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by

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Abstract

The fauna is now known to comprise 13 genera, of which one is new, and 15 species. *Heteromolpadia* n.g., type species *Ankyroderma marenzelleri* Theel, has tri-radiate anchor-plates and spired tables, but lacks rosettes of racquet-shaped plates. New records are *Neocucumella bicolumnata* (Dendy and Hindle), *Stolus huttoni* (Dendy), *Heteromolpadia marenzelleri* (Theel), and *Molpadia violacea* (Studer). A second new genus is proposed for the Australian species currently known as *Heterothyone semperi* (Bell) and the Arabian Sea species *Heterothyone pigra* (Koehler and Vaney).

The 12 species from the shelf have essentially a restricted distribution, although four are also known from Australia. The three deep water species are more widely distributed.

Introduction

Since 1954, a marine research team led by Professor L. R. Richardson has investigated the benthic and pelagic fauna of Cook Strait to depths in excess of 1,000 fathoms, and of Wellington Harbour. Analysis of benthic samples revealed 235 specimens of holothurians, which represent eleven genera and eleven species, of which four species are new records for the area. In addition, there are four more species, also known from Cook Strait, but not represented in the collections. These are diagnosed and briefly discussed here.

Throughout this report, the Cook Strait region is taken to comprise Cook Strait including Palliser Bay, and Wellington Harbour.

Farquhar (1898) recorded seven valid holothurian species from the Cook Strait region. Mortensen (1925) later added four species, bringing the total to eleven. No further records were made between 1925 and the present time. It is probable that the list of species is still far from complete; the shelf fauna is as yet imperfectly known, and deeper waters should yield many more species.

Perhaps the only Cook Strait holothurian to attract the attention of the casual collector is *Stichopus mollis* (Hutton), known locally as the "brown sea squirt" or "sea sausage". It is by far the largest and most common shallow water form. Other intertidal species are rather more secretive in their habits, and may be found only by assiduous digging and overturning of rocks in sandy or muddy pools. The apodous species *Trochodota dunedinensis* (Parker) frequently inhabits tufts of the red alga *Corallina*. Dendy (1898) noted that the dentrochirote *Ocnus calcareus* occurs ". . . not uncommonly on seaweed in Cook Straits near Wellington, where it may be collected at lowtide". Beyond the intertidal zone, the shelf and deep water species may be taken by dredging and trawling.

I am grateful to Professor H. B. Fell of this department for his careful guidance and constructive criticism throughout the course of this study. My thanks are also due to Professor L. R. Richardson for access to collections and for many valuable suggestions and discussions, and to Mr J. W. Brodie, Director of the New Zealand Oceanographic Institute, for making available to me specimens of *Heteromolpadia marenzelleri* (Theel) and *Paracaudina chilensis* (Muller).

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CHECKLIST OF COOK STRAIT HOLOTHURIANS

INTERTIDAL SPECIES

Kolostoneura novae-zealandiae (Dendy and Hindle)
Trochodota dunedinensis (Parker)
**Trochodota dendyi* Mortensen
**Ocnus calcareus* (Dendy)

SHELF SPECIES

Protankyra uncinata (Hutton)
Neocucumella bicolumnata (Dendy and Hindle)
**Neothyonidium dearmatum* (Dendy and Hindle)
Pentadactyla longidentis (Hutton)
Heterothyone alba (Hutton)
**Heterothyone ocnoides* (Dendy)
Stolus huttoni (Dendy)
Stichopus mollis (Hutton)

BATHYAL SPECIES

Heteromolpadia marenzelleri (Theel)
Molpadia violacea (Studer)
Paracaudina chilensis (Muller)
Pentadactyla longidentis (Hutton)
Heterothyone alba (Hutton)
Stichopus mollis (Hutton)

Note: Species marked with an asterisk were not represented in the collections examined.

MATERIAL EXAMINED

The holothurians forming the basis of this account were taken from Cook Strait and Wellington Harbour. The depths worked ranged between 5–10 fathoms and approximately 1300 fathoms. Benthic collections were made with dredge, otter trawl, beam trawl, Petersen grab, or a cone net fished on the bottom. Specimens of two species were kindly loaned to me by the New Zealand Oceanographic Institute, and supplementary intertidal species were collected by my colleagues and myself.

Victoria University of Wellington, Department of Zoology collections.

Coll. VUZ 10 (Station SAS): Palliser Bay, 41° 28′ 30″ S., 174° 59′ 30″ E., 5/2/55, 200–250 fathoms, green mud, dredge.
Heteromolpadia marenzelleri (Theel)—1 specimen.

Coll. VUZ 15 (Station SEB): Palliser Bay, 41° 29′ S., 175° 8′ 30″ E., 13/5/55, 100–150 fathoms, mud, otter trawl.
Heteromolpadia marenzelleri (Theel)—16 specimens.
Paracaudina chilensis (Muller)—2 specimens.
Pentadactyla longidentis (Hutton)—1 specimen.
Heterothyone alba (Hutton)—1 specimen.
Stichopus mollis (Hutton)—3 specimens.

Coll. VUZ 21 (Station CUC): Palliser Bay, 41° 32′ S., 175° 8′ 30″ E., 13/5/55, 38 fathoms, mud, beam trawl.
Heteromolpadia marenzelleri (Theel)—1 specimen.

Coll. VUZ 30 (Station W.REH): Wellington Harbour, south of Somes Island, 41° 15′ 48″ S., 174° 52′ 6″ E., 16/1/56, 5–10 fathoms, mud, rock trawl.
Heterothyone alba (Hutton)—13 specimens.

Coll. VUZ 32 (Station W.KEH): Wellington Harbour, off Petone Beach, 41° 14′ 30″ S., 174° 52′ 6″ E., 16/1/56, 8 fathoms, mud, dredge.
Protankyra uncinata (Hutton)—3 specimens.
Pentadactyla longidentis (Hutton)—2 specimens.

Coll. VUZ 35 (Station W.GOP): Wellington Harbour, off Days Bay, from 41° 16′ 42″ S., 174° 48′ 24″ E., to 41° 17′ 24″ S., 174° 53′ 48″ E., 16/1/56, 8–9 fathoms, mud, beam trawl.
Stichopus mollis (Hutton)—1 specimen.

Coll. VUZ 37 (Station W.LIJ): Wellington Harbour, off Shelly Bay, 41° 18′ 30″ S., 174° 48′ 42″ E., 18/1/56, 10–11 fathoms, mud, beam trawl.
Protankyra uncinata (Hutton)—8 specimens.
Pentadactyla longidentis (Hutton)—1 specimen.

Coll. VUZ 40 (Station W.JOJ): Wellington Harbour, off Ward Island, from 41° 18′ 18″ S,. 174° 52′ 18″ E., to 41° 17′ 42″ S., 174° 52′ 36″ E., 18/1/56, 2–4 fathoms, mud and sand, beam trawl.
Protankyra uncinata (Hutton)—2 specimens.

Coll. VUZ 62 (Station W.QOF): Wellington Harbour, east side, opposite Worser Bay, 41° 19′ 24″ S., 174° 51′ 36″ E., 2/4/56, 4–5 fathoms, gravel and sand, small beam trawl and dredge.
Stolus huttoni (Dendy)—1 specimen.

Coll. VUZ 64 (Station W.PEQ): Wellington Harbour, off Point Howard wharf, 41° 15′ 28″ S., 174° 54′ E., 2/4/56, 5 fathoms, blue mud, small beam trawl.
Protankyra uncinata (Hutton)—10 specimens.
Neocucumella bicolumnata (Dendy and Hindle)—1 specimen.
Pentadactyla longidentis (Hutton)—6 specimens.

Coll. VUZ 69 (Station W.BON): Wellington Harbour, Somes Island to Days Bay, 41° 16′ 24″ S., 174° 53′ 21″ E., 16/5/56, 11 fathoms, mud, Petersen grab, 3 hauls.
Pentadactyla longidentis (Hutton)—1 specimen.
Heterothyone alba (Hutton)—1 specimen.

Coll. VUZ 87 (Station KUJ): South of Cape Palliser, approximately 41° 44′ S., 175° 12′ E., 20/4/57, ca. 400 fathoms, mud, rock, gravel, 4 metre cone net fished on the bottom.
Heteromolpadia marenzelleri (Theel)—1 specimen.
Molpadia violacea (Studer)—1 specimen.
Paracaudina chilensis (Muller)—2 specimens.
Pentadactyla longidentis (Hutton)—2 specimens.

Coll. VUZ 96 (Station BOQ): Off Palliser Bay, 41° 31′ S., 174° 55′ E., 28/8/57, ca. 380 fathoms, mud, beam trawl.
Heteromolpadia marenzelleri (Theel)—13 specimens.

Coll. VUZ 101 (Station GOP): Off Palliser Bay, 41° 38′ S., 174° 53′ 30″ E., 29/8/57, ca. 550 fathoms, mud, beam trawl.
Molpadia violacea (Studer)—6 specimens.
Paracaudina chilensis (Muller)—135 specimens.

Order APODIDA

DIAGNOSIS: Modified vermiform holothurians with smooth, rough or warty surface. Tubefeet totally lacking, except for the tentacles. Anal papillae, tentacle ampullae, and respiratory trees absent. Tentacles 10 to 20 or even more in number, simple, digitate or pinnate. Characteristic deposits anchors and wheels, though some species lack deposits altogether.

The Order Apodida contains three well defined families, of which two have representatives in Cook Strait.

KEY TO THE FAMILIES IN ORDER APODIDA

1 (2) Deposits in the form of perforated plates accompanied by anchors ..... Fam. SYNAPTIDAE
2 (1) Deposits include wheels.
3 (4) Wheels with six spokes, together with sigmoid or C-shaped rods. Wheels arranged in papillae, or scattered in the body wall .... Fam. CHIRIDOTIDAE
4 (3) Wheels complex, with eight or more spokes .... Fam. MYRIOTROCHIDAE

Family SYNAPTIDAE

DIAGNOSIS: Tentacles with the stalks cylindrical or terete, not becoming widened distally, either with digits along each side for most of their length (pinnate), or with only one or two digits along each side near the tip (digitate), or without digits at all (simple). Calcareous deposits usually anchors and perforated plates often accompanied by irregular curved rods or minute particles (miliary granules), but any or all of these may be wanting. (Clark, 1907.)

The presence of distinctive anchors and anchor-plates appears to be the most important character for distinguishing this family. However, where calcareous deposits are lacking, the tentacles must be examined. Anchors are also found in the Family Molpadiidae, Order Molpadida, but reference to Plate I, fig. 4

(*Protankyra uncinata*) and Plate II, fig. 9 (*Heteromolpadia marenzelleri*) will show that the two types of anchors are readily distinguishable.

Family Synaptidae contains in excess of 120 species, the majority of which are littoral. There are a few species which live at depths below 250 fathoms. The family is especially well represented in the Indo-Pacific region, where more than half of the known species occur. A single species is at present known from New Zealand waters.

Protankyra Ostergren, 1898

DIAGNOSIS: Tentacles digitate, 10–12, rarely 13 or 14. Digits two on each side. Cartilaginous ring wanting. Polian vesicles 2–10 or rarely only one. Stone canal usually single. Stocks of the anchors more or less branched, but only finely toothed; arms usually serrate; vertex without knobs. Anchor-plates without handles, with numerous perforations, and with a more or less imperfectly developed bow across the outer surface of the posterior end. The anchor-plates and their perforations have either smooth or dentate margins.

Type Species: *Protankyra abyssicola* (Theel).

The genus *Protankyra* is a large and perplexing one. Most of the species are distinguishable on the basis of differences in the shape and size of the anchors and anchor-plates and their ornamentation. Heding (1928) stated ". . . . the ciliated funnels are of the greatest value as specific characters in *Protankyra*". It is felt, however, that the calcareous deposits should be regarded as of primary importance in diagnosing species of this genus, and such variable structures as the ciliated funnels should be used with caution.

The single New Zealand representative of this genus is quite distinct from the other known *Protankyra* species.

Protankyra uncinata (Hutton) Plate I, figs. 2–10

Synapta uncinata Hutton, 1872, p. 16; Theel, 1886, p. 27; Dendy, 1896, p. 25; Farquhar, 1898, p. 325.
Synapta inaequalis Hutton, 1872, p. 17.
Protankyra uncinata Mortensen, 1925, p. 367, figs. 48–51; Heding, 1928, p. 252; Dawbin, 1950, p. 40.

MATERIAL EXAMINED: VUZ 32, off Petone Beach, 8 fathoms, mud, 3 specimens; VUZ 37, off Shelly Bay, 10–11 fathoms, mud, 8 specimens; VUZ 40, off Ward Island 2–4 fathoms, mud, 2 specimens; VUZ 64, off Point Howard Wharf, 5 fathoms, blue mud, 10 specimens.

DIAGNOSIS: Tentacles 12, with sensory cups and four terminal digits. Colour white transparent to reddish brown. Anchors small (0.3–0.5mm long), usually symmetrical, with unbranched finely toothed stocks. Arms with few serrations or none. Anchor-plates oval or rectangular, smooth, with large smooth polygonal perforations of average diameter 0.025mm. Ciliated funnels slipper-shaped, numerous.

DESCRIPTION: The body is smooth, approximately cylindrical in shape, tapering abruptly to the terminal anus. Many of the specimens are completely contracted and carry a number of transverse wrinkles. In extended specimens the skin is semi-transparent. Length of largest extended specimen 100m; diameter at anterior end, 5mm. In alcohol, the colour varies between white transparent and reddish brown.

The skin is prickly to touch, the prickly sensation being caused by the sharp-pointed anchor arms which project above the level of the body wall. These arms can be seen with the naked eye. When completely contracted, the anterior end of the body folds inward and the tentacles disappear from view. If the animal is viewed end on, the five interradial areas between the radial muscle bands appear as soft fleshy lumps. This method of contraction may be a characteristic of the species. (Plate I, fig. 8.)

Twelve elongate, cylindrical tentacles surround the mouth, which lies in a shallow depression. There is a brown pigment spot at the base between each pair of tentacles. Each tentacle carries a terminal claw composed of two pairs of digits, and the stems carry a number of sensory cups on their inner margins (Plate I, fig. 9). The true function of these cups has apparently not been determined.

