1960, Foveaux Strait, 46° 55′ S, 168° 05′ E, 22m, soft mud.
Chiridota nigra Mortensen 3 sp.
Heterothyone alba (Hutton) 1 sp.
Stichopus mollis (Hutton) 1 sp.
Pentadactyla longidentis (Hutton) 2 sp.

B 218. 21 May 1960, Foveaux Strait, 46° 50′ S, 168° 09.8′ E. 39 m, yellow coarse sd.
Chiridota nigra Mortensen 1 sp.
Placothuria huttoni (Dendy) 1 sp.

B 219. 21 May 1960, Foveaux Strait, 46° 45′ S, 168° 09.8′ E, 36 m, Bryozoa, molluscs.
Stichopus mollis (Hutton) 2 sp.

B 224. 21 May 1960, Foveaux Strait, 46° 45′ S, 168° 16.8′ E. 32 m, slightly muddy coarse shelly sd.
Amphicyclus thomsoni (Hutton) 3 sp.

B 238. 23 May 1960, Foveaux Strait, 46° 35.2′ S, 168° 14′ E. 33 m, shelly sdy mud, sulphide layer.
Neothyonidium dearmatum (Dendy & Hindle) 3 sp.

B 248. 26 May 1960, Foveaux Strait, 46° 25′ S, 168° 02.5′ E. 17 m. pebbly sd, dead shell.
Neocucumella bicolumnata (Dendy & Hindle) 1 sp.

B 257. 27 May 1960, Foveaux Strait, 46° 40′ S, 168° 45.3′ E. 31 m, pebbly shelly coarse sd.
Placothuria huttoni (Dendy) 4 sp.

B 264A. 28 May 1960, Foveaux Strait, 46° 42′ 50″ S, 168° 19′ 48″ E, to 46° 44.2′ S, 168° 22.1′ E, 27 m.
Placothuria huttoni (Dendy) 2 sp.

B 267. 29 May 1960, Foveaux Strait, 46° 50′ S, 168° 45.8′ E. 72 m, dead and broken shell, hydroids.
Stichopus mollis (Hutton) 1 sp.

B 270. 29 May 1960, Foveaux Strait, 46° 42′ S, 169° 00′ E. 33 m, turret shells, mussels.
Amphicyclus thomsoni (Hutton) 1 sp.

B 277. 30 May 1960, Foveaux Strait, 46° 58.25′ S, 168° 09.55′ E, 11 m.
Pentadactyla longidentis (Hutton) 1 sp.

B 291. 12 June 1960, Off Kaikoura, 42° 28.2′ S, 173° 38.7′ E, 402 m, gr. mud.
Molpadia sp. ? nov. 2 sp.

B 296. 25 June 1960, Off Paekakariki, 41° 17.2′ S, 174° 51.4′ E. 22 m.
Pentadactyla longidentis (Hutton) 11 sp.
Rynkatorpa uncinata (Hutton) 2 sp.

B 318. 26 Oct 1960, W of New Plymouth, 39° 07.5′ S, 173° 35′ E, 172 m, tunicates, tusk shell, dead shell.
Heteromolpadia marenzelleri (Theel) 1 sp.

B 323. 27 Oct 1960, W of Wanganui, 40° 15′ S, 173° 38′ E. 88 m, dead shell, many varieties.
Paracaudina chilensis (Muller) 1 sp.

B 464. 3 June 1961, Off Westport, 41° 59.3′ S, 171° 08.7′ E. 148 m, soft gr., slightly sdy mud.
Pentadactyla longidentis (Hutton) 1 sp.

B 471. 3 June 1961, SW of Hokitika, 43° 20′ S, 169° 55′ E. 66 m, gr. sdy mud.
Paracaudina chilensis (Muller) frags

B 495. 9 June 1961, SW of Hokitika, 44° 33.6′ S, 167° 47.6′ E. 124 m, worms, bivalves.
Paracaudina chilensis (Muller) 1 sp.

B 496. 11 June 1961, E of Farewell Spit, 40° 36′ S, 173° 33′ E. 58 m, f. gr. mud with red ophiuroids.
Heteromolpadia marenzelleri (Theel) 1 sp.
Paracaudina chilensis (Muller) 3 sp.
Heterothyone alba (Hutton) 1 sp.

B 524. 13 Feb 1962, NE of Kaikoura, 43° 24′ S, 173° 50′ E. 95 m.
Heteromolpadia marenzelleri (Theel) 2 sp.

B 525, 13 Feb 1962, NE of Kaikoura, 42° 18′ S, 173° 55.2′ E, 77 m, worm tubes, brittle stars.
Paracaudina chilensis (Muller) frags

B 526, 13 Feb 1962, NE of Kaikoura, 42° 17.3′ S, 173° 56′ E, 84 m, mud-coated animals.
Pentadactyla longidentis (Hutton) 1 sp.

B 540, 4 Oct 1962, N of Kaikoura, 42° 00′ S, 174° 15.5′ E, 126 m.
Pentadactyla longidentis (Hutton) 1 sp.

B 545, 5 Oct 1962, S of Kaikoura, 43° 20′ S, 173° 47.3′ E, 22 m, f. gr. gn. mud.
Heterothyone ocnoides (Dendy) 10 sp.
Paracaudina chilensis (Muller) 2 sp.

B 546, 5 Oct 1962, S of Kaikoura, 43° 20′ S, 173° 14.6′ E, 50 m, f. gr. sdy mud.
Pentadactyla longidentis (Hutton) 1 sp.

B 547, 5 Oct 1962, S of Kaikoura, 43° 20′ S, 173° 20.8′ E, 77 m, med. bl. sd.
Rynkatorpa uncinata (Hutton) 1 sp.
Heterothyone alba (Hutton) 3 sp.

B 551, 5 Oct 1962, Pegasus Bay, 43° 48.45′ S, 172° 56.1′ E, 11 m, soft gr. mud.
Pentadactyla longidentis (Hutton) 14 sp.

B 553, 6 Oct 1962, Canterbury Bight, 44° 00′ S, 172° 35.5′ E, 49 m, f. muddy sd.
Heterothyone alba (Hutton) 2 sp.

B 554, 6 Oct 1962, Canterbury Bight, 44° 00′ S, 172° 58.2′ E, 81 m, f. muddy sd.
Amphicyclus thomsoni (Hutton) 4 sp.

B 556, 6 Oct 1962, Canterbury Bight, 44° 00′ S, 173° 47.5′ E, 179 m.
Placothuria huttoni (Dendy) 1 sp.

B 559, 7 Oct 1962, Canterbury Bight, 44° 40.4′ S, 172° 10′ E, 132 m.
Neothyonidium armatum Pawson 2 sp.

B 570, 9 Oct 1962, E of Foveaux Strait, 46° 23.4′ S, 169° 48.2′ E, 15 m, f. gr. sd.
Heterothyone alba (Hutton) 1 sp.

B 576, 10 Oct 1962, E of Stewart Island, 47° 20′ S, 168° 39′ E, 126 m, broken shell.
Chiridota nigra Mortensen 1 sp.

B 578, 11 Oct 1962, E of Stewart Island, 47° 20′ S, 169° 08′ E, 143 m, broken shell
Placothuria huttoni (Dendy) 1 sp.

B 592, 13 Oct 1962, SW of Stewart Island, 48° 46′ S, 107° 19′ E, 152 m.
Placothuria huttoni (Dendy) frag.

B 599, 14 Oct 1962, W of Foveaux Strait, 46° 40.5′ S, 167° 12′ E, 260 m.
Neothyonidium armatum Pawson 2 sp.

B 605, 17 Oct 1962, Foveaux Strait, 46° 23.5′ S, 167° 22′ E, 73 m.
Stichopus mollis (Hutton) 4 sp.

B 618, 18 Oct 1962, Off Milford Sound, 44° 43′ S, 167° 34.8′ E, 22 m, f. dark gr. sd.
Heterothyone ocnoides (Dendy) 1 sp. + frags

B 624, 19 Oct 1962, Jackson Bay, 43° 58.5′ S, 168° 38.1′ E, 29 m.
Paracaudina chilensis (Muller) frags

B 629, 20 Oct 1962, Off Hokitika, 42° 40′ S, 170° 59′ E, 22 m.
Paracaudina chilensis (Muller) 1 sp.

B 630, 20 Oct 1962, Off Hokitika, 42° 40.2′ S, 170° 52.2′ E, 81 m, mud.
Heterothyone alba (Hutton) 1 sp.

B 632, 20 Oct 1962, Off Hokitika, 42° 40.7′ S, 170° 43.5′ E, 289–146 m, sticky gr. mud, shell.
Heterothyone alba (Hutton) 1 sp.

B 635, 21 Oct 1962, S of Cape Foulwind, 41° S 59.5′ S, 171° 15′ E, 73 m, f. gr. muddy sd.
Heterothyone alba (Hutton) 2 sp.

B 640, 21 Oct 1962, Off Karamea, 41° 2.0′ S, 172° 3.2′ E, 20 m, pebbles and broken shell.
Heterothyone ocnoides (Dendy) frags

B 646, 22 Oct 1962, W of Wanganui, 40° 00′ S, 173° 00′ E, 117 m, f. gn gr. sdy mud.
Heteromolpadia marenzelleri (Theel) 4 sp.
Rynkatorpa uncinata (Hutton) 6 sp.

B 647, 22 Oct 1962, W of Wanganui, 40° 00′ S, 173° 23.5′ E, 97 m, soft gr. sdy mud.
Rynkatorpa uncinata (Hutton) 2 sp.

B 648, 22 Oct 1962, W of Wanganui, 40° 00′ S, 173° 52′ E, 97 m, shell, polyzoa.
Stichopus mollis (Hutton) 1 sp.

B 649, 22 Oct 1962, S Taranaki Bight, 40° 01′ S, 174° 20.5′ E, 68 m, coarse polyzoa and shell.
Neothyonidium dearmatum (Dendy & Hindle) 2 sp.

B 651, 22 Oct 1962, S Taranaki Bight, 40° 00.5′ S, 174° 57′ E, 24 m, sd and shell.
Placothuria huttoni (Dendy) 2 sp.

B 667, 25 Oct 1962, S of Manakau Harbour, 37° 18.7′ S, 174° 37.2′ E, 17 m, f. bl. sd.
Heterothyone ocnoides (Dendy) 1 sp.

B 670, 25 Oct 1962, W of Manakau, 37° 8.7′ S, 174° 03.8′ E, 170 m.
Heteromolpadia marenzelleri (Theel) 1 sp.

B 671, 26 Oct 1962, Kaipara Harbour, 36° 40′ S, 174° 17′ E, 22 m, f. bl. sd.
Heterothyone ocnoides (Dendy) 1 sp.

B 673, 26 Oct 1962, S of Kaipara Harbour, 36° 40′ S, 173° 56.5′ E, 124 m, mud.
Heteromolpadia marenzelleri (Theel) 3 sp.

B 675, 26 Oct 1962, SW of Kaipara Harbour, 36° 40′ S, 173° 50′ E, 384 m, mud, rock.
Heteromolpadia marenzelleri (Theel) 1 sp.

B 678, 26 Oct 1962, Off Raglan Harbour, 37° 44.9′ S, 174° 45.6′ E, 31 m, f. gr. sd.
Heteromolpadia marenzelleri (Theel) 3 sp.

B 686, 28 Oct 1962, N of Cape Farewell, 40° 16′ S, 172° 32.3′ E, 126 m, shell, worm tubes.
Heteromolpadia marenzelleri 3 sp.

B 695, 30 Oct 1962, E Tasman Bay, 41° 06.4′ S, 173° 46.8′ E, 20 m, soft gr. mud.
Rynkatorpa uncinata (Hutton) 2 sp.

C 166, 3 Sept 1959, S Taranaki Bight, 39° 37′ S, 171° 58.2′ E, 271 m.
Protankyra rigida Pawson 1 sp.
Heterothyone alba (Hutton) 2 sp.

C 167, 3 Sept 1959, S Taranaki Bight, 39° 40′ S, 172° 00′ E, 273 m.
Heteromolpadia marenzelleri (Theel) 1 sp.
Paracaudina chilensis (Muller) 1 sp. + frag.

C 170, 4 Sept 1959, S Taranaki Bight, 39° 40′ S, 172° 39′ E, 199 m.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 175, 4 Sept 1959, S Taranaki Bight, 39° 40′ S, 173° 44′ E, 84 m.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 183, 5 Sept 1959, S Taranaki Bight, 39° 50′ S, 173° 44′ E, 95 m.
Rynkatorpa uncinata (Hutton) 16 sp. + frags
Paracaudina chilensis (Muller) 2 sp.

C 184, 6 Sept 1959, S Taranaki Bight, 39° 50′ S, 173° 31′ E, 95 m.
Paracaudina chilensis (Muller) 3 sp.
Heteromolpadia marenzelleri (Theel) 14 sp.
Pentadactyla longidentis (Hutton) 2 sp.

C 185, 6 Sept 1959, S Taranaki Bight, 39° 50′ S, 173° 18′ E, 115 m.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 186, 7 Sept 1959, S Taranaki Bight, 40° 40′ S, 173° 03′ E, 37 m.
Heterothyone alba (Hutton) 7 sp.
Pentadactyla longidentis (Hutton) 8 sp.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 187, 7 Sept 1959, S Taranaki Bight, 40° 50′ S, 173° 03′ E, 29 m.
Heterothyone alba (Hutton) 2 sp.
Pentadactyla longidentis (Hutton) 1 sp.

C 188, 7 Sep 1959, S Taranaki Bight, 40° 50′ S, 173° 16.5′ E, 44m.
Heterothyone alba (Hutton) 3 sp.

C 189, 7 Sep 1959, S Taranaki Bight, 40° 40′ S, 173° 16.5′ E, 53m.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 209, 12 Sep 1959, Off Paekakariki, 41° 10′ S, 174° 44.5′ E, 40m. gr. gritty sd.
Rynkatorpa uncinata (Hutton) 1 sp.
Paracaudina chilensis (Muller) 1 sp.

C 218, 12 Sep 1959, Off Paekakariki, 41° 08.3′ S, 174° 14′ E, 46m, f. gr. mud.
Pentadactyla longidentis (Hutton) 1 sp.

C 223, 14 Sep 1959, Off Paekakariki, 41° 20′ S, 174° 18.3′ E, 95m, sdy gravel.
Heteromolpadia marenzelleri (Theel) 1 sp.
Paracaudina chilensis (Muller) 1 sp.

C 259, 20 Oct 1959, Off Paekakariki, 41° 06.45′ S, 174° 16.5′ E, 18m, sdy mud.
Pentadactyla longidentis (Hutton) 2 sp.
Paracaudina chilensis (Muller) 2 sp.

C 265, 22 Oct 1959, N Taranaki Bight, 38° 20′ S, 174° 32.1′ E, 49m, sdy mud, shells.
Heterothyone alba (Hutton) 3 sp.

C 266, 22 Oct 1959, N Taranaki Bight, 38° 20′ S, 174° 29.8′ E, 49m, sdy mud.
Heterothyone ocnoides (Dendy) 1 sp.
Heterothyone alba (Hutton) 4 sp.

C 376, 28 Oct 1959, N Taranaki Bight, 38° 54′ S, 174° 11′ E, 68m, sdy shelly gr. mud.
Heterothyone alba (Hutton) 2 sp.

C 381, 29 Oct 1959, N of Kapiti Is., 40° 28.2′ S, 174° 53.7′ E, 106m.
Rynkatorpa uncinata (Hutton) 1 sp.

C 411, 4 May 1960, Cook Strait, 41° 34.5′ S, 174° 32′ E, 150m, slightly shelly muddy sd.
Paracaudina chilensis (Muller) frags

C 412, 4 May 1960, Cook Strait, 41° 36′ S, 174° 34.5′ E, 220m, sdy mud.
Paracaudina chilensis (Muller) frags

C 414, 4 May 1960, Cook Strait, 41° 40′ S, 174° 32′ E, 126m, sdy mud.
Paracaudina chilensis (Muller) frags

C 415, 5 May 1960, Cook Strait, 41° 16′ S, 174° 52′ E, 22 m.
Pentadactyla longidentis (Hutton) 1 sp.

C 442, 7 May 1960, W of Wanganui, 40° 00′ S, 174° 38′ E, 54m.
Neothyonidium dearmatum (Dendy & Hindle) 1 sp.

C 449, 8 May 1960, W of Wanganui, 40° 00′ S, 174° 54′ E, 29m, med. coarse gr. iron sd.
Placothuria huttoni (Dendy) 1 sp.

C 461, 8 May 1960, W of Cape Egmont, 38° 40′ S, 173° 57.2′ E, 43m, gr-bl. iron sd.
Neothyonidium armatum Pawson frags

C 468, 9 May 1960, Golden Bay, 40° 39′ S, 172° 45.5′ E, 15m, sticky gr. mud, dead shell.
Pentadactyla longidentis (Hutton) 1 sp.

C 481, 10 May 1960, N of Nelson, 41° 00′ S, 173° 17.7′ E, 40m, soft gr. mud, dead shell.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 491, 17 June 1960, E of Cape Palliser, 41° 30.6′ S, 175° 42.4′ E, 1134m, mud.
Molpadia violacea (Studer) 1 sp.

C 520, 21 June 1960, Cook Strait, 41° 39.4′ S, 175° 09.6′ E, 112m, sdy mud, shells.
Neothyonidium armatum Pawson 1 sp.

C 591, 5 Nov 1960, W of Wanganui, 41° 45.5′ S, 174° 46′ E, 107m.
Heterothyone alba (Hutton) 1 sp.

C 593, 8 Nov 1960, Chatham Rise, 43° 30′ S, 178° 0′ E, 351m, gr. sd.
Pentadactyla longidentis (Hutton) frags

C 603, 25 Apr 1961, Chatham Rise, 42° 33′ S, 176° 41.9′ E, 1530m.
Echinocucumis hispida (Barrett) 2 sp.
Enypniastes eximia Theel 1 sp.

C 604, 26 Apr 1961, Chatham Rise, 42° 49′ S, 179° 30′ E, 990-865m.
Molpadia antarctica (Theel) 1 sp.

C 608, 27 Apr 1961, Chatham Rise, 43° 19′ S, 179° 00′ E, 450-465m.
Ocnus brevidentis (Hutton) 2 sp.

C 609, 27 Apr 1961, Chatham Rise, 43° 03′ S, 178° 58′ E, 580-570m.
Molpadia musculus Risso 1 sp.

C 619, 2 May 1961, Chatham Rise, 43° 52′ S, 174° 48′ E, 802-777m.
Laetmogone violacea Theel 3 sp.

C 624, 7 May 1961, Chatham Rise, 43° 57.5′ S, 175° 52′ E, 124m.
Stichopus mollis (Hutton) 2 sp. + frags

C 652, 14 June 1961, S of Kaikoura, 42° 49.6′ S, 173° 27.2′ E, 54m. gr. muddy shelly sd.
Placothuria huttoni (Dendy) 1 sp.
Amphicyclus thomsoni (Hutton) 1 sp.
Neothyonidium dearmatum (Dendy & Hindle) 2 sp.

C 653, 14 June 1961, S of Kaikoura, 42° 49.5′ S, 173° 31.3′ E, 95m, muddy shelly sd with cobbles.
Trachythyone amokurae (Mortensen) 1 sp.

C 662, 15 June 1961, S of Kaikoura, 42° 46.6′ S, 173° 27.7′ E, 40m, muddy shelly sd with pebbles.
Placothuria huttoni (Dendy) 1 sp.

C 666, 15 June 1961, S of Kaikoura, 42° 46.5′ S, 173° 35.7′ E, 239m, mud and shell frags.
Neocucumella bicolumnata (Dendy & Hindle) 3 sp.

C 668, 15 June 1961, S of Kaikoura, 42° 38′ S, 173° 31.8′ E, 60 m, slightly sdy stiff mud.
Heterothyone alba (Hutton) 1 sp.

C 672, 16 June 1961, S of Kaikoura, 42° 43.6′ S, 173° 0.6′ E, 64 m.
Stichopus mollis (Hutton) 1 sp.

C 673, 16 June 1961, S of Kaikoura, 42° 43.7′ S, 173° 27.7′ E, 30 m, muddy sd with cobbles up to 4 in.
Stichopus mollis (Hutton) 1 sp.

C 701, 19 June 1961, S of Kaikoura, 42° 40.4′ S, 173° 32.4′ S, 184 m, gr. mud.
Stichopus mollis (Hutton) 1 sp.

C 703, 19 June 1961, S of Kaikoura, 42° 42′ S, 173° 37.8′ E, 184 m, large boulders and blocks.
Amphicyclus thomsoni (Hutton) 40 sp.
Stichopus mollis (Hutton) 1 sp.
Ocnus brevidentis (Hutton) 11 sp.

C 707, 21 June 1961, S of Kaikoura, 42° 50′ S, 173° 27.7′ E, 69 m, shelly muddy sd.
Neothyonidium dearmatum (Dendy & Hindle) 4 sp.

C 748, 17 Feb 1962, S of Hokianga Harbour, 36° 00′ S, 173° 32.2′ E, 135 m, fine, shelly, muddy, dark gr. sd.
Heteromolpadia marenzelleri (Theel) 2 sp.

C 753, 17 Feb 1962, W of Hokianga Harbour, 35° 20.1′ S, 172° 52′ E, 190 m, med. muddy sd.
Heteromolpadia marenzelleri (Theel) 4 sp.

C 776, 20 Feb 1962, Doubtless Bay, 35° 20′ S, 174° 25.8′ E, 77 m, coarse slightly muddy shelly sd.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 780, 20 Feb 1962, SE of Hokianga Harbour, 35° 59.8′ S, 174° 47.4′ E, 70 m, f. gr. sdy mud.
Pentadactyla longidentis (Hutton) 1 sp.

C 787, 22 Feb 1962, Hauraki Gulf, 36° 40′ S, 175° 06.1′ E, 42 m, soft gr. mud.
Rynkatorpa uncinata (Hutton) 3 sp.
Paracaudina chilensis (Theel) 1 sp. + frags

C 792, 22 Feb 1962, Near Cuvier Is., 36° 40′ S, 175° 57.1′ E, 73 m, greenish gr. muddy sd.
Pentadactyla longidentis (Hutton) 1 sp.

C 803, 24 Feb 1962, Bay of Plenty, 37° 40′ S, 177° 24′E, 134 m, soft gr. mud.
Paracaudina chilensis (Muller) 1 sp. + frags

C 814, 25 Feb 1962, Off East Cape, 37° 40′ S, 178° 56.4′ E, 194 m, soft sloppy gr. mud.
Amphicyclus thomsoni (Hutton) 8 sp.
Paracaudina chilensis (Muller) 1 sp.

C 826, 27 Feb 1962, Hawke Bay, 39° 24.2′ S, 177° 23.8′ E, 77 m, gr. muddy sd.
Heteromolpadia marenzelleri (Theel) 11 sp.
Rynkatorpa uncinata (Hutton) 1 sp.

C 827, 27 Feb 1962, Hawke Bay, 39° 31.4′ S, 177° 39.4′ E, 132 m, soft gr. mud.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 828, 27 Feb 1962, Off Cape Kidnappers, 39° 36′ S, 177° 45.6′ E, 229 m, soft gr. mud.
Heteromolpadia marenzelleri (Theel) 2 sp.

C 839, 1 Mar 1962, NE of Cape Palliser, 41° 20.1′ S, 175° 58′ E, 135 m, f. sdy mud.
Pentadactyla longidentis (Hutton) 1 sp.

C 844, 1 Mar 1962, Cook Strait, 41° 38.3′ S, 175° 11.2′ E, 88 m, coarse shelly muddy sd.
Amphicyclus thomsoni (Hutton) 4 sp.

C 850, 1 Mar 1962, NE of Kapiti Is., 40° 40.2′ S, 175° 1.4′ E, 73 m, med. coarse muddy shelly sd.
Pentadactyla longidentis (Hutton) 2 sp.
Heterothyone alba (Hutton) 1 sp.

C 851, 1 Mar 1962, NW of Kapiti Is., 40° 40.4′ S, 174° 43.6′ E, 128 m, coarse gr. sdy shelly mud.
Heteromolpadia marenzelleri (Theel) 22 sp.
Stichopus mollis (Hutton) 1 sp.
Rynkatorpa uncinata (Hutton) 29 sp. + frags
Amphicyclus thomsoni (Hutton) 1 sp.

C 864, 4 Mar 1962, Pelorus Sound, 41° 4.5′ S, 173° 55.7′ E, 27 m, f. gr. mud.
Heterothyone alba (Hutton) 3 sp.
Pentadactyla longidentis (Hutton) 1 sp.

C 900, 4 Dec 1962, Off Jackson Bay, 43° 53.3′ S, 168° 41.4′ E, 104 m, f. sdy mud.
Heteromolpadia marenzelleri (Theel) 1 sp.

C 912, 8 Feb 1963, Pelorus Sound, 41° 13′ S, 173° 51.6′ E, 22 m, mud shell.
Paracaudina chilensis (Muller) 1 sp.

C 913, 8 Feb 1963, Pelorus Sound, 41° 12.8′ S, 173° 51.4′ E, 18 m, mud.
Paracaudina chilensis (Muller) 1 sp.

C 925, 10 Feb 1963, Pelorus Sound, 41° 00.6′ S, 173° 55.1′ E, 39 m, gr. mud.
Paracaudina chilensis (Muller) 1 sp.

C 945, 13 Feb 1963, Queen Charlotte Sound, 41° 14.4′ S, 174° 03.4′ E, 41 m, soft brown-gr. mud.
Paracaudina chilensis (Muller) 1 sp.

Dominion Museum, Wellington

The Dominion Museum has large collections of holothurians accumulated through the individual efforts of collectors, through expeditions by staff members on two vessels, m.v. *Alert* and m.t. *Admiral* (these are listed under BS stations below), and through the Cape Expedition (1941 and 1946) to the Auckland and Campbell Islands. A total of 290 specimens from the Dominion Museum were examined: these comprise 18 species.

BS 22, 2 May 1950, Doubtful Sound, Fiordland, 7-18m.
Neocucumella bicolumnata (Dendy & Hindle) 5 sp.

BS 130, 27 Dec 1951, Across entrance to Pelorus Sound, 54m.
Kolostoneura novae-zealandiae (Dendy & Hindle) 1 sp.
Amphicyclus thomsoni (Hutton) 2 sp.
Neocucumella bicolumnata (Dendy & Hindle) 2 sp.
Pentadactyla longidentis (Hutton) 8 sp.

BS 135, 1 Jan 1952, 3 miles south-east of Tonga Cove, Tasman Bay, 27m.
Rynkatorpa uncinata (Hutton) 1 sp.
Pentadactyla longidentis (Hutton) 1 sp.
Heterothyone alba (Hutton) 1 sp.

BS 141, 12 Jan 1952, Immediately north of South Point, Kaipipi Bay, Paterson Inlet, Stewart Island, 9m.
Chiridota nigra (Mortensen) 26 sp.
Trochodota dunedinensis (Parker) 31 sp.
Amphicyclus thomsoni (Hutton) 29 sp.

BS 142, 12 Jan 1952, In channel between Ulva Island and Bradshaw Peninsula, Paterson Inlet, Stewart Island, 32m.
Amphicyclus thomsoni (Hutton) 17 sp.

BS 144, 20 May 1952, Hawke Bay, 39° 31.5′ S, 177° 13′ E, 45m.
Paracaudina chilensis (Muller) 1 sp.

BS 148, 21 May 1952, Hawke Bay, 39° 17′ S, 177° 11′ E, 45m.
Placothuria huttoni (Dendy) 3 sp.

BS 150, 21 May 1952, Hawke Bay, 39° 13.5′ S, 177° 10.5′ E, 27m.
Neocucumella bicolumnata (Dendy & Hindle) 1 sp.

BS 154, 21 May 1952, Hawke Bay, 39° 29′ S, 176° 57.5′ E, 18m.
Heterothyone ocnoides (Dendy) 3 sp.

BS 155, 21 May 1952, Hawke Bay, 39° 27.5′ S, 176° 54′ E, 14m.
Paracaudina chilensis (Muller) 11 sp.
Heterothyone ocnoides (Dendy) frags

BS 156, 21 May 1952, Hawke Bay, 39° 27′ S, 176° 53.5′ E, 9m.
Paracaudina chilensis (Muller) 1 sp.
Heterothyone alba (Hutton) 1 sp.

BS 157, 22 May 1952, Hawke Bay, 39° 31′ S, 176° 7.5′ E, 14m.
Paracaudina chilensis (Muller) 20 sp.
Heterothyone ocnoides (Dendy) 7 sp.

BS 158, 22 May 1952, Hawke Bay, 39° 33.5′ S, 176° 59′ E, 13m.
Paracaudina chilensis (Muller) 4 sp.
Heterothyone ocnoides (Dendy) 3 sp.

BS 174, 26 May 1953, Off Petone, Wellington Harbour, 41° 14.6′ S, 174° 51.5′ E, 16m.
Rynkatorpa uncinata (Hutton) 5 sp.

BS 180, 21 Mar 1954, Cook Strait, 41° 28.5′ S, 174° 50′ E, 270m, sand and mud.
Chiridota nigra Mortensen 3 sp.
Neothyonidium armatum Pawson 1 sp.

BS 181, 6 Feb 1955, Off Palliser Bay, 41° 27′ S, 175° 03′ E, 180m, mud.
Heteromolpadia marenzelleri (Theel) 2 sp.
Pentadactyla longidentis (Hutton) 1 sp.

BS 194, 2 Jan 1957, Off Somes Island, 41° 16.1′ S, 174° 50.2′ E, 20m.
Rynkatorpa uncinata (Hutton) 7 sp.
Pentadactyla longidentis (Hutton) 1 sp.

BS 201, 23 Jan 1957, Off Taiaroa Head, Otago, 44° 45.6′ S, 171° 5′ E, 540m.
Ypsilothuria bitentaculata (Ludwig) 2 sp. + frag. of juvenile

BS 202, 23 Jan 1957, Off Taiaroa Head, Otago, 45° 44′ S, 171° 2′ E, 135m.

Ypsilothuria bitentaculata (Ludwig) 1 sp. + frag.
Heterothyone alba (Hutton) 3 sp.

BS 209, 27 Feb 1957, Off Mayor Island, 37° 20.5′ S, 176° 26.5′ E, 490m.

Laetmogone violacea Theel 1 sp.

Miscellaneous Collections

Dominion Museum, Wellington

Placothuria huttoni (Dendy)

Menzies Bay, Banks Peninsula 1 sp.

Psolidiella nigra Mortensen

Sandfly Bay, Otago Peninsula 2 sp.
Menzies Bay, Banks Peninsula 2 sp.

Ocnus brevidentis (Hutton)

Mamakau Rock, Foveaux Strait, 27–36 m 4 sp.
Muck Rock, Foveaux Strait 1 sp.
Ulva Island, Paterson Inlet, Stewart Island 5 sp.
Beach Harbour, Dusky Sound, 11–18 m, coll. 5/5/1950 1 sp.
Takapuna, Auckland, 11–18 m (attached to *Carpophyllum* sp. holdfast), coll. 18/11/1958 1 sp.

Heterothyone alba (Hutton)

Tasman Bay, intertidal zone 1 sp.
Wellington Harbour, 20 m 1 sp.

Heterothyone ocnoides (Dendy)

Off Karitane, Otago, 18 m, sand 3 sp.
Blueskin Bay, Otago, 18 m, sand frag.
Purakanui, Otago, 20 m, sand frag.

Amphicyclus thomsoni (Hutton)

Off Stephen's Island 1 sp.
Cook Strait, 180 m 1 sp.
North-east Otago, 72 m, coll. W. H. Dawbin, 13/2/1951 1 sp.
Mamakau Rock, Foveaux Strait, 27–36 m 1 sp.
Muck Rock, Foveaux Strait, 18 m 1 sp.
North of Kapiti Island, 54 m 1 sp.
Off Foxton, 90 m 2 sp.

Pentadactyla longidentis (Hutton)

Cook Strait, 72 m 1 sp.
Wellington Harbour, 18 m, mud 1 sp.
Tasman Bay, coll. M. Young, Nov 1934 1 sp.
Akaroa Harbour, 5 m, mud 1 sp.

Stichopus mollis (Hutton)

Farewell Spit, coll. S. Gamby, Nov 1952 1 sp.

