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NEW ZEALAND
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

BULLETIN 195

An Outline Distribution of the New Zealand Shelf Fauna

Benthos Survey, Station List, and Distribution of the Echinoidea

by
D. G. McKNIGHT

New Zealand Oceanographic Institute
Memoir No. 47

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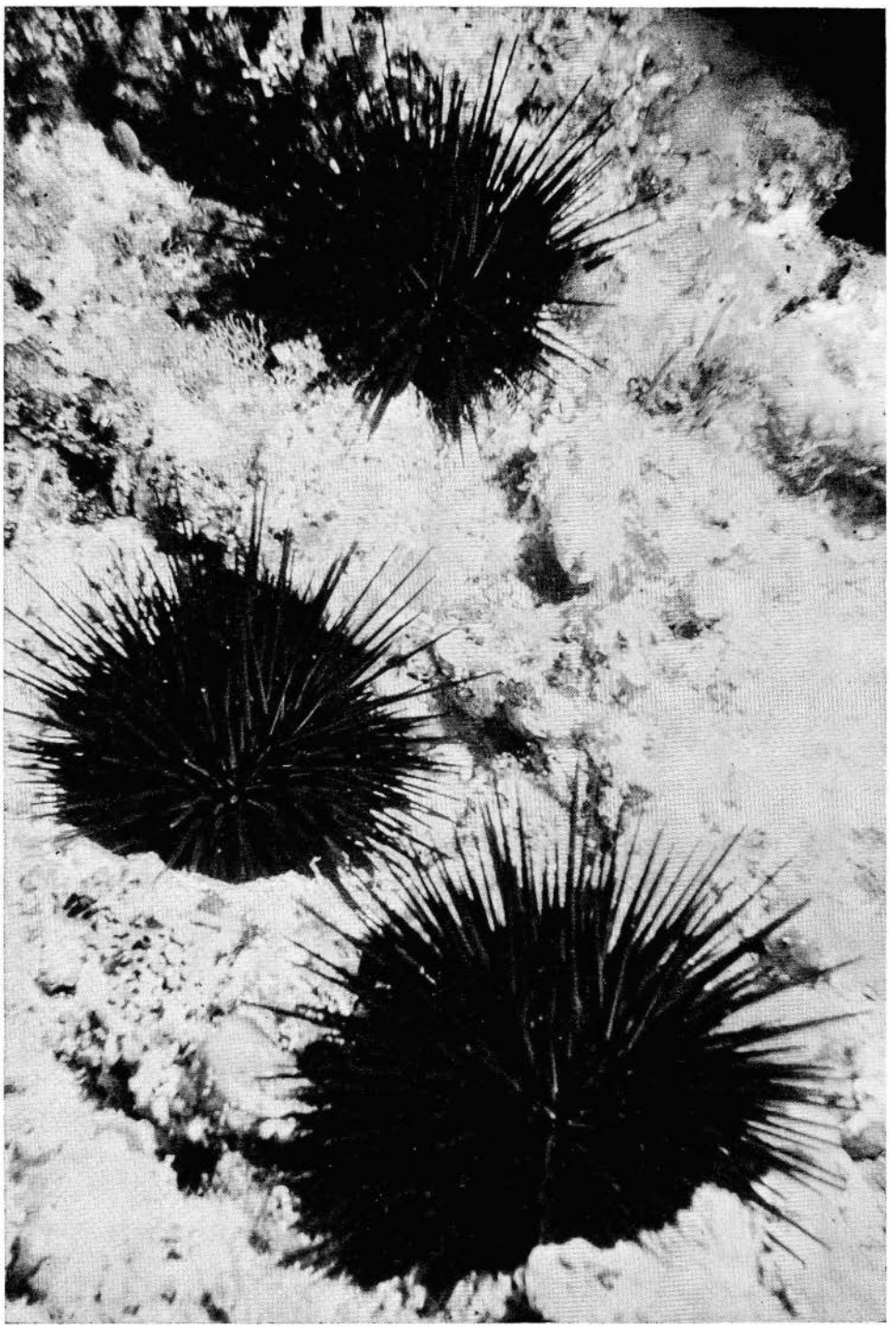

Photo: K. Tarlton 1966

A colony of *Centrostephanus rodgersii* (A. Agassiz) in *ca.* 12 m. at the Poor Knights Islands.

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FOREWORD

Two of the principal hindrances to the furtherance of ecological studies of the marine benthos in New Zealand waters have been the absence of factual data and the lack of extensive systematic consideration of the New Zealand fauna.

Earlier preliminary benthic surveys carried out by the Institute have led to a sampling programme that has included a reconnaissance survey of the bottom-living organisms on the New Zealand shelf.

The shelf survey has provided for the first time adequate geographic coverage by bottom dredgings and trawlings from all round the New Zealand coastline. The results must be regarded as preliminary and indicative, for the sampling grid has had to be coarse to enable the field work to be completed in reasonable time.

Analyses of the results will provide an outline of the distribution of major animal groups in the shelf waters, and the first of these, on the Echinoidea, is presented in this Memoir.

J. W. BRODIE, Director,
New Zealand Oceanographic Institute,
Wellington.

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An Outline Distribution of the New Zealand Shelf Fauna

Benthos Survey, Station List, and Distribution of the Echinoidea

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Abstract

A general account and the station list of a continental shelf benthos survey carried out around New Zealand by the New Zealand Oceanographic Institute are given.

Distribution of the Echinoidea in the New Zealand region is described. Faunal elements having restricted, semi-restricted, and widespread geographic distributions are recognised. A group of species restricted to the shelf can be recognised, as can the sediment preference of a number of species.

The echinoid distributions are compared with the faunal provinces erected on molluscan evidence, and substantial differences are apparent.

Introduction

During 1961 and 1962 the New Zealand Oceanographic Institute made a preliminary survey of the benthic fauna on the continental shelf around New Zealand. The area considered consisted of the region immediately offshore as far as the major break in slope, which is at an average depth of 130 m.

Some previous investigations into the distribution of the New Zealand marine fauna have been concerned with the definition of faunal provinces. The faunal province concept is based largely on the differences in distribution of intertidal organisms over the New Zealand region (e.g. Knox 1960); however the extent to which these, or any provinces, could be recognised on the continental shelf, was not and is not as yet clear. Until the present survey much of the shelf remained unsampled, the limits of distribution of many species were unknown, and little information existed on the depth and sediment preferences. The present survey was intended to supply preliminary data only; more detailed sampling will be needed in areas where the fauna is noticeably varied, and indeed generally over the shelf, before the ecology of the different members of the fauna and their associations can be fully appreciated.

This work describes the survey, and discusses the distribution of the Echinoidea of the New Zealand continental shelf based on the records of the survey and other collections made by the New Zealand Oceanographic Institute, as well as on records in the literature.

Additional material in the New Zealand Oceanographic Institute, which has been available for examination, is from the following areas: the Three Kings Islands, the west coast North Island shelf between the latitudes of 36° 40′ S and 39° 50′ S, Hawke Bay, Golden and Tasman Bays, Marlborough Sounds, Cook Strait, Kaikoura, and Foveaux Strait.

A station list is given for the survey stations and for other N.Z.O.I. stations at which echinoids have been taken.

General Account of the Shelf Benthos Survey

The New Zealand Continental Shelf

The continental shelf around New Zealand extends from 34° S to about 49° S, with the extreme eastern and western limits at 179° E and 166° E. The outer edge of the shelf, where the depth increases very rapidly, lies in an average depth of about 130 m; this limit is variable, the shelf edge being much deeper (about 180 m) to the south off Stewart Island, and also westward off Cape Egmont and Wanganui. The trend of the shelf is somewhat east of south from 34° S to nearly 38° S; southward of this point it trends almost south-west to about 49° S. It is commonly less than 50 miles in width; at its outer limit the upper continental slope is generally steep. Nearly all of the more extensive shelf areas are associated with wide embayments in the coastal outline, the notable exception being the plateau-like tongue extending for about 100 miles south from Stewart Island.

Several banks lie close to but separated from the main shelf; these occur around the Three Kings Islands in the north, and off the south-west corner of the South Island (Puysegur Bank). Other isolated shallow areas, Mernoo and Veryan Banks, lie on the Chatham Rise to the east of Banks Peninsula. Comparatively deep water (2,000–3,000 m) approaches close to the coast in eastern Cook Strait, off the southern Wairarapa and Kaikoura coasts (the Hikurangi Trench), and off the south-west coast of the South Island (depths of 4,000 m occur in the Fiordland Trough). In these areas the shelf becomes very narrow and steep. The coastal outline, approximate shelf area, and general bathymetric features of the New Zealand region are shown in Fig. 1.

The Physical Environment

Hydrology

In recent years the main features of the hydrological environment around New Zealand have been defined. Extensive drift-card releases have helped define a coastal circulation (Brodie 1960), and hydrological investigations carried out in 1955 and earlier give a general picture of the oceanographic "climate" on the shelf and further offshore (Garner 1961, 1962). The hydrology of southern New Zealand and waters further south has been described by Burling (1961). Many of the features have been described from surface information only or are themselves strictly surface phenomena. The temperature and salinity regime at the bottom is less well known, though it is to be expected that the broad distribution of hydrological properties would have an important influence on the distribution of the fauna.

The New Zealand region is affected by both subtropical and subantarctic surface water masses. To the north of New Zealand lies the subtropical Trade Wind Drift; to the south, the subantarctic West Wind Drift. To the west, in the Tasman Sea, is the Tasman Current, derived from subtropical waters moving eastward from the Australian region. The boundary between the subtropical and subantarctic waters, the Subtropical Convergence, lies within the New Zealand region. The Subtropical Convergence has been variously defined by different authors, and recently Burling (1961) has recognised and charted a broad zone (Fig. 1) within which the Convergence lies, the exact position varying throughout the year. This convergence region lies off South Westland and Fiordland on the west coast, and extends past Stewart Island (and to the south of this island) up to Cook Strait or even further north on the east coast. Offshore, on both coasts, the region is narrower. In the convergence zone different surface water masses may be expected to influence the environment at different times, and a subtropical influence from the west may at times extend to the waters over the Campbell Plateau.

In nearshore waters, a coastal circulation pattern has been identified by Brodie (1960). The surface currents recognised may be summarised as follows:

> The East Auckland Current flowing south from North Cape to Bay of Plenty; the West Auckland Current, from Cape Reinga southwards towards Kaipara Harbour or further south; the East Cape Current, drawing subtropical water, southwards from East Cape to the Cook Strait region and then eastwards; the Southland Current, from Fiordland, through Foveaux Strait and northwards up the South Island east coast; the cooler Canterbury Current, from Banks Peninsula northwards to Gisborne, inshore of the East Cape Current; the Westland Current, from northern Fiordland towards the west coast of the North Island, meeting the West Auckland Current and forming the East Tasman Convergence (Garner 1959); and the D'Urville Current, from between Cape Farewell and Cape Egmont, flowing eastwards through Cook Strait (Fig. 1).

Upwelling of locally colder water is known to occur near the Three Kings Islands, off East Cape, off the Canterbury Coast, off Cape Farewell, and generally off the west coast of the North Island.

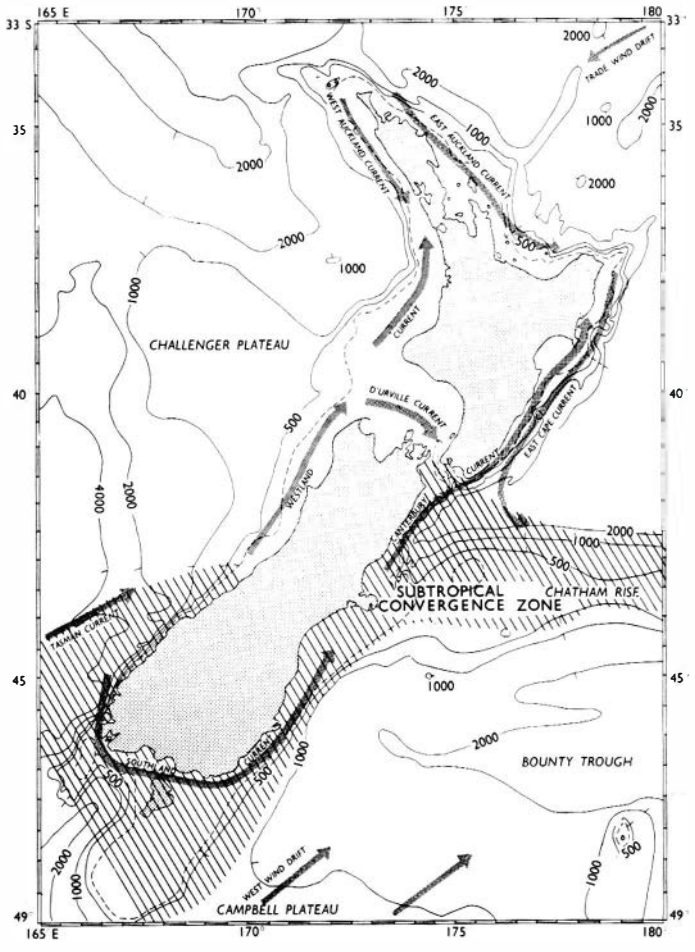


FIG. 1. General bathymetry, coastal currents, and the Subtropical Convergence zone in the New Zealand region. The broken line encloses the continental shelf; other isobaths in metres.

In February 1955 summer surface temperatures varied from 23°C round the Three Kings Islands to 14°C off south-east Otago and 13°C in Cook Strait (Garner 1961). In May 1955 temperatures of 20°C in the north dropping to 10°C off Banks Peninsula were found. In August 1955 the surface temperature in the Canterbury Bight and Cook Strait regions was about 10°C dropping to 7°C inshore in Pegasus Bay. In November and December surface temperatures off the east coast ranged from 17°C in the north to 11°C off Banks Peninsula.

In May the salinity was 35.9°/$_{oo}$ in the north decreasing to 34.5°/$_{oo}$ in the Canterbury Bight, and 33.9°/$_{oo}$ inshore in this region. In August in the Canterbury Bight — Cook Strait region, surface salinity varied from 34.7°/$_{oo}$ to 34.1°/$_{oo}$ inshore, south of Banks Peninsula. In November and December surface salinity off the east coast of the North Island was 35.6°/$_{oo}$ off North Cape decreasing to 35.0°/$_{oo}$ off Cape Palliser. The whole-year surface salinities ranged from 35.9°/$_{oo}$ in the north to 34.5°/$_{oo}$ off south-east Otago. Locally lower values (34.1°/$_{oo}$ in the Canterbury Bight and 31.9°/$_{oo}$ off Fiordland) were considered by Garner to result from freshwater dilution.

The hydrological environment of the sea floor on the shelf may be expected to be less variable than that of surface waters. In the New Zealand region, the extent to which fluctuations in the surface values of temperature and salinity influence the bottom environment of the shelf is not fully known and occasional complex hydrological situations have been recognised, especially at the shelf edge.

"In general, bottom water at the edge of the North Island shelf has a temperature of 12–15°C and a salinity of 34.9–35.4°/$_{oo}$" (Garner 1961, p.59).

Recently Knox (1960, 1963) has summarised a terminology for some of the coastal water masses in the Southern Hemisphere. The water masses recognised in the New Zealand area are:

1. Subantarctic Cold Temperate Water

The winter surface temperature range is from 3°C in the south to 11.5°C in the north, and the summer range is from 5.5°C to 14.5°C. Salinity is about 34.5°/$_{oo}$ or higher. Macquarie Island lies on or near the boundary between this water mass and the colder antarctic surface water. Subantarctic Cold Temperate Water covers the area from Macquarie Island to New Zealand, and affects the coasts of Stewart Island, the eastern coast of the South Island, and the southern North Island coasts.

2. Cold Temperate Mixed Water

This is on the cold side of the Subtropical Convergence, from Banks Peninsula to Castle Point and most of the west coast. Winter surface temperatures are between 7°C and 14.5°C, and summer between 11°C and 18°C. Salinities are variable, but usually range from 34.5°/$_{oo}$ to 34.8°/$_{oo}$. In the south the "climate" varies between this and the preceding type. This water mass extends to the Chatham Islands.

3. Transitional Warm Temperate Waters

The mean summer temperature does not usually rise above 20°C. This water mass covers northern New Zealand, north of about East Cape and about Herekino, on the east and west coasts respectively of the North Island.

With the general lack of detailed environmental data on the New Zealand fauna, it is not possible at present to make detailed correlations between the hydrological data and the distributions of members of the fauna. It should be possible, however, to see which species appear to be confined to the broad regional physical environments now known.

SHELF SEDIMENTS

Though no general investigation of the shelf sediments has been made, local studies have been carried out in Auckland Harbour (Powell 1936), Hawke Bay (Pantin 1966), Cook Strait (Reed and Leopard 1954), Foveaux Strait (Cullen 1967), and off the west coast of the North Island (McDougall and Brodie, 1967). Sediment analyses from the present survey are available, so general

characteristics of the shelf sediments can be described. Generally, in nearshore shallow water on the open coast, coarse-grained sediments of gravel or coarse sand grade predominate, the sediment becoming finer offshore. Much of the shelf is covered by finer-grained sediments such as fine sand, muddy sand, or sandy mud. In some areas coarser material is found together with sand or sandy mud near the shelf edge or in narrow zones on mid shelf. Mud is uncommon on the shelf, except off river mouths and in coastal embayments and protected harbours with little current or wave action. Fine-grained sand, muddy sands, and sandy muds cover most of the shelf area. Coarse sediments found during the present survey cover appreciable local areas. Coarse gravel-sand mixtures cover much of the shelf from off Otago Peninsula southwards to the southern shelf edge and in Foveaux Strait. Coarse sediments were also found off Puysegur Point, on Puysegur Bank, westward off Wanganui, and round the Three Kings Islands.

General Plan of Survey

The limits of time available at sea made it necessary to restrict the sampling programme to a fairly widely spaced network of stations. It was planned to sample along parallels of latitude 40 miles apart, adjusting the position of these lines where necessary, and to take additional samples in various sheltered harbours round the coast. On each survey line sampling was to be carried out at depths of 20, 40, 80, 140, and 200 m. With grabs and trawls it was expected to obtain reasonably representative samples of the fauna.

It proved impossible to sample the desired depths accurately, especially in deeper water, the 200 m depth being usually off the shelf on a steeply shelving bottom; however, most samples were taken within 10% of the desired depth. Weather conditions and damage to gear prevented the use of grabs and trawls at some stations, and dredges were used over much of the area. Where the sample recovered was small, it was not always possible to resample the position. A reasonable number of stations on each planned survey line were sampled, and in the course of the three cruises to complete the project, 331 stations were occupied, the majority of these being on the shelf.

Field and Laboratory Techniques

The survey lines were normally worked from inshore outwards into deeper water, the ship's position being plotted by means of radar and horizontal sextant angles. Continuous echo-sounding profiles were taken while working each line. On the initial cruise in 1961 (*West Coast Benthos*) an echo-sounder reader in metres was used. On the two subsequent cruises, *Benthos North* and *Benthos South*, the echo-sounder used was calibrated in fathoms and the soundings have been transformed into metres from prepared tables, no correction being made for variations in velocity of sound in sea water.

At most stations it was possible to obtain sediment as well as faunal samples. Upon recovery of the sampler, subsamples of the undisturbed sediment were removed for microfaunal and grain-size analyses. If visible, fragile specimens were removed before the sample was transferred to a nest of sieves and the remaining sediment washed away. The finest sieve used was of cotton mesh (stockingette) averaging about 20 meshes per inch. After being washed, specimens were picked off the sieves, the cotton mesh removed and rolled up, and the sample preserved either in 95% ethyl alcohol or 10% neutral formalin.

In the laboratory the sample was washed again to remove any remaining fine sediment, and specimens carefully picked or washed off the cotton mesh. The sample was then sorted into taxonomic groups, and re-preserved, generally in 95% ethyl alcohol; 5% neutral formalin was used for algae, and 10% neutral formalin or 50% ethyl alcohol for fish.

Sediments have been analysed for grain size only. The sediment data for each station have been transferred to punched cards and the relative abundance of each sediment grade has been noted using the following grouping: 0–10%; 10–20%; 20–40%; 40–60%; 60–80%; and 80–100% of the total sample by weight. Also punched on to the cards were the dominant grade of sediment and the Wentworth class term of the sediment. Where grain size analyses were not made, a visual examination of the sediment has been made and the dominant grain size and Wentworth class recorded.

Sediment grades recognised in the mechanical analysis are:

Grade	Grain Size (mm)
Granule gravel	2
Very coarse sand	1–2
Coarse sand	0.5–1
Medium sand	0.25–0.5
Fine sand	0.125–0.25
Very fine sand	0.0625–0.125
Mud	0.0625

Survey Cruise Details

I. *West Coast Benthos* 31/5/61–12/6/61: West Coast shelf off the South Island and Puysegur Bank. Stations B 454–B 498. MV *Viti*.

II. *Benthos North* 14/2/62–6/3/62: North Island shelf, from Kaipara Harbour on the west coast, the east coast shelf, Tasman Bay, and Marlborough Sounds. Stations C 744–C 863. MV *Taranui*.

III. *Benthos South* 3/10/62–31/10/62: South Island shelf, the west coast shelf off the North Island, north to Kaipara Harbour; also Golden and Tasman Bays, and Marlborough Sounds. Stations B 538–B 695. MV *Taranui*.

Symbols Used in the Station List

CUW	Underwater camera
DC	Cone dredge with canvas bag, diameter 1 ft, length 3 ft
DCM	Cone dredge, with cylindrical steel wire mesh bag ($\frac{1}{2}$ in. mesh) diameter 1 ft, length 3–4 ft
DCMB	Cone dredge as above (DCM) with canvas bag as inner lining
DD	Rectangular dredge with steel wire mesh bag; width 2 ft 6 in., height 6 in., length 3 ft ($\frac{1}{2}$ in. mesh)
Dietz	Dietz grab
DIS	Ironsand dredge
DO	Oyster dredge
GHO	Medium orange peel grab
GLO	Large orange peel grab
LH	Handlines
GP	Petersen grab
SC	Shore collections
TAL	Agassiz trawl with bag of 2 in. netting; width 6 ft, height 2 ft
TAM	Agassiz trawl, with bag of 2 in. netting; width 4 ft 6 in., height 1 ft 6 in.

All soundings quoted are uncorrected sonic depths in metres. Descriptive names of sediments are those of the Wentworth classification (Wentworth 1922).

Station List

(pp. 14-33)

CRUISE "WEST COAST BENTHOS" STATION LIST

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B454	1.6.61	40° 37.8'S	172° 25.5'E	DC	15	Sandy mud	Fine Sand	Sand
B455	1.6.61	40° 40'S	172° 13'E	DC	54	Yellow-brown sand	Medium sand	Sand
B456	1.6.61	40° 38'S	172° 01.4'E	DC	142	Soft grey mud	Very fine sand	Muddy sand
B457	1.6.61	40° 38'S	171° 43'E	DC	208-198	Soft grey pebbly mud	Fine sand	Muddy sand
B458	2.6.61	41° 23.5'S	171° 03'E	DC	198	Soft grey mud	Very fine sand	Muddy sand
B459	2.6.61	41° 22.5'S	171° 25'E	DC	139	Sandy mud	Fine sand	Muddy sand
B460	2.6.61	41° 23'S	171° 53.1'E	DC	58-57	Sandy mud	Mud	Mud
B461	2.6.61	41° 24'S	172° 00.5'E	DC	21	Dark grey sand	Fine sand	Sand
B462	2.6.61	41° 59'S	171° 22'E	DC	24-26	Sand	Fine sand	Sand
B463	2-3.6.61	41° 59'S	171° 17'E	DC	62	Muddy sand	Mud	Mud
B464	3.6.61	41° 59.3'S	171° 08.7'E	DC	144	Soft grey, slightly sandy mud	Mud	Mud
B465	3.6.61	41° 59.3'S	170° 49.4'E	DC	200-198	Firm sandy mud	Fine sand	Muddy sand
B466	3.6.61	42° 39.5'S	170° 59.5'E	DC	20	Clean grey sand	Very fine sand	Sand
B467	3.6.61	42° 39'S	170° 56.5'E	DC	65-64	Grey sandy mud	Mud	Mud
B468	3.6.61	42° 39'S	170° 47'E	DC	151-126	Muddy sand	Fine sand	Muddy sand
B469	3.6.61	42° 39'S	170° 41.6'E	DC	184-181	Grey muddy sand	Fine sand	Muddy sand
B470	3.6.61	43° 20'S	169° 59.5'E	DC	20	Grey sand	Fine sand	Sand
B471	3.6.61	43° 20'S	169° 55'E	DC	62	Grey sandy mud	Mud	Mud
B472	3.6.61	43° 20'S	169° 49'E	DC	148	Shelly grey muddy sand	Mud	Sandy mud
B473	3-4.6.61	43° 20'S	169° 47'E	DC	210-206	Grey mud and bored rock fragments	Mud	Mud
B474	4.6.61	43° 59.5'S	168° 30'E	DC	22-24	Compacted grey sand	Very fine sand	Muddy sand
B475	4.6.61	43° 59.5'S	168° 23.4'E	DC	62-61	Coarse grey shelly sand	Mud	Sandy mud
B476	4.6.61	43° 59.7'S	168° 17.2'E	DC	140-143	Grey sandy mud	Mud	Muddy sand
B477	4.6.61	44° 40.2'S	167° 35'E	DC	78	Coarse grey sand	Coarse sand	Gravelly sand
B478	5.6.61	45° 08.8'S	166° 57.8'E	GHO	138	Coarse shell and sand	Granule gravel	Gravelly sand
B479	5.6.61	45° 19.5'S	167° 00'E	DC	150	Coarse sand and large pebbles	Mud	Muddy sand
B480	5.6.61	45° 16.8'S	166° 51.3'E	DC	112	Coarse grey shelly sand, and large encrusted branch	Very coarse sand	Sand
B481	5.6.61	45° 20'S	166° 47.3'E	DC	55-87	Shell sand and large pebbles	Granule gravel	Gravel
B482	5-6.6.61	46° 08.8'S	166° 06'E	DD	84	Rock and encrusting fauna	-	-
B483	6.6.61	46° 01.5'S	166° 21'E	DC	183	Coarse shell sand	Very coarse sand	Sand
B484	6.6.61.	46° 05'S	156° 22'E	DC	120	Fine shell sand with rounded pebbles	Granule gravel	Sandy gravel
B485	6.6.61	46° 04.1S	166° 24.5'E	DC	58	Coral and sponge rocky bottom	-	-

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B486	6.6.61	46° 01.2'S	166° 30.1'E	DD	30	Small pebbles	Granule gravel	Gravel
B487	6.6.61	46° 16'S	166° 03'E	DD	192-189	Angular encrusted rocks	Granule gravel	Gravel
B488	7.6.61	46° 28.7'S	166° 14.3'S	DD	160	Encrusted small rocks	Granule gravel	Gravel
B489	7.6.61	46° 39'S	166° 09.5'E	DD	194	Encrusted small rocks	Granule gravel	Gravel
B490	8.6.61	45° 44.3'S	166° 44.8'E	DD	144-118	Coral, sponge and shell. No sediment.	-	-
B491	3.6.61	45° 40.4'S	166° 45.2'E	DD	228-220	Shell, muddy bottom	Mud	Mud
B492	8.6.61	45° 38'S	166° 57'E	DD LH	50 50	Mud with leaves and twigs. Gut contents of gurnard .	Mud	Mud
B493	8.6.61	45° 34.4'S	166° 39.1'E	DD LH	80-76 76	Pebbles Shark parasites preserved.	Granule gravel	Gravel
B494	9.6.61	44° 40'S	167° 55.3'E	DD	132	Grey mud, leaves and twigs	Fine sand	Muddy sand
B495	9.6.61	44° 33.6'S	167° 47.6'E	DD	120		Mud	Sandy mud
B496	11.6.61	40° 36.5'S	173° 33'E	DD	54	Grey mud	Mud	Mud
B497	11.6.61	40° 45.8'S	173° 59.1'E	DD	22	Fine grey muddy sand	Mud	Sandy mud
B498	11.6.61	40° 46.3'S	174° 02.8'E	DD	40	Shell, no sediment	-	-

CRUISE - "BENTHOS NORTH" STATION LIST

C744	15.2.62	37° 31'S	172°05'E	DD	957-991	Dredge lost		
C745	16.2.62	36° 40'S	174° 13.6'E	GH	35	Fine-medium blackish sand	Fine sand	Sand
C746	16.2.62	36° 00'S	173° 46'E	GL TAL	26 24-18	Dark medium-fine sand	Fine sand	Sand
C747	16.2.62	36° 00.2'S	173° 36.7'E	GL CUW	76 78	Dark medium-fine sand	Fine sand	Sand
C748	16.2.62	36° 00'S	173° 32.2'E	GL TAL	135 134-132	Fine shelly muddy dark grey sand	Fine sand	Sand
C749	16.2.62	36° 00'S	173° 31'E	GL TAL	207 210-214	Grey muddy sand	Fine sand	Sand
C750	17.2.62	35° 20'S	173° 10.5'E	GL CUW	20 22	Fine-medium grey sand	Fine sand	Sand
C751	17.2.62	35° 19.8'S	173° 02.2'E	GL TAL	75 75	Medium shelly muddy sand	Fine sand	Sand
C752	17.2.62	35° 19'S	172° 57.5'E	GL TAL	131 128-124	Medium shelly muddy grey sand	Fine sand	Muddy sand
C753	17.2.62	35° 20.1'S	172° 52'E	GL TAL	187 181-170	Medium muddy sand	Medium sand	Sand
C754	17.2.62	34° 40'S	172°51.3'E	GL TAL	24 24-20	Fine grey sand	Fine sand	Sand
C755	17.2.62	34° 40.5'S	172° 34.8'E	GL	46	Fine grey sand	Fine sand	Sand
C756	17.2.62	34° 40'S	172° 32.4'E	GL	75	Fine dark muddy sand	Fine sand	Sand
C757	17.2.62	34° 40.2'S	172° 29.2'E	GL	134	Fine muddy sand	Fine sand	Muddy sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain size	Wentworth Class
C758	17. 2. 62	34° 40'S	172° 14.5'E	GLO	199	Medium grey muddy sand	Fine sand	Muddy sand
C759	18. 2. 62	34° 11.7'S	172° 09.9'E	GLO	99	Coral and sponge. No sediment.		
C760	18. 2. 62	34° 10.8'S	172° 08.4'E	GLO	84	Polyzoa and pebbles	Fine sand	Muddy sand
C761	18. 2. 62.	34° 08.4'S	172° 08.6'E	CUW	66			
C762	18. 2. 62	33° 59'S	171° 37'E	GLO	252	Coral, no sediment		
C763	18. 2. 62.	33° 58'S	172° 17.6'E	GLO TAM CUW	73 73-77 99	Algae and sponge No sediment		
C764	19. 2. 62	34° 08.5'S	172° 08.5'E	GLO	66	Coarse shelly sand	Medium sand	Sand
C765	19. 2. 62	34° 26.5'S	172° 49'E	GLO TAM LH	22 21 22	Coarse shelly sand over thick mud.	Very coarse sand	Gravelly sand
C766	19. 2. 62	34° 18.2'S	172° 48.8'E	GLO TAM	75 75-79	Shelly coarse sand over thick mud.	Fine sand	Sand
C767	19. 2. 62	34° 05.7'S	172° 49.5'E	GLO TAM	135 134	Fine sand	Fine sand	Sand
C768	20. 2. 62	34° 40'S	173° 02.8'E	GLO	24	Medium shelly sand	Fine sand	Muddy sand
C769	20. 2. 62	34° 40.1'S	173° 11.2'E	GLO	77	Medium-coarse muddy shelly sand	Fine sand	Muddy sand
C770	20. 2. 62	34° 39.9'S	173° 20.5'E	GLO	134	Medium-coarse muddy shelly sand	Fine sand	Muddy sand
C771	20. 2. 62	34° 40'S	173° 27'E	GLO TAL	188 188-185	Coarse muddy shelly sand	Fine sand	Sand
C772	20. 2. 62	35° 00.3'S	173° 46'E	GLO	13	Soft grey mud	Mud	Sandy mud
C773	20. 2. 62	35° 02'S	173° 46'E	GLO	26	Coarse slightly muddy shelly sand	Granule gravel	Sandy gravel
C774	20. 2. 62	35° 09.8'S	174° 14.4'E	GLO	78	Soft grey sandy mud	Mud	Sandy mud
C775	20. 2. 62	35° 20.1'S	174° 22.7'E	GLO	41	Fine shelly gravel	Granule gravel	Sandy gravel
C776	20. 2. 62	35° 20'S	174° 25.8'E	GLO	77	Fine grey sandy mud	Mud	Sandy mud
C777	20. 2. 62	35° 19.4'S	174° 32.4'E	GLO	132	Fine grey sandy mud	Mud	Sandy mud
C778	20. 2. 62	35° 19.8'S	174° 47.6'E	GLO	187	Medium muddy sand	Fine sand	Sand
C779	21. 2. 62	36° 00'S	174° 32.7'E	GLO	20	Medium-coarse grey shelly sand	Medium sand	Gravelly sand
C780	21. 2. 62	35° 59.8's	174° 47.6'E	GLO	75	Fine grey sandy mud	Mud	Sandy mud
C781	21. 2. 62	36° 00'S	175° 20.6'E	GLO	93	Fine grey sandy mud	Mud	Mud
C782	21. 2. 62	35° 59.7'S	175° 36.7'E	GLO	134	Grey sandy mud	Mud	Sandy mud
C783	21. 2. 62	36° 00'S	175° 45.8'E	GLO	188	Grey muddy sand	Mud	Sandy mud
C784	21. 2. 62	36° 13.7'S	175° 17.5'E	CUW	59			
C785	22. 2. 62	37° 00.2'S	175° 21.8'E	GLO TAM	23 23-24	Soft grey-blue mud	Mud	Mud
C786	22. 2. 62	36° 40'S	175° 20.9'E	GLO	21	Soft grey mud	Mud	Mud
C787	22. 2. 62	36° 40'S	175° 06.1'E	GLO TAL	43 43	Soft grey mud	Mud	Sandy mud
C788	22. 2. 62	36° 40'S	174° 49.3'E	GLO	21	Soft grey mud	Mud	Mud
C789	22. 2. 62	36°13.7'S	175° 17.5'E	GLO	359	Soft grey sandy mud	Fine sand	Muddy sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C790	22.2.62	36° 10.9'S	175° 21.4'E	GLO	20	Soft grey mud	Mud	Mud
C791	23.2.62	36° 40'S	175° 35.1'E	GLO	22	Brown mud over coarse shelly sand.	Coarse sand	Gravelly sand
C792	23.2.62	36° 40'S	175° 57.1'E	GLO	73	Greenish-grey muddy sand	Mud	Sandy mud
C793	23.2.62	36° 39.9'S	176° 02'E	GLO	132	Fine grey sandy mud	Mud	Mud
C794	23.2.62	36° 40.2'S	176° 08.7'E	GLO	188	Fine grey sandy mud	Mud	Sandy mud
C795	23.2.62	37° 20'S	175° 57'E	GLO	17	Grey medium-coarse shelly sand	Fine sand	Sand
C796	23.2.62	37° 20'S	176° 11.2'E	GLO	74	Muddy medium-coarse sand	Granule gravel	Gravelly sand
C797	23.2.62	37° 20'S	176° 18.3'E	GLO	141	Medium-coarse sand	Fine sand	Sand
C798	23.2.62	37° 20.1'S	176° 19'E	GLO	201 192-177	Medium grey muddy sand	Fine sand	Muddy sand
C799	24.2.62	37° 40'S	176° 15.3'E	GLO	19	Fine-medium grey sand	Fine sand	Sand
C800	24.2.62	37° 40'S	176° 36.2'E	GLO	77	Medium grey muddy sand	Mud	Sandy Mud
C801	24.2.62	37° 40.3'S	176° 48.1'E	GLO	134	Coarse shelly muddy sand	Fine sand	Muddy sand
C802	24.2.62	37° 40'S	177° 08.2'E	GLO	183	Soft grey mud	Mud	Sandy mud
C803	24.2.62	37° 40'S	177° 24'E	GLO	133	Soft grey mud	Mud	Sandy mud
C804	24.2.62	37° 39.8'S	177° 43.6'E	GLO	77	Soft grey mud	Mud	Mud
C805	24.2.62	37° 40'S	177° 47.8'E	GLO	26	Grey-black fine-medium sand	Fine sand	Sand
C806	24.2.62	37° 57.4'S	177° 11'E	GLO	22	Fine-medium greysand	Very fine sand	Muddy sand
C807	24.2.62.	37° 48.1'S	177° 11'E	GLO	77	Soft grey mud	Mud	Mud
C808	24.2.62	37° 43.6'S	177° 11'E	GLO	148	Soft grey mud	Mud	Sandy mud
C809	25.2.62	37° 31.5'S	177° 09.7'E	CUW	113-152			
C810	25.2.62	37° 32.3'S	177° 11.6'E	CUW	90-51 108-100	Fine black muddy sand and pebbles	Fine sand	Muddy sand
C811	25.2.62	37° 40.2'S	178° 35'E	GLO DC	20 22	Pebbles Grey sand	Very fine sand	Sand
C812	25.2.62	37° 39.5'S	178° 37.6'E	GLO	75	Shelly gritty mud and cobbles	Mud	Sandy mud
C813	25.2.62	37° 40.2'S	178° 42'E	GLO	131	Soft grey mud	Mud	Sandy mud
C814	25.2.62	37° 40'S	178° 56.4'E	GLO TAL	190 209-157	Soft grey mud	Mud	Sandy mud
C815	25.2.62	37° 36.8'S	178° 52.6'E	GLO	46	Algae, no sediment		
C816	26.2.62	38° 00'S	178° 23.3'E	GLO	17	Compacted sand	Fine sand	Sand
C817	26.2.62	38° 00'S	178° 30.4'E	GLO	74	Soft grey mud	Mud	Mud
C818	26.2.62	38° 00'S	178° 38.6'E	GHO	129	Soft grey mud	Mud	Mud
C819	26.2.62	38° 00'S	178° 43.5'E	GHO	158	Soft grey mud	Mud	Sandy mud
C820	26.2.62	38° 40'S	178° 08'E	GHO	21	Polyzoa	Granule gravel	Gravel
C821	26.2.62	38° 40'S	178° 21.5'S	GHO CUW	32 47-48	Cobbles and coarse broken shell	Granule gravel	Gravel
C822	26.2.62	38° 40'S	178° 23'E	GHO	78	Muddy sand	Very fine sand	Sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C823	26. 2. 62	38° 40'S	178° 27. 4'E	GHO	130	Soft grey mud	Mud	Sandy mud
C824	26. 2. 62	38° 40'S	178° 30'E	GHO	198	Soft grey medium-fine sandy mud	Mud	Sandy mud
C825	27. 2. 62	39° 14'S	177° 05'E	GHO	21	Cobbles, gravel and shell	Granule gravel	Sandy gravel
C826	27. 2. 62	39° 24. 2'S	177° 23. 8'E	GLO TAL	77 77	Grey muddy sand	Fine sand	Muddy sand
C827	27. 2. 62	39° 31. 4'S	177° 39. 4'E	GHO TAM	131 132	Soft grey mud	Mud	Mud
C828	27. 2. 62	39° 36'S	177° 45. 6'E	GHO TAM	225 228-230	Soft grey mud	Mud	Sandy mud
C829	28. 2. 62	40° 00'S	176° 55. 5'F	GHO	21	Sand	Fine sand	Sand
C830	28. 2. 62	40°00'S	177° 01'E	GHO	80	Soft grey mud	Mud	Sandy mud
C831	28. 2. 62	40° 00'S	177° 04'E	GHO	138	Soft grey mud	Mud	Mud
C832	28. 2. 62	40° 00'S	177° 07'E	GHO	190	Soft grey mud	Mud	Mud
C833	28. 2. 62	40° 40'S	176° 23. 6'E	GHO	22	Tunicates, no sediment		
C834	28. 2. 62	40° 39. 8'S	176° 28. 8'E	GHO	75	Soft grey mud	Mud	Sandy mud
C835	28. 2. 62	40° 40'S	176° 33'E	GHO	130	Soft grey mud	Mud	Mud
C836	28. 2. 62-1. 3. 62	40° 40'S	176° 38. 6'E	GHO	188	Soft grey mud	Mud	Mud
C837	1. 3. 62	41° 20'S	175° 53. 2'E	GHO	23	Rock, no sediment		
C838	1. 3. 62	41° 20. 1'S	175° 55. 8'E	GHO	81	Dark grey muddy sand	Very fine sand	Muddy sand
C839	1. 3. 62	41° 20. 1'S	175° 58'E	GHO	136	Fine sandy mud	Mud	Sandy mud
C840	1. 3. 62	41° 20'S	176° 00. 7'E	GHO	190	Fine muddy sand	Very fine sand	Muddy sand
C841	1. 3. 62	41° 38. 5'S	175° 21'E	GHO	159	Soft grey mud	Mud	Mud
C842	1. 3. 62	41° 38. 5'S	175° 20'E	GHO	77	Coarse shelly muddy sand	Mud	Muddy sand
C843	1. 3. 62	41° 38. 5'S	175° 17. 2'E	GHO	53	Algae, no sediment		
C844	1. 3. 62	41° 38. 3'S	175° 11. 2'E	GHO TAM	88 90	Coarse shelly muddy sand	Granule gravel	Gravelly sand
C845	1. 3. 62	41° 38. 5'S	175° 06'E	GHO	188	Soft grey mud	Mud	Mud
C846	1. 3. 62	41° 38. 5'S	174° 30. 6'E	GHO	126	Fine grey sandy mud	Mud	Muddy sand
C847	1. 3. 62	41° 38. 5'S	174° 20. 7'E	GHO	75	Coarse dark grey muddy sand	Mud	Muddy sand
C848	1. 3. 62	41° 38. 8'S	174° 13. 6'E	GHO	21	Sand	Fine sand	Sand
C849	2. 3. 62	40° 40'S	175° 07. 3'E	GHO	15	Fine-medium grey sand	Fine sand	Sand
C850	2. 3. 62	40° 40. 2'S	175° 01. 4'E	GLO	73	Medium-coarse muddy shelly sand	Mud	Muddy sand
C851	2. 3. 62	40° 40. 4'S	174° 43. 6'E	GLO	128 130-134	Coarse grey sandy shelly mud	Mud	Muddy sand
C852	2. 3. 62	40° 41. 3'S	174° 20. 3'E	GHO	132	Coarse grey muddy shelly sand	Mud	Sandy mud
C853	2. 3. 62	40° 38. 3'S	174° 05. 2'E	GHO	93	Medium shelly sand	Fine sand	Sand
C854	2. 3. 62	40° 40. 2'S	174° 02. 8'E	GHO	274	Compacted mud and pebbles	Mud	Mud

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C856	2.3.62	40° 54.7'S	173° 53.7'E	GHO	41	Medium muddy shelly sand	Mud	Sandy mud
C856	2.3.62.	40° 55.2'S	173° 50.7'E	GHO	22	Coarse sandy shell and pebbles	Granule gravel	Sandy gravel
C857	2.3.62	40° 56.1'S	173° 48.4'E	GHO CUW LH	31 31 31	Shelly sandy mud Gut contents of blue cod	Mud	Sandy mud
C858	3.3.62	40° 59.7'S	173° 44.5'E	GHO	34	Coarse shelly sandy mud	Coarse sand	Sand
C859	3.3.62	41° 00'S	173° 32.5'E	GHO CUW	44 44	Fine grey, sandy shelly mud	Mud	Mud
C860	3.3.62	41° 00'S	173°26.5'E	GHO	43	Medium sandy shelly mud	Mud	Sandy mud
C861	3.3.62	41° 00'S	173° 15.5'E	GHO CUW	38 38	Sandy shelly mud	Mud	Sandy mud
C862	3.3.62	41° 00'S	173° 08.5'E	GHO CUW	25 25	Fine grey shelly sandy mud	Mud	Mud
C863	4.3.62	40° 57.3'S	174° 00.2'E	GHO	39	Grey mud and polyzoa	Mud	Sandy mud
C864	4.3.62	41° 04.5'S	173° 55.7'S	GHO	27	Fine grey mud	Mud	Mud
C865	4.3.62	41° 10.8'S	174° 01.4'E	GHO	26	Fine grey mud	Mud	Mud
C866	4.3.62	41° 06'S	174° 17.4'E	GHO	10	Fine grey muddy sand	Very fine sand	Muddy sand
C867	5.3.62	41° 02.2'S	174° 21.1'E	GHO	38	Medium shelly sand over fine sandy mud	Medium sand	Muddy sand
C868	5.3.62	41°03.45'S	174° 23.6'E	GHO	198	Gravel	Granule gravel	Gravel
C869	5.3.62	41° 13'S	174° 17.1'E	GHO CUW	19 36-33	Sandy shelly gravel	Granule gravel	Gravel
C870	5.3.62	41° 14.3'S	174° 12.8'E	GHO CUW	53 53-57	Coarse sandy shelly mud	Granule gravel	Gravelly sand
C871	5.3.62	41° 14.4'S	174° 09.1'E	GHO CUW	66 66-68	Coarse shelly mud	granule gravel	Gravelly sand
C872	5.3.62	41° 12'S	174° 12.5'E	GHO CUW	62 64.-60	Soft grey mud	Mud	Mud