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

PLATE I

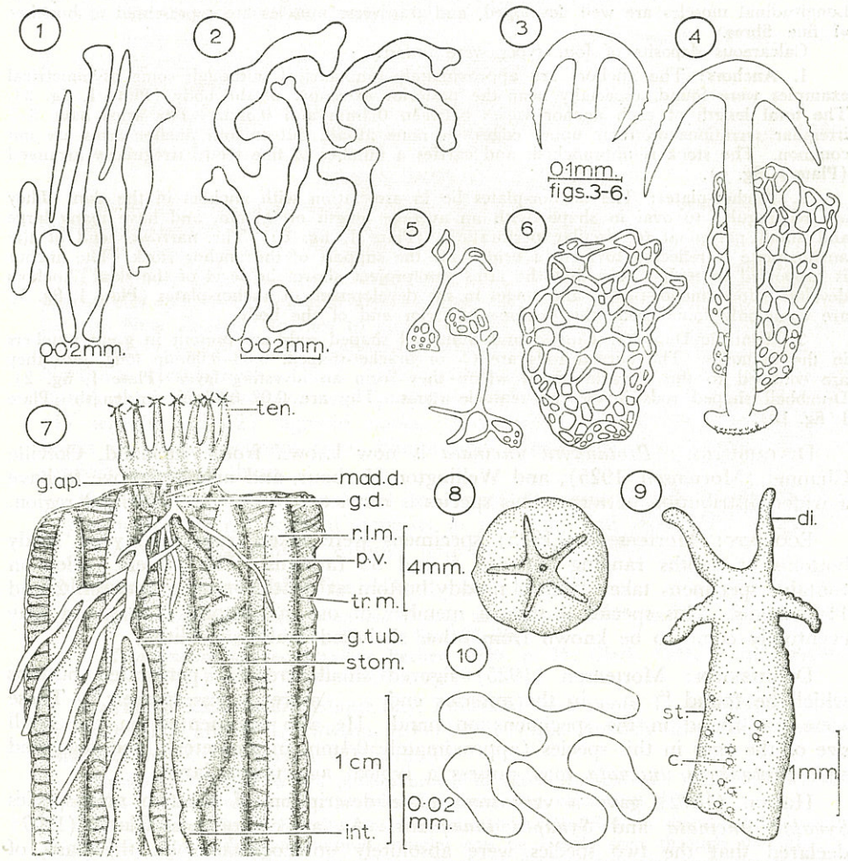

PLATE I.—*Trochodota dunedinensis* (Parker).—Fig. 1, tentacle rods.
Protankyra uncinata (Hutton).—Fig. 2, tentacle digit deposits; fig. 3, portion of an anchor from the posterior end of the body; fig. 4, anchor and anchor-plate; fig. 5, developing anchor-plates; fig. 6, anchor-plate; fig. 7, anterior of the body, dissected from the dorsal side (portions of gonad removed); fig. 8, anterior end of a contracted specimen; fig. 9, tentacle; fig. 10, tentacle stem deposits.
Abbreviations: c, sensory cup; di., tentacle digit; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; mad.d., stone canal; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; st., tentacle stem; stom., stomach; ten., tentacle; tr.m., transverse muscles.

A short, thin-walled oesophagus leads into a well-defined stomach which has a thick muscular wall (Plate I, fig. 7). The intestine takes a short loop and terminates in an undifferentiated cloaca.

There are 4–5 Polian vesicles, two or three of which may be longer than the rest (Plate I, fig. 7). They are tubular, and their length varies between 3mm and 25mm. The single stone canal leaves the water-vascular ring on the dorsal side, and runs anteriorly in the dorsal mesentery as a short loosely coiled tube 0.2mm in diameter, terminating in a small madreporite of an irregular shape.

The genital tubules are moniliform and sparsely branched, arranged in two bunches, extending for about half of the length of the body cavity in mature specimens. The common

genital duct lies in the dorsal mesentery, and opens to the exterior as a minute genital pore in the mid-dorsal interradius, immediately posterior to the ring of tentacles (Plate I, fig. 7). Longitudinal muscles are well developed, and transverse muscles are represented as bunches of fine fibres.

Calcareous deposits of four types were found:

1. Anchors: The anchors are approximately symmetrical, although some asymmetrical examples were found, especially near the posterior extremity of the body (Plate I, fig. 3). The total length of each anchor varies between 0.3mm and 0.5mm. The arms have 3–7 irregular serrations on their upper edges, or none at all, but smooth anchor arms are not common. The stock is unbranched, and carries a number of fine teeth, irregularly arranged (Plate I, fig. 4).

2. Anchor-plates: The anchor-plates lie in association with anchors in the skin. They are rectangular to oval in shape, with an average length of 0.3mm, and have many large and small polygonal to circular perforations (Plate I, fig. 6). The narrower end of the anchor-plate is reflected to form a bridge for the support of the anchor stock. The anchor is supported in such a way that the arms can project above the level of the skin. Anchors develop before anchor-plates, and stages in the development of anchor-plates (Plate I, fig. 5) are commonly found near the extreme posterior end of the body.

3. Tentacle Deposits: Curved and dumbbell shaped rods are present in great numbers in the tentacles. The curved rods are C- or bracket-shaped, 0.03–0.06mm long, and they are confined to the tentacle digits, where they form an investing layer (Plate I, fig. 2). Dumbbell shaped rods invest the tentacle stems. Thy are 0.02–0.05mm in length (Plate I, fig. 10).

DISTRIBUTION: *Protankyra uncinata* is now known from Auckland, Colville Channel (Mortensen, 1925), and Wellington Harbour, and may yet prove to have a wider distribution pattern. This species is restricted to the New Zealand region.

ECOLOGY: Mortensen's (1925) specimens were taken from muddy or sandy bottoms at depths ranging between 5 and 35 fathoms. The present collection contains specimens taken from a muddy bottom at depths ranging between 2 and 11 fathoms. This species is then a member of our sub-littoral fauna, and may eventually come to be known from other sheltered muddy localities.

DISCUSSION: Mortensen (1925) figured small irregular perforated buttons which he found ". . . . in the anterior end . . . more or less sparsely". These were not found in the specimens on hand. He also commented on the small size of the eggs in this species (approximately 0.1mm in diameter), and suggested that *Protankyra uncinata* may possess a typical auricularia larva.

Hutton (1872) gave a very inadequate description of his two new species *Synapta uncinata* and *Synapta inaequalis*. As a consequence Clark (1907) declared that the two species were absolutely unrecognisable on the basis of Hutton's descriptions. Mortensen (1925) established the validity of *P. uncinata* and reduced *P. inaequalis* to synonymy with that species. *P. inaequalis* was based on a fragment of skin containing asymmetrical anchors, but Mortensen (1925) suggested that this was probably an individual variant of *P. uncinata*.

Family CHIRIDOTIDAE

DIAGNOSIS: Calcareous deposits in the form of six-spoked wheels; sigmoid or C-shaped rods may be present. Tentacles with short stalks, becoming widened distally, where they bear 3–10 digits on each side. The digit-bearing portion forms a disc and the tentacles are therefore peltato-digitate.

Clark (1907) noted that the sexes are separate in many species. Sigmoid rods have each end curved in opposite directions, often in planes at right angles to each other. Rods in which the ends are curved inward towards each other are C-shaped or bracket-shaped.

This family comprises mainly small holothurians. The group is world-wide, and most of the species live in the littoral zone. Three genera and six species of Chiridotidae are known from New Zealand, of which three species are found in the Cook Strait region.

KEY TO THE COOK STRAIT GENERA IN FAMILY CHIRIDOTIDAE

1	(2)	Calcareous deposits absent from the body wall	*Kolostoneura* Becher, 1909
2	(1)	Wheels present, scattered or arranged into loose heaps, or sometimes so scattered as to be easily overlooked. Sigmoid rods also present in numbers	*Trochodota* Ludwig, 1892

Kolostoneura Becher, 1909

DIAGNOSIS: Calcareous deposits absent from the body wall. Tentacles ten. General features of anatomy similar to those in *Trochodota* Ludwig.

Type Species: *Kolostoneura novae-zealandiae* (Dendy and Hindle).

The genus *Kolostoneura* is monotypic, and Dendy and Hindle (1907) originally placed the species in genus *Rhabdomolgus*. Becher (1909) proposed a new genus for the New Zealand species to eliminate any suggestion of a genetic relationship with *Rhabdomolgus ruber* Keferstein, which is known from deeper waters in the Northern Hemisphere. Clark (1921) fully agreed with Becher's decision, and stated that *Kolostoneura* was probably derived from *Trochodota* by loss of (1) wheels and (2) sigmoid hooks. Mortensen's (1925) discovery of sigmoid hooks in some specimens from Plimmerton infected by ectoparasitic snails lends support to Clark's thesis.

Kolostoneura forms a parallel to *Anapta* Semper, which is described as a *Leptosynapta* Verrill without deposits in the skin, and *Achiridota* Clark, which is a *Chiridota* Eschscholtz without deposits (Clark, 1921).

Kolostoneura novae-zealandiae (Dendy and Hindle)

Rhabdomolgus novae-zealandiae Dendy and Hindle, 1907, p. 113, Pl. 11, figs. 1–4; Pl. 13, figs. 16–17; Pl. 14, figs. 22–29.
Kolostoneura novae-zealandiae Becher, 1909, p. 35; Clark, 1921, p. 164; Mortensen, 1925, p. 383; Dawbin, 1950, p. 40.

MATERIAL EXAMINED: Island Bay, intertidal rock pools, 11 specimens, collected by A. D. Allen and D. L. Pawson, 15/7/1959; Napier, muddy tide pool, 3 specimens, collected by D. L. Pawson, 20/5/1959.

DIAGNOSIS: Colour in life pinkish brown to white transparent. White and transparent in alcohol. Tentacles pinnate, occasionally containing calcareous deposits.

DESCRIPTION: Small holothurians, approximately cylindrical in shape, white transparent in alcohol. The radial longitudinal muscles can be clearly seen through the skin. Total length varies between 15mm and 40mm. Each of the ten tentacles gives rise to five pairs of pinnately arranged digits, which increase in length toward the distal extremities of the tentacles.

Dendy and Hindle (1907) gave a very thorough description of the internal anatomy of this species. Mortensen (1925) added that he almost invariably found calcareous deposits in the tentacles.

DISTRIBUTION: Dendy and Hindle's (1907) specimens were taken from New Brighton Beach, Kaikoura, and Owenga in the Chatham Islands. Mortensen (1925) found specimens at Akaroa, Plimmerton, Takapuna Beach and Stewart Island. The new locality, Napier, leads to the suggestion that *K. novae-zealandiae* may prove to be present around the entire New Zealand coast. The species is endemic to the New Zealand region.

ECOLOGY: This species has only been taken from the intertidal zone, where it lies concealed under rocks in mud or sand.

DISCUSSION: Examination of the tentacles of all the specimens on hand showed that only two were found to possess calcareous deposits in the tentacles.

K. novae-zealandiae appears to have no near relatives in New Zealand or overseas.

Trochodota Ludwig, 1892

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

Type Species: *Trochodota purpurea* (Lesson).

This well-defined genus contains in excess of 15 species at the present time. The species are separated on the basis of differences in average wheel size, in the size and arrangement of sigmoid rods, and the size and shape of the tentacle deposits. Some of the known species are closely related to each other and may yet prove to be synonyms.

The greatest concentration of species lies in the Indo-West Pacific region. Two species are known from New Zealand, and both are members of the Cook Strait Holothurian fauna.

KEY TO THE NEW ZEALAND SPECIES OF *Trochodota* LUDWIG

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

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

Trochodota dunedinensis (Parker) Plate I, fig. 1

Chiridota dunedinensis Parker, 1881, p. 418; Theel, 1886, p. 34; Dendy, 1896, p. 26, Pl. 3, figs. 1–8; Farquhar, 1898, p. 323.
Trochodota dunedinensis Ludwig, 1898, p. 87; Perrier, 1905, p. 123; Clark, 1907, p. 124; Clark, 1921, p. 166; Mortensen, 1925, p. 376, figs. 59b, 60b, 61; John, 1939, p. 315; Dawbin, 1950, p. 40, fig. 19.
Chiridota geminifera Dendy and Hindle, 1907, p. 112, Pl. 14, fig. 30.
Chiridota benhami Dendy, 1909, p. 151, Pl. 16, fig. 3a-1.
Trochodota benhami Clark, 1921, p. 166.
Non. *Trochodota dunedinensis* Allan, 1911, p. 325 (= *Trochodota alleni* Joshua); Ohshima, 1914, p. 478 (= *Trochodota diasema* Clark).
Chiridota australiana Theel, 1886, p. 16.

MATERIAL EXAMINED: Island Bay, intertidal rock pool, 1 specimen, collected by G. W. Gibbs, 11/7/1960.

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

DESCRIPTION: These are small holothurians, rarely more than 50mm in length when fully extended. The single specimen in the collection is 35mm in total length; the diameter at the anterior end is 3mm. Colour in life reddish-brown, deepening to a dark brown at the anterior and posterior extremities of the body; the tentacles are transparent, with numerous dark brown spots. Colour in alcohol, yellowish-white and semi-transparent.

The calcareous ring is composed of 12 unsymmetrical pieces. Each piece is narrow, about 1mm in length, with an anterior and a posterior notch. The radials are not perforated and are virtually indistinguishable from the interradials.

The oesophagus is short and thinwalled and enters the intestine which describes an S-shaped loop and runs to the anus. The single Polian vesicle arises from the ventral side of the water-vascular ring. The stone canal is very small and convuluted, lying in the dorsal mesentery, terminating in a minute nodular madreporite.

Gonads consist of a few long and slender tubes which extend almost to the posterior end of the body cavity.

Calcareous deposits of three kinds were found:

1. Wheels: The dorsal side of the body contains numerous six-spoked wheels in the skin, whose diameters range between 0.06mm and 0.16mm, the average diameter being 0.1mm.

2. Sigmoid Hooks: Sigmoid hooks, with an average length of 0.1mm are scattered among the wheels on the dorsal surface of the body. They lie transverse to the longitudinal axis of the body.

3. Tentacle Rods: The tentacles contain large numbers of small rods 0.02–0.06mm in length. They are irregular in shape and frequently have enlarged extremities (Plate I, fig. 1). The rods are scattered in the stems of the tentacles, but in the digits they are arranged in narrow double rows.

BEHAVIOUR OF A LIVING SPECIMEN: A living specimen of *T. dunedinensis* was placed in a dish of seawater, the bottom of which was partly covered by a thick layer of sandy mud. The general behaviour of the specimen was observed for some time.

1. *Feeding*: The tentacles were pushed into the mud and sand in turn. Small particles of the substrate adhered to the outer surfaces of the tentacles which apparently were covered by a sticky secretion. No particles of sand adhered to the inner surfaces of the tentacles. The tentacles were then rapidly wiped across the mouth one at a time, or pushed into the mouth, and the adhering particles were removed and ingested. While feeding, the specimen was fully extended, and waves of contraction passed along the body from time to time. The feeding process took place almost continuously during the time of observation.

2. *Defaecation*: The anal aperture of the body was completely closed, and the posterior half of the body contracted. Then the anus opened suddenly and egesta emerged in small lumps. No vermiform "casts" were seen. Defaecation took place at irregular intervals.

3. *Locomotion*: The specimen pulled itself around the walls of its dish by means of its sticky tentacles. There was no tendency to burrow away from strong light, although the animal was photosensitive.

DISTRIBUTION: Parker (1881) described the type specimen from Otago Harbour. Since that time specimens of this species have been found in many parts of the South Island of New Zealand, the Cook Strait region, Stewart Island, and the Auckland and Campbell Islands (Mortensen, 1925).

ECOLOGY: *T. dunedinensis* appears to favour comparatively sheltered sandy to muddy localities where it conceals itself under stones or by burrowing.

DISCUSSION: Mortensen (1925) stated that the oral disc is "distinctly oblique in dorso-ventral section" and "the calcareous ring is . . . parallel to the oral disc". The calcareous ring is no doubt asymmetrical owing to its oblique position.

There appears to be some variation in the course of the intestine in this species. Dendy's *T. benhami* possessed an S-shaped intestine. However Mortensen (1925) noted that in some of the specimens at his disposal the intestine ran straight to the anus, while in others it looped twice, or described an S-shaped path to the anus. He also showed that the other characters for *T. benhami* given by Dendy (1909) fell within the range of variation of *T. dunedinensis*.

Dendy (1896) noted that the sexes are separate in this species, and John (1939) observed that the females are viviparous.

Trochodota dunedinensis has certain characters in common with other species of the same genus. Clark (1921) pointed out that it is almost impossible to make an accurate key to the species of the genus without re-examining many of the species. To the writer's knowledge, this has not been done as yet.