Rynkatorpa uncinata (Hutton)

Foveaux Strait, middle ground, 72 m 1 sp.
Tasman Bay, 27 m 1 sp.
Wellington Harbour 2 sp.

Kolostoneura novae-zealandiae (Dendy & Hindle)

Menzies Bay, Banks Peninsula 2 sp.

Chiridota nigra Mortensen

North Port, Chalky Inlet, 18 m 2 sp.

Trochodota dunedinensis (Parker)

Preservation Inlet, Fiordland 3 sp.

Heteromolpadia marenzelleri (Theel)

Cook Strait, 72 m, coll. F. Abernethy, 14/11/1952 2 sp.
Off Foxton, 90 m 1 sp.

Paracaudina chilensis (Muller)

Port Gore 1 sp.
Menzies Bay, Banks Peninsula 3 sp.
Cape Campbell, 72 m 1 sp.
Cook Strait, in gut of fish 1 sp.
New Brighton 1 sp.
East Cape, 108 m 1 sp.
New Plymouth, in gut of snapper (*Chrysophrys auratus* Forster) 1 sp.

Cape Expedition

25 Mar 1943, Waterfall Inlet, Auckland Islands, among rocks, in mud, coll. W. H. Dawbin.
Trochodota dunedinensis (Parker) 2 sp.

8 Aug 1943, No. 1 Station Inlet, Auckland Islands, in rock pool, coll. E. F. Doley.
Ocnus brevidentis (Hutton) 1 sp.

20 Aug 1943, No. 1 Station Inlet, Auckland Islands, in mud under boulders, coll. W. H. Dawbin and J. Jones.
Kolostoneura novae-zealandiae (Dendy & Hindle) 1 sp.

9 Aug 1943, Crozier Point, Auckland Islands, in mud between boulders at low tide, coll. W. H. Dawbin.
Trochodota dunedinensis (Parker) 3 sp.

18 Aug 1943, Crozier Point, Auckland Islands, in mud-gravel under sheltered gravel at low tide, coll. W. H. Dawbin.
Trochodota dunedinensis (Parker) 2 sp.

18 Sep 1943, Tagua Bay, Auckland Islands, in mud under boulders, coll. W. H. Dawbin.
Trochodota dunedinensis (Parker) 6 sp.

30 Sep 1943, Tagua Bay, Auckland Islands, in rock crevices at low tide level, coll. W. H. Dawbin.
Pseudocnus leoninoides (Mortensen) 8 sp.

24 Mar 1943, opposite Passage Island, Auckland Islands, in sediment of rock pools, coll. J. Jones.
Trochodota dunedinensis (Parker) 4 sp.

Chatham Islands (1954) Expedition

This expedition, organised and led by Professor G. A. Knox of the University of Canterbury, New Zealand, investigated the distribution of animals across the Chatham Rise and the relationships of the Chatham Islands marine fauna. Fell (1960) has already reported on the asterozoans and echinoids collected by the expedition. The 15 holothurians collected, representing two species, are listed below and discussed in this report.

Sta. 9, 25 Jan 1954, Glory Bay, Pitt Island, shore collection, stones.
Ocnus brevidentis (Hutton) 2 sp.

Sta. 15, 27 Jan 1954, Hanson Bay, 43° 56′ S, 176° 18.5′ W, 54 m, f. gr. sd.
Ocnus brevidentis (Hutton) 1 sp.

Sta. 34, 1 Feb 1954, East of the Forty Fours, 44° 04′ S, 175° 23.5′ W, 234 m, f. sdy gravel.
Ocnus brevidentis (Hutton) 6 sp.

Sta. 41, 3 Feb 1954, SE of Pitt Island, 44° 35.5′ S, 176° 04′ W, 595 m, f. gn mud and sd.
Heterothyone alba (Hutton) 1 sp.

Sta. 44, 7 Feb 1954, N 30° E of Kaingaroa, 43° 35′ S, 176° 03.5′ W, 224 m, f. gn muddy sd.
Heterothyone alba (Hutton) 1 sp.

Sta. 46, 7 Feb 1954, Kaingaroa, 5 m, f. gr. sd.
Heterothyone alba (Hutton) 3 sp.

Sta. 52, 10 Feb 1954, Chatham Rise, 44° 04′ S, 178° 04′ W, 468 m, f. gn mud and sd.
Heterothyone alba (Hutton) 1 sp.

PREPARATION OF SPECIMENS

Specimens collected alive generally contract and withdraw their tentacles, and will die in this state unless they are carefully narcotised. A convenient method of narcotisation is to add a saturated solution of Epsom Salts ($MgSO_4$) to the sea water in which the specimen is contained, and leave the preparation overnight, after which time the specimen can be preserved in 70% alcohol. Larger specimens should be left in the narcotising solution for a longer period. Other narcotising agents are useful, but Epsom Salts has proved to be quite effective and inexpensive.

Specimens should be preserved in 70% alcohol and never in formalin. The calcareous spicules in the body wall are fragile and highly susceptible to dissolution in slightly acid conditions. For this reason formalin is useless as a long-term preservative.

Dissection of holothurians is relatively simple, specimens being opened by a longitudinal incision to either the right or left of the mid-dorsal line. An incision made here will not destroy any of the important internal structures.

The calcareous elements in the body (spicules and calcareous ring) form the basis for identification, and these must be separated from surrounding tissues. The elements of the calcareous ring can be studied by removing the ring *in toto* from the body and dissolving the surrounding soft tissues away in a liquid household bleach (sodium hypochlorite), or by boiling it gently in a concentrated solution of sodium hydroxide (NaOH). Spicules can easily be extracted from the body wall by immersing pieces of it in household bleach. Permanent slides can be made by washing the spicules in acetic acid (Ch_3COOH), water, absolute alcohol (several times), alcohol/xylol, and finally mounting them in Canada balsam. Care must be taken to ensure that all traces of acid are removed from the spicules, otherwise they will deteriorate rapidly after mounting. For study of spicules a high-power microscope with some form of drawing attachment is required, such as a camera lucida. Measurements can be made with the aid of a graduated microscope slide.

MORPHOLOGY AND SYSTEMATIC CHARACTERS

MORPHOLOGY

Text-figs 1 and 2 indicate the morphological features of a typical holothurian. The body is usually elongate, approximately cylindrical, with a mouth surrounded by 10 or more tentacles (these are extensions of the water vascular system) at one end of the body and an anus at the other. Externally, the body may carry five rows of suctorial tube feet, which form radii, the rows running from the anterior to the posterior end of the body. Three radii are ventral, and two dorsal, the spaces between them being termed interradii. Internally, the radii are marked by five broad, strap-like radial longitudinal muscles.

The body wall carries numerous calcareous deposits or spicules (see p. 19).

Internally, the body wall is lined by more or less conspicuous circular and radial longitudinal muscles. At the anterior end, surrounding the oesophagus, is a ring of large calcareous plates (the calcareous ring), which forms a support for the oesophagus and is a point of insertion for the radial muscles and retractor muscles (when present). The oesophagus leads into a stomach, which may be undifferentiated, and the intestine usually describes a large loop, running to the terminal anus, often enlarging as a cloaca (rectum) posteriorly. The alimentary tract is supported by a series of mesenteries, the most conspicuous being the dorsal mesentery, which arises in the mid-dorsal interradius and supports the first loop of the intestine. From the cloaca arise (in some groups) a pair of long branching tubes, the respiratory trees, which aid in the excretion of wastes and respiration, fresh sea water being drawn into the trees through the anus.

Surrounding the oesophagus immediately posterior to the calcareous ring is the water vascular ring. The madreporite is internal, carried with the stone canal in the dorsal mesentery. From the ring on the ventral surface arise one or more polian vesicles, which act as reservoirs. The ring gives rise to five radial water vessels, which run anteriorly, sending branches to the tentacles, and then posteriorly, giving rise to the tube feet.

A nerve ring giving rise to five radial nerves surrounds the oesophagus, and a haemal ring with five haemal vessels is also present. The intestine carries dorsal and ventral haemal vessels, in communication through transverse vessels. The complex haemal system is not fully understood.

The sexes are generally separate, and the gonad is one bunch (often divided into two by the dorsal mesentery) of caeca lying adjacent to the dorsal mesentery. A single genital duct runs anteriorly in the dorsal mesentery and opens to the exterior in the mid-dorsal interradius, near the tentacles.

SYSTEMATIC CHARACTERS

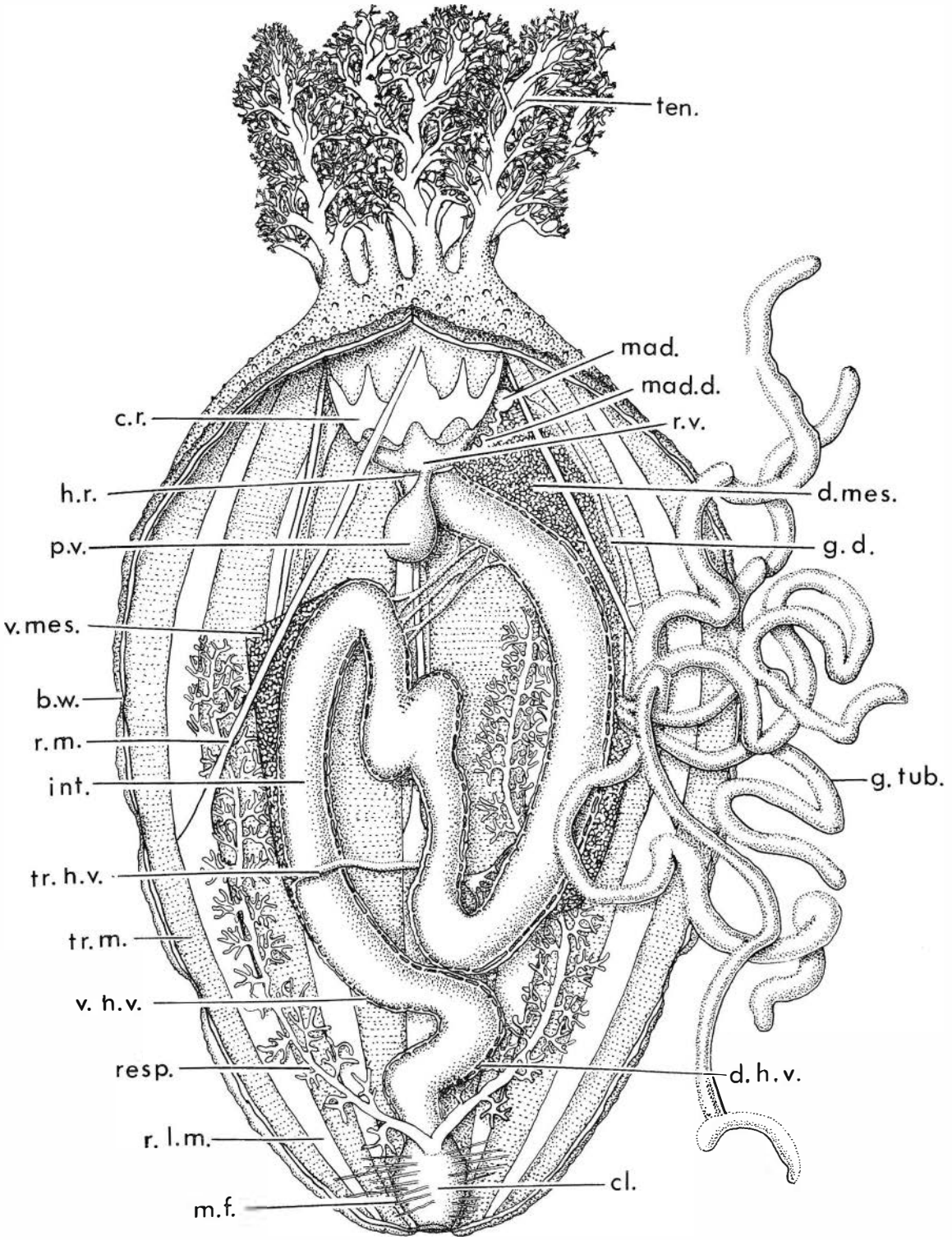
At the ordinal level, the classification generally depends on gross external anatomical features, but, for lower taxa, features of the external and internal anatomy are used, with particular emphasis on structure of the calcareous ring and calcareous deposits in the body wall.

1. EXTERNAL CHARACTERS

The shape and size can vary considerably from group to group; some are U-shaped, others fusiform, dorso-ventrally flattened, or cylindrical. A conspicuous tail may or may not be present. The colour is often useful as a guide. Shades of yellow, brown, red (especially in Molpadida), and violet (deep-sea forms) are predominant. The tube feet may be represented as simple suctorial structures restricted to the radii, or they may be modified in some way, or absent altogether (as in Superorder Apodacea). They may take the form of large warts or long filamentous processes, and may be numerous or few, restricted to radii, or scattered over the body surface (especially the ventral surface). The tentacles around the mouth may be arranged into 1 ring or more, and their number is usually a multiple of 5 (mostly 10, but 15–30 in some groups). Many apodous holothurians have 12 or 13 tentacles, and some dactylochirotids have 8. The shape of the tentacles is an important diagnostic feature. They can be dendritic, pinnate, digitate, or disc-shaped. The anus may or may not be surrounded by a ring of anal papillae.

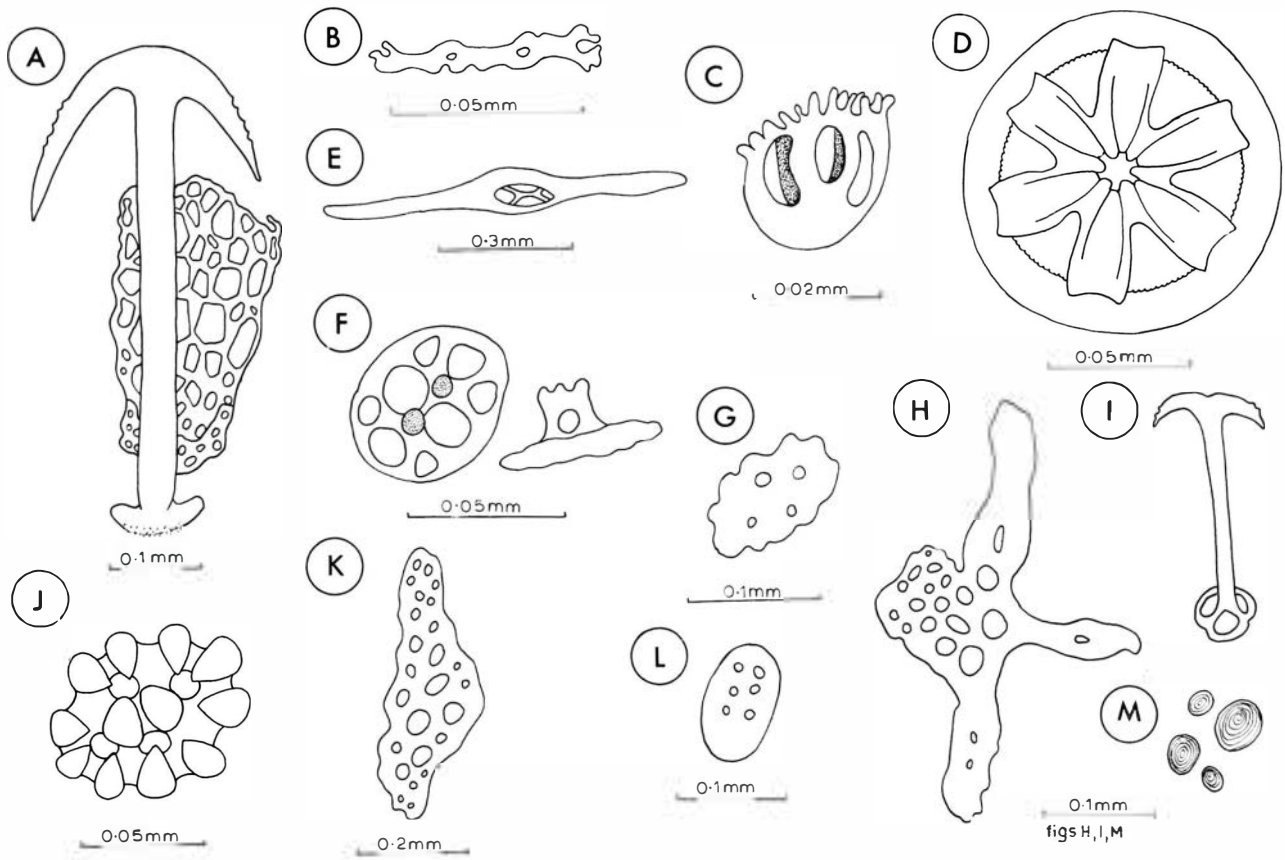
2. INTERNAL CHARACTERS

The calcareous ring is usually composed of 10 pieces; 5 radial pieces and 5 interradials. In some apodous holothurians there are 12, while in the deep-sea Elasipodida the ring is reduced to form a fragile network of calcareous material. The individual elements of the ring may be solid or composed of a mosaic of smaller pieces. Each piece may have an anterior and posterior projection, or one of these, or none.



TEXT-FIG. 1. Anatomy of a holothurian of the family Cucumariidae. Specimen dissected from the left side.

ABBREVIATIONS: b.w., body wall; cl., cloaca; c.r., calcareous ring; d.h.v., dorsal haemal vessel; d. mes., dorsal mesentery; g.d., genital duct; g. tub., genital tubule; h.r., haemal ring; int., intestine; mad., madreporite; mad. d., madreporic duct (stone canal); m.f., muscle fibres; p.v., polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; resp., respiratory tree; r.v., ring vessel (ambulacral ring); ten., tentacle; tr. h. v., transverse haemal vessel; tr. m., transverse (circular) muscles; v.h.v., ventral haemal vessel; v. mes., ventral mesentery.



TEXT-FIG. 2. Representative deposits of holothurians. A, anchor and anchor-plate (Apodida); B, rod (Dendrochirotida); C, cup (Dendrochirotida); D, wheel (Apodida); E, rod (Molpadida); F, tables (Dendrochirotida); G, button (Dendrochirotida); H, anchor-plate (Molpadida); I, anchor (Molpadida); J, knobbed plate (Dendrochirotida); K, smooth plate (Dendrochirotida); L, button (Dendrochirotida); M, phosphatic deposits (Molpadida).

The mesenteries supporting the alimentary canal have some importance in classification. The mesentery supporting the posterior loop of the intestine may lie in the right or left ventral interradius. Respiratory trees are present in some groups and absent from others (e.g., Elasipodida, Apodida).

There may be one or more stone canals arising from the water vascular ring. The madreporite may be in contact with the exterior (as in elasipodids and molpadids) but is internal in all other groups. The five radial water vessels are absent in the Apodida. The vessels to the tentacles are often provided with ampullae which hang into the coelom; these are absent in some groups.

The radial longitudinal muscles may comprise single or double straps. Retractor muscles are present only in the Dendrochirotacea, although vestigial retractors have been observed in some Molpadida. The gonad may consist of branched or unbranched genital caeca, and the genital duct may be long or quite short.

3. CALCAREOUS DEPOSITS

These are present in the body wall, tentacles, and tube feet of almost all holothurian species, and they display an incredible variety of sizes and shapes. They are commonly used as criteria for separation at the generic and specific levels. Certain types of deposits have convenient names (such as plates, buttons), and the various major groups of holothurians have characteristic deposit types. These are summarised here.

1. Dendrochirotida

The deposits include scales (large—1 mm and more in diameter—oval to round, with complex structure, often overlapping and forming a "mail" covering the body, as in *Heterothyone alba* (Hutton)); plates, smooth (Text-fig. 2K) or knobbed (Text-fig. 2J), usually perforated; tables (Text-fig. 2F) with a flat, perforated disc and 1 to 6 columns, usually joined at their distal extremity; buttons (Text-figs. 2G, 2L) (small plates

which may be flat or knobbed); cups (Text-fig. 2C) or baskets; rods (Text-fig. 2B), straight or curved, often perforated.

II. Dactylochirotida
Deposits include scales, plates, and rods.

III. Apodida
Deposits include six-spoked wheels (Text-fig. 2D) (Family Myriotrochidae, unknown from the Southern Hemisphere, has more complex wheels), sigmoid hooks, bracket-shaped rods, anchors, and anchor-plates (Text-fig. 2A).

IV. Aspidochirotida
Deposits include tables and buttons.

V. Elasipodia
Deposits include spinous and smooth rods, wheels of a unique type.

VI. Molpadida
Deposits include anchors (Text-fig. 2I) supported either by rosettes of racquet-shaped plates or by a single anchor plate (Text-fig. 2H); tables; rods (Text-fig. 2E); cups (in certain members of family Caudinidae). In members of the genus *Molpadia* the calcareous deposits tend to become transformed into red posphatic deposits superficially resembling starch grains (Text-fig. 2M).

The arrangement of various deposits in the body wall is also often important. For example, in the Apodida, wheels may be aggregated into discrete heaps, or scattered in the body wall. Generally cups, when present, form the outer layer of spicules, and the inner layer(s) comprise plates or buttons. The conventional names given to the deposits are not rigidly defined, and one may find, for example, plates that might equally well be termed buttons; but, if these limitations are borne in mind, the names prove to be a very convenient method of labelling the great variety of deposits that occur.

CHECKLIST OF NEW ZEALAND HOLOTHURIANS

Order DENDROCHIROTIDA

Placothuria huttoni (Dendy)
P. squamata Pawson
Heterothyone alba (Hutton)
H. ocnoides (Dendy)
Psolus neozelanicus Mortensen
Neothyonidium dearmatum (Dendy and Hindle)
N. armatum Pawson
Pentadactyla longidentis (Hutton)
Neocucumella bicolumnata (Dendy and Hindle)
Amphicyclus thomsoni (Hutton)
Pseudocnus leoninoides (Mortensen)
Psolidiella nigra Mortensen
Pseudopsolus macquariensis (Dendy)
Trachythyone amokurae (Mortensen)
T. bollonsi (Mortensen)
Ocnus farquhari (Mortensen)
O. calcarea (Dendy)
O. brevidentis (Hutton)

Order DACTYLOCHIROTIDA

Ypsilothuria bitentaculata (Ludwig)
Echinocucumis hispida (Barrett)

Order APODIDA

Rynkatorpa uncinata (Hutton)
Protankyra rigida Pawson
Kolostoneura novaezealandiae (Dendy and Hindle)
Chiridota mortenseni Pawson
C. gigas Dendy and Hindle
C. nigra Mortensen
C. carnleyensis Mortensen
Trochodota dunedinensis (Parker)
T. dendyi Mortensen

Order MOLPADIDA

Heteromolpadia pikei Pawson
H. marenzelleri (Theel)
Molpadia musculus Risso
M. violacea (Studer)
M. antarctica (Theel)
Hedingia albicans (Theel)
Paracaudina chilensis (Muller)

Order ASPIDOCHIROTIDA

Stichopus mollis (Hutton)
Vaneyothuria neozelanica (Mortensen)
Bathyplotes natans (Sars)
Mesothuria lactea (Theel)

Order ELASIPODIDA

Ilyodaemon abstrusus Sluiter
Pannychia moseleyi Theel
Laetmogone violacea Theel
Bathygone papillatum Pawson
Benthogone rosea Koehler
Enypniastes eximia Theel
Benthodytes hystrix Sluiter
Amperima tui Pawson
Scotoplanes gilpinbrowni Pawson

KEY TO THE NEW ZEALAND HOLOTHURIANS

The key below does not include the Order Elasipodida, an exclusively deep-sea group of holothurians, of which nine species are now known in the New Zealand region. Thus, 40 of the 49 species are treated here. The key to the New Zealand holothurians by Dawbin (1950) included 28 species, and 3 deep-water species (*Bathyplotes natans*, *Mesothuria lactea*, and *Hedingia albicans*) were omitted. In view of the many new additions to the fauna, and because many name changes have occured since 1950, it has been considered desirable to prepare a revised key to the New Zealand forms. However, Dawbin's key has been used as a guide, and many of the diagnoses given below are copied directly from his work. For further diagnostic details and for diagnoses of elasipodid holothurians see the systematics section following this key.

The shapes and numbers of the tentacles are frequently used in the key as diagnostic criteria. To reveal retracted tentacles, cut through the body wall and calcareous ring in the anterior part of the body wall. The shapes and types of the calcareous deposits, and in many cases their sizes, are used as diagnostic characters throughout the key. This means that for proper identification of the species a high-power microscope with a camera lucida and graduated microscope slide, or some other accurate measuring device, is required. Where possible, details of external features are given, but these should be used with caution, for often external features are not a reliable guide to the identification of a species. This is particularly true in the apodous holothurians (Apodida and Molpadida), where different species and even genera may almost exactly resemble each other. The colour, when given, is that of live specimens; details of colour are not available for all species.

The key, and others throughout this paper, should be used in the following way: if the character indicated agrees with the specimen in hand, proceed to the next paragraph, and continue to do so until an identification is reached. If a character does not agree, proceed to the contrasting character, indicated by the number of the relevant paragraph in parantheses. For example, in the following key, if the specimen at hand agrees with paragraph 1, then proceed to paragraph 2. If it disagrees, proceed to paragraph 48. Final check of an identification can be made by reference to diagnoses and descriptions in the ensuing text or in other relevant publications.

1 (48) Tube feet present on body wall (sometimes inconspicuous). Body approximately cylindrical, sometimes U-shaped, never long and worm-like.

2 (41) Tentacles profusely branched or digitate with very few branches. Retractor muscles present.

3 (6) Tentacles digitiform or digitate. Body always U-shaped. Deposits scales carrying spires. Tube feet inconspicuous.

4 (5) Scales as one-layered perforated lattices with long excentric spires..... *Echinocucumis hispida* (Barrett)

5 (4) Scales as multi-layered lattices with long central spires; cream-translucent ... *Ypsilothuria bitentaculata* (Ludwig)

6 (3) Tentacles profusely branched (dendritic). Body cylindrical or U-shaped. No spired scales but smaller spired plates may occur. Tube feet generally conspicuous.

7 (8) Body broad, dorso-ventrally flattened with scales on dorsal surface. Soft ventral surface (sole) surrounded by tube feet..... *Psolus neozelanicus* Mortensen

8 (7) Body not broad, dorso-ventrally flattened, generally cylindrical or U-shaped.

9 (16) Body U-shaped, enclosed in a conspicuous firm test made up of overlapping scales. Tentacles 10.

10 (13) Calcareous ring complex, long, tubular, composed of a mosaic of minute pieces.

11 (12) Conspicuous anal teeth present. No glassy buttons overlying scales ..... *Placothuria squamata* Pawson

12 (11) Conspicuous anal teeth absent. Numerous glassy buttons overlie scales. Light yellow..... *Placothuria huttoni* (Dendy)

13 (10) Calcareous ring simple, short, composed of 10 solid pieces.

14 (15) Body small (up to 30 mm long); interradials of calcareous ring with long, narrow anterior processes. Generally white ..... *Heterothyone alba* (Hutton)

15 (14) Body larger (up to 60 mm long); interradials of calcareous ring with short, broad anterior processes. Light orange ..... *Heterothyone ocnoides* (Dendy)

16 (9) Body usually cylindrical (when U-shaped, 15 or more tentacles present), not enclosed in a conspicuous test of overlapping plates.

17 (26) Tentacles 20–25 in one or more rings (often fewer tentacles in young individuals).

18 (21) Tube feet restricted to radii, numerous.

19 (20) Tentacles 20. Tube feet in two rows in each radius. Deposits numerous regular tables with eight perforations. Brown to brick red..... *Neocucumella bicolumnata* (Dendy and Hindle)

20 (19) Tentacles 25. Tube feet in 8–10 rows in each radius. Deposits rare, in form of irregular tables with more than eight perforations. Yellowish to brown, tentacles and tube-feet discs white ..... *Amphicyclus thomsoni* (Hutton)

21 (18) Tube feet not restricted to radii, but scattered over entire body wall.

22 (25) Deposits (when present) small tables, typically with eight perforations and with a short, blunt, two-pillared spire.

23 (24) Tables rare or absent, average length 0.07 mm. Light to dark brown.....
Neothyonidium dearmatum (Dendy and Hindle)

24 (23) Tables numerous, average length 0.1 mm. Greyish white with brown patches .... *Neothyonidium armatum* Pawson

25 (22) Deposits perforated plates which may be cruciform, with long, sharp spires composed of two long rods fused together. Brown .....
Pentadactyla longidentis (Hutton)

26 (17) Tentacles 10 in a single ring.

27 (32) Calcareous deposits merely plates and/or buttons; no cups.

28 (31) Plates smooth, without knobs; body soft, with conspicuous creeping ventral sole.

29 (30) Dorsal feet numerous, scattered all over dorsal surface. Deposits numerous. Black dorsally, white ventrally
Psolidiella nigra Mortensen

30 (29) Dorsal feet few, restricted to radii. Deposits rare....
Pseudopsolus macquariensis (Dendy)

31 (28) Plates with conspicuous knobs. Body firm, without conspicuous creeping sole. Yellowish white.....
Pseudocnus leoninoides Mortensen

32 (27) Calcareous deposits plates and/or buttons and cups.

33 (36) Calcareous deposits rudimentary cups and plates or buttons.

34 (35) Deposits large plates, smooth ventrally, coarse and spinose dorsally. Knobbed buttons and X-shaped rudimentary cups present.....
Trachythyone amokurae Mortensen

35 (34) Deposits small, smooth plates with few perforations. Four-holed buttons and rudimentary cups present..
Trachythyone bollonsi (Mortensen)

36 (33) Calcareous deposits well developed cups and knobbed plates or buttons of two types.

37 (38) Deposits include large, coarse, overlapping plates, with numerous knobs .....*Ocnus farquhari* (Mortensen)

38 (37) No such plates present; deposits typically small knobbed buttons and plates.

39 (40) Buttons with 8–10 marginal knobs, and all perforations of approximately equal size. Pink (var. *carnleyensis* Dendy from Auckland Islands is bright red).....
Ocnus brevidentis (Hutton)

40 (39) Buttons with 12–14 marginal knobs and with 2 lateral perforations much the largest ....*Ocnus calcarea* (Dendy)

41 (2) Tentacle tips not branched, but shield- or disc-shaped. Retractor muscles absent.

42 (45) Tentacle ampullae present. Shallow water forms.

43 (44) Tentacles 20. Tube feet crowded on ventral surface; dorsal feet modified to form warts or papillae. Shades of brown, generally lighter ventrally .....
Stichopus mollis (Hutton)

44 (43) Tentacles 16. Tube feet scattered all over body.....
Vaneyothuria neozelanica (Mortensen)

45 (42) Tentacle ampullae absent. Deep water forms, generally large.

46 (47) Gonad in a single tuft. Deposits tables with approximately circular discs bearing large perforations and a spire made up of three rods. White.....
Mesothuria lactea (Theel)

47 (46) Gonad in two tufts. Deposits tables with cruciform discs bearing spire made up of four rods. Greyish white, with numerous small brown spots.....
Bathyplotes natans (Sars)

48 (1) Tube feet absent (except for tentacles). Body either cylindrical and worm-like, or stout with distinct tail region, but never U-shaped.

49 (62) Body stout anteriorly, tapering to a distinct tail-like region. Tentacles 15, short, with simple finger-like processes.

50 (59) Tentacles with 1–3 pairs of digits and a terminal digit. Deposits may include tables, fusiform perforated rods, anchors, and associated plates. Body wall often red, due to presence of numerous phosphatic deposits.

51 (54) Deposits include tables and two-armed anchors associated with single perforated anchor-plates, usually with three marginal projections. No fusiform rods; no rosettes of racquet-shaped plates.

52 (53) Tables of average diameter 0.3 mm, with 3–5 large perforations. Grey.....*Heteromolpadia pikei* Pawson

53 (52) Tables of average diameter 0.15 mm, typically with three large perforations. Small specimens grey, large ones dark red.....*Heteromolpadia marenzelleri* (Theel)

54 (51) Deposits include tables, anchors associated with rosettes of racquet-shaped plates, and large fusiform rods in various combinations.

55 (58) Deposits of body wall and tail include large fusiform rods. Phosphatic deposits numerous.

56 (57) Anchors and rosettes of racquet-shaped plates present. Smaller specimens grey, larger ones red.....
Molpadia musculus Risso

57 (56) Anchors and rosettes absent. Larger specimens dark red .....*Molpadia violacea* (Studer)

58 (55) Fusiform rods absent; deposits spired tables. Phosphatic deposits rare or absent. Grey.....
Molpadia antarctica (Theel)

59 (50) Tentacles with two pairs of digits and no terminal digit. Deposits large tables or plates or small crossed cups. Phosphatic deposits, anchors, and anchor-plates absent.