CRUISE "BENTHOS SOUTH" STATION LIST

B538	4.10.62	42° 00'S	174° 03'E	GHO DCM	21 21	Fine grey sand	Fine sand	Sand
B539	4.10.62	42° 00'S	174° 08'E	GLO DCM	77 77	Very fine grey muddy sand	Fine sand	Sandy mud
B540	4.10.62	42° 00'S	174° 15.5'E	DCM	126-124		Mud	Sandy mud
B541	4.10.62	42° 04'S	174° 20'E	DCM	168	One pebble		
B542	4.10.62	42° 40'S	173° 28.3'E	DCM	19-21	Shell	Very fine sand	Sand
B543	4.10.62	42° 39.7'S	173° 32'E	GLO	150		Mud	Mud
B544	4.10.62	42° 40'S	173° 39'E	GLO	132	Coarse sandy mud and shell	Medium sand	Muddy sand
B545	5.10.62	43° 20'S	172° 47.3'E	GLO DCM	22 22	Fine grey sand	Very fine sand	Muddy sand
B546	5.10.62	43° 20'S	173° 14.6'E	GLO DCM	50 51	Fine grey sandy mud Shell	Mud	Sandy mud

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B547	5.10.62	43° 20'S	173° 20.8'E	GLO DCM	77 77	Medium black sand	Fine sand	Muddy sand
B548	5.10.62	43° 19.2'S	173° 28.8'E	GLO DCM	110 110	Fine grey sandy mud	Mud	Muddy sand
B549	5.10.62	43° 20.5'S	173° 40.5'E	GLO TAL	129 128-130	Fine muddy sand	Fine sand	Sand
B550	5.10.62	43° 52.2'S	172° 56.25'E	GLO	20	Fine grey black sand	Fine sand	Sand
B551	5.10.62	43° 48.45'S	172° 56.1'E	GLO	11	Soft grey mud	Mud	Mud
B552	6.10.62	44° 00'S	172° 05'E	GLO	20	Shelly shingle	Granule gravel	Gravelly sand
B553	6.10.62	44° 00'S	172° 35.5'E	GLO	49	Fine muddy sand	Very fine sand	Muddy sand
B554	6.10.62	44° 00'S	172° 58.2'E	GLO TAL	80 81-79	Fine muddy sand	Fine sand	Muddy sand
B555	6.10.62	44° 00.5'S	173° 35'E	GLO TAL	128 132-135	Fine muddy sand	Fine sand	Muddy sand
B556	6.10.62	44° 00'S	173° 47.5'E	DCM	179-198	Shell	Granule gravel.	Gravel
B557	7.10.62	44° 40'S	171° 12.5'E	GLO	21	Shingle	Granule gravel	Gravel
B558	7.10.62	44° 40'S	171° 39.2'E	GLO TAL	78 79	Fine sandy mud	Mud	Sandy mud
B559	7.10.62	44° 40.4'S	172° 10'E	GLO	132 132-133	Yellow grey compact sandy mud	Mud	Sandy mud
B560	7.10.62	44° 40'S	172° 24'E	GLO TAL	236 251	Grey muddy sand	Fine sand	Muddy sand
B561	7.10.62	45° 18.2'S	171° 28.5'E	DCM	176-177	Shell and polyzoa	Coarse sand	Sand
B562	7.10.62	45° 18.2'S	171° 27.5'E	DCM	128	Shell and polyzoa	Coarse sand	Sand
B563	7.10.62	45° 18.4'S	171° 15'E	DCM	71	Fine sandy mud	Mud	Sandy mud
B564	8.10.62	45° 20'S	170° 53.5'E	DCM	21	Pebbles, shell and sand	Granule gravel	Gravelly sand
B565	8.10.62	46° 00'S	170° 18'E	DCM	19-18	Sponges, and algae, no sediment		
B566	8.10.62	45° 59.8'S	170° 59.2'E	DCM	177	Polyzoa and shell	Granule gravel	Sandy gravel
B567	8.10.62	46° 00'S	170° 55'E	DCM	126	Shell	Granule gravel	Gravelly sand
B568	8.10.62	46° 00'S	170° 43.2'E	DCM	70	Fine shelly pebbly sand	Granule gravel	Sandy gravel
B569	9.10.62	46° 40'S	170° 07.5'E	DCM	165-181	Shell and polyzoa	Granule gravel	Gravel
B570	9.10.62	46°23.4'S	169° 48.2'E	GLO	16	Fine grey sand	Fine sand	Sand
B571	10.10.62	47° 20'S	167° 02'E	DCM	174	Shell	Mud	Mud
B572	10.10.62	47° 20.5'S	167° 51'E	GLO	84	Encrusted rocks	Granule gravel	Gravel
B573	10.10.62	47° 19.8'S	168° 00.5'E	GLO	101	One hermit crab, rocky bottom		
B574	10.10.62	47° 20'S	168° 13'E	GLO	113	Medium sand and coarse shell fragments	Medium sand	Sand
B575	10.10.62	47° 20'S	168° 26'E	GLO	110	Sand and shell	Coarse sand	Gravelly sand
B576	10.10.62	47° 20'S	168° 39'E	DCM	126	Broken shell and polyzoa	Coarse sand	Gravelly sand
B577	11.10.62	47° 20'S	168° 55'E	DCM	130	Broken shell and polyzoa	Coarse sand	Gravelly sand
B578	11.10.62	47° 20'S	169° 08'E	DCM	144-141	Shell and polyzoa	Granule gravel, Coarse sand	Gravelly sand
B579	11.10.62	48° 00'S	168° 34'E	DCM	145	Shell and polyzoa	Coarse sand	Gravelly sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B580	11. 10. 62	48° 00'S	168° 20'E	DCM	140	Dead shell	Granule gravel	Gravelly sand
B581	11. 10. 62	48° 00'S	168° 06'E	DCM	138	Polyzoa and shell	Granule gravel	Sandy gravel
B582	11. 10. 62	48° 00'S	167° 38'E	DCM	143-144	Polyzoa and shell	Granule gravel	Sandy gravel
B583	11. 10. 62	48° 00'S	167° 26'E	DCM	144	Polyzoa and shell	Granule gravel	Sandy gravel
B584	12. 10. 62	48° 01'S (Snares Island)	166° 35'E	SC	-			
B585	12. 10. 62	49° 00. 1'S	166° 35. 2'E	DCM	81	Polyzoa	Granule gravel	Sandy gravel
B586	12. 10. 62	48° 00'S	166° 26. 5'E	DCM	302-227	Dead shell	Granule gravel	Sandy gravel
B587	12. 10. 62	48° 00. 2'S	166° 39'E	DCM	155-152	Polyzoa and shell	Granule gravel	Sandy gravel
B588	12. 10. 62	48° 00'S	166° 53'E	DCM	148	Polyzoa and shell	Medium sand	Sand
B589	13. 10. 62	48° 44'S	166° 30'E	DCM	188-187	Coarse polyzoa and shell	Granule gravel	Sandy gravel
B590	13. 10. 62	48° 46'S	166° 49'E	DCM	156-158	Polyzoa	Granule gravel	Sandy gravel
B591	13. 10. 62	48° 46'S	167° 05'E	DCM	143-145	Sponge and polyzoa	Granule gravel	Sandy gravel
B592	13. 10. 62	48° 46'S	167° 19'E	DCM	754-148	Polyzoa and sponge	Granule gravel	Sandy gravel
B593	13. 10. 62	48° 43'S	167° 32'E	DCM	161-168	Polyzoa	Granule gravel	Sandy gravel
B594	14. 10. 62	46° 40. 3'S	170° 04'E	DCM	132	Shell	Granule gravel	Sandy gravel
B595	14. 10. 62	46° 40'S	169° 22. 6'E	DCM	74-75	Rocks and shell	Granule gravel	Gravel
B596	14. 10. 62	46° 40'S	169° 08'E	DCM	2. 3	Crayfish legs, no sediment		
B597	14. 10. 62	46° 40. 3'S	167° 32'E	DCM	78-81	Shell	Granule gravel	Gravel
B598	14. 10. 62	46° 40'S	167° 22. 5'E	DCM	134-137	Shell	Granule gravel	Gravel
B599	14. 10. 62	46° 40. 5'S	167° 12'E	DCM	205-260	Shell	Very coarse sand	Gravelly sand
B600	15. 10. 62	47° 11. 8'S	167° 30. 5'E	GLC CUW	18 18	Medium-coarse sand	Coarse sand	Sand
B601	15. 10. 62	47° 14. 5'S	167° 36'E	GLC	33	Fine grey sandy mud	Mud	Muddy sand
B602	15. 10. 62	47° 09. 7'S	167° 43. 5'E	GLC CUW	22 22	Medium-coarse shelly muddy sand	Mud	Muddy sand
B603	17. 10. 62	46° 35'S	166° 55'E	DCM	53	Gravel and shell	Granule gravel	Gravel
B604	17. 10. 62	46° 29'S	167° 08'E	DCM	145-137	Polyzoa and shell	Granule gravel	Gravel
B605	17. 10. 62	46° 23. 5'S	167° 22'E	TAL DCM B	71-72 73-76	Grey mud, pebbles and shell	Mud	Mud
B606	17. 10. 62	46° 19. 5'S	167° 38'E	DCM B	24	Fine dark grey sand	Fine sand	Sand
B607	17. 10. 62	46° 05'S	166° 38. 2'E	DCM B	22-20	Fine golden grey sand	Fine sand	Sand
B608	17. 10. 62	46° 05. 35'S	166° 36. 73'E	GLC	17	Medium golden sand	Fine sand	Sand
B609	18. 10. 62	46° 00'S	166° 21. 8'E	DCM B	210-241	Coarse sand and broken shell	Very coarse sand	Sand
B610	18. 10. 62	46° 00'S	166° 22. 7'E	DCM B	128-152	Slightly muddy coarse sand, shell and pebbles	Very coarse sand	Sand
B611	18. 10. 62	45° 59. 8'S	166° 25. 8'E	DCM B	70-64	Coarse broken shell and rocks	Very coarse sand	Gravelly sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain size	Wentworth Class
B612	18. 10. 62	46° 00'S	166° 27. 4'E	DCM B	32-35	Encrusted rocks	Granule gravel	Gravel
B613	18. 10. 62	45° 48. 1'S	166° 28'E	DCM B	91-106	Fine grey sand	Fine sand	Sand
B614	18. 10. 62	45° 43. 8'S	166° 39. 6'E	GLO	27	Fine grey-black sandy mud	Mud	Muddy sand
B615	18. 10. 62	45° 23'S	166° 45. 4'E	DCM B	79-82	Medium-coarse sand, pebbles and shell	Medium sand	Sand
B616	18. 10. 62	45° 20'S	166° 47'E	DCM B	132-137	Medium-coarse sand and shell	Medium sand	Sand
B617	19. 10. 62	44° 42. 1'S	167° 33. 8'E	DCM B	58-55	Fine grey sand	Fine sand	Sand
B618	19. 10. 62	44° 43'S	167° 34. 8'E	DCM B	95-21	Fine dark grey sand	Fine sand	Sand
B619	19. 10. 62	44° 42'S	167° 33. 25'E	DCM B	95-93	Coarse black sand over fine dark grey sand.	Fine sand	Muddy sand
B620	19. 10. 62	44° 17'S	168° 00'E	DCM B	43			
B621	19. 10. 62	43° 59'S	168° 20. 4'E	DCM B	117-84	Boulders, fine grey sand and medium coarse gravelly sand.	Mud	Sandy mud
B622	19. 10. 62	43° 59. 5'S	168° 24. 5'E	DCM B	68-66	Fine grey muddy sand	Very fine sand	Sand
B623	19. 10. 62	43° 59. 5'S	168° 31'E	DCM B	28-29		Granule gravel	Gravel
B624	19. 10. 62	43° 58. 5'S	168° 38. 1'E	DCM B	13	Fine grey sand	Fine sand	Sand
B625	20. 10. 62	43° 20'S	169° 47. 7'E	DCM B	137	Fine grey sandy mud	Fine sand	Muddy sand
B626	20. 10. 62	43° 20'S	169° 53. 7'E	TAL	70-68	Sticky grey mud	Mud	Mud
B627	20. 10. 62	43° 20'S	169° 59'E	DCM B	21-20		Medium sand	Sand
B628	20. 10. 62	42° 55. 5'S	170° 27'E	TAL	28-27	Shell and wool fragments	Medium sand	Sand
B629	20. 10. 62	42° 40'S	170° 59'E	DCM B	21-20		Medium sand	Sand
B630	20. 10. 62	42° 40. 2'S	170° 52. 5'E	TAL DCM B	79-81 81-82	Trawl and bag lost. Fine grey sandy mud	Mud	Sandy mud
B631	20. 10. 62	42° 40'S	170° 45. 6'E	DCM B	134 -133	Grey muddy sand	Fine sand	Muddy sand
B632	20. 10. 62	42° 40. 7'S	170° 43. 5'E	DCM B	289-146	Sticky grey mud	Mud	Mud
B633	20. -21. 10. 62	42° 00'S	170° 52'E	DCM B	183-184	Muddy fine grey sand	Fine sand	Muddy sand
B634	21. 10. 62.	41° 58. 8'S	171° 10. 1'E	DCM B	143	Fine grey sandy mud	Mud	Mud
B635	21. 10. 62	41° 59. 5'S	171° 15'E	DCM B	73-72	Fine grey muddy sand	Mud	Sandy mud
B636	21. 10. 62	41° 59. 5'S	171° 21'E	DCM B	31	Fine grey muddy sand	Fine sand	Muddy sand
B637	21. 10. 62.	41° 20'S	171° 00'E	DCM. B	137-135	Fine grey sandy mud.	Fine sand	Muddy sand
B638	21. 10. 62	41° 21. 5'S	171° 32. 5'E	DCM. B	137-135	Fine grey sandy mud	Fine sand	Muddy sand
B639	21. 10. 62	41° 20'S	171° 54. 2'E	DCM. B	71-72	Fine grey sandy mud	Mud	Mud
B640	21. 10. 62	41° 20'S	172° 03. 2'E	DCM. B	20	Broken shell and pebbles	Granule gravel	Gravel
B641	21. 10. 62	40° 40'S	172° 22. 6'E	DCM. B	19-17	Fine grey sand	Fine sand	Sand
B642	21. 10. 62	40° 40'S	172° 09'E	DCM. B	77-80	Mud gravel and shell	Granule gravel	Sandy gravel
B643	21. 10. 62	40° 39. 8'S	172° 00. 5'E	DCM. B	134	Fine grey sandy mud	Fine sand	Muddy sand
B644	22. 10. 62	40° 40'S	171° 42. 7'E	DCM. B	203	Fine grey muddy sand	Fine sand	Muddy sand
B645	22. 10. 62	40° 00'S	172° 34'E	DCM. B	187	Grey mud	Mud	Mud

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B646	22. 10. 62	40° 00'S	173° 00'E	TAL	117	Very fine green-grey sandy mud	Fine sand	Muddy sand
B647	22. 10. 62	40° 00'S	173° 23. 5'E	DCM. B	97	Soft grey sandy mud	Fine sand, mud	Sandy mud
B648	22. 10. 62	40° 00'S	173° 52'E	TAL	97	Sand, polyzoa and shell	Granule gravel	Muddy sand
B649	22. 10. 62	40° 01'S	174° 20. 5'E	DCM. B	66-68	Coarse polyzoa and shell	Granule gravel	Gravelly sand
B650	22. 10. 62	40° 00'S	174° 43'E	DCM. B	42-40	Coarse sand and shell	Fine sand	Sand
B651	22. 10. 62	40° 00. 5'S	174° 57'E	DCM. B	25-26	Shelly sand	Medium sand	Sand
B652	23. 10. 62.	39° 20'S	173° 44. 5'E	DCM. B	24-26	Encrusted rock	Granule gravel	Gravel
B653	23. 10. 62	39° 20'S	173° 42'E	DCM. B	30-76	Coarse pebbly sand and boulders	Granule gravel	Sandy gravel
B654	23. 10. 62	39° 20. 5'S	173° 18'E	DCM. B	127	Mud, and very little sand	Mud	Sandy mud
B655	23. 10. 62	39° 20'S	172° 27'E	DCM. B	188-189	Mud	Mud	Sandy mud
B656	24. 10. 62	38° 38'S	172° 45. 5'E	DCM. B	172-170	Failed to sample		
B657	24. 10. 62	38° 37'S	173° 07'E	DCM. B	155	Muddy fine grey sand	Fine sand	Muddy sand
B658	24. 10. 62	38° 39'S	173° 25'E	TAL	143-144	Polyzoa and shell	Very fine sand	Muddy sand
B659	24. 10. 62	38° 39. 5'S	173° 47. 5'E	DCM. B	124	Medium grey muddy sand	Fine sand	Muddy sand
B660	24. 10. 62	38° 40'S	174° 12'E	TAL	73-75	Sponge and shell	Very fine sand	Muddy sand
B661	24. 10. 62	38° 40'S	174° 36'E	DCM. B	22-21		Medium sand	Sand
B662	25. 10. 62	38° 06'S	174° 44. 7'E	DCM. B	15-14	Medium sand	Very fine sand	Sand
B663	25. 10. 62	38° 00'S	174° 48'E	DCM. B	22-21		Medium sand	Sand
B664	25. 10. 62	38° 00'S	174° 27. 5'E	TAL	75	Sponge and shell	Medium sand	Sand
B665	25. 10. 62	38° 00'S	174° 03. 4'E	TAL	131-123	Shell, no sediment		
B666	25. 10. 62	38° 00'S	173° 58. 2'E	TAL	187-166	Polyzoa and shell. Some bored rock fragments, no sediment.		
B667	25. 10. 62	37° 20'S	174° 40'E	DCM. B	22	Fine black sand	Very fine sand	Muddy sand
B668	25. 10. 62	37° 20'S	174° 23'E	TAL	77-75	Shell, no sediment.		
B669	25. 10. 62	37° 20'S	174° 09'E	TAL	132-128	Mud	Fine sand	Sand
B670	25. 10. 62	37° 20'S	174° 06. 5'E	TAL	198-161	Shell, no sediment		
B671	26. 10. 62	36° 40'S	174° 17'E	DCM. B	22-20	Fine black sand	Fine sand	Sand
B672	26. 10. 62	36° 40'S	174° 03. 3'E	TAL	76	Shell and crustacea, no sediment		
B673	26. 10. 62	36° 40'S	173° 56. 5'E	TAL	135-118	Mud	Fine sand	Muddy sand
B674	26. 10. 62	36° 40'S	173° 53'E	TAL	192-176	Shell and crustacea, no sediment.		
B675	26. 10. 62	36° 40'S	173° 50'E	TAL	284-282	Mud	Mud	Sandy mud
B676	26. 10. 62	37° 11'S	174° 30. 5'E	GLO	35	Fine grey sand	Fine sand	Muddy sand
B677	26. 10. 62	37° 30'S	174° 40'E	GLO	58	Fine grey sand	Very find sand	Sand
B678	26. 10. 62	37° 43. 5'S	174° 48'E	GLO	31	Fine grey sand	Very fine sand	Muddy sand
B679	26. 10. 62	37° 53'S	174° 45. 5'E	GLO	38	Fine grey sand	Very find sand	Muddy sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B680	27. 10. 62	39° 00'S	173° 12. 5'E	DCM. B	134	Mud	Mud	Mud
B681	27. 10. 62	39° 01'S	172° 53'E	DCM. B	134	Mud	Mud	Sandy mud
B682	27. 10. 62	39° 13'S	172° 50. 5'E	DCM. B	135	Grey sandy mud	Mud	Sandy mud
B683	28. 10. 62	40° 00'S	171° 15'E	TAL	691-697	Sponge, and mud	Mud	Mud
B684	28. 10. 62	40° 00'S	171° 41. 5'E	TAL	539-587	Soft, light grey mud	Mud	Mud
B685	28. 10. 62	40° 00'S	172° 08'E	TAL	307-304	Crustacea	Mud	Mud
B686	28. 10. 62	40° 16'S	172° 32. 3'E	TAL	127-126	Shell, no sediment		
B687	28. 10. 62	40° 33'S	173° 05. 4'E	TAL	59-60	Shell	Medium sand	Sand
B688	28. 10. 62	40° 35. 3'S	172° 44. 8'E	GLO	18	Soft grey mud	Mud	Mud
B689	29. 10. 62	40° 40. 2'S	172° 48. 8'E	TAL	30	Soft grey mud	Mud	Mud
B690	29. 10. 62	41° 00'S	173° 05. 1'E	TAL	25-27	Soft grey mud	Mud	Mud
B691	29. 10. 62	41° 00'S	173° 20. 5'E	TAL	42	Soft grey mud	Mud	Sandy mud
B692	30. 10. 62	40° 56. 2'S	173° 48. 8'E	LH	26	Large piece of polyzoa		
B693	30. 10. 62	41° 00'S	173° 49. 3'E	GHO	29	Soft grey mud	Mud	Mud
B694	30. 10. 62	41° 00. 7'S	173° 47. 3'E	GHO	21	Grey gritty shelly mud	Mud	Muddy sand
B695	30. 10. 62	41° 06. 4'S	173° 46. 8'E	GHO	20	Soft grey mud	Mud	Mud

N.Z.O.I. SUPPLEMENTARY STATIONS

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
A319	28. 1.57	44°37'S	167°52'E	DC PG	234		Mud	Sandy mud
A320	27. 1.57	44°38'S	167°54.5'E	DC PG	241		Mud	Muddy sand
A322	28. 1.57	44°40.2'S	167°55.2'E	DC PG	18		Mud	Mud
A323	28. 1.57	44°40'S	167°55.2'E	DC PG	108		Very coarse sand	Muddy sand
A326	28. 1.57	44°34.3'S	167°48.4'E	DC	117		Mud	Muddy sand
A327	28. 1.57	44°36'S	167°49.2'E	DC	113		Mud	Muddy sand
A437	3.10.58	41°08'S	174°22.2'E	PG	37	Muddy sand	Very fine sand	Muddy sand
A438	3.10.58	41°06.5'S	174°10.6'E	PG	37		Mud	Mud
A441	4.10.58	41°07.4'S	174°38.5'E	DC	214-229	Muddy shingle with concretions and lumps of mud	Granule gravel	Sandy gravel
A444a	5.10.58	41°23.1'S	174°31.8'E	DD	276	Sandy shingle		
A444c	5.10.58	41°20.8'S	174°31.6'E	DD	232-258			
A444g	5.10.58	41°16.5'S (approx.)	174°29.7'E	DD	256			
A444k	5.10.58	41°20'S (approx.)	174°28.6'E	DD	192			
A444p	5.10.58	41°20.3'S	174°30.6'E	DD	236-220			
A444r	5.10.58	41°23.5'S (approx.)	174°33.4'E	DD	273-210			
A445	5.10.58	41°07.9'S (approx.)	174°22.2'E	DC	11		Mud	Mud
A447a	7.10.58	41°20'S	174°02'E	DC	18-27	Sand and muddy sand	Very fine sand	Muddy sand

N.Z.O.I. SUPPLEMENTARY STATIONS

B1	25. 8.56	38°08.5'S	177°11.8'E	DC	15	Fine green sand	Very fine sand	Muddy sand
B2	25. 8.56	38°08.8'S	177°13'E	DC	17	Fine green sand	Very fine sand	Sand
B6	25. 8.56	38°09.9'S	177°21.7'E	DC	37	Sandy mud	Mud	Mud
B11	26. 8.56	38°18.4'S	177°38'E	DC	66	Fine sand, clayey mud	Mud	Mud
B14	27. 8.56	38°04.4'S	177°41.5'E	DC	20	Sloshy sand	Very fine sand	Muddy sand
B15	27. 8.56	38°08.8'S	177°46.6'E	DC	35	Fine green sand	Very fine sand	Muddy sand
B18	27. 8.56	38°18'S	177°48.2'E	DC	46	Sand	Very fine sand	Muddy sand
B37	2. 9.57	38°25.4'S	176°56.2'E	DC	17	Sand	Very fine sand	Muddy sand
B38	2. 9.57	38°22'S	177°02.3'E	DC	29	Fine sandy mud	Mud	Sandy mud
B39	2. 9.57	38°18.1'S	177°06.4'E	DC	40	Glutinous mud	Mud	Mud
B40	2. 9.57	38°16.2'S	177°11.8'E	DC	42	Fine glutinous greyish mud	Mud	Mud
B42	2. 9.57	38°15.4'S	177°03.0'E	DC	20	Shell, gravel and stones	Very fine sand	Muddy sand

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B43	3. 9. 57	39°32.2'S	176°55.8'E	DC	9	Fine sandy mud	Very fine sand	Muddy sand
B44	3. 9. 57	39°28.3'S	177°00.6'E	DC	23	Fine sandy mud	Very fine sand	Muddy sand
B45	3. 9. 57	39°27.1'S	177°06.2'E	DC	35	Fine sandy mud and mud (2 layers)	Mud	Mud
B46	3. 9. 57	39°23'S	177°10.8'E	DC	53	Fine grey sandy glutinous mud	Mud	Mud
B59	4. 9. 57	39°28.5'S	177°32.5'E	DC	121	Grey green glutinous mud	Mud	Mud
B60	4. 9. 57	39°31.9'S	177°27.6'E	DC	128	Grey green glutinous mud	Mud	Mud
B61	4. 9. 57	39°34.8'S	177°22.7'E	DC	121	Grey green glutinous mud	Mud	Mud
B62	4. 9. 57	39°37.5'S	177°17.3'E	DC	115	Grey green mud	Mud	Mud
B63	4. 9. 57	39°40.7'S	177°13'E	DC	99	Grey green mud	Mud	Mud
B66	22. 9. 58	34°00'S	172°30'E	DC TAM	55		Coarse sand	Gravelly sand
B215	20. 5. 60	46°50'S	168°31.5'E	DD GLO	32	Sandy shelly pebbly gravel	Granule gravel	Gravel
B216	20. 5. 60	46°50'S	168°23'E	DD GLO	22	Gravel, pebbles, dead shells	Granule gravel	Gravel
B219	21. 5. 60	[illegible]	168°09.8'E	DD GLO	38	Yellow, fairly coarse sand with muddier patches	Medium sand	Sand
B219	21. 5. 60	[illegible]	168°09.8'E	DD GLO	36	Shelly sand	Medium sand	Gravelly sand
B220	21. 5. 60	46°40'S	168°09.8'E	DD GLO	37	Shell Very small pebbles	Granule gravel	Sandy gravel
B221	21. 5. 60	46°40'S	168°16.8'E	DD GLO	31	Pebbly shelly sand Pebbly shelly sand	Medium sand	Gravelly sand
B222	21. 5. 60	46°40.3'S	168°24.2'E	DD GLO	27	Dead shells Coarse pebbly shelly sand	Granule gravel	Sandy gravel
B223	21. 5. 60	46°45'S	168°24.2'E	DD GLO	26	Dead shells Coarse, pebbly, shelly sand	Medium sand	Gravelly sand
B224	21. 5. 60	[illegible]	168°16.8'E	DD GLO	32	Dead and alive shells Muddy coarse shelly sand	Medium sand	Gravelly sand
B225	21. 5. 60	[illegible]	168°18'E	DD GL●	31	Dead Shells Muddy coarse shelly sand	Granule gravel	Gravel
B226	21. 5. 60	[illegible]	168°16.8'E	DD GLO	42	Dead shells Dead shells, coarse shelly sand	Medium sand	Sand
B228	22. 5. 60	[illegible]	168°02.5'E	DD GL●	36	Coarse shelly sand Coarse shelly sand	Medium sand	Sand
B229	22. 5. 60	[illegible]	167°55'E	DD GLO	28	Pebbly shelly coarse sand Pebbly shelly coarse sand	Medium sand	Gravelly sand
B230	22. 5. 60	[illegible]	168°02.5'E	DD GLO	26	Fine broken shelly sand	Medium sand	Sand
B232	23. 5. 60	46°54.8'S	168°09.5'E	DD GLO	9	Fine shelly sand Fine shelly sand	Medium and fine sand	Sand
B233	23. 5. 60	46°39.7'S	167°43'E	DD GLO	37	Rock Sand	Granule gravel	Gravel
B237	23. 5. 60	[illegible]	168°11'E	DD GLO	25	Dead shells Shelly sandy mud	Medium sand	Gravelly sand
B238	23. 5. 60	46°35.2'S	[illegible]	DD GL●	33	Shelly sandy mud Dead shells	Granule gravel	Gravelly sand
B243	25. 5. 60	46°56.6'S	168°03.3'E	GLO	21	Shelly sandy mud	Medium sand	Sandy gravel

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
B244	25. 5.60	46°58.9'S	168°06'E	GLO	19	Grey mud, khaki in upper layers	Mud	Sandy mud
B247	26. 5.60	46°30'S	168°02.5'E	DD GLO	36	Gravel and pebbles, shelly sand Gravel and pebbles	Granule gravel	Sandy gravel
B253	26. 5.60	46°40'S	168°31.4'E	DD GLO	17	Pebbles, no sand, dead shells Shelly pebbly sand, dead shells	Granule gravel	Sandy gravel
B264	27. 5.60	46°39.5'S	168°07'E	DD DC	17	Dead shells	Granule gravel	Sandy gravel
B264a	28. 5.60	46°42.5'S	168°19.4'E	DD GHC GLO	27		Medium sand	Gravelly sand
B267	29. 5.60	46°50'S	168°45.8'E	DD GLO	72	Dead and broken shell Pebbly, shelly sand	Granule gravel	Sandy gravel
B272	29. 5.60	46°44'S	168°31.4'E	DD GLO	21	No sample Sand, pebbles, and flattish rocks	Granule gravel	Sandy gravel
B290	12. 6.60	42°23'S	173°37.8'E	GLO	348	Grey mud		
B291	12. 6.60	42°28.2'S	173°38.7'E	GLO	402	Grey mud, softer than at 290, Darker patches in smelly (because of H_2S) subsurface		
B296	25. 6.60	41°17.25'S	174°51.4'E	DC	22		Mud	Mud
B308	24.10.60	39°39'S	172°14'E	GHC	282			
B309	24.10.60	39°39'S	172°24'E	GHC	245			
B313	25.10.60	39°23.5'S	171°37'E	DD	624			
B319	26-27.10.60	39°03.5'S	171°21.5'E	GHC	642	Grey mud with some sand		
B320	27.10.60	39°52.5'S	171°31.5'E	GHC	238	Fine grey mud, light brown surface		
B321	27.10.60	39°53'S	172°52'E	GHO	150	Grey mud, firmer than B320	Mud	Mud
B322	27.10.60	40°00'S	173°08'E	GHO	124	Grey mud	Mud	Sandy mud
N.Z.O.I. SUPPLEMENTARY STATIONS								
C43	6. 6.56	41°19.85'S	174°18.5'E	PG	91	Grit, sand, mud with shells and pebbles	Granule gravel	Gravelly sand
C44	6. 6.56	41°19.2'S	174°15.6'E	PG	91	Sand and mud with shells, pebbles		
C51	7. 6.56	41°15.7'S (approx.)	174°26.2'E	DC	238	Concretion. Pebbles and gravel		
C60	7. 6.56	41°23'S	174°25.5'E	DC	143	Large proportion pebbles but much sand and mud, many shells	Granule gravel and Medium sand	Gravelly sand
C90	7. 5.58	41°22.4'S	174°22.6'E	DC	124	Muddy shingle	Coarse sand	Sand
C99	8. 5.58	41°19.25'S	174°31.06'E	DC	172	Muddy shingle	Granule gravel	Sandy gravel
C101	8. 5.58	41°18.19'S	174°29.8'E	DC	210	Muddy shingle		
C107	16. 5.58	41°17.98'S	174°33.8'E	DC	166	Pebbles, shingle		
C118	16. 5.58	41°19.6'S	174°28.7'E	DC	172	Rounded stones, shingle, mud, sand and shell	Medium sand	Gravelly sand
C125	18. 5.58	41°17.28'S	174°28.8'E	DC	263	Shingle		

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C167	3. 9.59	39°40'S	172°00'E	DC Dietz TAS	273			
C168	3. 9.59	39°40'S	172°13'E	TAS	284			
C170	4. 9.59	39°40'S	172°39'E	TAS	199		Mud	Sandy mud
C171	4. 9.59	39°40'S	172°52.5'E	TAS	163		Mud	Mud
C172	4. 9.59	39°40'S	173°05'E	TAS	139		Mud	Mud
C174	4. 9.59	39°40'S	173°32'E	TAS	106		Mud	Mud
C177	5. 9.59	39°40'S	174°10'E	DC TAS	24		Fine sand	Sand
C179	5. 9.59	39°50'S	174°23'E	DC TAS	24		Muddy sand	Sand
C185	6. 9.59	39°50'S	173°18'E	TAS	115		Mud	Mud
C186	7. 9.59	40°40'S	173°03'E	TAS	37		Fine sand	Muddy sand
C187	7. 9.59	40°50'S	173°03'E	GLO	29		Mud	Mud
C188	7. 9.59	40°50'S	173°16.5'E	GLO	44		Fine sand	Mud
C189	7. 9.59	40°40'S	173°16.5'E	GLO	53		Mud	Mud
C200	11. 9.59	41°00'S	174°29'E	DC	170	Grey brown gravel, fine sand	Fine sand	Muddy sand
C218	13. 9.59	41°08.3'S	174°14'E	GLO	46	Fine grey mud	Mud	Mud
C220	14. 9.59	41°09.1'S	174°13.2'E	GLO	53	Grey silty mud, a few shell fragments	Mud	Mud
C228	15. 9.59	41°19'S	174°10'E	GLO	15	Sandy mud, shells	Mud	Mud
C229	15. 9.59	41°22.5'S	174°07.7'E	DC	29	Grey clean silty sand.		
C241	7.10.59	41°37.5'S	175°24.8'E	Dietz	174	Grey mud	Mud	Mud
C259	20.10.59	41°06.45'S	174°16.5'E	PG	18	Sandy mud		
C272	22.10.59	38°20.3'S	174°11.8'E	PG	91	Dead shells, pebbles	Fine sand	Muddy sand
C275	22.10.59	38°20'S	173°43.67'E	PG	137	Loosely compacted, sandy mud. Iron sand	Mud	Sandy mud
C290	23.10.59	38°00'S	174°25'E	PG	60	Mud, sand, ironsand, ground up shell	Fine sand	Sand
C295	24.10.59	36°39.8'S	174°17.5'E	PG	22	Ironsand, small shells	Fine sand	Sand
C309	25.10.59	37°00'S	174°26.2'E	PG	22	Ironsand and grey sand	Fine sand	Sand
C316	25.10.59	37°00'S	174°09'E	PG	112	Silty mud and ironsand, dead shells	Mud	Sandy mud
C329	25.10.59	37°20'S	174°05.5'E	PG	327	Grey gritty ooze	Mud	Sandy mud
C334	26.10.59	37°40'S	174°39.5'E	PG	49	Muddy golden ironsand, live and dead shells	Fine sand	Muddy sand
C344	26.10.59	37°57.3'S	174°34'E	DD	55			
C383	30. 4.60	41°25.9'S	174°37'E	DC	150	Fine, muddy sand and large rounded pebbles; shells concretions, mud pebbles		
C399	3. 5.60	41°35'S	174°45.7'E	DC	468	Grey blue mud		

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C401	4. 5.60	41°41.5'S	174°50.2'E	DC	183	Bluish mud		
C403	4. 5.60	41°36'S	174°44'E	DC	549	Two layers 1. Yellow brown sandy mud 2. Black shelly sandy mud		
C411	4. 5.60	41°34.5'S	174°32'E	DC	160	Slightly shelly muddy sand		
C415	5. 5.60	41°16'S	174°52'E	GLO	22	Mud		
C416	6. 5.60	39°20'S	173°44.5'E	GHO	37	Rock pieces, boulders		
C421	6. 5.60	39°20'S	173°37'E	GHO	108	Grey sandy mud	Mud	Mud
C423	6. 5.60	39°20'S	173°32'E	GHO	108	Grey sandy mud, shells	Mud	Mud
C425	6. 5.60	39°20'S	173°28'E	GHO	113	Grey sandy mud, shells	Mud	Mud
C430	6. 5.60	39°20'S	172°55'E	GHO	130	Soft grey sandy mud, dead broken shell		
C433	7. 5.60	39°40'S	173°43.5'E	GHO	68	Grey sandy mud, shells	Very fine sand	Muddy sand
C435	7. 5.60	39°40'S	173°18'E	GHO	104	Soft grey sandy mud, dead shells	Mud	Mud
C456	8. 5.60	39°40'S	174°10.5'E	GHO	28	Coarse grey and ironsand shells	Medium sand	Sand
C462	8. 5.60	39°40'S	173°54.5'E	GHO	48	Grey sand and ironsand, shells	Fine sand	Sand
C463	9. 5.60	40°45'S	173°00'E	GHO	33	Sticky grey shelly sandy mud, shells		
C464	9. 5.60	40°45'S	172°52'E	GHO	26	Sticky grey sandy mud, shells		
C465	9. 5.60	40°49'S	172°52'E	GHO	9	Sticky grey sandy mud, shells	Mud	Mud
C466	9. 5.60	40°45'S	172°45.5'E	GHO	11	Sticky grey sandy mud, shells	Mud	Sandy mud
C467	9. 5.60	40°39'S	172°45.5'E	GHO	15	Sticky shelly soft mud	Mud	Mud
C468	9. 5.60	40°39'S	172°45.5'E	GHO	15	Sticky grey mud, shells	Mud	Mud
C469	9. 5.60	40°40'S	172°52'E	GHO	29	Soft grey sticky mud, dead shells	Mud	Mud
C470	9. 5.60	40°40'S	172°59'E	GHO	33	Soft grey sandy mud, dead shells	Mud	Mud
C471	9. 5.60	40°37.5'S	172°59'E	GHO	33	Soft grey sandy mud, top layer with lumps of compacted mud	Mud	Mud
C472	9. 5.60	40°37.5'S	172°52'E	GHO	26	Soft grey sticky sandy mud, dead shells	Mud	Mud
C473	9. 5.60	40°37.5'S	172°45'E	GHO	22	Soft grey sticky sandy mud, dead shells	Mud	Mud
C474	9. 5.60	40°37'S	172°44.5'E	GHO	17	Soft grey sandy mud, dead shells	Mud	Mud
C476	10. 5.60	41°00'S	173°04.6'E	GHO	20	Soft grey mud, slightly sticky, dead shells	Mud	Mud
C477	10. 5.60	41°10'S	173°04.6'E	GHO	11	Soft grey mud with some browny river mud, dead shells	Mud	Mud
C478	10. 5.60	41°10'S	173°11.4'E	GHO	15	Soft grey, sandy mud, stones, shells	Mud	Sandy mud
C479	10. 5.60	41°13.5'S	173°14.4'E	GHO	9	Soft grey mud, less sand than C478, shell	Mud	Mud
C480	10. 5.60	41°10'S	173°17.7'E	GHO	20	Harder, compact grey mud, very little sand, large amount dead shell	Mud	Mud
C481	10. 5.60	41°00'S	173°17.7'E	GHO	40	Soft grey mud, some compact mud, dead shell	Mud	Mud
C482	10. 5.60	41°00'S	173°31'E	GHO	46	Compacted grey shelly mud, dead shell		

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C483	10. 5.60	40°50'S	173°31'E	GHO	53	Compacted grey mud, dead shell	Mud	Mud
C488	17. 5.60	41°37'S	175°39.2'E	DD	459	Sandy mud		
C493	17. 5.60	41°33'S	175°46'E	GHO	914	Mud		
C502	19. 6.60	41°22.9'S	175°51.2'E	DC	37	Muddy pebbly grit		
C505	19. 6.60	41°15.3'S	176°11.6'E	GHO	521	Mud		
C591	5.11.60	41°45.5'S	174°46'E	DC	108	Broken shells in quantity	Mud	Sandy mud
C593	8.11.60	43°30'S	178°00'E	GHO	351	Grey sand and ooze		
C601	24. 4.61	44°18'S	176°16'E	DD GHO	144	1 Sack rocks		
C602	24. 4.61	43°13.2'S	176°40.3'E	DD	287			
C605	26. 4.61	43°40'S	179°30'E	DD	441-461			
C607	27. 4.61	43°48'S	179°00'W	DD	431-421			
C608	27. 4.61	43°19'S	179°00'W	DD	465-450			
C619	2. 5.61	43°52'S	174°48'W	DD	802-777			
C637	28. 5.61	39°02'S	172°06'E	DD	945			
C652	14. 6.61	42°46.6'S	173°27.2'E	GLO	54			
C654	14. 6.61	42°49.4'S	173°35.4'E	GLO	124	Muddy shelly sand	Granule gravel	Sand
C656	14. 6.61	42°49.5'S	173°43.8'E	DC	582	Grey mud		
C657	14. 6.61	42°42.5'S	173°45.5'E	DC	999	Sloppy grey mud		
C658	14. 6.61	42°40'S	173°43'E	DC	622	Sloppy mud with harder lumps and pieces of bored "rock"	Mud	Sandy mud
C664	15. 6.61	42°46'S	173°31.5'E	GLO	284	Mud with fragmented shell and ? glauconitic grains		
C665	15. 6.61	42°46.4'S	173°33.6'E	GLO	205	Stiff grey mud with shell fragments	Mud	Mud
C666	15. 6.61	42°46.5'S	173°35.7'E	GHO	239	Mud and shell fragments		Sand
C669	15. 6.61	42°37.6'S	173°34'E	GHO	503	Sloppy mud		
C671	16. 6.61	42°41'S	173°30'E	GHO	28	Muddy shelly sand with rolled fragments of fine sandstone	Fine sand	Muddy sand
C677	16. 6.61	42°43.6'S	173°37.5'E	DC	245	Sloppy brownish mud with lumps of harder material and concretions		
C678	16. 6.61	42°43.3'S	173°38.2'E	GLO	124	Shelly sandy mud with slabs of bored rock and pebbles	Medium sand	Sand
C680	16. 6.61	42°41'S	173°40'E	GLO	235	Uniform stiff grey mud with some sloppy mud on surface		
C686	17. 6.61	42°32.5'S	173°45.1'E	DD	820	Grey green indurated siltstone with weathered and bored surface and also stiff grey mud		
C692	18. 6.61	42°31.2'S	173°38.7'E	DD	549	Dark grey slabby mudstone with black, well rounded pebbles		
C693	18. 6.61	42°32.2'S	173°40.4'E	DD	878	Fairly stiff grey mud	Mud	Mud

Station No.	Date	Latitude	Longitude	Gear	Sampled Depth Metres	Shipboard Description	Dominant Grain Size	Wentworth Class
C694	18. 6.61	42°33.6'S	173°41'E	DD	732	Grey semi-indurated mud and sloppy mud.		
C697	19. 6.61	42°34.5'S	173°33'E	DD	110	Black foetid clayey mud		
C703	19. 6.61	42°42'S	173°37.3'E	DD	184	Large boulders and blocks of bored and encrusted rock. Black pebbles and cobbles, stiff, grey, semi-indurated mud	Granule gravel and mud	Gravel

N.Z.O.I. SUPPLEMENTARY STATIONS

Station No.	Latitude	Longitude	Sampled Depth Metres	Gear	Shipboard Description	Wentworth Class	Dominant Grain Size
A444 (n)	41°19.2'S to 41°20.65'S	174°30.8'E to 174°31.15'E	--	DD			
A444 (o)	41°19.55'S to 41°19.95'S	174°31.65'E to 174°31.45'E	--	DD			
B196	46°20.6'S to 46°19.8'S	170°27.6'E to 170°28.2'E	135	DN	Bryozoa, shell and shelly sand		
B197	46°14.1'S to 46°13.5'S	170°32'E to 170°32.5'E	110	DN	Bryozoa, shell and shelly sand		
B205	41°27.5'S	174°53.5'E	82	DC	Shelly, pebbly sand	Gravelly sand	Fine sand
B241	47°00'S	168°16.8'E	53	GLO DD	Fine sand and broken shell	Sand	Fine sand
B245	47°00'S	167°48'E	49	GLO DD	Pebbly gravel	Sandy gravel	Granule gravel
B246	46°30'S	167°55.4'E	49	GLO DD	Shell and bryozoa		
B248	46°25'S	168°02.5'E	17	GLO DD	Pebbly sand	Sandy gravel	Granule gravel
B249	46°25'S	167°55.4'E	18	GLO	Small boulders and encrusting fauna		
B251	46°25'S	168°10'E	15	GLO DD	Pebbly shelly sand	Sandy gravel	Granule gravel
B254	46°37'S	168°32.2'E	14	GLO DD	Shelly sand	Gravelly sand	Granule gravel
B260	46°45.4'S	168°39'E	25	GLO DD	Rock fragments and encrusting fauna		
B261	46°50'S	168°38.3'E	53	GLO DD	Sand	Sand	Fine sand
B263	46°55'S	168°24'E	53	GLO DD	Shelly sand	Sand	Fine sand
B278	46°55'S	168°38.5'E	80	GLO DD	Shelly sand	Sand	Fine sand
B509	43°39.2'S	168°02.6'E	33	CUW			
B515	43°27'S	175°03'E	146	DCM DC	Shelly sand		

N.Z.O.I. SUPPLEMENTARY STATIONS

C184	39°50'S	173°31'E	95	TAS	Grey mud	Sandy mud	Mud
C224	41°22.4'S	174°24'E	146	TAS	Shell gravel		
C321	37°30'S	174°34'E	24	GP	Shelly sand	Muddy sand	Fine sand
C330	38°54'S	174°21.5'E	37	GP DD	Muddy sand	Sand	Very fine sand
C598	37°00.5'S	175°19'E	17		By hand, scraping from cable.		
C605	43°40'S	179°30'E	441-461	DD			

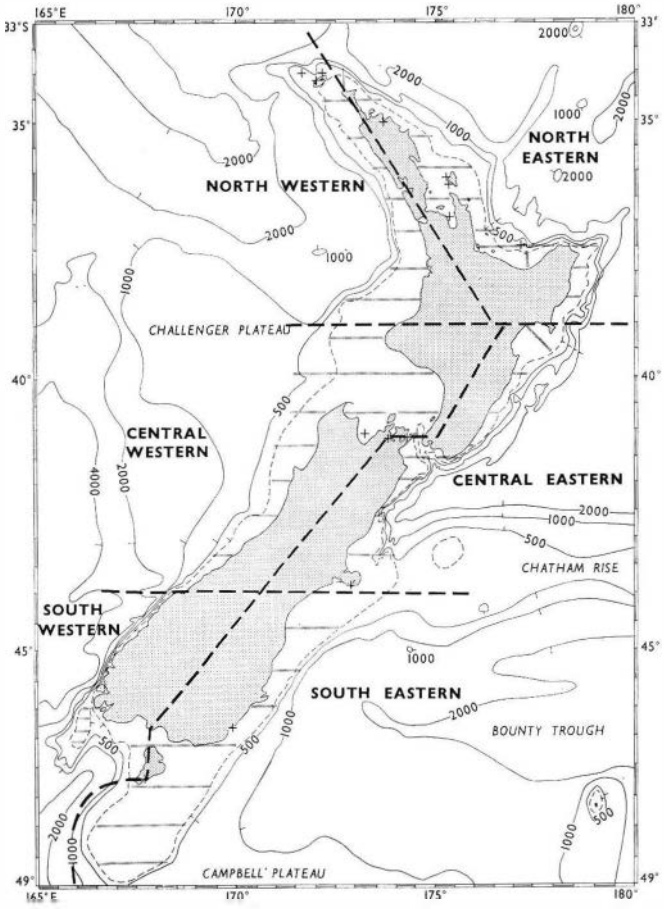
Station No.	Latitude	Longitude	Sampled Depth Metres	Gear	Shipboard Description	Wentworth Class	Dominant Grain Size
C606	44°15.2'S	178°35.4'E	985-1,000	DD			
C608	43°03'S	178°58'W	537-568	DD			
C623	44°25.5'S	175°16'W	388-697	DD			
C624	43°57'S	175°52'W	124	DD			
C640	39°17'S	171°53'E	364	DD	Shell		
C672	42°43.6'S	173°30.6'E	64	DR	Bored boulders		
C693	42°28.1'S	173°40.1'E	88	DD	Fragments of grey indurated siltstone		
C693	42°32.2'S	173°40.4'E	878	DD	Stiff grey mud		
C706	42°26.3'S	173°45.6'E	104	DD	Rocks, mud and sand		
C707	42°50'S	173°27.7'E	64	DD	Pebbly shelly muddy sand	Muddy sand	Mud
Z1179	Cook Strait		77	CUW			
Z1180	Cook Strait		137	CUW			
Z1191	Cook Strait		156	CUW			
Z1195	Cook Strait		119	CUW			
Z1202	Cook Strait		170	CUW			

The Echinoidea

INTRODUCTION

Comments on Material

At the time of writing, 28 species of Echinoidea, comprising 20 genera and 13 families, are known from the New Zealand continental shelf. Only 13 species were collected during the survey, and those not collected are all known from five or fewer occurrences within the New Zealand region. Several of these species inhabit the intertidal zone or adjacent shallow seas, which were not sampled during the survey, and the rest seem to be of rare occurrence. Echinoidea were collected at 131 survey stations, and evidence of many other occurrences was found in other collections in the New Zealand Oceanographic Institute and in the literature, although the search of the latter cannot be claimed to be exhaustive.