Trochodota dendyi Mortensen

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

DIAGNOSIS: Colour white or faint purple. Skin papillate, each papilla containing 3–6 sigmoid hooks. Wheels numerous or absent. Tentacle deposits with bifurcating ends.

DISTRIBUTION: The type specimen was from Plimmerton. The species is also known from Waikeke (Auckland Harbour), and Paterson Inlet (Stewart Island) (Mortensen, 1925). Restricted to the New Zealand region.

ECOLOGY: Known only from the intertidal zone.

DISCUSSION: Mortensen examined nine specimens of this interesting species and after giving a very careful description, he stated that the species is nearly related to *Trochodota japonica* (v. Marenzeller) but differs in colour, number of sigmoid hooks in each papilla, and in the shape of the tentacle deposits.

Order MOLPADIDA

DIAGNOSIS: Stout, sausage-shaped holothurians, usually possessing a caudal prolongation or tail. Tentacles 15, digitate. Anal papillae, tentacle ampullae, respiratory trees present. Radial muscles in the form of double bands. Deposits commonly in the form of tables, fusiform rods, or perforated plates. Anchors sometimes occur, but wheels and sigmoid hooks do not. Phosphatic bodies often present.

The Order Molpadida is cosmopolitan, most abundant in the Indo-West Pacific, and its members have a bathymetric range from a little below low-water mark to at least 2,000 fathoms, where an almost exclusively subterranean life is led in a sandy or mud bottom. Most of the known species have been taken in deep water, and consequently, many species have a wide geographic distribution.

There are three families in Order Molpadida, of which two are represented in New Zealand waters, species from both having been taken in the Cook Strait region.

KEY TO THE FAMILIES IN ORDER MOLPADIDA

1 (4) Tentacle ampullae present.
2 (3) Tentacles with 1–3 pairs of digits and a terminal digit ..... Fam. MOLPADIIDAE
3 (2) Tentacles with 2 pairs of digits and no terminal digit ..... Fam. CAUDINIDAE
4 (1) Tentacle ampullae absent ..... Fam. EUPYRGIIDAE (unknown in New Zealand)

Family MOLPADIIDAE

DIAGNOSIS: Tentacles with lateral digits, or claw-shaped. Tentacle ampullae long (reduced in one deep-water species). Spicules derived from triradiate tables with solid three-pillared spire; tail with tables with round to oblong disc, or long fusiform rods. In one species large fusiform plates or rods develop in the skin of the body wall with advancing age. Dark red egg-shaped phosphatic bodies often present. In some species anchors and racquet-shaped plates present in young individuals. Mostly large forms, 6–15cm long (Deichmann, 1960).

The members of this family are unique in that the calcareous deposits of the juvenile may be transformed into phosphatic material with the passage of time. The phosphatic material is deposited as small orange or red concentrically laminated granules. As a consequence of this phenomenon, juveniles, half-grown specimens, and adults of the same species have often been placed in different species, because of the differences in their spiculation. Clark (1907) referred all of the then known species of the family Molpadiidae to the genus *Molpadia* Risso. Heding (1931) attempted a revision of the family, listing the known species under five genera, one of which (*Pseudomolpadia*) was a new genus. Later, Heding (1935) erected another new genus (*Eumolpadia*). Deichmann (1936), pointed out a number of inconsistencies in Heding's reasoning, and suggested a return to Clark's (1907) idea that all of the species be placed under the single generic name *Molpadia* in the meantime, until the life histories of at least a few typical cases be worked out.

Heding (1931, 1935) used differences in structure and sculpture of the calcareous ring, in certain features of internal anatomy, and (to a lesser extent) in calcareous deposits, as criteria for separation at the generic level. It appears that these criteria may be rather unreliable, and subject to more or less drastic changes with growth. The calcareous deposits of the tail are relatively unaffected by deposition of phosphatic material and these deposits are thus reliable criteria for identification of juvenile and adult specimens alike. The deposits in the body wall should be used only when the life history of the species is fairly well known, and a series of specimens have been examined, or when the body wall deposits

are so distinctive as to belong to a certain species. The calcareous ring should supply characters of secondary importance only.

Two genera of Molpadiidae are represented in the Cook Strait collections.

KEY TO THE COOK STRAIT GENERA IN FAMILY MOLPADIIDAE

1 (2) Deposits include anchors and three-armed anchor-plates, and spired tables with three perforations .... *Heteromolpadia* n.g.
2 (1) Deposits in the form of large fusiform rods and scattered irregular tables ..... *Molpadia* Risso

Heteromolpadia n.g.

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

Type Species: *Ankyroderma marenzelleri* Theel.

Also included here: *Ankyroderma tridens* Sluiter.

DISCUSSION: Heding (1931) in his subdivision of the genus *Molpadia* proposed a new genus *Pseudomolpadia* for those species which have the anchors either united with a single fenestrated plate, or supplied with more than two arms. In this genus Heding placed the following species:

1. *brevicaudata* (Koehler and Vaney) 1905 type species.
2. *marenzelleri* (Theel) 1886.
3. *tridens* (Sluiter) 1901.
4. *inflata* (Augustin) 1914.

Subsequently, Deichmann (1936) pointed out that it is only in *tridens* and *marenzelleri* that the anchor-plates are definitely known to be "not united in rosettes". Thus *brevicaudata* and *inflata* do not belong with the two other species unless it is proved that they have single anchor-plates. As *brevicaudata* is the type of *Pseudomolpadia,* this generic name cannot be used here, and it is necessary to propose a new genus, *Heteromolpadia,* with *H. marenzelleri* (Theel) as the type species.

KEY TO THE SPECIES OF *Heteromolpadia*

1 (2) Deposits in the body wall include tables, typically with three perforations ..... *H. marenzelleri* (Theel)
2 (1) No such tables present .... *H. tridens* (Sluiter)

Heteromolpadia marenzelleri (Theel) Plate II

Ankyroderma marenzelleri Theel, 1886, p. 41, Pl. 3, fig. 1 a-g.
Molpadia marenzelleri Clark, 1907, p. 171, Pl. 10, fig. 23; Benham, 1909, p. 70, Pl. 11, fig. 4, a-d; Deichmann, 1936, p. 464; Dawbin, 1950, p. 39, Pl. 2, fig. 17; Deichmann, 1960.
Molpadia dendyi Benham, 1909, p. 71, Pl. 11, figs. 1–3.
Pseudomolpadia marenzelleri Heding, 1932, p. 280.

MATERIAL EXAMINED: VUZ 10, Palliser Bay, 200–250 fathoms, green mud, 1 specimen; VUZ 15, Palliser Bay, 100–150 fathoms, mud, 16 specimens; VUZ 21, Palliser Bay, 38 fathoms, mud, 1 specimen; VUZ 87, South of Cape Palisler, 400 fathoms, mud, rock and gravel, 1 specimen; VUZ 96, off Palliser Bay, 380 fathoms, mud, 13 specimens; Cook Strait, 40 fathoms, 2 specimens, collected by F. Abernethy, 14/11/1952; off Foxton, 50 fathoms, 1 specimen.

New Zealand Oceanographic Institute, Wellington: B 11, Hawke Bay, 35 fathoms, mud, 1 specimen; B 44, Hawke Bay, 14 fathoms, sandy mud, 1 specimen;

B 49, Hawke Bay, 44 fathoms, fine grey-green mud, 1 specimen; A 435, off Foxton, 64 fathoms, sandy mud, 1 specimen; C 185, off Wanganui, 25 fathoms, mud, 1 specimen; C 186, off Wanganui, 25 fathoms, mud, 1 specimen; C 189, entrance to Tasman Bay, 30 fathoms, soft mud, 1 specimen.

DIAGNOSIS: Deposits in the body wall comprise spired tables with 3 large perforations, and anchors associated with single three-armed perforated anchor-plates up to 0.4mm in length. Tail deposits lozenge-shaped, 0.1–0.16mm in length.

DESCRIPTION: Short-tailed, fat-bodied holothurians which are greyish-white as juveniles, and gradually become red in colour with growth, until the largest specimens are almost uniformly dark red. The calcareous deposits comprise distinctive anchors, anchor-plates and tables. The tables in the tail persist unchanged throughout life, and are always readily usable as a diagnostic character. The deposits in the rest of the body become gradually transformed into phosphatic bodies with age, and thus they range from well-formed anchors, anchor-plates and tables in smaller specimens to simple, small, concentrically laminated ovoidal red phosphatic granules in larger specimens. Large specimens of the species often lack calcareous deposits altogether, except in the tail, and are dark red is colour, due to the presence of great numbers of phosphatic deposits.

Three groups, based mainly on colour of specimens, may be recognised:

1. Small specimens: 15–30mm in total length. The smallest specimen on hand is 15mm in total length, with a tail length of 6mm. The ratio tail : body in this group is about 1 : 3. The body is about twice as long as it is broad. These animals are uniformly greyish-white in colour, and the body wall is quite thin, but opaque. The body is often clothed in particles of mud and sand, which are caught on the arms of anchors and the spires of the tables, as they project above the level of the skin. When touched, the skin gives the sensation of carrying a number of short sharp spines. The inadequate development of the gonads indicates that the specimens in this group may not be sexually mature, and they may be regarded as juveniles.

2. Medium Specimens: 30–70mm in total length. The shape is approximately the same as that in the juvenile, but the tail : body ratio has now become 1 : 6. These specimens are orange to dark red in colour, with many greyish spots. The tail and circum-oral regions still retain the grey colour of the juvenile. At this stage in growth, many of the calcareous deposits have been transformed into red phosphatic material, and thus there are but small numbers of anchor arms and table spires projecting from the skin.

3. Large Specimens: 70–101mm in total length. The largest specimen is 101mm in total length, with a tail length of 12mm. The tail : body ratio is here 1 : 8. In these specimens the body is uniformly dark red, while the tail is grey. In these large specimens, virtually all of the calcareous deposits have been transformed into phosphatic bodies. No anchor arms project above the skin, and the skin is quite smooth and leathery to touch.

The calcareous ring is made up of 10 sculptured pieces, 5 radials and 5 interradials, which are joined to form a solid ring (Plate II, fig. 8). Each radial piece has two rounded anterior projections and a slightly bifurcated posterior projection. There are no perforations for the passage of the radial nerves. The radial pieces each carry a groove for attachment of the radial muscle. Each interradial has a single anterior process, carries a sharp ridge, and has no posterior process. The ring has 15 grooves for tentacle ampullae. Sculpture of the ring varies considerably in this species. The calcareous ring in the juvenile has long and slender posterior projections.

A short thin-walled oesophagus leads into the intestine, which takes a very large loop and runs to the cloaca, which is undifferentiated, save for the numerous very fine muscle strands attaching it to the body wall. These strands also fill the cavity in the tail.

A single Polian vesicle leaves the water vascular ring in the left ventral interradius. It consists of a short narrow tube which carries a dark brown bulbous extremity (Plate II, fig. 1). The stone canal lies in the mid-dorsal interradius, runs anteriorly and dorsally into

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fig. 6, mid-body tables; fig. 7, stages in development of a mid-body table; fig. 8, calcareous ring of an adult specimen; fig. 9, anchors; fig. 10, mid-body tables showing phosphatic material.

Abbreviations: amp.g., groove for passage of tentacle ampulla; c.r., calcareous ring; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., interradial piece; m.a., attchmeant area for radial muscles; mad., madreporite; m.f., muscle fibres; oes., oesophagus; ph.mat., phosphatic material; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.p., radial piece; r.resp., right respiratory tree; tr.m., tranverse muscles.

PLATE II

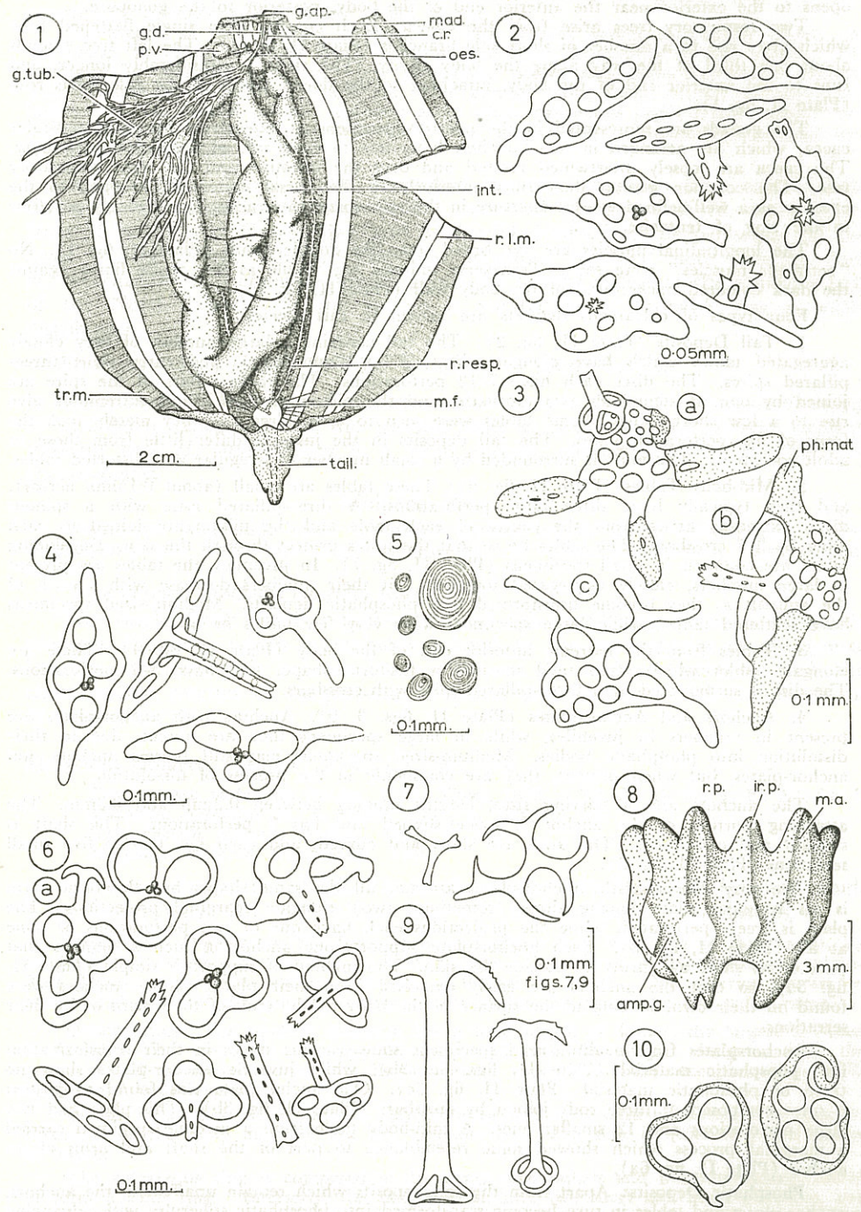

PLATE II.—*Heteromolpadia marenzelleri* (Theel).—Fig. 1, Internal anatomy of adult, dissected from the dorsal side (portions of the gonad removed); fig. 2, tail deposits; fig. 3, anchor-plates; fig. 4, deposits from the extreme anterior end of the body; fig. 5, phosphatic deposits;

the centre of a spherical madreporite. The madreporite is joined to a pore-canal which opens to the exterior near the anterior end of the body, posterior to the gonopore.