60 (61) Deposits crossed cups. White, often with light brown tinge or patches .....*Paracaudina chilensis* (Müller)

61 (60) Deposits large tables with high spires. White.....
Hedingia albicans (Theel)

62 (49) Body slender, cylindrical, often worm-like and thin-walled. Tentacles 10–12, either pinnate or bearing finger-like processes.

63 (64) Calcareous deposits absent from body wall. Tentacles 10. White to pinkish-brown.....
Kolostoneura novaezealandiae (Dendy and Hindle)

64 (63) Calcareous deposits present. Tentacles 10 or 12.

65 (76) Deposits include wheels with six spokes, either arranged into papillae or scattered in body wall. No anchors.

66 (69) Sigmoid rods present. Wheels scattered or arranged into loose heaps.

67 (68) Wheels and hooks scattered in body wall, with no regular arrangement. Pinkish with more or less conspicuous reddish spots...*Trochodota dunedinensis* (Parker)

68 (67) Wheels scattered (often absent), but hooks tend to be arranged in groups of 3–6 in minute papillae. White or light purple .....*Trochodota dendyi* Mortensen

69 (66) Sigmoid rods absent. Wheels arranged into heaps (papillae).

70 (73) Thick rods with spinous extremities present in body wall.

71 (72) Radial pieces of calcareous ring perforated for passage of radial nerve. Warm pink.....
Chiridota mortenseni Pawson

72 (71) Radial pieces of calcareous ring not perforated for radial nerve. Scarlet ..*Chiridota gigas* Dendy and Hindle

73 (70) No thick spinous rods in body wall.

74 (75) Miliary granules present in radial muscles. Black or dark red, with whitish spots (wheel papillae).....
Chiridota nigra Mortensen

75 (74) No miliary granules in radial muscles. White-transparent ..... *Chiridota carnleyensis* Mortensen

76 (65) Deposits anchors accompanied by perforated anchor-plates; no wheels.

77 (78) Anchors small (0.3–0.5 mm long); anchor-plates with large perforations. Reddish-brown.....
Rynkatorpa uncinata (Hutton)

78 (77) Anchors large (1.0–1.2 mm long); anchor-plates with many small perforations .....*Protankyra rigida* Pawson

SYSTEMATICS

Class **HOLOTHUROIDEA** de Blainville, 1834

DIAGNOSIS: Armless, mostly unattached echinoderms, with a tough leathery body wall containing strongly developed circular and longitudinal muscles, lacking an articulated test. Body typically cylindroid, elongated orally-aborally, mouth located anteriorly, encircled by a ring of tentacles which are modified tube feet; anus at opposite extremity. Ambulacral grooves represented by closed canals; tube feet variously disposed along ambulacra, in interambulacral areas, or absent. Madreporite internal, but external in many deep-sea forms. Symmetry pentamerous, modified by secondary bilateral symmetry in dorsoventral plane.

Skeletal elements usually reduced to microscopic calcareous deposits of varied shape; in some, deposits form a test of imbricating plates. Range; ?Ordovician, Lower Devonian–Recent. (After Frizzell, Exline, and Pawson, 1966.)

REMARKS: Three subclasses, proposed by Pawson and Fell (1965) are distinguishable on the basis of gross anatomical features.

KEY TO SUBCLASSES OF CLASS HOLOTHUROIDEA

1 (2) Introvert with retractor muscles present. Tube feet and respiratory trees well developed. Tentacles usually dendritic ..... **DENDROCHIROTACEA** Grube, 1840

2 (1) Introvert and retractor muscles absent. Tube feet and respiratory trees present or absent. Tentacles not usually dendritic.

3 (4) Tube feet present. Tentacles shield-shaped. Body conspicuously bilaterally symmetrical ..... **ASPIDOCHIROTACEA** Grube, 1840

4 (3) Tube feet greatly reduced or absent. Tentacles digitate or pinnate. Body not conspicuously bilaterally symmetrical ..... **APODACEA** Brandt, 1835

Subclass **DENDROCHIROTACEA** Grube, 1840
(Nomen translatum Pawson and Fell, 1965)

DIAGNOSIS: Introvert (with retractor muscles) always present. Tube feet and respiratory trees usually present. Madreporite free in the body cavity. Mesentery of posterior loop of intestine in right or left ventral interradius. Free tentacle ampullae absent. Gonad in two tufts, one tuft to each side of dorsal mesentery.

REMARKS: This subclass was erected by Pawson and Fell (1965) to accommodate two orders, the Dendrochirotida and the new order Dactylochirotida.

KEY TO THE ORDERS OF DENDROCHIROTACEA

1 (2) Tentacles 8–30, not branched but digitiform or digitate, the digits sometimes bifurcating. Calcareous ring simple. Body enclosed in test ..... DACTYLOCHIROTIDA Pawson and Fell, 1965

2 (1) Tentacles 10–30, richly branched. Calcareous ring simple or complex. Test well developed or reduced ..... DENDROCHIROTIDA Grube, 1840

Order DENDROCHIROTIDA Grube, 1840
(Restricted Pawson and Fell, 1965)

DIAGNOSIS: See key above.

REMARKS: This order comprises the bulk of the dendrochirotacean holothurians, and it is believed (Pawson and Fell, 1965; Pawson, 1966) that some primitive genera of holothurians are included here.

KEY TO FAMILIES OF ORDER DENDROCHIROTIDA

1 (8) Body partially or completely enclosed by imbricating plates.

2 (7) Body completely enclosed by plates; sole absent.

3 (4) Calcareous ring complex, with long, paired posterior processes .. PLACOTHURIIDAE Pawson and Fell, 1965

4 (3) Calcareous ring simple, without long, paired posterior processes.

5 (6) Body wall deposits plates with spires; no cups. Radial pieces of calcareous ring notched posteriorly ..... PARACUCUMIDAE Pawson and Fell, 1965

6 (5) Body wall deposits plates without spires; cups present. Radial pieces of calcareous ring with short but well defined posterior processes ..... HETEROTHYONIDAE new family

7 (2) Body invested dorsally in plates; ventral sole present. ..... PSOLIDAE Perrier, 1902

8 (1) Body without test of plates; calcareous deposits usually small, inconspicuous.

9 (12) Calcareous ring complex, with paired or unpaired posterior processes.

10 (11) Processes composed of a mosaic of minute pieces .... PHYLLOPHORIDAE Oestergren, 1907

11 (10) Processes entire .. SCLERODACTYLIDAE Panning, 1949

12 (9) Calcareous ring simple, lacking posterior processes ..... CUCUMARIIDAE Ludwig, 1894

The families Paracucumidae and Sclerodactylidae are unknown from the New Zealand region.

Family PLACOTHURIIDAE Pawson and Fell, 1965

DIAGNOSIS: Body completely enclosed in a test of imbricating plates without spires. Sole lacking. Calcareous ring long, slender, with long posterior processes.

REMARKS: The family was erected for the single genus *Placothuria*, which appears to have two very important and perhaps primitive features; a complex calcareous ring and a test of imbricating plates.

Placothuria Pawson and Fell, 1965

DIAGNOSIS: Tentacles 10, richly branched. Body U-shaped. Posterior processes of calcareous ring composed of a mosaic of small pieces.

TYPE-SPECIES: *Cucumaria huttoni* Dendy.

REMARKS: At present this genus includes two species, both of which appear to be restricted to the New Zealand region.

KEY TO THE SPECIES OF THE GENUS *Placothuria*

1 (2) Scales of body wall overlain by perforated buttons 0.01–0.03 mm long. Anal teeth absent.... *P. huttoni* (Dendy)

2 (1) Perforated buttons absent. Anal teeth present..... *P. squamata* Pawson

Placothuria huttoni (Dendy)

Plate 1, Fig. 1

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. 63, fig. 58; Pawson, 1963, p. 32, pl. 7.
Placothuria huttoni, Pawson and Fell, 1965, p. 2.

MATERIAL EXAMINED: 19 specimens. NZOI Sta. B 2; 1: B 218, 1; B 257, 4; B 264A, 2; B 556, 1; B 578, 1, B 592, fragment; B 651, 2; C 449, 1; C 652, 1; C 662, 1. Dom. Mus. Sta. BS 148, 3; Menzies Bay, 1.

DIAGNOSIS: Scales overlain by perforated buttons 0.01–0.03 mm long. No anal teeth.

DESCRIPTION: Pawson (1963, p. 32) described and illustrated a single specimen of this species collected in Wellington Harbour. Present specimens 60–110 mm in length. Colour usually light yellow to grey; some specimens white. All specimens U-shaped, contracted. In one specimen (C 662) tube feet expanded, arranged in double rows in three ventral radii, in single rows in two dorsal radii; interradii naked.

DISTRIBUTION: *P. huttoni* has been recorded from as far north as Hawke Bay, but appears to favour colder waters of the South Island, where it has been found at various points along the coast to Stewart Island in the south.

BATHYMETRIC RANGE: An off-shore species, in 18–179 m.

HABITAT: This species has only been collected in sandy areas, where the substrate may range from muddy sand to coarse sand. Often found in association with *Heterothyone ocnoides*.

Placothuria squamata Pawson

Placothuria squamata Pawson, 1968b, p. 19, text-fig. 2, figs 5–9.

MATERIAL EXAMINED: None.

DIAGNOSIS: No perforated buttons in body wall. Anal teeth present.

DESCRIPTION: This species is described and illustrated in Pawson, 1968b, p. 19.

DISTRIBUTION: Auckland Islands and Bounty Islands.

BATHYMETRIC RANGE: 115–164 m.

Family HETEROTHYONIDAE, new family

DIAGNOSIS: Body U-shaped, completely invested in imbricating plates. Calcareous ring simple; radial pieces with short posterior projections. Body wall deposits plates without spires, and cups.

REMARKS: This family is proposed to accommodate the New Zealand genus *Heterothyone*, which is the only genus yet known to possess the combination of characters given above. It is probable that some other taxa of dendrochirotids should be referred to this family. The relationships of the Heterothyonidae to other groups within the Dendrochirotida are not clear, for several important anatomical features are shared with the Placothuriidae, but the structure of the calcareous ring does not indicate a close relationship to the placothuriids.

Heterothyone Panning, 1949

DIAGNOSIS: As for the family.

TYPE-SPECIES: *Chiridota alba* Hutton.

REMARKS: The genus, when originally diagnosed (Panning, 1949), contained three species, the type, *Heterothyone semperi* (Bell), and *H. pigra* (Koehler and Vaney). Pawson (1963) referred the last two species to the new genus *Hemithyone* (family Cucumariidae), and later (Pawson, 1967) declared the two species to be synonymous. A second species, *H. ocnoides* (Dendy), was referred to *Heterothyone* by Pawson (1963). Thus, the only two species at present recognised in the genus are known only from the New Zealand region.

KEY TO THE SPECIES OF GENUS *Heterothyone*

1 (2) Radial pieces of calcareous ring with poorly defined anterior notches; interradials with long, narrow anterior processes ..... *H. alba* (Hutton)

2 (1) Radial pieces with well defined anterior notches; interradials with short, broad anterior processes..... *H. ocnoides* (Dendy)

Heterothyone alba (Hutton)

Plate 1, Fig. 3

Chiridota alba Hutton, 1872, p. 17.
Echinocucumis alba: Hutton, 1878, p. 307.
Colochirus alba: Dendy, 1896, p. 35, pl. 4, figs 21–32; Farquhar, 1898, p. 325.
Cucumaria alba: Ludwig, 1898a, p. 29; Perrier, 1905, p. 85; Dendy and Hindle, 1907, p. 98; Mortensen, 1925, p. 346; Dawbin, 1950, p. 36.
Cucumaria filholi Perrier, 1903, p. 144; 1905, p. 88, pl. 5, figs 10–12.
Heterothyone alba: Panning, 1949, p. 464, pl. 59, figs a–i; Pawson, 1963, p. 29, pl. 6.

MATERIAL EXAMINED: 76 sp. NZOI Sta. A 327, 1; B 10, 1; B 11, 3; B 16, 1; B 25, 2; B 37, 4; B 45, 1; B 46, 3; B 47, 3; B 49, 2; B 54, 1; B 217, 1; B 496, 1; B 547, 3; B 553, 2; B 570, 1; B 630, 1; B 632, 1; B 635, 2; C 166, 2; C 186, 7; C 187, 2; C 188, 3; C 265, 3; C 266, 4; C 376, 2; C 591, 1; C 668, 1; C 850, 1; C 864, 3. Dom. Mus. Sta. BS 135, 1; BS 156, 1; BS 202, 3; Tasman Bay, 1; Wellington Harbour, 1. Chatham Islands Exped. Sta. 41, 1; 44, 1; 46, 3; 52, 1.

DIAGNOSIS: Small (up to 30 mm long), U-shaped, colour white in life. Radials each with poorly defined anterior notch; interradials with long and narrow anterior processes. Cups in body wall deep, their rims with numerous closely set projections.

DESCRIPTION: See Pawson (1963, p. 29). All specimens typical of the species. Those from the vicinity of Cape Egmont often of darker colour, generally greyish-white; this is probably due to dark colour of sand in which they live.

DISTRIBUTION: Present data indicate that *H. alba* is distributed all around the New Zealand coast, although there is so far only one record of the species from further north than Hawke Bay (Mortensen (1925) described material from Auckland). The species is also now known from the Chatham Islands.

BATHYMETRIC RANGE: An off-shore species, in 5–595 m.

HABITAT: Fine sandy mud or muddy sand, but occasionally found in mud or sand. This species is often collected with *H. ocnoides.*

Heterothyone ocnoides (Dendy)

Text-fig. 3; Plate 1, Fig. 2

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. 1, figs 9–13, pl. 5, fig. 13; Dendy and Hindle, 1907, p. 100; Mortensen, 1925, p. 347; Dawbin, 1950, p. 36.
Ludwigia ocnoides: Reiffen, 1901, p. 598, fig. 15; Panning, 1949, p. 435, figs 30, 31.
Heterothyone ocnoides: Pawson, 1963, p. 31.

MATERIAL EXAMINED: 51 specimens. NZOI Sta. B 6, 1; B 8, fragments; B 9, 4; B 13, 1; B 14, 1 + fragments; B 15, 3 + fragments; B 18, 5 + fragments; B 19, 2; B 37, 4 + fragments; B 545, 10; B 618, 1 + fragments; B 640, fragments; B 667, 1; B 671, 1; C 266, 1. Dom. Mus. Sta. BS 154, 3; BS 155, fragments; BS 157, 7; BS 158, 3; off Otago, 3 + fragments.

DIAGNOSIS: Large (up to 60 mm long), U-shaped, colour orange in life. Radials each with well defined anterior notch; interradials with short, broad, and blunt anterior projections. Cups in body wall deep, their rims with few (fewer than 10) projections.

DESCRIPTION: Posterior end strongly upturned, giving body characteristic U-shape. Total length 20–50 mm. Integument hard, due to presence of great number of imbricating scales. Colour in life and in alcohol orange to pinkish brown; tentacles covered with irregular brown spots; tube feet darker orange.

Tube feet numerous, confined to three ventral radii in middle of body; dorsally scattered on radii and interradii. Tentacles branched; two ventral tentacles smaller than others.

Calcareous ring composed of 10 pieces. Radials long, narrrow; anterior projection with definite notch for insertion of retractor muscle. Posteriorly, each radial piece with two projections which curve toward each other but do not meet. Each interradial piece Y-shaped, with tail pointing anteriorly; anterior projection short, blunt. Posteriorly, each interradial piece with a shallow notch (Text-fig. 3A).

Internal anatomy similar to that of *H. alba* (see Pawson, 1963 p. 29).

The body is invested in oval to rectangular imbricating scales (Text-fig. 3H) which are up to 1.0 mm long; each scale with a central dark brown pigment spot. Scales made up of several layers of calcareous network. Overlying scales are deep cups (Text-fig. 3G) of average diameter 0.06 mm. Basin with four large perforations, rim with several projections. Also present, but scattered, are oval to elongate perforated plates up to 0.3 mm in length (Text-fig. 3F).

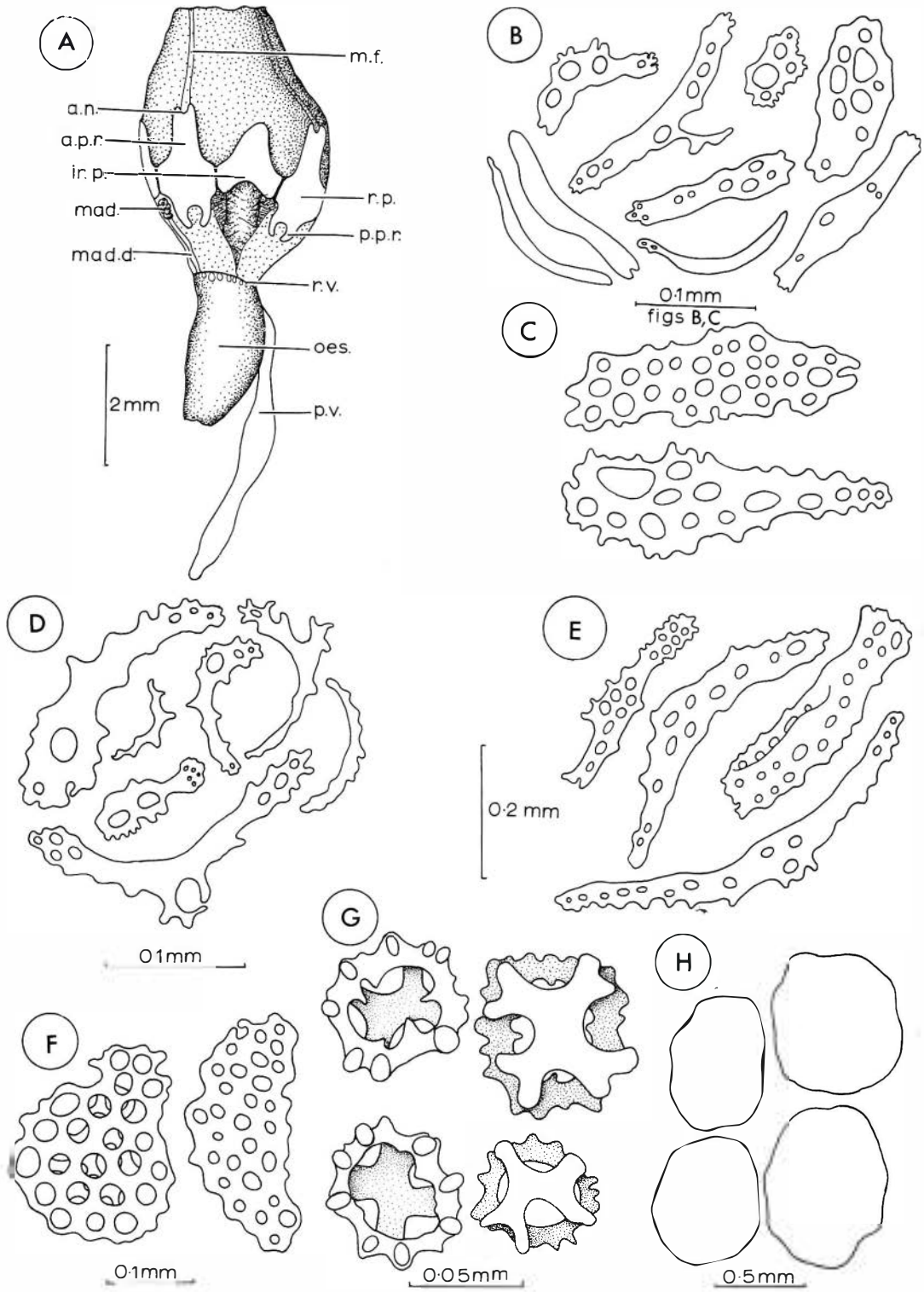
Introvert with scattered plates of average length 0.25 mm. Plates long, narrow, with many perforations (Text-fig. 3C).

Tentacle stems with long perforated rods and plates (Text-fig. 3E) of average length 0.5 mm. Digits packed with irregular rods (Text-fig. 3D) which vary greatly in size (0.05–0.25 mm long); most rods have perforations, but some have none. Tube feet with well developed end plates surrounded by perforated and unperforated rods and small plates (Text-fig. 3B).

REMARKS: The similarities between this species and *H. alba* (Hutton) are striking, and it is quite clear that they are closely related. Both species are often found in the same type of habitat, and presumably both share the same living habits.

DISTRIBUTION: *H. ocnoides* ranges from Hawke Bay and the North Taranaki Bight to Otago, and has not been collected from any outlying islands. In some areas the species is particularly common; Dendy (1898) reported that after a storm "shovelfuls" of this species could be collected from New Brighton Beach, near Christchurch.

BATHYMETRIC RANGE: An off-shore species, in 9–49 m.



TEXT-FIG. 3. *Heterothyone ocnoides* (Dendy). A, calcareous ring and related structures; B, deposits from tube feet; C, deposits from introvert; D, deposits from tentacle digits; E, deposits from tentacle stems; F, small perforated plates from body wall; G, cups from body wall; H, large scales (outline only).

ABBREVIATIONS: a.n., anterior notch; a.p.r., anterior process of radial piece; ir.p., interradial piece; mad., madreporite; mad. d., madreporic duct (stone canal); m.f., muscle fibres; oes., oesophagus; p.p.r., posterior process of radial piece; p.v., polian vesicle; r.p., radial piece; r.v., ring vessel.

HABITAT: Prefers sand or sandy mud; occasionally found in mud. This species commonly occurs with *Placothuria huttoni* and *Heterothyone alba*.

Family PSOLIDAE Perrier, 1902

DIAGNOSIS: Body flattened, with well defined ventral sole. Dorsal surface of body invested by imbricating scales. Ventral sole soft, surrounded by tube feet. Mouth and anus dorsally turned.

REMARKS: This family comprises approximately 80 nominal species, and is in process of revision by the writer. There are six genera, of which only one, *Psolus*, is confirmed as present in the New Zealand region. The distribution of *Psolidium* leads to the suggestion that that genus also occurs in the New Zealand region.

Psolus Oken, 1815

DIAGNOSIS: Tentacles 10. Dorsal surface of body lacks tube feet.

TYPE-SPECIES: *Holothuria phantapus* Strussenfeldt.

REMARKS: The inclusion of this genus in the New Zealand fauna rests on the discovery by Mortensen (1925) of a single specimen of a new species in the northern part of New Zealand.

Psolus neozelanicus Mortensen

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

MATERIAL EXAMINED: None.

DIAGNOSIS: Dorsal surface with large scales, 4–5 between mouth and anus. Mouth with five large interradial valves; radial valves absent. Anal aperture surrounded by 3–4 circles of small scales. Ventrolateral tube feet in double rows; midventral radius naked.

REMARKS: No further specimens of this species have since been collected. *P. neozelanicus* shares some features with *P. squamatus* Düben and Koren, a widespread species in the Eastern Pacific and Arctic regions. Both have large dorsal scales and lack radial valves around the mouth. A key to the Australasian psolids is given by Pawson (1968b).

DISTRIBUTION: Two miles east of North Cape.

BATHYMETRIC RANGE: 99 m.

HABITAT: Hard bottom (Mortensen, 1925).

Family PHYLLOPHORIDAE Oestergren, 1907, emend. Pawson and Fell, 1965

DIAGNOSIS: Body more or less naked, not enclosed by a test. Calcareous ring complex, with posterior processes composed of a mosaic of minute pieces. Calcareous deposits generally small and inconspicuous.

REMARKS: The content of this family was altered by Pawson and Fell (1965), for it is believed that the structure of the calcareous ring is of more fundamental importance than the number of tentacles, on which latter character the older classification was based. The effect upon the nomenclature of the New Zealand fauna is not great. *Neocucumella bicolumnata* (Dendy and Hindle) and *Amphicyclus thomsoni* (Hutton), both New Zealand species, are now placed in the emended family Cucumariidae and no longer belong in the Phyllophoridae.

KEY TO THE SUBFAMILIES IN FAMILY PHYLLOPHORIDAE

1 (2) Radial pieces of calcareous ring with moderately long posterior projections, which are divided into a few large elements ..... PHYLLOPHORINAE Oestergren, 1907

2 (1) Calcareous ring with very long posterior projections; ring and projections made up of a mosaic of minute pieces.

3 (4) Tentacles 10 ..... THYONINAE Panning, 1949

4 (3) Tentacles 15–20 ..... SEMPERIELLINAE Heding and Panning, 1954

Only representatives of the Semperiellinae are at present known from the New Zealand region. The subfamilies Thyoninae and Phyllophorinae are chiefly Northern Hemisphere groups with few representatives in the southern oceans. The genus *Lipotrapeza* (Phyllophorinae) has two of its three species in south-eastern Australia; this genus may eventually be discovered in the New Zealand fauna.

Subfamily SEMPERIELLINAE Heding and Panning, 1949

DIAGNOSIS: Calcareous ring with very long posterior projections; both ring and projections made up of a mosaic of minute pieces. Tentacles 15–20. Calcareous deposits tables, each with a spire composed of two or four rods.

REMARKS: This subfamily comprises five genera, two of which occur in the New Zealand region. *Phyrella* Heding and Panning, 1954, is well represented in eastern Australia, and may occur in New Zealand waters.

KEY TO NEW ZEALAND GENERA IN SUBFAMILY SEMPERIELLINAE

1 (2) Deposits tables with short, blunt, two-pillared spires and few perforations ..... *Neothyonidium* Deichmann, 1938

2 (1) Deposits tables and plates, the tables each with a sharp spire composed of two rods fused together, and many perforations ..... *Pentadactyla* Hutton, 1878

Neothyonidium Deichmann, 1938

DIAGNOSIS: Tentacles 20, arranged in a single ring. Deposits exclusively two-pillared tables with few perforations.

TYPE-SPECIES: *Thyonidium hawaiiense* Fisher.

REMARKS: Two species are found in New Zealand, but neither of them is common. *Neothyonidium dearmatum* (Dendy and Hindle) is also known from eastern Australia. *N. armatum* Pawson was described (Pawson, 1965b) on the basis of Dominion Museum material from Cook Strait.

KEY TO THE NEW ZEALAND SPECIES OF GENUS *Neothyonidium*

1 (2) Deposits tables of average diameter 0.07 mm, present only in anterior and posterior extremities of body..... *N. dearmatum* (Dendy and Hindle)

2 (1) Deposits tables of average diameter 0.1 mm, present in great numbers everywhere in body wall..... *N. armatum* Pawson

Neothyonidium dearmatum (Dendy and Hindle)

Phyllophorus dearmatus Dendy and Hindle, 1907, p. 103, pl. 11, figs 7, 8, pl. 12 fig. 15, pl. 13, fig. 20; Joshua, 1914, p. 4; Mortensen, 1925, p. 353, figs 36, 37; Clark, 1938, p. 494.
Lipotrapeza dearmatus: Clark, 1946, p. 411; Dawbin, 1950, p. 39.
Neothyonidium dearmatum: Heding and Panning, 1954, p. 191, fig. 93; Pawson, 1963, p. 24.

MATERIAL EXAMINED: 12 specimens. NZOI Sta. B 238, 3; B 649, 2; C 442, 1; C 652, 2; C 707, 4.

DIAGNOSIS: Colour in alcohol dark brown. Deposits absent from body wall except at anterior and posterior extremities, where two-pillared tables of average diameter 0.07 mm occur in small numbers; tables generally with eight perforations.

DESCRIPTION: All specimens dark brown, with numerous scattered tube feet. Total length 35–65 mm. Anatomy and deposits similar to those described by Dendy and Hindle (1907) and Mortensen (1925).

REMARKS: Superficially this species resembles *Pentadactyla longidentis* Hutton (*see* p. 31), except that the skin and tube feet are soft, while those of *P. longidentis* are firm and prickly to touch. Joshua (1914) did not describe the specimens that he found on the coast of Victoria in Australia and attributed to this species; he merely reported their presence there. Clark (1946) doubted whether Joshua's specimens were *Neothyonidium dearmatum*.

DISTRIBUTION: In the New Zealand region the species ranges from about 39° S to Foveaux Strait but is nowhere common. It also may occur off Victoria, Australia.

BATHYMETRIC RANGE: An off-shore species, in 9–68 m.

HABITAT: The species has been collected from shelly sand, shelly mud, and coarse polyzoan bottoms.

Neothyonidium armatum Pawson

Text-fig. 4

Neothyonidium armatum Pawson, 1965 b, p. 80. figs 12–19.

MATERIAL EXAMINED: 6 specimens and fragments. NZOI Sta. B 559, 2; B 599, 2; C 461, fragments; C 520, 1. Dom. Mus. Sta. BS 180, 1.

DIAGNOSIS: Deposits numerous everywhere in body wall in form of two-pillared tables of average diameter 0.1 mm, with varying numbers of perforations in disc. Colour in alcohol greyish-white with light brown patches.

DESCRIPTION (based on specimen from Dom. Mus. Sta. BS 180; holotype of species). Body contracted, plump, narrowing posteriorly to form well defined tail 4 mm in length. Total length 35 mm, greatest diameter 17 mm. Anterior end of body bluntly rounded. Skin thin, firm, rough to touch. Tube feet scattered over body, more numerous ventrally than elsewhere. Colour in alcohol white dorsally, with scattered light brown patches; ventral surface grey, with brown patches, brown colour darker near posterior end of body. Tail greyish white, tentacles grey, liberally speckled with small dark brown spots. Tube feet visible as small circular white spots.

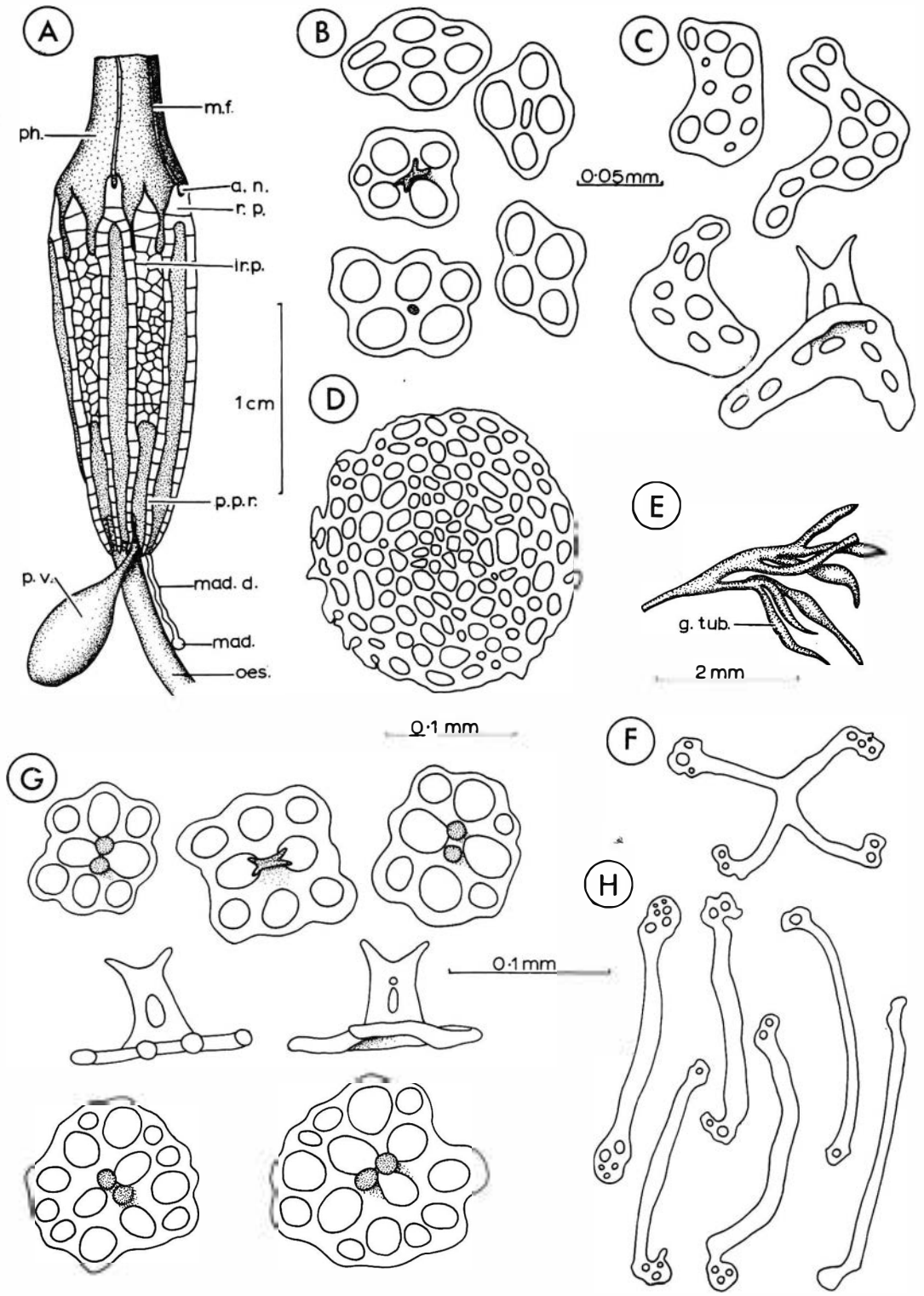
Calcareous ring massive, tubular, with five interradial and five radial pieces, all composed of a mosaic of small fragments. Each radial with deep anterior notch and long posterior processes; interradials sharply pointed anteriorly, lacking posterior processes. Small components of radials sub-rectangular; those of interradials polygonal (Text-fig. 4A). Gonad a large tuft of richly branched caeca (Text-fig. 4E).