Some caution must be expressed as to the significance of the distributions to be described. While 331 stations were occupied during the survey, and data from these have been considerably augmented by other collections and reports, data are in fact sparse for most species. For one species—*Echinocardium cordatum*—sediment data are sufficient to allow analysis of its distribution with respect to the proportions of the various sediment grades present. The need for further sampling and publication of relevant data is obvious.

Identifications were made by the author using published descriptions of species and comparative material in the reference collections of the New Zealand Oceanographic Institute. Identified species were checked by Professor H. B. Fell and Dr D. L. Pawson, Victoria University of Wellington, who named all the material in the reference collections used. All material collected during the survey is deposited in the New Zealand Oceanographic Institute.

Records of the occurrence of each species are listed under two headings—shelf occurrence and archibenthal occurrence. Archibenthal records, as defined here, are all those records from depths greater than that of the edge of the continental shelf (130 m). No division into "slope" or "abyssal" groupings has been made.

Where tables give the percentage distribution of a species in various categories, percentages are approximate only. In several instances, a sample is included in more than one category, and in others the data are insufficient to assign any category. It is not possible to show the position of every record of each species on the distribution maps because in a few cases several stations are closely grouped, and some of the records in the literature are imprecisely located.

FIG. 2. Positions of the six geographic areas (boundaries marked by heavy broken lines) mentioned in the text. A cross indicates the location of additional samplings.

Station Prefixes

Within each section, New Zealand Oceanographic Institute stations are listed first, in alphabetical and numerical sequence, followed by reports from the literature, usually with the northernmost ones first. The following station prefixes denote the various collections:

Station Prefix	Collection
A	N.Z. Oceanographic Institute
B	N.Z. Oceanographic Institute
C	N.Z. Oceanographic Institute
Z	N.Z. Oceanographic Institute
Ch	HMS *Challenger* 1874 (Hamilton 1896)
CIE	Chatham Islands 1954 Expedition (Knox 1957, Fell 1960)
DMBS	Dominion Museum Wellington (Dell 1951, Fell 1958)
AL	*Alert* stations (Fell 1952)
K	*Kotuku* Expedition (Fell 1958)
NGH	*New Golden Hind* Expedition (Fell 1952)
NP	*Northern Prawn* Expedition (Fell 1958)
VUZ	Victoria University of Wellington, Zoology Department (Fell 1958)
NZGT	New Zealand Government Trawling Expedition (Benham 1909)
TN	British Antarctic (*Terra Nova*) Expedition 1910–1914 (Bell 1917)
P	Auckland and Manukau Harbours (Powell 1936)

A further miscellaneous group of stations, including those of samples taken by Mortensen's Pacific expedition, are not given prefixes.

Zonation of Shelf and Archibenthal Regions

For convenience in discussion the New Zealand shelf and the adjacent archibenthal zone are divided into six areas. The latitudes 39° S and 44° S separate the northern, central, and southern areas. Within each area, eastern and western areas are identified, with the intervening land as the boundary; southward from Stewart Island this division follows the 166° E meridian (Fig. 2). Similarly, for bathymetric distribution five depth zones are recognised: zone 1, 0–20 m; zone 2, 21–50 m; zone 3, 51–90 m; zone 4, 91 m to the shelf edge; zone 5, the archibenthal region. These divisions, both geographic and bathymetric, are purely arbitrary and erected only to avoid cumbersome descriptions in the distributional summaries.

CHECKLIST OF THE NEW ZEALAND ECHINOIDEA

This list contains all species known to the author from the New Zealand shelf, the offshore islands including Macquarie Island but not the Kermadec group, and the surrounding archibenthal zone which includes the Campbell Plateau, the Chatham Rise, and the Challenger Plateau† down to 2,000 m, i.e. the New Zealand Plateau.

The classification of the higher categories of the Echinoidea is still fluid. Durham and Melville (1957) proposed a classification differing considerably from that of Mortensen (1928–51). More recently, Philip (1965) has proposed another system closer to Mortensen's classification. The system adopted below does not rigidly follow either of these two recent classifications.‡

An asterisk denotes genera and species not recorded from the New Zealand shelf.

†The shallower New Zealand extension of Lord Howe Rise, tending north-westward from Cape Farewell.

‡A new classification which is likely to have general acceptance is proposed in the echinoderm volume of "Treatise on Invertebrate Paleontology" (Moore, 1966).

Class **ECHINOIDEA**

Subclass **REGULARIA**

Order **CIDAROIDA**

Family CIDARIDAE

*Genus Austrocidaris H. L. Clark 1907
**Austrocidaris* sp. Pawson 1968

Genus Goniocidaris L. Agassiz and Desor 1846
Subgenus Goniocidaris Mortensen 1928
Goniocidaris umbraculum (Hutton 1872)
Goniocidaris magi Pawson 1964b

*Subgenus Aspidocidaris Mortensen 1928
**Goniocidaris parasol* Fell 1958

Genus Ogmocidaris Mortensen 1921
Ogmocidaris benhami Mortensen 1921

Order **LEPIDOCENTROIDA**

Suborder **ECHINOTHURIINA**

Family ECHINOTHURIIDAE

Subfamily PHORMOSOMINAE

Genus Phormosoma Wyville Thomson 1872
**Phormosoma bursarium* A. Agassiz 1881
**Phormosoma rigidum* A. Agassiz 1881
**"Phormosoma zelandiae"* A. Agassiz 1881

Subfamily ASTHENOSOMINAE
Genus ARAEOSOMA Mortensen 1903
Araeosoma thetidis (H. L. Clark 1909)

Order **HEMICIDAROIDA**
Family SALENIIDAE
Genus SALENOCIDARIS A. Agassiz 1869
Salenocidaris hastigera (A. Agassiz 1879)

Order **ARBACIOIDA**
Family ARBACIIDAE
Genus COELOPLEURUS L. Agassiz 1840
Coelopleurus sp. Pawson 1965

Order **DIADEMATOIDA**
Suborder **DIADEMINA**
Family DIADEMATIDAE
Genus CENTROSTEPHANUS Peters 1855
Centrostephanus rodgersii (A. Agassiz 1863)

Suborder **PEDININA**
Family PEDINIDAE
*Genus CAENOPEDINA
**Caenopedina novaezelandiae* Pawson 1964a

Order **TEMNOPLEUROIDA**
Family TEMNOPLEURIDAE
Genus TEMNOPLEURUS L. Agassiz 1841
*"*Temnopleurus reynaudi*" A. Agassiz 1881
Genus AMBLYPNEUSTES L. Agassiz 1841
Amblypneustes pachistus H. L. Clark 1912
Genus HOLOPNEUSTES L. Agassiz 1841
Holopneustes inflatus Lutken 1872
Genus PSEUDECHINUS Mortensen 1903
Pseudechinus albocinctus (Hutton 1872)
Pseudechinus flemingi Fell 1958
Pseudechinus huttoni Benham 1908
**Pseudechinus grossularia* (Studer 1880)
Pseudechinus novaezealandiae (Mortensen 1921)
Pseudechinus sp.
Pseudechinus variegatus Mortensen 1921

Order **ECHINOIDA**
Family ECHINIDAE
*Genus GRACILECHINUS Fell and Pawson, in Moore 1966
**Gracilechinus multidentatus* (H. L. Clark 1925)
Family ECHINOMETRIDAE
Genus EVECHINUS Verrill 1871
Evechinus chloroticus (Valenciennes 1846)
Genus HELIOCIDARIS L. Agassiz and Desor 1846
Heliocidaris tuberculatus (Lamarck 1816)

Subclass **IRREGULARIA**

Order **CLYPEASTROIDA**
Suborder **CLYPEASTRINA**
Family CLYPEASTRIDAE
Genus CLYPEASTER Lamarck 1801
Clypeaster australasiae (Gray 1851)
Clypeaster virescens Doderlein 1885
Family ARACHNOIDIDAE
Genus FELLASTER Durnham 1955
Fellaster zelandiae (Gray 1855)

Suborder **LAGANINA**
Family LAGANIDAE
Genus PERONELLA Gray 1855
Peronella hinemoae Mortensen 1921
Genus LAGANUM Klein 1734
Laganum depressum Lesson 1841
Family FIBULARIIDAE
Genus ECHINOCYAMUS van Phelsum 1774
Echinocyamus polyporus Mortensen 1921

Order **CASSIDULOIDA**
Suborder **CASSIDULINA**
Family APATOPYGIDAE
Genus APATOPYGUS Hawkins 1920
Apatopygus recens (Milne-Edwards 1836)

Order **SPATANGOIDA**
Family SPATANGIDAE
Genus SPATANGUS Gray 1825
Spatangus beryl Fell 1963a
Spatangus multispinus Mortensen 1925
Spatangus thor Fell 1963
**Spatangus mathesoni* McKnight 1968
Genus PARAMARETIA Mortensen 1950
**Paramaretia multituberculata* Mortensen 1950
Paramaretia peloria (H. L. Clark 1916)
Family LOVENIIDAE
Genus ECHINOCARDIUM Gray 1825
Echinocardium cordatum (Pennant 1777)
Family SCHIZASTERIDAE
Genus BRISASTER Gray 1855
**Brisaster* n. sp. Pawson 1968
Family BRISSIDAE
Genus BRISSOPSIS L. Agassiz 1840
Brissopsis oldhami Alcock 1893
*Genus CYCLASTER Cotteau 1856
**Cyclaster* sp. Fell
Genus GYMNOPATAGUS Doderlein 1901
**Gymnopatagus magnus* A. Agassiz and H. L. Clark 1907
Genus BRISSUS Gray 1825
Brissus gigas Fell 1947

KEY TO THE NEW ZEALAND ECHINOIDEA

For an explanation of technical terms refer to a suitable text, such as Cuenot (1948) or Hyman (1955).

1 (48) Periproct within apical system, body spherical or hemispherical, rigid, or soft and flexible, and often flattened.

2 (11) Ambulacral and interradial series of plates continuing over peristome to mouth. Spines large and strong. Ambulacral plates simple.

3 (8) Primary radioles coarse or coarsely thorny, basal spurs often present. Adapical primaries with distal discs or crowns.

4 (5) Adapical primaries with small distal crown only. 1 internal tubercule below and median to marginal tubercule. Ambulacra weakly sinuate, almost straight, *ca.* 25% of interambulacra
Goniocidaris magi Pawson

5 (4) Adapical primaries with umbrella-like distal discs.

6 (7) Primary radioles lacking basal disc. 1–2 internal tubercules below marginal tubercule. Ambulacra almost straight, *ca.* 30% of interambulacra
Goniocidaris umbraculum (Hutton)

7 (6) Primary radioles with more or less developed basal disc. 2–3 internal tubercules in roughly vertical linear series. Ambulacra weakly sinuate, *ca.* 16% of interambulacra .. **Goniocidaris parasol** Fell

8 (3) Primary radioles tapering, slender, and cylindrical.

9 (10) Primary radioles fairly smooth with conspicuous milled ring. 1 internal tubercule median to and above marginal tubercule. Sunken median furrow in ambulacra and interambulacra
Austrocidaris sp. Pawson

10 (9) Primary radioles with small thorns, milled ring inconspicuous. Adapical discs developed in mature specimens. 1 prominent internal tubercule within and below marginal tubercule as well as 2–3 small miliary tubercules. Narrow conspicuous zig-zag furrow running down each interambulacrum and conspicuous wavy vertical groove on ambital and subambital part of ambulacra
Ogmocidaris benhami Mortensen

11 (2) Only ambulacral plates on peristome. Ambulacral plates compound.

12 (17) Test soft, leathery, and flexible, usually flattened on capture. Peristome usually covered by ambulacral plates.

13 (16) Primary spines of oral side club-shaped and skin-clad, areoles large and deep, and oral side appearing "honeycombed." Aboral areoles small and inconspicuous. Edge of test sharp.

14 (15) Pores and tube feet on aboral side partly rudimentary, and only a single line of tube-feet evident aborally .. ..**Phormosoma rigidum** A. Agassiz

15 (14) Pores and tube-feet of oval side well developed in distinct arcs of three
Phormosoma bursarium A. Agassiz

16 (13) Oral primary spines terminating in a flared hoof, not skin-clad nor club-shaped, areoles not large or deep, oral and aboral sides more or less similar. Test edge rounded
Araeosoma thetidis (H. L. Clark)

17 (12) Test spherical or hemispherical, rigid. Only a single pair of plates (buccal plates) from each ambulacrum on peristome.

18 (19) Spines long and hollow, deep purple to nearly black. Test large, robust, and flattened, pale cream
Centrostephanus rodgersii (A. Agassiz)

19 (18) Not as above.

20 (21) Ambulacral plates with 7–10 pore pairs arranged in an arc. Test strong and low, bright reddish brown. Spines with a green tip
Heliocidaris tuberculatus (Lamarck)

21 (20) Ambulacral plates with 3 pore-pairs.

22 (23) Ambulacra broad with numerous pores forming three vertical and horizontal rows. Test large and robust, test and spines bright green
Evechinus chloroticus (Valenciennes)

23 (22) Ambulacra narrow with 1 vertical row of pores.

24 (25) Only every second or third ambulacral plate with primary tubercule. Test thin and fragile, deep purple, ambulacra sunken and buff. Spines short and bristly, pink .. **Holopneustes inflatus** Lutken

25 (24) All ambulacral plates with primary tubercule.

26 (27) Primary ambulacral tubercules regularly arranged below ambitus, but occur in two sizes above with larger on every second or third plate only. Test large and robust, straw-coloured or pale pink. Spines long and tapering, pink with darker tips
Gracilechinus multidentatus H. L. Clark

27 (26) Not as above.

28 (29) Primary spines triangular in cross-section
Coelopleurus sp. Pawson

29 (28) Primary spines not so.

30 (33) Areoles of primary tubercules large and confluent.

31 (32) Secondary radioles flattened. White with light violet dots, and violet striae on the spines (dried)
Salenocidaris hastigera (A. Agassiz)

32 (31) Secondary radioles not flattened. Spines green basally with white, green, and reddish brown bands. Test flattened somewhat, white, with green apically and periproct grey
Caenopedina novaezealandiae Pawson

33 (30) Areoles of primary tubercules not large and confluent.

34 (35) Buccal plates small. Spines dark olive, sometimes white-tipped. Test spheroidal
Amblypneustes pachistus H. L. Clark

35 (36) Buccal plates well developed, usually bearing numerous pedicellariae.

36 (41) Larger secondary tubercules in distinct transverse series on middle of interambulacral plates.

37 (38) Up to 9 tubercules in ambital interambulacral horizontal series. Test high, hemispherical, pink and/or straw-coloured. Spines reddish, or sometimes green or white .. **Pseudechinus huttoni** Benham

38 (37) Only 2–3 tubercules in horizontal interambulacral series.

39 (40) Test high, almost globular, primary tubercules reddish orange, test white with a few greenish streaks round subambital primary tubercules. Spines red basally, then intensely green, and white distally .. .. **Pseudechinus grossularia** (Studer)

40 (39) Test hemispherical, white or cream below ambitus and in vertical streaks above, mingling with brown or green streaks. Primary tubercules whitish, pink, brown, or green .. .. **Pseudechinus** sp.

41 (36) No transverse series of tubercules on interambulacral plates.

42 (45) Test green, or white with greenish spots.

43 (44) Test and spines dull green or grey-green. Spines short and rather coarse
Pseudechinus novaezealandiae (Mortensen)

44 (43) Test white with green or grey-green spots. Spines with red-brown band
Pseudechinus variegatus Mortensen

45 (42) Test and spines pink or red.

46 (47) Test bright red, spines similar or salmon with white tips, normally 20–30 mm long, dense and obscuring test .. .. **Pseudechinus flemingi** Fell

47 (46) Test pink, spines pink to red-brown, white-tipped, usually less than 12 mm long, and not obscuring test. General colouration duller than preceding species .. .. **Pseudechinus albocinctus** (Hutton)

48 (1) Periproct outside apical system in posterior interambulacrum. Body depressed, thin, and disc-like, or inflated and ovoid or heart-shaped.

49 (58) Test flattened, thin, and disc-like, sometimes conical adapically.

50 (51) Anus above, near posterior margin of test. Ambulacral furrows distinct, continuing on to apical system. Tubercules and pores in regular oblique series, orally and aborally
Fellaster zelandiae (Gray)

51 (50) Anus below, ambulacral furrows indistinct. Tubercules and pores not in regular oblique series.

52 (55) Plates of petals alternating primaries and demiplates. Anus near posterior margin of test. Aboral miliary spines simply serrate.

53 (54) 6–9 tubercules on each transverse costa between pore-pairs of petals, tubercules of distal costae in double series, others in single series. Outline ovoid or sub-pentagonal .. **Clypeaster australasiae** (Gray)

54 (53) Costae between pore-pairs of petals with 4 or fewer tubercules in a single row. Outline ovoid, rarely pentagonal .. .. **Clypeaster virescens** Doderlein

55 (52) Plates of petals, all primaries, anus near mouth. Aboral miliary spines with terminal crown or terminal glandular bag.

56 (57) Madreporic pores scattered over apical system and individually visible. Outline more or less circular
Peronella hinemoae Mortensen

57 (56) Madreporic pores collected into sunken lines, not individually visible. Outline elliptical
Laganum depressum Lesson

58 (49) Test inflated, ovoid or heart-shaped.

59 (66) All ambulacra flush with surface of test.

60 (61) Anus above in elongate depression, oval side concave, outline ovoid, wider posteriorly. Brownish
Apatopygus recens (Milne-Edwards)

61 (60) Anus below, behind mouth.

62 (63) Small, ovoid, grey or white. Ambulacra short and broad, not reaching edge of test.
Echinocyamus polyporus Mortensen

63 (62) Large broadly oval forms with faint frontal depression.

64 (65) Numerous (30–85) large primary tubercules in posterior unpaired interambulacrum. Brown to deep reddish purple
Paramaretia multituberculata Mortensen

65 (64) Very few (1–2) large primary tubercules in posterior unpaired interambulacrum. Greyish fawn to brown .. .. **Paramaretia peloria** (H. L. Clark)

66 (59) One or more ambulacra in a groove.

67 (70) Outline ovoid, anterior ambulacrum not lying in a conspicuous groove which notches anterior test margin.

68 (69) Other ambulacra in deep grooves. Large, inflated, broadly ovate, and truncated posteriorly
Brissus gigas Fell

69 (68) Other ambulacra in grooves but not deeply sunken. Test of small to medium size, low, arched, highest posteriorly, and truncate posteriorly. Outline rounded-oval .. .. .. **Cyclaster** sp. Fell

70 (67) Interior ambulacrum lying in groove which notches anterior test margin. Outline more or less heart-shaped.

71 (80) Other ambulacra flush with surface of test.

72 (79) Only subanal fasciole present. Frontal notch conspicuous.

73 (74) Numerous tubercules in all interambulacra of upper surface. Periproct on truncated posterior test margin, not visible from above or below. Subanal fasciole ovoid. Violet
Spatangus multispinus Mortensen

74 (73) Few or no tubercules in interambulacra of upper surface. Periproct not visible from above.

75 (76) Periproct not overhung by an anal rostrum, just visible from below. 6–7 enlarged tubercules in 2 converging series in posterolateral interambulacra of upper surface. Subanal fasciole transverse-oval with anterior point. Reddish brown or reddish purple .. .. **Spatangus mathesoni** McKnight

76 (75) Periproct overhung by anal rostrum, visible from below. Subanal fasciole heart-shaped. Deep reddish purple or purple.

77 (78) None or only 1–2 enlarged tubercules in posterolateral interambulacra of upper surface
Spatangus beryl Fell

78 (77) 15–17 enlarged tubercules in posterolateral interambulacra of upper surface, arranged in short zig-zag series .. .. **Spatangus thor** Fell

79 (72) Subanal and peripetalous fascioles present. Frontal notch not deep on upper surface. Test more or less ovoid, truncate posteriorly. Larger spines of upper surface confined to area with peripetalous fasciole. Brownish
Gymnopatagus magnus A. Agassiz and H. L. Clark

80 (71) Other ambulacra lying in grooves.

51 (82) Internal fasciole present. Ambulacra confluent adapically. Small and low. Brown
Echinocardium cordatum (Pennant)

52 (81) No internal fasciole, and ambulacra not confluent adapically.

53 (84) Ambulacral grooves shallow, ambulacra not extending beyond central region of upper surface. Conspicuous peripetalous and subanal fascioles. Brown to dull yellow-pink, fascioles deep purple or darker . . . . . **Brissopsis oldhami** Alcock

54 (83) Frontal notch deep and keels developed between other ambulacral grooves. Apical system displaced posteriorly, posterior ambulacra short. Peripetalous and lateroanal fasciole developed. Test low, broadly ovoid, and when dried, brown or purple, petals lighter . . . . . **Brisaster** n. sp. Pawson

The following species have not been included in the key:

"*Phormosoma zelandiae*" A. Agassiz—a small specimen from off East Cape in 1,280 m. Similar to *Phormosoma rigidum*, but it may be a juvenile form of a described species (cf. Mortensen 1935, p. 148).

"*Temnopleurus reynaudi*" A. Agassiz—a small specimen from the Challenger Plateau in 500 m. "The existence of a red spot on each genital plate and the lack of distinct pits also indicate that it cannot be *Temnopleurus reevesii*" (= *T. reynaudi*) (Mortensen 1943a, p. 98).

DESCRIPTIONS AND DISTRIBUTION RECORDS OF ECHINOID SPECIES

Phylum **ECHINODERMATA**

Class **ECHINOIDEA**

Order **CIDAROIDA**

Family CIDARIDAE

Goniocidaris umbraculum (Hutton)
(Figs. 3, 4)

REFERENCES: Hutton, F. W. 1872: p. 10. Mortensen, Th. 1921: p. 145. Mortensen, Th. 1928: p. 164. Fell, H. B. 1954: p. 40.

RECOGNITION

GENERAL MORPHOLOGY: Test small, more or less spherical, flattened above and below. Some of the adapical radioles distally flattened, forming discs over the aboral surface. Other primary radioles long and thick, often encrusted by sponges, polyzoa, and hydroids. A zig-zag groove runs vertically down the middle of each ambulacrum, and a sinuous line runs similarly down each interambulacrum.

COLOUR: Primary radioles white, tinted pink at the base; the secondaries sometimes reddish brown. The naked test is greenish. "Colour in alcohol: test and secondary radioles dark brown, primary radioles dirty white" (Pawson, 1968). A juvenile specimen, dried, ex alcohol—"the test is very light brown in colour. Above the ambitus, the primaries are uniformly dark brown, as also are the oral primaries. Ambital primaries are light green for most of their length, brown distally" (Pawson, 1968).

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 218, 4 specimens; B 488, 3 specimens; B 489, 5 specimens; B 544, 2 fragments; B 581, 5 specimens; B 582, 1 specimen; B 583, 2 specimens, 3 fragments; B 588, 14 specimens; B 604, 1 specimen; B 610, 2 specimens; C 90, 7 radioles; C 591, 2 fragments, 9 radioles; C 654, 8 radioles; C 678, 2 fragments, 11 radioles.

PUBLISHED DATA

VUZ 54 Cook Strait 91–366m	22 specimens (Fell 1958)
Between Moeraki and Timaru 73–110m	1 specimen (Mortensen 1921)
8 miles ENE off Otago Heads 110m	numerous (Young 1924)
Foveaux Strait	8 specimens (Mortensen 1921)

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

A 444q, 3 fragments, 36 radioles; A 444c, 1 radiole; A 444k, 1 radiole; A 444l, 1 fragment, 1 radiole; A 444p, 4 fragments, 29 radioles; A 444r, 1 fragment, 43 radioles; B 556, 1 specimen; B 560, 3 specimens; B 610, 2 specimens; C 60, 4 radioles; C 101, 1 fragment; C 118, 2 fragments, 3 spines; C 125, 5 radioles; C 383, 3 radioles; C 399, 1 juvenile specimen; C 656, 1 fragment, 10 radioles; C 658, *ca.* 25 radioles; C 664, 5 radioles; C 703, 3 specimens.

PUBLISHED DATA

VUZ 51 Cook Strait 366–549m	2 specimens (Fell 1958)
VUZ 53 Cook Strait 457–549m	1 specimen (Fell 1958)
VUZ 54 Cook Strait 91–366m	22 specimens (Fell 1958)

DISTRIBUTION

GEOGRAPHIC

This species has been obtained from the central eastern and southern shelf areas. On the eastern shelf it has been found from Cook Strait to south of Stewart Island, and on the south-western shelf, on Puysegur Bank, off Chalky Inlet, and off Solander Island. With the possible exception of several specimens from Cook

Strait (VUZ 54, 91–366 m) no living examples have been found on the shelf north of about Timaru, although there are four stations between Timaru and Cook Strait where fragments have been found. This species is also known from shallow depths (112–119 m) approximately 150 miles to the north of Macquarie Island (Pawson, 1968) and from the Auckland Islands shelf.

Archibenthal distribution around New Zealand is broadly similar to shelf distribution, with occurrences in the central eastern and southern shelf areas. Recent New Zealand Oceanographic Institute samplings from the Chatham Rise include this species, but it is uncommon in archibenthal samplings to the south of New Zealand, where it is almost completely replaced by *Goniocidaris* cf. *parasol* Fell.

Bathymetric

Of the total number of occurrences 55% are from the archibenthal zone and only 5% are from depths of less than 100 m. Seventy percent of the samples that consisted of fragments only are from the archibenthal zone. However, only 37% of the samples containing live specimens came from this zone.

Live specimens: No live specimens have been obtained from zone 1, and only 5% of the samples that contained live specimens came from zone 2; these stations were both in Foveaux Strait. Most specimens have been obtained from zone 4 and most stations from which live specimens have been obtained are also in zone 4 of the shelf. Only 37% of the records* and 22% of the

**Record* is used here and throughout to mean a sample in which the relevant species was found, i.e. one or more whole or partial specimens obtained at one place at one time of sampling.

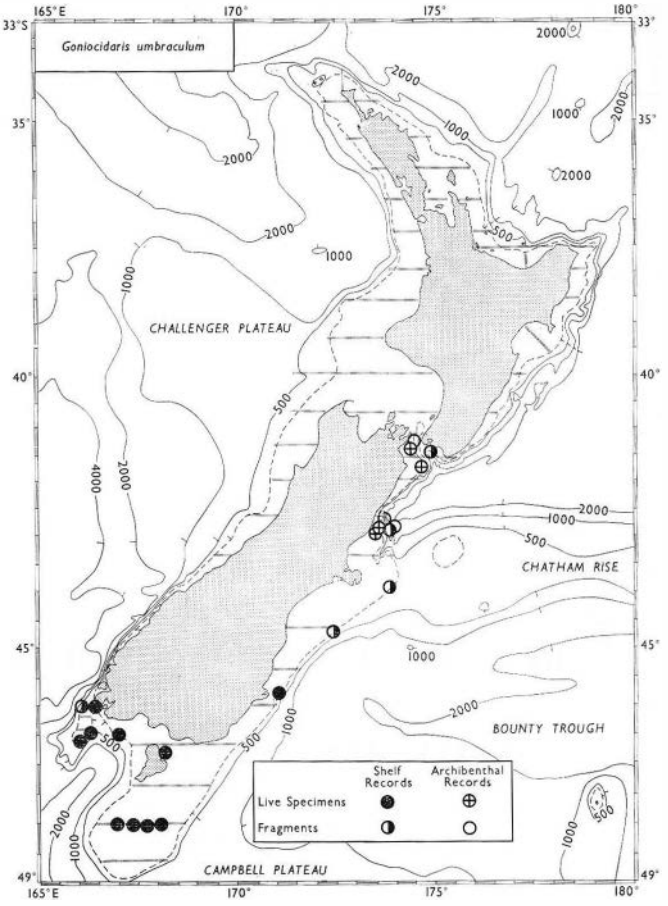


Fig. 3. Geographic distribution of *Goniocidaris umbraculum* (Hutton). Survey lines indicated by hatching.

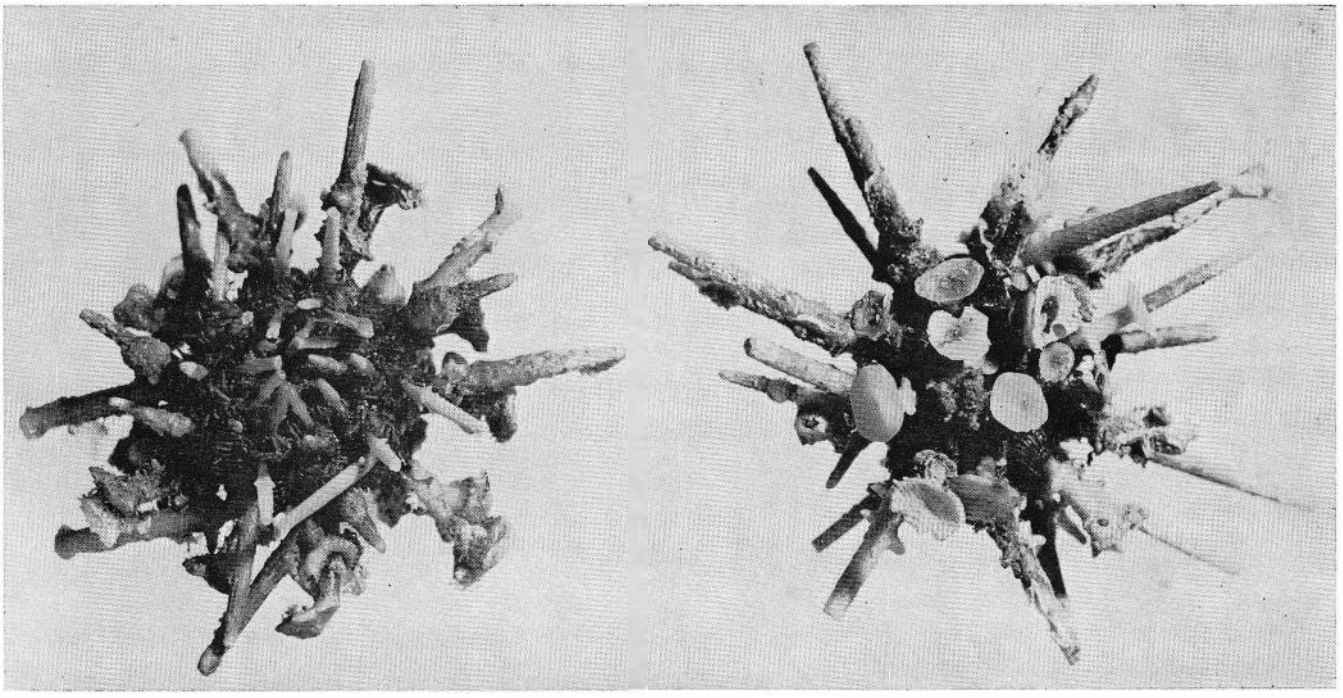


Fig. 4. *Goniocidaris umbraculum* (Hutton).

specimens are from the archibenthal zone, but this low percentage may be due to insufficient sampling. The known depth range of living material is 39–549 m.

FRAGMENTARY MATERIAL: There are no records from zones 1–3 (less than 90 m) and only 30% of all the records are from the shelf. Depth range of the fragmentary material is 108–590 m.

Bathymetric Distribution of *Goniocidaris umbraculum*
(percentages, VUZ 54 omitted)

Depth Zone	Live Specimens	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
1	0	0	0	0
2	20	11	0	5
3	0	0	0	0
4	58	53	30	39
Shelf records	78	64	30	44
Archibenthal records	22	37	70	55

SEDIMENT PREFERENCE

LIVE SPECIMENS: The primary sediment associated with this species is sand, this occurring in 48% of the samples. Other associated sediments were: gravel in 24% of the samples, sandy gravel in 19% of the samples, and muddy sand in 7% of the samples. Most records of specimens are from gravel, this substrate occurring in 36% of the samples; sandy gravel and sand both occurred in 27% of the samples. Granule gravel was the dominant grade in 64% of samples, and fine sand in 18% of the samples; 43% of the specimens were collected where granule gravel was dominant and 41% where fine sand was dominant.

FRAGMENTARY MATERIAL: Most records of fragments are from sand, occurring in 33% of the samples, but all sediment types from gravelly sand to sandy mud are represented. Muddy sand was the dominant grade in 33% of the samples, but granule gravel and mud were quite common, each being dominant in 22% of the samples. The general occurrence of fragments on finer sediments than live specimens may be due to changes in the benthic environment or transport of the fragments or even living specimens away from the normal habitat. It should be noted that this species has been found living on muddy sand (B 560).

TOTAL RECORDS: All sediments except mud are represented; sand occurred in 26% of the samples and gravel in 22%. Granule gravel was the dominant grade in 42% of the samples and medium sand in 22%.

Sediment Preference of *Goniocidaris umbraculum*
(percentages)

Sediment	Live Specimens	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Gravel	24	36		22
Sandy gravel	19	27		16
Gravelly sand			22	10
Sand	48	27	33	26
Muddy sand	7	9	22	16
Sandy mud			22	10
Mud				

Dominant Grades in Samples

Grade	Live Specimens	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Granule gravel	43	64	22	42
Very coarse sand	5	9		5
Coarse sand			11	5
Medium sand	10	9	33	22
Fine sand	41	18	11	15
Very fine sand				
Mud			22	10

Goniocidaris magi Pawson
(Figs, 5, 6)

REFERENCES: Pawson, D. L. 1964b: p. 67.

RECOGNITION

GENERAL MORPHOLOGY: Test small, flattened above and below. Adapical radioles with fine spines and thin glass-like hairs, lacking discs distally but with weakly developed crowns.

COLOUR: Test and scrobicular spines creamy white, and primary radioles white.

SHELF OCCURRENCE

N.Z. OCEANOGRAPHIC INSTITUTE DATA (Pawson 1964b): B 93, 10 specimens.

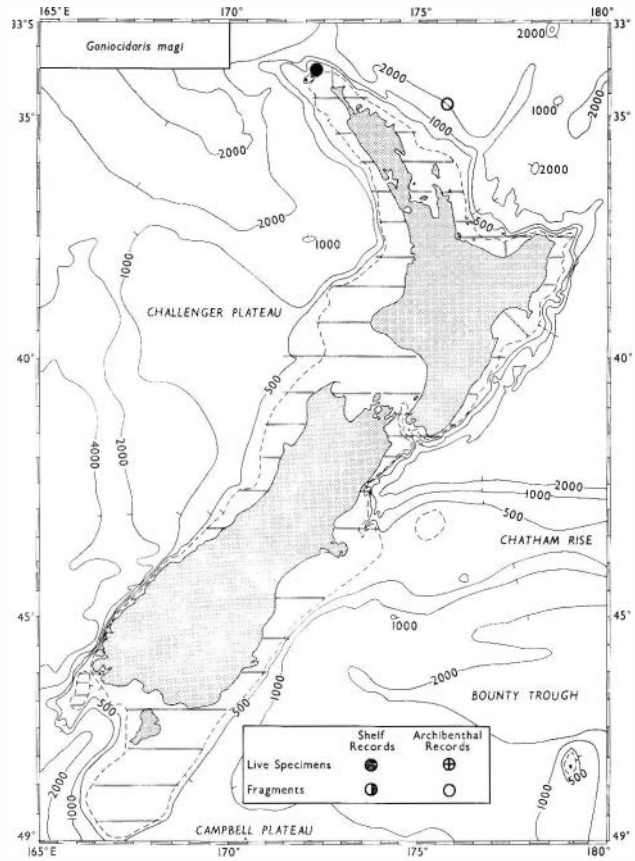


FIG. 5. Geographic distribution of *Goniocidaris magi* Pawson. Survey lines indicated by hatching.

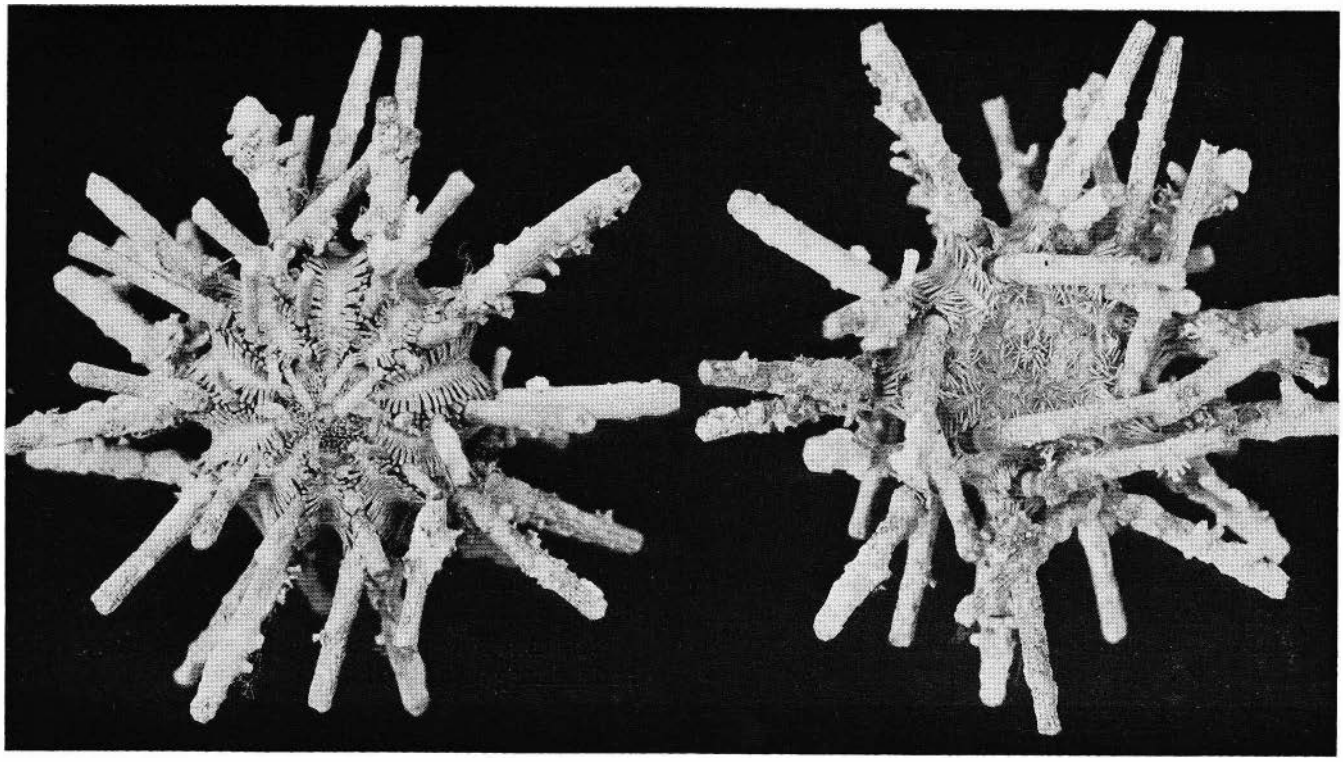


FIG. 6. *Goniocidaris magi* Pawson.