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

The gonads are represented in the mature specimens as extensively branched vesicular caeca, which are arranged in two bunches, lying one to each side of the dorsal mesentery. The caeca are loosely intertwined around and over the intestine and the right respiratory tree. The common genital duct runs anteriorly in the dorsal mesentery to open to the exterior as a well-defined genital aperture in the mid-dorsal interradius, immediately posterior to the ring of tentacles.

The longitudinal muscles are five broad strap-like double bands (Plate II, fig. 1). No "retractor muscles" were seen. Transverse muscles are visible as fine white fibres against the dark coloured background of the body wall (Plate II, fig. 1).

Four types of calcareous deposits are known in this species:

1. Tail Deposits (Plate II, fig. 2): The tail contains a large number of very closely aggregated tables which have elongate discs (0.1–0.16mm long), and carry short three-pillared spires. The discs each have 7–12 perforations. The three pillars of the spire are joined by one or sometimes two crossbars, and the pillars at their distal extremities give rise to a few short spines. Some tables were seen to lack spires and they merely took the form of flat perforated plates. The tail deposits in the juvenile differ little from those in adult specimens. The anus is surrounded by a small number of irregular and distorted tables.

2. Mid-body Tables (Plate II, fig. 6): These tables are small (about 0.15mm across), and they typically have three large perforations. A three-pillared spire with a spinous distal extremity arises from the centre of each table and the pillars are joined to each other by 3–7 crossbars. The tables lie so that the spires project through the skin. Developing tables are common in small specimens (Plate II, fig. 7). In juveniles, the tables are present in large numbers, closely aggregated together, but their numbers decrease with growth of the animals as they become transformed into phosphatic deposits. Medium-sized specimens have scattered tables, while large specimens have very few tables or none.

3. Tables from the extreme anterior end of the body (Plate II, fig. 4): These are elongate tables which often tend towards a fusiform shape, and have 3–7 perforations. The disc is surmounted by a three-pillared spire with crossbars.

4. Anchors and Anchor-plates (Plate II, figs. 3, 9): Anchors with anchor-plates are present in numbers in juveniles, while in large specimens they are absent, due to their dissolution into phosphatic bodies. Medium-sized specimens may still possess anchors and anchor-plates, but when present, they are commonly in the process of dissolution.

The anchors are of varying sizes, lengths ranging between 0.2mm and 0.3mm. The attaching portion of the anchor is saucer-shaped and has 3 perforations. The shaft is straight and cylindrical. The arms are short and curved, and each has two to five small serrations (Plate II, fig. 9).

The very characteristic anchor-plates are not all the same shape, but the basic form is an irregular plate having three (sometimes two) elongate marginal projections. The plate is freely perforated, while the projections each have one or two perforations or none at all (Plate II, fig. 3). Each anchor-plate supports one anchor in such a manner that part of its shaft and arms lie outside the skin. The method of support is simple (Plate II, fig. 3a), so that the anchors are easily detached from their plates. Some anchors were found on their own, holding to the surface of the body by the ends of their arms or by their serrations.

Anchor-plates from medium-sized specimens show various stages in their transformation into phosphatic material (Plate II, figs. 3a, 3b), while juvenile anchor-plates show no trace of phosphatic material (Plate II, fig. 3c). One anchor-plate was found to possess a spire composed of three rods joined by crossbars (Plate II, fig. 3b). This plate had two large perforations and 12 smaller ones. A mid-body table from a juvenile specimen carried a marginal process which showed some resemblance to part of the shaft and arms of an anchor (Plate II, fig. 6a).

Phosphatic Deposits: Apart from the tail deposits which remain unaffected, the anchors, anchor-plates and tables in turn become transformed into phosphatic spherules with advancing age. It is therefore possible to encounter specimens which lack anchors, anchors and anchor-plates, or anchors anchor-plates and tables. Transformation into phosphatic material is a gradual process and one often sees deposits which are in the process of dissolution (Plate II, figs. 3a, 3b, 10).

The resulting phosphatic bodies are amber or red, ovoid to spherical, and they superficially resemble starch grains (Plate II, fig. 5).

Knowledge of the changes in deposits with growth serves to explain clearly the differences in colour between small, medium and large individuals of this species. The greyish-white juveniles have very few phosphatic bodies and many calcareous deposits. The medium-sized specimens, dark red with greyish spots, have clusters of phosphatic bodies, and the greyish patches represent areas where calcareous deposits still remain. The uniformly dark red large individuals have great numbers of phosphatic bodies and very few calcareous deposits.

DISTRIBUTION: Theel (1886) described the type specimen from east of East Cape in 700 fathoms. Benham (1909) recorded specimens of *H. marenzelleri* from 38 fathoms in Hawke Bay, and *Molpadia dendyi* from deeper water off the coast of the North Island. The new localities recorded here indicate that *H. marenzelleri* is a common species about the deeper waters of the southern half of the North Island. As the species is eurybathic, it probably has a wider distribution.

ECOLOGY: This species lives on a muddy or sandy bottom.

DISCUSSION: The status of this species has been in doubt for some time, owing to insufficient knowledge of the juvenile and its deposits. The present findings indicate that *H. marenzelleri* is a valid species, characterised by the peculiar anchor-plates.

Molpadia Risso, 1826

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

Type Species: *Molpadia musculus* Risso.

The single Cook Strait representative of this perplexing genus is *Molpadia violacea* (Studer), which is probably related to the type species of the genus, but the relationship is not absolutely clear, as *M. violacea* seems to lack the characteristic rosettes of racquet-shaped plates and anchors which are found in *M. musculus*.

Molpadia violacea (Studer) Plate III, figs. 4–8

Trochostoma violaceum Studer, 1876; Theel, 1886, p. 42, Pl. II, fig. 4; Pl. XI, fig. 1.
Molpadia musculus H. L. Clark, 1907, p. 165, Pl. XI.
Haplodactyla violacea Heding, 1931, p. 280.
Molpadia violacea Deichmann, 1960.

MATERIAL EXAMINED: VUZ 87, South of Cape Palliser, 400 fathoms, mud, 1 specimen; VUZ 101, off Palliser Bay, 550 fathoms, mud, 6 specimens.

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

DESCRIPTION: The smallest specimen has a total length of 47mm; the largest is 78mm in length. The specimens are approximately cylindrical in shape, elongate, with the posterior end attenuated to form a distinct caudal appendage which occupies up to 20% of the total body length.

Colour in alcohol ranges from a light-brownish red to a dark brick-red. The anterior extremity of the body and the tail are greyish-white. The skin is quite thin and coarse to touch.

The calcareous ring is composed of 10 pieces, five radials and five interradials, joined to form a solid ring. Anteriorly, the radials each have two short and blunt processes, one of which carries a small perforation for the passage of the radial nerve. The interradials each have one anterior process and no perforation. The radials have a forked posterior process, while the interradials have none. The ring is sculptured on its outer surface, and the sculpture varies within the species.

The internal anatomy is similar to that in *Heteromolpadia marenzelleri*.

Two types of calcareous deposits are present in the skin:

1. Fusiform Rods: These are found everywhere in the body wall, especially in the tail, where they occur in great numbers, closely aggregated together, lying transverse to the longitudinal axis of the body. The rods vary in length up to a maximum of 1.1mm, and they have an expanded central portion which carries a small number of perforations.

(a) Rods from the tail (Plate III, fig. 6): The tail rods are in general smaller (average length 0.7mm) than those from other areas, and have fewer perforations. The ends of the rods tend to project above the level of the skin, and they can be seen with the naked eye.

(b) Rods from the posterior third of the body, near the tail (Plate III, fig. 8): These are massive deposits, with an average length of 1.0mm. Many of the rods have three arms, while others have two, and there are four to eight central perforations. The rods are grouped into small clusters.

(c) Rods from the middle of the body (Plate III, fig. 7): Mid-body deposits closely resemble those from the posterior third of the body in general features, but even more variability in shape is displayed.

(d) Rods from the extreme anterior end of the body (Plate III, fig. 4): These are similar to those from the tail, and are of a comparable size.

2. Perforated tables (Plate III, fig. 7a): Tables (length 0.3–0.6mm) with short central spires and 3–6 perforations are scattered sparsely in the skin. The spire is composed of a single column, and in many cases it is absent. Developmental stages are occasionally seen (Plate III, fig. 5).

Red phosphatic deposits are present, grouped together in small clumps. They are similar to those in *Heteromolpadia marenzelleri* (Theel).

DISTRIBUTION: Theel (1886) described specimens taken from the vicinity of Kerguelen Island at depths between 20 and 120 fathoms, and from about 50 miles east of East Cape, New Zealand in 700 fathoms. The two new localities recorded here, Palliser Bay, 550 fathoms, and south of Cape Palliser, 400 fathoms, indicate that this species may be relatively common in deeper waters about New Zealand, and probably elsewhere, achieving its distribution by spreading across the seafloor in deep water.

DISCUSSION: The specimens described here are similar in most respects to those described and figured by Theel (1886). There appears to be a complete lack of anchors and rosettes, even in smaller specimens. Thus the species is sharply distinguished from *M. musculus* (Risso). Deichmann (1960) believes that *M. violacea* is an extreme form of *M. musculus* with narrow rods and lacking the anchor and racquet stage completely.

Family CAUDINIDAE

DIAGNOSIS: Tentacles with one to two pairs of digits, but no terminal digit. Spicules large tables or plates, or small crossed cups or irregular bodies. No phosphatic bodies, but discolouration of the skin may occur in older individuals of some species (Deichmann, 1960).

The genera within this family, in contrast to those in the family Molpadiidae, are clearly defined, the calcareous deposits of the skin being particularly useful as criteria for separation. The deposits are not transformed into phosphatic material as are those of so many species in the family Molpadiidae, although in some cases the deposits are known to change shape with growth and age, but this change is by no means a dramatic one.

Four genera are recognised at the present time. *Acaudina* Clark is readily distinguishable from the rest as its tentacles have one pair of digits, while the other genera have two pairs of digits per tentacle. *Paracaudina* Heding has characteristic deposits in the form of "crossed cups" (Plate IV, fig. 2). *Caudina* Stimpson has deposits which usually take the form of spired tables and knobbed buttons. *Hedingia* Deichmann has distinctive tables and plates of considerable size.

PLATE III

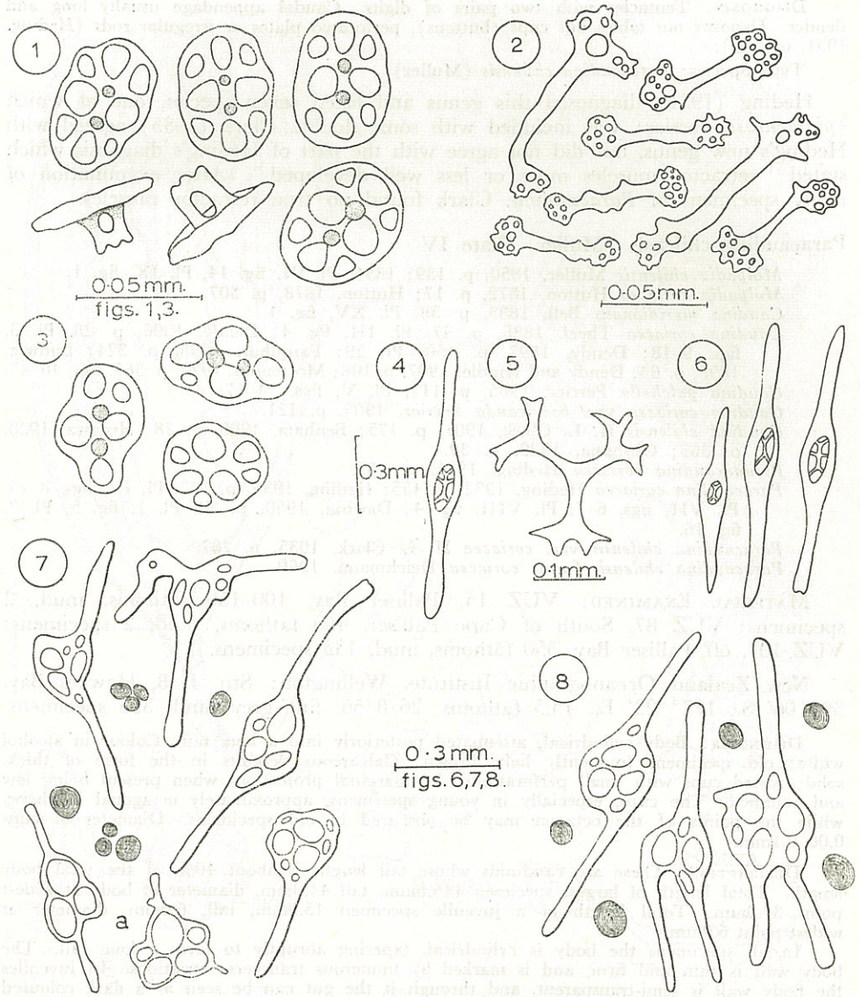

PLATE III.—*Neocucumella bicolumnata* (Dendy and Hindle).—Fig. 1, tables; fig. 2, tentacle deposits; fig. 3, abnormal tables.

Molpadia violacea (Studer).—Fig. 4, rod from anterior end of body; fig. 5, developmental stage of perforated plate; fig. 6, rods from the tail; fig. 7, deposits from the middle of the body; fig. 8, rods from the posterior of the body, near the tail.

The family is cosmopolitan, with representatives in all seas. Most species are known from moderate depths, although *Hedingia albicans* has been taken from depths in excess of 1500 fathoms.

Genus *Paracaudina* Heding is represented in the Cook Strait region by a single species.

Paracaudina Heding, 1931

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

Type Species: *Paracaudina chilensis* (Muller).

Heding (1931) diagnosed this genus and listed seven species, one of which (*pigmentosa* Perrier) was included with some doubt. Clark (1935) agreed with Heding's new genus, but did not agree with the part of Heding's diagnosis which stated "retractor muscles more or less well developed". After examination of many specimens of *Paracaudina,* Clark found no true retractor muscles.

Paracaudina chilensis (Muller) Plate IV

Molpadia chilensis Muller, 1850, p. 139; 1854, Pl. VI, fig. 14, Pl. IX, fig. 1.
Molpadia coriacea Hutton, 1872, p. 17; Hutton, 1878, p. 307.
Caudina meridionalis Bell, 1883, p. 58, Pl. XV, fig. 1.
Caudina coriacea Theel, 1886, p. 47, Pl. III, fig. 4; Dendy, 1896, p. 28, Pl. 3, figs. 9–18; Dendy, 1897, p. 456, Pl. 29; Farquhar, 1898, p. 324; Ludwig, 1898, p. 63; Dendy and Hindle, 1907, p. 108; Mortensen, 1925, p. 363, figs. 46–47.
Caudina pulchella Perrier, 1905, p. 117, Pl. V, figs. 14–17.
Caudina coriacea var. *brevicauda* Perrier, 1905, p. 121.
Caudina chilensis H. L. Clark, 1907, p. 175; Benham, 1909, p. 28; Hozawa, 1928, p. 363; Ohshima, 1929, p. 39.
Pseudocaudina coriacea Heding, 1931, p. 283.
Paracaudina coriacea Heding, 1932, p. 455; Heding, 1933, p. 127, Pl. IV, figs. 8–13, Pl. VII, figs. 6–7, Pl. VIII, fig. 4; Dawbin, 1950, p. 39, Pl. 1, fig. 5, Pl. 2, fig. 16.
Paracaudina chilensis var. *coriacea* H. L. Clark, 1935, p. 267.
Paracaudina chilensis forms *coriacea* Deichmann, 1960.