Body wall with numerous two-pillared tables (Text-fig. 4G), most with eight perforations, although some have more. Average length of tables 0.1 mm. Each with short, two-pillared spire, pillars joined by one or two crossbars. Near extreme anterior end of body tables consistently irregular in shape, many in form of simple, flat, perforated plates lacking spires (Text-fig. 4B). Tentacle digits contain narrow rods of average length 0.16 mm. Rods occasionally branched, their expanded extremities with up to six perforations (Text-fig. 4H). Tentacle stems contain branched rods, mostly cruciform in shape (Text-fig. 4F). Tube feet with well developed end plates (Text-fig. 4D) surrounded by irregular perforated plates of average length 0.09 mm; some have two-pillared spires (Text-fig. 4C).

ADDITIONAL MATERIAL (specimens from NZOI Sta. B 559, C 461, C 520). Two complete specimens of total length 43mm and 53mm. Colour in alcohol greyish white; otherwise closely similar to holotype. Dissection of largest specimen revealed single large polian vesicle and short stone canal.

REMARKS: The shape and structure of the calcareous ring distinguishes this species from most of the others in the genus *Neothyonidium*, although it is similar to that of its New Zealand congener, *N. dearmatum*. The New Zealand species are apparently related, but are readily distinguishable on the basis of colour and the structure of the calcareous deposits (see key this page).

DISTRIBUTION: The holotype was collected in Cook Strait (Pawson, 1965b). The species is recorded here from west of Cape Egmont, Cook Strait, and south of Christchurch.



TEXT-FIG. 4. *Neothyonidium armatum* Pawson. A, calcareous ring and related structures; B, tables from extreme anterior end of body; C, deposits from tube foot; D, end plate of tube foot; E, portion of gonad; F, cruciform deposit from tentacle stem; G, tables from body wall; H, deposits from tentacle digits.

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

BATHYMETRIC RANGE: 43–270m.

HABITAT: Shelly sandy mud, iron sand (off Cape Egmont).

Pentadactyla Hutton, 1878

DIAGNOSIS: Tentacles 20, arranged in two rings. Deposits tables and plates, the tables each with a sharp spire composed of two rods fused together, and many perforations.

TYPE-SPECIES: *Thyone longidentis* Hutton.

REMARKS: This genus comprises only two species, the type from New Zealand, and *Pentadactyla japonica* (von Marenzeller) from Japan.

Pentadactyla longidentis (Hutton)

Plate 2, Fig. 3

SYNONYMY: *See* Pawson (1963, p. 24).

MATERIAL EXAMINED: 73 specimens and fragments. NZOI Sta. A 435, 2; A 445, 2; B 217, 2; B 277, 1; B 296, 11; B 464, 1; B 526, 1; B 540, 1; B 546, 1; B 551, 14; C 184, 2; C 186, 8; C 187, 1; C 218, 1; C 259, 2; C 415, 1; C 468, 1; C 593, fragments; C 780, 1; C 792, 1; C 839, 1; C 850, 2; C 864, 1. Dom. Mus. Sta. BS 130, 8; BS 135, 1; BS 181, 1; BS 194, 1; Cook Strait, 1; Wellington Harbour, 1; Tasman Bay, 1; Akaroa Harbour, 1.

DIAGNOSIS: Colour in life and in alcohol dark brown. Body wall deposits very numerous oval to cruciform spired plates 0.3mm in average length, together with smooth plates 0.5mm in average length. Tentacle deposits perforated rods.

DESCRIPTION: See Pawson (1963, p. 24). Present specimens of total length 22-65mm. In all specimens tentacles retracted; body plump at centre, tapering toward anterior and posterior ends, which are more or less upturned, giving body a typical U-shape, with ventral radius occupying greater curvature. Colour dark brown overall. Body wall prickly to touch owing to presence of numerous spired tables in skin and tube feet.

REMARKS: This species is one of the more common New Zealand holothurians, and is now well known. The body shape is variable and this has caused some confusion among earlier workers.

DISTRIBUTION: The species appears to range the entire New Zealand coast, and is especially common in the Cook Strait area. It is also recorded from the Chatham Rise, in bathyal depths.

BATHYMETRIC RANGE: 5–720m.

HABITAT: Substrate generally mud or muddy sand; rarely coarse muddy, shelly sand.

Family CUCUMARIIDAE Ludwig, 1894
emend. Pawson and Fell, 1965

DIAGNOSIS: Body more or less naked, not enclosed by a test. Calcareous ring simple, lacking posterior processes. Deposits generally small and inconspicous.

REMARKS: This family is large, and embraces most of the holothurians generally referred to as "cucumarias". The systematic status of certain groups within the family remains somewhat confused, but the continuing work of Panning (1949–1966) is steadily eliminating the confusion. Three subfamilies were included in this family by Pawson and Fell (1965). All are represented in the New Zealand region.

KEY TO THE SUBFAMILIES OF FAMILY CUCUMARIIDAE

1 (2) More than 10 tentacles (15–25). Calcareous deposits of body wall plates or tables..... THYONIDIINAE Heding and Panning, 1954

2 (1) Tentacles 10. Calcareous deposits of body wall plates only or plates and cups.

3 (4) Deposits plates only ....CUCUMARIINAE Panning, 1949

4 (3) Deposits plates and cups ..... COLOCHIRINAE Panning, 1949

Subfamily THYONIDIINAE Heding and Panning, 1954

DIAGNOSIS: Tentacles 15–25. Calcareous deposits of body wall plates or tables.

REMARKS: This subfamily is essentially cosmopolitan, and is especially well represented in the western Pacific Ocean. Two genera occur in the New Zealand region; both also occur in Australian waters.

KEY TO THE NEW ZEALAND GENERA IN SUBFAMILY THYONIDIINAE

1 (2) Tentacles 20 in a single ring. Deposits numerous spired tables with eight perforations (four large and four small) *Neocucumella* Pawson, 1962

2 (1) Tentacles 25 in 2 rings. Deposits rare; when present, in form of spired tables with variable number of perforations..... *Amphicyclus* Bell, 1884

Neocucumella Pawson, 1962

DIAGNOSIS: Tentacles 20, in a single ring. Calcareous ring simple; radials each with pronounced anterior notch; interradials small, with short blunt anterior projections. Deposits tables, in form of disc with eight perforations (four large and four small) surmounted by a short two-pillared spire. Tube feet confined to radii, arranged in double rows.

TYPE-SPECIES: *Neocucumella bicolumnata* (Dendy and Hindle).

REMARKS: The genus is monotypic, and the single species occurs in Australia and New Zealand. The calcareous deposits of *Neocucumella* resemble those of the Australian genus *Mensamaria*, but the former genus has 20 tentacles, and the latter has 30.

Neocucumella bicolumnata (Dendy and Hindle)

Plate 1, Fig. 4

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: Clark, 1946, p. 406; Dawbin, 1950, p. 38.
Neocucumella bicolumnata: Pawson, 1962c, p. 65; 1963, p. 22, pl. 3, figs 1–3.

MATERIAL EXAMINED: 15 specimens. NZOI Sta. B 41, 2; B 53, 1; B 248, 1; C 666, 3. Dom. Mus. Sta. BS 22, 5; BS 130, 2; BS 150, 1.

DIAGNOSIS: As for the genus.

REMARKS: All specimens conform well to the descriptions given by Dendy and Hindle (1907) and Pawson (1963). The total length ranges from 20 to 90 mm. In alcohol the body wall is light brown to brick red; tentacles are light red to dark brown.

DISTRIBUTION: *N. bicolumnata* ranges from Hawke Bay in the north to Foveaux Strait in the south but has never been taken in numbers. It is also recorded from south-eastern Australia (Joshua and Creed, 1915).

BATHYMETRIC RANGE: An off-shore species, 7–239 m.

HABITAT: The species has been collected with shell, gravel, stones, pebbly sand, and mud and shell, indicating that a hard substrate is preferred.

Amphicyclus Bell, 1884

DIAGNOSIS: Tentacles 25. Tube feet confined to radii in closely crowded rows, 8 to 10 rows in each radius. Calcareous ring simple, interradials reduced. Calcareous deposits absent from body wall and tube feet, apart from sucking discs. Introvert may contain small numbers of two-columned tables of variable shape.

TYPE-SPECIES: *Amphicyclus japonicus* Bell.

REMARKS: Heding and Panning (1954) include three species in this genus. *A. thomsoni* was formerly believed to be common to Australia and New Zealand, but Heding and Panning (1954) considered that the Australian representatives constitute another (new) species, *A. mortenseni*.

Amphicyclus thomsoni (Hutton)

Text-fig. 5; Plate 1, Figs 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: Clark, 1946, p. 406 (pars); Dawbin, 1950, p. 38.
Amphicyclus thomsoni: Heding and Panning, 1954, p. 88, fig. 29 a–f; Pawson, 1962b, p. 65.
Not: *Pseudocucumis thomsoni:* Clark, 1938, p. 484 (= *Amphicyclus mortenseni* Heding and Panning).
Mensamaria thomsoni: Clark, 1946, p. 406 (pars) (= *Amphicyclus mortenseni* Heding and Panning).

MATERIAL EXAMINED: 121 specimens. NZOI Sta. B 41, 3; B 224, 3; B 270, 1; B 554, 4; C 652, 1; C 703, 40; C 814, 8; C 844, 4; C 851, 1. Dom. Mus. Sta. BS 130, 2; BS 141, 29; BS 142, 17; Cook Strait, 2; North-east Otago, 1; Foveaux Strait, 2; north of Kapiti Island, 1; off Foxton, 2.

DIAGNOSIS: Body pentagonal, with numerous transverse wrinkles. Tube feet numerous, 8 to 10 rows in each radius. Calcareous deposits present only in extremities, in the form of irregular tables 0.04–0.08 mm in diameter with numerous perforations.

DESCRIPTION: Body fusiform, approximately pentagonal in cross section. Total length 10–75 mm. Living and preserved specimens yellowish to light brown; tube feet and tentacles white. Body wall with large numbers of transverse wrinkles. Tube feet very numerous, confined to radii, arranged in simple double rows on introvert, elsewhere on radii in 8 to 10 rows.

Tentacles 25, arranged in 2 concentric rings. Outer ring is of 15 large tentacles, of which 2 dorsal tentacles are smallest. Inner ring with 10 small tentacles, all more or less equal in size. Mouth lies at base of funnel-shaped depression.

Calcareous ring of five radial pieces and five slender, needle-like interradials. Radials long and broad, each with a conspicuous median notch and two lesser notches, one to each side of the median notch. Shape of interradials varies. Both radials and interradials with shallow posterior notch. (Text-fig. 5B).

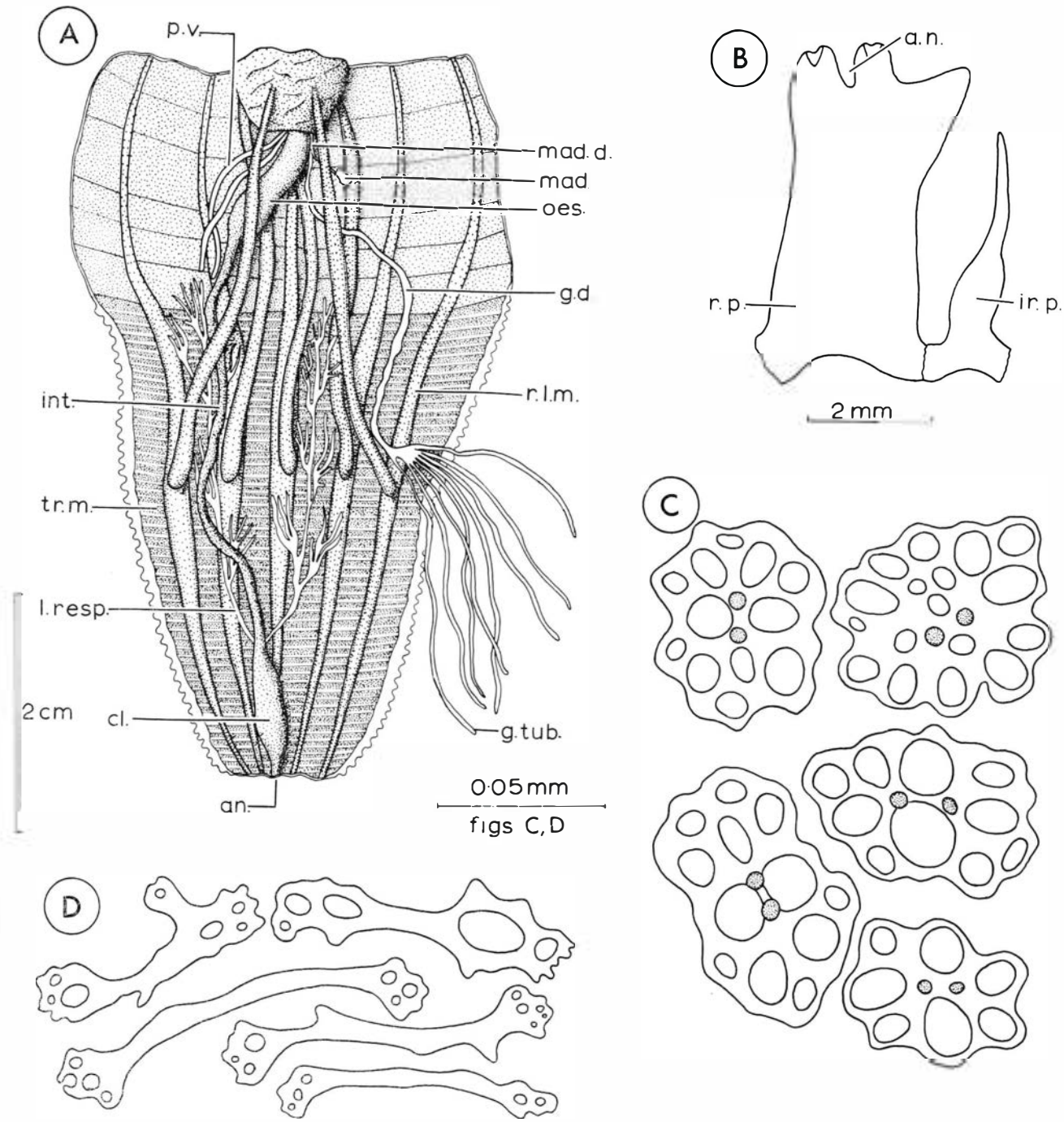
Oesophagus broad and muscular, narrowing rapidly to merge with intestine. A ring of small papillae (function unknown) surrounds junction of oesophagus and intestine. Intestine narrow, thin-walled, describing a poorly defined loop; cloaca enlarged. In some specimens intestine straight, not looped (Text-fig. 5A).

Two long, tubular, transparent polian vesicles arise from ventral side of water vascular ring. Single stone canal straight, supported by dorsal mesentery, terminating in an oval madreporite. Stone canal tends to run posteriorly in dorsal mesentery (Text-fig. 5A).

Gonad a bunch of long, unbranched, intertwining caeca, bright yellow or orange; in many specimens caeca almost fill anterior half of body cavity. Genital duct long, running along dorsal interradius close to body wall, opening to exterior at tip of well defined genital papilla which lies between the two mid-dorsal tentacles in outer ring.

Respiratory trees feebly developed, arising from anterior end of cloaca on ventral side. There are two main trunks of equal length extending about $\frac{2}{3}$ along body cavity; respiratory tubules well branched.

Longitudinal muscles thick, broad in contracted areas of body; elsewhere narrow and thin. Retractor muscles well developed, originating from longitudinal muscles half-way along body cavity, inserting into anterior notches of radial pieces of calcareous ring. Transverse muscles prominent in contracted areas (Text-fig. 5A). All muscles light orange in colour, in contrast to overall white colour of peritoneum.



TEXT-FIG. 5. *Amphicyclus thomsoni* (Hutton). A, internal anatomy of adult dissected from dorsal side (portions of gonad removed). B, radial and interradial pieces of calcareous ring; C, tables from anterior end of body; D, deposits from tentacles.

ABBREVIATIONS: 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., madreporic duct (stone canal); oes., oesophagus; p.v., polian vesicle; r.l.m., radial longitudinal muscle; r.p., radial piece; tr. m., transverse muscle.

Calcareous deposits absent from most of body wall, but tables (Text-fig. 5C) usually present in extreme anterior and posterior regions. Table disc of irregular outline, varying in size (0.04–0.08 mm diameter) and number of perforations. Each table surmounted by a spire composed of two short columns joined at top by single crossbar. Mortensen (1925) described finely branched elongate spicules from small papillae around the mouth. Well developed end plates in tube feet. Tentacles contain numerous spicules in digits, but none in stems. Spicules rod-like (Text-fig. 5D), of average length 0.08 mm, with few (no more than eight) perforations largely confined to enlarged extremities of rods.

REMARKS: The smaller specimens of this species do not have their full complement of tentacles. Some have as few as 17 tentacles. Mortensen (1925) noted that the outer ring of tentacles is the first to form.

Clark (1938) recorded *A. thomsoni* from Western Australia and Tasmania but indicated that the Australian material might represent a different species. The New Zealand and Australian forms differ in external appearances but Clark (1938) could find no reliable differences in the calcareous deposits or calcareous rings. Later, Clark (1946) referred *thomsoni* to a new genus, *Mensamaria*, and suggested that perhaps two or three species might be confused under the name *thomsoni*. Heding and Panning (1954) finally referred the Australian forms to a new species, *mortenseni*. It is evident, however, that the species are closely related, in spite of their apparently consistent difference in colour.

DISTRIBUTION: From East Cape in the north to Foveaux Strait in the south.

BATHYMETRIC RANGE: An off-shore species, 9–180 m.

HABITAT: Usually collected from coarse, muddy, shelly sand, but has been taken in mud and boulders. This species tends to cover itself in sand and pieces of shell.

Subfamily CUCUMARIINAE Panning, 1949

DIAGNOSIS: Tentacles 10. Deposits in body wall merely plates, smooth or knobbed. Cups and spired plates absent.

REMARKS: Most genera in this subfamily have a soft body and some have a more or less well defined ventral sole, indicating living habits similar to those of the psolid holothurians. Three genera are now known from the New Zealand region.

KEY TO THE NEW ZEALAND GENERA OF SUBFAMILY CUCUMARIINAE

1 (2) Calcareous deposits very numerous oval knobbed plates, with one end denticulate ..... *Pseudocnus* Panning, 1949

2 (1) Deposits few simple plates, smooth or with very few isolated spines.

3 (4) Tube feet scattered over dorsal surface of body. Tentacles and tube feet with calcareous deposits..... *Psolidiella* Mortensen, 1925

4 (3) Tube feet restricted to radii on dorsal surface of body. Tentacles and tube feet lack calcareous deposits..... *Pseudopsolus* Ludwig, 1898

Pseudocnus Panning, 1949

DIAGNOSIS: Deposits in body wall a thick layer of knobbed, oval plates, with narrower end denticulate. Smaller circular knobbed plates may also occur.

TYPE-SPECIES: *Cucumaria dubiosa* Semper.

REMARKS: Panning (1949, 1951, 1962) has revised this genus, and in 1962 he included in *Pseudocnus* several of the species he had formerly (1949) referred to *Stereoderma*, including the Auckland and Campbell Island species *S. leoninoides* (Mortensen). More recently, Panning (1964) declared that *Stereoderma* should be regarded as monotypic, comprising only the North American east coast species *S. unisemita* (Stimpson).

Pseudocnus leoninoides (Mortensen)

Text-fig. 6

Cucumaria leonina: Dendy, 1909, p. 146, pl. 6, fig. 1a–c.
Cucumaria leoninoides: Mortensen, 1925, p. 338, fig. 27a–b; Dawbin, 1950, p. 38.
Stereoderma leoninoides: Panning, 1949, p. 422; Pawson, 1961, p. 16; 1965d, p. 258.
Pseudocnus leoninoides: Panning, 1962, p. 74, fig. 12; Pawson, 1968b, p. 22.

MATERIAL EXAMINED: Eight specimens. Cape Exped. Tagua Bay, 8.

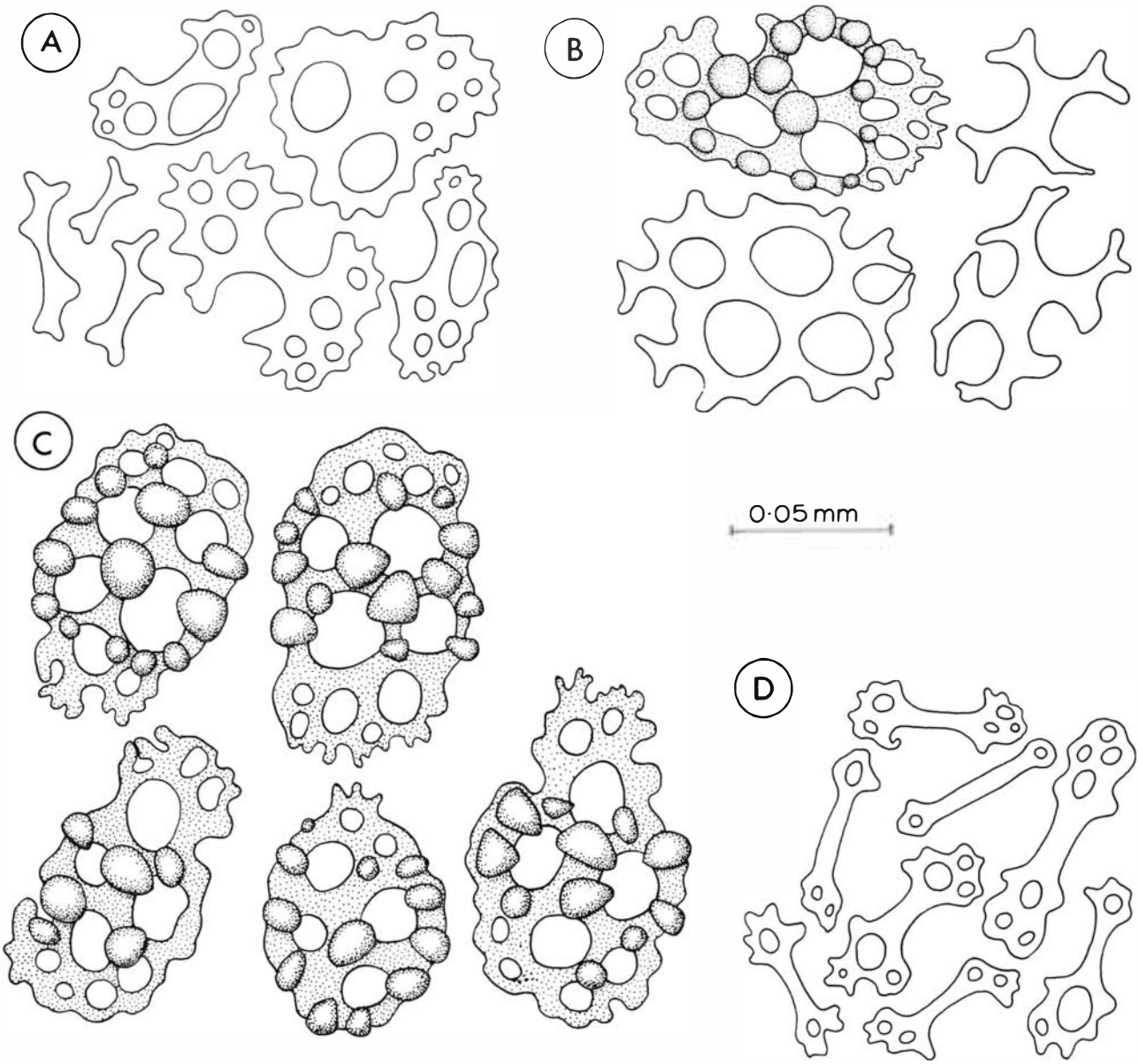
DIAGNOSIS: Body wall plates of average length 0.1 mm; each plate with four large central perforations and many smaller perforations.

DESCRIPTION: All specimens damaged, a result of sudden contraction upon preservation. In most, portions of viscera project through body wall; bodies twisted and deformed, rendering successful dissection impossible. Body more or less cucumiform, tapering abruptly to anus at posterior end. Tentacles carried on transparent introvert. Skin thick, rough, coriaceous, with numerous deep transverse wrinkles. Total length of largest specimen 15 mm.

In alcohol body bright yellow, tentacles light orange. Anus surrounded by five small anal teeth which are virtually invisible in most specimens.

Tube feet present on introvert in five irregular rows, but not visible elsewhere. Dendy (1909) states that the tube feet are arranged in five well marked irregularly double bands. Ten short, much branched tentacles surround mouth. Two ventral tentacles smaller than others. A brownish spot lies at base between each pair of tentacles.

Body wall contains great numbers of small, knobbed, perforated plates (Text-fig. 6C), oval to rectangular in shape, of average length 0.1 mm. Plates usually narrower at one end than other; narrow end denticulate, broad and quite smooth. In skin, plates overlap closely, with denticulate end pointing outward, projecting above level of skin. Each plate with four large perforations and several smaller perforations, but many



TEXT-FIG. 6. *Pseudocnus leoninoides* (Mortensen). A, deposits from introvert; B, deposits from extreme posterior end of body; C, knobbed plates from body wall; D, deposits from tentacles.

variations of this basic pattern occur. Near posterior end of body plates tend to become even more irregular in shape (Text-fig. 6B). Here stages in development of plates can be seen.

Introvert contains irregular plates (Text-fig. 6A) of 0.07 mm average length, with 3 to 10 perforations. Introvert also contains small number of slightly branched unperforated rods. Tentacles with large numbers of rods (Text-fig. 6D) of 0.05 mm average length; rods dumb-bell shaped, enlarged ends with varying numbers of small perforations. Tube feet contain well developed end plates surrounded by deposits similar to those of introvert and tentacles.

REMARKS: W. H. Dawbin (pers. comm.) noted 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 collections, I at first assumed that *Pseudocnus leoninoides* is in fact strawberry red when alive. However, Mortensen (1925) noted that *Ocnus brevidentis* var. *carnleyensis* Dendy is particularly common in Carnley Harbour, and is strawberry red in colour. It seems likely, then, that this is the species to which Dawbin was referring, even though no specimens of the species were collected. Mortensen (1925) had seen live specimens of *Pseudoc-*

nus leoninoides but had made no colour notes. However, he was almost sure that *P. leoninoides* was yellowish white when alive.

P. leoninoides appears to be closely related to *P. laevigatus* (Verrill), the latter species being circumpolar in distribution and now known from Macquarie Island (Pawson, 1968a). A fundamental difference between the two species is that *P. laevigatus* is brood-protecting, while *P. leoninoides* is not.

DISTRIBUTION: The species is known from Carnley Harbour in the Auckland Islands (Dendy, 1909; Mortensen, 1925); Perseverance Harbour, Campbell Island (Mortensen, 1925); the Snares Islands (Pawson, 1965c); and approximately 150 miles NNE of Macquarie Island (Pawson, 1968b). Mortensen (1925) described two specimens taken live from a piece of floating brown alga (*Lessonia* sp.) 1 mile east of the Auckland Islands.

BATHYMETRIC RANGE: 0–112 m.

HABITAT: The species is usually found in intertidal areas, concealed in rock crevices, but also appears to live on seaweeds. The record of the single specimen from a depth of 112 m (Pawson, 1968b) is interesting; further material may reveal that the deep-water specimens represent a different species.

Psolidiella Mortensen, 1925

DIAGNOSIS: Body *Psolus*-like in shape, with ventral sole, but sole not sharply delimited from rest of body by a sharp edge. Dorsal surface with numerous tube feet which show no serial arrangement. Calcareous deposits small plates up to 0.15 mm in length.

TYPE-SPECIES: *Psolidiella nigra* Mortensen.

REMARKS: Panning (1949) referred the species *spectabilis* (Ludwig) and *mollis* (Ludwig and Heding) to this formerly monotypic genus, but later transferred *spectabilis* to *Hemioedema* Herouard, 1929. Hickman (1962) described a new species *Psolidiella adhaerens* from Tasmania. Thus, the genus now embraces three species, all of which are southern oceans forms.

Psolidiella nigra Mortensen

Text-fig. 7

Psolidiella nigra Mortensen, 1925, p. 360, figs 42, 43; Dawbin, 1950, p. 35, pl. 1, fig, 3; Panning, 1949, p. 424; 1961, p. 192, figs 1–4.

MATERIAL EXAMINED: Four specimens. Dom. Mus. Otago Peninsula, 2; Menzies Bay, 2.

DIAGNOSIS: Ventrolateral tube feet in four rows. Dorsal surface black, ventral surface white.

DESCRIPTION: Mouth ventrally turned, anus subdorsal, at tip of distinct posterior "tail". Skin soft, thin, opaque. Sole and tube feet white, dorsal surface black. Numerous dorsal tube feet appear as small white spots, scattered over entire dorsal surface. Tentacles black, with few white spots.

Sole delimited by tube feet of lateral ventral radii, arranged in four crowded rows in each radius; tube feet of mid-ventral radius in double row. Tentacles 10, mid-ventral pair smaller than others.

Calcareous ring (Text-fig. 7B) simple, well developed. Radial pieces each with long, broad anterior process, notched at anterior extremity. Posteriorly, radials each with shallow notch. Interradial pieces with broad, blunt anterior projections and V-shaped posterior notches. A single spherical polian vesicle arises from water vascular ring in left ventral interradius. Stone canal short and straight, terminating in flocculate madreporite (Text-fig. 7B).

Oesophagus thin-walled, dilated, narrowing into intestine that describes two S-shaped loops and runs to terminal anus (Text-fig. 7A). Posterior loop of intestine and mesentery lie in left ventral interradius. Respiratory trees short, copiously branched; left trunk slightly longer than right.