ARCHIBENTHAL OCCURRENCE

PUBLISHED DATA (Pawson 1965): 34° 45′S 173° 51′ E, 529–536 m primary radiole.

This is the third species of *Goniocidaris* to be found in New Zealand waters. Additional collecting near the above locality has not produced further specimens. A cidarid ("*Cidaris* species, juvenile") was recorded from this general area (Mortensen 1921), and two small cidarid fragments were found south off Cape Brett at stations C 776 and C 777.

It is possible that this species, in common with the other New Zealand Cidaridae, has a fairly wide depth range, and it may prove to be more common in the archibenthal region of the north. The sediment at this station was classified as gravelly sand, the dominant grade being coarse sand, but it is suspected that a rocky bottom fauna was also sampled.

Ogmocidaris benhami Mortensen
(Figs. 7, 8)

REFERENCES: Mortensen, Th. 1921: p. 148. Mortensen, Th. 1928: p. 144. Fell, H. B. 1954: p. 42.

RECOGNITION

GENERAL MORPHOLOGY: Test small, flattened above and below. Circumference rounded. No grooves along the ambulacra, adapically. A narrow conspicuous zig-zag furrow in the middle of each interambulacrum. Primary radioles long and serrate, not forming discs over the aboral surface, except in older specimens.

COLOUR: The primary radioles are pale pink, the base somewhat darker pink. "Pale yellowish pink, the primary radioles cream" (juvenile specimen, Fell 1960).

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 673, 1 specimen; C 316, 1 radiole; C 793, 30 radioles; C 801, 3 radioles; C 803, 17 radioles.

PUBLISHED DATA

Off Opotiki 128m	(Mortensen 1921)
Off White I. 101 m	radioles
NZGT 83, 12 miles NE of Cape Kidnappers, 143–124 m	(Benham 1909)
NZGT 89, 12 miles WSW of Cape Runaway, 172–121 m	
NP 9, Bay of Plenty, 183–110 m	2 specimens (Fell 1958)

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

C 607, 7 specimens; C 753, 10 radioles; C 771, 4 specimens (3 juvenile) and 39 radioles; C 778, radioles; C 783, radioles; C 794, 16 radioles; C 798, 14 radioles; C 802, 21 radioles; C 814, 1 radiole; C 488, 4 broken radioles.

PUBLISHED DATA (from Fell 1958, 1960)

DMBS 208, off Mayor I., 210–207 m	1 specimen
DMBS 209, off Mayor I., 494 m	10 specimens
DMBS 210, off Mayor I., 732 m	1 large, several juvenile specimens
NP 6, Bay of Plenty, 227 m	56 specimens
NP 9, Bay of Plenty, 183–110 m	2 specimens
VK 5, S off Cape Kidnappers, 366 m	1 specimen
CIE 59, 43° 48′ S 177° 19′ E, 531 m	2 specimens (1 juvenile)

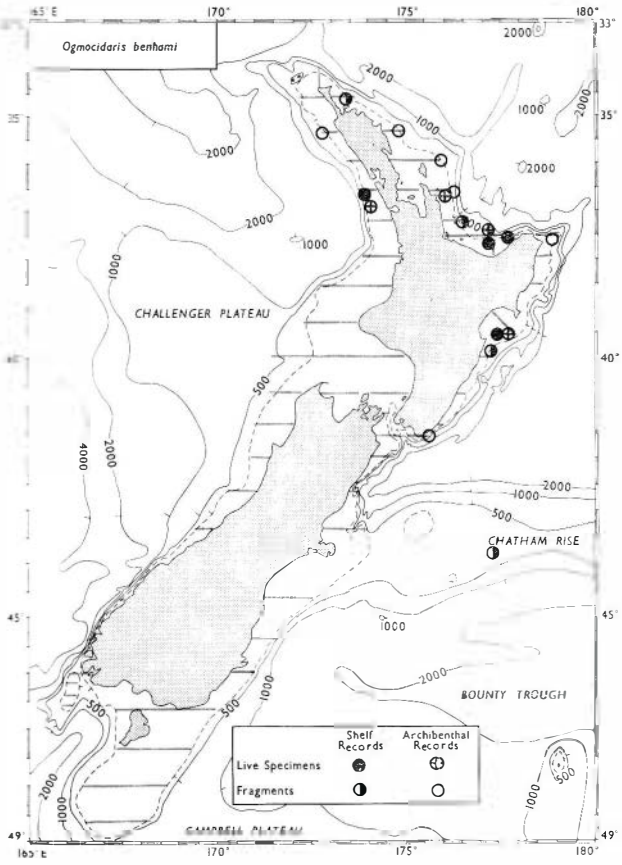


FIG. 7. Geographic distribution of *Ogmocidaris benhami* Mortensen. Survey lines indicated by hatching.

DISTRIBUTION

GEOGRAPHIC

Shelf records of this species are from the north western, north eastern, and central eastern areas, i.e. north of Manukau Harbour on the west coast, and Hawke Bay on the east coast. Archibenthal records cover the same areas, but do not extend as far south on the west coast, by about 100 miles. On the east coast records extend approximately 250 miles to the south of the shelf records on to the Chatham Rise. Of the 26 records only three are from the west coast, and of the remainder, 13 are from the Bay of Plenty.

BATHYMETRIC

There are no records from zones 1 or 2 and only 38% of the records (4% of the specimens) are from the shelf. The distribution of live and dead material is similar, the species being predominantly archibenthal. The recorded depth range of living specimens is 110–531 m, and of fragments 101–585 m.

Bathymetric Distribution of *Ogmocidaris benhami* (percentages)

Depth Zone	Live Specimens	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	4	39	39	38
Shelf records	4	39	39	38
Archibenthal records..	99	69	62	65

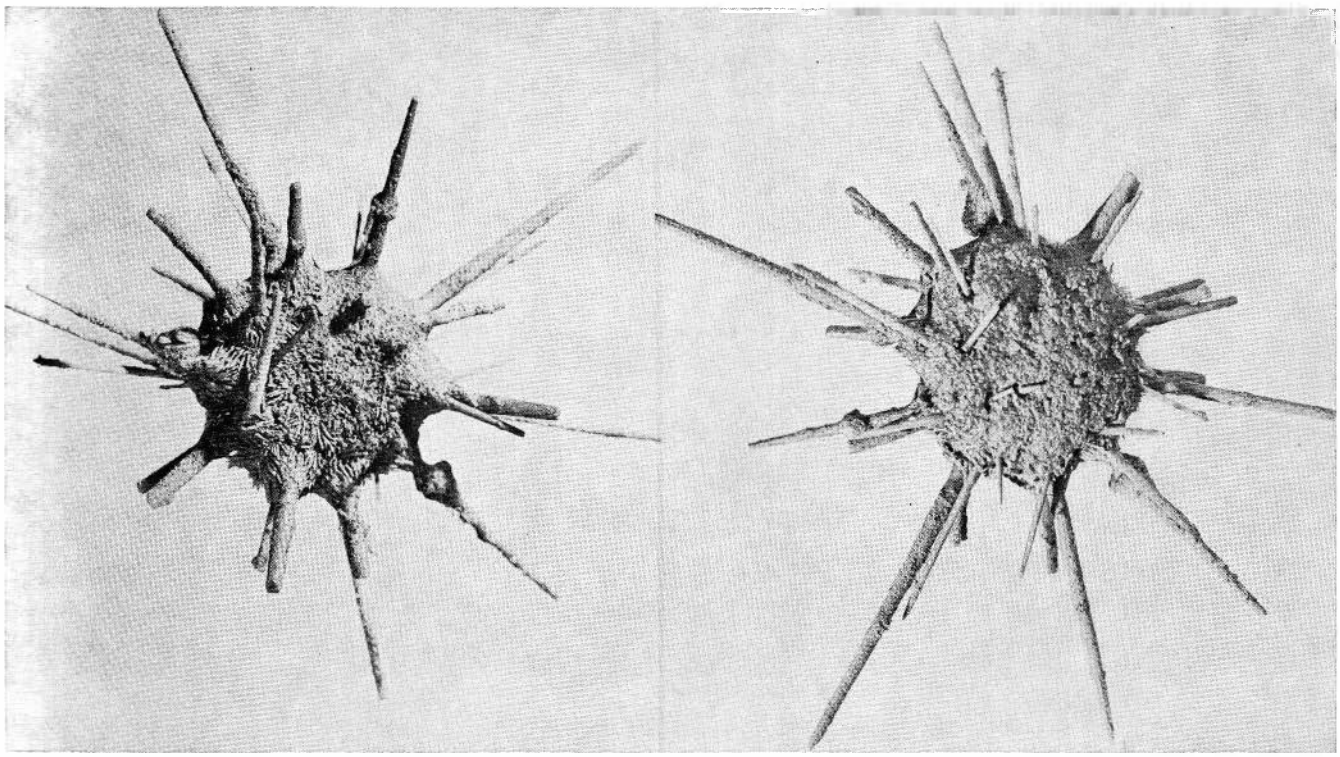


FIG. 8. *Ogmocidaris benhami* Mortensen.

Sediment Preference

This species was collected alive only twice during the survey, on sand and muddy sand, the dominant grade being fine sand. Fragmentary material occurred with sandy mud (in 50% of the samples), sand and muddy sand (each 20% of the samples), and mud (in 10% of the samples). Mud was the dominant grade in 60% of the samples, fine sand in 30% of the samples, and medium sand in 10% of the samples. All material is from fine sediments.

Order **LEPIDOCENTROIDA**

Family ECHINOTHURIIDAE

Araeosoma thetidis (H. L. Clark)
(Figs. 9, 10)

References: Clark, H. L. 1909: p. 134. Mortensen, Th. 1935: p. 267. Clark, H. L. 1946: p. 303.

Recognition

General morphology: Test soft and flexible. Specimens usually flattened when captured. Primary spines of the oval side with a hoof-like distal end.

colour: "A deep red-purple" (Fell 1958).

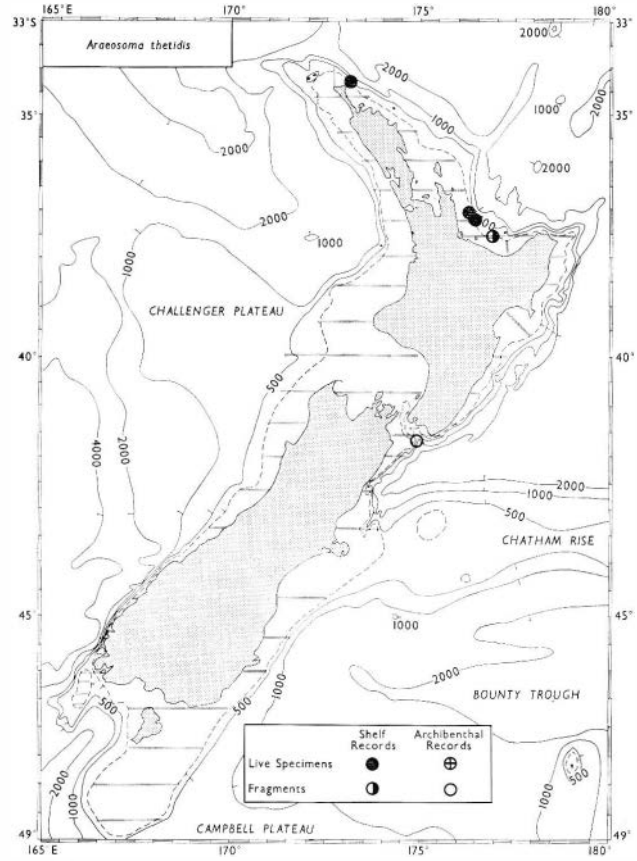


Fig. 9. Geographic distribution of *Araeosoma thetidis* (H. L. Clark). Survey lines indicated by hatching.

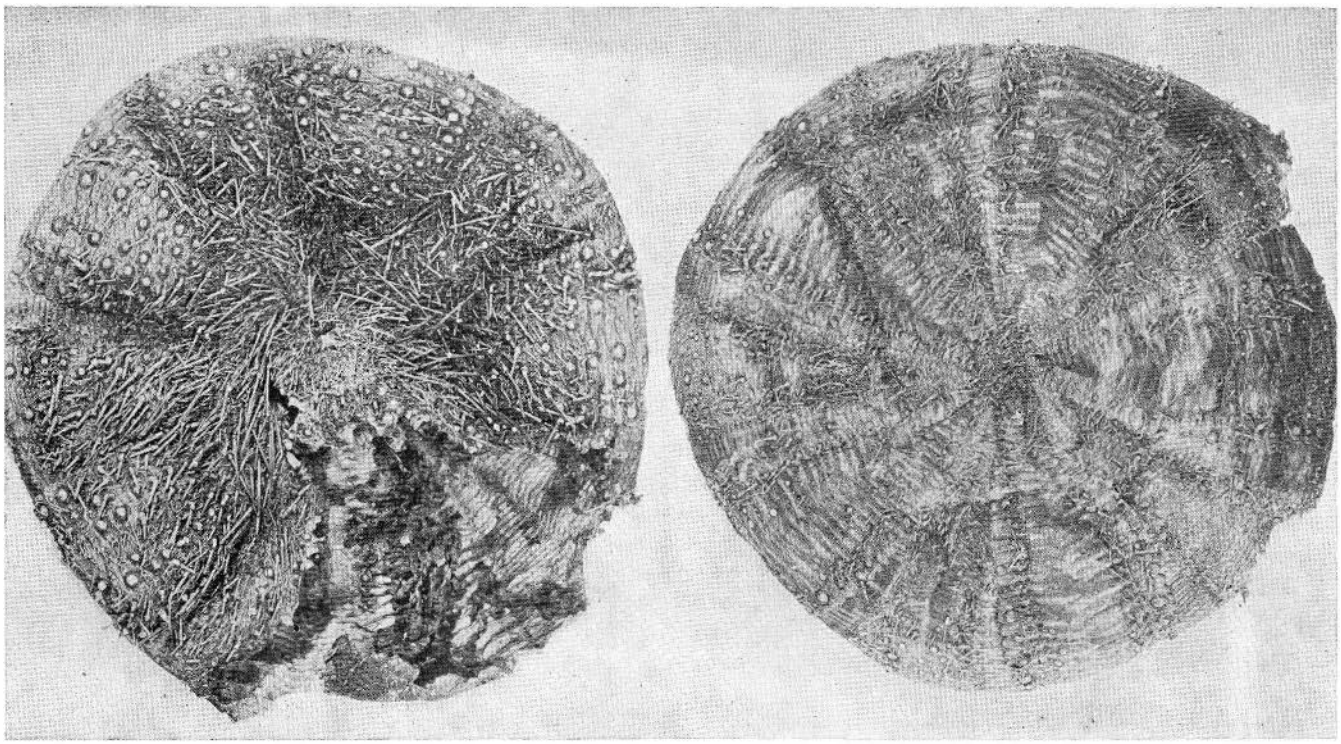


Fig. 10. *Araeosoma thetidis* (H. L. Clark).

Shelf Occurrences

Published data

TN 96, 7 miles E of North Cape, 128 m	3 specimens (Mortensen 1921)
NP 8, Bay of Plenty, 229–83 m	2 specimens (Fell 1958)
NP 9, Bay of Plenty, 183–110 m	1 specimen

Archibenthal Occurrences

Published data (from Fell 1958)

Off Plate I., Bay of Plenty, 238–183 m	1 specimen
VUZ 87, Cook Strait, 732 m	1 large primary hoof

See also NP 8 and NP 9 above.

Distribution

The only shelf records of *Araeosoma thetidis* are from the north eastern area, off North Cape, and possibly the Bay of Plenty. Archibenthal records extend the range to the central eastern area (Cook Strait) and the species is also known from south-eastern Australia. The known depth range is 110–732 m, the species being mainly archibenthic. The sediment preference is unknown, but is presumably for the finer grades. Recent samples taken near Campbell Island also contain this species.

Order **DIADEMOIDA**

Family DIADEMATIDAE

Centrostephanus rodgersii (A. Agassiz)
(Figs. 11, 12)

References: Agassiz, A. 1863: p. 354. Mortensen, Th. 1940: p. 320. Fell, H. B. 1949: p. 343.

Recognition

General Morphology: Test large, robust, and flattened. Pores in distinct arcs of three, except adapically. Spines long and hollow. Secondary tubercules forming a conspicuous longitudinal series parallel to the primary series.

Colour: Test pale cream, spines deep purple to nearly black.

Shelf Occurrences

N.Z. Oceanographic Institute data

Z 1920, near Matapouri Bay, east coast, Northland, 2m	1 specimen

Published data (from Fell 1949)

Off Cavalli Is., 70–110 m	2 specimens
5½ mi. SE of Little Barrier I., 46–51 m (edge of Centre Reef, Hauraki Gulf)	1 specimen
Stephenson I. off Whangaroa Harbour	several specimens

Mr R. V. Grace of Auckland (pers. comm.) has kindly supplied the following localities:

Cape Karikari (common); the Bay of Islands, especially Deep Water Cove where it occurs more commonly than *Evechinus chloroticus;* more rarely at Goat Island beach (north of Cape Rodney); Tiritiri Island in the Hauraki Gulf; and Mayor Island in the Bay of Plenty.

Distribution

The north eastern area from Cape Karikari to Mayor Island. *C. rodgersii* is also known from eastern Australia, Lord Howe Island and New Caledonia. It usually occurs intertidally or in shallow water, on or among rocks. The New Zealand records are the deepest known.

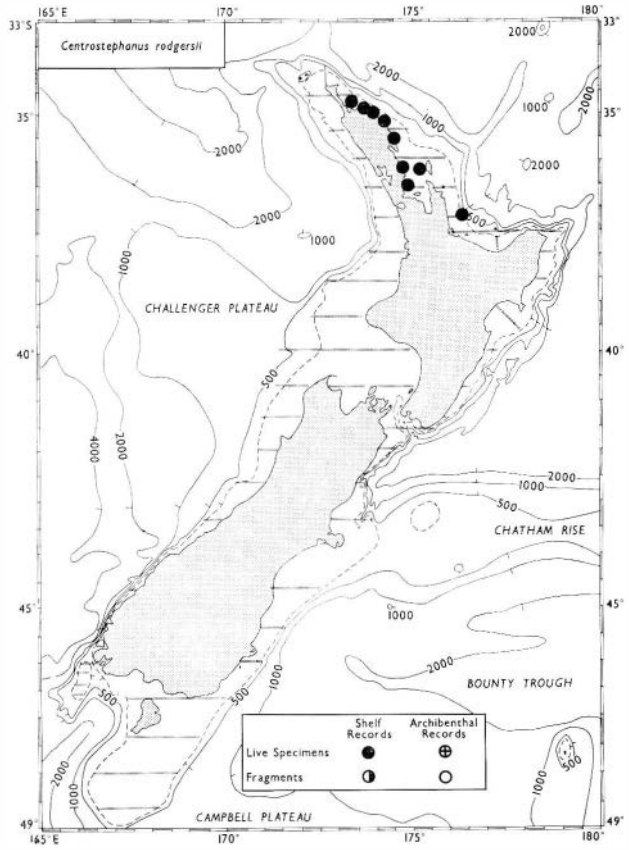


Fig. 11. Geographic distribution of *Centrostephanus rodgersii* (A. Agassiz). Survey lines indicated by hatching.

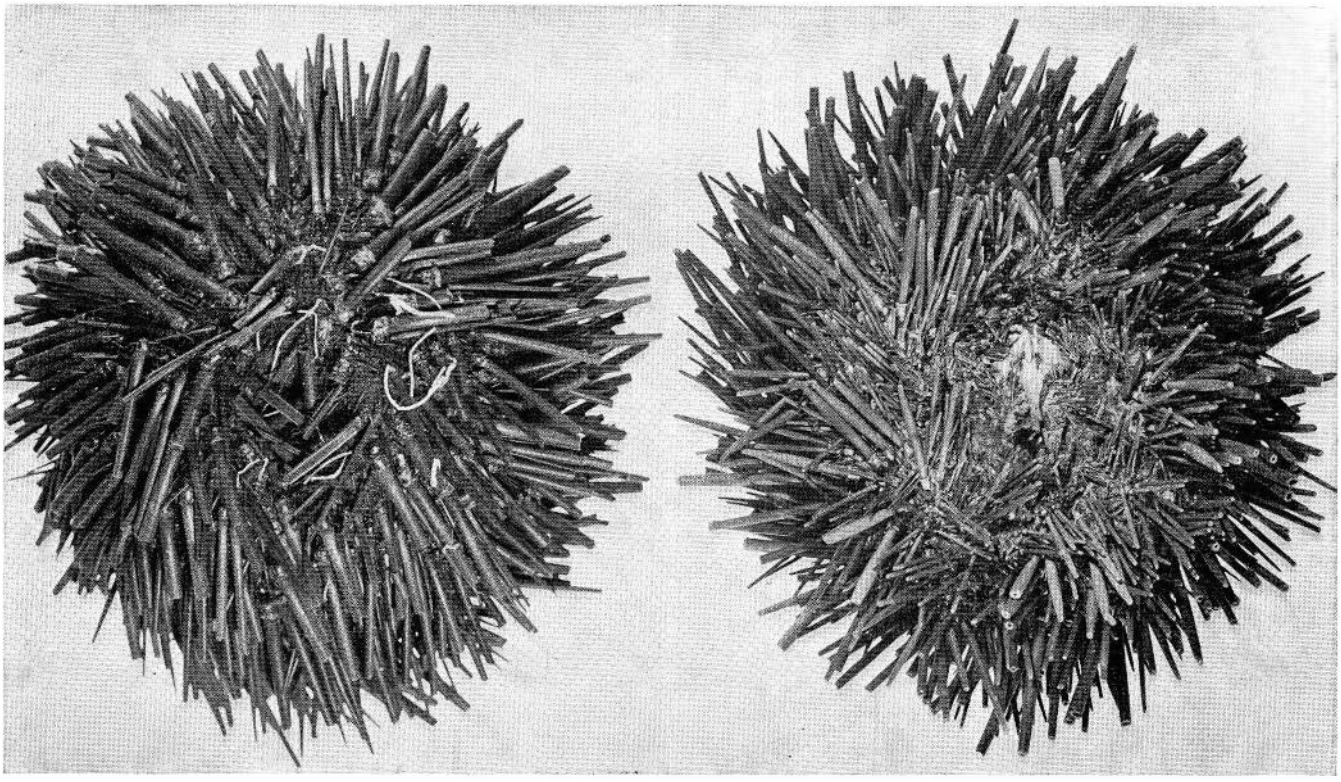


FIG. 12. *Centrostephanus rodgersii* (A. Agassiz).

Order **TEMNOPLEUROIDA**

Family TEMNOPLEURIDAE

Amblypneustes pachistus H. L. Clark
(Fig. 13)

REFERENCES: Clark, H. L. 1912: p. 327. Mortensen, Th. 1943a: p. 196.

RECOGNITION

GENERAL MORPHOLOGY: Test spheroidal, slightly flattened on the oral side, the adoral edge sunken slightly. Pore pairs forming three distinct vertical rows. Gill slits small and inconspicuous. Periproctal plates bearing one or more tubercules, not smooth.

COLOUR: Spines dark olive, sometimes white-tipped, tube feet colourless. Cleaned test dark grey, grey-olive, or brown, with lighter tinted pore zones.

SHELF OCCURRENCE

PUBLISHED DATA: Mokohinau Island, 4 specimens (Farquhar 1926)

DISTRIBUTION

The above record is the only one from New Zealand waters, and is probably from the intertidal region. This species is also known from southern Australia and Tasmania intertidally and down to about 50m.

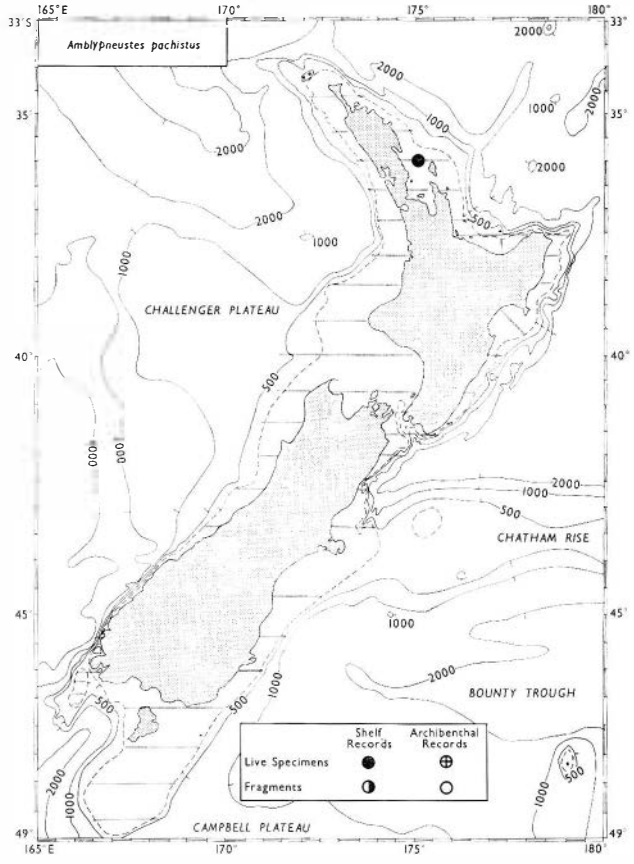


FIG. 13. Geographic distribution of *Amblypneustes pachistus* H. L. Clark. Survey lines indicated by hatching.

Holopneustes inflatus Lutken
(Fig. 14)

REFERENCES: Agassiz, A. 1872: p. 56. Mortensen, Th. 1943a: p. 217. Fell, H. B. 1949: p. 344.

RECOGNITION

GENERAL MORPHOLOGY: Test thin, shape varying from globular to low hemispherical. Ambulacra sunken, generally distinctly narrower than interambulacra. Pore pairs arranged in three vertical series. Spines bristly, dense, and short (4–5 mm).

COLOUR: Test deep purple or red, ambulacra buff. Spines usually red, but may be mauve or purple in large specimens.

SHELF OCCURRENCES

PUBLISHED DATA (from Fell 1949, Mortensen 1921)

Houhora Heads	1 specimen
Tryphena Harbour, Great Barrier I., *ca.* 30 m	1 test
Doubtless Bay (washed ashore?)	16 specimens
Little Barrier I. (washed ashore?)	1 test

DISTRIBUTION

The north eastern area from Houhora Heads to the Great Barrier Island. *H. inflatus* is also known from New South Wales, in the intertidal zone and in shallow water.

A possible second species of *Holopneustes* is mentioned by Mortensen (1943a, p. 222) on the basis of a poorly preserved test from Dusky Sound in the collections of the Hamburg Museum.

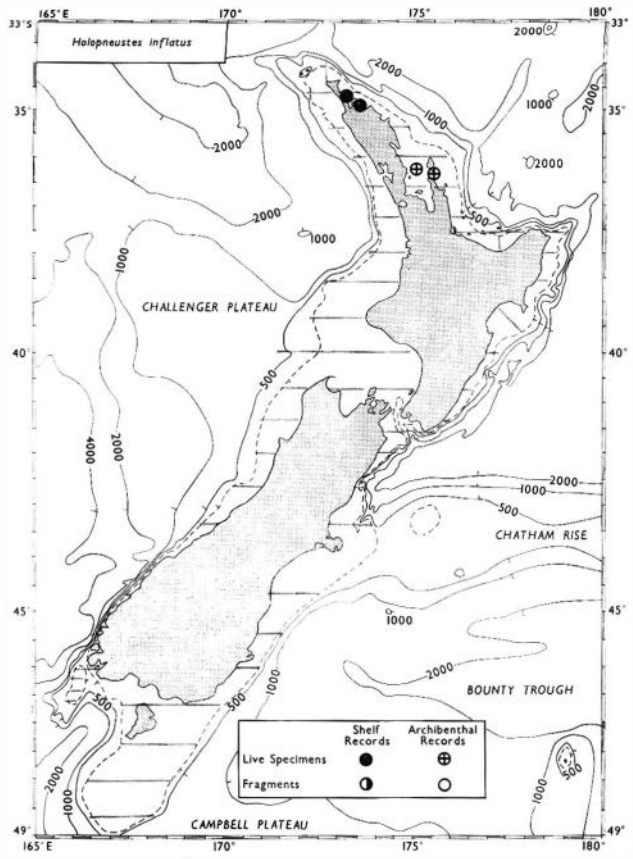


FIG. 14. Geographic distribution of *Holopneustes inflatus* Lutken. Survey lines indicated by hatching.

Pseudechinus albocinctus (Hutton)
(Figs. 15, 16)

REFERENCES: Hutton, F. W. 1872: p. 12. Mortensen, Th. 1921: p. 160. Mortensen, Th. 1943a: p. 227.

RECOGNITION

GENERAL MORPHOLOGY: Test small, hemispherical, oval side slightly flattened, sunken at peristomial edge. Ambulacra narrow with one vertical row of pores. No horizontal rows of tubercules on interambulacral plates. Spines usually less than 12 mm.

COLOUR: Test pink, spines pink to red-brown with white tips.

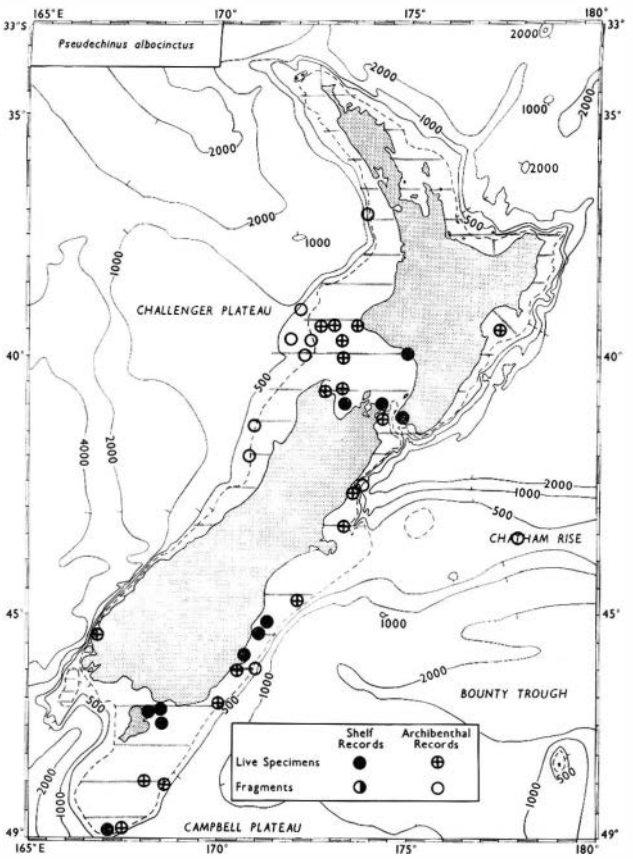


FIG. 15. Geographic distribution of *Pseudechinus albocinctus* (Hutton). Survey lines indicated by hatching.

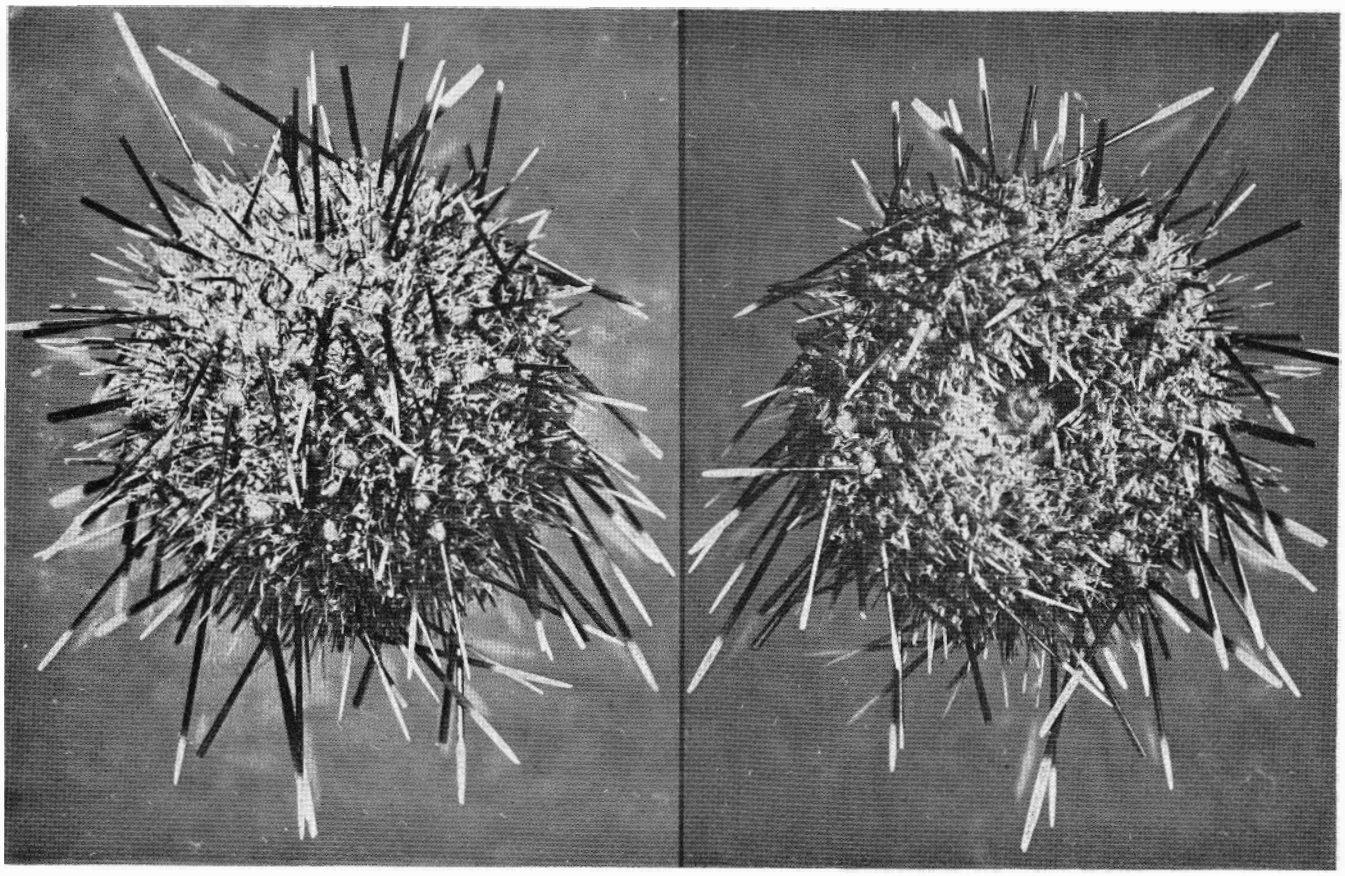


FIG. 16. *Pseudechinus albocinctus* (Hutton).

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

A 437, 1 specimen; B 61, 2 spines; B 228, 1 specimen; B 230, 1 specimen; B 238, fragments; B 264, 3 specimens; B 264a, 2 specimens; B 267, 1 specimen; B 322, 1 fragment, 14 spines; B 547, 2 spines; B 559, *ca.* 15 spines; B 568, 1 encrusted test; B 579, 1 encrusted test; B 581, 1 clean test; B 591, 1 specimen; B 592, 3 clean tests; B 594, 1 clean test; B 600, 2 spines; B 602, 1 fragment, 1 spine; C 43, 1 spine; C 172, 3 spines; C 174, 3 spines; C 185, 4 broken spines; C 188, 1 spine; C 189, 3 spines; C 423, several spines; C 430, 1 spine; C 435, 2 spines; C 467, 3 spines; C 468, 3 spines; C 469, several spines; C 470, 1 spine; C 471, 1 fragment, 1 spine; C 472, 3 spines; C 473, 11 spines; C 481, 1 fragment, 6 spines; C 482, 1 fragment, 8 spines; C 483, 2 fragments, 4 spines; C 652, 1 fragment; C 851, 2 fragments, 3 spines; C 863, 4 spines; C 864, 1 fragment, 16 spines; C 866, 1 fragment; C 871, 2 specimens.

PUBLISHED DATA

Off Wanganui	(Mortensen 1921)
Wellington Harbour Queen Charlotte Sound Tasman Bay Dunedin Stewart I.	"very plentiful"
North Otago Shelf, 9–88 m, gravel, muddy shell sand	uncommon (Graham 1962)
46° 43′ S 168° 30′ E, 24 m	(Fleming 1952)
NZGT 22, 15½ mi. E off Shag Point, 55–73 m, fine sand	8 specimens (Benham 1909)
NZGT 24, 5 mi. ENE off Moeraki, 37 m, fine sand	
AL 11, Doubtful Sound, in passage between Bauza and Gaol Is., *ca.* 91 m	3 dead tests (Fell 1952)
Chatham Is.	"very common in rock pools." Also found in blue cod (*Parapercis colias*) stomachs (Young 1929)

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

A 441, 2 fragments; B 319, *ca.* 29 broken spines; B 320, 2 broken spines; B 321, 8 broken spines; B 308, 9 spines; B 309, 3 spines; B 459, 6 fragments, 2 spines; B 464, 8 spines; B 473, 1 spine; B 566, 1 clean test; B 645, 6 spines; C 99, 1 clean test; C 167, 7 spines; C 168, 2 spines; C 170, 3 spines; C 171, 1 fragment, several spines; C 241, 2 spines; C 329, *ca.* 8 broken spines; C 593, *ca.* 15 spines; C 680, 8 spines.

DISTRIBUTION

GEOGRAPHIC

This species is known from the shelf in the central and southern areas. The southern limit of shelf records is the southern shelf extremity, south of Stewart Island. The northern limit of shelf records is off Cape Egmont and in Hawke Bay, although no living specimens are known north of Wanganui. Archibenthal records are from the same areas and extend into the north western area to

approximately 120 miles further north than the shelf records. They do not extend as far south as the shelf records by approximately 150 miles. All the archibenthal records are of fragmentary material.

BATHYMETRIC

LIVE SPECIMENS: Live specimens occur in all shelf zones, but are commonest in zone 2 (21–50 m). Comparatively few occur in zone 4 (91 m – shelf edge) and there are no archibenthal records. The known depth range is 0–145 m.

DEAD MATERIAL: Records occur in all zones, and 67% are from the shelf, being more abundant in zones 2 and 4. The largest single group is the archibenthal (zone 5), where 36% of the records occur. Dead but complete tests occur most commonly in zones 3 and 4; 63% of the records occur in zone 4 and 75% on the shelf. The known depth range of dead material is 15–638 m, and of dead tests alone is 70–177 m. All the dead material is more common in deeper water than the living specimens.

Bathymetric Distribution of *Pseudechinus albocinctus* (percentages)

Depth Zone	Records of Live Specimens	Records of Live Specimens	Records of Dead Material (Tests, fragments, spines)	Total Records
1	15	17	7	8
2	45	50	23	27
3	35	25	7	10
4	5	8	29	24
Shelf records	100	100	67	69
Archibenthal records	0	0	36	28

SEDIMENT PREFERENCE

LIVE SPECIMENS: Most records were from sandy gravel (38%), other sediments represented being gravelly sand (25%), sand (25%), and muddy sand (13%). Similarly most specimens were from sandy gravel (42%), the other types being gravelly sand (33%), sand (17%), and muddy sand (8%). The single occurrence (A 437) on muddy sand in the Marlborough Sounds shows this species to be tolerant of fine sediments, at least in sheltered localities. Granule gravel was the main dominant grade in the sediments (58% specimens, 50% records); other dominants were medium sand (33% specimens, 38% records) and very fine sand (8% specimens, 13% records).

DEAD TESTS: Most occurrences were with sandy gravel (89% tests, 86% records), the only other sediment represented being gravelly sand (11% tests, 14% records). Dominant grades were granule gravel (89% tests, 86% records) and coarse sand (11% tests, 14% records).

FRAGMENTS AND SPINES: These occurred over all sediments from sandy gravel to mud, where they were commonest (61%). The dominant grade analysis showed similar results, all grades being represented except very coarse sand. Most records (81%) occurred where mud was the dominant sediment grade. The fragmentary material collected shows little sign of abrasion or loss of colour, and occurs both in sheltered localities on the shelf and in archibenthal samples.

Sediment Preference of *Pseudechinus albocinctus*

Sediment	Records of Live Specimens	Records of Tests	Records of Fragments	Total Records
Gravel				
Sandy gravel	38	86	5	15
Gravelly sand	25	14	5	9
Sand	25		2	6
Muddy sand	13		12	11
Sandy mud			15	11
Mud			61	48

Dominant Grades in Samples (percentages)

Grade	Records of Live Specimens	Records of Tests	Records of Fragments	Total Records
Granule gravel	50	86	7	19
Very coarse sand				
Coarse sand		14	2	4
Medium sand	38		2	8
Fine sand			5	4
Very fine sand	13		2	4
Mud			81	61

Pseudechinus flemingi Fell
(Figs. 17, 18)

REFERENCES: Fell, H. B. 1958: p. 36. Fell, H. B. 1960: p. 71.

RECOGNITION

GENERAL MORPHOLOGY: Test small, hemispherical, and flattened orally. A radiating pattern of spokes around primary tubercules. Similar in general appearance to *Pseudechinus albocinctus*. Spines 20–30 mm in length, usually so dense as to obscure test.

COLOUR: Denuded test is "a rich rose red with paler tubercules." Spines are "a brilliant orange-red or deep salmon tint with white tips" (Fell 1958). Colouration much brighter than in *Pseudechinus albocinctus*.

SHELF OCCURRENCES

PUBLISHED DATA (Fell 1960)

CIE 2, 42° 59·4′S 175° 30·5′E, 112 m	1 specimen
CIE 28, 43°57′S 176°47′W, 92 m	30 specimens
CIE 30, 43°56′S 176°53′W, 128 m	4 specimens
CIE 37, 44°21·5′S 176°13′W, 55 m	2 specimens

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

C 505, *ca.* 29 spines, 8 fragments; C 602, 2 juvenile specimens; C 656, 1 spine; C 658, 5 spines; C 666, 3 spines; C 677, several spines.

PUBLISHED DATA (Fell 1958, 1960)

DMBS 191, off East Otago, 457–549 m	2 specimens
CIE 6, 43° 40′ S 179° 28′ E, 403 m	5 specimens
CIE 29, 43° 55·5′ S 177° 08′ W, 172 m	1 specimen
CIE 41, 44° 35·5′ S 176° 04 W, 604 m	*ca.* 300 specimens
CIE 52, 44° 04′ S 178° 04′ W, 476 m	5 specimens

Distribution

Geographic

On the shelf, it is known from the Chatham Islands and Mernoo Bank; in deeper waters, from off the Chatham Islands, the Chatham Rise, off eastern Otago, Kaikoura, and the Wairarapa coast.

Bathymetric

Pseudechinus flemingi occurs on the shelf only around the Chatham Islands and on Mernoo Bank. All records nearer the New Zealand shelf are in the archibenthal zone. A total of approximately 350 specimens has been collected: of these, 38 are from the shelf (*ca.* 10%) and only one specimen is known from Mernoo Bank. The known bathymetric range is 92–604 m, and most of the specimens (*ca.* 300) were collected at the lowest depth.

Sediment Preference

No analyses of the sediments are available. Knox (1957) gives a brief description of the sediment at each station, and field notes are available for the N.Z. Oceanographic Institute stations. All of the Chatham Islands 1954 Expedition stations, with one exception, are recorded as fine sand for shelf collections, and fine sand and mud for the deeper samples. The exception, Station 37, is described as rock, coral, shell, and sand. In the N.Z. Oceanographic Institute samples, the sediment is recorded as mud or muddy sand. It is evident therefore, that this species shows a preference for fine sediments of a sandy or muddy nature.