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 2 specimens; VUZ 87, South of Cape Palliser, 400 fathoms, mud, 2 specimens; VUZ 101, off Palliser Bay, 550 fathoms, mud, 135 specimens.

New Zealand Oceanographic Institute, Wellington: Stn. B 8, Hawkes Bay, 39° 06′ S., 177° 23′ E., 15.5 fathoms, 26/8/56, fine grey sand, 326 specimens.

DIAGNOSIS: Body cylindrical, attenuated posteriorly into a long tail. Colour in alcohol white; old specimens frequently light brown. Calcareous deposits in the form of thick, solid crossed cups with small perforations, the marginal projections when present being low and rounded. The cups, especially in young specimens, approximately octagonal in shape, while the points of the octagon may be obscured in old specimens. Diameter of cups 0.06–0.1mm.

DESCRIPTION: These are caudinids whose tail length is about 40% of the total body length. Total length of largest specimen 115.0mm, tail 44.0mm, diameter of body at widest point 37.0mm. Total length of a juvenile specimen 15.0mm, tail, 6.0mm, diameter at widest point 6.0mm.

In all specimens the body is cylindrical, tapering abruptly to form a long tail. The body wall is thin and firm, and is marked by numerous transverse striations. In juveniles the body wall is semi-transparent, and through it the gut can be seen as a dark coloured mass. Colour in life and in alcohol varies from white to light yellow or brown. Anal papillae are present. The mouth is circular, lying in the middle of a circular oral disc. Tentacles 15, usually retracted.

The calcareous ring comprises ten pieces, five radials and five interradials. The radials each have a bifurcated posterior projection and three anterior projections. The interradials each have no posterior projection and one anterior projection. Many workers (Hozawa, 1928; Heding, 1933; Clark, 1935) have described the calcareous ring in detail.

PLATE IV

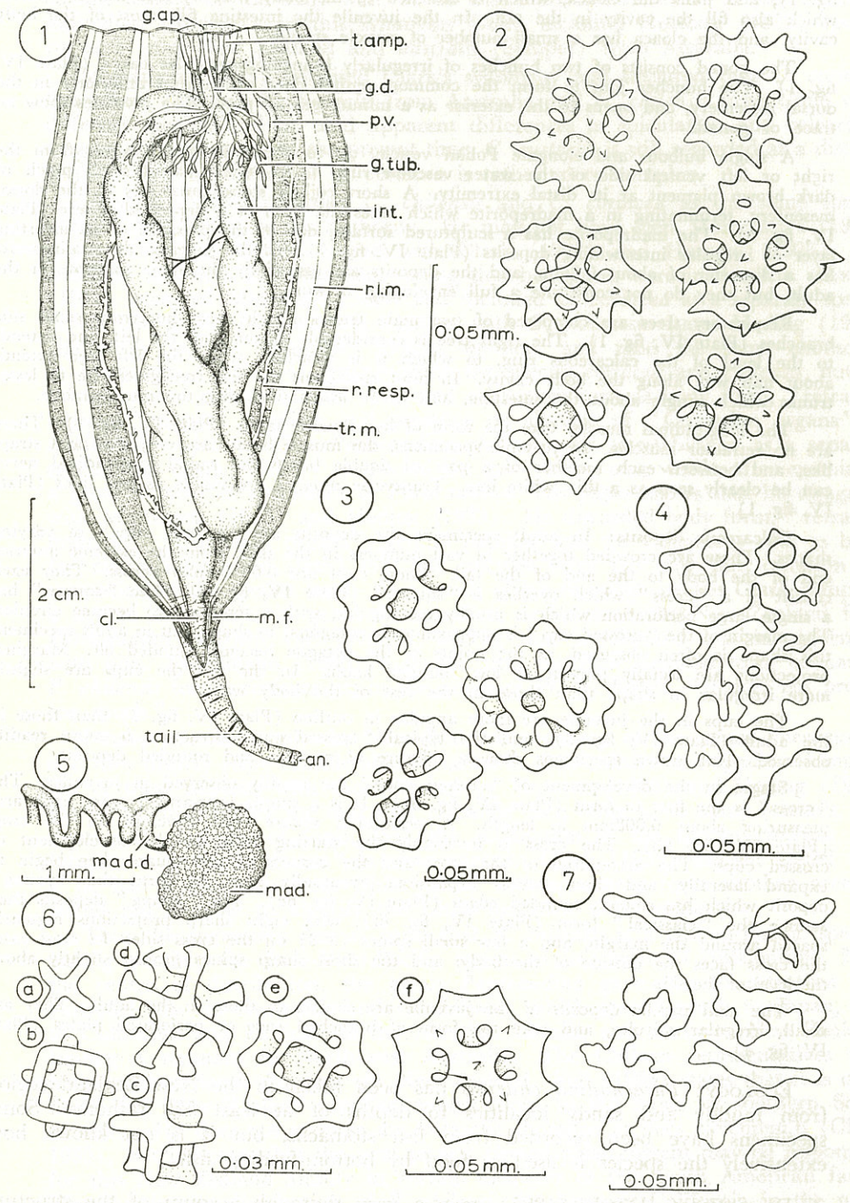

PLATE IV.—*Paracaudina chilensis* (Muller).—Fig. 1, internal anatomy of adult dissected from the dorsal side (portions of the gonad removed); fig. 2, crossed cups from a juvenile specimen; fig. 3, crossed cups from an adult specimen; fig. 4, anal papilla deposits; fig. 5, stone canal and madreporite; fig. 6, developmental stages of crossed cups; fig. 7, madreporite deposits.

Abbreviations: an., anus; cl., cloaca; g.ap., genital aperture; g.d., genital duct; g.tub., genital tubules; int., intestine; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; p.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.resp., right respiratory tree; t.amp., tentacle ampulla; tr.m., transverse muscles.

A short thinwalled oesophagus meets the intestine which takes a large loop (Plate IV, fig. 1), and joins the cloaca, which is attached to the body wall by fine muscle strands which also fill the cavity in the tail. In the juvenile the intestine fills most of the body cavity, and the cloaca has a small number of muscle strands.

The gonad consists of two bunches of irregularly branching vesicular caeca (Plate IV, fig. 1). The bunches join to form the common genital duct which runs anteriorly in the dorsal mesentery, and opens to the exterior as a minute genital pore. The juveniles show no trace of gonads.

A single bulbous and elongate Polian vesicle, up to 10mm in length arises from the right or left ventral side of the water vascular ring. The vesicle has a small patch of dark brown pigment at its distal extremity. A short coiling stone canal lies in the dorsal mesentery, terminating in a madreporite which takes the form of a depressed sphere (Plate IV, fig. 5). The madreporite has a sculptured surface, due to the presence of an investing layer of irregular intertwining deposits (Plate IV, fig. 7). In the juvenile the madreporite has a diameter of about 0.2mm, and the deposits are essentially the same as those in the adult, but they do not constitute a full enveloping network.

Respiratory trees are composed of two main trunks which carry numerous small side branches (Plate IV, fig. 1). The right tree is considerably longer than the left, and extends to the level of the calcareous ring, to which it is attached, while the left tree extends about half way along the body cavity. In most specimens the left tree gives rise to lesser trunks which tangle about the intestine, and lie in association with the rete mirabile.

The longitudinal muscles take the form of five double bands (Plate IV, fig. 1). There are no retractor muscles. In juvenile specimens, the muscle bands are very thin and strap-like, and between each member of a pair of double bands the radial longitudinal nerve can be clearly seen as a thin white line. Transverse muscles are visible as fine lines (Plate IV, fig. 1).

Calcareous deposits: In adult specimens the deposits are "crossed cups" of varying shapes. These are crowded together in vast numbers in the skin, from the extreme anterior end of the body to the end of the tail. These cups are 0.06–0.1mm across. They each consist of a "cross" which overlies a "square" (Plate IV, fig. 2). The "square" has a single large perforation which is usually rectangular, with a tendency to become circular. The margin of the "crossed cup" is approximately octagonal in shape, but in adult specimens this shape is often obscured, as the points of the octagon become rounded off. Marginal projections are usually present as low rounded knobs. In the tail the cups are slightly more irregular in shape than those in the rest of the body wall.

The cups in the juvenile are more angular in outline (Plate IV, fig. 2) than those in the adult (Plate IV, fig. 3), and the typical "crossed cup" structure is more readily observed. Half-grown specimens show a mixture of angular and rounded deposits.

Stages in the development of "crossed cups" are readily observed in juveniles. The "cross" is the first to form (Plate IV, fig. 6a). It is a simple four-armed cross, each arm measuring about 0.008mm in length. A perforated square then develops on the cross (Plate IV, fig. 6b). The cross is invariably the starting point in the development of crossed cups. The extremities of the cross and the corners of the square then begin to expand laterally, and these lateral expansions eventually meet to form the "young" deposit which has smooth rounded edges (Plate IV, fig. 6e). The "young" deposits then assume the "classical" form (Plate IV, fig. 6f), with eight sharp projections regularly spaced around the margin, and a few small spines (3–8) on the cross side. In most cases the cross faces the outside of the body, and the short sharp spines project slightly above the level of the skin.

The anal papilla deposits of the juvenile are similar to those in the adult. They are small, irregular spicules, and take the form of branched rods or perforated plates (Plate IV, fig. 4).

ECOLOGY: *Paracaudina chilensis* has been taken in the New Zealand region from muddy and sandy localities to depths of at least 550 fathoms. Some specimens have been recorded from fish stomachs, but it is not known how extensively the species is used as food by bottom-feeding fish.

DISCUSSION: Dendy (1897) gave a very thorough account of the structure and disposition of the anal papillae in this species.

Clark (1907) placed eight species of *Caudina* Stimpson into the single species *Caudina chilensis* (Muller), as many of the original species descriptions had

been inadequate, based as they were on such characters as size of the specimens, colour, texture of the body wall, all of which are known to be subject to much individual variation. In this synonymy Clark included Hutton's (1872) species *coriacea* from New Zealand and *australis* (Semper) from Australia.

Mortensen (1925) criticised Clark's synonymy and declared that *C. coriacea* from New Zealand, *C. australis* from Australia and *C. chilensis* from Chile were different species, and he used apparent differences in spiculation and calcareous rings as his evidence. At the present time, *C. australis* is still regarded as a distinct species. But the history of *C. coriacea* is rather more complex.

Hozawa (1928) regarded *C. chilensis* and *C. coriacea* as the same species using Clark (1907) as his authority. He may not have seen Mortensen's (1925) paper. Ohshima (1929) agreed with Clark (1907) and Hozawa (1928), and criticised the work of Mortensen, stating that his figures were inadequate. Heding (1932) accepted Mortensen's view and included *C. coriacea* as a separate species in his new genus *Paracaudina,* together with *C. chilensis.* Later Heding (1933) vigorously opposed Ohshima's (1929) opinion, and used the same characters as Mortensen (1925) for distinguishing the species *coriacea* and *chilensis,* but on a much more elaborate scale. He used characters such as body form, "retractor muscles", genital papillae, and presence or absence of "Cuvierian organs" as additional evidence. Thus *Paracaudina chilensis* was re-established as a separate species, but Clark (1935) "re-entered the lists" in his own words, after examining a great number of specimens of *Paracaudina.* His paper shows that he disagreed with Mortensen (1925) and Heding (1933). He discarded body form, "retractor muscles", "Cuvierian organs", genital papillae and the calcareous ring as bases for classification, and stated that the spicules were the only safe criterion for separation at the species level. As a result of his thorough studies Clark compiled a key to the species in genus *Paracaudina,* and named the New Zealand form *Paracaudina chilensis* var. *coriacea,* adding that Deichmann was in agreement with him. Deichmann (1960) suggested that the New Zealand form be named *P. chilensis* forma *coriacea* as, in the words of W. K. Fisher, "it does not protest too much".

I have examined only the New Zealand specimens of the genus *Paracaudina* and they display some considerable variation in their calcareous deposits. Comparison of these deposits with those figured by Hozawa (1928) and Heding (1933) has served to convince me that they resemble each other in so many features, and show such diversity of form, that the subdivision of the species *chilensis* into subspecies or even "forms" is unwarranted. Clark (1935) himself stated that if he had a specimen from Chile mixed with specimens from another area he would not be able to identify the Chile specimen with certainty.

Thus the suggestion lies at hand that *P. chilensis* is a circum-Pacific species, having possibly the Indo-West-Pacific region as its centre of distribution. Near the centre of distribution, the genus *Paracaudina* gave rise to *tetrapora* and *australis,* now in Australia, and to *chilensis,* which spread north to Japan, and to California and Florida via the Aleutian Islands, and south to New Zealand, leaving a remnant in North-west Australia. The Chilean representatives may have reached South America via New Zealand. Fell (1953) states that it is quite likely that New Zealand supplied contributions to the fauna of southern South America. He does not propose an Antarctic shoreline as does Deichmann (Clark, 1935), but indicates that the west to east circum-polar current may be responsible for this New Zealand affinity in certain elements of the South American fauna. The gap in the distribution of *P. chilensis* lies between California in the north and Chile in the south. The gap may possibly be due to unfavourable environmental conditions, or the species may still be undiscovered there. As *P. chilensis* is eurybathic to a certain degree, there should be few depth barriers to dispersal.

Order DENDROCHIROTIDA

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

The Order Dendrochirotida is cosmopolitan, containing predominantly shallow water forms, but a number of species are found in deeper waters, especially in the Arctic region. The numerous species in this order feed selectively on planktonic organisms or detrital material.

There are three families, of which two are represented in Cook Strait. The third family (Psolidae) has two representatives in the New Zealand region, namely *Psolus neozelanicus* Mortensen which is known from off North Cape, and *Pseudopsolus macquariensis* (Dendy) recorded from Macquarie Island and Stewart Island.

KEY TO THE FAMILIES IN ORDER DENDROCHIROTIDA

1 (4) Body cylindrical or fusiform, without a well-defined ventral sole.
2 (3) Tentacles 10 .... Fam. CUCUMARIIDAE
3 (2) Tentacles 15 to 30 .... Fam. PHYLLOPHORIDAE
4 (1) Body flattened, with a well-defined ventral sole. Mouth and anus dorsal Fam. PSOLIDAE

Family PHYLLOPHORIDAE

DIAGNOSIS: Tentacles 15–30, usually in two or even three circles, the inner circles having smaller tentacles. Calcareous ring well developed, with or without forked processes.

Heding and Panning (1954) revised the Phyllophoridae and diagnosed five subfamilies. Of these subfamilies, two have representatives in Cook Strait.

KEY TO THE COOK STRAIT SUBFAMILIES IN FAMILY PHYLLOPHORIDAE

1 (2) Calcareous ring without posterior processes. The individual pieces of the ring are undivided .... Subfamily THYONIDIINAE
2 (1) Calcareous ring complex, composed of a mosaic of minute pieces .... Subfamily SEMPERIELLINAE

Subfamily THYONIDIINAE

DIAGNOSIS: Calcareous ring without posterior processes. The individual pieces of the ring are undivided.

Heding and Panning (1954) listed 13 genera in this subfamily. A new genus was described from Cook Strait by the writer (Pawson, 1962), thus increasing the number of genera to 14.

Neocucumella Pawson, 1962

DIAGNOSIS: Tentacles 20 (outer ring with five pairs of larger tentacles, interradial; inner ring with five pairs of smaller tentacles, radial). Tubefeet confined to the radii, arranged in double rows. Radial pieces of the calcareous ring each with a deep median anterior notch. Interradials rounded anteriorly. Calcareous deposits numerous two-pillared tables, with symmetrical circular or elliptical bases, 0.05mm in average length, perforated by four large and four small (alternating) holes.