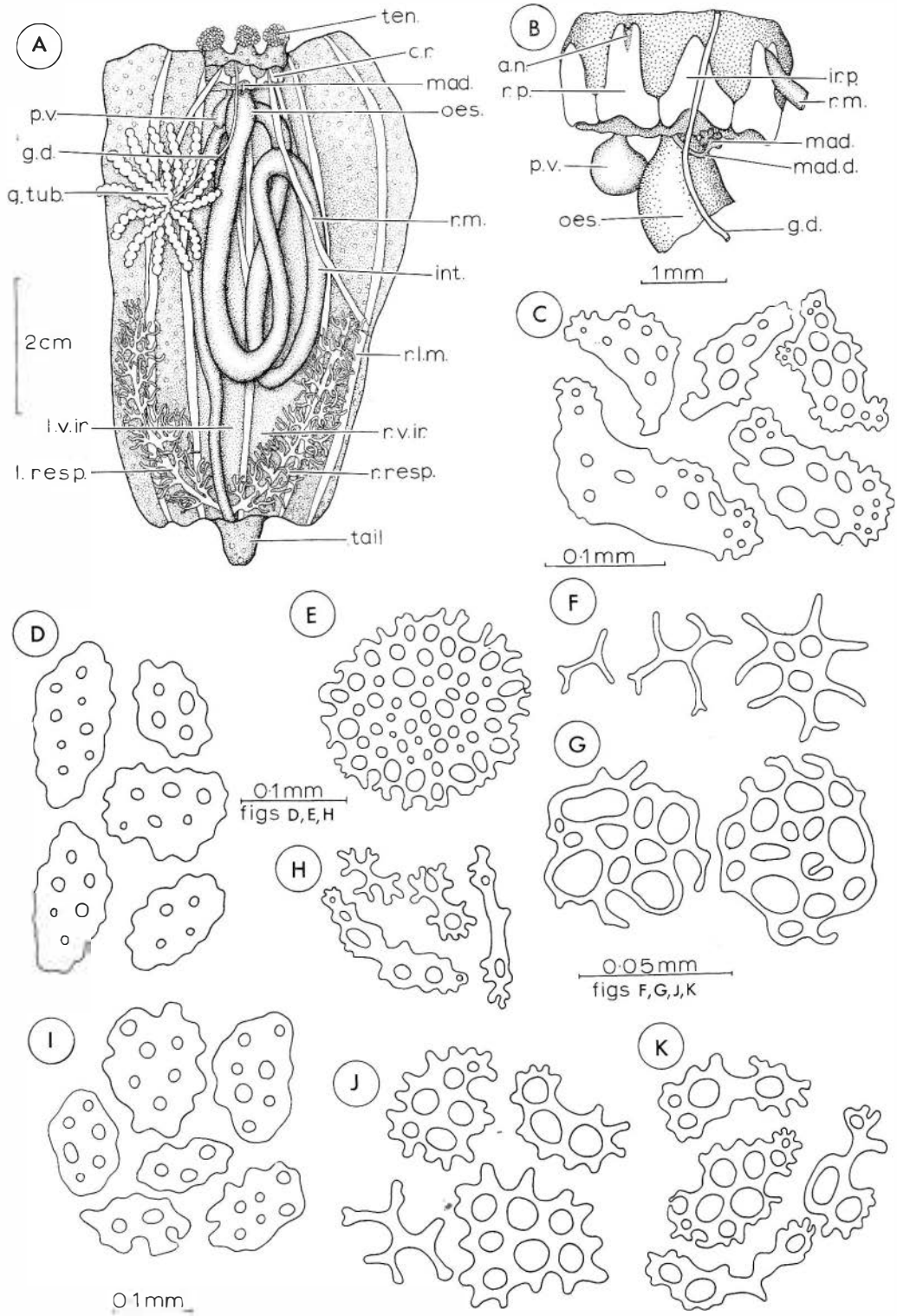
Gonad a small number of short tubular caeca filled with large eggs (Text-fig. 7A). Average diameter of eggs 1.4 mm. Genital duct runs anteriorly in dorsal mesentery and opens to exterior in mid-dorsal interradius, near ring of tentacles. On inside of body wall, ampullae of tube feet visible as small white spots.

Sole contains large numbers of plates and button-like deposits closely crowded together but not overlapping. Plates (Text-fig. 7D) small (0.1–0.15 mm long), oval to elongate, with small number of perforations. Button-like deposits (Text-fig. 7J) of variable shape, with 3 to 10 large perforations. Various developmental stages of buttons also present. Dorsal body wall with deposits (Text-fig. 7I) similar in most respects to plates in sole, but smaller (average length 0.11 mm) and far less numerous.

Deposits in dorsal tube feet differ conspicuously from those in ventral tube feet. End plates of dorsal feet (Text-fig. 7G) with small number of angular perforations. Developmental stages of end plates also occur (Text-fig. 7F). End plates surrounded by irregular perforated rods and plates (Text-fig. 7K). End plates of ventral feet circular, with numerous small perforations (Text-fig. 7E). These end plates surrounded by irregular deposits (Text-fig. 7H) similar to those of dorsal feet, but with fewer perforations. Tentacles with many perforated plates of variable shape; average length 0.12 mm (Text-fig. 7C).

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

DISTRIBUTION: The holotype described by Mortensen (1925) was collected at Paterson Inlet, Stewart Island. Panning (1961) described specimens from Menzies Bay, Banks Peninsula. The new locality recorded here, Sandfly Bay, Otago Peninsula, indicates that the species



TEXT-FIG. 7. *Psolidiella nigra* Mortensen. A, internal anatomy of adult dissected from dorsal side; B, calcareous ring and related structures; C, deposits from tentacles; D, plates from sole; E, end plate from ventral tube foot; F, stages in development of dorsal tube foot end plate; G, end plates from dorsal tube feet; H, irregular deposits from ventral tube feet; I, plates from dorsal body wall; J, button-like deposits from ventral sole; K, deposits from dorsal tube feet.

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., madreporic duct (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.

is distributed along the east coast of the South Island of New Zealand, but its habitat preferences probably limit its distribution.

BATHYMETRIC RANGE: Intertidal.

HABITAT: This species clings to rocks or ledges in small crevices. It is apparently inconspicuous, and prefers dark coloured substrates. "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" (Mortensen, 1925).

Pseudopsolus Ludwig, 1898

DIAGNOSIS: Tube feet on dorsal surface restricted to radii. Calcareous deposits scarce in body wall, absent from tube feet and tentacles.

TYPE-SPECIES: *Psolus macquariensis* Dendy.

REMARKS: This genus is monotypic. Pawson (1968a) has shown that Bell's (1908) species *Pseudopsolus ferrari* does not belong in *Pseudopsolus.*

Pseudopsolus 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; Pawson, 1968a, p. 143, fig. 1.

MATERIAL EXAMINED: None.

DIAGNOSIS: As for the genus.

REMARKS: This species is known from Macquarie Island (Dendy, 1898; Pawson, 1968a). Its inclusion in the fauna of the New Zealand region rests on Mortensen's (1925) record of the species from Stewart Island. However, Mortensen doubted the accuracy of the labelling of the specimens, and it is not yet certain that this species does actually occur in the New Zealand region.

Subfamily COLOCHIRINAE Panning, 1949

DIAGNOSIS: Tentacles 10. Calcareous deposits plates and cups.

REMARKS: Both Clark (1923) and Deichmann (1948) have shown conclusively that the genus *Colochirus* Troschel, 1846 is an objective junior synonym of *Pentacta* Goldfuss, 1820. Panning apparently erred in resurrecting *Colochirus* in place of *Pentacta* and in basing the subfamily (Colochirinae) upon that generic name. Although *Pentacta* is now universally accepted as the valid generic name, the subfamily name Colochirinae must be retained in accordance with the Code of Zoological Nomenclature (article 40).

KEY TO THE NEW ZEALAND GENERA IN SUBFAMILY COLOCHIRINAE

1 (2) Calcareous deposits cups and smooth plates ..... *Trachythyone* Studer, 1876
2 (1) Calcareous deposits cups and knobbed plates ..... *Ocnus* Forbes, 1841

Trachythyone Studer, 1876

DIAGNOSIS: Calcareous deposits cups and smooth plates.

TYPE-SPECIES: *Trachythyone muricata* Studer.

REMARKS: This widely distributed genus has two New Zealand representatives, neither of which is common in the New Zealand region. A closely related species, *T. macphersonae* Pawson, occurs in the intertidal zone at Macquarie Island.

KEY TO THE NEW ZEALAND SPECIES OF *Trachythyone*

1 (2) Deposits include large plates of variable shape, with many perforations ..... *T. amokurae* (Mortensen)
2 (1) Plates small, with few perforations .. *T. bollonsi* (Mortensen)

Trachythyone amokurae (Mortensen)

Cucumaria amokurae Mortensen, 1925, p. 341, figs 29, 30a; Dawbin, 1950, p. 38, pl. 2, fig. 13.
Trachythyone amokurae: Panning, 1949, p. 425.

MATERIAL EXAMINED: One specimen. NZOI Sta. C 653, 1.

DIAGNOSIS: Skin thin, delicate. Deposits large plates of variable shape, with many perforations. Plates with smooth inner surface and coarse and spinose outer surface. Plates overlain by small, irregular X-shaped deposits (reduced cups). Small knobbed buttons also present.

REMARKS: The single specimen examined conforms well with Mortensen's (1925) description, and needs no further discussion here. Total length 9 mm. Colour in alcohol light brown.

DISTRIBUTION: Mortensen's (1925) specimens were collected at Carnley Harbour in the Auckland Islands and at Stewart Island. The present specimen from south of Kaikoura somewhat extends the known range of the species; probably it occurs around the coast of the South Island.

BATHYMETRIC RANGE: An off-shore species, in 9–95 m.

HABITAT: Mud, sandy mud, muddy shelly sand.

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, delicate. Deposits small smooth plates with few perforations; plates scattered, not overlapping. Four-holed buttons and rudimentary cups overlie plates.

REMARKS: This species appears to be closely related to *T. macphersonae* Pawson, from Macquarie Island. So far, *T. bollonsi* is known only from the type locality, Cape Maria van Diemen in the north of New Zealand, among algae on a rocky shore (Mortensen, 1925).

Ocnus Forbes, 1841

DIAGNOSIS: Calcareous deposits cups and knobbed plates of two types.

TYPE-SPECIES: *Ocnus brunneus* Forbes.

REMARKS: Three species are known from the New Zealand region. They are superficially similar externally, but can readily be distinguished on the basis of their calcareous deposits.

KEY TO NEW ZEALAND SPECIES OF THE GENUS *Ocnus*

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

2 (1) No such scales present.

3 (4) Deposits include knobbed plates, typically with 4 primary perforations and 12 marginal knobs..... *O. calcarea* (Dendy)

4 (3) Deposits include knobbed plates, typically with 4 primary perforations and 10 marginal knobs.. *O. brevidentis* (Hutton)

Ocnus farquhari (Mortensen)

Cucumaria farquhari Mortensen, 1925, p. 343, figs 30b, 31; Dawbin, 1950, p. 38, pl. 2, fig. 12.
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 tube feet in three biserial rows. Dorsal surface black; elsewhere white.

REMARKS: The species is known so far from only two specimens collected in 99 m, off North Cape, on a hard bottom (Mortensen, 1925).

Ocnus calcarea (Dendy)

Plate 1, Fig. 5

Colochirus calcarea Dendy, 1896, p. 38, pl. 5, figs 44–53; Farquhar, 1898, p. 325.
Colochirus brevidentis: Ludwig, 1898b, p. 442, pl. 26, figs 22–29.
Cucumaria calcarea: Mortensen, 1925, p. 335, fig. 26a–d; Dawbin, 1950, p. 38, pl. 2, fig. 11.
Ocnus calcarea: Panning, 1949, p. 437.

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.

REMARKS: Mortensen (1925) demonstrated conclusively that *O. calcarea* can readily be distinguished from *O. brevidentis* (Hutton).

DISTRIBUTION: Although *O. calcarea* is not a common species, it has been recorded from Auckland, Wellington, and Stewart Island in the New Zealand region, and also from Juan Fernandez (Ludwig, 1898b).

BATHYMETRIC RANGE: 0–27 m.

HABITAT: Rock, seaweed holdfasts, gravel.

Ocnus brevidentis (Hutton)

Text-fig. 8; Plate 2, Fig. 1

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, fig. 32; Pawson, 1968b, p. 22.
Not *Colochirus calcareus* Dendy, 1896, or *Colochirus brevidentis:* Ludwig, 1898b, p. 442, pl. 26, figs 22–29 (= *Ocnus calcarea* (Dendy)).

MATERIAL EXAMINED: 35 specimens. NZOI Sta. C 608, 2; C 703, 11. Dom. Mus. Foveaux Strait, 5; Stewart Island, 5; Dusky Sound, 1; Auckland, 1. Chatham Islands Exped. 9, 2; 15, 1; 34, 6. Cape Exped., No. 1 Station Inlet, 1.

DIAGNOSIS: Deposits include knobbed plates, typically with 4 primary perforations and 10 marginal knobs; knobbed cups and curved perforated rods also present.

DESCRIPTION: All specimens but one completely contracted. Total length 6–20 mm. Body sausage-shaped, bluntly rounded anteriorly and posteriorly. Skin thick, coriaceous. Colour in life pink; in alcohol some specimens white, others light brown; tentacles light brown in preserved specimens.

Mouth circular. Two ventral tentacles considerably smaller than others. Tube feet numerous, crowded over entire ventral surface, except at anterior and posterior extremities; feet scattered over dorsal surface.

Calcareous ring simple, composed of 10 small pieces. Radials notched anteriorly for insertion of retractor muscles. Each interradial with short, blunt, anterior process. Oesophagus short, thick-walled, narrowing abruptly to pass into convoluted intestine, which describes an S-shaped loop and runs to the undifferentiated cloaca (Text-fig. 8A).

A single polian vesicle arises from water vascular ring in left ventral interradius. Polian vesicle elongate, swollen distally. Loosely coiled stone canal runs anteriorly in dorsal mesentery (Text-fig. 8A), terminating in minute nodular madreporite. Respiratory trees well developed; two main trunks each give rise to small number of long, branching, filamentous respiratory tubules. Right trunk about twice as long as left, extending about $\frac{2}{3}$ along body cavity.

Gonad a bunch of unbranched tubular caeca which lie tangled around oesophagus and intestine. Genital duct lies in dorsal mesentery, opening to exterior at an indistinct genital pore in dorsal interradius immedi-

ately posterior to ring of tentacles. Longitudinal muscles and retractor muscles as broad straps; transverse muscles well developed (Text-fig. 8A).

Body wall thick and hard, containing great numbers of knobbed plates, knobbed cups, and curved perforated rods. Knobbed plates (Text-fig. 8D) oval, of 0.08 mm average length. Each plate typically with four primary perforations of equal size; some have a few additional smaller perforations. Margin of each plate carries conspicuous knobs, usually 10, but number varies between 8 and 11. Central area of plates with one to four knobs.

Cups knobbed, shallow, oval to rectangular, 0.08 mm in average length (Text-fig. 8C). Cups with many perforations, knobbed on one side only. Curved perforated rods (Text-fig. 8B) of 0.11 mm average length scattered in body wall, far less numerous than cups or plates.

Digits and stems of tentacles contain large numbers of irregular perforated plates and rod-like spicules with 4–18 perforations (Text-fig. 8E). Tube feet with well developed end plates, surrounded by deposits similar to plates in body wall.

DISTRIBUTION: Records show that this species occurs all around the coast of New Zealand, and also at the Auckland Islands, Antipodes Islands, and the Chatham Islands.

BATHYMETRIC RANGE: 0–465 m.

HABITAT: Inshore, the species has been collected from rocks and the holdfasts of brown seaweeds. Off-shore, the substrate may be boulders, sand, or gravel.

Order DACTYLOCHIROTIDA Pawson and Fell, 1965

DIAGNOSIS: Tentacles 8–30, not branched but digitiform or digitate, digits sometimes bifurcate. Body enclosed in a test comprising imbricating plates. Calcareous ring simple, lacking complex posterior processes.

REMARKS: This order was erected to accommodate several genera of holothurians, formerly scattered through the Order Dendrochirotida, which share the important antomical features mentioned in the above diagnosis. The order comprises the families Ypsilothuriidae Heding, 1942, Rhopalodinidaè Perrier, 1902, and Vaneyellidae Pawson and Fell, 1965. Of these one family, the Ypsilothuriidae, is so far known from the New Zealand region.

Family YPSILOTHURIIDAE Heding, 1942

DIAGNOSIS: Spherical to U-shaped holothurians, with 8 to 10 tentacles, of which 2 are much larger than the others. Calcareous deposits large plates, each with a spiny spire. Tube feet not well developed, usually placed along radii. (Partly after Heding, 1942.)

REMARKS: For remarks on this family see Pawson, 1965e p. 5. Two species, *Ypsilothuria bitentaculata* (Ludwig) and *Echinocucumis hispida* (Barrett), are known from the bathyal of New Zealand. Both are described and illustrated in Pawson (1965e).

Ypsilothuria Perrier, 1876

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

TYPE-SPECIES: *Y. talismani* Perrier.

Ypsilothuria bitentaculata (Ludwig)

SYNONYMY: *See* Pawson, 1965e, fig. 6.

MATERIAL EXAMINED: Three specimens and fragments. Dom. Mus. Sta. BS 201, 2 + fragment; BS 202, 1 + fragment.

REMARKS: For description of this material, see Pawson, 1965e, p. 6.

DISTRIBUTION: This species is circum-Pacific in distribution, with a variety occurring in the Atlantic Ocean. In the New Zealand region it has so far been collected only off Taiaroa Head, Otago, but presumably it occurs in other bathyal areas around New Zealand.

BATHYMETRIC RANGE: 135–4,000 m.

HABITAT: Mud.

Echinocucumis Sars, 1859

DIAGNOSIS: Tentacles 10, unequal in size. Body spherical; mouth and anus placed at ends of non-retractile tubes. Tube feet scarce, slender, restricted to ambulacra. Body invested in large scales (1 mm diameter) made up of a single layer of calcareous material, never multilayered. Most scales with single long spire placed near margin.

TYPE-SPECIES: *Echinocucumis hispida* (Barrett).

Echinocucumis hispida (Barrett)

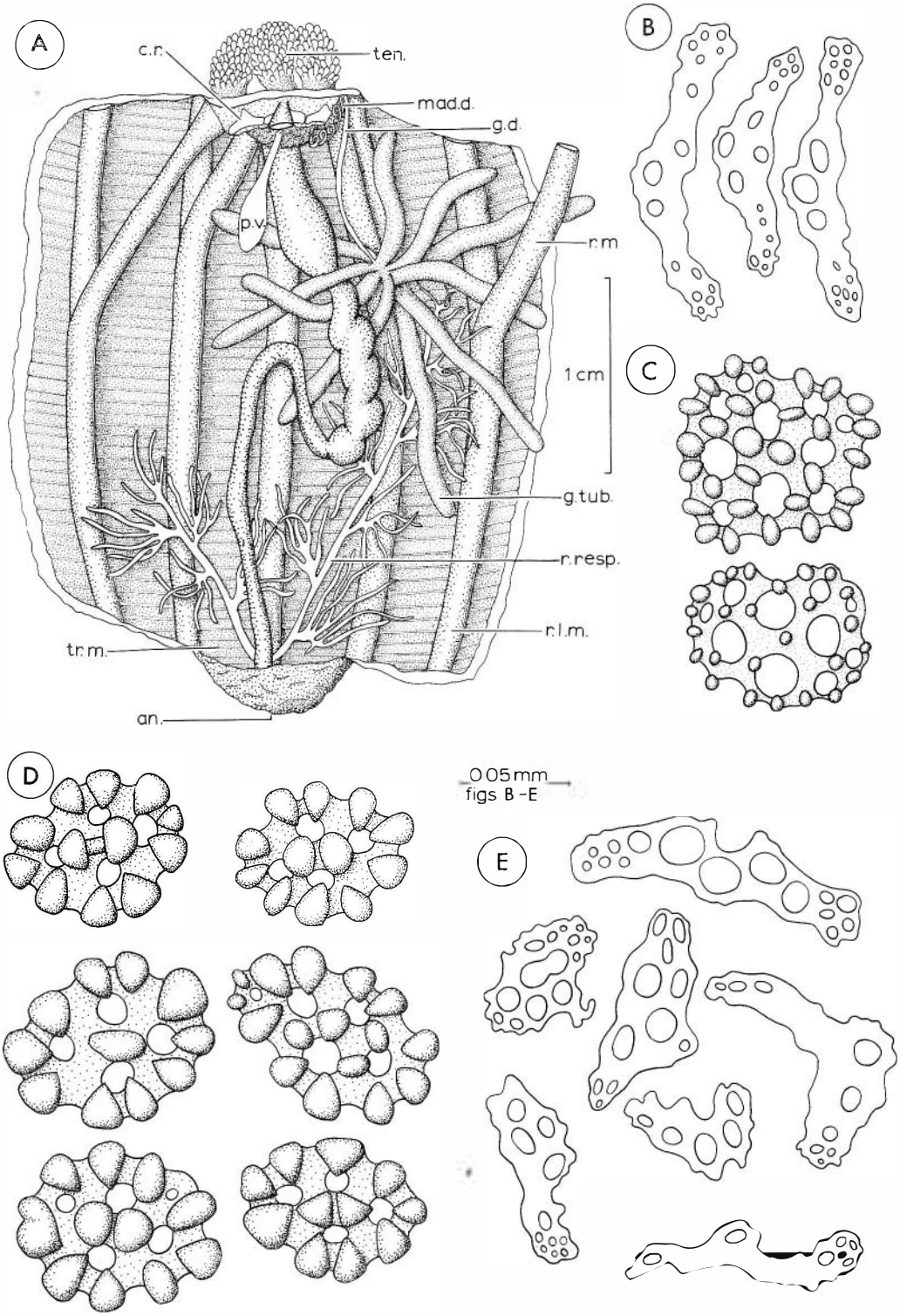
SYNONYMY: *See* Pawson, 1965e, p.8.

MATERIAL EXAMINED: Two specimens, NZOI Sta. C 603, 2.

REMARKS: New Zealand material of this widespread species differs in some respects (Pawson, 1965e) from northern specimens. Further material may show that the New Zealand specimens represent a new species.

DISTRIBUTION: North-eastern Atlantic and West Indian region (Deichmann, 1930). In New Zealand known so far from the Chatham Rise.

BATHYMETRIC RANGE: 50–1,400 m.



TEXT-FIG. 8. *Ocnus brevidentis* (Hutton). A, internal anatomy of adult dissected from left ventral side (portions of gonad removed); B, perforated rods from body wall; C, knobbed cups from body wall; D, knobbed plates from body wall; E, deposits from tentacles.

ABBREVIATIONS: an., anus; c.r., calcareous ring; g.d., genital duct; g. tub., genital tubule; mad. d., madreporic; duct (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 muscle.

Subclass **APODACEA** Brandt, 1835
(Nomen translatum Pawson and Fell, 1965)

DIAGNOSIS: Tentacles simple, digitate or pinnate. Tube feet markedly reduced or, more usually, lacking altogether. No introvert, hence retractor muscles lacking. Deposits may include anchors and anchor-plates.

KEY TO THE ORDERS IN SUBCLASS APODACEA

1 (2) Body cylindrical. Respiratory trees and anal papillae lacking. Deposits often include wheels..... APODIDA Brandt, 1835

2 (1) Body fusiform, often with tapering caudal portion. Respiratory trees and anal papillae present. Wheels lacking.....MOLPADIDA Haeckel, 1896

Although the two orders included within this subclass share several unusual features, it is quite possible that they are not closely related to each other; the shared characters may have arisen from evolutionary convergence. Certain anatomical features of members of the order Molpadida ally the group to the dendrochirotacean holothurians.

Order APODIDA Brandt, 1835

DIAGNOSIS: Body vermiform, with smooth, rough, or warty surface. Tube feet (except for tentacles) totally absent. Anal papillae, tentacle ampullae, and respiratory trees absent. Tentacles 10–25, simple digitate or pinnate. Calcareous deposits may include anchors and wheels, or are absent altogether.

REMARKS: Apodous holothurians are found in all seas, to depths of about 5,000 m. They are especially common in shallow waters in the Indo-west Pacific. It is currently believed that apodous holothurians were derived from dendrochirotids by loss of various structures. The internal anatomy is very simple. As respiratory trees are absent, respiration must take place through the usually thin body wall. Most apodids are burrowing forms.

Of the three families in this order, the Myriotrochidae does not occur in the New Zealand region; this family is mostly restricted to the boreal region, although one species is known from near the equator.

KEY TO NEW ZEALAND FAMILIES OF THE ORDER APODIDA

1 (2) Deposits include anchors and anchor-plates ..... SYNAPTIDAE Burmeister, 1837

2 (1) Deposits include wheels with six spokes arranged in papillae or scattered in the body wall. Sigmoid or C-shaped rods may also be present..... CHIRIDOTIDAE Oestergren, 1898

Family SYNAPTIDAE Burmeister, 1837

DIAGNOSIS: Calcareous deposits as 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).

REMARKS: This large family is represented in New Zealand by two genera and two species.

KEY TO NEW ZEALAND GENERA OF SYNAPTIDAE

1 (2) Anchor-plates more or less elongate and irregular in outline, with few (25–50) perforations, of which two near centre of plate are usually conspicuously larger than others .....*Rynkatorpa* Rowe and Pawson, 1967

2 (1) Anchor-plates usually rounded, with numerous perforations; central perforations not conspicuously larger than others .....*Protankyra* Oestergren, 1898

Rynkatorpa Rowe and Pawson, 1967

DIAGNOSIS: Anchors and anchor-plates all of one kind; anchors not conspicuously asymmetrical. Anchor-plates more or less elongate and irregular in outline with few (25–50) perforations, of which two near centre of plate are conspicuously larger than others. Perforations with smooth or spinous margins. Polian vesicles usually one to three (except in *R. uncinata*, which has four or five).

TYPE-SPECIES: *Rynkatorpa hickmani* Rowe and Pawson.

REMARKS: This genus was erected (Rowe and Pawson, 1967) to accommodate a group of species (formerly referred to *Protankyra*) that shares characters of the calcareous deposits and polian vesicles. Rowe and Pawson (1967) allied them partly to *Protankyra* and partly to *Labidoplax*. The New Zealand species *P. uncinata* (Hutton) appears to fall between *Rynkatorpa* and *Protankyra*, differing from the former genus in having more numerous polian vesicles, and from the latter in having anchor-plates of a unique type. However, polian vesicle numbers have often proved to be unreliable as diagnostic characters, and Rowe and Pawson (1967) preferred to rely more heavily on the structure of the anchor-plates in placing *R. uncinata*.

Rynkatorpa uncinata (Hutton)

Synapta uncinata Hutton, 1872, p. 17; Theel, 1886, p. 27; Dendy, 1896, p. 25; Farquhar, 1898, p. 325.
Synapta inaequalis Hutton, 1872, p. 17.
Protankyra uncinata: Mortensen, 1925, p. 367, figs 48–51; Heding, 1928, p. 252; Dawbin, 1950, p. 40; Pawson, 1963, p. 4, pl. 1.
Rynkatorpa uncinata: Rowe and Pawson, 1967, p. 31.

MATERIAL EXAMINED: 83 specimens and fragments. NZOI Sta. B 21, 1; B 54, 1; B 296, 2; B 547, 1; B 646, 6; B 647, 2; B 695, 2; C 183, 16 + fragments; C 209, 1; C 381, 1; C 787, 3; C 826, 1; C 851, 29 + fragments. Dom. Mus. Sta. BS 135, 1; BS 174, 5; BS 194, 7; Foveaux Strait, 1; Tasman Bay, 1; Wellington Harbour, 2.

DIAGNOSIS: Tentacles 12, with sensory cups and 4 terminal digits. Colour in life white 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.

DESCRIPTION: Most specimens in collection contracted; total length 20–100 mm. Colour generally light reddish

brown. This species has been described in detail by Mortensen (1925) and Pawson (1963).

DISTRIBUTION: Apparently occurs all around the New Zealand coast, being known from the Hauraki Gulf in the north to Stewart Island in the south.

BATHYMETRIC RANGE: An off-shore species, in 12–128 m.

HABITAT: Mud to muddy sand.

Protankyra Oestergren, 1898
(emend. Rowe and Pawson, 1967)

DIAGNOSIS: Anchors and anchor-plates of one or more kinds; anchors sometimes asymmetrical. Anchor-plates usually rounded, with numerous perforations, of which central perforations not conspicuously larger than others. Perforations with smooth or spinous margins. Usually more than three polian vesicles.

TYPE SPECIES: *Synapta abyssicola* Theel (= *Synapta brychia* Verrill).

REMARKS: This genus is essentially cosmopolitan in distribution, embracing approximately 30 species.

Protankyra rigida Pawson

Text-fig. 9

Protankyra rigida Pawson, 1965 b, p. 75, figs 1–3.

MATERIAL EXAMINED: One specimen. NZOI Sta. C 166, 1.

DIAGNOSIS: Body elongate, approximately cylindrical. Colour in alcohol buff, with numerous large white spots. Anchors large (1.0–1.2 mm long) and symmetrical; arms with 10–14 serrations; stock unbranched and finely toothed. Anchor-plates also large, oval, with many small perforations.

DESCRIPTION: Holotype contracted, tentacles completely retracted. Total length 39 mm, diameter at anterior end 9 mm. Body elongate, cylindrical, interradial areas raised, each with 60 or fewer anchors and anchor-plates, clearly visible as white spots to 1.2 mm in diameter. Anchor-plates diminish in size toward posterior end of body; they are lacking from extreme anterior and posterior ends of body. Radii naked. Colour in alcohol buff.

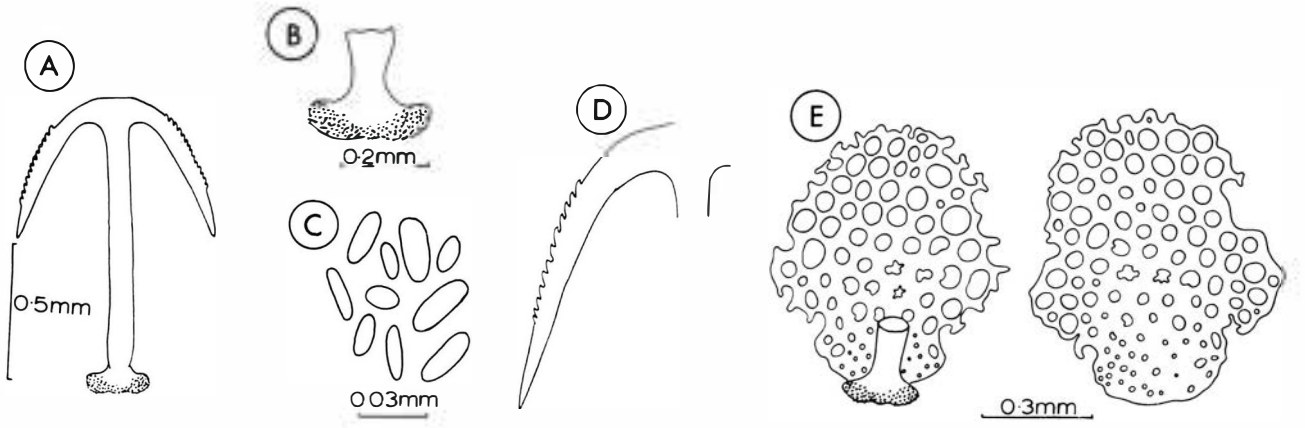
Anchors symmetrical, with long sharply pointed arms with 10–14 serrations on upper edges (Text-fig. 9A,D). Stock unbranched, with closely aggregated teeth, irregularly arranged (Text-fig. 9B). Length usually greater than 1 mm; maximum length 1.2 mm.

Anchor-plates (Text-fig. 9E) approximately oval, 0.7–1.0 mm long and 0.5–0.7 mm broad; perforations small, round, numerous (60–110 per plate); some central perforations may have 1–5 small indentations. No true bridge for support of anchor, but supporting area is distinguishable, having smaller, more scattered perforations.

Radial longitudinal muscles with large numbers of oval to elongate miliary granules (Text-fig. 9C) 0.015–0.03 mm in length, arranged in irregular rows, parallel to longitudinal axes of muscles.

REMARKS: Although this species is based on a single specimen, it is clearly distinguishable from most species of the genus by the very large size of its anchors and anchor-plates. The nearest relative appears to be *Protankyra denticulata* Koehler and Vaney (1905), also known from a single specimen from a depth of 738 m off Madras, India. Although the anchors are of approximately the same length in both species, the shaft in *P. denticulata* is rather more massive than that in *P. rigida* (ratio shaft width : anchor length in *P. denticulata* is 1 : 6, and in *P. rigida* the ratio is 1 : 10). In *P. denticulata* the anchor arms are broader and shorter than they are in *P. rigida*, and they carry fewer serrations. The anchor-plates of both species are of approximately the same size and shape, but in *P. denticulata* the larger perforations tend to be centrally placed, while in *P. rigida* they are near the margin of each plate.

The only other synaptid known from New Zealand, *Rynkatorpa uncinata* (Hutton), differs from *Protankyra rigida* in having small anchors 0.3–0.5 mm long and anchor-plates with few and large perforations.



TEXT-FIG. 9. *Protankyra rigida* Pawson. A, anchor; B, detail of anchor stock; C, miliary granules from longitudinal muscles; D, detail of anchor arm (same scale as B); E, anchor-plates.

DISTRIBUTION: Holotype taken from west of Cape Egmont.