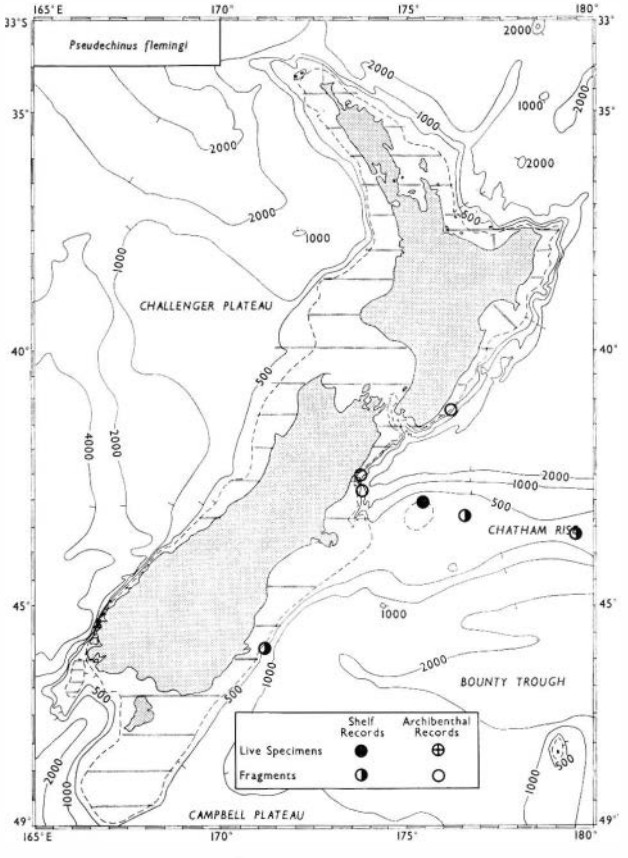


FIG. 17. Geographic distribution of *Pseudechinus flemingi* Fell. Survey lines indicated by hatching.

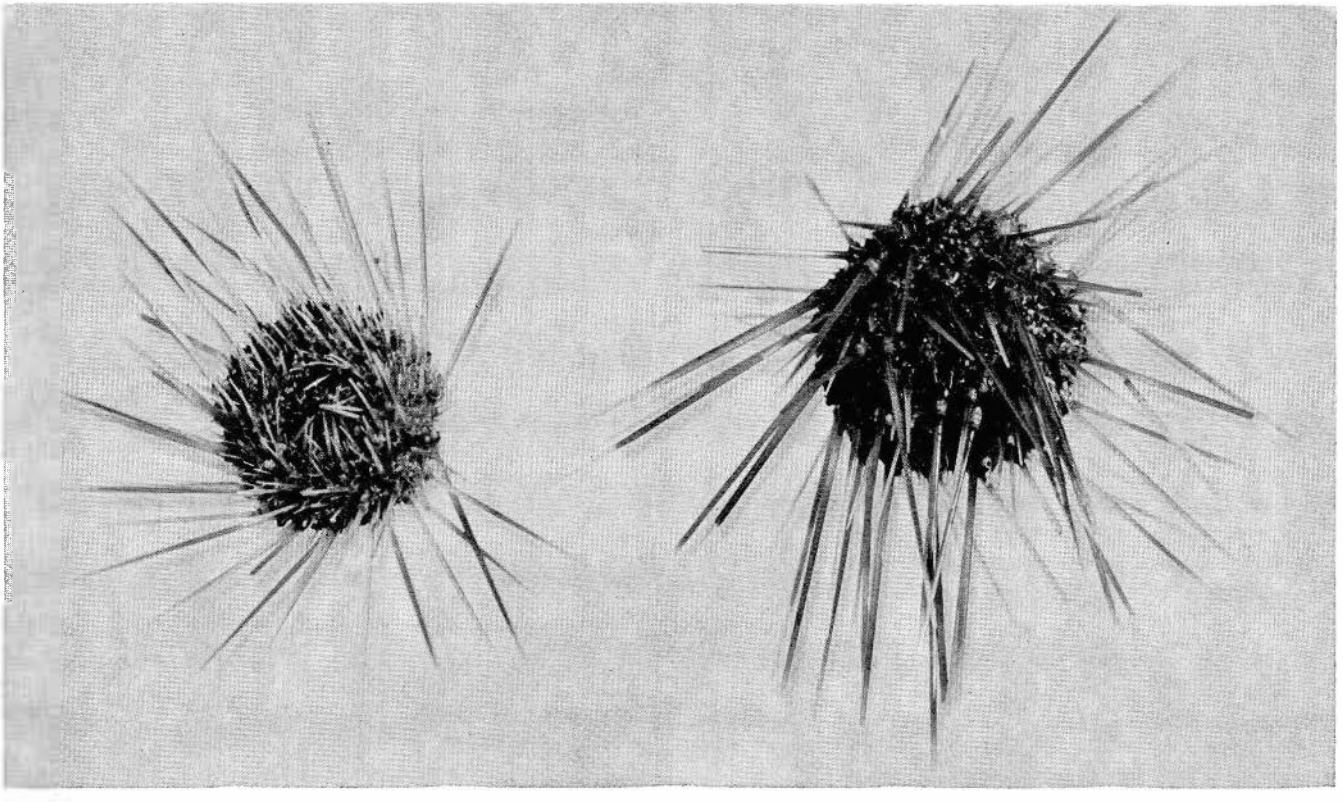


FIG. 18. *Pseudechinus flemingi* Fell.

Pseudechinus huttoni Benham
(Figs. 19, 20)

REFERENCES: Hutton, F. W. 1878: p. 306. Benham, W. B. 1908: p. 104. Mortensen, Th. 1943a: p. 238.

RECOGNITION

GENERAL MORPHOLOGY: Similar in shape to *Pseudechinus albocinctus*, but sometimes test is higher, assuming a subconical outline. Ambital interambulacral plates bear a distinct horizontal series of tubercules of roughly equal size; up to nine such tubercules may be found on large specimens.

COLOUR: Test pinkish, straw-coloured when dried. Spines reddish, but sometimes green or white.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 93, 4 specimens; B 568, 1 clean test; B 579, 3 clean tests; B 581, 1 clean test; B 589, 1 fragment; B 591, 1 specimen; B 593, 1 specimen; B 594, 3 specimens, 2 clean tests; B 600, 5 specimens, 2 fragments; C 601, 7 specimens; C 678, 2 fragments.

PUBLISHED DATA

Stewart I.	(Mortensen 1921)
Preservation Inlet	
Off east coast South I., *ca.* 40–100 m	
Paterson Inlet, Stewart I., 10–30 m	
North Otago Shelf—	common (Graham
9–55 m, gravel, muddy shell sand	1962)
55–88 m, muddy shell sand	uncommon
46° 43′ S 168° 30′ E, 24 m	(Fleming 1952)
Ruapuke oyster beds, 22m	2 specimens
Between Moeraki and Timaru, 73 m	3 specimens
Between Moeraki and Taiaroa Heads, 73 m	3 large specimens
NGH 2, Long Sound, Preservation Inlet, 35–44 m, mud, shelly sand	7 tests
NZGT 15, 8 mi. ESE off Otago Heads, 81–70 m, coarse sand	5 specimens (Benham 1909)
NZGT 16, 9 mi. SE off Otago Heads, 70–33 m, coarse sand	
NZGT 22, 15½ mi. E off Shag Point, 55–73 m, fine sand	
NZGT 24, 5 mi. ENE off Moeraki, 37 m, fine sand	

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

A 444g, 1 specimen; B 566, 5 clean tests; B 569, 1 clean test; B 616, 1 fragment; C 51, 1 clean test.

PUBLISHED DATA (Fell 1958)

DMBS 189, off East Otago, 210 m	27 specimens
DMBS 191, off East Otago, 457–549 m	7 specimens

DISTRIBUTION

GEOGRAPHIC

This species occurs in the north western, central eastern, and southern areas, but mainly in the central eastern and south eastern areas from Cook Strait southwards, and also on Veryan Bank. There are only two records from the south western area, both from Fiordland, and only one near the Three Kings Islands, in the north western area. The archibenthal records are from the central eastern and southern areas. *P. huttoni* is also known from off Tasmania.

BATHYMETRIC

The records show that this species occurs mainly on the shelf, being most abundant in zone 4. However, the percentages for the zones 2–5 do not differ very much. In contrast with *P. albocinctus*, live specimens of *P. huttoni* are known from the deepest samples.

LIVE SPECIMENS: Most live specimens have been obtained from the archibenthal zone, but this is because of the large numbers in one sample off Otago (DMBS 189). On the shelf most specimens occur in zones 3 and 4. Records of live specimens occur in every zone, but mainly in zones 2 (39%), and 3 (37%); 84% of the records are from the shelf. The recorded depth range is 0–549 m.

DEAD MATERIAL: All zones are represented with most records in zone 4 (42%), and only 24% of the records are from zones 1–3; 66% of the records are from the shelf. Dead tests occur in all zones except 1, with 57% occurring on the shelf. Of the shelf records, most occurred in zone 4 (29%), and the larger proportion of the total occurred in the archibenthal zone. Tests are recorded from depths of 35–238 m; and all dead material from 18–238 m.

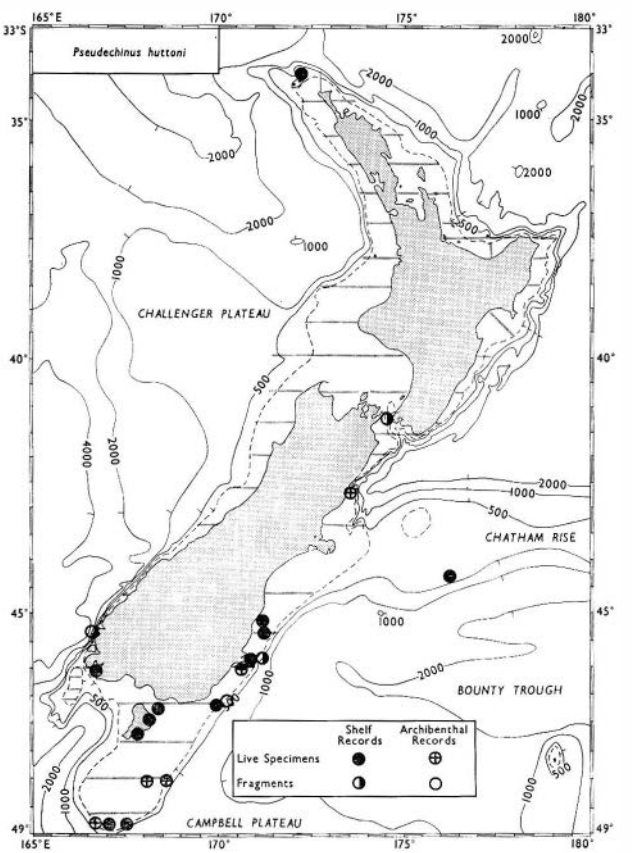


FIG. 19. Geographic distribution of *Pseudechinus huttoni* Benham. Survey lines indicated by hatching.

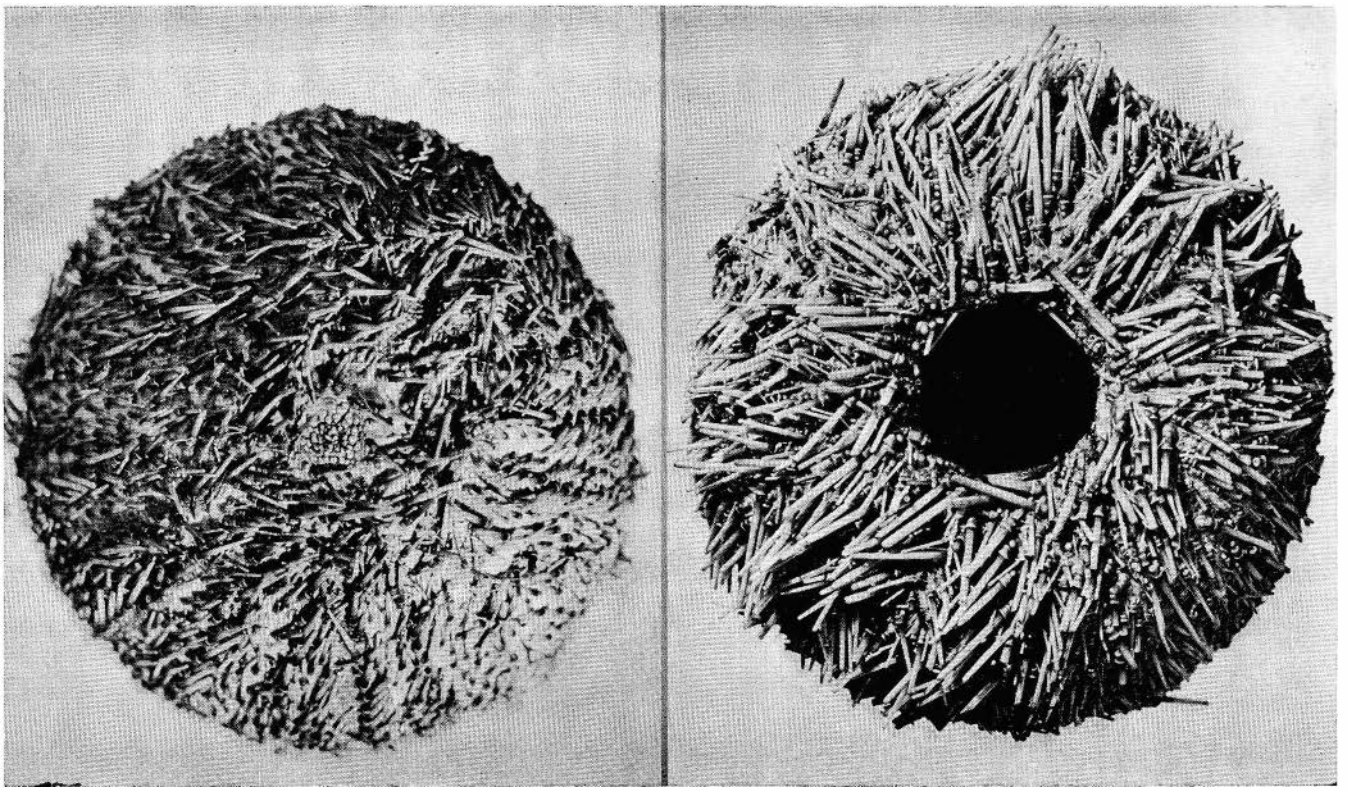


FIG. 20. *Pseudechinus huttoni* Benham.

Bathymetric Distribution of *Pseudechinus huttoni*
(percentages)

Depth Zone	Live Specimens	Records of Live Specimens	Records of Dead Material (tests, fragments)	Total Records
1	8	11	8	7
2	6	39	8	22
3	19	37	8	25
4	18	22	42	29
Shelf records	49	54	66	75
Archibenthal records	51	17	33	25

SEDIMENT PREFERENCE

LIVE SPECIMENS: Most records are from a sediment classified as sandy gravel, the dominant grade being granule gravel. Sandy gravel and sand are the dominant sediment types, with regard to the actual number of specimens collected, and the dominant grade here is coarse sand. No living specimens were collected from fine sediments.

DEAD TESTS: The dominant grade in the records is gravel, and the chief sediment granule gravel. Most tests were found in or on a sediment classified as sandy gravel, the dominant grade being gravel. The finest sediment from which tests are recorded is muddy sand, the dominant grade being fine sand.

FRAGMENTS: Fragments have been found in coarse to fairly fine-grained sediments, the dominant type being sand, and the dominant grade medium sand. This is the finest sediment with which fragments of this species were found.

Sediment Preference of *Pseudechinus huttoni*
(percentages)

Sediment	Records of Live Specimens	Records of Tests	Records of Fragments	Total Records
Gravel		57		7
Sandy gravel	60	14	25	50
Gravelly sand	20	4		14
Sand	20		75	21
Muddy sand		14		7
Sandy mud				
Mud				

Dominant Grades in Samples

Grade	Live Records	Records of Tests	Records of Fragments	Total Records
Granule gravel	60	72	25	57
Very coarse sand				
Coarse sand	40	14	25	21
Medium sand			50	14
Fine sand		14		17
Very fine sand				
Mud				

Pseudechinus novaezealandiae (Mortensen)
(Figs. 21, 22)

REFERENCES: Mortensen, Th. 1921: p. 153. Mortensen, Th. 1943a: p. 237.

RECOGNITION

GENERAL MORPHOLOGY: Similar in general shape to the other species of *Pseudechinus*. Suranal plate is not large or conspicuous, spines are short and coarse.

COLOUR: Test dull green, grey-green, or greyish with greener median areas in ambulacra and interambulacra, but sometimes test is light brown with darker median areas. Small specimens may be greyish white with green or very light red in median areas. Spines are dull green, light green with white tips, or uniformly grey.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 554, 1 clean test; B 585, 1 fragment; B 588, 1 clean test; B 594, 1 clean test; B 600, 3 spines; B 618, 1 fragment.

PUBLISHED DATA

Cape Campbell	(Mortensen 1921)
Kaikoura	
Dunedin	
Stewart I.	
North Otago Shelf, 9–88m, gravel, muddy shell sand	uncommon (Graham 1962)
43° 42′ S 168° 30′ E, 24 m	(Fleming 1952)
NZGT 29, 10 mi. E and N off Oamaru, 46–55 m, shell-gravel	2 specimens (Benham 1909)
Paterson Inlet, Stewart I., 10–30 m	1 specimen (Mortensen 1921)
Foveaux Strait, *ca.* 40 m	a few specimens
Shag Point, Otago, at low water	2 specimens
East Coast, South I., *ca.* 40–100 m	1 specimen
Ruapuke oyster beds, Foveaux Strait, 22 m	1 specimen (Fell 1952)
Between Timaru and Moeraki, 73 m	2 large specimens
AZ 11, Doubtful Sound in passage between Bauza and Gaol Is., *ca.* 91 m	3 tests
AL 13, Dusky Sound off Passage Point, 20–27 m, sand	5 young tests
AL 23, Dusky Sound, Beach Harbour, 11–18 m, hard bottom	5 young specimens
AL 24, Dusky Sound, Big Petrel I., 6–9 m	1 young specimen

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 544, 1 clean test, 2 fragments; B 616, 1 clean test, 2 fragments.

DISTRIBUTION

GEOGRAPHIC

The species occurs in the central eastern and southern areas; from Cape Campbell southwards on the east coast, and in Fiordland on the west coast. It is known from the islands south of New Zealand: Macquarie, Campbell, Auckland, Bounty, and Antipodes Islands (Pawson, 1968). The two archibenthal records are from the central eastern area, off Pegasus Bay, and the south western area, in Fiordland.

BATHYMETRIC

LIVE SPECIMENS: No archibenthal records are cited, but this species has been recorded from 306 m off the Bounty Islands (Pawson, 1968). Most records are from zone 2, but all shelf zones are represented. The recorded depth range is 0–306 m.

DEAD MATERIAL: Dead material occurs in all zones and 90% of the records are from the shelf. Most records of all dead material occur in zone 2, and most records of dead tests (43%) occur in zone 4; 90% of the total records are from the shelf.

Bathymetric Distribution of *Pseudechinus novaezelandiae* (percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (tests, fragments)	Total Records
1	33	20	30
2	58	20	40
3	25	20	25
4	25	30	20
Shelf records	100	90	90
Archibenthal records	0	10	10

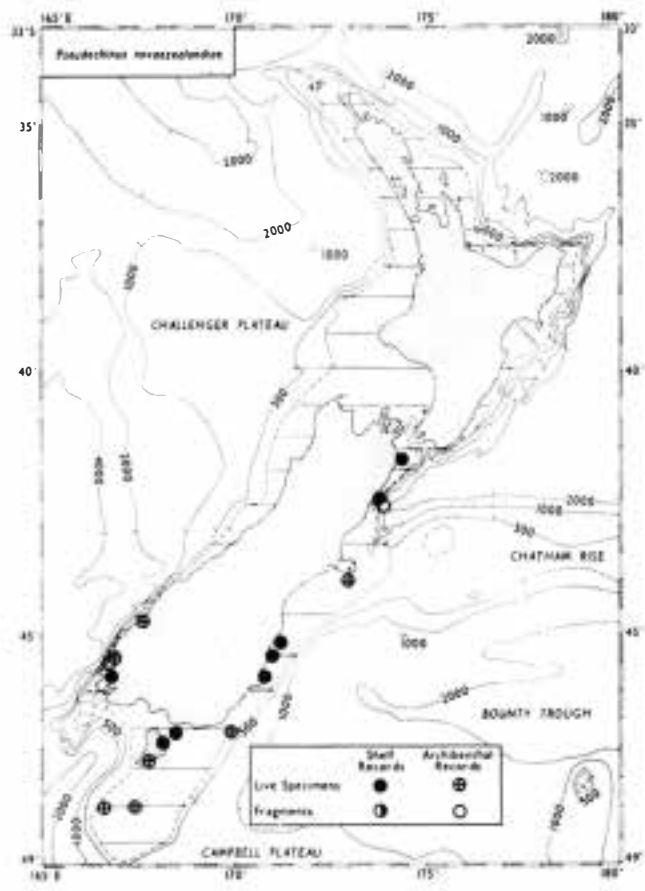


FIG. 21. Geographic distribution of *Pseudechinus novaezealandiae* (Mortensen). Survey lines indicated by hatching.

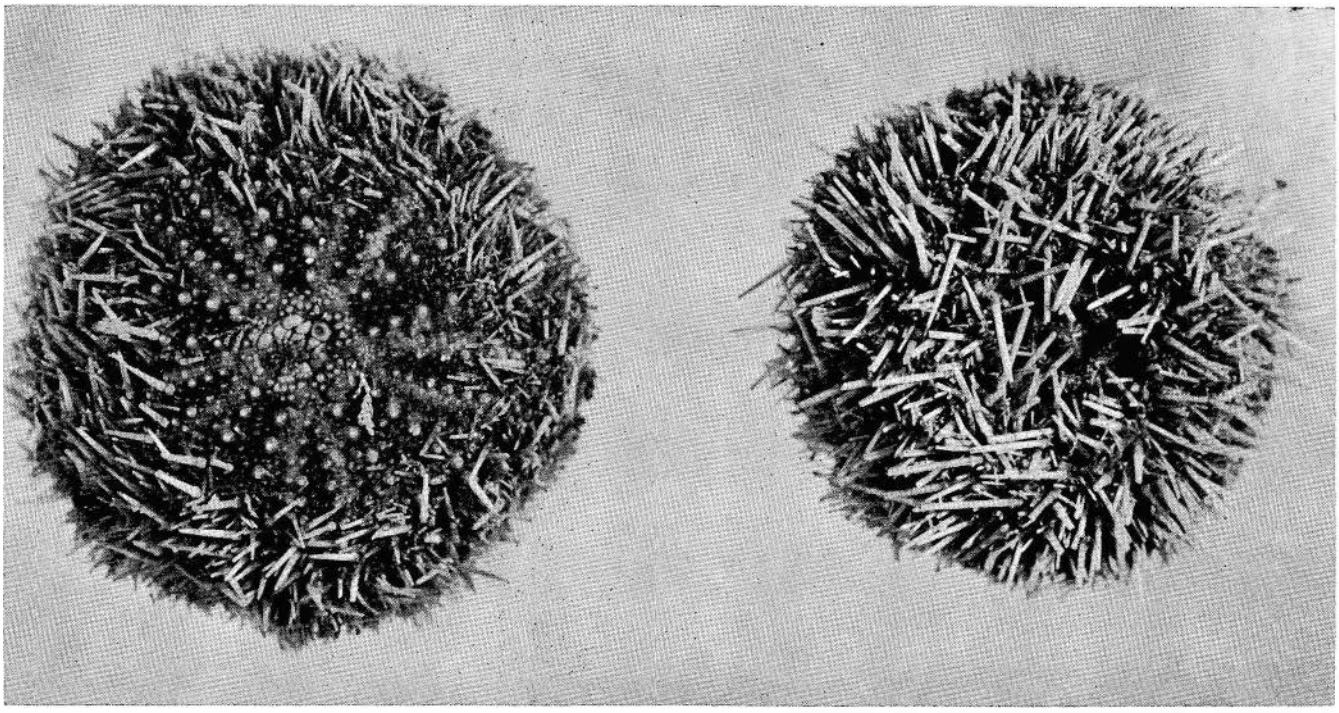


FIG. 22. *Pseudechinus novaezealandiae* Mortensen.

SEDIMENT PREFERENCE

No living specimens were collected during the survey, and this species has not been taken during other investigations around New Zealand by the N.Z. Oceanographic Institute. The records in the literature cited (and Pawson, 1968) are predominantly from coarse-grained sediments.

DEAD TESTS: The chief sediment type is sand (60% of the total records and specimens); other types represented are muddy sand (20%) and sandy gravel (20%). The dominant grades are medium sand (40%), fine sand (40%), and granule gravel (20%).

FRAGMENTS: The chief sediment is sand (50%) and other types represented are muddy sand (17%) and sandy gravel (33%). The dominant grades are granule gravel and medium sand (33% each); the others represented are coarse sand and fine sand (17% each).

Pseudechinus variegatus Mortensen
(Fig. 23)

REFERENCES: Mortensen, Th. 1921: p. 167. Mortensen, Th. 1943a: p. 243.

RECOGNITION

GENERAL MORPHOLOGY: Test small and hemispherical. Similar to other members of this genus.

COLOUR: Test white with green or grey-green spots. Spines have a red-brown band.

SHELF OCCURRENCES

PUBLISHED DATA (Mortensen 1921)

Off Three Kings Is., 119 m	2 specimens
10 miles W off Cape Maria van Diemen, 91 m	1 specimen
W off Cuvier I., 64 m	2 specimens

ARCHIBENTHAL OCCURRENCE

PUBLISHED DATA (Pawson 1965)

33° 56′ S 72° 00′ E, 792–810 m	2 tests

DISTRIBUTION

Known only from the north-eastern part of the North Island shelf. The absence of specimens from the survey would indicate that this species is either rare, or inhabits a restricted environment rarely sampled. Similarly, *Pseudechinus grossularia* is known solely from a single archibenthal occurrence (179 m) from near the Three Kings Islands.

Pseudechinus sp.
(Figs. 24, 25)

RECOGNITION

GENERAL MORPHOLOGY: Test small, more or less hemispherical, usually not very high. Every ambulacral plate bearing, in addition to primary tubercule, one secondary tubercule near median suture. Below ambitus

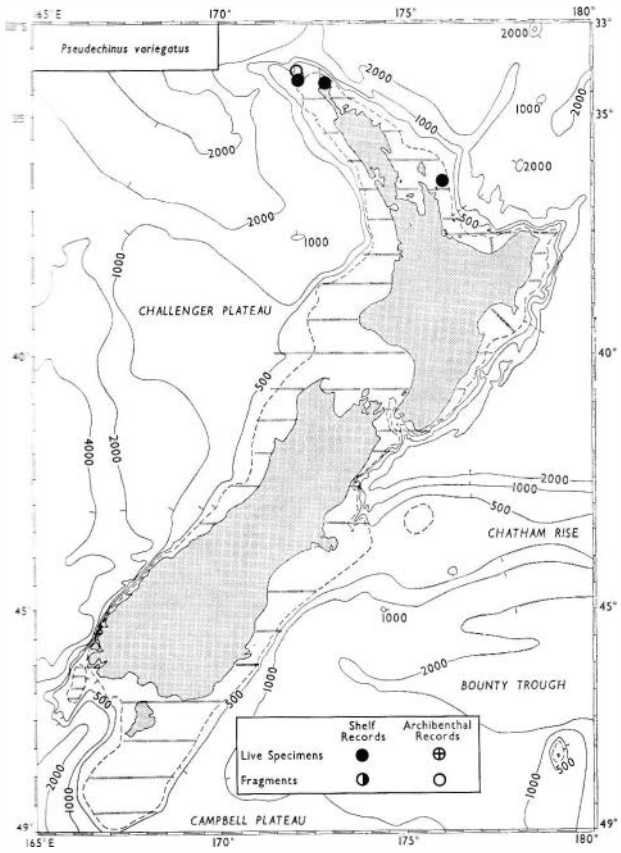


FIG. 23. Geographic distribution of *Pseudechinus variegatus* Mortensen. Survey lines indicated by hatching.

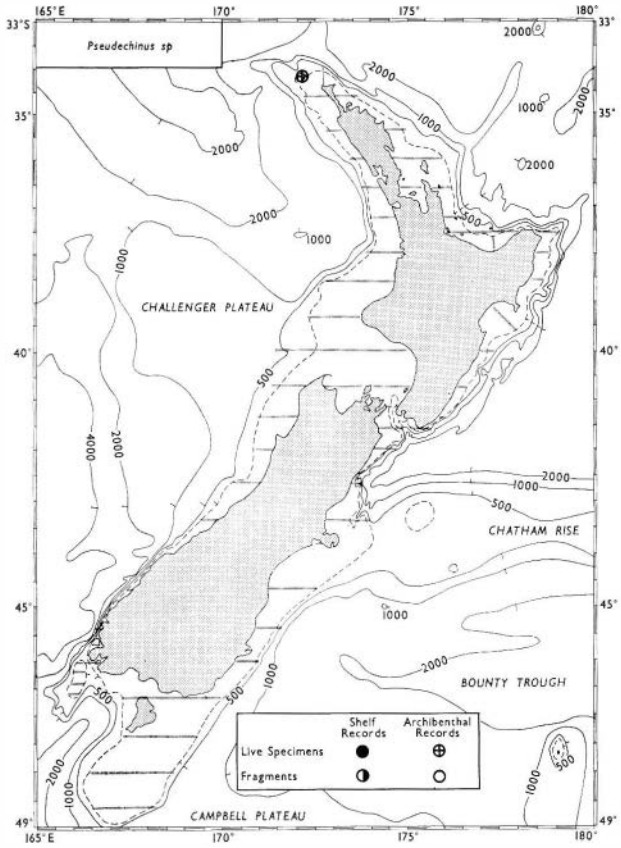


FIG. 24. Geographic distribution of *Pseudechinus* sp. Survey lines indicated by hatching.

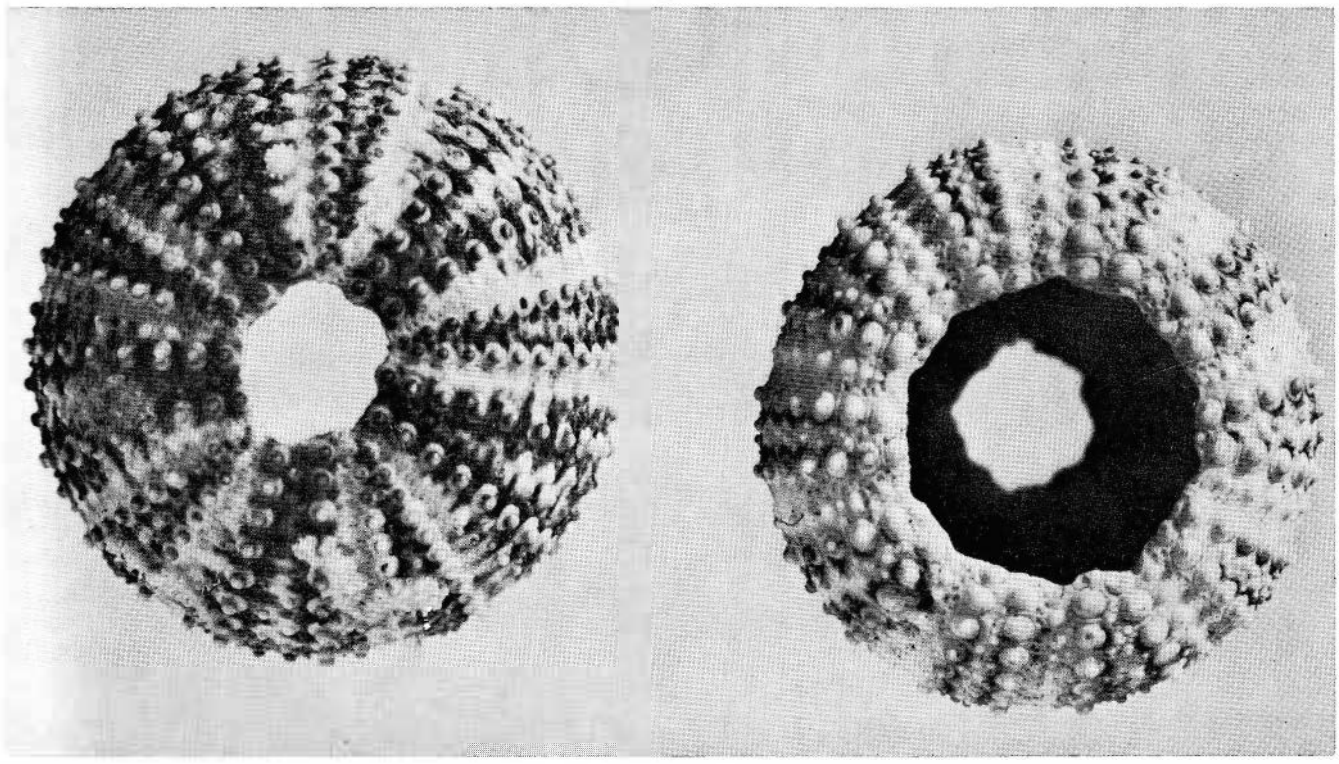


FIG. 25. *Pseudechinus* sp.

tubercules are all more or less the same size. Above ambitus secondary tubercule gradually decreases in size and disappears near apex. Pore zones narrow, pore-pairs oblique. Interambulacral plates with a secondary tubercule on either side of primary tubercule. These tubercules become smaller adapically, but orally approach primary tubercule in size. Both series of plates carry a few small miliary tubercules in no definite pattern.

COLOUR: Below ambitus test is white or cream, this colour continuing up test in pore zones and medianly in ambulacra and interambulacra. Streaks of green or brown extend from apex down ambulacra and interambulacra, outside the white. Adapically they converge, more or less covering the two plates in each column, but nearer ambitus are reduced to a thin line median to primary tubercule and sometimes covering it; do not extend far below ambitus. Primary tubercules are white, green, brown, or pink.

SHELF OCCURRENCE

N.Z. OCEANOGRAPHIC INSTITUTE DATA: C 760, 6 tests.

DISTRIBUTION

Known only from the above station, near the Three Kings Islands.

Pseudechinus sp. appears most closely related to *P. grossularia* (Studer) recorded from the same general area, and also to *P. variegatus* Mortensen from north-eastern New Zealand, and *P. notius* (H. L. Clark) from Australia. These three species are of rare occurrence and their variation unknown. Distinct differences exist between their published descriptions and the material recorded above, mainly in colouration and the arrangement of the secondary tubercules. It seems preferable therefore to regard these tests as a separate species, although no further discussion is made of them here.

Order **CAMARODONTA**

Family ECHINOMETRIDAE

Evechinus chloroticus (Valenciennes)
(Figs. 26, 27)

REFERENCES: Valenciennes, A. 1846: pl. VII (2–2d) Mortensen, Th. 1943b: p. 298. McRae, A. 1959: p. 205.

RECOGNITION

GENERAL MORPHOLOGY: Test large, up to 145 mm in diameter; hemispherical and low, height more than half horizontal diameter. Broad ambulacra with pore-pairs arranged in three rows, vertically and horizontally.

COLOUR: Test bright green, the numerous tubercules lighter. Spines bright green, sometimes tipped with white.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

A 326, 1 worn fragment; B 215, fragments; B 216, fragments; B 218, 1 specimen; B 219, fragments; B 220, specimens; B 221, specimens; B 223, fragments; B 224, 1 specimen; B 225, fragments; B 226, spines; B 228, 1 specimen; B 229, fragments; B 230, 1 specimen; B 232, fragments; B 233, fragments; B 237, 1 specimen; B 238, fragments; B 247, 1 specimen; B 253, 1 specimen; B 264, 6 specimens; B 272, spines; B 481, 1 fragment, 15 spines; B 486, 12 fragments; B 498, 5 worn fragments; B 600, several small fragments, several spines; B 602, 5 fragments, 2 broken spines; B 608, 2 fragments, 1 spine; B 615, 2 fragments, 2 spines; B 616, 2 fragments, 6 spines; B 618, 3 spines; C 179, 1 spine; C 259, 1 fragment, 2 spines; C 344, 46 fragments, *ca.* 100 spines; C 416, 1 spine; C 456, 7 spines; C 479, 2 fragments, 1 spine; C 671, 2 spines; C 750, 1 fragment, 1 spine; C 805, 1 fragment, 7 spines; C 856, 2 spines.

PUBLISHED DATA

Wellington Harbour, just below low tide	numerous (McRae 1959)
North Otago shelf—	
intertidal	uncommon (Graham 1962)
9–55 m, gravel, mud, shell, sand	common (Fleming 1952)
46° 43′ S 168° 30′ E, 24 m	fragments (Fell 1952)
AL 11 Doubtful Sound, in passage between Bauza and Gaol Is., *ca.* 91 m	1 large test
Dusky Sound, washed ashore	
Pegasus Bay, Stewart I.	
CIE 9, Glory Bay, Pitt I., intertidal	1 specimen (Fell 1960)
CIE 18, 43° 41′ S 176° 48′ W, 27 m, rock	1 specimen

DISTRIBUTION

GEOGRAPHIC

This species occurs in all areas. None of the above records is further north than Whangape Harbour (35° 20′ S); however, the author has noted this species at Cape Reinga and commonly elsewhere round the North Auckland peninsula just below low-tide mark. This species is also recorded as ranging from Stewart Island to the Kermadec Islands (Fell 1953, McRae 1959); and from the Snares (Pawson 1961), and the Chatham Islands.

BATHYMETRIC

All records of living specimens are from depths of less than 55 m, and are chiefly from very shallow waters. Fragmentary material has been found out to depths of 137 m, but the majority of these deeper records are from the Fiordland region, where steep submarine profiles exist, allowing easy transport of material into these deeper waters. This material shows no signs of abrasion. All records of fragments are reasonably close to land. The many fragments from C 344, 55 m, near Gannet Island off Aotea Harbour, seem to imply the transport of a whole specimen, or a large portion of a specimen, to this depth.

Bathymetric Distribution of *Evechinus chloroticus* (percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
	33	19	24
	67	66	65
	0	9	7
	0	3	2
Shelf records	100	97	98
Archibenthal records	0	3	2

Sediment Preference

Live specimens: All live specimens in the N.Z. Oceanographic Institute collections were obtained from Foveaux Strait where the bottom sediment is coarse, ranging from sand to gravelly sand and sandy gravel. A preference for the latter two types is shown. The dominant grade is medium sand, the only other important grade being granule gravel. Habitats noted by McRae (1959) include rock pools, shallow-water coarse sediments, and finer sediments of a sandy or muddy nature. The author has noted this species on a sandy mud substrate at Urquharts Bay, Whangarei Heads, in depths of *ca.* 3–5 m. All recorded instances of this species occurring on a fine substrate are in sheltered waters.

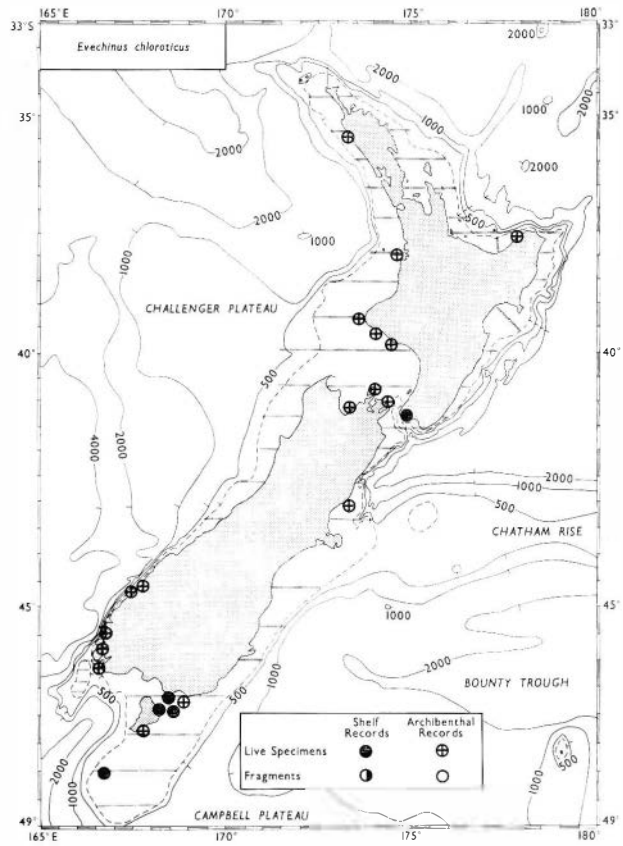


FIG. 26. Geographic distribution of *Evechinus chloroticus* (Valenciennes). Survey lines indicated by hatching.

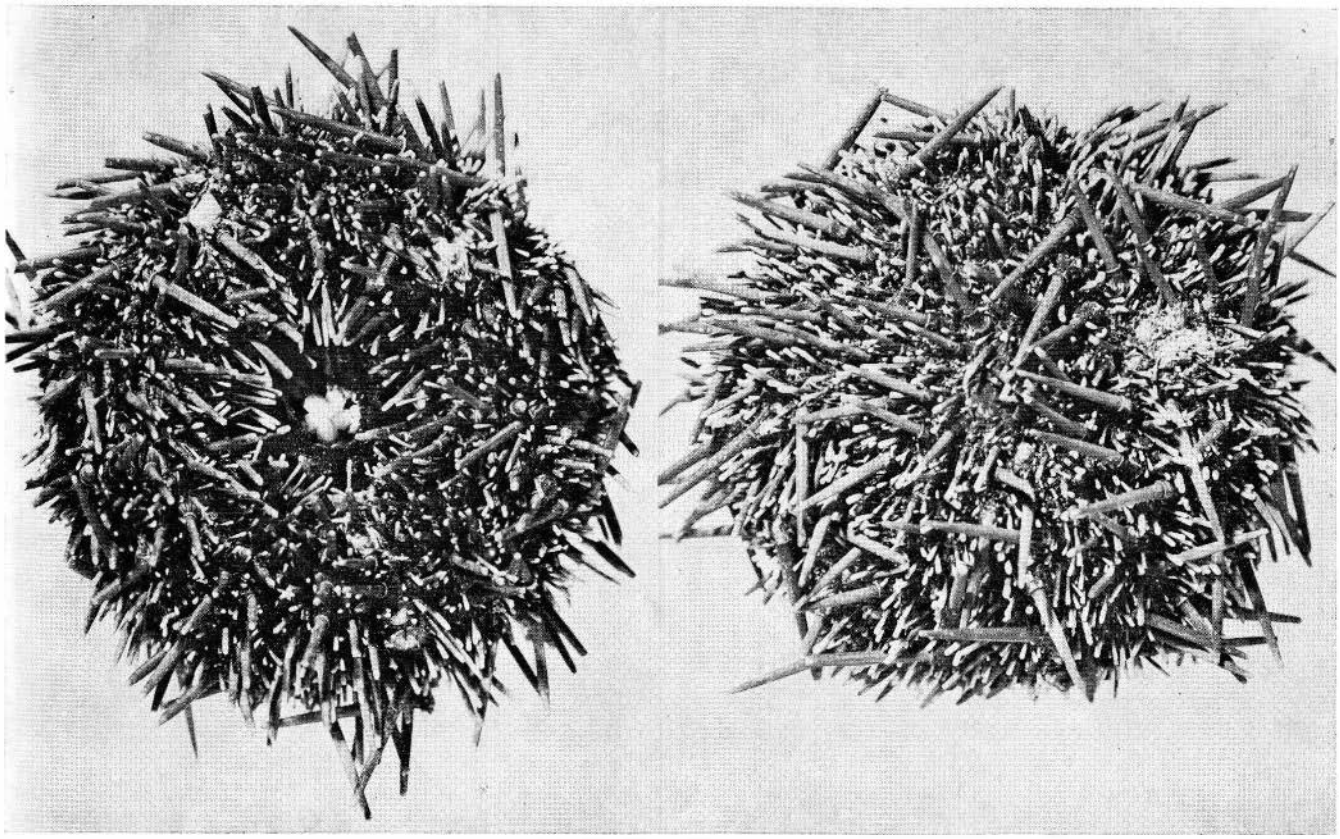


FIG. 27. *Evechinus chloroticus* (Valenciennes).