Neocucumella bicolumnata (Dendy and Hindle) Plate III, figs. 1–3

Pseudocucumis bicolumnatus Dendy and Hindle, 1907, p. 106, Pl. 11, fig. 6, Pl. 12, figs. 13–14; Joshua and Creed, 1915, p. 19; Engel, 1933, p. 36.
Mensamaria bicolumnata Clark, 1946, p. 406; Dawbin, 1950, p. 38.
Neocucumella bicolumnata Pawson, 1962, p. 65, figs. 1–2.
Non: *Amphicyclus thomsoni* (Hutton).

MATERIAL EXAMINED: VUZ 64, off Point Howard Wharf, 5 fathoms, blue mud, 1 specimen.

DIAGNOSIS: Shape fusiform. Colour light brown. Tubefeet dark brown. Tentacles reddish-brown.

DESCRIPTION: The single specimen is 30mm in total length, and the body is attenuated posteriorly to form a more or less distinct "tail" region. The anterior end narrows as an introvert which carries the crown of 20 tentacles. The body wall is quite thin but opaque, and there is some transverse wrinkling near the posterior end.

Colour in alcohol light brown. The tubefeet are dark brown and the tentacles are dark reddish-brown. The tubefeet are confined to the five ambulacra, where they are arranged in double rows. There are no tubefeet on the introvert. Near the extreme posterior end of the body they are more scattered, and the double row arrangement is lost.

Two rings of richly branched tentacles surround the mouth. The outer ring has five pairs of large tentacles 4–5mm in length, lying in an interradial position, while the inner ring has five pairs of small tentacles, 1mm in length, radially placed. The mid-dorsal pair of larger tentacles are smaller than the other outer ring tentacles.

The calcareous ring is composed of ten simple pieces. Each radial piece is approximately rectangular in shape and has a wide and deep posterior notch and a pronounced median anterior notch. There are no anterior processes on the radials. Interradials are Y-shaped, with the tail of the "Y" directed anteriorly. This anterior projection is bluntly rounded. Length of each radial piece 2.0mm; length of each interradial piece 1.0mm.

The internal anatomy has been described by Dendy and Hindle (1907).

Calcareous deposits of three types were found:

1. Tables: The skin contains very large numbers of tables, closely aggregated together. In general the table disc is oval in shape, and has eight perforations, four large (approximately 0.013mm diameter) and four small (approximately 0.007mm diameter). Average table length is 0.05mm, breadth 0.03mm (Plate III, fig. 1). Departures from this basic pattern are so rare that only three tables of unusual shape were found (Pl. III, fig. 3). At its centre the disc of each table carries two short pillars, which are joined at the top by a single crossbar. Average height of pillars is 0.02mm.

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

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

DISTRIBUTION: The type specimen was recorded from "off Dunedin" (Dendy and Hindle, 1907). Joshua and Creed (1915) recorded a specimen from Australia, probably collected near Adelaide. The new record, Wellington Harbour, enlarges the distribution area of the species, but *N. bicolumnata* is still a rare species.

DISCUSSION: Dendy and Hindle (1907) described an S-shaped intestine, feebly developed respiratory trees, a single Polian vesicle, and gonads consisting of two bunches of very long filaments in their specimen of this species..

The systematic history of *N. bicolumnata* has already been outlined (Pawson, 1962).

Subfamily SEMPERIELLINAE

DIAGNOSIS: Calcareous ring tube-shaped with long processes; both radials and interradials are composed of a complex mosaic of small pieces.

Heding and Panning (1954) included five genera in this group, of which two are represented in the Cook Strait region.

KEY TO THE COOK STRAIT GENERA IN SUBFAMILY SEMPERIELLINAE

1 (2) Deposits (when present) small tables, typically with eight perforations, and a short blunt two-pillared spire ..... *Neothyonidium* Deichmann
2 (1) Deposits perforated plates, with a long, sharp spire composed of two long rods fused together .... *Pentadactyla* Hutton

Neothyonidium Deichmann, 1938

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

Type Species: *Neothyonidium hawaiiense* (Fisher).

A single species, *N. dearmatum* is known from New Zealand at the present time.

Neothyonidium dearmatum (Dendy and Hindle)

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

DIAGNOSIS: Calcareous deposits usually absent from the skin, apart from the anal extremity, where they take the form of two-pillared tables (average length 0.07mm), typically with eight perforations, four large alternating with four small.

DISCUSSION: This interesting species has been recorded from Akaroa Harbour (Dendy and Hindle, 1907), and Wellington Harbour (Mortensen, 1925). Joshua (1914) reported the presence of specimens at various points along the south coast of Australia.

Pentadactyla Hutton, 1878

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

Pentadactyla longidentis (Hutton) Plate V

Thyone longidentis Hutton, 1872, p. 16; Theel, 1886, p. 141.
Thyone caudata Hutton, 1872, p. 16.
Pentadactyla longidentis Hutton, 1878, p. 307; Heding and Panning, 1954, p. 199.
Thyonidium rugosum Theel, 1886, p. 95, Pl. V, fig. 5.
Thyonidium caudatum Theel, 1886, p. 147.
Thyonidium longidentis Dendy, 1896, p. 42, Pl. VI, figs. 62-69; Farquhar, 1898, p. 326.
Phyllophorus longidentis Ludwig, 1898, p. 49; Dendy and Hindle, 1907, p. 101, Pl. 13, fig. 18 a-d; Benham, 1909, p. 28; Mortensen, 1925, p. 325; Dawbin, 1950, p. 39, Pl. 2, fig. 15.
Thyonidium anatinum Perrier, 1903, p. 142.
Phyllophorus anatinus Perrier, 1905, p. 112, Pl. V, figs. 1–9.

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 1 specimen; VUZ 32, off Petone Beach, 8 fathoms, mud, 2 specimens; VUZ 37, off Shelly Bay, 10–11 fathoms, 1 specimen; VUZ 64, off Point Howard Wharf, 5 fathoms, blue mud, 6 specimens; VUZ 69, Somes Is. to Days Bay, 11 fathoms, mud, 1 specimen; VUZ 87, South of Cape Palliser, 400 fathoms, mud, rock, gravel, 2 specimens.

DIAGNOSIS: Colour dark brown in life and in alcohol. Calcareous deposits in the form of very numerous oval to cruciform spired plates 0.3mm long, together with smooth plates 0.5mm in length. Polian vesicle single, bulbous.

DESCRIPTION: These are stout holothurians, with a total length varying between 20mm and 70mm. The body tapers abruptly posteriorly to form a more or less distinct tail. There is, however, considerable variation in shape, depending on the degree of contraction of specimens. The body carries a number of short (1–3mm long) spinous projections scattered over its surface. These projections render the skin prickly to touch.

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

An introvert, usually retracted, is present, and carries a crown of 20 tentacles which are disposed in two circles. The outer ring has five pairs of large (4mm long) interradial tentacles, while the inner ring has five pairs of small (1–2mm long) radial tentacles. The mouth lies in a shallow depression in the centre of an oral disc. The introvert is thin-walled and transparent, and carries double rows of tubefeet on the radii.

PLATE V

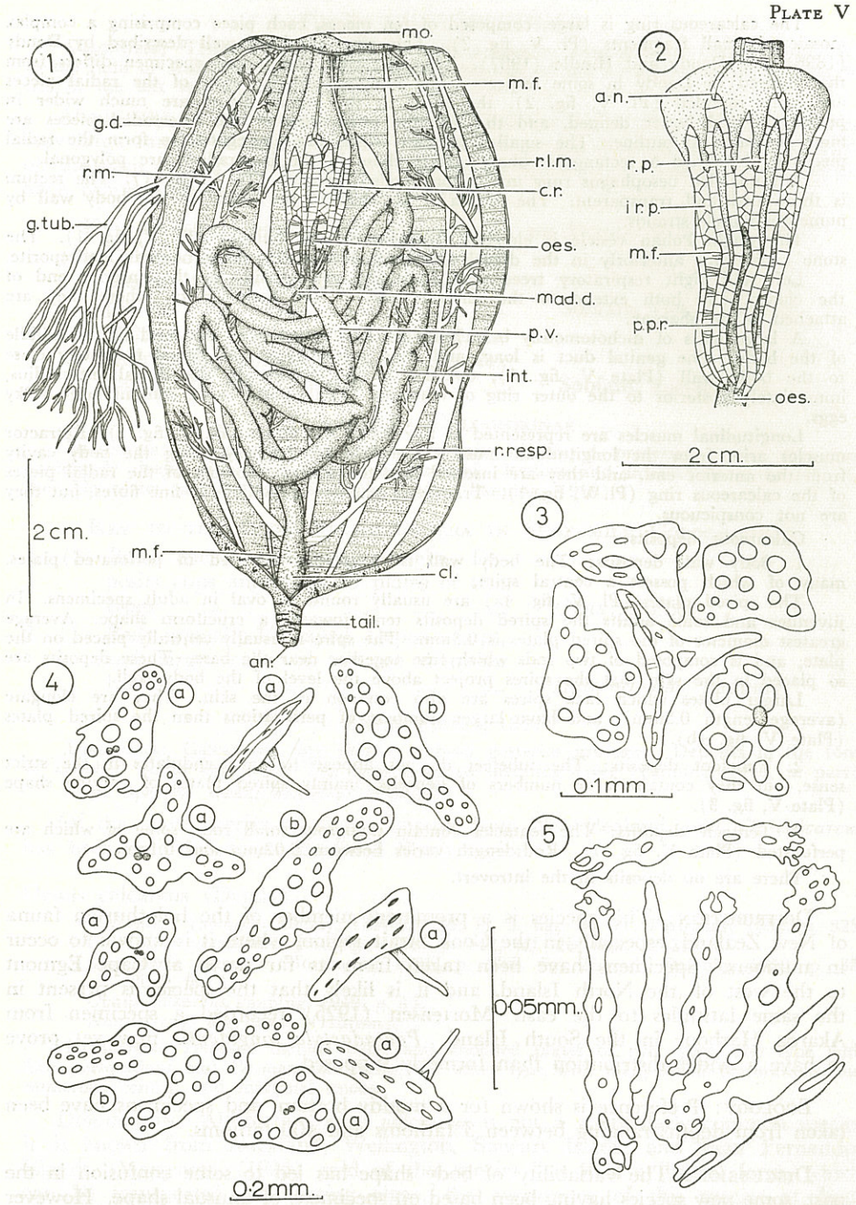

PLATE V.—*Pentadactyla longidentis* (Hutton).—Fig. 1, internal anatomy of adult dissected from the dorsal side (portions of gonad removed); fig. 2, pharynx and calcareous ring of a large specimen; fig. 3, deposits from a tubefoot; fig. 4, bodywall deposits; fig. 5, tentacle rods. Abbreviations: a.n., anterior notch; an., anus; a.p.r., anterior process of radial; cl., cloaca; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., interradial piece; mad.d., stone canal; mo., mouth; m.f., muscle fibres; oes., oesophagus; p.p.r., posterior process of the radial; P.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; r.p., radial piece; r.resp., right respiratory tree.

The calcareous ring is large, composed of ten pieces, each piece comprising a complex mosaic of small fragments (Pl. V, fig. 2). This ring has been well described by Dendy (1896) and Dendy and Hindle (1907). The ring from the largest specimen differs from that figured by Dendy in some respects. The notched anterior ends of the radial pieces are more rounded (Pl. V, fig. 2), the splits in the radial pieces are much wider in proportion and better defined, and the anterior projections of the interradial pieces are more irregular in outline. The small fragments which are aggregated to form the radial pieces tend toward a rectangular shape, while those in the interradials are polygonal.

A thinwalled oesophagus runs into a long coiled intestine (Pl. V, fig. 1). The rectum is thinwalled and transparent. The cloaca is attached to the inside of the body wall by numerous muscle strands.

The single Polian vesicle is elongate, transparent and bulbous (Pl. V, fig. 1). The stone canal runs anteriorly in the dorsal mesentery, terminating in a nodular madreporite.

Left and right respiratory trees arise from the ventral side of the anterior end of the cloaca, and both extend to the anterior end of the body cavity, where they are attached to the pharynx.

A large mass of dichotomously branching genital caeca lies at the level of the middle of the body. The genital duct is long, and runs anteriorly in the dorsal mesentery close to the body wall (Plate V, fig. 1), opening to the outside in the dorsal interradius, immediately posterior to the outer ring of tentacles. The genital caeca contain large yolky eggs.

Longitudinal muscles are represented as five broad flat straps (Pl. V, fig. 1). Retractor muscles arise from the longitudinal muscles one-third of the way along the body cavity from the anterior end, and they are inserted into the anterior notches of the radial pieces of the calcareous ring (Pl. V, fig. 1). Transverse muscles are visible as fine fibres, but they are not conspicuous.

Calcareous deposits:

1. Body wall deposits: The body wall is completely invested in perforated plates, many of which possess a central spire.

The spired plates (Pl. V, fig. 4a) are usually round to oval in adult specimens. In juveniles and some adults the spired deposits tend towards a cruciform shape. Average greatest diameter of the spired plates is 0.3mm. The spire is usually centrally placed on the plate, and is composed of two rods which fuse together near the base. These deposits are so placed in the skin that the spires project above the level of the body wall.

Larger plates which lack spires are also common in the skin. They are elongate (average length 0.5mm), and have larger numbers of perforations than the spired plates (Plate V, fig. 4b).

2. Tubefoot deposits: The tubefeet do not appear to have endplates in the strict sense, but they contain large numbers of deposits, mainly spired plates of varying shape (Plate V, fig. 3).

3. Tentacle deposits: The tentacles contain numerous small rods, some of which are perforated (Plate V, fig. 5). Rod length varies between 0.02mm and 0.1mm.

There are no deposits in the introvert.

DISTRIBUTION: This species is a prominent member of the holothurian fauna of New Zealand, especially in the Cook Strait region, where it is known to occur in numbers. Specimens have been taken from as far north as Cape Egmont to the west of the North Island, and it is likely that the species is present in the same latitudes to the east. Mortensen (1925) recorded a specimen from Akaroa Harbour in the South Island. *Pentadactyla longidentis* may yet prove to have a wider distribution than formerly supposed.

ECOLOGY: Preference is shown for a muddy bottom, and specimens have been taken from depths ranging between 3 fathoms and 400 fathoms.

DISCUSSION: The variability of body shape has led to some confusion in the past, some new species having been based on specimens of unusual shape. However this error was rectified by Dendy and Hindle (1907) and Mortensen (1925). The presence of large yolky eggs in the genital caeca leads to the suggestion that this species lacks a pelagic larva and has direct development.

Because of its colour, shape, and the rough texture of the body wall, this species is one of the most easily recognised of the Cook Strait holothurians.

Family CUCUMARIIDAE

DIAGNOSIS: Tentacles 10, equal, or with a smaller ventral pair. Tubefeet confined to the radii or scattered over the body. The mesentery of the posterior loop of the intestine lies in the left ventral interradius.

About 30% of the known New Zealand holothurian species are placed in this very large family. Panning (1949) revised the group, diagnosing five subfamilies on the basis of calcareous rings and calcareous deposits. Two of these subfamilies have representatives in the Cook Strait region.