BATHYMETRIC RANGE: 180–270 m.

HABITAT: Soft grey mud.

Family CHIRIDOTIDAE Oestergren, 1898

DIAGNOSIS: Calcareous deposits absent, or as six-spoked wheels; sigmoid or C-shaped rods may or may not be present. Tentacles with short stalks, becoming widened distally, where they bear 3 to 10 digits on each side (peltato-digitate).

REMARKS: Three genera and seven species of this family are known from the New Zealand region.

KEY TO THE NEW ZEALAND GENERA IN FAMILY CHIRIDOTIDAE

1 (2) Calcareous deposits absent from the body wall..... *Kolostoneura* Becher, 1909

2 (1) Calcareous deposits present.

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

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

Kolostoneura Becher, 1909

DIAGNOSIS: Calcerous deposits absent. Tentacles 10. General features of anatomy similar to those in genus *Trochodota* Ludwig.

TYPE-SPECIES: *Rhabdomolgus novaezealandiae* Dendy and Hindle.

REMARKS: The genus is monotypic. Clark (1921) believed that *Kolostoneura* may be regarded as a *Trochodota* lacking wheels and hooks. Mortensen's (1925) discovery of sigmoid hooks in some pathological specimens from Plimmerton lends much support to Clark's theory. The genus forms a parallel to *Anapta* and *Achiridota*, which appear to have been derived from *Leptosynapta* and *Chiridota* respectively by loss of calcareous deposits.

Kolostoneura novaezealandiae (Dendy and Hindle)

Rhabdomolgus novaezealandiae Dendy and Hindle, 1907, p. 113, pl. 11, figs 1–4, pl. 13, figs 16, 17, pl. 14, figs 22–29.
Kolostoneura novaezealandiae: Becher, 1909, p. 33; Clark, 1921, p. 164; Mortensen, 1925, p. 383; Dawbin, 1950, p. 40; Pawson, 1963, p. 7.

MATERIAL EXAMINED: 4 specimens. Dom. Mus. Sta. BS 130, 1; Menzies Bay, Banks Peninsula, 2; Cape Exped., No. 1 Station Inlet, Auckland Islands, 1.

DIAGNOSIS: Colour in life white or pinkish brown; transparent; white transparent in alcohol. Tentacles pinnate, occasionally containing calcareous deposits.

REMARKS: This species was fully described by Dendy and Hindle (1907). Individuals may reach a length of 100–150 mm.

DISTRIBUTION: Auckland to Stewart Island and the Chatham Islands.

BATHYMETRIC RANGE: Intertidal.

HABITAT: Under rocks in mud or sand.

Chiridota Eschscholtz, 1829

DIAGNOSIS: Tentacles 12. Polian vesicles numerous. Deposits six-spoked wheels aggregated into papillae. No sigmoid deposits, but small curved rods with enlarged ends may be present, and minute lenticular bodies may occur in longitudinal muscles.

REMARKS: This genus is represented in the New Zealand region by four species. One, *Chiridota gigas*, is also known from Australia.

KEY TO THE NEW ZEALAND SPECIES OF GENUS *Chiridota*

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

2 (3) Radial pieces of calcareous ring perforated. Wheels arranged in discrete papillae..... *C. mortenseni* Pawson

3 (2) Radial pieces of calcareous ring not perforated. Wheel papillae merge as vermiform aggregations of wheels near the middle of the body....*C. gigas* Dendy and Hindle

4 (1) Spinous rods absent.

5 (6) Colour in life black with white spots, ranging to white overall. Miliary granules present in radial muscles .... *C. nigra* Mortensen

6 (5) Colour white transparent. Miliary granules absent from radial muscles.....*C. carnleyensis* Mortensen

Chiridota mortenseni Pawson

Chiridota mortenseni Pawson, 1962b, p. 61–64, figs 1–5.

MATERIAL EXAMINED: None.

DIAGNOSIS: Light red alive, orange-brown in alcohol. Wheel papillae numerous in dorsal interradii, scattered ventrally. Wheels confined to papillae. Spinous rods (average length 0.1 mm), present in small numbers in skin. Tentacle rods smooth, not extensively bifurcating.

REMARKS: No further specimens of this species have been examined by the writer. It may be a synonym of *C. gigas* Dendy and Hindle (see below).

DISTRIBUTION: Known only from the type locality, Little Papanui, Otago.

BATHYMETRIC RANGE: Intertidal.

HABITAT: Under stones on sand.

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. 2.

MATERIAL EXAMINED: None.

DIAGNOSIS: Wheel papillae numerous, irregularly scattered, circular anteriorly and posteriorly, but forming vermiform prominences near the middle of the body. Calcareous ring of 12 pieces, the radials rounded anteriorly, interradials ovoid. Radials not perforated for passage of radial nerve.

REMARKS: This species is apparently rare in the New Zealand region, being known from two specimens. Joshua (1914) recorded specimens from Victoria, noting that the colour is bright scarlet, with prominent white papillae (wheel papillae). Hickman (1962) recorded specimens from Tasmania; they were yellowish-pink anteriorly, merging into dark red posteriorly.

When Dendy and Hindle (1907) described the holotype of this species, they emphasised the fact that the radial pieces of the calcareous ring were ovoid in shape, lacking perforations for the radial nerves, and lacking posterior notches. Joshua (1914) did not refer to the calcareous ring in his material, but Hickman (1962) noted that specimens he identified as *C. gigas* had well developed radial pieces in the calcareous ring, with perforations and posterior notches. Hickman's material closely resembled the specimen described as *C. mortenseni* (Pawson, 1962b.) If Dendy and Hindle's (1907) description of *C. gigas* is correct, then this is the only species in the large genus *Chiridota* that lacks perforations in the radial pieces of the calcareous ring. If their description is inaccurate or if their specimen was deformed in some way, then *C. mortenseni* Pawson may ultimately be synonymised with *C. gigas*, even though the former species differs in colour and has far fewer polian vesicles (7) than the latter (19–25). In general, Dendy and Hindle's work has proved to be thoroughly reliable, and I am unwilling to synonymise *C. gigas* and *C. mortenseni* until further material becomes available. (I have not been able to locate Dendy and Hindle's type material for re-examination.)

DISTRIBUTION: The type specimen was recorded from the Chatham Islands. Mortensen (1925) examined a specimen from Dusky Sound. Joshua (1914) and Clark (1946) report the species from various localities about Victoria and north-eastern Tasmania. Hickman (1962) recorded further material from Tasmania.

Chiridota nigra Mortensen

Text-fig. 10; Plate 2, fig. 4

Chiridota gigas: Benham, 1909, p. 73.
Chiridota nigra Mortensen, 1925, p. 371, figs 54–57; Dawbin, 1950, p. 40, pl. 2, fig. 21.

MATERIAL EXAMINED: 36 specimens. NZOI Sta. B 217, 3; B 218, 1; B 576, 1. Dom. Mus. Sta. BS 141, 26; BS 180, 3; North Point, Chalky Inlet, 2.

DIAGNOSIS: Dorsal surface generally black with white spots; ventral surface greyish-white. Dorsal skin usually peels off to reveal white undersurface. Wheel papillae few, large, and confined to three dorsal interradii. Spinous rods lacking. Tentacles contain bracket-shaped rods 0.03–0.05 mm long.

DESCRIPTION: All specimens large, largest 180 mm long, 8 mm in diameter at anterior end. Two specimens from Chalky Inlet uniformly wine-coloured, others black with white spots dorsally, greyish ventrally. In contracted specimens skin thick, with numerous transverse wrinkles; in relaxed specimens skin thin, smooth. White spots are wheel papillae, arranged in single irregular rows in dorsal interradii.

Mouth circular, in centre of small funnel-shaped depression, surrounded by ring of 12 tentacles. Stems of tentacles greyish-black, digits white. Each tentacle with five pairs of digits which increase in length toward distal extremity of tentacle, terminal pair being longest, about twice as long as proximal pair. Outer surface of tentacle with distinctive pattern of small polygonal areas (Text-fig. 10B).

Calcareous ring firm, composed of 12 pieces. Radials perforated for passage of radial nerve, with sharp anterior projection and shallow posterior notch. Anterior projection more pronounced on interradials.

From ventral side of water-vascular ring arise 15 to 20 polian vesicles 0.5–9 mm long. Stone canal loosely coiled, running anteriorly in dorsal mesentery, terminating in small madreporite (Text-fig. 10A).

Gonads are two small bunches of long unbranched caeca, each bunch about 30 mm long. Common genital duct opens to exterior in mid-dorsal interradius between two dorsal tentacles as inconspicuous genital pore. Ciliated funnels (Text-fig. 10C) numerous in left dorsolateral and left ventrolateral interradial. Funnels bell-shaped, with wide mouths and short stalks.

Dorsal papillae circular, 1–2 mm in diameter; each contains up to 250 wheels of varying size. Largest wheel found with diameter of 0.2 mm. Bracket-shaped rods (Text-fig. 10E) scattered in tentacle stems, arranged in double rows in digits. Rods 0.03–0.05 mm long, with enlarged ends. Radial muscles contain scattered, elongate, slightly curved miliary granules (Text-fig. 10D) with rounded ends; length 0.02–0.04 mm.

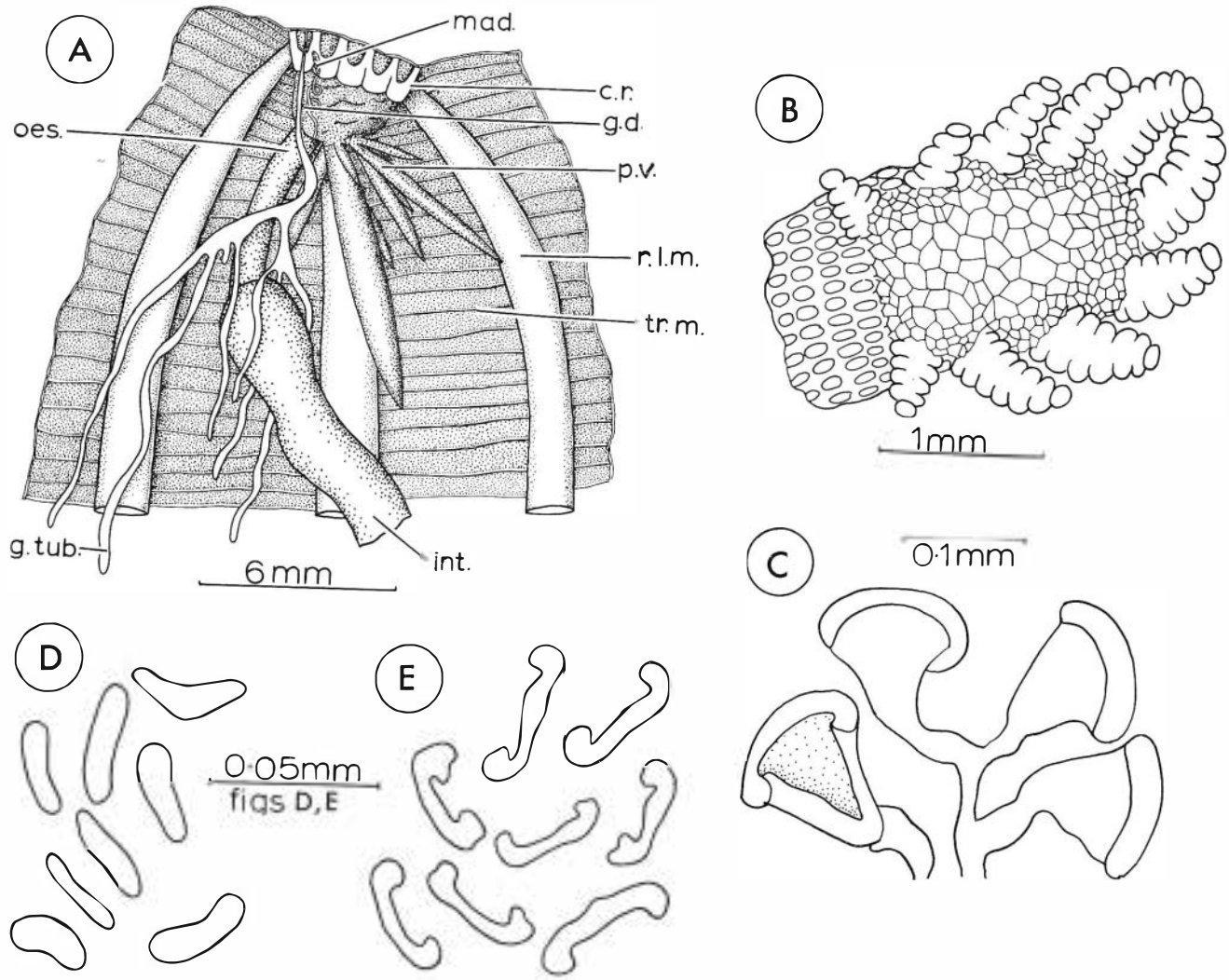
REMARKS: Mortensen (1925) stated that 8 polian vesicles were present in his material; no fewer than 15 were found in the present collection. The colour is variable, as the wine-red specimens indicate. The black skin can be peeled or rubbed to reveal a grey undersurface; uniformly grey specimens occur in collections I have examined more recently.

C. nigra resembles the boreal species *C. discolor* Eschscholz in several respects, but the shape and arrangement of the ciliated funnels serve to distinguish the two species.

DISTRIBUTION: Known from Stewart Island and Foveaux Strait to north of Cook Strait, and the Auckland Islands.

BATHYMETRIC RANGE: An offshore species, in 9–270 m.

HABITAT: Mud.



TEXT-FIG. 10. *Chiridota nigra* Mortensen. A, internal anatomy of anterior end of adult (portions of gonad and body wall removed); B, tentacle; C, ciliated funnels; D, miliary granules from radial muscles; E, bracket-shaped rods from tentacles.

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 muscle.

Chiridota carnleyensis Mortensen

Chiridota carnleyensis Mortensen, 1925, p. 374, fig. 58. Heding, 1928, p. 283; Dawbin, 1950, p. 40, pl. 2 fig. 21; Pawson, 1968b, p. 24, fig. 3 (7–8).

MATERIAL EXAMINED: None.

DIAGNOSIS: Colour in alcohol white transparent. Deposits in body wall wheels only, collected into diffuse round heaps. No deposits in radial muscles.

DISTRIBUTION: Known only from Auckland Islands.

BATHYMETRIC RANGE: 81–202 m.

Trochodota Ludwig, 1892

DIAGNOSIS: Tentacles 10, digits 2–6 on each side. Calcareous ring of 10 pieces, radials not perforated. Deposits include sigmoid hooks, scattered or arranged into groups, and wheels, scattered, never gathered into papillae.

TYPE-SPECIES: *Sigmodota purpurea* Lesson.

REMARKS: This distinctive genus embraces 10 species, 8 of which occur in the Western Pacific region.

KEY TO THE NEW ZEALAND SPECIES OF GENUS *Trochodota*

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

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

Trochodota dunedinensis (Parker)

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; Clark, 1907, p. 124; Clark, 1921, p. 166; Mortensen, 1925, p. 376, figs 59b, 60b, 61; John, 1939, p. 315; Dawbin, 1950, p. 40, fig. 19; Pawson, 1963, p. 8, pl. 1, fig. 1; 1968b, p. 24.

Chiridota geminifera Dendy and Hindle, 1907, p. 112, pl. 14, fig. 30.
Chiridota benhami Dendy, 1909, 151, pl. 6, fig. 3a–1.
Not: *Trochodota dunedinensis:* Allan, 1911, p. 325 (= *T. allani* Joshua); Ohshima, 1915a, p. 478 (= *T. diasema* Clark).
Chiridota australiana: Theel, 1886, p. 16.

MATERIAL EXAMINED: 51 specimens. Dom. Mus. Sta. BS 141, 31; Preservation Inlet, 3. Cape Exped. Waterfall Inlet, 2; Crozier Point, 3, 2; Tagua Bay, 6; opposite Passage Island, 4.

DIAGNOSIS: Colour in life reddish brown, darker near anterior and posterior extremities of body. Body smooth, without papillae. Deposits wheels and sigmoid hooks scattered in skin. Radials and interradials irregular in shape, notched anteriorly, and posteriorly.

REMARKS: This small holothurian, usually less than 50 mm in total length, is readily recognised because of its distinctive colour, and is frequently found, particularly in the Cook Strait region, concealed in tufts of the seaweed *Corallina* or under stones.

DISTRIBUTION: This species is known to range from Hawke Bay south to Stewart Island on the New Zealand coast, and is also recorded from the Auckland Islands (Mortensen, 1925), Campbell Island (Mortensen, 1925, Pawson, 1968b), and Macquarie Island (Pawson, 1968b).

BATHYMETRIC RANGE: 0–180 m.

HABITAT: In mud under stones, or in tufts of *Corallina*. Offshore, in mud, or mud and gravel.

Trochodota dendyi Mortensen

Trochodota dendyi Mortensen, 1925, p. 381, figs 62–63a; Dawbin, 1950, p. 40; Pawson, 1963, p. 9; 1968b; p. 25 fig. 3 (4–6).

MATERIAL EXAMINED. None.

DIAGNOSIS: Colour white or faint purple. Skin papillate, each papilla containing three to six sigmoid hooks. Wheels numerous or absent. Tentacle deposits with bifurcating extremities.

REMARKS: This species seems to be approaching the condition found in the monotypic Australian genus *Scoliorhapis*, which typically lacks wheels in the body wall. Specimens of *Trochodota dendyi* and *Scoliorhapis theeli* may be distinguished by their tentacle rods, which are branched in *Trochodota dendyi* and unbranched in *Scoliorhapis theeli*.

DISTRIBUTION: *Trochodota dendyi* is widespread on the New Zealand coast and has been recorded from intertidal and shallow localities at Auckland, Wellington, and Stewart Island (Mortensen, 1925), also from 100 miles north-west of Auckland Island (Pawson, 1968b).

BATHYMETRIC RANGE: 0–126 m.

HABITAT: Mud, sand, and shell.

Order MOLPADIDA Haeckel, 1896

DIAGNOSIS: Body stout, tapering posteriorly to form more or less conspicuous tail. Tentacles 15, digitate. Anal papillae, respiratory trees, tentacle ampullae present. Radial muscles in form of double bands. Deposits commonly tables, fusiform rods, or perforated plates, anchors. Phosphatic bodies often present.

KEY TO FAMILIES OF ORDER MOLPADIDA

1 (4) Tentacle ampullae present.
2 (3) Tentacles with one to three pairs of digits and a terminal digit ..... MOLPADIIDAE Muller, 1850
3 (2) Tentacles with two pairs of digits and no terminal digit CAUDINIDAE Heding, 1931
4 (1) Tentacle ampullae absent..EUPYRGIDAE Semper, 1868

REMARKS: This order is cosmopolitan, with a bathymetric range of 0–3600 m. The greatest number of species occurs in the Indo-west Pacific region; some (e.g., *Molpadia musculus* (Muller)) are cosmopolitan in distribution, but most are restricted. The family Eupyrgidae is unknown from the New Zealand region, being known so far from the Arctic and North-western Pacific.

Family MOLPADIIDAE Muller, 1850

DIAGNOSIS: Tentacles with lateral digits, or claw-shaped. Tentacle ampullae long (reduced in one deep-water species). Spicules derived from triradiate tables with solid three-pillared spire. Tail with tables with round to oblong disc, or long fusiform rods. Dark red egg-shaped phosphatic bodies often present.

REMARKS: For remarks on the content of this family see Pawson 1963 p.10.

KEY TO NEW ZEALAND GENERA OF THE FAMILY MOLPADIIDAE

1 (2) Deposits include anchors, three-armed anchor-plates, spired tables ..... *Heteromolpadia* Pawson, 1963
2 (1) Deposits may include anchors and rosettes of racquet-shaped plates, fusiform rods, spired tables. No three-armed anchor-plates ..... *Molpadia* Risso, 1826

Heteromolpadia Pawson, 1963

DIAGNOSIS: Calcareous deposits include two-armed anchors associated with single perforated anchor-plates of varying shapes, which have three marginal projections. No rosettes of racquet-shaped plates; no fusiform rods. Phosphatic bodies present, at least in adult specimens.

TYPE-SPECIES: *Ankyroderma marenzelleri* Theel.

REMARKS: The genus now comprises three species, *Heteromolpadia marenzelleri* and *H. pikei* Pawson from New Zealand, and *H. tridens* (Sluiter) from the Java Sea.

KEY TO SPECIES OF GENUS *Heteromolpadia*

1 (2) Tables absent from body wall..... *H. tridens*
2 (1) Tables present.
3 (4) Tables of average diameter 0.3 mm, with 3–5 large perforations ..... *H. pikei*
4 (3) Tables of average diameter 0.15 mm, typically with three large perforations ..... *H. marenzelleri*

Heteromolpadia pikei Pawson

Heteromolpadia pikei Pawson, 1965b, p. 79, figs 4–6; 1965e, p. 10.

MATERIAL EXAMINED: None.

DIAGNOSIS: Deposits spired tables (average diameter 0.3 mm) with 3 to 15 large perforations, and anchors associated with triradiate anchor-plates, the plates having two long projections (0.15 mm) and one short (0.075 mm), each projection usually having a single perforation at its broadened distal extremity. Tail deposits elongate perforated tables of average length 0.17 mm, each with a three-pillared spire and 6 to 10 perforations.

DISTRIBUTION: This species is so far known only from the Bay of Plenty.

BATHYMETRIC RANGE: 370–504 m.

HABITAT: Unknown, probably mud.

Heteromolpadia marenzelleri (Theel)

Ankyroderma marenzelleri Theel, 1886, p. 41, pl. 3, fig. 1a–g.
Molpadia marenzelleri: Clark, 1907, p. 171, pl. 10, fig. 23; Benham, 1909, p. 70, pl. 11 fig. 4a–d; Deichmann, 1936, p. 464; Dawbin, 1950, p. 39, pl. 2, fig. 17.
Molpadia dendyi Benham, 1909, p. 71, pl. 11, fig. 1–3.
Pseudomolpadia marenzelleri: Heding, 1931, p. 280.
Heteromolpadia marenzelleri: Pawson, 1963, p. 1, pl. 2; 1965b, p. 10.

MATERIAL EXAMINED: 94 specimens. NZOI Sta. A 435, 1; B 11, 1; B 44, 1; B 49, 1; B 318, 1; B 496, 1; B 524, 2; B 646, 4; B 670, 1; B 673, 3; B 675, 1; B 678, 3; B 686, 3; C 167, 1; C 170, 1; C 175, 1; C 184, 14; C 185, 1; C 186, 1; C 189, 1; C 223, 1; C 481, 1; C 748, 2; C 753, 4; C 776, 1; C 826, 11; C 827, 1; C 828, 2; C 851, 22; C 900, 1. Dom. Mus. Sta. BS 181, 2; Cook Strait, 2; off Foxton, 1.

DIAGNOSIS: Deposits in body wall spired tables with three large perforations, and anchors associated with three-armed perforated anchor-plates up to 0.4 mm in length. Tail deposits elongate oval, 0.1–0.15 mm in length. With growth, anchors and anchor-plates tend to disappear, due to their transformation into phosphatic deposits.

REMARKS: All specimens agree well with those described from Cook Strait (Pawson, 1963) and elsewhere (Pawson, 1965e). Colour ranges from greyish to dark red, and the tail is uniformly grey in every specimen. This species is one of the more common of the New Zealand off-shore holothurians, and is now well defined.

DISTRIBUTION: Present records indicate that this species is distributed all around the New Zealand coast.

BATHYMETRIC RANGE: An off-shore species, in 22–720 m.

HABITAT: Occurs in a variety of habitats, including fine mud, muddy sand, shell, and sandy gravel.

Molpadia Risso, 1826

DIAGNOSIS: Calcareous deposits include tables, anchors, and rosettes of racquet-shaped plates, and large fusiform rods in various combinations. Tail deposits fusiform rods.

TYPE-SPECIES: *Molpadia musculus* Risso.

REMARKS: Four species of this perplexing genus are now known to occur in the New Zealand region. One, collected off Kaikoura in 490 m (NZOI Sta. B 291), is possibly new (see Pawson, 1965e, p. 13), but was not described as such, for the material was inadequate and it was not possible to make a detailed description, which is so necessary in this genus.

KEY TO THE NEW ZEALAND SPECIES OF GENUS *Molpadia*

1 (4) Calcareous deposits include large fusiform rods, which are present in the body wall and in the tail.
2 (3) Anchors and rosettes of racquet-shaped plates present *M. musculus* Risso
3 (2) Anchors and rosettes absent ..... *M. violacea* (Studer)
4 (1) Fusiform rods absent from body wall and tail. Deposits spired tables ..... *M. antarctica* (Theel)

Molpadia musculus Risso

SYNONYMY: *See* Pawson, 1965e, p. 11.

MATERIAL EXAMINED: One specimen, NZOI Sta. C 609, 1.

DIAGNOSIS: Deposits anchors and rosettes of racquet-shaped plates, together with oval to elongate plates 0.3 mm to 1.0 mm in length, typically with three central perforations. Tables of average diameter 0.3 mm with three perforations and a spire composed of a single rod also occur.

REMARKS: The inclusion of this species in the New Zealand fauna rests on the single specimen collected from the Chatham Rise (NZOI Sta. C 609). The specimen is described elsewhere (Pawson, 1965e).

DISTRIBUTION: This species is cosmopolitan. In the New Zealand region it is known so far from the Chatham Rise.

BATHYMETRIC RANGE: 100–900 m.

HABITAT: Generally mud.

Molpadia violacea (Studer)

Trochostoma violaceum Studer, 1876, p. 460; Theel, 1886, p. 42, pl. 2, fig. 4, pl. 11, fig. 1.
Molpadia musculus (pars): Clark, 1907, p. 165, pl. 11.
Haplodactyla violacea: Heding, 1931, p. 280.
Molpadia violacea: Pawson, 1963, p. 15, pl. 3, figs 4–8; 1965e, p. 12.

MATERIAL EXAMINED: One specimen. NZOI Sta. C 491, 1.

DIAGNOSIS: Deposits in form of large fusiform rods with two or three arms, up to 1.1 mm in length; no anchors or anchor-plates. No rosettes of racquet-shaped plates. Tail deposits fusiform rods up to 0.8 mm in length. One anterior process on each radial piece of calcareous ring perforated for passage of radial nerve.

DESCRIPTION: Total length 71 mm, tail 18 mm. Colour in alcohol dark red, anterior extremity of body and tail grey. Tentacles retracted. Calcareous deposits typical of species; these have been described elsewhere (Theel, 1886; Pawson, 1963).

DISTRIBUTION: East of East Cape, New Zealand, in the region of Cook Strait, and near Kerguelen Island.

BATHYMETRIC RANGE: In New Zealand, 720–1,260 m. Near Kerguelen Island, 36–216 m.

HABITAT: Mud.

Molpadia antarctica (Theel)

Trochostoma antarcticum Theel, 1886, p. 44, pl. 2, fig. 7. Herouard, 1901, p. 42; Augustin, 1908, p. 35, text-fig. 22a–c.
Molpadia antarctica: Clark, 1907, p. 32, p. 168; Ohshima, 1915b, p. 252; Pawson, 1965e, p. 13, text-fig. 3, figs 5–7.

MATERIAL EXAMINED: One specimen. NZOI Sta. C 604, 1.

DIAGNOSIS: Body wall deposits exclusively spired tables of average diameter 0.28 mm, with six or more large perforations; spires composed of three pillars. Anchors and anchor-plates or rosettes absent. Tail deposits elongate tables of average length 0.16 mm, carrying three-pillared spires. Phosphatic deposits rare or absent.

REMARKS: This unique molpadid was collected from the Chatham Rise (NZOI Sta. C 604) in 990–865 m, and is described elsewhere (Pawson, 1965e).

DISTRIBUTION: Occurs off Chile, Alexander Land (Antarctica), Japan, and New Zealand.

BATHYMETRIC RANGE: 80–1,218 m.

Family CAUDINIDAE Heding, 1931

DIAGNOSIS: Tentacles with one or two pairs of digits, but no terminal digit. Deposits large tables or plates, or small crossed cups, or irregular bodies. No phosphatic bodies, but discolouration of skin may occur in older individuals of some species.

REMARKS: This cosmopolitan family is represented in New Zealand by two species of two genera.

KEY TO NEW ZEALAND GENERA OF THE FAMILY CAUDINIDAE

1 (2) Calcareous deposits large tables with numerous holes in disc ..... *Hedingia* Deichmann, 1938
2 (1) Calcareous deposits cups, buttons, perforated plates, or irregular rods ..... *Paracaudina* Heding, 1931

Hedingia Deichmann, 1938

DIAGNOSIS: Calcareous deposits large tables (0.15–0.27mm diameter) with numerous holes in disc; a three-pillared spire may be present, reduced, or lacking altogether; deposits often spinous.

TYPE-SPECIES: *Trochostoma albicans* Theel.

REMARKS: This genus was established to include four deep-water caudinid species, all of which have characteristic large tables in the body wall. One species has been recorded from near New Zealand.

Hedingia albicans (Theel)

SYNONYMY: *See* Pawson, 1965e, p.14.

MATERIAL EXAMINED: None.

DIAGNOSIS: Deposits large tables; disc often triangular in outline. Spine three-pillared; disc and spine often spinous.

REMARKS: Theel (1886) described the variety *glabra* of this species from off East Cape in a depth of 1,260m. This variety differs from the typical form chiefly in having fewer calcareous deposits in the skin, which is consequently smoother.

DISTRIBUTION: Off New Zealand, south of Iceland, off the north-east coast of North America, the Cape Verde Islands, Mediterranean Sea, Bay of Bengal. The species is therefore virtually cosmopolitan in distribution.

BATHYMETRIC RANGE: 500–3,200m.

HABITAT: Mud.

Paracaudina Heding, 1931

DIAGNOSIS: Tentacles with two pairs of digits. Caudal appendage usually long and slender. Deposits not tables but cups or buttons, perforated plates, or irregular rods.

TYPE-SPECIES: *Molpadia chilensis* Muller.

Paracaudina chilensis (Muller)

Plate 2, Fig. 2

SYNONYMY: *See* Pawson, 1963, p.10.

MATERIAL EXAMINED: 399 specimens. NZOI Sta. B 8, 326 + fragments; B 37, 2; B 323, 1; B 471, fragments; B 495, 1; B 496, 3; B 525, fragments; B 545, 2; B 624, fragments; B 629, 1; C 167, 1+fragments; C 183, 2; C 184, 3; C 209, 1; C 223, 1; C 259, 2; C 411, fragments; C 412, fragments; C 414, fragments; C 787, 1 + fragments; C 803, 1 + fragments; C 814, 1; C 912, 1; C 913, 1; C 925, 1; C 945, 1. Dom. Mus. Sta. BS 144, 1; BS 155, 11; BS 156, 1; BS 157, 20; BS 158, 4; Port Gore, 1; Menzies Bay, 3; Cape Campbell, 1; Cook Strait, 1; New Brighton, 1; East Cape, 1; New Plymouth, 1.

DIAGNOSIS: Calcareous deposits present as thick crossed cups with small perforations, marginal projections when present being low and rounded. Cups, especially in young specimens, approximately octagonal, while points of octagon may be obscured in older specimens. Diameter of cups 0.06–0.1mm.

DESCRIPTION: In present specimens total length ranges from 20 to 160mm. Colour generally white, although some large specimens light brown. Skin firm, coriaceous, tentacles retracted in all specimens. Calcareous deposits and internal anatomy typical (see Pawson, 1963, p.18).

DISTRIBUTION: This species is circum-Pacific in distribution, occurring off north-west Australia, Japan California, Florida, Chile, and New Zealand. In the New Zealand region it appears to range from the northern part of the North Island to Otago in the South Island.

BATHYMETRIC RANGE: 9–990m.

HABITAT: Sand to mud, rarely shell.

Subclass **ASPIDOCHIROTACEA** Grube 1840

(Nomen translatum Pawson and Fell, 1965, ex Aspidochirotae Grube, 1840)

DIAGNOSIS: Tube feet present, tentacles shield-shaped, 10–30 in number. No introvert, hence retractor muscles absent. Body with conspicuous external bilateral symmetry.

REMARKS: This subclass comprises the Orders Aspidochirotida and Elasipodida. It is evident that these orders are related for they share some fundamental features. The elasipodids are essentially restricted to deep waters. Theel (1886) was the first to suggest that the elasipodids probably arose from the aspidochirotids by simplification and loss of certain structures. Both orders are represented in the New Zealand region.