FRAGMENTARY MATERIAL: All sediment types are represented, the commonest being sand. Other important types are gravel and sandy gravel. All grades of sediment are represented except very coarse sand. The dominant grade is medium sand, the only other important grade being granule gravel.

Sediment Preference of *Evechinus chloroticus* (percentages)

Sediment	Live Specimens	Records of Live Specimens	Records of Dead Material (fragments)
Gravel	0	0	20
Sandy gravel	50	36	10
Gravelly sand	35	36	7
Sand	15	28	43
Muddy sand	0	0	3
Sandy mud	0	0	3
Mud	0	0	3

Dominant Grades in Samples

Grade	Live Specimens	Records of Live Specimens	Records of Dead Material (fragments)
Granule gravel	50	36	30
Very coarse sand	0	0	0
Coarse sand	0	0	3
Medium sand	50	64	33
Fine sand	0	0	17
Very fine sand	0	0	3
Mud	0	0	13

Heliocidaris tuberculatus (Lamarck)
(Figs. 28, 29)

REFERENCES: Lamarck, J. P. B. 1816: p. 50. Mortensen, Th. 1943b: p. 339.

RECOGNITION

GENERAL MORPHOLOGY: Test strong, low, and hemispherical, flattened on oral side. Pore zones petaloid on oral side; 7–10 pore-pairs arranged in an arc.

COLOUR: Test is bright brown with a red tinge. Denuded test is a light green, lighter orally, sometimes tinged red on aboral pore zones. Spines are bright brown with marked green tips. Dried spines are dark olive-brown-green towards base, with a rosy tinge near tip.

SHELF OCCURRENCE

PUBLISHED DATA: Mokohinau I. (Benham 1911)

This species is also known from the Kermadec Islands, Lord Howe Island, and eastern and south-eastern Australia. It is a shallow water form occurring on hard substrates. Wellington is given as a further New Zealand locality by Benham (1911), but recent intensive collecting in this area has not produced any specimens.

Order **CASSIDULOIDA**

Family APATOPYGIDAE

Apatopygus recens (Milne-Edwards)
(Figs. 30, 31)

REFERENCES: Milne-Edwards, H. 1836: pl. XIV.3. Mortensen, Th. 1921: p. 391. Mortensen, Th. 1948a: p. 181.

RECOGNITION

GENERAL MORPHOLOGY: Outline ovoid, wider posteriorly, aboral side low and vaulted, oval side concave. Anus in an elongate depression on upper surface. Spines short and coarse.

COLOUR: Brown or red-brown, turning green and then fading on preservation in alcohol. The naked test is usually bleached white, especially when washed ashore. A juvenile specimen is recorded as being "pale dull greenish yellow, with a touch of pink aborally" (Fell, 1960).

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 219, fragments; B 222, 1 specimen; B 224, 1 specimen; B 226, 1 specimen; B 228, 2 specimens; B 230, 2 specimens; B 253, 1 fragment; B 264, 6 specimens; B 264a, 8 specimens; B 267, 4 specimens; B 486, 9 specimens, 1 test, 2 fragments; B 498, 1 specimen; B 575, 1 test; B 576, 1 specimen, 8 tests, 10 fragments; B 577, 1 fragment; B 579, 2 specimens, 2 tests; B 580, 1 specimen, 2 tests; B 581, 3 specimens, 3 tests, 4 fragments; B 582, 1 specimen, 1 test, 1 fragment; B 583, 3 specimens, 1 test, 3 fragments; B 587, 1 test; B 588, 1 fragment; B 592, 2 specimens; B 594, 1 test; B 658, 1 fragment; C 177, 9 specimens, 1 fragment; C 179, 2 specimens.

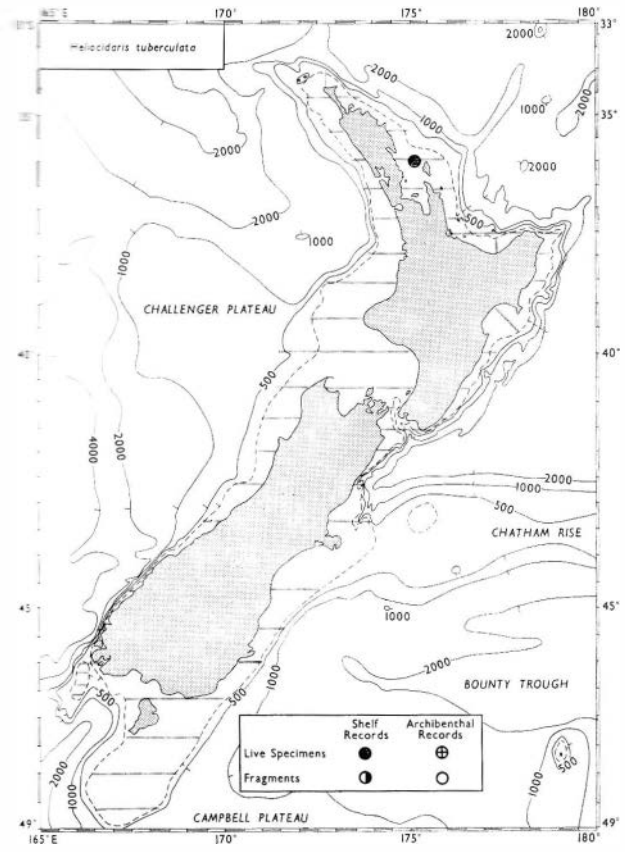
PUBLISHED DATA

Wellington Harbour entrance, 10–12 m	(Farquhar 1897, 1907; Mortensen 1921)
Cook Strait, *ca.* 90 m	
Stephens I.	
Tasman Bay	
North Otago shelf, 9–55 m, gravel, mud, shell, sand	1 specimen (Graham 1962)
Foveaux Strait	
46° 43′ S 168° 30′ E, 24 m	(Fleming 1952)
Ruapuke oyster beds, 20 m	3 specimens (Fell 1952)
Off Stewart I., 40 m	(Mortensen 1921)
Paterson Inlet, Stewart I., 10–30 m	
NGH 2, Long Sound, Preservation Inlet, 35–44 m, mud, large shells, shell sand	1 encrusted test
CIE, 44° 00′ S 176° 21′ W, 27 m, coral, shell, sand, limestone	3 specimens (Fell 1960)
CIE, 43° 38′ S 176° 34.5′ W, 37 m, coral, shell sand	1 specimen
CIE, 43° 32.5′ S 176° 47.5′ W, 60 m, coral, shell sand	4 specimens
CIE, 44° 21.5′ S 176° 13′ W, 55 m, rock, coral, shell, sand	3 juvenile specimens
Auckland Is.	1 large specimen (Fell 1949)

DISTRIBUTION

GEOGRAPHIC

Known from the north western, central, and southern shelf areas. In the north western area only one fragment is recorded; in the central eastern area the only records are from Wellington Harbour and Cook Strait; and in the south western area the only records are in Chalky



and Preservation Inlets. Records are more widely spread in the central western and south eastern areas but there are no records from most of the west coast of the South Island and none from Banks Peninsula to Cook Strait on the east coast. This species also occurs at the Chatham Islands, and Bounty and Auckland Islands (Pawson, 1968).

A naked test from near the Three Kings Islands—33° 56′ S 172° 00′ E, 792–810 m—is doubtfully referred to this species by Pawson (1965). In view of the pronounced "southern" distribution of *A. recens* and its virtual restriction to shelf waters, it seems probable that this record indicates the presence of a different species to the north of New Zealand in the archibenthal zone.

BATHYMETRIC

Records of live specimens are commonest in zone 2 (58 % of the samples), but occur in all zones except the archibenthal. The recorded depth range is 9–148 m.

Dead material is present in all shelf zones except zone 3. Most records are from zone 4 where 76 % of the records occurred. The recorded depth range of dead material is 9–162 m.

FIG. 28. Geographic distribution of *Heliocidaris tuberculatus* (Lamarck). Survey lines indicated by hatching.
On figure, for '*tuberculata*' read '*tuberculatus*'.

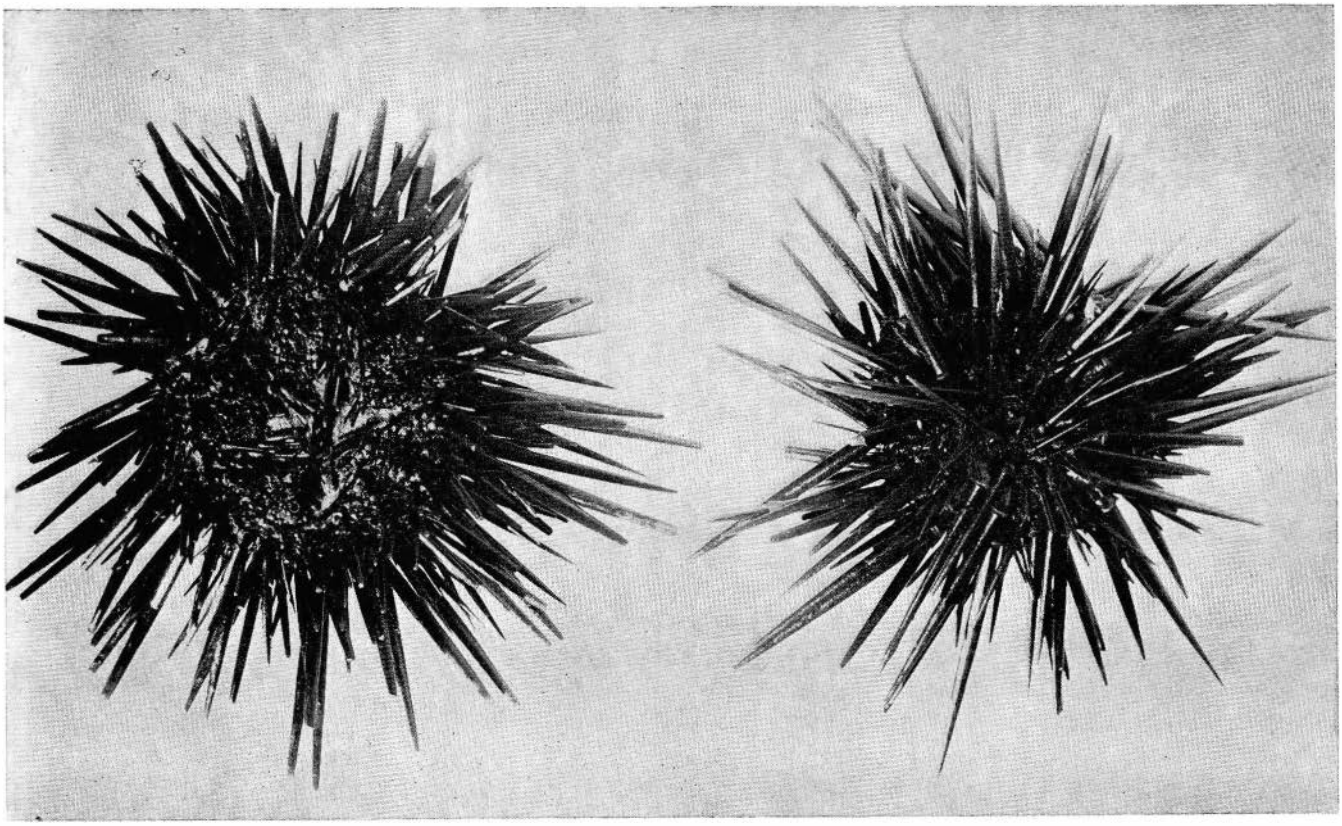


FIG. 29. *Heliocidaris tuberculatus* (Lamarck).

Dead tests are present only in zones 2 and 4 (82% of the samples). The recorded depth range of dead tests is 30–152 m, and they are more abundant in the deeper shelf waters, south of Stewart Island. The records cover all the shelf zones but are most abundant in zone 2, (48% of the records) and zone 4 (34% of the records.)

Bathymetric Distribution of *Apatopygus recens* (percentages)

Depth Zone	Records of Live Specimens	Records of Tests	Records of All Dead Material	Total Records
1	7	0	6	9
2	58	18	18	18
3	11	0	0	9
4	26	82	76	34
Shelf records ..	100	100	100	100
Archibenthal records	0	0	0	0

Sediment Preference

Live specimens: All sediment types from gravel to sand were represented. The chief type was sandy gravel, for both numbers of specimens and numbers of records. The dominant grade was granule gravel, but all grades down to fine sand were represented.

Dead tests: Most dead tests were found on a gravelly sand substrate, sandy gravel and gravel being also represented. The dominant grade was coarse sand, the only other grade to be represented being granule gravel. Most of the records of tests are on a substrate of sandy gravel; gravelly sand and gravel are also represented. The dominant grade was granule gravel, and coarse sand was also represented.

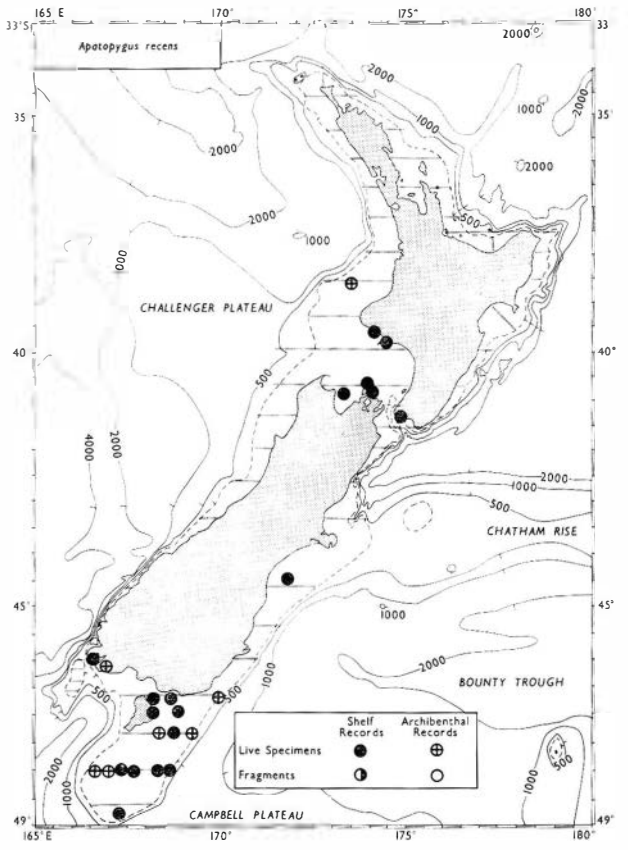


Fig. 30. Geographic distribution of *Apatopygus recens* (Milne-Edwards). Survey lines indicated by hatching.

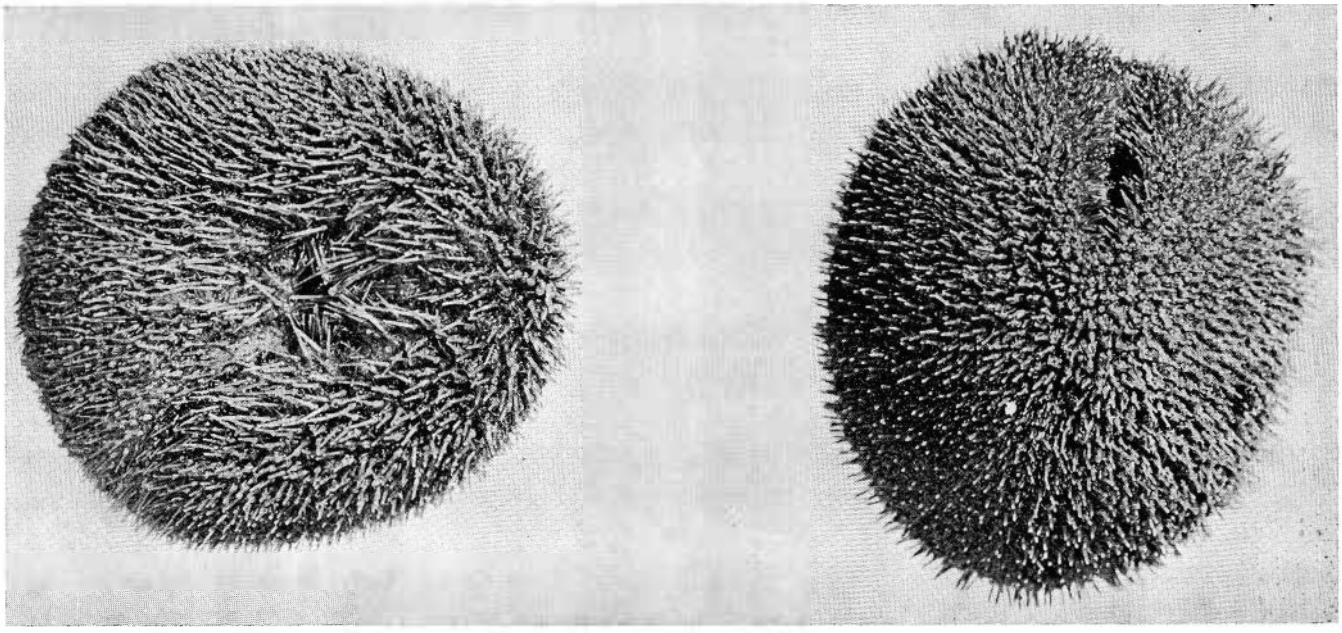


Fig. 31. *Apatopygus recens* (Milne-Edwards).

FRAGMENTARY MATERIAL: The chief sediment type was sandy gravel, although records did occur over all types from gravel to muddy sand. Granule gravel was the dominant grade, all types being represented except very coarse sand and mud.

Sediment Preference of *Apatopygus recens*
(percentages)

Sediment	Live Specimens	Records of Live Specimens	Records of Dead Tests	Records of Tests	Records of Fragments
Gravel	15	5	5	10	9
Sandy gravel	34	37	33	50	36
Gravelly sand	22	26	62	40	27
Sand	29	32	0	0	18
Muddy sand	0	0	0	0	9
Sandy mud	0	0	0	0	0
Mud	0	0	0	0	0

Dominant Grades in Samples
(percentages)

Grade	Live Specimens	Records of Live Specimens	Records of Dead Tests	Records of Tests	Records of Fragments
Granule gravel	51	47	48	70	45
Very coarse sand	0	0	0	0	0
Coarse sand	5	11	52	30	18
Medium sand	29	37	0	0	9
Fine sand	15	5	0	0	18
Very fine sand	0	0	0	0	9
Mud	0	0	0	0	0

Order **CLYPEASTROIDA**

Family ARACHNOIDIDAE

Fellaster zelandiae (Gray)
(Figs. 32, 33)

REFERENCES: Gray, J. E. 1855: p. 14. Mortensen, Th. 1921: p. 180. Mortensen, Th. 1948b: p. 148.

RECOGNITION

GENERAL MORPHOLOGY: Test flattened, low, aboral side vaulted slightly, oval side flat. Parallel oblique series of tubercules (like a fine-toothed comb) across ambulacral plates on either side of a marked median furrow. Ambulacra wider than interambulacra on oval side. Anus above, near posterior margin of test. Primary spines short and numerous, club-shaped on "combed" ambulacral areas, straight or slightly curved elsewhere.

COLOUR: Uniform grey, grey-purple, or brown. Denuded test is dark grey to light brown. Preserved specimens usually dark green.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 14, 3 immature specimens; B 462, 5 fragments; B 496, 1 fragment; B 498, 10 fragments; B 646, 2 slightly worn fragments; B 661, 1 fragment; B 671, 9 fragments; C 177, 15 fragments; C 200, 4 fragments; C 272, 2 fragments; C 290, 1 fragment; C 295, 1 fragment, C 309, 3 fragments; C 334, 1 fragment; C 344, 3 fragments; C 479, 5 fragments; C 746, 29 fragments; C 751, 8 fragments; C 750, 6 fragments; C 754, 10 fragments; C 801, 19 fragments; C 803, 1 fragment; Waitarere Beach, several specimens.

PUBLISHED DATA

PM 4, off Te Haua Bank, Manukau Harbour, 7 m, fine sand (Powell 1936)
PM 9, off Te Haua Bank, Manukau Harbour, 29 m, sand
PM 10, off Wattle Bay, Manukau Harbour, 31 m, fine sand
PM 11, off Puhonga Point, Manukau Harbour, 31 m, fine sand
Inner Harbour Napier, shallow water, in great numbers (Mortensen 1921) (habitat since destroyed)
Wellington Harbour

DISTRIBUTION

GEOGRAPHIC

This species is recorded from the northern, central, and south eastern areas. On the west coast records extend from near Cape Maria van Diemen to Cape Foulwind, while the east coast records are from the Bay of Plenty and Hawke Bay. Mortensen (1948b) records this species from "The North Island and so far as Dunedin in the South Island." This was not confirmed by the survey, possibly because of the difficulty of sampling shallow waters off the open coast. The species is also doubtfully recorded from Australia.

BATHYMETRIC

Records cover all shelf zones, and there is one archibenthal occurrence (fragments only). Most records are from zones 1 and 2. The bulk of dead material occurs in zone 2, the balance coming equally from the other shelf zones. Records of live specimens occur in zone 1 and especially in zone 2.

Bathymetric Distribution of *Fellaster zelandiae*
(percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
1	20	19	23
2	80	39	50
3	0	19	15
4	0	19	15
Shelf records	100	96	96
Archibenthal records	0	4	4

SEDIMENT PREFERENCE

LIVE SPECIMENS: At one occurrence (B 14) the sediment is muddy sand, the dominant grade being very fine sand. Other records from Manukau Harbour (Powell 1936) are from a sandy sediment. (The different sieve mesh sizes used by Powell do not permit ready comparison with these data.)

FRAGMENTS: Sediments from sand to mud are represented. Sand (50% of the records) is the main type represented; muddy sand (33%) is next; then follow mud (10%) and sandy mud (6%). The dominant grade is fine sand (70% of the records), the other grades represented being medium sand (10%), very fine sand (5%) and mud (15%).

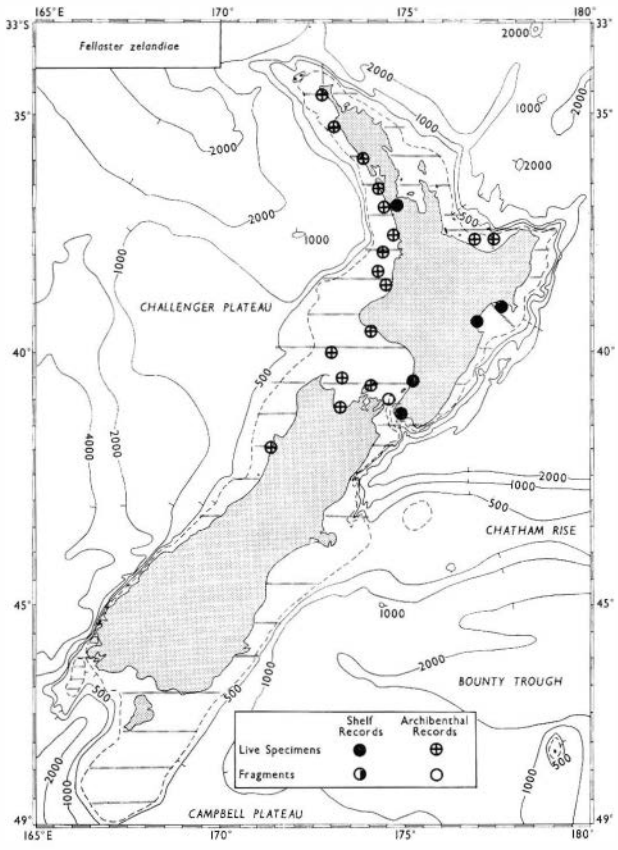


FIG. 32. Geographic distribution of *Fellaster zelandiae* (Gray). Survey lines indicated by hatching.

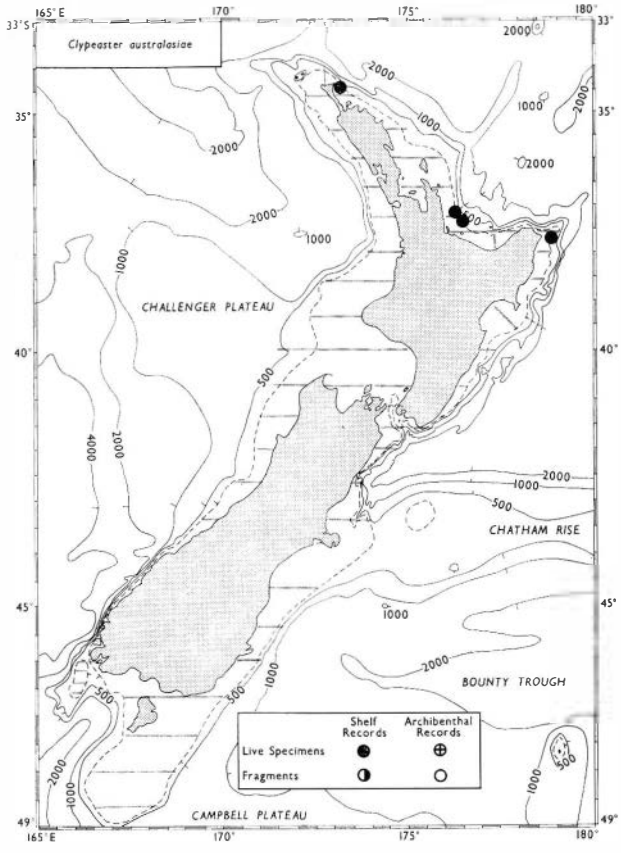


FIG. 34. Geographic distribution of *Clypeaster australasiae* (Gray). Survey lines indicated by hatching.

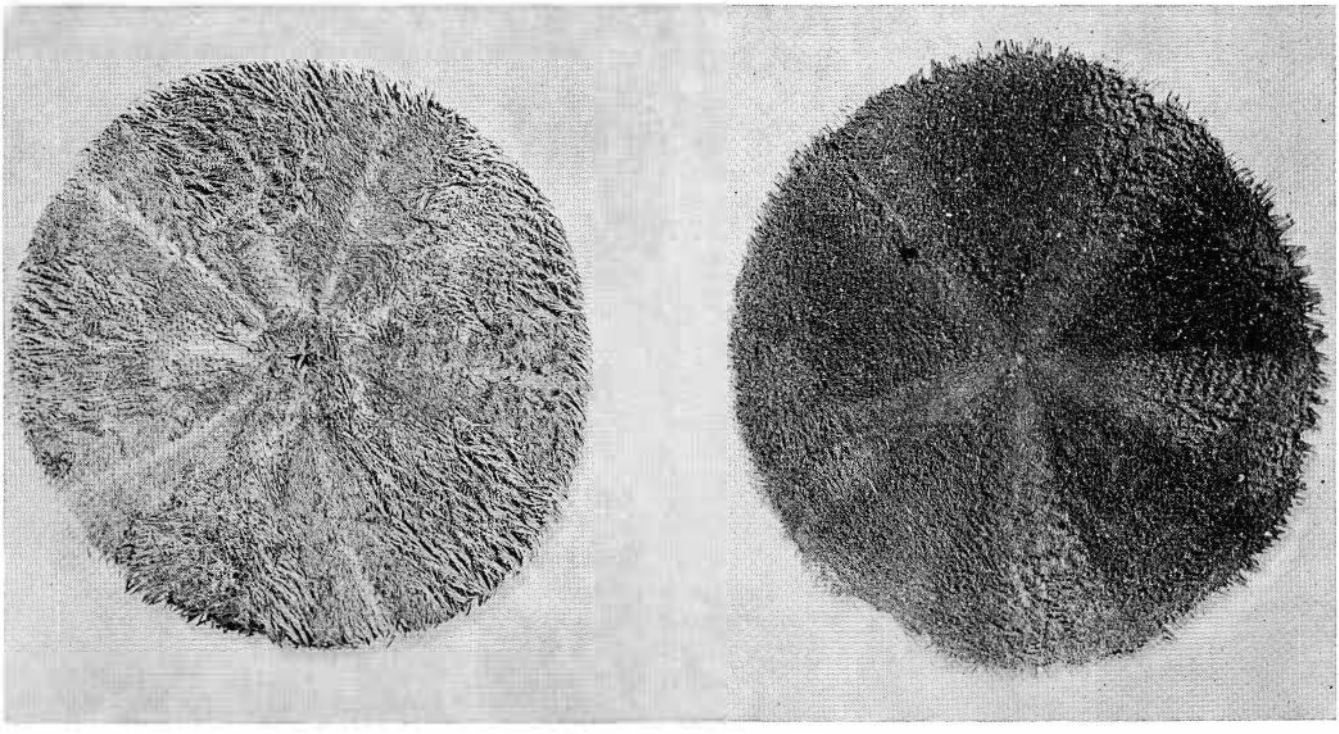


FIG. 33. *Fellaster zelandiae* (Gray).

Family CLYPEASTRIDAE

Clypeaster australasiae (Gray)
(Fig. 34)

REFERENCES: Gray, J. E. 1851: p. 34. Mortensen, Th. 1948b: p. 79. Fell, H. B. 1949: p. 345.

RECOGNITION

GENERAL MORPHOLOGY: Test flattened with internal supports. Outline ovoid to sub-pentagonal. Sometimes petaloid region raised subconically. Six–nine tubercules on each transverse costa between pore-pairs, tubercules of distal costa in a double series, others in a single series.

COLOUR: Spines green or light brown, white in specimens from "deeper water" (Mortensen 1948b). Denuded test light brown or white, sometimes with borders of plates conspicuously white. Turns green when damaged or preserved.

OCCURRENCES

PUBLISHED DATA (Fell 1949, 1958)

Off Parengarenga Harbour, 90–70 m	
NP 8, Bay of Plenty, 229–73 m	2 specimens
NP 9, Bay of Plenty, 183–110 m	1 specimen
Off East Cape, 157 m	

DISTRIBUTION

Known only from the north eastern area, from near North Cape to East Cape. Also known from Tasmania, south-eastern Australia, Lord Howe Island, and Norfolk Island; known bathymetric range intertidal(?) to 229 m.

Clypeaster virescens Doderlein

REFERENCES: Doderlein, L. 1885: p. 30. Mortensen, Th. 1925: p. 390. Mortensen, Th. 1948b: p. 96. Fell, H. B. 1949: p. 346.

RECOGNITION

GENERAL MORPHOLOGY: Test flattened, with internal supports. Test usually distinctly longer than wide, rarely pentagonal. Spines short and numerous. Costae between pore-pairs of petals with four or fewer tubercules in a single row.

COLOUR: Yellow-brown. Denuded test is uniform yellow or white, but turns green and then fades on preservation.

OCCURRENCE

PUBLISHED DATA

"From off New Zealand" (*Terra Nova* collections, recorded by H. L. Clark 1925)	2 specimens

DISTRIBUTION

The one record is presumed to be from the northern area. This species is known also from Australia (New South Wales), the Philippines, Indo-China, and southern Japan, in depths of *ca.* 40–300 m. This species was possibly found at Station C 441, 40° 00′ S 174° 17.5′ E, 42 m, off Wanganui, but the condition of the fragments does not permit positive identification.

Family LAGANIDAE

Peronella hinemoae (Mortensen)
(Figs. 35, 36)

REFERENCES: Mortensen, Th. 1921: p. 117. Mortensen, Th. 1948b: p. 284.

RECOGNITION

GENERAL MORPHOLOGY: Test flat, disc-like. More or less circular. Madreporic pores scattered over apical system, and individually visible. Oral ambulacral furrows not distinct. Spines of aboral side low and dense, primary spines of oval side longer and more scattered.

COLOUR: Red, turning green and fading on preservation. Dead test is white to straw-coloured.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 487, 2 specimens, 2 dead tests; B 489, 5 specimens, 12 tests, 3 fragments; B 576, 1 fragment; B 591, 2 specimens; B 659, 1 fragment; B 669, 6 specimens, 1 test, 2 fragments; B 673, 1 specimen; C 751, fragments; C 769, 2 fragments; C 776, 1 test, 2 fragments; C 780, 2 fragments; C 781, 1 test, 1 fragment; C 792, 1 fragment; C 796, 5 tests, 1 fragment.

PUBLISHED DATA

TN 96, off North Cape, 96 m	4 specimens (Mortensen 1921)
2 mi. E off North Cape, 110 m	1 specimen
Off Hen and Chicken Is., 100 m	4 specimens
Colville Channel, 70 m	2 specimens
NP 9, Bay of Plenty, 91–201 m	2 specimens (Fell, 1952, 1958)
NGH 3, Long Sound, narrow upper end of Preservation Inlet, 22–55 m, shell detritus	1 specimen
AL 13, Dusky Sound, off Passage Point, 22–27 m, sand	4 tests
Dusky Sound, Nine Fathom Passage, 17–18 m	3 tests

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 599, 1 test; B 658, 2 specimens, 3 tests, 6 fragments; B 666, 2 specimens; B 670, 3 tests, 2 fragments; B 674, 2 fragments; B 682, 4 fragments; C 275, 1 small fragment; C 748, 1 specimen, 1 fragment; C 749, 1 specimen; C 752, 1 specimen, 1 fragment; C 753, 12 specimens, 6 tests, 4 fragments; C 757, 1 test; C 770, 3 tests, 1 fragment; C 771, 1 specimen; C 777, 1 test, 2 fragments; C 778, fragments; C 783, fragments; C 793, 1 fragment; C 797, 1 test, 2 fragments; C 798, 1 specimen, 3 fragments; C 801, 1 test.

PUBLISHED DATA (Fell 1958)

NP 8, Bay of Plenty, 146–210 m	5 specimens
NP 9, Bay of Plenty, 91–201 m	2 specimens

Distribution

Geographic

This species is recorded from the northern, central western, and southern areas. In the northern and central western areas records extend from North Cape to the Bay of Plenty on the east coast and to off Cape Egmont on the west coast. In the southern area the records include southern Fiordland, Puysegur Bank, and the shelf to the south of Stewart Island. There are no west coast records between Cape Egmont and Dusky Sound, and no east coast records from the Bay of Plenty to off Stewart Island. It is recorded from the Kermadec and Norfolk Islands by Pawson (1965).

Bathymetric

The records cover all zones, with the greatest proportion in the archibenthal zone (52%). On the shelf, records are few from zone 1 (2%) increasing to 25% in zone 4. The depth range for both live specimens and dead material is 17–260 m.

Live specimens occur in all zones except zone 1 with 39% of the records in zone 4, and 50% in the archibenthal zone. The recorded depth range is 22–214 m. Dead material occurs in all zones, but most abundantly in the archibenthal. On the shelf records are rare from zones 1 and 2. The recorded depth range is 17–260 m.

Unbroken dead tests occur in all zones, but are uncommon in zones 1 and 2. On the shelf they occur mainly in zone 4; 50% of the records are from the shelf. The recorded depth range of tests is 17–260 m.

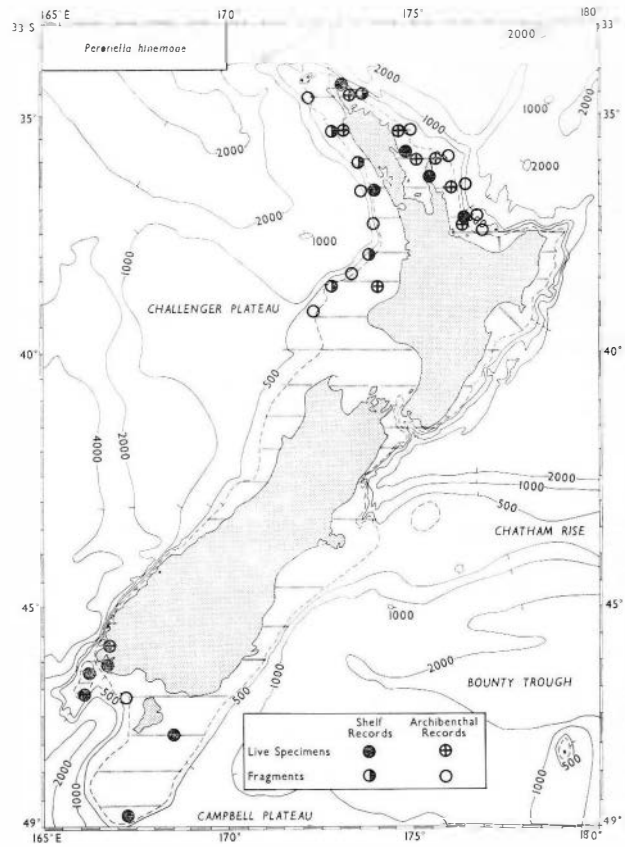


FIG. 35. Geographic distribution of *Peronella hinemoae* Mortensen. Survey lines indicated by hatching.

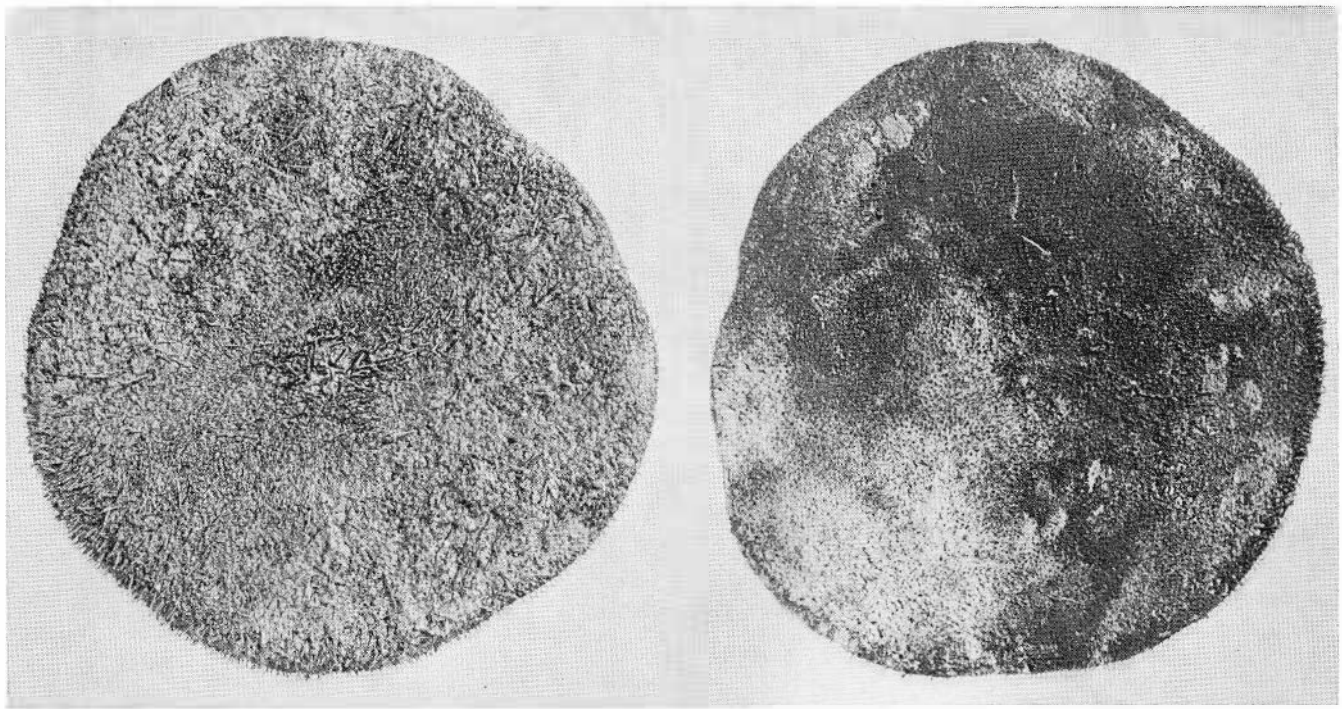


FIG. 36. *Peronella hinemoae* Mortensen.

Bathymetric Distribution of *Peronella hinemoae*
(percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (tests)	Total Records
[illegible]	0	3	2
[illegible]	6	3	5
[illegible]	11	19	18
[illegible]	39	19	25
Shelf records	50	43	48
Archibenthal records	50	56	52

Sediment Preference

The records cover all sediment types, occurring mainly with sand, muddy sand, and sandy mud. Only 3% of the records occur with sandy gravel.

There are no records of living specimens associated with gravelly sand or mud. Most are associated with sand or muddy sand, but specimens from Puysegur Bank are associated with a coarse sediment of gravel or sandy gravel.

Dead material occurs with all sediment types except sandy gravel, most occurring with sand, muddy sand, and sandy mud. The distribution of complete dead tests is similar.

Sediment Preference of *Peronella hinemoae*
(percentages)

Sediment	Records of Live Specimens	Records of Dead Material (tests)	Total Records
Gravel	18	7	6
Sandy gravel	8	0	3
Gravelly sand	0	10	9
Sand	33	20	21
Muddy sand	33	26	25
Sandy mud	8	30	30
Mud	0	7	6

Dominant grade: Fine sand is the dominant grade in 49% of the samples, mud in 27%, and gravel in 13%. In the samples containing dead material the situation is similar. No dead tests are found where coarse sand is the dominant grade, and fine sand is the dominant grade in 37% of the samples. No live specimens occur where very coarse sand, coarse sand, or mud is the dominant grade; 58% of the samples occur where fine sand is dominant, and 26% where granule gravel is dominant.

Dominant Grade in Samples
(percentages)

Grade	Records of Live Specimens	Records of Tests	Records of All Dead Material	Total Records
Granule gravel	26	21	11	13
Very coarse sand	0	7	4	3
Coarse sand	0	0	4	3
Medium sand	8	7	4	3
Fine sand	58	37	43	49
Very fine sand	8	7	4	3
Mud	0	21	30	27

Proportion of grade present: There are sufficient data to analyse the proportion of each grade present, in selected samples from northern New Zealand, containing live *Peronella hinemoae*. No specimens occur where the proportion of granule gravel, very coarse sand or coarse sand is greater than 10%; 28% of the specimens occur where the medium sand grade is below 10%, 6% where it is between 10% and 20%, and 67% where it is between 60% and 80%. No specimens occur where the fine sand grade is less than 10%, but 67% occur where it is between 10% and 20%. Higher proportions of this grade contain a lower percentage of specimens. No specimens occur where the fine sand grade is above 40%, and only 2% of the specimens occur where the proportion is between 20% and 40%; 83% of the specimens occur where very fine sand is present in a small proportion (0–10%). Most specimens (72%) occur where mud is between 10% and 20% of the sample. No specimens occur where the proportion of mud is over 40%.

Grade Preference of *Peronella hinemoae*
(from selected northern stations)

Grade	Proportion Present 0–10%	10–20%	20–40%	40–60%	60–80%	80–100%
Granule gravel	100	0	0	0	0	0
Very coarse sand	100	0	0	0	0	0
Coarse sand	100	0	0	0	0	0
Medium sand	28	6	0	0	67	0
Fine sand	0	67	6	6	11	11
Very fine sand	83	13	2	0	0	0
Mud	17	72	11	0	0	0

Laganum depressum (Quoy and Gaimard)
(Fig. 37)

References: Agassiz, L. 1841: p. 114. Mortensen, Th. 1921: p. 179. Mortensen, Th. 1948b: p. 323.

Recognition

General morphology: Test flattened, disc-like, elliptical. Anus on lower surface near mouth. Madreporic pores collected in sunken lines or irregular pits, *not individually visible.*

Colour: Uniform yellow brown, petals darker (dried specimens). Cleaned test yellow or white.

Shelf Occurrence

Published data: Off Hen and Chicken Is., 55 m (Mortensen 1921)

Distribution

Widely distributed in the southern Pacific, also occurring in Queensland, the Kermadec Islands, and New Zealand, in the intertidal zone and shallow water. Bathymetric distribution 0–55 m.