KEY TO THE COOK STRAIT SUBFAMILIES OF FAMILY CUCUMARIIDAE

1	(2)	Calcareous rings composed of 10 solid pieces. Calcareous deposits cups and plates	Subfam. COLOCHIRINAE
2	(1)	Calcareous ring long and slender, the entire ring composed of a complex mosaic of minute pieces	Subfam. THYONINAE

Subfamily COLOCHIRINAE

DIAGNOSIS: Calcareous ring simple, without bifurcated processes, or at the most moderately deep, with short undivided processes. Radials and interradials undivided. In the skin plates and baskets; no tables (After Panning, 1949).

KEY TO THE COOK STRAIT GENERA IN SUBFAMILY COLOCHIRINAE

1	(2)	Body cucumber-shaped, straight. Deposits cups and knobbed plates of two types	*Ocnus* Forbes
2	(1)	Body typically U-shaped. Deposits cups, and large scales of average diameter 1.0mm	*Heterothyone* Panning

Ocnus Forbes, 1841

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

Type Species: *Ocnus brunneus* (Forbes).

Of the three species of *Ocnus* known from New Zealand, one, *O. calcareus* has been recorded from the Cook Strait region.

Ocnus calcareus (Dendy)

Colochirus calcareus Dendy, 1896, p. 38, Pl. 5, figs. 44–53; Farquhar, 1898, p. 325.
Colochirus brevidentis Ludwig, 1898, p. 442, taf. 26, figs. 22–29.
Cucumaria calcarea Mortensen, 1925, p. 335, fig. 26 c-d; Dawbin, 1950, p. 38, Pl. 2, fig. 11.
Ocnus calcareus Panning, 1949, p. 437.
Non: *Ocnus brevidentis* (Hutton).

DIAGNOSIS: Deposits include cups, and knobbed plates of two types, one type with four perforations and 12 marginal knobs, the other type with many small perforations and numerous central and marginal knobs.

DISCUSSION: Although *Ocnus calcareus* is not a particularly common species it is known from Auckland, Wellington, Stewart Island, and Juan Fernandez Islands. Mortensen (1925) said of this species "as it is a littoral form, which can be transported on floating algae, the occurrence of this species at Juan Fernandez is not so very surprising. But it is to be expected that it will prove to occur also on the other subantarctic localities".

O. calcareus is similar to *O. brevidentis* (Hutton) in some respects, but the two species differ markedly in the structure of their calcareous deposits, as pointed out by Dendy (1896) and Mortensen (1925).

Heterothyone Panning, 1949

DIAGNOSIS: Calcareous ring composed of 10 solid pieces; radials each with a more or less well developed posterior notch. Deposits include large scales 1–2mm in diameter, which invest the body, and well developed deep cups, usually with four perforations.

Type Species: *Heterothyone alba.*

Also included here: *H. ocnoides* (Hutton).

Panning (1949) erected the new genus *Heterothyone,* with species *alba* as the type, and he also included under this generic name the species *pigra* (Koehler and Vaney) and *semperi* (Bell). This genus was placed in Subfamily Thyoninae Panning, which was diagnosed as follows:

"Calcareous ring slender, with long processes; radials and interradials flat, fused together; the entire calcareous ring composed of a complex mosaic of minute pieces" (Panning, 1949).

Dissection of many specimens of the species *alba* showed that the ring is in fact composed of 10 solid yet fragile pieces. Consequently this species belongs in Subfamily Colochirinae Panning.

Descriptions of the species *semperi* (Bell, 1884) and *pigra* (Koehler and Vaney, 1905) point out that the ring in these species is composed of a mosaic of pieces. Thus *semperi* and *pigra* should remain in Subfamily Thyoninae, but a new generic name should be supplied. I propose the name *Hemithyone* for these species, with *Hemithyone semperi* as the type species.

The species *alba* is quite closely allied to another New Zealand species originally described as *Colochirus ocnoides* (Dendy). This has already been pointed out by other workers, including Dendy (1896) and Mortensen (1925). Panning (1949) resurrected Reiffen's (1901) genus *Ludwigia* for species *ocnoides* (Reiffen had designated *ocnoides* as the type of *Ludwigia*). However, *Ludwigia* is preoccupied, and the name cannot be used again. Under this generic name Panning (1949) listed 17 species (including *ocnoides*). Of the 16 species beside *ocnoides,* none appear to possess the large imbricating scales investing the body which are so characteristic of the species *ocnoides* and *alba.* In this respect, and in others, the two New Zealand species are distinct and I have placed them together in genus *Heterothyone,* and transferred the genus to Subfamily Colochirinae.

The 16 species included in *Ludwigia* by Panning (1949) are listed below. These may have to be assigned to new genera in due course. I am not in a position to critically examine these species, but study of the literature shows that they tend to fall into two categories on the basis of their calcareous deposits. It must be pointed out that descriptions of some of these species are inadequate.

"Ludwigia"

Species which have buttons with four holes: *spyridophora* (Clark); *vicaria* (Bell); *lefevrei* (Barrois); *tetracentriophora* (Heding); *punctata* (Ludwig); *solida* (Deichmann); *gemmata* (Pourtales); *pervicax* (Theel); *suspecta* (Ludwig).

Species which have buttons with more than four holes, or none: *lactea* (Forbes); *planci* (Brandt); *glacialis* (Ljungman); *hedingi* (Panning); *lutea* (Sluiter); *bouvetensis* (Heding); *ekmani* (Heding).

KEY TO THE SPECIES IN GENUS *Heterothyone* PANNING

1 (2) Small holothurians (up to 30mm long); radials with a poorly defined anterior notch; interradials with long and narrow anterior processes .... *H. alba* (Hutton)

2 (1) Larger holothurians (up to 60mm long); radials each with a well defined anterior notch; interradials with short and broad anterior processes ..... *H. ocnoides* (Dendy)

Heterothyone alba (Hutton) Plate VI

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

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 1 specimen; VUZ 30, off Somes Island, 5–10 fathoms, mud, 13 specimens; VUZ 69, Somes Island to Days Bay, 11 fathoms, mud, 1 specimen; Kau Bay, 20 fathoms, mud, 1 specimen.

DIAGNOSIS: Small, U-shaped, colour white in life. Radials with a poorly defined anterior notch; interradials with long and narrow (almost needle-like) anterior processes. Deposits scales and deep cups. The cup rims carry many small projections.

DESCRIPTION: These are pure white to grey holothurians, almost invariably U-shaped, with the ventral surface occupying the greater curvature. The total length varies between 10mm and 25mm. The tentacles are retracted in all specimens, and the anterior end of the body is bluntly rounded. Toward the posterior end, the body tapers gently to form a slender tail. The body wall is thick and firm, due to the investing layer of imbricating scales.

There are ten tentacles, the ventral pair being the smallest. They are grey, covered with dark brown spots. The crown of tentacles is carried on a short, thinwalled introvert.

Tubefeet are numerous, confined to the radii anteriorly and posteriorly, but scattered in radii and interradii on the ventral surface of the middle of the body, in greater numbers than elsewhere. These tubefeet are stiff, and not completely retractile, their walls containing large numbers of perforated rods.

The calcareous ring is composed of ten pieces, five radials and five interradials (Plate VI, fig. 4). The radials each have a well developed anterior process with an attachment area for the radial muscle and a poorly defined median split. The posterior process of the radial is long and broad, with a shallow but distinct V-shaped posterior notch. Each interradial piece is Y-shaped, with the tail of the "Y" directed anteriorly.

A short thinwalled oesophagus leads into the thinwalled intestine, which is extensively coiled near the middle of the body (Pl. VI, fig. 1). The rectum runs direct to the terminal anus and the cloaca is undifferentiated. Both intestine and rectum are dark brown in colour.

The water-vascular system surrounds the oesophagus immediately posterior to the calcareous ring (Plate VI, fig. 1), and gives rise to a single bulbous Polian vesicle from its ventral side (Plate VI, fig. 1). The stone canal is a short coiled white tube, terminating in a minute nodular madreporite which is attached to the dorsal mesentery.

The right respiratory tree is considerably longer than the left, and extends to the extreme anterior end of the body. In some specimens the right tree carries a short subsidiary branch. The left tree is about half as long as the right. Respiratory tubules are long and narrow, branching copiously.

The gonad consists of two small bunches of unbranched genital caeca (Plate VI, fig. 1), which lie half way along the body cavity. As a consequence the genital duct is a long and narrow tube, which runs anteriorly on the dorsal mesentery, opening to the exterior in the introvert, in the dorsal interradius. In some specimens the genital caeca are packed with small eggs (Plate VI, fig. 8), which vary considerably in size (0.05–0.3mm diameter).

Radial longitudinal muscles, retractor muscles and transverse muscles are poorly developed, the radial muscles being represented as thin white straps.

Calcareous deposits:

1. Large Scales (Plate VI, figs. 5, 7): The body is completely invested in calcareous scales which are approximately oval in shape. The average greatest length of these scales

PLATE VI

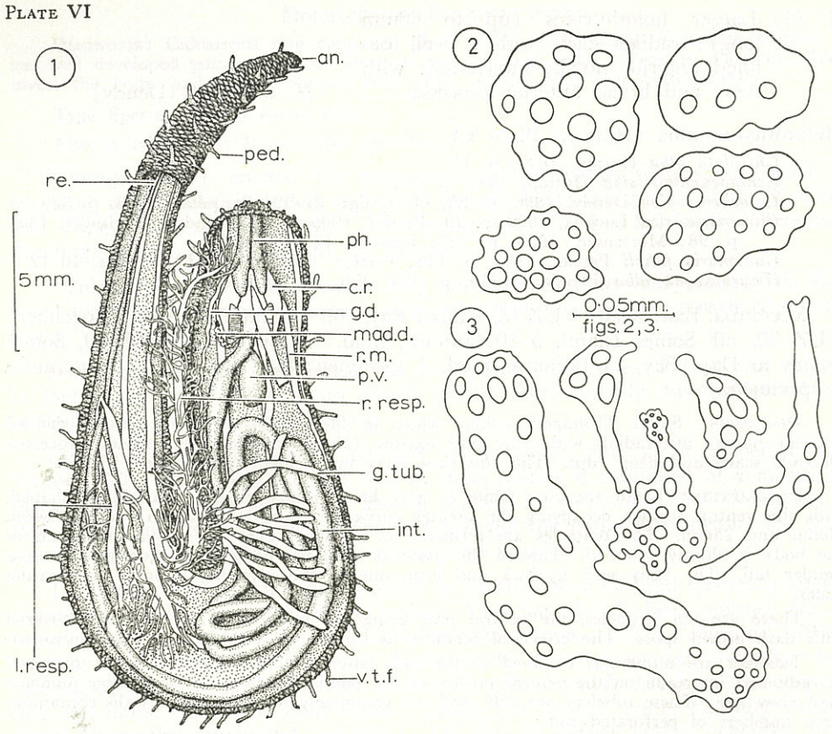

PLATE VI.—*Heterothyone alba* (Hutton).—Fig. 1, internal anatomy of adults; fig. 2, buttons; fig. 3, tentacle deposits; fig. 4, pharynx and calcareous ring; fig. 5, scales from the skin (in outline only); fig. 6, cups; fig. 7, surface features of a scale; fig. 8, genital tubule packed with eggs.

Abbreviations: an., anus; a.p.r., anterior process of radial; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubule; int., intestine; ir.p., interradial piece; l.resp., left respiratory tree; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; oes., oesophagus; ped., pedicel; ph., pharynx; p.p.r., posterior process of radial; P.v., Polian vesicle; re., rectum; r.m., retractor muscle; r.resp., right respiratory tree; r.v., ring vessel; v.t.f., ventral tubefoot.

is 1.0mm, but there is some considerable size variation. The surfaces of the scales are reticulate, and carry small knobs (Plate VI, fig. 7). In general, the free edges of these overlapping scales face the posterior end in the posterior half of the body, and the anterior end in the anterior half of the body.

2. Cups (Plate VI, fig. 6): Deep perforated cups overlie the plates in large numbers. The basin of each cup has four perforations, while the cup rim carries a number of irregular projections. Average diameter of the cups is 0.03mm, and the cups are approximately as deep as they are wide.

3. Buttons (Plate VI, fig. 2): Oval to rectangular smooth buttons, with 5–20 perforations are scattered sparingly among the cups in the body wall. The greatest length of the buttons varies between 0.05 and 0.1mm.

4. Tentacle Deposits (Plate VI, fig. 3): The stems and digits of the tentacles contain large numbers of perforated plates and rods, which show considerable variation in shape and size. The perforated plates reach a length of 0.24mm.

DISTRIBUTION: *Heterothyone alba* is one of our best known dendrochirote holothurians. It is restricted to the New Zealand region, where it has been taken in numbers from many points along the east coast of the North and South Islands. The species has not been recorded from any of the outlying islands.

ECOLOGY: This species prefers a sandy to muddy bottom in comparatively sheltered localities. A degree of eurybathy is displayed, specimens having been taken from lowtide level to depths of 150 fathoms.

DISCUSSION: Mortensen (1925) suggested that the small size of the eggs in this species may indicate indirect development, with the presence of a true pelagic larva.

H. alba has but one close relative, *H. ocnoides* (Dendy), which also has a restricted distribution. The two species differ in size, and in certain features of their calcareous rings and calcareous deposits.

Heterothyone ocnoides (Dendy)

Colochirus ocnoides Dendy, 1896, p. 36, Pl. 4, figs. 33–43; Farquhar, 1898, p. 325.
Cucumaria ocnoides Ludwig, 1898, p. 30; Perrier, 1905, p. 96, Pl. 1, figs. 9–13, Pl. V, fig. 13; Dendy and Hindle, 1907, p. 100; Mortensen, 1925, p. 347; Dawbin, 1950, p. 36.
Ludwigia ocnoides Reiffen, 1901, p. 598, taf. 15; Panning, 1949, p. 435, abb. 30, 31.

DIAGNOSIS: Large (up to 50mm long), U-shaped, colour orange in life. Radials each with a well-defined anterior notch; interradials with short, broad and blunt anterior processes. Deposits scales and deep cups. The cup rims have less than ten projections.

DISCUSSION: This species is known in the Cook Strait region from a single specimen taken in Wellington Harbour at a depth of 5–10 fathoms by Mortensen (1925). Other localities include New Brighton (Dendy, 1896, 1898), Dendy and Hindle (1907), and Cloudy Bay and Akaroa (Mortensen, 1925). Mortensen (1925) suggested that *H. ocnoides* will prove to have a much wider distribution in New Zealand seas.

Subfamily THYONINAE

DIAGNOSIS: Calcareous ring slender, long, with long processes; radials and interradials flat, the entire ring composed of a complex mosaic of minute pieces (Panning, 1949, in part).

The subfamily Thyoninae is represented in Cook Strait by a single species of the genus *Stolus* Selenka.

Stolus Selenka, 1867

DIAGNOSIS: Calcareous ring with long processes, composed of a mosaic of minute pieces. Deposits large scales with many perforations, and smaller buttons with few perforations. No cups.

Type Species: *Stolus sacellus* Selenka.

At the present time, this genus contains less than ten species.

Stolus huttoni (Dendy) Plate VII

Cucumaria huttoni Dendy, 1896, p. 32, Pl. 3, figs. 19–20; Ludwig, 1898, p. 39; Farquhar, 1898, p. 324; Perrier, 1905, p. 93; Mortensen, 1925, p. 384, figs. 33–35; Dawbin, 1950, p. 36.
Stolus huttoni Panning, 1949, p. 463, abb. 58.

MATERIAL EXAMINED: VUZ 62, opposite Worser Bay, 4–5 fathoms, green sand, 1 specimen.