KEY TO ORDERS OF SUBCLASS ASPIDOCHIROTACEA

1 (2) Respiratory trees present. Mesentery of posterior loop of intestine attached to right ventral interradius..... ASPIDOCHIROTIDA Grube, 1840

2 (1) Respiratory trees absent. Mesentery of posterior loop of intestine attached to right dorsal interradius..... ELASIPODIDA Theel, 1882

Order ASPIDOCHIROTIDA Grube, 1840

DIAGNOSIS: Tentacles shield-shaped, 15–30 in number. Respiratory trees present. Mesentery of posterior loop of intestine attached in right ventral interradius. Longitudinal muscles as five double bands.

KEY TO FAMILIES OF ORDER ASPIDOCHIROTIDA

1 (4) Tentacle ampullae present.

2 (3) Gonad in two tufts, one to each side of dorsal mesentery STICHOPODIDAE Haeckel, 1896

3 (2) Gonad in one tuft, lying on left side of dorsal mesentery HOLOTHURIIDAE Ludwig, 1894

4 (1) Tentacle ampullae absent ..... SYNALLACTIDAE Ludwig, 1896

REMARKS: All of the above families are represented in the New Zealand region.

Family STICHOPODIDAE Haeckel, 1896

DIAGNOSIS: Gonad in two tufts, one to each side of dorsal mesentery. Stone canal connected to body wall, but not opening to exterior. Deposits tables and rarely buttons.

REMARKS: This family comprises four genera, of which *Stichopus* is by far the largest. This genus is especially well developed in tropical regions of the Pacific and Indian Oceans, and is represented in the New Zealand region by one species, *S. mollis* (Hutton).

Stichopus Brandt, 1835

DIAGNOSIS: Ventral surface flattened, markedly distinct from dorsal surface; pedicels more or less fully covering ventral side. Dorsal surface with tubercles or papillae, at least along lateral margins. Tentacles typically 20. No cuvierian organs, no anal teeth or noticeable papillae around cloacal opening. Numerous calcareous tables in skin. Polian vesicles few, unbranched, stone canal single (after Clark, 1922).

TYPE-SPECIES: *Stichopus chloronotus* Brandt.

REMARKS: The New Zealand species of this genus, *S. mollis*, is unique in that it occurs to at least 46°S. Most members of the genus are restricted to tropical and subtropical areas.

Stichopus mollis (Hutton)

Holothuria mollis Hutton, 1872, p. 15; 1878, p. 308.
Stichopus sordidus Theel, 1886, p. 167, pl. VIII, fig. 3.
Holothuria victoriae Bell, 1887, p. 534, pl. 45, fig. 7.
Stichopus mollis: Dendy, 1896, p. 46, pl. 7, figs 73–82; Whitelegge, 1897, p. 50; Farquhar, 1898, p. 326; Ludwig, 1898a, p. 7; Perrier, 1905, p. 83; Dendy and Hindle, 1907, p. 96, pl. 12, fig. 12; Erwe, 1913, p. 387, Taf. VII, fig. 22; Joshua, 1914, p. 2; Clark, 1922, p. 60; Mortensen, 1925, p. 327; Clark, 1938, p. 511; Clark, 1946, p. 417; Dawbin, 1950, p. 35, pl. 1, fig. 1; Pawson, 1963, p. 34.
Stichopus simulans Dendy and Hindle, 1907, p. 97, pl. 11, fig. 5, Joshua, 1914, p. 3; Clark, 1922, p. 69.
Stichopus simultans Erwe, 1913, p. 388, Taf. VIII, fig. 23a–d.

MATERIAL EXAMINED: 17 specimens + fragments. NZOI Sta. B 217, 1; B 219, 2; B 267, 1; B 605, 4; B 648, 1; C 624, 2 + fragments; C 672, 1; C 673, 1; C 701, 1; C 703, 1; C 851, 1; Dom. Mus. Farewell Spit, 1.

DIAGNOSIS: Large forms, colour light mottled brown to black. Deposits tables with regular spires which are more or less open at the top with one or two cross bars.

Discs of tables square or squarish, 0.055–0.065 mm in diameter, with four large holes and four smaller ones at the corners. (Clark, 1922.)

REMARKS: *S. mollis* is perhaps the best known of the New Zealand holothurians, as it is so commonly encountered in intertidal pools on rocky shores and on sandy-mud bottoms in shallow water. Previous workers have fully described the deposits and anatomy of this species.

The present collection comprises typical examples of the species, although the specimen from Sta. B 217 is unusual in being black overall.

DISTRIBUTION: Central and southern New Zealand and the Chatham Rise, southern and western Australia and Tasmania.

BATHYMETRIC RANGE: 0–270 m.

HABITAT: Varied. In-shore, occurs on sandy mud, sand, and in intertidal rock pools. Off-shore, substrate ranges from mud through muddy sand to coarse polyzoans and shell.

Family HOLOTHURIIDAE Ludwig, 1894

DIAGNOSIS: Gonad in one tuft on left side of dorsal mesentery. Tentacle ampullae long and slender. Deposits tables and buttons.

REMARKS: Deichmann (1958) is the most recent worker to have attempted a revision of the very large tropical and subtropical genus *Holothuria*. The revision was incomplete, based primarily on the species of the Panama region of the West Coast of America, and the sole New Zealand species of this genus was referred to a new genus *Vaneyothuria*.

Vaneyothuria Diechmann, 1958

DIAGNOSIS: *See* Deichmann, 1958, p. 307.

TYPE-SPECIES: *Holothuria lentiginosa* v. Marenzeller

Vaneyothuria neozelanica (Mortensen)

Holothuria neozelanica Mortensen, 1925, p. 330, fig. 23; Dawbin, 1950, p. 35.
Vaneyothuria neozelanica: Deichmann, 1958, p. 308.

MATERIAL EXAMINED: None.

DIAGNOSIS: Colour greyish with white spots. Deposits include tables with marginal spines and a diameter of 0.08 mm, and smooth buttons, each with six to eight perforations. Tentacles 16.

REMARKS: Mortensen (1925) attaches some importance to the tentacle numbers as a specific character in this species. The holotype was taken 2 miles east of North Cape from a depth of 100 m. No further specimens of *V. neozelanica* have been recorded from New Zealand. No representatives of the family Holothuriidae are known to occur south of about 35° S, and thus it is likely that *V. neozelanica* is restricted to the warmer waters in the northern part of New Zealand.

Family SYNALLACTIDAE Ludwig, 1894

DIAGNOSIS: Tentacle ampullae absent. Stone canal sometimes opening outwards through body wall. No cuvierian organs. Deposits tables, occasionally C-shaped bodies, very rarely buttons (after Mortensen, 1927).

REMARKS: This cosmopolitan family comprises 15 nominal genera. Two of these, *Mesothuria* and *Bathyplotes*, are known from the New Zealand region. It is probable, in view of the known distribution of the other genera in the family, that several other genera will eventually be discovered in the New Zealand region.

KEY TO NEW ZEALAND GENERA OF FAMILY SYNALLACTIDAE

1 (2) Gonad a single tuft. Deposits tables with approximately circular discs bearing large perforations..... *Mesothuria* Ludwig, 1894
2 (1) Gonad in two tufts. Deposits tables with cross-shaped discs ..... *Bathyplotes* Oestergren, 1896

Bathyplotes Oestergren, 1896

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

TYPE-SPECIES: *Holothuria natans* M. Sars.

REMARKS: *Bathyplotes* is cosmopolitan in distribution, comprising more than 30 species and having a bathymetric range of 60–3,000 m.

Bathyplotes natans (Sars)

SYNONYMY: *See* Pawson, 1965e, p.16.

MATERIAL EXAMINED: None.

DESCRIPTION: *See* Pawson, 1965e, p.16, text-fig. 4.

DISTRIBUTION: From New Zealand, the species is known from the vicinity of the Poor Knights and Cavalli Islands and from Chalky Inlet (Pawson, 1965e). Elsewhere known from the North Atlantic, the Caribbean, and Japan.

BATHYMETRIC RANGE: 200–1,600 m.

Mesothuria Ludwig, 1894

DIAGNOSIS: Gonad in one tuft. Ventral surface flattened. Tube feet all over body, or in single or double rows on paired radii. Deposits tables with approximately circular disc bearing large perforations, and a spire composed of three processes united by cross bars.

TYPE-SPECIES: *Mesothuria multipes* Ludwig.

REMARKS: Like *Bathyplotes*, *Mesothuria* is cosmopolitan in distribution, but contains fewer than 30 species.

Mesothuria lactea (Theel)

SYNONYMY: *See* Pawson, 1965e, p.18.

MATERIAL EXAMINED: None.

DISTRIBUTION: Arctic, Pacific, and Atlantic Oceans. Theel (1886) described specimens from "Challenger" Sta. 169, east of East Cape, New Zealand, in 1,260 m. No specimens of this species have since been collected in the New Zealand region.

BATHYMETRIC RANGE: 700–5,100 m.

Order ELASIPODIDA Theel, 1882

DIAGNOSIS: Respiratory trees absent. Mesentery of posterior loop of intestine attached to right dorsal interradius. Deposits include pointed rods or their derivatives, wheels, cruciform bodies, or are lacking altogether.

REMARKS: Elasipods are deep-sea forms, which generally live on muds or oozes, but some are bathypelagic for long or short periods of time. Pawson (1965a, 1965e) has described the nine species of elasipodids now known to occur in the New Zealand region.

Two of these were collected by the New Zealand Oceanographic Institute and the Dominion Museum. To avoid unnecessary repetition the New Zealand forms are merely diagnosed below, with some information on distribution. For further details the reader is referred to Pawson (1965a, 1965e).

As many elasipodids have a more or less cosmopolitan distribution it is probable that several more representatives of this group will be found to occur in the New Zealand region.

KEY TO FAMILIES OF ORDER ELASIPODIDA

1 (2) Body ovoid, gelatinous, lacking calcareous deposits. Usually a large brim developed anteriorly..... PELAGOTHURIIDAE Ludwig, 1894

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

3 (4) Elongate non-retractile lateral processes present. Skin usually thin, parchment-like or brittle..... DEIMATIDAE Theel, 1882

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

5 (6) Calcareous deposits include wheels ..... LAETMOGONIDAE Ekman, 1925

6 (5) Wheels lacking.

7 (8) Calcareous deposits most commonly include straight or curved rods and three-armed spicules, rarely minute net-like plates and rosette-shaped or elliptical bodies..... ELPIDIIDAE Theel, 1882

8 (7) Deposits simple rods or four-armed bodies, with inwardly curved arms and often an outer central projection PSYCHROPOTIDAE Theel, 1882

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

Family LAETMOGONIDAE Ekman, 1925

DIAGNOSIS: Body elongate, more or less cylindrical. Ventrolateral radii each with large, well developed pedicels, distributed throughout the radius. Midventral radius naked, or with some small pedicels. Dorsal processes elongate, flexible, distributed throughout the radii. Calcareous deposits include wheels in large numbers. Gonads branched. Mesenteries as continuous membranes. (After Mortensen, 1927; Deichmann, 1930.)

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

KEY TO NEW ZEALAND GENERA OF FAMILY LAETMOGONIDAE

1 (8) Midventral radius naked.

2 (3) Apart from the deposits in the processes and pedicels, deposits of the dorsal body wall aggregated into heaps *Bathygone* Pawson, 1965

3 (2) Deposits scattered, not aggregated.

4 (5) Dorsal processes elongate, not retractile, usually not in crowded series .....*Laetmogone* Theel, 1879

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

6 (7) Deposits wheels of one type, strongly vaulted..... *Benthogone* Koehler, 1896

7 (6) Deposits wheels of two distinct types..... *Ilyodaemon* Theel, 1879

8 (1) Midventral radius with a double series of pedicels..... *Pannychia* Theel, 1882

Ilyodaemon Theel, 1879

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

TYPE-SPECIES: *Ilyodaemon maculatus* Theel.

REMARKS: The genus is widespread in the Indo-west Pacific (*I. fimbriatus*, *I. maculatus*, and *I. abstrusus*) and off Japan (*I. ijimai* and *I. muriense*), in depths ranging between about 159 m and 1,000 m. The fact that one species of *Ilyodaemon* is now known to occur in New Zealand waters considerably extends the known range of distribution, and it seems likely that the genus will be found to have a far wider distribution than formerly has been supposed.

KEY TO SPECIES OF GENUS *Ilyodaemon*

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

2 (3) Approximately 140–150 processes in each dorsal radius *I. maculatus* Theel

3 (2) Approximately 100 processes in each dorsal radius..... *I. muriense* Ohshima

4 (1) "Rosettes" lacking.

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

6 (7) Dorsal radii each with approximately 140–160 processes. Colour in alcohol violet to dark violet....*I. abstrusus* Sluiter

7 (6) Dorsal radii each with approximately 100 processes. Colour in alcohol whitish-grey..... *I. ijimai* Mitsukuri

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

Ilyodaemon abstrusus Sluiter

Ilyodaemon abstrusus Sluiter, 1901a, p. 24; 1901b, p. 69, pl. 4, figs 1–3, pl. 9, fig. 9; Pawson, 1965e, p. 20, text-fig 5, figs 1–6.

MATERIAL EXAMINED: None.

DIAGNOSIS: Dorsal radii each with approximately 140–160 processes. Less than 50 pedicels in each ventrolateral radius. Colour in alcohol violet to dark violet.

DISTRIBUTION: The species is known from the Java and Banda Seas and from the north-east of New Zealand.

BATHYMETRIC RANGE: In New Zealand, 468–543 m. In the Java and Banda Seas, 694–959 m.

Pannychia Theel, 1882

DIAGNOSIS: Tentacles 20, large, non-retractile. Ventrolateral radii with large pedicels in a single row throughout each radius. Midventral radius with a double row of pedicels. Dorsal surface with a crowded series of very numerous slender processes along each side. Deposits large wheels and small wheel-shaped plates.

TYPE-SPECIES: *Pannychia moseleyi* Theel.

REMARKS: The genus contains five species. The type-species is wide ranging in the Pacific Ocean in depths of 500–2,000 m.

Pannychia moseleyi Theel

Pannychia moseleyi Theel, 1882, p. 88, pl. XVII, XXXII, figs 1–13; Ludwig, 1894, p. 95; Sluiter, 1901b, p. 71; Mitsukuri, 1912, p. 207; Ohshima, 1915b, p. 235; Djakonov, *et al.* 1958, p. 360.

MATERIAL EXAMINED: None.

DIAGNOSIS: Lateral ventral radii each with about 30 pedicels. Midventral radius with about 55 pedicels. Each dorsal radius with about 100 long processes.

DISTRIBUTION: Theel (1882) described two specimens of this species, one from east of Australia (34° 8′ S, 152° 0′ E) in 1,719 m, the other from off New Zealand (37° 34′ S, 179° 22′ E) in 1,260 m. The species has since been recorded from several localities in the Pacific ocean (*see* Ohshima, 1915b, p. 235).

BATHYMETRIC RANGE: 500–2,000 m.

Laetmogone Theel, 1879

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

TYPE-SPECIES: *Laetmogone wyvillethomsoni* Theel.

REMARKS: Of the 10 species in this genus, two, *L. violacea* and *L. wyvillethomsoni*, are cosmopolitan. One, *L. violacea*, is known from New Zealand.

Laetmogone violacea Theel

Laetmogone violacea Theel, 1879, p. 11; Theel, 1882, p. 78, pl. 13, figs 1–3, pl. 36, figs 20–24, pl. 42, fig. 2; Perrier, 1902, p. 390, pl. 19, figs 1–7; Augustin, 1908, p. 21; Mitsukuri, 1912, p. 192, pl. 6, figs 52–54, text-fig. 36; Ohshima, 1915b, p. 237; Greig, 1921, p. 9; Herouard, 1923, p. 37; Mortensen, 1927, p. 361, fig. 213; Deichmann, 1930, p. 120; Heding, 1942, p. 14, text-fig. 14; Pawson, 1965e, p. 23, text-fig. 6.
Cryodora spongiosa Theel, 1879, p. 9.
Laetmogone spongiosa Theel, 1882, p. 80, pl. 14, figs 1–3, pl. 39, figs 5,6.
Laetmogone jourdaini Petit, 1885, p. 9.
Laetmogone brogniarti Perrier, 1886, fig. 241.

MATERIAL EXAMINED: Four specimens. NZOI Sta. C 619, 3. Dom. Mus. Sta. BS 209, 1.

DIAGNOSIS: Lateral ventral radii each with 10–15 pedicels. Dorsal radii each with 20–27 long, thin processes. Deposits include four- to six-rayed spinous spicules, numerous ventrally but scattered dorsally.

REMARKS: *L. wyvillethomsoni* differs from *L. violacea* in having more numerous pedicels (15–29) and fewer dorsal processes (5–17). The two species can be readily distinguished on the basis of these characters.

DISTRIBUTION: Cosmopolitan. In New Zealand region known from Northern Bay of Plenty and Chatham Rise.

BATHYMETRIC RANGE: In New Zealand 461–802 m; elsewhere 250–1,800 m.

Bathygone Pawson, 1965

DIAGNOSIS: Tentacles 15. Body elongate, flattened ventrally, arched dorsally. Midventral radius naked. Lateral ventral radii each with approximately 50 narrow, elongate pedicels arranged in a single, often apparently double, series. Dorsal radii each with about 10 small retractile processes, regularly spaced. Deposits include wheels, circular perforated plates, and spinous rods. Wheels and plates tend to be aggregated into scattered heaps on the dorsal side of the body.

TYPE-SPECIES: *Bathygone papillatum* Pawson.

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

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

Bathygone papillatum Pawson

Bathygone papillatum Pawson, 1965b, p. 77, figs 7–11.

MATERIAL EXAMINED: None.

DIAGNOSIS: As for the genus.

REMARKS: This species has already been discussed elsewhere (Pawson, 1965b). It is known only from the north of New Zealand, from 360 m.

Benthogone Koehler, 1896

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

TYPE-SPECIES: *Benthogone rosea* Koehler.

REMARKS: This genus is monotypic. It differs from other genera in the family Laetmogomidae in having wheels of only one type; these are not associated with any other deposits, except in the pedicels. Accessory deposits are spinous rods, found in the pedicels, processes, and tentacles.

Benthogone rosea Koehler

Benthogone rosea Koehler, 1896, p. 114; Pawson, 1965a, p. 219, pl. 5, figs 2–5 (complete synonymy).

MATERIAL EXAMINED: None.

DIAGNOSIS: As for the genus.

REMARKS: The species is described and discussed elsewhere (Pawson, 1965a).

DISTRIBUTION: Off south-west Ireland, Bay of Biscay, off Azores Is., African coast to Cape Verde Islands (Mortensen, 1927). The occurrence of this species north of New Zealand was unexpected, but it now seems likely that *B. rosea* is widespread in the Atlantic and southern Pacific Oceans.

BATHYMETRIC RANGE: In New Zealand region, 1,170 m; elsewhere, 1,000–2,320 m.

Family PELAGOTHURIIDAE Ludwig, 1894

DIAGNOSIS: Tentacles 12–29. Body wall thick, gelatinous, completely lacking calcareous deposits. A large brim is usually present anteriorly, and the pelagothuriids have adopted a bathypelagic habit.

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

Enypniastes Theel, 1882

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

TYPE-SPECIES: *Enypniastes eximia* Theel.

REMARKS: The three species in this genus are all so far known only from the Pacific Ocean. In commenting on Heding's (1950) attempt to revise the classification of the bathypelagic holothurians, Hansen and Madsen (1956) note that perhaps at least three species are confused under the name *Enypniastes eximia.*

Enypniastes eximia Theel

Enypniastes eximia Theel, 1882, p. 56, pl. 8, figs 6, 7; Sluiter, 1901b, p. 77, pl. 2, figs 8, 9, pl. 10, fig. 5; Mitsukuri, 1912, p. 215, pl. 7, figs 59, 60; Ohshima, 1915b, p. 243; Heding, 1950, p. 117; Pawson, 1965e, p. 27.

MATERIAL EXAMINED: One specimen. NZOI Sta. C 603, 1.

DIAGNOSIS: As for the genus.

DESCRIPTION: Single specimen badly damaged, 80 mm in length and 55 mm broad. Mouth apparently ventral; a large web of tissue projects from anterior end of body. Other external features indistinguishable, but anus appears dorsally placed. Colour in alcohol grey, tentacles purple. Most internal structures missing or lacerated. Small remaining fragment of intestine dark brown, supported by strong mesenteries. Longitudinal muscles pinkish-brown. Calcareous deposits lacking.

REMARKS: The general form of this specimen somewhat resembles that of *E. eximia* Theel, which was described from four specimens taken near New Zealand (40° 28′ S, 177° 43′ E) at a depth of 1,980 m (Theel, 1882). As the specimen was taken from near the type locality it probably represents the true *E. exima*, and not one of the synonyms referred to by Hansen and Madsen (1956).

DISTRIBUTION: Off Japan (Mitsukuri, 1912; Ohshima, 1915b), the Moluccas (Sluiter, 1901b), and New Zealand (Theel, 1882).

BATHYMETRIC RANGE: In the New Zealand region 1,530–1,980 m; elsewhere about 600 m.

Family PSYCHROPOTIDAE Theel, 1882

DIAGNOSIS: Tentacles 10 to 20. Body elongate, either subcylindrical or depressed; anterior end always depressed. Body wall thick, forming a brim anteriorly. Lateral ventral radii with a single row of numerous small pedicels. Midventral radius naked, or with double row of minute pedicels. Dorsal surface naked, or with numerous or few large or small processes. Deposits usually four-armed bodies, with inwardly curved arms;

often an outer central projection. Mesenteries continuous membranes; calcareous ring composed of five separate pieces, incompletely developed. (After Theel, 1882; Ekman, 1925.)

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

Benthodytes Theel, 1882

DIAGNOSIS: Midventral radius with a double row of pedicels.

TYPE-SPECIES: *Benthodytes typica* Theel.

REMARKS: *Benthodytes* contains approximately 20 species, of which one, *B. typica*, has a cosmopolitan distribution, while *B. sanguinolenta* appears to be confined to the Pacific Ocean. The species are most commonly found at depths of approximately 3,000 m, and have been taken from depths in excess of 5,000 m.

Benthodytes hystrix Sluiter

Benthodytes hystrix Sluiter, 1901a, p. 19; 1901b, p. 59, pl. IV, fig. 4, pl. IX, fig. 10; Heding, 1940, p. 367; Pawson, 1965e, p. 28, text-fig. 7.

MATERIAL EXAMINED: None.

DIAGNOSIS: Dorsal surface with 5–6 pairs of papillae. Lateral ventral radii each with about 35 pedicels, fusing anteriorly to form a narrow brim. Deposits include large four-armed spinous spicules, about 1.0 mm across.

REMARKS: Further material from New Zealand may show the New Zealand form represents a new species.

DISTRIBUTION: Banda Sea, west of Sumatra, and Cook Strait (New Zealand).

BATHYMETRIC RANGE: In New Zealand 1,080 m. In Banda Sea and west of Sumatra 768–2,798 m.

Family ELPIDIIDAE Theel, 1882

DIAGNOSIS: Tentacles 10, rarely 11 to 12 or 20. Midventral radius naked. Lateral ventral radii each with a single row of pedicels, which may be distributed throughout radius, or confined to posterior half or posterior extremity. Dorsally, a smaller number of long, short, or rudimentary processes, more common anteriorly, where they may form a branched or unbranched lobe-like appendage. Calcareous deposits most commonly include straight or slightly curved C-shaped or horseshoe-shaped rods and three-armed spicules; rarely minute net-like plates, rosette-shaped or elliptical bodies (after Theel, 1882).

REMARKS: This is a large family containing a dozen nominal genera. The distribution is cosmopolitan in all depths below about 500 m. Representatives are more common in the Northern Hemisphere.

Two genera are now known to be present in the New Zealand region (Pawson, 1965e).

KEY TO NEW ZEALAND GENERA OF THE FAMILY ELPIDIIDAE

1 (2) Lateral ventral radii with pedicels distributed along their entire length ..... *Scotoplanes* Theel, 1882

2 (1) Pedicels of the lateral ventral radii confined to the posterior half of each radius.... *Amperima* Pawson, 1965

Amperima Pawson, 1965

DIAGNOSIS: Body slightly elongate or egg-shaped, at most $2\frac{1}{2}$ times as long as broad; tentacles 10. Anteriorly, dorsal side carries a transverse row of 3–4 papillae, sometimes discrete, sometimes adjoining, sometimes fused into a voluminous transverse four-lobed process. Immediately posterior to papillae a small number of isolated very small papillae present on radii. Ventral radii each with a row of pedicels, usually restricted to posterior half of each radius. Deposits triradiate bodies, together with sigmas (after Perrier, 1901, *in* Deichmann, 1930).

TYPE-SPECIES: *Periamma roseum* Perrier.

REMARKS: This genus was formerly known as *Periamma* Perrier, but the name is preoccupied and has been replaced by *Amperima* (Pawson, 1965a). *Amperima* is cosmopolitan and contains seven species, five of which are known from the Pacific and Indian Oceans. Madsen (1953) notes that most species can be found below about 3,000 m.

Amperima tui Pawson

Amperima tui Pawson, 1965a, p. 216, pl. 4, figs 1–3.

MATERIAL EXAMINED: None.

DIAGNOSIS: Calcareous deposits absent from body wall.

REMARKS: *Amperima tui* has been described and discussed elsewhere (Pawson, 1965a).

DISTRIBUTION: West of Kermadec Islands (30° 18′ S, 180° E).

BATHYMETRIC RANGE: 1,170 m.

Scotoplanes Theel, 1882

DIAGNOSIS: Body elongate to ovate. Tentacles 10. Dorsal surface of body with a small number of processes, restricted to anterior end of body or present anteriorly and posteriorly. Ventrolateral pedicels present in small numbers throughout radii. Midventral radius naked. Deposits include C-shaped spicules, unbranched rods, and three-armed spicules, of which the last two types may be spinous.

TYPE-SPECIES: *Scotoplanes globosa* Theel.

REMARKS: This genus embraces seven species, and is known from the Atlantic and Pacific Oceans, from depths of 500 m to approximately 10,000 m.

Scotoplanes gilpinbrowni Pawson

Scotoplanes gilpinbrowni Pawson, 1965a, p. 217, pl. 4, figs 4–6.

MATERIAL EXAMINED: None.

DIAGNOSIS: Calcareous deposits exclusively simple straight or curved spinous rods.

REMARKS: *Scotoplanes gilpinbrowni* has been described and discussed elsewhere (Pawson, 1965a).

DISTRIBUTION: North of New Zealand (34° 20′ S, 175° 12′ E).

BATHYMETRIC RANGE: 1,782 m.

COMPOSITION, DISTRIBUTION, AND RELATIONSHIPS OF THE NEW ZEALAND HOLOTHURIAN FAUNA

COMPOSITION

All orders in the Class Holothuroidea occur in New Zealand waters. The Dendrochirotida, Apodida, and Elasipodida are especially well represented, but the number of Aspidochirotids is small. This is not surprising, for the largest families in the Aspidochirotida, namely the Holothuriidae and Stichopodidae, are essentially tropical or subtropical in distribution. Only the northernmost part of New Zealand can be regarded as subtropical, and one species of the Holothuriidae (*Vaneyothuria neozelanica*) is known from northern New Zealand. Very few holothuriids and stichopodids occur south of about 35° S, but a notable exception is *Stichopus mollis*, which extends as far south as Stewart Island, and has a broad temperature tolerance.

The families Paracucumidae, Sclerodactylidae, Rhopalodinidae, Vaneyellidae, Eupyrgidae, and Deimatidae are as yet unknown from the New Zealand region, but it is to be expected that at least the elasipodid family Deimatidae will be discovered there. The other families mentioned comprise rather specialised forms, and appear to be restricted in their distribution. More representatives of the family Psolidae probably will be discovered in the New Zealand region; only one species, *Psolus neozelanicus*, is known so far, but six species occur in the shallow waters of Australia, and the family is particularly well represented in Chile and and Antarctica. As psolids are invariably sedentary in habit, living attached to rocks, dredging in rocky areas should yield members of the genus *Psolus* and perhaps also *Psolidium*.

Thirty-six genera occur in the New Zealand region. Studies at present nearing completion on the distribution of Southern Hemisphere holothurian genera show that the most notable absentees from the New Zealand fauna are *Pentacta*, *Psolidium*, and *Taeniogyrus*. *Pentacta* is represented in Australia by 11 species and should occur in northern New Zealand. *Psolidium* is essentially cosmopolitan with many southern species, while the distribution of *Taeniogyrus* (Australia, various Subantarctic islands, Chile) closely parallels that of *Trochodota* and *Chiridota*, and it is virtually certain that *Taeniogyrus* occurs around New Zealand.

There are 49 species; the number of species per genus is approximately 1.5, and this approximates the ratio for Antarctica and Southern Chile, but is slightly lower than that for Australia.

In considering the fauna as a whole, a few general remarks may be made. Recent work (Pawson and Fell, 1965; Pawson, 1966) indicates that perhaps U-shaped holothurians reflect a primitive stage in the evolution of the group. No less than 10 of the commonly encountered New Zealand species are U-shaped, and 7 of these have a hard calcareous test as in other echinoderms. This high incidence of possibly primitive forms is a notable feature of the New Zealand fauna.

It is also remarkable that there are no conspicuous species in the intertidal areas apart from *Stichopus mollis*. In most other areas of the world, except the arctic and antarctic, several species of holothurians are common in the intertidal area, or can be collected without diving. In the tropics most of the conspicuous species are aspidochirotids, but in temperate or subtropical areas dendrochirotids become more prominent. The secretive or burrowing apodids are, however, ubiquitous, and usually one or two species can be found on New Zealand shores by careful searching.

No special adaptations for life in New Zealand waters are evident. The high percentage of dendrochirotids is not unexpected; these holothurians are especially well adapted to life in cold water, for they comprise 70% of the antarctic fauna (Pawson, 1969). In the warmer waters of the New Zealand shelf 45% of the species are dendrochirotids. These holothurians develop directly, and have no pelagic larval stage in their life history.

DISTRIBUTION

The distribution of the New Zealand echinoderm fauna has been studied recently by Fell (1949) and Pawson (1961, 1965c), and thus it is not necessary to discuss patterns of distribution at length here. However, some distribution details not available in Fell (1949) and Pawson (1961, 1965c) are given here.

1. Bathymetric Distribution

Intertidal zone

As mentioned previously, the intertidal species are by no means conspicuous, but the following 12 species have been collected intertidally (figures indicate bathymetric range in metres):

Ocnus calcarea (0–27)
O. brevidentis (0–465)
Trachythyone bollonsi (0)
Pseudocnus leoninoides (0–112)
Psolidiella nigra (0)
Pseudopsolus macquariensis (0)
Stichopus mollis (0–270)
Chiridota gigas (0)
C. mortenseni (0)
Trochodota dunedinensis (0–180)
T. dendyi (0–126)
Kolostoneura novaezealandiae (0–54)

Ocnus calcarea is rare; *Trachythyone bollonsi* is known from one record; *Pseudocnus leoninoides* is an Antipodean species that extends north to the Snares Is.; and *Pseudopsolus macquariensis* is not known with certainty from New Zealand. It is clear that dendrochirotids do not favour the intertidal habitat in New Zealand. Only five of the species listed above appear to be restricted to shallow water; the others range into the deep water of the continental shelf or slope.

CONTINENTAL SHELF

On the shelf 27 species occur, and of these 13 (approximately 50%) appear to be restricted to the shelf; the remainder extend into bathyal depths. Of the entire echinoderm fauna of New Zealand approximately 58% are stenobathic shelf species.

CONTINENTAL SLOPE

In the bathyal zone 31 species occur, of which 17 (approximately 55%) are restricted; the remaining 14 species extend on to the shelf.

It is evident from the above figures that many New Zealand species have a broad bathymetric range.

2. Horizontal Distribution

The holothurians do not show as convincingly the "provincial" patterns of distribution of the other echinoderm groups (*see* Fell, 1949; Pawson, 1961, 1965c; Dell, 1962). The reasons for this difference from the other echinoderm groups are not clear, but the high incidence of direct development and the broad bathymetric range of many species may be contributing factors. For convenience and to aid in future faunal studies those species that occur in each of the New Zealand marine "provinces" are listed. The lists do not include exclusively bathyal species; those species marked with an asterisk are so far known only from the "province" under which they are listed.