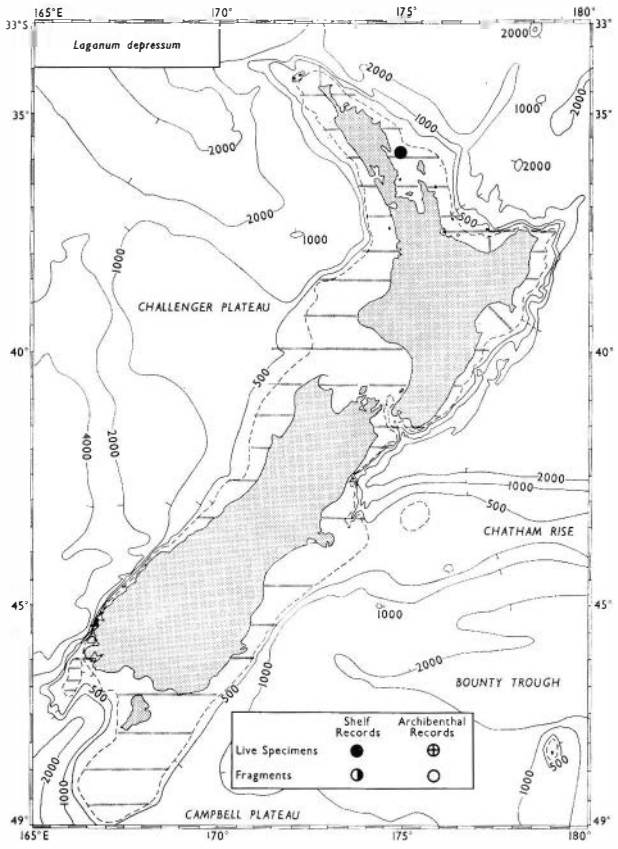


FIG. 37. Geographic distribution of *Laganum depressum* (Lesson). Survey lines indicated by hatching.

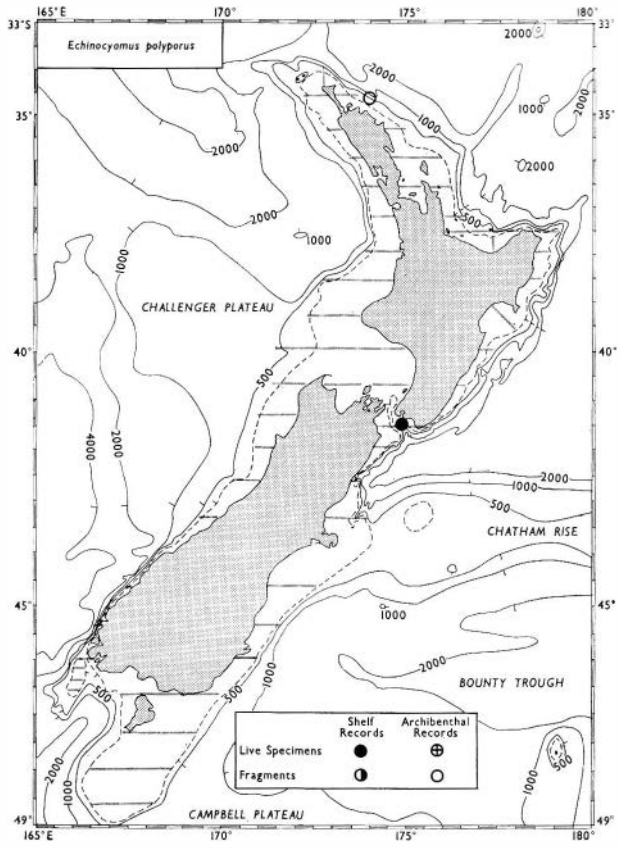


FIG. 38. Geographic distribution of *Echinocyamus polyporus* Mortensen. Survey lines indicated by hatching.

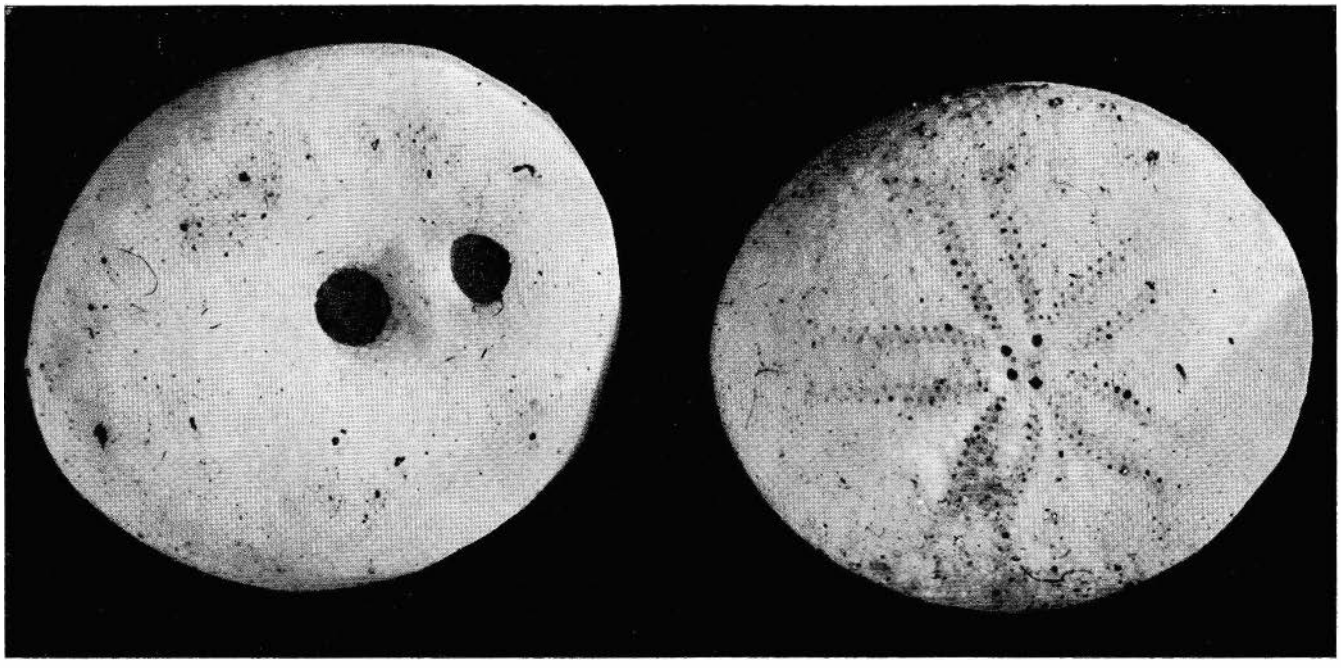


FIG. 39. *Echinocyamus polyporus* Mortensen.

Family FIBULARIIDAE

Echinocyamus polyporus Mortensen
(Figs. 38, 39)

REFERENCES: Mortensen, Th. 1921: p. 176. Mortensen, Th. 1948b: p. 200.

RECOGNITION

GENERAL MORPHOLOGY: Test small, ovoid. Broad ambulacra not reaching edge of test, pore series not convergent. Anus on lower surface behind mouth. Primary spines dense and short.

COLOUR: Uniform grey to white. Cleaned test is white but turns green and then fades on preservation.

SHELF OCCURRENCE

PUBLISHED DATA: Cook Strait, *ca.* 40 m (Mortensen 1921)

ARCHIBENTHAL OCCURRENCE

PUBLISHED DATA: 34° 45′ S 173° 51′ E, 529–536 m — 1 test (Pawson 1965)

DISTRIBUTION

Also known from the Kermadec Islands in shallow water (9–18 m) and Norfolk Island.

It has been suggested by Mortensen (1948b, p. 162) that the absence of living specimens of the Fibulariidae in his collections may have been due to the deep-burrowing habits of this family. This species is evidently rare in New Zealand waters, although common at the Kermadec Islands (Benham 1910).

Order **SPATANGOIDA**

Family SPATANGIDAE

Spatangus beryl Fell
(Figs. 40, 41)

REFERENCE: Fell, H. B. 1963a: p. 5.

RECOGNITION

GENERAL MORPHOLOGY: Test large (over 120 mm long), robust, heart-shaped. Periproct overhung by anal rostrum, visible from below. Subanal fasciole heart-shaped with a posterior re-entrant angle or re-entrant curve. Vertical series of tubercules on dorsal midline of posterior unpaired interambulacrum and on either side of the frontal groove. Only one or two enlarged tubercules if any, in any of the lateral interambulacra. Test thickly covered by short delicate spinules.

COLOUR: Deep reddish purple.

SHELF OCCURRENCE

PUBLISHED DATA (Fell 1963a): Foveaux Strait, western oyster beds, 1 specimen
Other specimens are known (Fell 1963a)

DISTRIBUTION

This species is known only from the south eastern area, presumably in moderate depths. The sediments of the Foveaux Strait oyster beds are generally fairly coarse.

Spatangus thor Fell
(Figs. 42, 43)

REFERENCES: Fell, H. B. 1963a: p. 3. Pawson, D. (MS).

RECOGNITION

GENERAL MORPHOLOGY: Test large (over 120 mm long), robust, heart-shaped. Periproct overhung by an anal rostrum, visible from below. Subanal fasciole heart-shaped with a posterior re-entrant angle or re-entrant curve. Vertical series of tubercules along dorsal midline of posterior unpaired interambulacrum, and on either side of frontal groove. About 15–17 enlarged whitish tubercules in each posterolateral ambulacrum in short zig-zag series. Test covered by dense, short, delicate spinules.

COLOUR: Deep reddish purple.

SHELF OCCURRENCE

PUBLISHED DATA (Fell 1963a): Foveaux Strait, western oyster beds, 29–34 m, 2 specimens

DISTRIBUTION

This species is recorded only from the south eastern shelf region, presumably from a fairly coarse sediment, in zone 2 (21–50 m). It is also recorded from Veryan Bank on the Chatham Rise, and the Bounty and Antipodes Islands, in depths of 43–324 m, on coarse sediments (the finest being described as "dark volcanic sand and gravel") by Pawson 1968. Recent collections from the archibenthal zone on the Chatham Rise contain this species. Small fragments from Sta. B 583 (48° 00′ S 167° 26′ E, 144 m, sandy gravel) may be referrable to either *S. thor* or *S. beryl*.

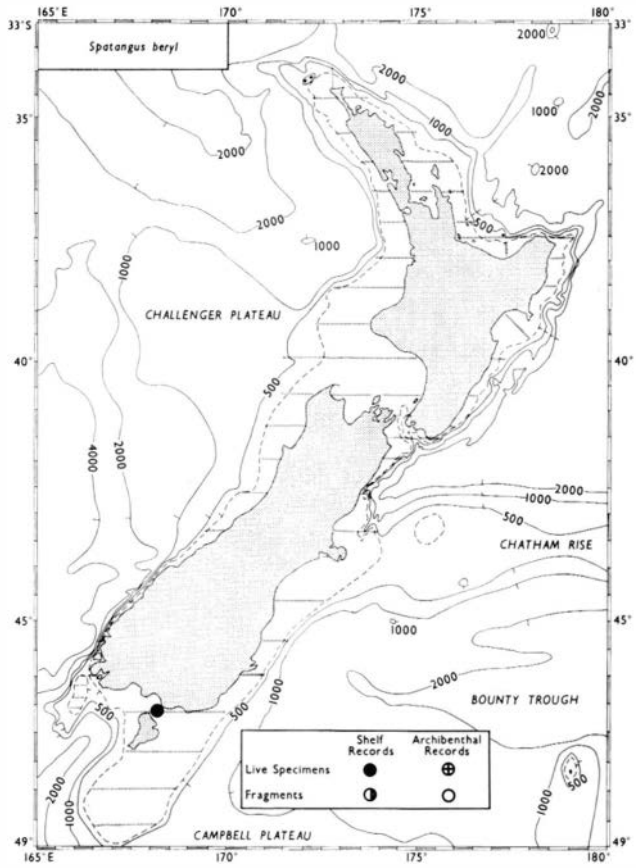


FIG. 40. Geographic distribution of *Spatangus beryl* Fell. Survey lines indicated by hatching.

Spatangus multispinus Mortensen
(Figs. 44, 45)

REFERENCES: Mortensen, Th. 1921: p. 413. Mortensen, Th. 1951: p. 15.

RECOGNITION

GENERAL MORPHOLOGY: Test large and low, broadly oval in outline, with a deep frontal groove, and test heart-shaped. Distinct petaloid ambulacra flush with surface of test. Posterior end of test almost vertically truncated. Primary spines long, erect, and fairly dense.

COLOUR: "Test and spines a deep rich violet fading after preservation to a dull mauve." (Fell 1960.)

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 59, many small fragments ("probably *S. multispinus*"—Fell pers. comm.); C 601, 1 fragmented specimen.

PUBLISHED DATA

Off Cape Campbell, 37 m, soft mud	1 specimen (Fell 1952)
Occasional shelf records in Cook Strait	
CIE 2, 42° 59.4′ S 175° 30.5′ E, 112 m, fine bryozoa, shell sand	9 specimens (Fell 1960)

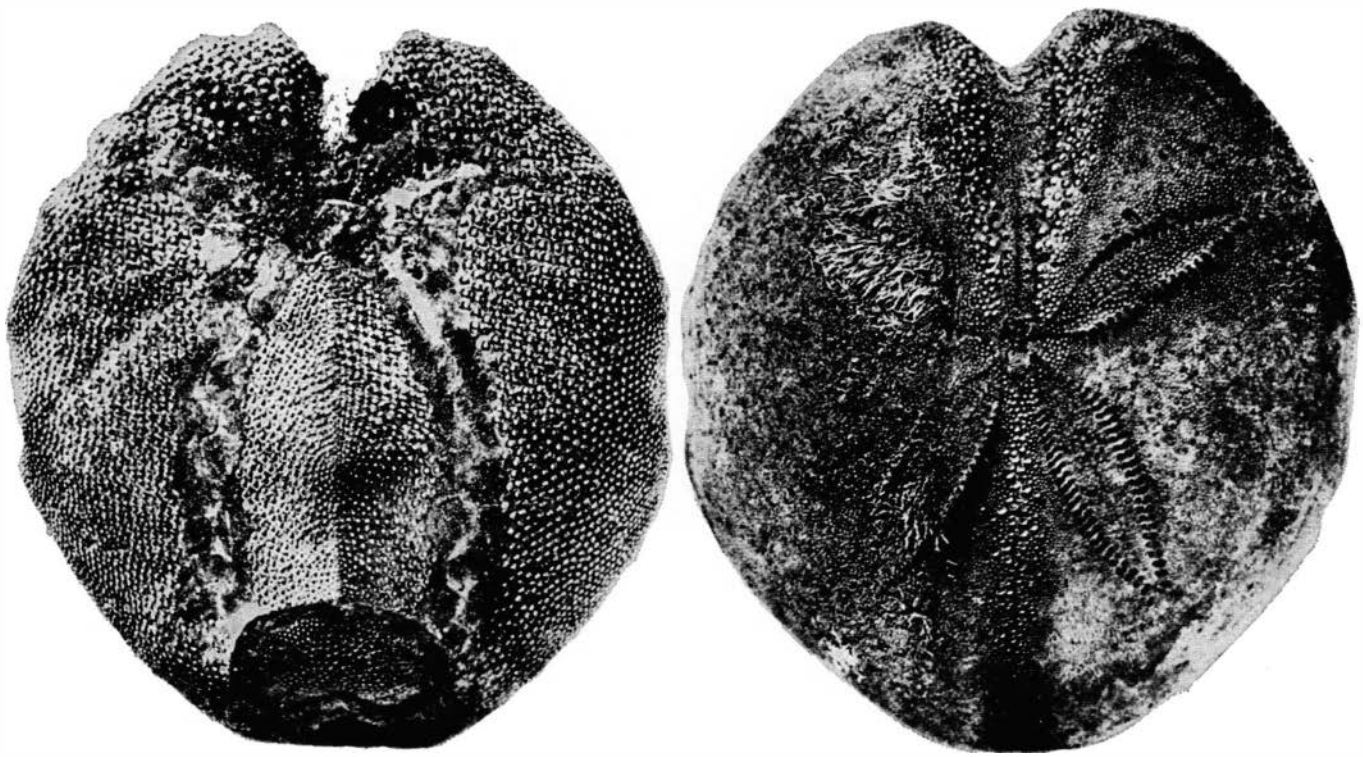


FIG. 41. *Spatangus beryl* Fell.

Archibenthal Occurrences

N.Z. Oceanographic Institute data

B 464, 1 fragmented specimen; B 543, live fragments; B 560, several fragments; B 634, 1 specimen; B 675, 7 specimens, fragments; C 607, 1 specimen; C 608, 7 specimens; C 637, 1 fragment; C 694, 1 specimen.

Published data (Fell 1958, 1960)

VUZ 53, Cook Strait, 457–640 m	30 specimens
VUZ 77, Cook Strait, 796 m	fragments
VUZ 96, Cook Strait, 732 m	1 small specimen
CIE 6, 43° 40′ S 179° 28′ E, 403 m, fine grey sand, mud	1 specimen
CIE 7, 43° 42′ S 179° 55′ E, 512 m, fine grey sand, mud	18 specimens, fragments
CIE 41, 44° 35.5′ S 176° 04′ W, 604 m, fine green sand, mud	1 specimen
CIE 52, 44° 04′ S 178° 04′ W, 476 m, fine green sand, mud	10 specimens, fragments
CIE 59, 43° 38′ S 177° 19′ W, 531 m, fine green sand, mud	2 specimens

Distribution

Geographic

On the shelf this species is known only from the central eastern area, i.e. Hawke Bay to Cape Campbell, Mernoo and Veryan Banks. Archibenthal records are from the north western, central, and south eastern areas, from Manukau Harbour to Cape Foulwind on the west coast, and Cook Strait to the Canterbury Bight and the Chatham Rise on the east coast.

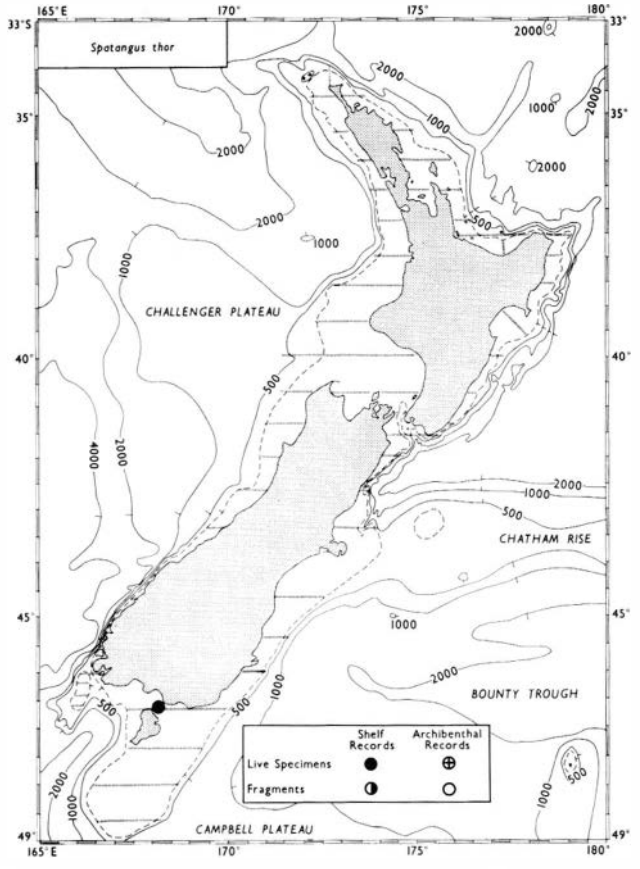


Fig. 42. Geographic distribution of *Spatangus thor* Fell. Survey lines indicated by hatching.

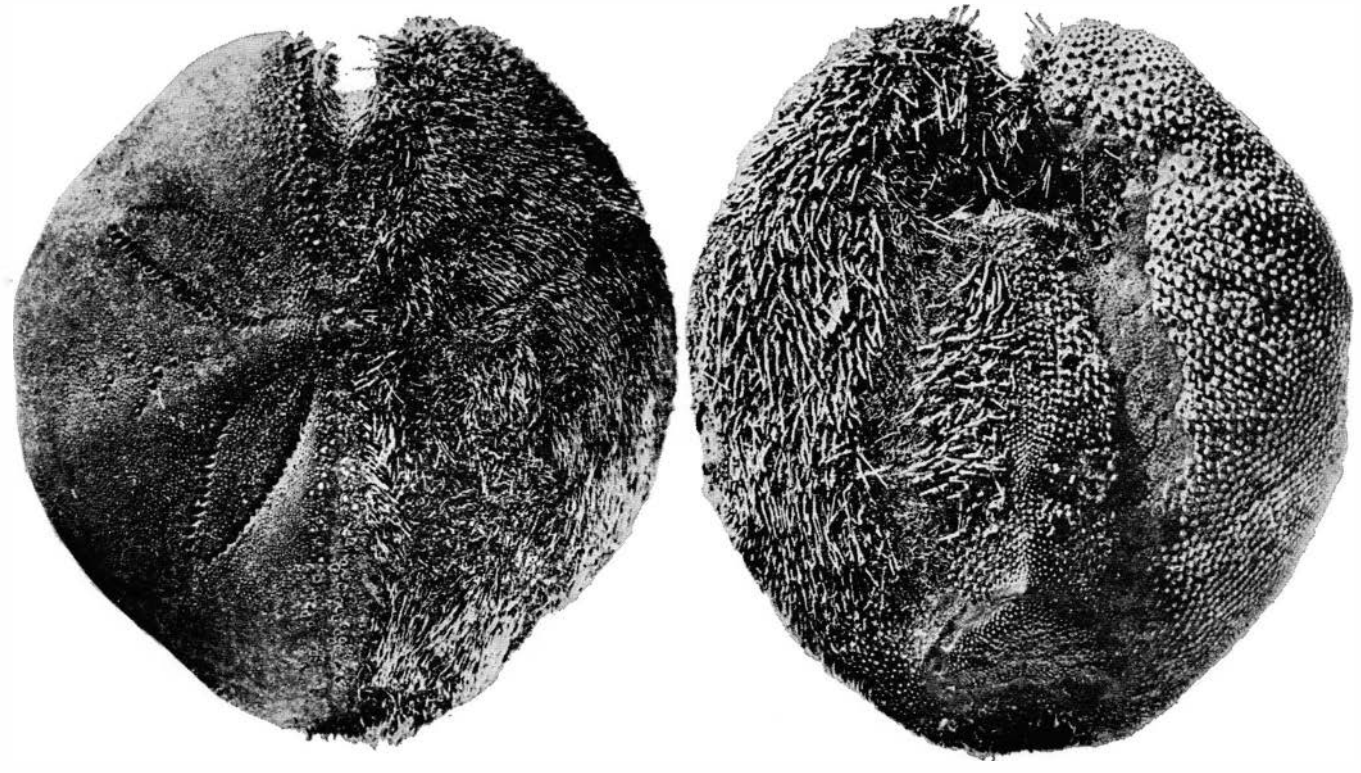


Fig. 43. *Spatangus thor* Fell.

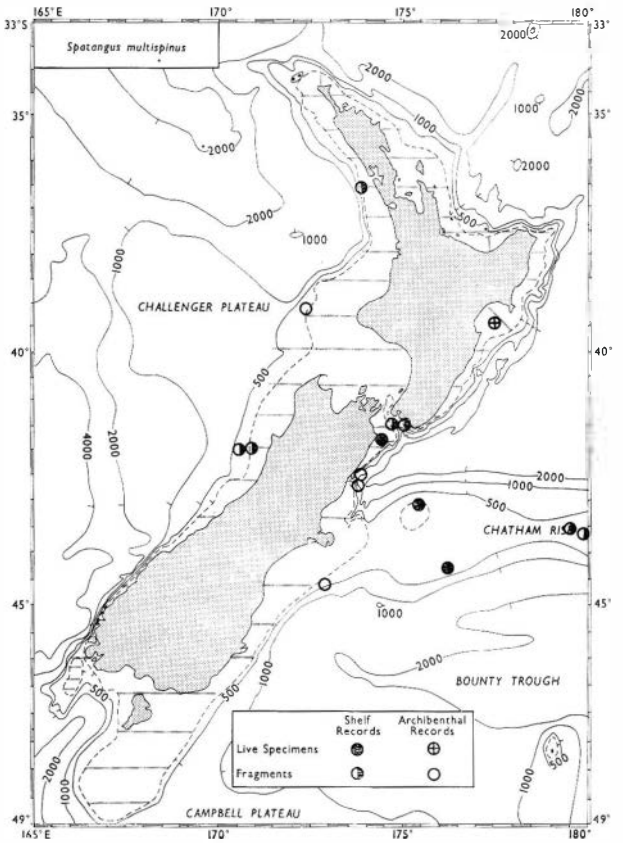


FIG. 44. Geographic distribution of *Spatangus multispinus*. Survey lines indicated by hatching.

BATHYMETRIC

The total recorded depth range is 37–980 m, and the known depth range of living material is 37–732 m. On the shelf there are no records from zones 1 or 3, and only one from zone 2; most shelf records are from zone 4. The species is decidedly archibenthal with 87% of the records from this zone.

Bathymetric Distribution of *Spatangus multispinus* (percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
1	0	0	0
2	6	0	5
3	0	0	0
4	12	14	14
Shelf records	18	14	19
Archibenthal records	82	86	81

SEDIMENT PREFERENCE

Most records (68%) occur with mud, the other sediments represented being muddy sand and sand. Most records of live specimens (75%) are from mud, and sand is the only other sediment represented. Fragments occur equally on sand, muddy sand, and mud. The dominant grade in the samples is mud; the only other

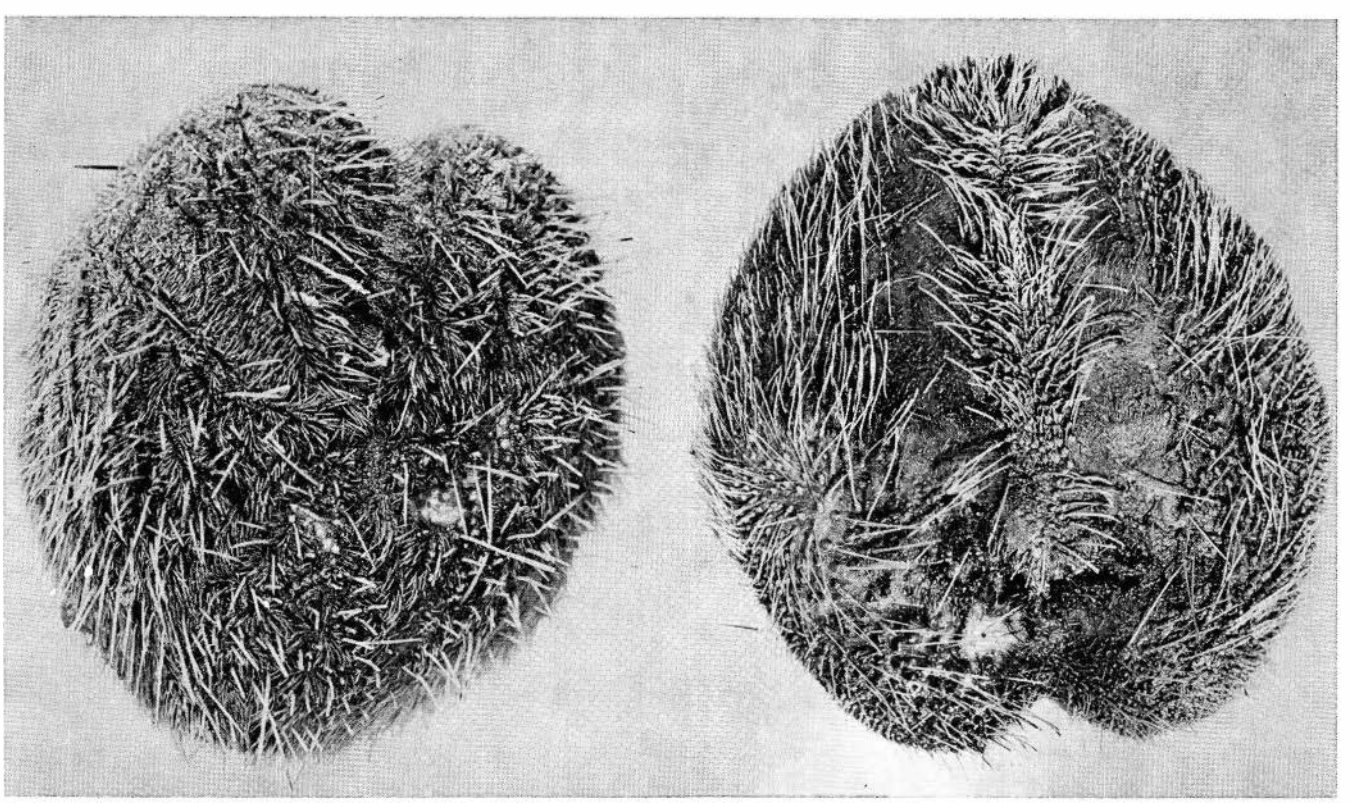


FIG. 45. *Spatangus multispinus* Mortensen.

grade represented is sand. At Station B 583 (48° 00′ S 167° 20′ E, 144 m, sandy gravel) small fragments of *Spatangus* were collected. In view of the pronounced preference for fine sediments of *S. multispinus*, it seems probable that these fragments indicate the presence of *S. beryl* or *S. thor*.

Sediment Preference of *Spatangus multispinus* (percentages)

Sediment	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Gravel	0	0	0
Sandy gravel	0	0	0
Gravelly sand	0	0	0
Sand	25	33	16
Muddy sand	0	33	16
Sandy mud	0	0	0
Mud	75	33	68

Dominant Grades in Samples (percentages)

Grade	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Granule gravel	0	0	0
Very coarse sand	0	0	0
Coarse sand	0	0	0
Medium sand	0	0	0
Fine sand	0	33	16
Very fine sand	0	0	0
Mud	100	67	84

Paramaretia peloria (H. L. Clark)
(Figs. 46, 47)

REFERENCES: Clark, H. L. 1916: p. 121. Mortensen, Th. 1951: p. 51. Fell, H. B. 1963a: p. 8.

RECOGNITION

GENERAL MORPHOLOGY: Test large (up to *ca.* 120 mm long), fairly strong. Aboral side low and arched, oval side concave, edge of test fairly sharp. Petals narrow, flush with test, only a slight frontal depression. Plastron bare except at posterior end. Very few large primary tubercules in posterior unpaired interambulacrum.

COLOUR: Greyish fawn.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 567, 1 specimen, 1 fragment; B 576, 4 fragments; B 579, 2 fragments; B 580, 6 fragments; B 583, 14 fragments; B 592, 1 fragment; B 593, *ca.* 10 fragments; B 594, 1 specimen, fragments.

PUBLISHED DATA (Fell 1963a): Near Taiaroa Heads; Foveaux Strait.

ARCHIBENTHAL OCCURRENCE

N.Z. OCEANOGRAPHIC INSTITUTE DATA: B 566, 1 specimen.

DISTRIBUTION

GEOGRAPHIC

This species is known from the south eastern area only on the shelf, and the only archibenthal record occurs here also. *P. peloria* also occurs at the Bounty Islands in 306 m (Pawson, 1968).

BATHYMETRIC

In the N.Z. Oceanographic Institute stations there are no records from zones 1–3 and 89% of the records occur in zone 4. The species is recorded only once as living in the archibenthal zone. However, the one record from Foveaux Strait implies that this species does inhabit shallower water than indicated. The total recorded depth range is 126–644 m, and the recorded range of live specimens is 126–177 m.

Bathymetric Distribution of *Paramaretia peloria* (percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
1	0	0	0
2	0	0	0
3	0	0	0
4	67	100	89
Shelf records	67	100	89
Archibenthal records	33	0	11

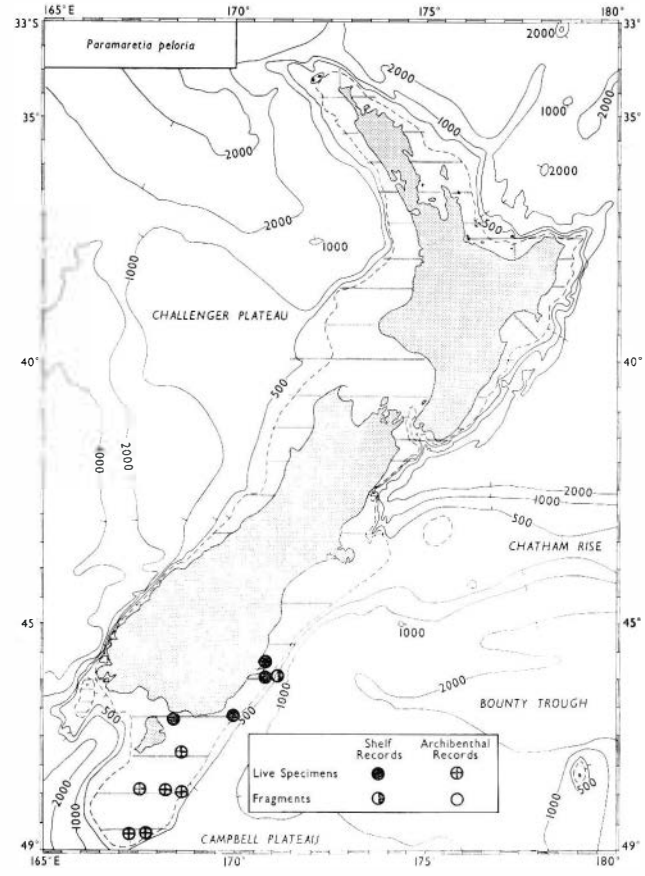


FIG. 46. Geographic distribution of *Paramaretia peloria* (H. L. Clark). Survey lines indicated by hatching.

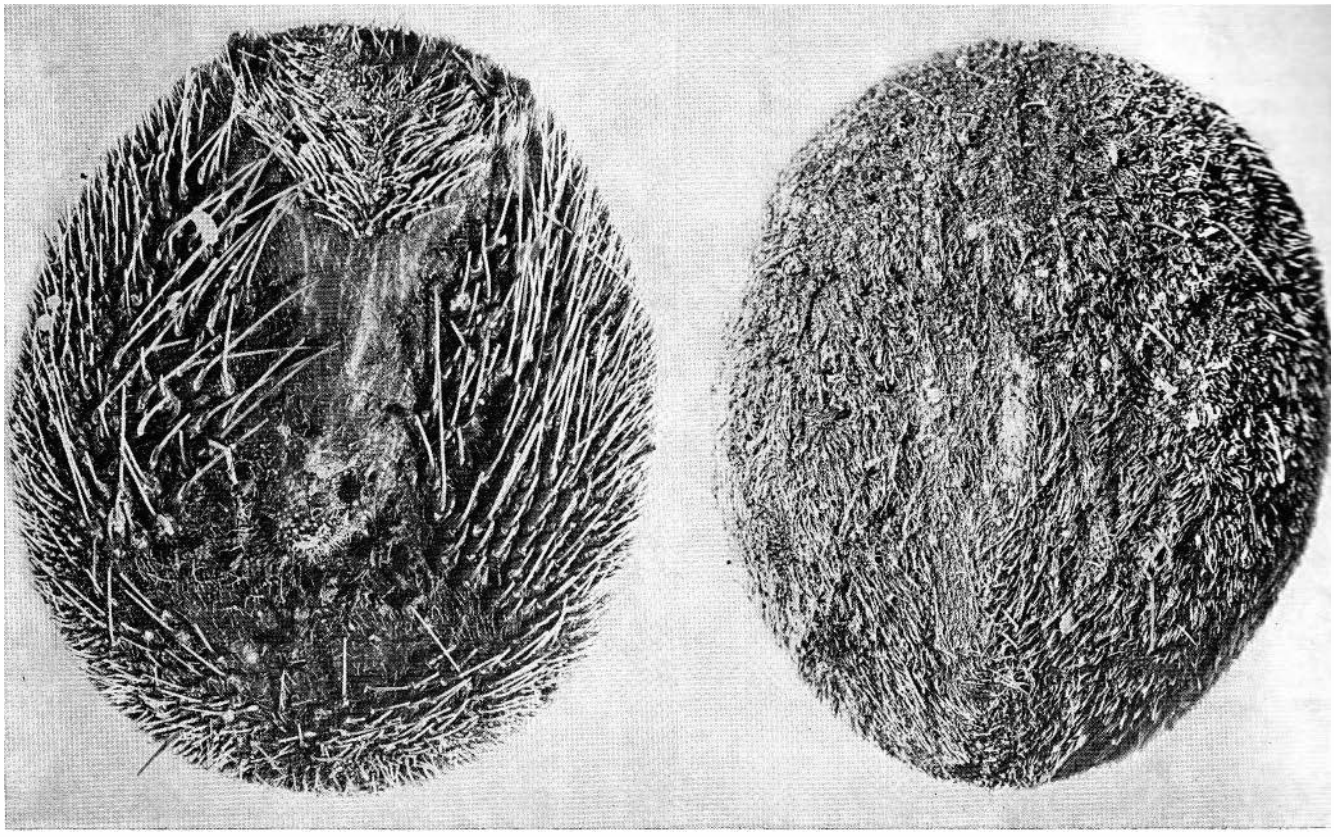


FIG. 47. *Paramaretia peloria* (H. L. Clark).

SEDIMENT PREFERENCE

All records of live specimens occur in sandy gravel (67%) or gravelly sand (33%); fragments also occur in these two grades. Granule gravel is the dominant grade in the samples. All records of live specimens occur where granule gravel is dominant. Most fragments (75% of the records) occur where granule gravel is dominant, but 25% of the records occur where coarse sand is dominant.

Sediment Preference of *Paramaretia peloria* (percentages)

Sediment	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Gravel	0	0	0
Sandy gravel	67	50	56
Gravelly sand	33	50	44
Sand	0	0	0
Muddy sand	0	0	0
Sandy mud	0	0	0
Mud	0	0	0

Dominant Grades in Samples (percentages)

Grade	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Granule gravel	100	75	78
Very coarse sand	0	0	0
Coarse sand	0	25	22
Medium sand	0	0	0
Fine sand	0	0	0
Very fine sand	0	0	0
Mud	0	0	0

Family LOVENIIDAE

Echinocardium cordatum (Pennant)
(Figs. 48, 49)

REFERENCES: Pennant, T. 1777: p. 58. Mortensen, Th. 1921: p. 192. Mortensen, Th. 1951: p. 152.

RECOGNITION

GENERAL MORPHOLOGY: Test small–medium, low, and thin. Anterior ambulacrum in a groove and notching anterior test margin. Outline heart-shaped. Pore zones of ambulacra (excluding anterior one) confluent on upper surface, and not separately distinguishable. Spines of moderate length.

COLOUR: A uniform brown, pore zones darker.

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

A 322, numerous specimens; A 323, 6 specimens; A 326, fragments; A 327, fragments; A 437, 3 specimens; A 438, 1 specimen; A 445, 3 specimens, fragments; A 447(a), 3 specimens, fragments; B 1, fragments; B 2, fragments; B 6, 3 young specimens; B 11, fragments; B 15, fragments; B 18, minute fragments; B 37, 12 young specimens, fragments; B 38, 5 young specimens, fragments; B 39, fragments; B 40, 1 spine; B 42, fragments; B 43, fragments; B 44, 4 young specimens, fragments; B 45, fragments; B 46, fragments; B 60, fragments; B 61, fragments; B 62, fragments; B 63, fragments; B 232, live fragments; B 253, 1 specimen, B 296; 5 specimens; B 461, 5 specimens; B 466, fragments; B 467, 115 specimens; B 471, 2 fragments; B 492, 1 specimen, 1 fragment; B 496, 5 specimens, fragments; B 497, 11 specimens, fragments;

B 498, 39 specimens, fragments; B 538, 2 fragments; B 542, 2 specimens; B 546, 7 specimens; B 547, 3 specimens, fragments; B 550, fragments; B 553, 9 specimens, fragments; B 554, 1 specimen; B 555, 1 specimen; B 558, 2 specimens, fragments; B 601, 1 specimen; B 613, 5 specimens; B 614, 9 specimens; B 617, 1 small specimen; B 618, 3 small specimens; B 621, 8 specimens, fragments; B 626, 1 specimen, fragments; B 627, 2 specimens, fragments; B 628, fragments; B 629, 1 specimen; B 630, 8 specimens; B 635, 1 specimen; B 667, fragments; B 688, 1 specimen, fragments; B 689, 2 specimens; B 690, very numerous; B 691, 6 specimens; C 186, 254 specimens, fragments; C 187, 14 specimens, fragments; C 188, fragments; C 218, fragments; C 220, 1 specimen; C 228, 2 specimens, fragments; C 229, several live fragments; C 259, 2 specimens, fragments; C 272, 5 fragments; C 415, 3 specimens; C 421, 15 fragments; C 433, *ca.* 20 fragments; C 462, *ca.* 12 fragments; C 463, 1 specimen, fragments; C 464, 4 specimens, fragments; C 465, fragments; C 466, 9 specimens, fragments; C 467, *ca.* 20 fragments; C 468, 1 specimen, *ca.* 25 fragments; C 469, 2 specimens, 1 fragment; C 470, 2 specimens, fragments; C 471, 3 specimens, fragments; C 472, 2 specimens, fragments; C 473, 2 specimens, fragments; C 474, 2 specimens, fragments; C 476, 1 specimen, fragments; C 477, *ca.* 10 fragments; C 478, 5 specimens; fragments; C 479, many fragments; C 480, 1 specimen, fragments; C 481, 1 specimen, fragments; C 482, many fragments; C 483, fragments; C 755, fragments; C 768, 2 specimens, fragments; C 787, 530 specimens, fragments; C 790, 2 specimens; C 863, 5 fragments; C 864, 1 spine, 26 fragments; C 865, 1 specimen, fragments; C 866, 1 spine, 12 fragments.

PUBLISHED DATA

Tiritiri Matangi I., 30 m	numerous (Mortensen 1921)
Wellington Harbour	
Queen Charlotte Sound, near entrance, 37–55 m	1 specimen
Queen Charlotte Sound	3 specimens
Tasman Bay	
Cape Campbell	
North Otago shelf, 55–88 m, mud, shell, sand	1 specimen (Graham 1962)
Paterson Inlet, Stewart I., 30 m	1 specimen
Northport, Chalky Inlet	
NZGT 30, 18 mi. ENE of Oamaru, 64 m, ooze	3 immature specimens (Benham 1909)
NGH 1, Preservation Inlet, Revolver Arm, 24 m, mud	2 specimens (Fell 1952)
NGH 3, Long Sound, narrow upper end of Preservation Inlet, 22–55 m, shell detritus and sand	3 specimens
NGH 56A, Dusky Sound, Supper Cove, 37 m, mud	2 specimens
AL 1, Pelorus Sound, 22–27 m, fine viscid mud	1 specimen
AL 3, Pelorus Sound, across entrance, 55 m, fine mud, shell, and coral	2 specimens
AL 4, W of middle Trio I., 37 m, fine mud, shell, and coral	1 specimen
AL 6, 1 mi. NE off entrance to Kaiteriteri Cove, 9 m, very fine gluey clay mud	1 specimen
AL 10, 3 mi. SE off Tonga Cove, Tasman Bay, 27 m, fine gluey mud and shell detritus	1 specimen
AL 12, Doubtful Sound, Gaol Passage, 91 m	1 specimen
AL 19, Stewart I., Paterson Inlet, N off south point of Kaipipi Bay, 9 m, mud and sand	8 specimens
AL 29, Preservation Inlet, near entrance	2 specimens (Powell 1936)
PB 18, Off Hobson Point, Auckland Harbour, 7 m, mud	
PB 34, Off Sandspit Beacon, Devonport, Auckland Harbour, 9 m, sandy mud	

The following 18 stations in Hauraki Gulf

PC 7, Between Islington Bay and Browns I., 11 m, mud	
PD 12, Midway along SE coast of Motuike I., 11 m, mud	
PD 17, Tamaki Strait, 8 m, mud	
PD 19, Mataitia Bay, 4 m, mud	
PE 8, Off Takapuna Beach, 7 m, mud, sand	
PE 9, Midway between Takapuna and Rangitoto I., 13 m, mud, sand	
PE 12, S off Takapuna Beach, 9 m, shell, mud	
PG 1, Off NW coast of Motutapu I., 18 m, mud	
PG 2, Off Station Bay, Motutapu I., 9 m, mud	
PG 3, Between Motutapu I., and Rangitoto I., 20 m, mud	
PH 3, Outside David Rocks, 27 m, mud	
PH 5, Between David Rocks and Rakino I., 20 m, mud	
PH 8, Between "Noises" and Rakino I., 22 m, mud	
PI 3, NE off Manly, Whangaparaoa Peninsula, 8 m, sand, mud	
PI 4, Off Manly Bay, Whangaparaoa Peninsula, 8 m, sand, mud	
PJ 2, Hooks Bay, Waiheke I., 9–6 m, mud-shell mud	
PJ 3, From rock towards Cowes Bay, Waiheke I., 15 m, mud	
PJ 5, Off Tarakihi I., (Shag Rock), 37 m, mud	
DMBS 102, *ca.* 41° 04.3′ S 174° 22.4′ E, 46 m, black fine sandy mud	8 specimens (Dell 1951)
DMBS 103, *ca.* 41° 09.5′ S 174° 19′ E, 18m, fine yellowish mud	1 specimen

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA: A 319, 5 specimens; A 320, 6 specimens; B 491, 1 specimen; C 411, 1 specimen.