DIAGNOSIS: Body large (up to 180mm total length), U-shaped, completely invested by large overlapping scales, which are overlain by small perforated buttons 0.01–0.03mm long. Colour grey to yellow.

DESCRIPTION: The single specimen is U-shaped, with a total length of 125mm. The integument is very hard and thick, due to the presence of great numbers of calcareous deposits. The colour in alcohol is yellowish-white. The tentacles are abundantly speckled with brown spots on a grey background.

Tubefeet are present in all radii and confined to them. They are more numerous in the mid-ventral portion of the body, where they are arranged in distinct double rows. A semi-transparent introvert is surmounted by a crown of ten richly branched tentacles, of which the ventral pair is the smallest.

The calcareous ring is complex, each piece being composed of a number of fragments (Plate VII, fig. 2). The radials each have a pronounced anterior notch and long, narrow posterior processes. The interradials are not notched, but do possess long posterior processes.

The oesophagus is short and muscular (Plate VII, fig. 1), and joins to the thinwalled convoluted intestine. The rectum is long and straight and runs to the terminal anus. Two long and slender Polian vesicles are attached to the ventral side of the water-vascular ring (Plate VII, fig. 1). The stone canal is short, and runs anteriorly in the dorsal mesentery to terminate in a conspicuous madreporite (Plate VII, fig. 2).

The two trunks of the respiratory trees arise from near the anterior end of the rectum as flattened tubes.. At the level of the junction between the intestine and the rectum, each trunk divides and gives rise to a long and a short branch. The two long branches extend anteriorly for a considerable distance and attach to the body wall in the interradii. Each trunk carries many short, sparsely branched respiratory tubules (Plate VII, fig. 8).

There are two bunches of intertwining, unbranched, filamentous genital caeca. The genital duct opens into the introvert in the dorsal interradius (Plate VII, fig. 1).

The radial muscles are narrow, especially near the posterior end of the body. They thicken in the anterior half, and are thickest at the point of origin of the retractors, which is about one-third of the way along the body from the anterior end. Transverse muscles are present as fine fibres. All of the muscles are orange coloured in preserved material.

Calcareous deposits:

1. Large Scales: The body is completely invested in oval to round imbricating scales (Plate VII, fig. 3), with an average diameter of 1.0mm.

2. Perforated Buttons: Great numbers of perforated buttons overlie the scales (Plate VII, fig. 4). These are 0.1–0.3mm long, and have two to twenty perforations. The presence of these buttons gives the integument a granular appearance.

3. Tubefoot Deposits: The endplate in each tubefoot is surrounded by perforated deposits 0.1–0.25mm in length (Plate VII, fig. 6). They are easily distinguishable from the buttons in the skin as they are not nearly as thick, and are more irregular in outline.

4. Tentacle Deposits: Irregular perforated buttons and rods of varying shape and average length 0.2mm are present in the digits of the tentacles (Plate VII, fig. 7). The tentacles are consequently prickly to touch.

5. Introvert Deposits: The thinwalled introvert contains small perforated buttons of a different character from those in the rest of the body wall (Plate VII, fig. 5). They are oval to rectangular in shape and have few (6–12) perforations. Average length of these buttons is 0.05mm.

DISTRIBUTION: *Stolus huttoni* has previously been recorded from Oamaru (Dendy, 1896) and Otago Harbour (Mortensen, 1925). The new locality Wellington Harbour, somewhat extends the area of distribution of this species.

ECOLOGY: Specimens of *S. huttoni* have been taken from sandy or muddy bottoms in sheltered shallow areas.

PLATE VII

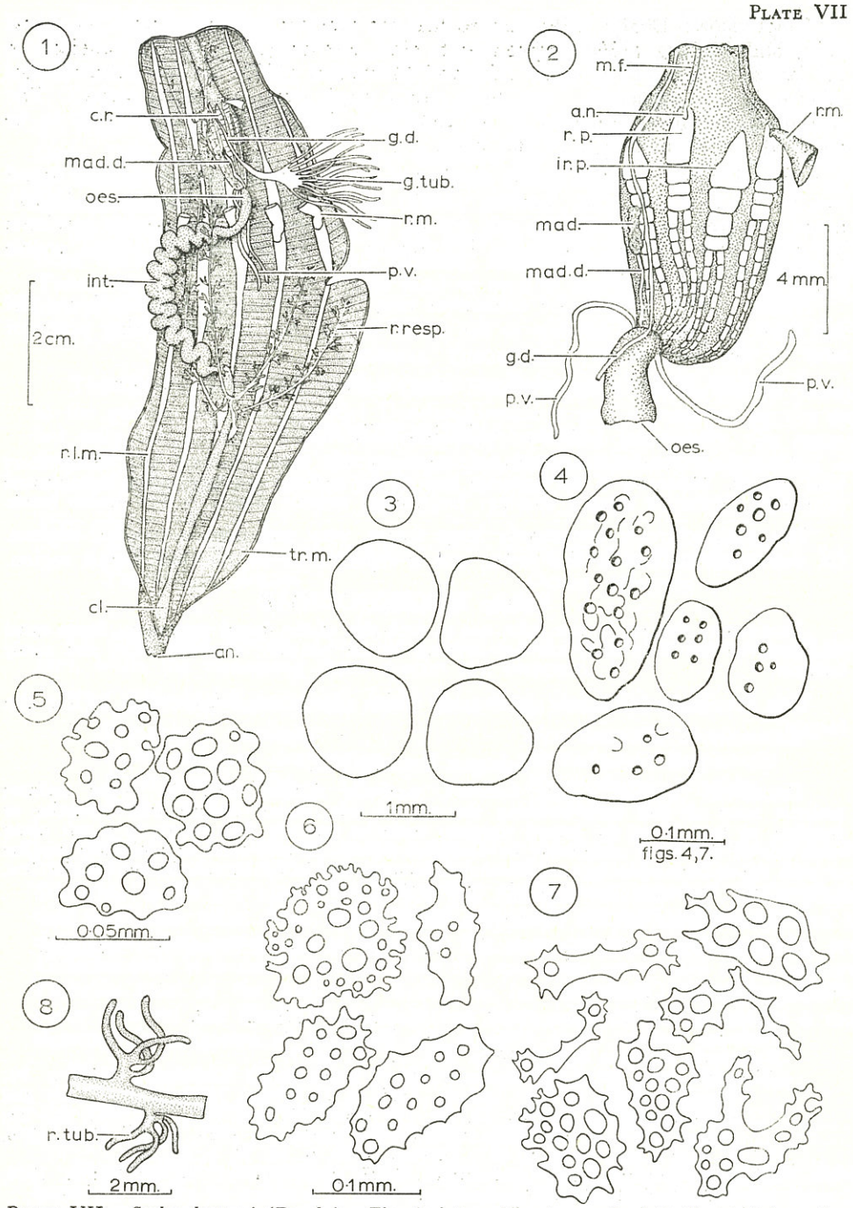

PLATE VII.—*Stolus huttoni* (Dendy).—Fig. 1, internal anatomy of adult dissected from the dorsal side; fig. 2, pharynx and calcareous ring; fig. 3, scales from the skin (in outline only); fig. 4, buttons; fig. 5, introvert deposits; fig. 6, tubefoot deposits; fig. 7, tentacle deposits; fig. 8, portion of a respiratory tree.
Abbreviations: a.n., anterior notch; an., anus; cl., cloaca; c.r., calcareous ring; g.d., genital duct; g.tub., genital tubules; int., intestine; ir.p., interradial piece; mad., madreporite; mad.d., stone canal; m.f., muscle fibres; oes., oesophagus; P.v., Polian vesicle; r.l.m., radial longitudinal muscle; r.m., retractor muscle; r.p., radial piece; r.resp., right respiratory tree; r.tub., respiratory tubule; tr.m., transverse muscles.

DISCUSSION: Dendy (1896) stated that the tubefeet are absent from the dorsal radii, and Ludwig (1898) agreed with him. Perrier (1905) found tubefeet on the lateral regions of the dorsal side, and Mortensen (1925) stated that the dorsal tubefeet are inconspicuous "and form only a single irregular zig-zag series". The present writer noted tubefeet in all radii, the dorsal tubefeet appearing to be confined to the middle ⅓ of the body.

There is some variation in the number of Polian vesicles. Dendy (1896) found two in the type specimen. Ludwig (1898) found one, while Mortensen (1925) noted the presence of five long and slender Polian vesicles. The present specimen has two. Therefore no taxonomic importance can be attached to Polian vesicle numbers in this species.

Dendy (1896) figured the calcareous ring of the holotype, but his figure did not show the anterior notches in the radial pieces, nor the bifurcating posterior ends of the interradials.

S. huttoni has no near relatives, either in New Zealand or overseas.

Order ASPIDOCHIROTIDA

DIAGNOSIS: Tentacles shield-shaped, numerous (15 to 30, usually 20). Respiratory trees present. Mesentery of the posterior loop of the intestine attached in the right ventral interradius. Retractor muscles wanting: longitudinal muscles present as five double bands.

The aspidochirotes are mostly large forms, very common in tropical regions. Of the three families in this order, one is represented in the Cook Strait region.

Family STICHOPODIDAE

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

This family contains four genera, of which the genus *Stichopus* is by far the largest.

Stichopus Brandt, 1835

DIAGNOSIS: Ventral surface flattened, markedly distinct from the dorsal surface; pedicels more or less fully covering the ventral side; dorsal surface with tubercles or papillae, at least along the lateral margins; tentacles typically 20; gonads in a tuft along each side of the dorsal mesentery; no cuvierian organs; no anal teeth or noticeable papillae around the cloacal opening; numerous calcareous tables in epidermis. Polian vesicles few, unbranched; madreporic canal single (After Clark, 1922).

Type Species: *Stichopus chloronotus* Brandt.

A single species, *Stichopus mollis* (Hutton) is known from New Zealand.

Stichopus mollis (Hutton)

Holothuria mollis Hutton, 1872, p. 15; Hutton, 1878, p. 308.
Stichopus sordidus Theel, 1886, p. 167, Pl. 8, fig. 3.
Holothuria victoriae Bell, 1887, p. 534, Pl. 45, fig. 7.
Stichopus mollis Dendy, 1896, p. 46, Pl. 7, figs. 73–82; Whitelegge, 1897, p. 50; Farquhar, 1898, p. 326; Ludwig, 1898, p. 7; Perrier, 1905, p. 83; Dendy and Hindle, 1907, p. 96, Pl. 12, fig. 12; Erwe, 1915, p. 387, Taf. VII, fig. 22; Joshua, 1914, p. 2; Clark, 1922, p. 60; Mortensen, 1925, p.327; Clark, 1938, p. 511; Clark, 1946, p. 417; Dawbin, 1950, p. 35, Pl. 1, fig. 1.
Stichopus simulans Dendy and Hindle, 1907, p. 97, Pl. 11, fig. 5; Joshua, 1914, p. 3; Clark, 1922, p. 69.
Stichopus simultans Erwe, 1913, p. 388, Taf. VIII, fig. 23 a-d.

MATERIAL EXAMINED: VUZ 15, Palliser Bay, 100–150 fathoms, mud, 3 specimens; VUZ 39, off Days Bay, 8–9 fathoms, mud, 1 specimen; Island Bay, intertidal rock pool, 3 specimens, coll. A. D. Allen, 3/6/1959; Balaena Bay, Wellington Harbour, intertidal rock pool, 1 specimen, coll. D. L. Pawson, 21/8/1960.

DIAGNOSIS: Large forms (up to 25cm total length), colour light brown to black. Deposits tables with regular spires, which are more or less open at the top, with one or two crossbars. Discs of tables square or squarish, 0.055–0.065mm in diameter, with four large holes and four smaller holes at the corners.

DISCUSSION: This species is the best known and most easily recognised of the New Zealand holothurians. Previous workers (Dendy, 1896; Erwe, 1915; Clark, 1922; Mortensen, 1925) have described the anatomy and calcareous deposits of *Stichopus mollis* very fully, and Dawbin (1949) has given an account of its autoevisceration and regeneration.

Stichopus mollis is common in the areas in which it occurs, and it is known from central and southern New Zealand, southern and western Australia, and Tasmania, where it lives on coarse sand or mud in sheltered areas to depths of at least 150 fathoms.

GENERAL DISCUSSION

The holothurian fauna of the Cook Strait region is notable for its diversity at the generic level. The Order Dendrochirotida is well represented on the shelf, but only one species, *Ocnus calcareus* may be found intertidally. In contrast, three of the four apodous species appear to be restricted to the intertidal zone where five holothurian species are known to occur.

They are:

Kolostoneura novae-zealandiae — *Trochodota dunedinensis*
Trochodota dendyi — *Ocnus calcareus*
Stichopus mollis

Of the above species, *Trochodota dendyi* and *Ocnus calcareus* are relatively rare, while the remaining three species are common.

The following eight species have been taken from the shelf:

Protankyra uncinata — *Neocucumella bicolumnata*
Neothyonidium dearmatum — *Pentadactyla longidentis*
Heterothyone alba — *Heterothyone ocnoides*
Stolus huttoni — *Stichopus mollis*

All but three of these species are restricted to the shelf. *Pentadactyla longidentis* has been found at 400 fathoms (Station 87), and *Heterothyone alba* and *Stichopus mollis* are known from 100–150 fathoms (Station 15). It is possible that specimens taken from these depths may have strayed accidentally from the shelf into deep water, as a result of the steep marine profiles in the area. Unfortunately it is not known whether the specimens were alive when captured. Probably most of the specimens known so far only from Wellington Harbour occur also on the Cook Strait shelf, but there is a definite need for a more thorough investigation of the shelf and slope.

There are three deep water species known from the area. They are:

Heteromolpadia marenzelleri — *Molpadia violacea*
Paracaudina chilensis

As a result of the greater depth tolerances in the above species, they should have the ability to achieve a wide distribution by spreading across the deep sea floor. Although *Heteromolpadia marenzelleri* is known so far only from New Zealand, *Molpadia violacea* also occurs near Kerguelen (Theel, 1886), and *Paracaudina chilensis* is a circum-Pacific species. It is expected that further deep water investigation in Cook Strait will reveal members of the almost exclusively deep sea group, Order Elasipodida.

Present records indicate that no shelf holothurian species are restricted to the Cookian Province as defined by Finlay (1925) and applied to the echinoderms by Fell (1949) and Pawson (1961). The fauna of Cook Strait contains a mixture of northern and southern New Zealand elements, with southern elements predominating. Cook Strait does not appear to present a barrier to northward dispersal of southern species.

Among the Cook Strait holothurians are four species which are also known in Australia. They are:

Paracaudina chilensis — *Neocucumella bicolumnata*
Neothyonidium dearmatum — *Stichopus mollis*

The above species comprise about 25% of the known fauna. The means by which echinoderms can cross the ocean gap between Australia and New Zealand have been discussed by Mortensen (1925) and Fell (1953). Drift in surface waters across the Tasman Sea in the planktonic larval stage is feasible for those species which possess pelagic larvae (as is probably the case with *Stichopus mollis*). Both *Neothyonidium dearmatum* and *Neocucumella bicolumnata* have yolky eggs, and probably lack a larval stage in their life history. They may have been carried across the Tasman Sea in rafts of seaweed, or perhaps dispersed via the Lord Howe Rise to which Fell (1953) attaches some importance as at least a former, if not a present, dispersal route. More complete information on the life history and bathymetric distribution of such problematical species may assist in revealing their dispersal mechanism.

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