Aupourian Assemblage

Heterothyone alba
**Psolus neozelanicus*
Pentadactyla longidentis
**Trachythyone bollonsi*
**Ocnus farquhari*
O. calcarea
O. brevidentis
Rynkatorpa uncinata
Kolostoneura novaezelandiae
Trochodota dendyi
Heteromolpadia marenzelleri
Paracaudina chilensis
**Vaneyothuria neozelanica*

The four species marked above as restricted to the Aupourian assemblage are known from one record only, and thus they can be ignored for the purposes of zoogeography; no species, then, in the above list, can be regarded as typically Aupourian. This situation is in marked contrast to that applying in the echinoids and asteroids (*see* Pawson, 1965c).

Cookian Assemblage (includes the Chatham Islands, southern part of North Island and northern part of the South Island)

Placothuria huttoni
Heterothyone alba
H. ocnoides
Neothyonidium dearmatum
**N. armatum*
Pentadactyla longidentis
Neocucumella bicolumnata
Amphicyclus thomsoni
Psolidiella nigra
Trachythyone amokurae
Ocnus calcarea
O. brevidentis
Rynkatorpa uncinata
**Protankyra rigida*
Kolostoneura novaezealandiae
Chiridota gigas
C. nigra
Trochodota dunedinensis
T. dendyi
Heteromolpadia marenzelleri
Paracaudina chilensis
Stichopus mollis

Protankyra rigida is known from one record. *Neothyonidium armatum* has a bathymetric range of 43–270 m, and thus is expected to occur in at least the Forsterian fauna.

Forsterian Assemblage (southern part of the South Island, Stewart Island, and the Snares Islands)

Placothuria huttoni
Heterothyone alba
H. ocnoides
Neothyonidium dearmatum
Pentadactyla longidentis
Neocucumella bicolumnata
Amphicyclus thomsoni
Pseudocnus leoninoides
Psolidiella nigra
?*Pseudopsolus macquariensis*
Trachythyone amokurae
Ocnus calcarea
O. brevidentis
**Ypsilothuria bitentaculata*
Rynkatorpa uncinata
Kolostoneura novaezealandiae
**Chiridota mortenseni*
C. gigas
C. nigra
Trochodota dunedinensis
T. dendyi
Heteromolpadia marenzelleri
Paracaudina chilensis
Stichopus mollis

Ypsilothuria bitentaculata is a deep-water species and is probably widespread in the New Zealand bathyal zone. *Chiridota mortenseni* remains a problematical species, and may yet prove to be a synonym of *C. gigas*. The Forsterian assemblage differs from the Cookian in lacking *Neothyonidium armatum* and *Protankyra rigida*, and in having *Pseudocnus leoninoides*, *Pseudopsolus macquariensis* (possibly), *Ypsilothuria bitentaculata*, and *Chiridota mortenseni*.

Antipodean Assemblage (Auckland, Campbell, Bounty and Antipodes Islands)

**Placothuria squamata*
Pseudocnus leoninoides
Trachythyone amokurae
Ocnus brevidentis
Chiridota nigra
**C. carnleyensis*
Trochodota dunedinensis
T. dendyi

The New Zealand "character" of the Antipodean fauna is readily apparent (*see* Fell, 1953, Pawson, 1968b).

An examination of the above lists will show that there are virtually no "province indicator species" in any of the assemblages. The small size of the Aupourian assemblage reflects a less intensive collecting effort in the area rather than an impoverished fauna. Northern elements are not conspicuous at present; further collecting in the northern part of New Zealand may alter the picture considerably. In the Forsterian assemblage *Pseudocnus leoninoides* and *Pseudopsolus macquariensis* may be regarded as truly southern elements (a characteristic of the Forsterian fauna).

RELATIONSHIPS

If the bathyal species (which are mainly widespread or cosmopolitan) are ignored, 83% of the New Zealand holothurian species are endemic to the New Zealand region. The remaining 17% comprise an Australian element of four species (*Neocucumella bicolumnata*, *Neothyonidium dearmatum*, *Stichopus mollis*, *Chiridota gigas*) and a single species (*Ocnus calcarea*) that also occurs at Juan Fernandez Is. Thus, at the species level, the relationships of the New Zealand holothurians are not at all clear. In contrast, the echinoids show obvious close relationships with Australia and the Indo-west Pacific generally, and at least 10 species of New Zealand shelf echinoids (45% of the shelf fauna) are shared with Australia and the Indo-west Pacific. The discrepancy between the echinoids and holothurians is probably because all the echinoids that have immigrated to New Zealand possess pelagic larval stages and probably arrived with the aid of the favourable currents, while a large proportion of the New Zealand holothurians lack such free-floating larval stages and consequently have seriously reduced vagility.

At the generic level, relationships hardly become clearer. Of the shelf genera two (*Placothuria*, *Heterothyone*) are endemic. Nine genera are shared with Australia, seven with Chile, and five with Antarctica. It must be pointed out here that most of the genera in the New Zealand fauna are more or less widespread in world seas, and the fact that seven genera are shared between New Zealand and Chile does not necessarily imply that the faunas of those areas are closely related. The fauna of New Zealand has apparently been built up by immigration of taxa; that of Antarctica is of a similar nature (Pawson, 1969). There is little evidence of active speciation in the New Zealand fauna; only *Chiridota* has more than three species here.

It is apparent from the foregoing discussion that no definitive statements can be made about the origin of the New Zealand holothurian fauna, but evidence afforded by other echinoderm groups and other invertibrate phyla points to a convincing donor-recipient relationship between New Zealand and Australia. It is therefore most reasonable to assume that most of the holothurians of New Zealand were initially derived from an Indo-west Pacific source. The off-shore fauna of Australia remains poorly known, but one would expect to find that an increasing number of species at present known from New Zealand also occur in Australian waters.

REFERENCES

ALLAN, M. J. 1911: *Trochodota dunedinensis* in Victoria. *Trans. Am. microsc. Soc. 3*: 325.

AUGUSTIN, E. 1908: Uber Japanische Seewalzen. *Abh. bayer. Akad. Wiss. Suppl. Vol. 1 (1)*: 1–441, 2 pl.

BECHER, S. 1909: Die systematische Stellung des *Rhabdomolgus novaezealandiae. Archs Zool. exp. gén. 5*: 33–43.

BELL, F. J. 1887: Studies in the Holothurioidea. 6. *Proc. zool. Soc. Lond.*, pp. 531–4, pl. 45, fig. 2.
——1908: Echinoderma. *Br. Mus. (nat. Hist.) Publs: Natn. Antarct. Exped. 1901–1904 4*: 1–16, 5 pl.

BENHAM, W. B. 1909: Echinoderma. *Rec. Canterbury [N.Z.] Mus. 1 (2)*: 43–75.

BENNETT, E. W. 1964: The marine fauna of New Zealand: Crustacea Brachyura. *Bull. N.Z. Dep. scient. ind. Res. 153*. 120 pp., 141 figs.

CLARK, H. L. 1907: Apodous holothurians. *Smithson. Contr. Knowl. 35*: 1–231, pl. 1–13.
——1921: The echinoderm fauna of Torres Strait: its composition and origin. *Publs. Carnegie Instn (Marine Biol.) 10*: 224 pp., 38 pl.
——1922: The holothurians of the genus *Stichopus*. *Bull. Mus. comp. Zool. Harv. 65 (3)*: 40–74, pl. 1–2.
——1923: The echinoderm fauna of South Africa. *Ann. S. Afr. Mus. 13 (7)*: 221–435, pl. 8–23.
——1935: The holothurian genus *Caudina*. *Ann. Mag. nat. Hist. ser. 10 (15)*: 267–84.
——1938: Echinoderms from Australia. *Mem. Mus. comp. Zool. Harv. 55*: 597 pp., 28 pl.
——1946: The echinoderm fauna of Australia: its composition and origin. *Publs Carnegie Instn 566*: 567 pp.

DAWBIN, W. H. 1949a: Autoevisceration and regeneration of viscera in the holothurian *Stichopus mollis* (Hutton). *Trans. Proc. R. Soc. N.Z. 77 (4)*: 497–523, 9 figs.
——1949b: Regeneration of the alimentary canal of *Stichopus mollis* (Hutton) across a mesenteric adhesion. *Ibid. 77 (4)*: 524–9, 2 figs.
——1950: A guide to the holothurians of New Zealand. *Tuatara 3 (1)*: 33–41, pl. 1–2.

DEICHMANN, E. 1930: The holothurians of the western part of the Atlantic Ocean. *Bull. Mus. comp. Zool. Harv. 71 (3)*: 43–226, pl. 1–24.
——1936: Arctic specimens of *Molpadia*, and remarks on Heding's attempt to subdivide the genus. *Ann. Mag. nat. Hist. ser. 10 (17)*: 452–64.
——1948: The holothurian fauna of South Africa. *Ann. Natal Mus. 11 (2)*: 325–76, pl. 17–21.
——1958: The Holothurioidea collected by the Velero III and IV during the years 1932 to 1954. Part II. Aspidochirota. *Allan Hancock Pacif. Exped. 11 (2)* : 253–348, pl. 1–9.

DELL, R. K. 1962: New Zealand marine provinces—do they exist? *Tuatara 10 (1)*: 43–52.

DENDY, A. 1896: Observations on the holothurians of New Zealand. *J. Linn. Soc. (Zool.) 26*: 22–52, pl. 3–7.
——1898: Notes on a remarkable collection of marine animals, lately found on the New Brighton Beach, near Christchurch. *Trans. Proc. N.Z. Inst. 30*: 320–6.
——1909: On a small collection of holothurians from the Auckland Islands. Pp. 146–53, pl. 6, *in* Chilton, C. "The Subantarctic Islands of New Zealand" Vol. I Philosophical Institute of Canterbury, Christchurch.

DENDY, A.; HINDLE, E. 1907: Some additions to our knowledge of the New Zealand holothurians. *J. Linn. Soc. (Zool.) 30* : 95–125, pl. 11–14.

DJAKONOV, A. M.; BARANOVA, Z. I.; SAVELJEVA, T. S. 1958: Note on the Holothurioidea of the South Sakhalin and South Kurile Islands area. *Issled. dal'nevost. Morei SSSR 5:* 358–80, 14 figs. (In Russian.)

EKMAN, S. 1925: Systematische-Phylogenetische Studien über Elasipoden und Aspidochiroten. *Zool. Jb. (Abt. Syst.) 47*: 430–540.

ERWE, W. 1913: Holothurioidea. *Fauna Südwest-Aust. 4*: 349–402, pl. 5–8.

FARQUHAR, H. 1898: The echinoderm fauna of New Zealand. *Proc. Linn. Soc. N.S.W. 23*: 300–27.

FELL, H. B. 1949: The constitution and relations of the New Zealand echinoderm fauna. *Trans. Proc. R. Soc. N.Z. 77 (5)*: 208–12.
——1953: Echinoderms from the subantarctic islands of New Zealand: Asteroidea, Ophiuroidea, and Echinoidea. *Rec. Dom. Mus. N.Z. 2 (2)* : 73–111, 6 figs, 2 pl.
——1958: Deep-sea echinoderms of New Zealand. *Zoology Publs Vict. Univ. Wellington 24* : 1–40, pl. 1–5.
——1960: Archibenthal and littoral echinoderms of the Chatham Islands. *Bull. N.Z. Dep. scient. ind. Res. 139 (2)*: 55–75, pl. 1–10.
——1965: The early evolution of the Echinozoa. *Breviora No. 219* : 1–17, figs 1–13.

FRIZZELL, D. H.; EXLINE, H.; PAWSON, D. L. 1966: Holothurians. *In* Moore, R. C. "Treatise on Invertebrate Paleontology" (U) Echinodermata 3 (2): 641. University of Kansas Press, Lawrence.

GRIEG, J. 1921: Echinodermata. *Rep. scient. Results Michael Sars N. Atlant. deep Sea Exped. 3 (2)*: 1–47.

HANSEN, B.; MADSEN, F. J. 1956: On two bathypelagic holothurians from the South China Sea. *Galathea Rep. 2*: 55–9, figs 1–5.

HEDING, S. G. 1928: Synaptidae. *Vidensk. Meddr. dansk naturh. Foren. 85* : 105–323, figs 1–69, pl. 2–3.
——1931: On the classification of the molpadids. *Ibid. 92*: 275–84.
——1940: Die Holothurien der Deutschen Tiefsee-Expedition. 2. Aspidochirote und Elasipode Formen. *Wiss. Ergebn. dt. Tiefsee-Exped. 'Valdivia' 24 (3)*: 319–75, figs 1–21.
——1942: Holothurioidea. Part 2. Aspidochirota, Elasipoda, Dendrochirota. *Dan. Ingolf-Exped. 4 (13)*: 1–39, figs 1–2.
——1950: Uber die *Planktothuria* der Deutschen Tiefsee-Expedition, nebst einigen Bemerkungen über die Systematik der Pelagischen Holothurien. *Zool. Anz. 145* : 111–8, figs 1–4.

HEDING, S. G.; PANNING, A. 1954: Phyllophoridae. Eine Bearbeitung der Polytentaculen Holothurien des Zoologischen Museums in Kopenhagen. *Spolia Zool. Mus. haun. 13*: 1–209, figs 1–102.

HEROUARD, E. 1901: Note préliminaire sur les Holothuries rapportées par l'Expédition Antarctique Belge. *Archs Zool. exp. gen. notes 3 (9)*: 39–48.
——1923: Holothuries provenant des campagnes de la Princesse Alice et l'Hirondelle. *Résult. Camp. scient. Prince Albert I, 66* : 1–161, pl. 1–10.

HICKMAN, V. V. 1962: Tasmanian sea-cucumbers (Holothuroidea). *Pap. Proc. R. Soc. Tasm. 96*: 49–72, figs 1–186, pl. 1–2.

HUTTON, F. W. 1872: "Catalogue of the Echinodermata of New Zealand, with Diagnoses of the Species." James Hughes, Wellington. 20 pp.
——1878: Notes on some New Zealand Echinodermata, with descriptions of new species. *Trans. Proc. N.Z. Inst. 11*: 305–8.

JOHN, D. D. 1939: A viviparous synaptid holothurian from New Zealand (*Trochodota dunedinensis*). *Ann. Mag. nat. Hist. ser 2 (4)*: 315–9.

JOSHUA, E. C. 1914: Victorian Holothurioidea, with descriptions of new species. *Proc. R. Soc. Vict. 28 (1)*: 1–11, pl. 1.

JOSHUA, E. C.; CREED, E. 1915: South Australian Holothurioidea with descriptions of new species. *Trans. R. Soc. S. Aust. 39*: 16–24, pl. 2–4.

KOEHLER, R. 1896: Résultats scientifiques de la Campagne du "Caudan" Golfe de Gascogne (Août–Septembre 1895). Echinodermes. *Annls Univ. Lyon 26*: 33–127.

KOEHLER, R.; VANEY, C. 1905: An account of the deep-sea Holothurioidea collected by the Royal Marine Survey Ship "Investigator". *In* "Echinoderma of the Indian Museum I." Indian Museum, Calcutta. vi + 124 pp., 15 pl.

LUDWIG, H. 1894: Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer "Albatross" during 1891, Lieut. Commander Z. L. Tanner, U.S.N., commanding. 12. The Holothurioidea. *Mem. Mus. comp. Zool. Harv. 17*: 1–183, pl. 1–19.
———1898a: Holothurien. *Ergebn. Hamburger magalhaens. Sammelreise 3*: 1–98, pl. 1–3.
———1898b: Die Holothurien der Sammlung Plate. *Zool Jb. (Suppl. 4, Fauna Chilensis) 2*: 431–54, pl. 14.

MCKNIGHT, D. G. 1967: Additions to the echinoderm fauna of the Chatham Rise. *N.Z. Jl mar. Freshwat. Res. 1 (3)*: 291–313.

MADSEN, F. J. 1953: Holothurioidea. *Rep. Swed. deep Sea Exped. 2. Zool. 12*: 151–73, figs 1–10.

MITSUKURI, K. 1912: Studies on Actinopodous Holothurioidea. *Jl Coll. Sci. imp. Univ. Tokyo 29 (2)*: 1–284, pl. 1–7.

MORTENSEN, T. 1924: Pighude (Echinodermer). *In* "Danmarks Fauna". Copenhagen. 274 pp.
———1925: Echinoderms of New Zealand and the Auckland – Campbell Islands. 3–5: Asteroidea, Holothurioidea and Crinoidea. *Vidensk. Meddr. dansk naturh. Foren. 79*: 261–420, figs 1–70, pl. 1–3.
———1927: "Handbook of the Echinoderms of the British Isles". Oxford University Press, London. 471 pp.

OHSHIMA, H. 1915a: The Synaptidae of Japan. *Annotnes. zool. jap. 8*: 467–82.
———1915b: Report on the holothurians collected by the United States Fisheries Steamer "Albatross" in the northwestern Pacific during the summer of 1906. *Proc. U.S. natn. Mus. 48*: 213–91, pl. 8–11.

PANNING, A. 1949: Versuch einer Neuordnung der familie Cucumariidae (Holothurioidea, Dendrochirota). *Zool. Jb. (Abt. Syst.) 78 (4)*: 404–70, figs 1–62.
———1951: Uber *Pseudocnus leoninus* und verwandte Arten. *Zool. Anz. 146*: 73–80, figs 1–7.
———1961: Uber *Psolidiella nigra* Mortensen. *Zool. Anz. 166*: 192–4, figs 1–4.
———1962: Bemerkungen über die Holothurien-Familie Cucumariidae (ordnung Dendrochirota). 3 Teil. Die Gattung *Pseudocnus* Panning, 1949. *Mitt. hamb. zool. Mus. Inst. 60*: 57–80, figs 1–20.
———1964: Bemerkungen über die Holothurien-Familie Cucumariidae (ordnung Dendrochirota). 4 Teil. Die Gattungen *Stereoderma, Staurothyone* und *Trachythyone*. *Ibid. 61 (Kosswig-Festschrift)*: 159–74, figs 1–10.
———1966: Bemerkungen über die Holothurien-Familie Cucumariidae (ordnung Dendrochirota). 5 Teil. Die Gattungen *Heterothyone* Panning 1949 und *Leptopentacta* H. L. Clark 1938. *Ibid. 63*: 51–69, figs 1–9.

PARKER, T. J. 1881: On a new holothurian (*Chiridota dunedinensis* n. sp.). *Trans. Proc. N.Z. Inst. 13*: 418.

PAWSON, D. L. 1961: Distribution patterns of New Zealand echinoderms. *Tuatara 9 (1)*: 9–18, 1 fig.

PAWSON, D. L. 1962a: A new sea cucumber from Macquarie Island *Trans. R. Soc. N. Z., Zool. 2 (7)*: 47–8, figs 1–5.
———1962b: *Chiridota mortenseni* n. sp., a new apodous holothurian from New Zealand. *Ibid. 2 (10)*: 61–4, figs 1–5.
———1962c: A new phyllophorid genus in the Holothuroidea. *Ibid. 2 (11)*: 65–7, figs 1–2.
———1963: The holothurian fauna of Cook Strait, New Zealand. *Zoology Publs Vict. Univ. Wellington 36*: 1–38, pl. 1–7.
———1964: The Holothuroidea collected by the Royal Society Expedition to Southern Chile, 1958–59. *Pacif. Sci. 18 (4)*: 453–70, figs 1–3.
———1965a: Some echinozoans from north of New Zealand. *Trans. R. Soc. N.Z., Zool. 5 (15)*: 197–224, pl. 1–5.
———1965b: New sea-cucumbers (Echinodermata: Holothuroidea) from New Zealand waters. *Rec. Dom. Mus. N.Z. 5 (11)*: 75–82, figs 1–19.
———1965c: The distribution of echinoderms along the east coast of New Zealand. *Trans. R. Soc. N.Z., Zool. 6 (24)*: 245–52, 1 fig.
———1965d: New records of echinoderms from the Snares Islands to the south of New Zealand. *Ibid. 6 (25)*: 253–60, figs 1–4.
———1965e: The bathyal holothurians of the New Zealand region. *Zoology Publs Vict. Univ. Wellington 39*: 1–33, text-figs 1–7.
———1966: Phylogeny and evolution of the holothuroids. *In* Moore, R.C., "Treatise on Invertebrate Paleontology" (U) Echinodermata 3 (2): 641–6, fig. 518. University of Kansas Press, Lawrence.
———1967: Redescription of *Cucumaria semperi* Bell, an Indo-west-Pacific holothurian echinoderm. *Proc. biol. Soc. Wash. 80*: 157–62, figs 1–10.
———1968a: Some holothurians from Macquarie Island. *Trans. R. Soc. N.Z., Zool. 10 (15)*: 141–50, figs 1–13.
———1968b: The echinozoan fauna of the New Zealand subantarctic islands, Macquarie Island, and the Chatham Rise. *Bull. N.Z. Dep. scient. ind. Res. 187*: 35 pp., 1 pl.
———1969: Holothuroidea. *In* American Geographical Society Antarctic Map Folio Series, 36–8, Folio 11.

PAWSON, D. L.; FELL, H. B. 1965: A revised classification of the dendrochirote holothurians. *Breviora 214*: 1–7.

PERRIER, R. 1886: "Les Explorations sous Marines". Librairie Hachette, Paris. 352 pp.
———1902: Holothuries. *Expéd. scient. 'Travailleur' 'Talisman'*: 273–554, 14 figs, pl. 12–22.
———1903: Sur deux espèces nouvelles d'holothuries de la Nouvelle Zélande. *Bull. Mus. Hist. nat., Paris 9*: 142–5.
———1905: Holothuries antarctiques du Musée d'Histoire Naturelle de Paris. *Annls Sci. nat. Zool. sér. 9 (1)*: 1–146, pl. 1–5.

PETIT, LOUIS, 1885: Sur une nouvelle espèce d'holothurie, le *Laetmogone jourdaini. Bull. Soc. philomath. Paris 9*: 9–11.

REIFFEN, A. 1901: Uber eine neue Holothurien-Gattung von Neu-Seeland. *Z. wiss. Zool. 69*: 598–621, pl. 45.

ROWE, F. W. E.; PAWSON, D. L. 1967: A new genus in the holothurian family Synaptidae, with a new species from Tasmania. *Pap. Proc. R. Soc. Tasm. 101*: 31–5, figs 1–15.

SLUITER, C. P. 1901a: Neue Holothurien aus der Tief-See des indischen Archipels gesammelt durch die "Siboga-Expedition". *Tijdschr. ned. dierk. Vereen. 2 (7)*: 1–28.
———1901b: Die Holothurien der Siboga-Expedition. *Siboga Exped. 28 (Monogr. 44, livr. 1)*: 1–142, pl. 1–10.

STUDER, T. 1876: Uber Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln, gesammelt auf der Reise SMS "Gazelle" um die Erde. *Mber. dt. Akad. Wiss. Berl.*: 452–65.

THEEL, H. 1879: Preliminary report on the Holothuridae of the exploring voyage of HMS "Challenger". *K. svenska Vetensk-Akad. Handl. 5 (19)* : 3–20, pl. 1–2.
———1882: Report on the Holothurioidea. Part I. *Rep. scient. Results Voy. Challenger, Zool. 4 (13)*: 1–176, pl. 1–46.
———1886: Report on the Holothurioidea. Part II. *Ibid. 4 (39)* : 1–290, pl. 1–16.

WHITELEGGE, T. 1897: On *Stichopus mollis. Rec. Aust. Mus. 3 (2)* : 50.

PLATE 1

FIG. 1. *Placothuria huttoni* (Dendy), left lateral view. Total length (around greater curvature) 112 mm.
FIG. 2. *Heterothyone ocnoides* (Dendy), left lateral view. Total length (around greater curvature) 60 mm.
FIG. 3. *Heterothyone alba* (Hutton), left lateral view. Total length (around greater curvature) 22 mm.
FIG. 4. *Neocucumella bicolumnata* (Dendy and Hindle), left lateral view. Total length 27 mm.
FIG. 5. *Ocnus calcarea* (Dendy), ventral view. Total length 16 mm.
FIG. 6. *Amphicyclus thomsoni* (Hutton), ventral view. Total length 60 mm.
FIG. 7. *Amphicyclus thomsoni* (Hutton), left lateral view. Live specimen, showing expanded tube feet.Total length 82 mm.

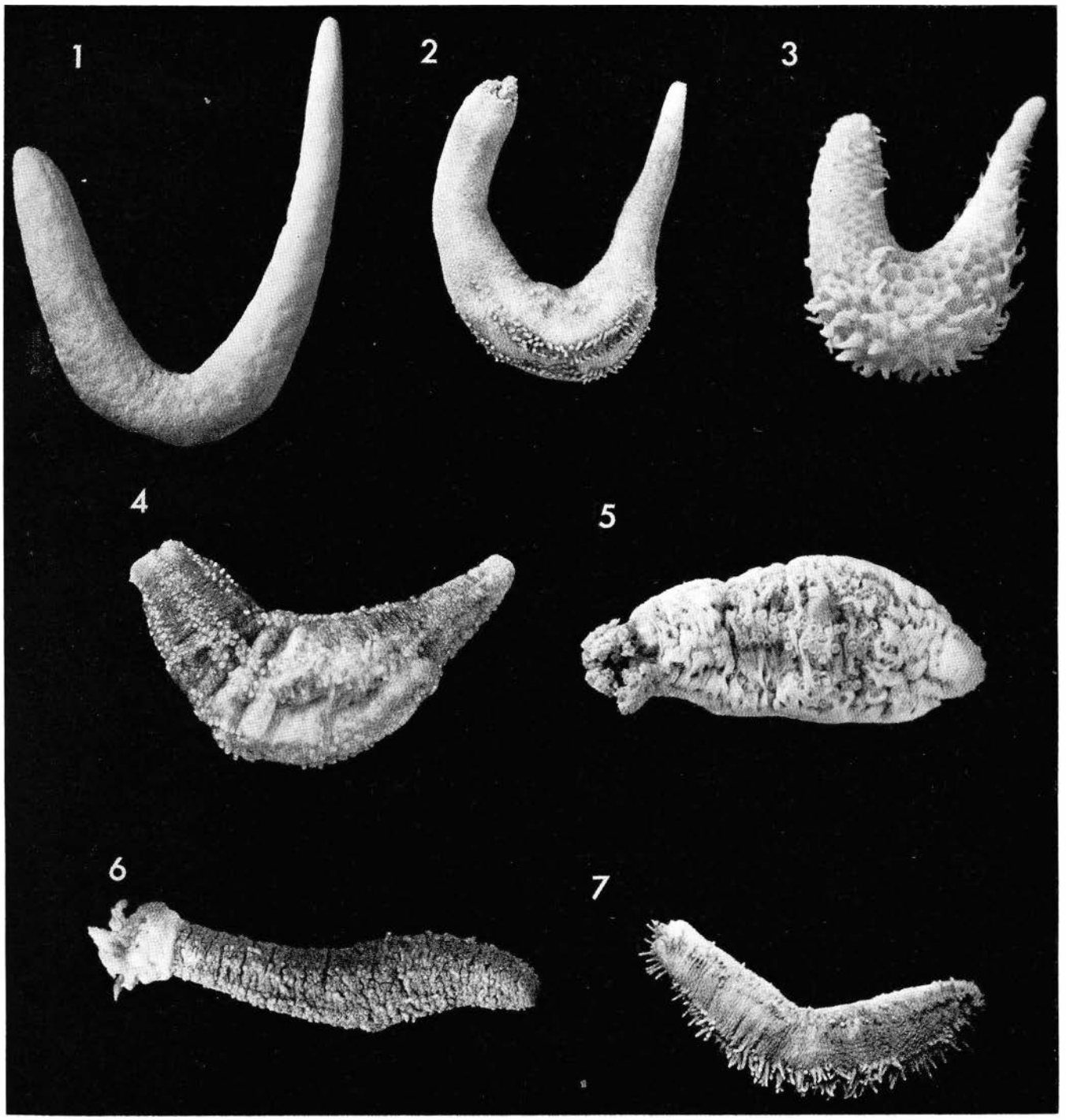
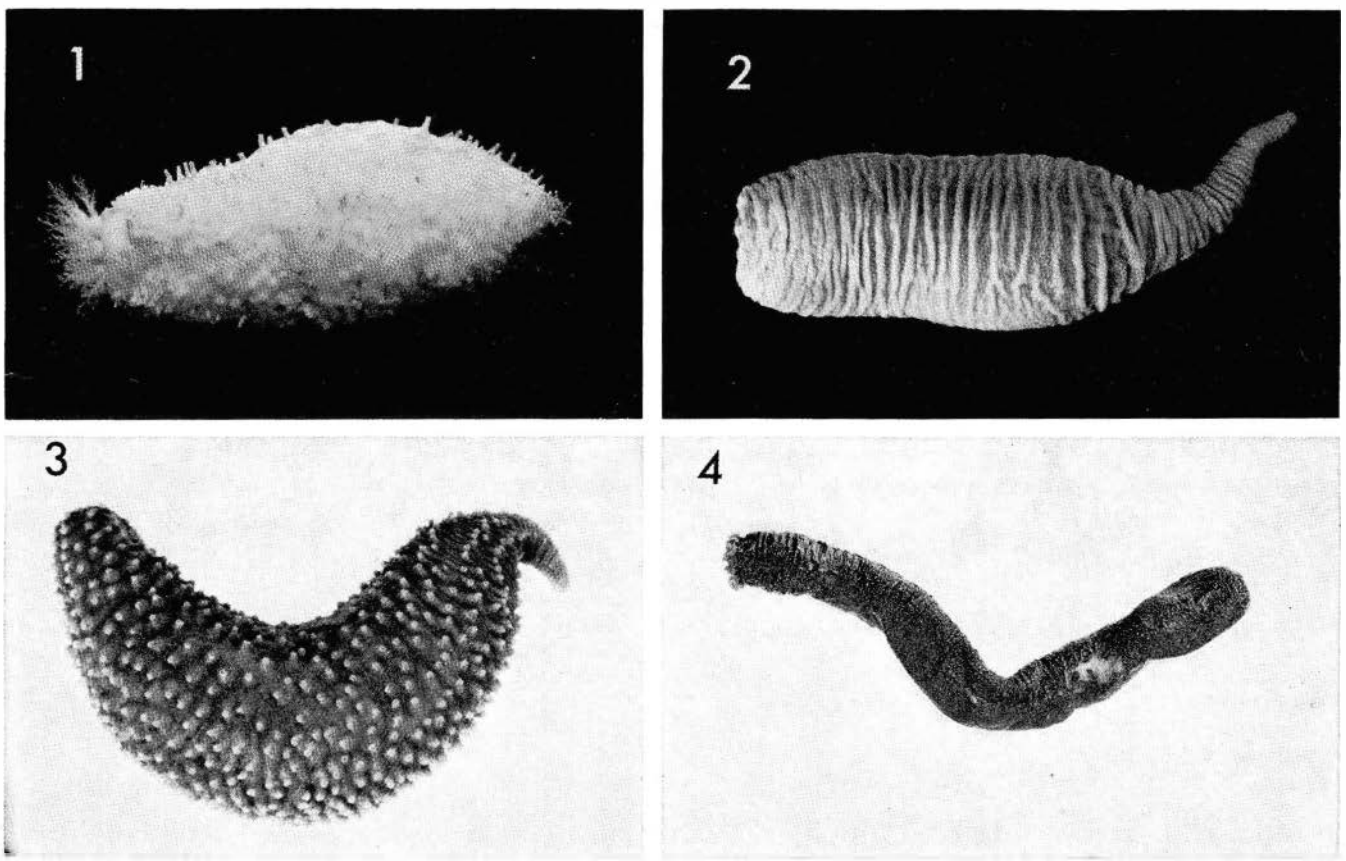


PLATE 2

FIG. 1. *Ocnus brevidentis* (Hutton), dorsal view. Live specimen, showing dendritic tentacles. Total length 35 mm.
FIG. 2. *Paracaudina chilensis* (Müller), dorsal view. Total length 47 mm.
FIG. 3. *Pentadactyla longidentis* (Hutton), left lateral view. Total length (around greater curvature) 65 mm.
FIG. 4. *Chiridota nigra* Mortensen, ventral view. Total length 65 mm.



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