DISTRIBUTION

GEOGRAPHIC

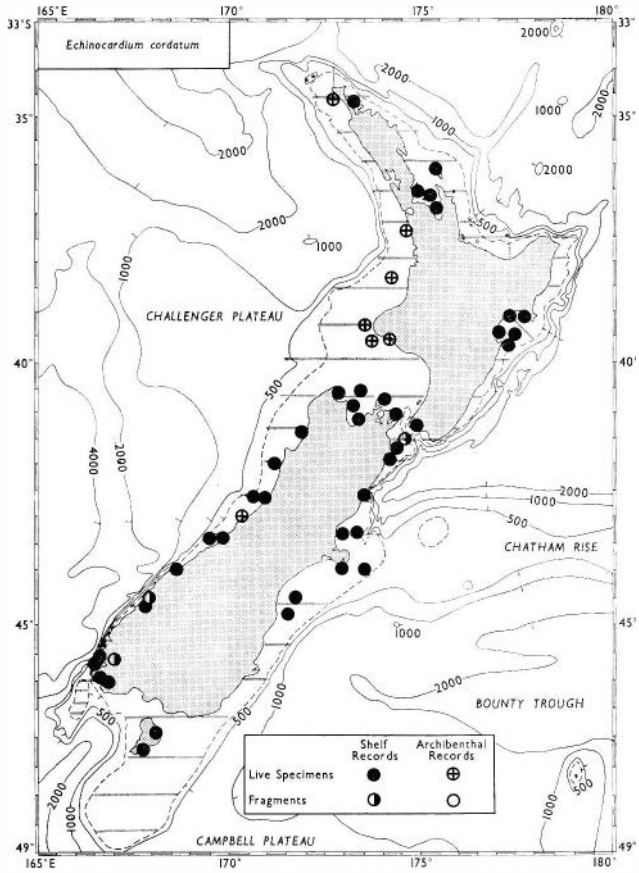
This species, the commonest collected during the survey, occurs in all areas, mainly in sheltered or coastal waters. Records are absent from most of the North Island shelf and there are no records in the southern area except for those in sheltered localities.

BATHYMETRIC

Records are mainly (72%) from zones 1 and 2, but records occur in all the other zones. All the fragments and nearly all the specimens occur on the shelf and there are only four archibenthal records: two in Milford Sound, one in Dusky Sound, and one in Cook Strait. The recorded depth range is 4–269 metres.

Bathymetric Distribution of *Echinocardium cordatum* (percentages)

Depth Zone	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
1	35	30	30
2	43	43	42
3	14	16	16
4	5	11	9
Shelf records	97	100	97
Archibenthal records	3	0	3



Sediment Preference

This species occurs on sediments ranging from sand to mud. Most records of live specimens are from sandy mud, least from sand. Fragments are least common in sandy mud, most common in mud.

Sediment Preference of *Echinocardium cordatum* (percentages)

Sediment	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Gravel	0	0	0
Sandy gravel	0	0	0
Gravelly sand	0	0	0
Sand	11	15	15
Muddy sand	25	26	25
Sandy mud	39	8	16
Mud	25	51	44

Mud is the dominant grade in 65% of all the samples. Very fine sand and fine sand are each dominant in 15% of the samples, muddy sand in 4% of the samples, and very coarse sand in 1% of the samples. The records of live specimens occur mainly where mud is the dominant grade. One anomalous record is noted. At station A 323 (Milford Sound) the dominant grade is very coarse sand making up 64.5% of the sediment. This is the coarsest grade represented in this sample; the grades of fine sand, very fine sand, and mud represent nearly 35%.

FIG. 48. Geographic distribution of *Echinocardium cordatum* (Pennant). Survey lines indicated by hatching.

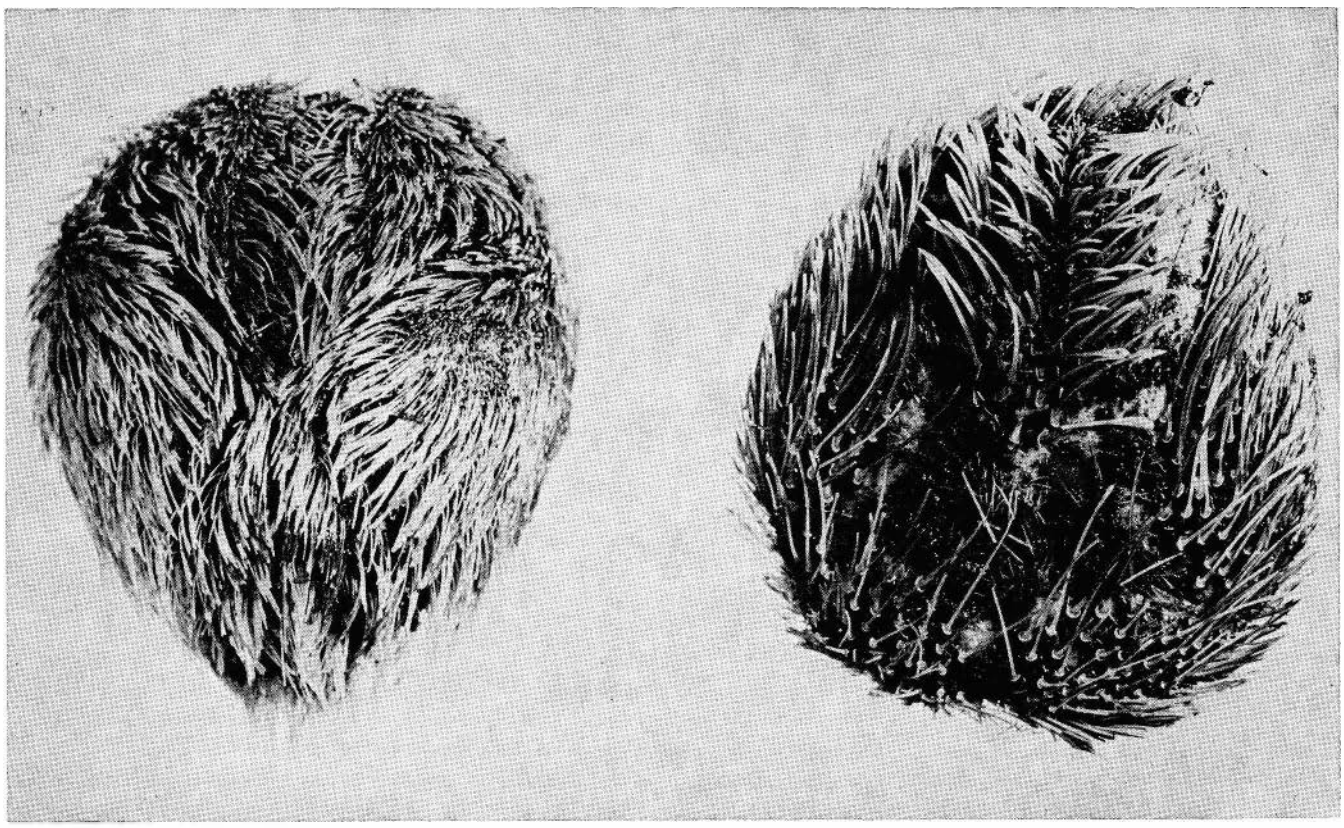


FIG. 49. *Echinocardium cordatum* (Pennant).

Dominant Grades in Samples (percentages)

Grade	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Granule gravel	0	0	0
Very coarse sand	1	0	1
Coarse sand	0	0	0
Medium sand	2	8	4
Fine sand	14	20	15
Very fine sand	8	18	15
Mud	75	54	65

There are sufficient data to analyse the proportion of each sediment grade in the samples. All the samples contain less than 10% of granule gravel, and all except A 323, less than 10% of very coarse sand. No samples contain more than 20% of coarse or medium sand. The species is most abundant where the proportion of fine sand is low (0–10%), but does occur where the proportion is from 80–100%. Most samples (42%) contain less than 10% of very fine sand and none more than 80%. All proportions of mud are represented, but the species is most abundant where the proportion is 40–60%.

Grade Preference of *Echinocardium cordatum* (from 45 stations)

Grade	Proportion Present 0–10%	10–20%	20–40%	40–60%	60–80%	80–100%
Granule gravel	100	0	0	0	0	0
Very coarse sand	96	0	0	0	4	0
Coarse sand	95	5	0	0	0	0
Medium sand	92	8	0	0	0	0
Fine sand	56	14	15	8	6	1
Very fine sand	42	10	35	7	5	0
Mud	12	2	12	36	12	25

Family BRISSIDAE

Brissopsis oldhami Alcock
(Figs. 50, 51)

REFERENCES: Alcock, J. 1893: p. 174. Mortensen, Th. 1951: p. 395, p. 409. Fell, H. B. 1958: p. 38. Fell, H. B. 1960: p. 73.

RECOGNITION

GENERAL MORPHOLOGY: Test more or less heart-shaped with anterior ambulacral notch and anterior ambulacrum in a groove, fairly fragile. Ambulacral grooves shallow, not extending past central area of upper surface, and not confluent at apex. A conspicuous fasciole surrounds all ambulacra except anterior one. Also a subanal fasciole. Spines short, numerous.

COLOUR: "Pale dull yellow-pink, the fascioles wine-coloured. Juvenile specimens dull pink, the fascioles purplish and the eye-spots showing up as red dots" (Fell 1960).

SHELF OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

C 182, 39° 50′ S 173° 57′ E, 66 m, muddy sand	1 fragment
C 769, 34° 40.1′ S 173° 11.2′ E, 77 m, muddy sand	7 fragments

PUBLISHED DATA

Off Bare I., *ca.* 75 m	2 specimens (Mortensen 1921)
VUZ 54, Cook Strait, 91–366 m	2 juvenile specimens (Fell 1958)

ARCHIBENTHAL OCCURRENCES

N.Z. OCEANOGRAPHIC INSTITUTE DATA

B 290, 2 specimens; B 291, 2 specimens, 1 fragment; B 313, 1 juvenile specimen; B 683, 1 fragment; C 401, 2 specimens; C 403, 2 specimens; C 488, 1 specimen; C 493, *ca.* 30 fragments; C 605, several fragments; C 607, 28 specimens; C 619, 1 specimen; C 637, 1 fragment; C 656, 1 specimen, fragments; C 657, 1 specimen, fragments; C 658, several fragments; C 665, 2 juvenile specimens; C 669, 1 large specimen, fragments; C 686, 1 specimen, fragments; C 692, *ca.* 15 specimens; C 693, 17 specimens, fragments; C 694, fragments; C 697, 1 specimen.

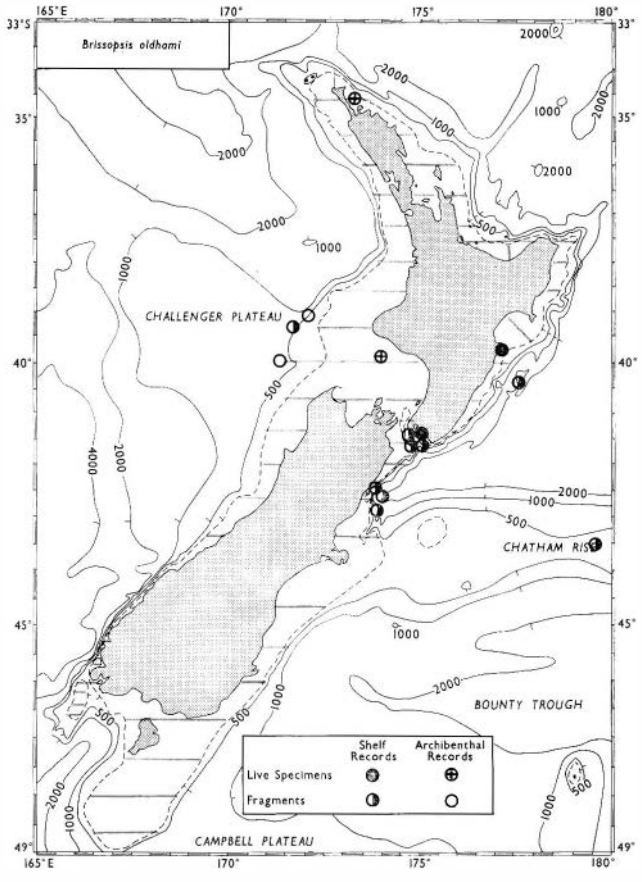


FIG. 50. Geographic distribution of *Brissopsis oldhami* Alcock Survey lines indicated by hatching.

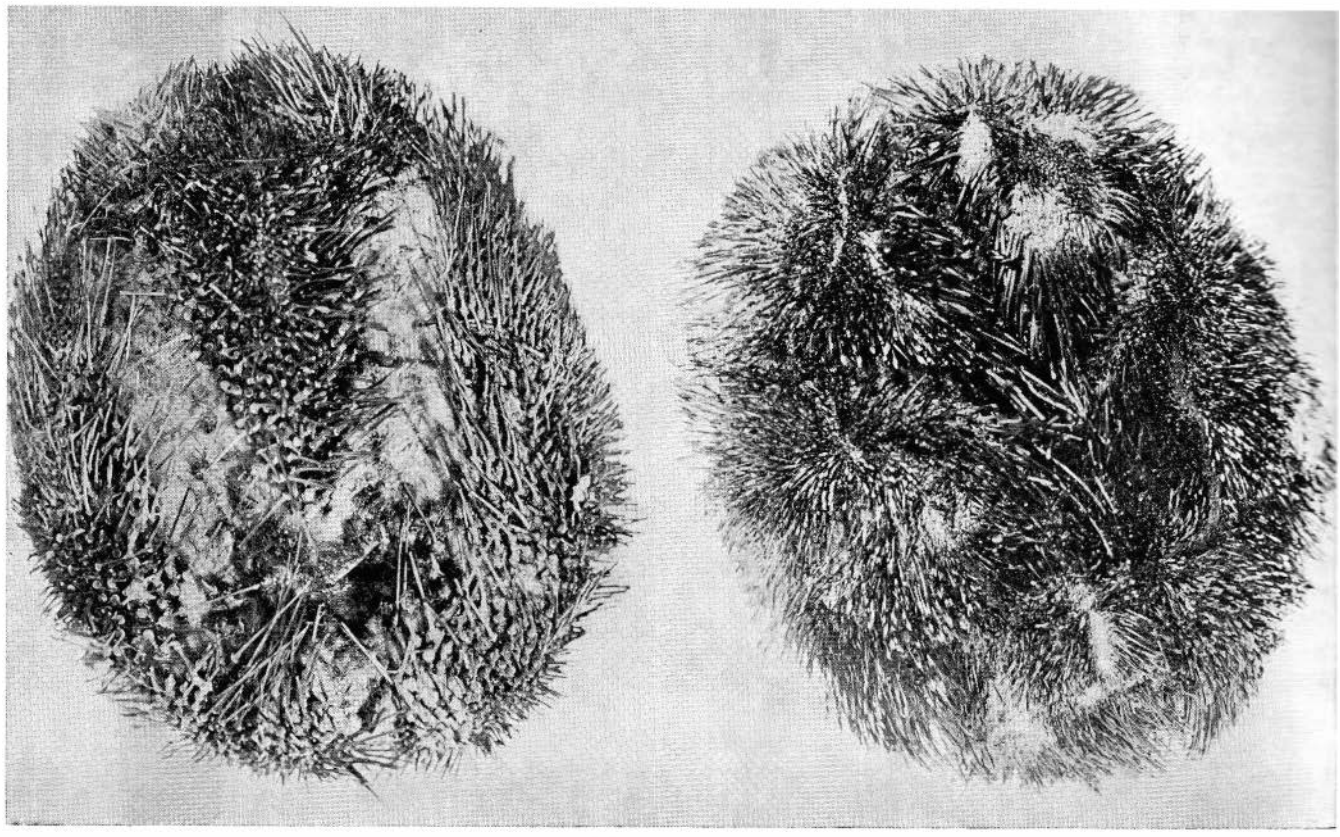


FIG. 51. *Brissopsis oldhami* Alcock.

PUBLISHED DATA

Ch 168, 40° 28′ S 177° 43′ E, 2,012 m, "grey ooze"	1 specimen (Agassiz 1881)
VUZ 10, Cook Strait, 366–457 m	9 specimens (Fell 1958)
VUZ 53, Cook Strait, 457–640 m	2 juvenile specimens
VUZ 54, Cook Strait, 91–366 m	2 juvenile specimens
VUZ 77, Cook Strait, 796 m	*ca.* 200 specimens
VUZ 87, Cook Strait, 732 m	several specimens
VUZ 96, Cook Strait, 695 m	40 specimens
VUZ 97, Cook Strait, 786 m	5 specimens
VUZ 100, Cook Strait, 695 m	several specimens
VUZ 101, Cook Strait, 1,006 m	*ca.* 30 specimens
CIE 41, 44° 35.5′ S 716° 04′ W, 604 m, fine green mud, sand	23 specimens (Fell 1960)
CIE 52, 44° 04′ S 178° 04′ W, 476 m, fine green sand, mud	3 specimens

DISTRIBUTION

GEOGRAPHIC

This species is recorded from the north eastern, central western, and central eastern areas only. Shelf records are from Great Exhibition Bay in the north eastern area; from off Bare Island and possibly Cook Strait in the central eastern area, and south-west of Patea in the central western area. The archibenthal records are from the central eastern and central western areas; from Cook Strait to Kaikoura and the Chatham Rise on the east coast; and from south-west of Cape Egmont on the west coast. *Brissopsis oldhami* is a widely ranging species in the Indo-Pacific region.

BATHYMETRIC

The recorded depth range within the New Zealand area is 66–2,012 m. The only shelf records are from zones 3 and 4, comprising only 1% of the records and only 1% of the specimens. In the following tabulation the occurrence of specimens is shown first with all the samples included, and then with six large samples omitted.

Bathymetric Distribution of *Brissopsis oldhami* (percentages)

Depth Zone	Specimens	Specimens (6 samples omitted)	Total Records
1	0	0	0
2	0	0	0
3	1	5	6
4	1	1	6
Shelf occurrence	1	6	11
Archibenthal occurrence	99	94	89

SEDIMENT PREFERENCE

In the samples analysed coarse sediments do not occur. Most of the records of live specimens (75%) are from mud, the remainder from sandy mud. The dominant grade is mud. Fragments occur on sediments of muddy sand, sandy mud, and mud, the dominant grade being mud.

Sediment Preference of *Brissopsis oldhami* (percentages)

Sediment	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Gravel	0	0	0
Sandy gravel	0	0	0
Gravelly sand	0	0	0
Sand	0	0	0
Muddy sand	0	40	25
Sandy mud	25	20	25
Mud	75	40	50

Dominant Grade in Samples (percentages)

Grade	Records of Live Specimens	Records of Dead Material (fragments)	Total Records
Granule gravel	0	0	0
Very coarse sand	0	0	0
Coarse sand	0	0	0
Medium sand	0	0	0
Fine sand	0	20	13
Very fine sand	0	20	13
Mud	100	60	74

Brissus gigas Fell
(Fig. 52)

REFERENCES: Fell, H. B. 1947: p. 145. Mortensen, Th. 1951: p. 518. Baker, A. N. 1965: p. 69.

RECOGNITION

GENERAL MORPHOLOGY: Test large, inflated, with an anterior notch. Broadly ovate in outline and truncated posteriorly. Anterior ambulacrum flush with test, others narrow and deeply sunken. Posterior end of test obliquely truncated and posterior interambulacrum keeled obliquely above. Two fasciolar areas.

COLOUR: Unknown in life. Solitary test is pale cream. Peripetalous fasciole and the two anterior interambulacra are pale grey.

SHELF OCCURRENCES

PUBLISHED DATA

Deep Water Cove, Bay of Islands, on shingle beach	1 test (Fell 1947)
Port Abercrombie, Great Barrier I., *ca.* 20 m	fragments, possibly this species (Baker 1965)
Vicinity of Okahu and Waewaetorea I., Bay of Islands, shallow water	4 specimens
Islands, Bay of Islands, cast ashore	3 specimens

DISTRIBUTION

This species occurs on the north-eastern New Zealand shelf in shallow depths. The material described by Baker (1965) was either cast ashore or on a shallow sandy bottom, while the original specimen of Fell (1947) was found on a shingle beach. The species is probably confined to the shallow waters of the north eastern area.

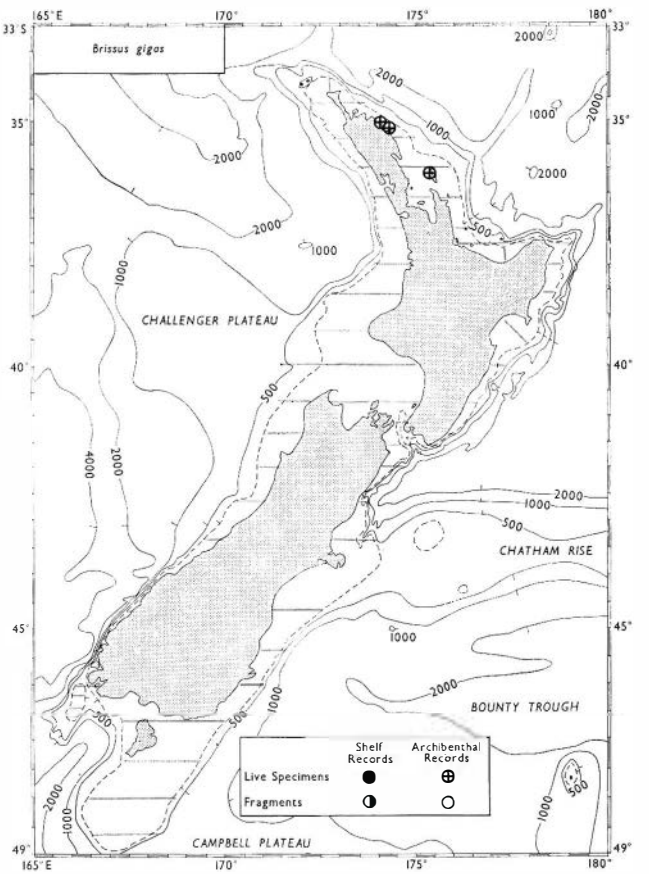


FIG. 52. Geographic distribution of *Brissus gigas* Fell. Survey lines indicated by hatching.

ARCHIBENTHAL ECHINOIDEA OF THE NEW ZEALAND REGION

Sixteen species, i.e. 35% of the total fauna, occur in the archibenthal region around New Zealand, but have not been reported from the shelf. These species are described below.

Family CIDARIDAE

Goniocidaris parasol Fell. Originally described from off the Chatham Islands, this species has now been found to occur commonly on the Campbell Plateau. During the shelf survey one juvenile specimen was captured from off Hawke Bay (Sta. C 828, 39° 36′ S 177° 45.6′ E, 228–230 m, mud).

Family PEDINIDAE

Caenopedina novaezealandiae Pawson. Known only from the type locality, 16 miles south-east of Mayor Island, Bay of Plenty, 329–439 m.

Family ECHINOTHURIIDAE

Phormosoma bursarium A. Agassiz. This species is now known from the Challenger Plateau, the Chatham Rise, and the Campbell Plateau.

Phormosoma rigidum A. Agassiz. Known only from off East Cape in 1,280 m.

"Phormosoma zelandiae" A. Agassiz. Known only from off East Cape in 1,280 m. A juvenile specimen whose systematic position is uncertain.

Family SALENIIDAE

Salenocidaris hastigera (A. Agassiz). Recorded from east of North Cape; 34° 20′ S 175° 12′ E, 1,782 m.

Family ARBACIIDAE

Coelopleurus sp. Pawson. Recorded from off the Three Kings Islands; 33° 58′ S, 172° 07′ E, 252–342 m.

Family TEMNOPLEURIDAE

"Temnopleurus reynaudi" A. Agassiz. Recorded from the Challenger Plateau in 503 m; systematic position is uncertain.

Pseudechinus grossularia (Studer). From off the Three Kings Islands in 172 m.

Family ECHINIDAE

Gracilechinus multidentatus H. L. Clark. This species, from near the Kermadec Islands, also occurs on the Chatham Rise and the Campbell Plateau.

Family SPATANGIDAE

Spatangus mathesoni McKnight. From the Challenger Plateau; distinct from the other New Zealand members of the genus.

Paramaretia multituberculata Mortensen. Occurs commonly on the Chatham Rise and is also known from Australian waters.

Family BRISSIDAE

Cyclaster sp. Fell (pers. com.). Known only from the Bay of Plenty; between Alderman and Red Mercury Islands, 622 m, and 10 miles north-north-west of Mayor Island, 366 m.

Gymnopatagus magnus A. Agassiz and H. L. Clark. Recent collections from the Challenger Plateau contain this species in some numbers. It is also known from the Indo-Pacific region.

OTHER SPECIES

Two species are recorded by Pawson (1968) from the Bounty and Antipodes Islands. *Austrocidaris* sp. is described from fragments obtained in 310 and 396 m, on coarse sediment near the Antipodes Islands; *Brisaster* n. sp. is described from eight samples from the Bounty Islands, in depths of 108–821 m, on coarse and finer sediments. A fragment of this species is present in one sample from the Campbell Plateau.

Two small fragments of a bright red regular echinoid occur in one sample from the Challenger Plateau and appear distinct from any other members of the fauna, although they cannot be identified with any certainty.

DISTRIBUTION OF THE NEW ZEALAND SHELF ECHINOIDEA

This report presents significantly more data on the distribution of the New Zealand Echinoidea than have previously been available. (Cautions already expressed on the adequacy of the data should be borne in mind.) A general consideration of the fauna and its components is therefore in order, although the conclusions reached may be modified as further records of distribution accumulate.

ABUNDANCE AND RARITY OF SHELF SPECIES

Twenty-eight species occur on the New Zealand shelf and intertidal zone; 642 records and more than 2,350 specimens are considered in this work. During the survey, 13 species, 187 records, and about 1,160 specimens were collected. Since the survey covered all of the continental shelf and sampled a variety of

bottom sediments, it is possible to determine which species are common and characteristic of the New Zealand shelf area, and which are rare.

RARE SPECIES (all known from fewer than five records)

	Total Records	Survey Records	Taken Alive on Survey
Goniocidaris magi	2	..	..
Amblypneustes pachistus	1	..	..
Holopneustes inflatus	4	..	..
Pseudechinus variegatus	4	..	..
Heliocidaris tuberculatus	1	..	..
Clypeaster australasiae	4	..	..
Clypeaster virescens	1	..	..
Echinocyamus polyporus	2	..	..
Laganum depressum	1	..	..
Spatangus beryl	1	..	..
*Spatangus thor**	1	..	..
Brissus gigas	4	..	..

**Spatangus thor* is recorded from the Bounty Islands (5 records) and the Chatham Rise (1 record) by Pawson (1968).

These 12 species, comprising 43% of the fauna, must at present be considered as either of rare occurrence or of very local distribution, or, if abundant, as inhabiting shallow water or the intertidal or archibenthal zones.

MODERATELY RARE SPECIES

The following four species, comprising 14% of the fauna, are known from fewer than 20 but more than five records. The distribution of these forms parallels that of the previous group.

	Total Records	Survey Records	Taken Alive on Survey
Araeosoma thetidis	5	..	..
Centrostephanus rodgersii	9	..	..
Pseudechinus flemingi	15	..	..
Paramaretia peloria	11	9	3

It should be noted that these two groups comprise 57% of the fauna.

MODERATELY COMMON SPECIES

The following nine species are known from between 20 and 50 records. They comprise 33% of the fauna.

	Total Records	Survey Records	Taken Alive on Survey
Goniocidaris umbraculum	40	12	38
Ogmocidaris benhami	27	13	..
Pseudechinus huttoni	33	12	10
Pseudechinus novaezealandiae	25	8	..
Apatopygus recens	43	15	21
Fellaster zelandiae	29	10	..
Peronella hinemoae	45	34	36
Spatangus multispinus	22	6	11
Brissopsis oldhami	38	2	..

COMMON SPECIES

The following three species are the commonest of the shelf echinoids.

	Total Records	Survey Records	Taken Alive on Survey
Pseudechinus albocinctus	76	17	2
Evechinus chloroticus	51	12	..
Echinocardium cordatum	157	47	>1000

These last two groups comprise 43% of the fauna.

BATHYMETRIC DISTRIBUTION OF LIVE SPECIMENS

A. INTERTIDAL SPECIES

No species, with the possible exception of *Heliocidaris tuberculatus*, appears confined to this zone. Twelve species are recorded as occurring intertidally:

Centrostephanus rodgersii
Amblypneustes pachistus
Holopneustes inflatus
Pseudechinus albocinctus
Pseudechinus huttoni
Pseudechinus novaezealandiae
Evechinus chloroticus
Heliocidaris tuberculatus
Fellaster zelandiae

Clypeaster australasiae, *C. virescens*, and *Laganum depressum* are known from the intertidal zone in Australia.

B. SPECIES RESTRICTED TO INTERTIDAL ZONE AND ADJACENT SHALLOW WATER

Amblypneustes pachistus to *ca.* 50 m
Holopneustes inflatus to *ca.* 20 m?
Evechinus chloroticus to 55 m
Heliocidaris tuberculatus to *ca.* 20 m?
Fellaster zelandiae to 31 m

Although *Centrostephanus rodgersii* is recorded once from 110 m (maximum depth), it probably belongs to this group.

C. SPECIES RESTRICTED TO CONTINENTAL SHELF

Pseudechinus albocinctus
Pseudechinus huttoni
Pseudechinus novaezealandiae
Pseudechinus sp.
Apatopygus recens
Spatangus beryl
Paramaretia peloria
Echinocardium cordatum
Brissus gigas

Also included in this group are all species mentioned in A and B above, except *Clypeaster australasiae*, *C. virescens*, and *Laganum depressum*. This group comprises 15 species, i.e. 55% of the fauna. The rarer species may not belong to this group, but may have a bathymetric distribution similar to that of *Goniocidaris umbraculum* and *Spatangus multispinus*. Occasional "escapes" of this fauna to the greater depths have been recorded: *Pseudechinus huttoni*, *Paramaretia peloria*, and *Echinocardium cordatum* are known from the archibenthal zone. In each case, however, it seems probable that the specimens have been transported down the steeply shelving continental slope from nearby shelf populations (cf. Fell 1958; Hurley 1964).

D. Species Occurring on, but not Restricted to, Shelf

Goniocidaris umbraculum
Goniocidaris magi
Ogmocidaris benhami
Araeosoma thetidis
Pseudechinus flemingi
Pseudechinus variegatus
Clypeaster australasiae
Clypeaster virescens
Peronella hinemoae
Laganum depressum
Spatangus thor
Spatangus multispinus
Brissopsis oldhami

These 13 species (45% of the fauna) occur mainly on the outer shelf. Within the New Zealand area, only *Goniocidaris umbraculum* and *Peronella hinemoae* are known from depths shallower than 30 m, but the sand-dollars, *Clypeaster* and *Laganum*, are known from shallow water (intertidal?) from Australia and elsewhere. *Ogmocidaris benhami*, *Pseudechinus flemingi*, *Spatangus multispinus*, and *Brissopsis oldhami* occur mainly below the shelf, with occasional representatives in shallower depths.

Bathymetric Distribution of Dead Material

The occurrence of much of the dead material examined presents no problems of evaluation; in most cases it lies within the known depth range of the species in question. However, in a small number of species, dead fragmentary material has been found considerably deeper than live specimens.

Fragments of *Evechinus chloroticus* and *Pseudechinus novaezealandiae* occur not far from suitable habitats, in regions where steeply shelving submarine slopes exist. No lengthy transport of the fragments is required for them to reach their present position.

The gap between the deepest live record and the deepest fragmentary record is somewhat larger for *Pseudechinus albocinctus* (493 m) and for *Fellaster zelandiae* (103 m). This material is generally of small size, and appears reasonably fresh, with few signs of abrasion. *Pseudechinus albocinctus* is commonly represented by spines, occasionally by small test fragments, and in one case (Sta. C 99, 168 m, Cook Strait) by a complete test; and *Fellaster zelandiae* is represented by small test fragments. While the material shows little sign of extensive transportation, neither does it show any signs of fossilisation. The origin of this material is therefore uncertain. It may be of recent origin and may have been transported to greater depths, possibly after capture by fish. (Young (1929) records *P. albocinctus* in blue cod (*Parapercis colias* Forster) from the Chatham Islands.) Conversely, the material may be fossil, perhaps remaining from periods of lowered sea level during the Pleistocene.

Sediment Preferences

No species found during the survey was confined to a single sediment type. However, all species showed some preference for either a coarse or a fine sediment.

Species inhabitating inshore and intertidal rocky areas; on coarse sediments; or known living on algae are

Centrostephanus rodgersii
Amblypneustes pachistus
Holopneustes inflatus
Pseudechinus albocinctus
Pseudechinus huttoni
Pseudechinus novaezealandiae
Evechinus chloroticus
Heliocidaris tuberculatus

H. L. Clark (1946) records *Amblypneustes* species as occurring on "grassy [or] weedy bottoms in rather shallow water"; and *Holopneustes* species as living "among the distal fronds of large kelp".

Species preferring coarse sediment—gravel to sandy-gravel—although they may occasionally occur on finer sediment types, are

Goniocidaris umbraculum
Goniocidaris magi
Pseudechinus albocinctus
Pseudechinus huttoni
Pseudechinus novaezealandiae
Evechinus chloroticus
Apatopygus recens
Spatangus beryl
Spatangus thor
Paramaretia peloria

Species preferring fine sediments—mud to sand—although they may occur on coarser types, are

Ogmocidaris benhami
Araeosoma thetidis
Pseudechinus flemingi
?Pseudechinus variegatus
Clypeaster australasiae
Clypeaster virescens
Fellaster zelandiae
Echinocyamus polyporus
Peronella hinemoae
Laganum depressum
Spatangus multispinus
Echinocardium cordatum
Brissopsis oldhami
Brissus gigas

Dead material of all species found during the survey was either in similar sediment to the living material or from finer sediments.

Geographic Distribution of Live Specimens

Faunal Elements

Four elements can be distinguished within the fauna, and two of these can be further subdivided. In placing species into these elements some consideration of the range of species outside the New Zealand shelf is necessary.

1. *Northern element*

Sixteen species (55 % of the shelf fauna) belong in this group. It is characterised by a large proportion of rarer species with restricted ranges.

a. Restricted group

Goniocidaris magi
Centrostephanus rodgersii
Amblypneustes pachistus
Holopneustes inflatus
Pseudechinus sp.
Pseudechinus variegatus
Heliocidaris tuberculatus
Clypeaster australasiae
Clypeaster virescens
Laganum depressum
Brissus gigas

b. Other species

Ogmocidaris benhami
Fellaster zelandiae
Echinocyamus polyporus
Spatangus multispinus
Brissopsis oldhami

Echinocyamus polyporus is known only from Cook Strait on the New Zealand shelf, but is also recorded from the Kermadec and Norfolk Islands.

2. *Southern element*

Eight species (28 % of the fauna) are included in this group. Characteristic of the group is the fairly wide range of latitude for most of the species.

a. Restricted group

Spatangus beryl
Paramaretia peloria

b. Other species

Goniocidaris umbraculum
Pseudechinus albocinctus
Pseudechinus flemingi
Pseudechinus novaezealandiae
Apatopygus recens
Spatangus thor

Pseudechinus flemingi occurs mainly in archibenthal waters. It is recorded only once from the New Zealand shelf, and is best left out of further discussion. *Spatangus thor* is known from the Chatham Rise and the southern shelf.

. *Widespread element*

a. Species occurring throughout New Zealand

Araeosoma thetidis
Evechinus chloroticus
Echinocardium cordatum

Araeosoma thetidis occurs on the Campbell Island shelf, but the bathymetric distribution shows some similarities to *Pseudechinus flemingi*, and the main populations may be in the archibenthal zone. *Echinocardium cordatum* could also be classified as a widely ranging northern element.

b. Other species

Pseudechinus huttoni

This species occurs over much of the southern shelf, occupying a similar area to the southern semi-restricted group of species, i.e. from the southern shelf extremity to Cook Strait on the east coast, and the southern west coast shelf. It is also known, however, from one record in the Three Kings area. The occurrence of this characteristic South Island east coast species in northern waters may parallel the occurrence here of a distinct group of chiefly southern mollusca, noted by Fleming (1944) and Powell (1940). On the other hand, this type of distribution may reflect the absence of suitable substrate between Cook Strait and the Three Kings. However, it is likely that suitable sediments do occur nearshore over much of this distance, and it is doubtful if this distribution reflects merely a sampling deficiency. The western North Island shelf is among the most intensively sampled areas within the New Zealand region, and *P. huttoni* has not been found in the several hundred samples from this area collected by the N.Z. Oceanographic Institute.

Peronella hinemoae

This species occurs in northern New Zealand, from North Cape to East Cape on the east coast, and from North Cape to Cape Egmont on the west coast. It also occurs in southern New Zealand in southern Fiordland, on Puysegur Bank, and south of Stewart Island. Between these limits suitable sediments occur on the east coast from the southern shelf to Cook Strait, but they are generally too fine in the area further north which extends to East Cape. On the west coast suitable sediments occur over much of the shelf between the two known areas of occurrence, but the species itself is absent.

Geographic Distribution of Dead Material

Records of dead material fall almost completely within the geographic range of living specimens. In two cases however, dead material is recorded some distance to the north of living.

For *Pseudechinus albocinctus* the distance is approximately 160 miles—from off Wanganui, the northernmost record of live material, to the archibenthal zone off the mouth of Waikato River. The possibility of live material occurring at this latitude cannot be discounted at present, in which case the material may have been transported offshore; so far, however, no living *P. albocinctus* is known north of Wanganui, and the species appears commoner to the south. The situation may be analogous to that described by Fleming (1944) for various mollusca, especially *Chlamys delicatula* (Hutton): this species is believed to have moved north and subsequently retreated following variations in the hydrological environment in the early Pleistocene; likewise the fragments of *P. albocinctus* may represent the northward

migration of this species at some cooler period in the past.

The second species, *Apatopygus recens*, is known live from off Wanganui, and from off Mokau River, dead. While the above explanation may apply equally to this species, the distance involved is only about 60 miles—sufficiently close for other factors, such as transport of the material, to be responsible for the anomaly. The sediment at this northernmost record is muddy sand and does not appear suitable for the establishment of the species.

Discussion

Faunal Elements

Two main faunal elements have been distinguished and some degree of exclusion is apparent between them. On the east coast northern restricted elements occur in the area between the Three Kings Islands and East Cape, while the other northern species occur more or less north of the Cook Strait area; southern elements occur more or less in and south of the Cook Strait area, with the restricted elements occurring on the southern shelf. On the west coast, northern elements extend as far south as Cape Foulwind, while most of the southern elements are confined to southern Fiordland, although both *Pseudechinus albocinctus* and *Apatopygus recens* are recorded live from off Wanganui.

Since 83% of the fauna can be classified into northern and southern elements, it is worth while to discuss some of the factors which may be responsible for this. The species of *Goniocidaris* and *Ogmocidaris* have direct-developing young with no pelagic larval life, and two of them are more or less exclusive in range. However, their distributions are broadly paralleled by those of species with pelagic larvae, and the mode of larval development does not appear important in the distribution of any of these species. Sediment preference may account for species such as *Spatangus beryl* and *Paramaretia peloria* being confined to the southern shelf. The majority of species, however, appear restricted in range even when suitable sediments exist elsewhere. In one area, south of Stewart Island, shallow water exists only at the Snares, yet no species appears restricted by this, since of the strictly shallow-water fauna only *Evechinus* occurs in the south and it is present at the Snares.

Of the older members of the fauna, *Apatopygus* is southern in distribution and *Fellaster* is more northern, but other species, e.g. *Goniocidaris* spp., *Pseudechinus* spp., *Peronella hinemoae*, and *Evechinus chloroticus*, occur in both north and south. Recent or Pleistocene immigrants to the fauna, such as *Holopneustes*, *Heliocidaris*, *Clypeaster*, *Laganum*, *Brissus*, and *Brissopsis*, are all included in the northern faunal element. Fell (1953) suggests that most of these species have migrated from Australia by means of the Tasman Current. If this is so, then they or their representatives should be found on the west coast, particularly in the Fiordland area, where the eastward flowing current approaches the coast. Their absence from this area (except perhaps for *Holopneustes*, *see* p. 47) and their restricted occurrence in northern New Zealand suggests that other environmental factors are responsible for their distribution.

Some degree of correlation does exist between the restriction of the range of much of the fauna and the hydrological situation around New Zealand. Southern elements of the fauna are more or less restricted to waters in or to the south of the subtropical convergence zone, and the species with restricted ranges in this group occur south of the Canterbury Current ("Cold Subantarctic Water", Knox 1963), generally in the region of the Southland Current ("Mixed Subantarctic and Subtropical Water", Knox 1963), although sediment preference may be as important a factor in restricting the northward range of these species. Northern elements of the fauna generally occur in or to the north of the sub-tropical convergence zone, and the species with restricted ranges are confined to the sub-tropical waters of the East Auckland Current (the "Transitional Warm Temperate Water" of Knox 1963). A similar hydrological situation occurs on the west coast in the region of the West Auckland Current, and members of the northern restricted element may be expected to occur in this area.

Faunal Provinces

The faunal provinces into which the New Zealand area has been divided (Powell 1961) are based almost wholly on the distribution of Mollusca, although Pawson (1961) has recently discussed the distribution of echinoderms in terms of this concept. Criticism of the factors used to establish these provinces and even doubts as to their reality have been expressed by some zoologists, e.g. Dell (1962). It is of interest to compare the distribution of groups of the shelf Echinoidea with the molluscan provinces to determine the degree of coincidence.

The Aupourian province is defined as extending from North Cape to East Cape on the east coast, and from North Cape Point, Ahipara, and Manukau Harbour (molluscs), or Cape Egmont (echinoderms), on the west coast. The following species are restricted to this province:

Goniocidaris magi
Centrostephanus rodgersii
Amblypneustes pachistus
Holopneustes inflatus
Pseudechinus variegatus
Heliocidaris tuberculatus
Clypeaster australasiae
Clypeaster virescens (probably)
Laganum depressum
Brissus gigas

If these species are to be regarded as typical of this province, the boundary may well be redefined as from the Three Kings Islands to East Cape, i.e. on the east coast only. None, with the possible exception of *Centrostephanus rodgersii*—which may be locally abundant—is common in this region. The typical fauna is, in fact,

composed of species such as *Ogmocidaris benhami*, *Evechinus chloroticus*, *Fellaster zelandiae*, *Peronella hinemoae*, and *Echinocardium cordatum*, all of which occur in one or both of the other mainland provinces.

The Cookian province is defined as extending from the Aupourian boundary to rather vague limits southwards, but roughly to Jackson Head and the Otago Peninsula on the west and east coasts respectively of the South Island. One species, the rare *Echinocyamus polyporus*, is possibly restricted to this province, but the majority of the echinoid fauna of this province occurs also in the other provinces.

The Forsterian province is defined as covering the remainder of the New Zealand shelf in the south. Restricted to this province are

Spatangus beryl
Paramaretia peloria

If these species are regarded as typical, the province should be redefined to extend from the Otago Peninsula southward to the southern New Zealand shelf edge, including Foveaux Strait but not the shelf to the west. Common species of this province are

Goniocidaris umbraculum
Pseudechinus albocinctus
Pseudechinus huttoni
Pseudechinus novaezealandiae
Evechinus chloroticus
Apatopygus recens
Peronella hinemoae
Echinocardium cordatum

None is restricted to the province, and all occur in one or both of the other mainland provinces.

It is obvious that the molluscan provinces bear little relation to the distribution found in the Echinoidea, and much of the difference relates to the basis of province separation. In the erection of zoogeographic units such as these New Zealand faunal provinces, the proportion of endemic species often gives a misleading picture, as the endemic species are often rare with restricted ranges, while the commoner species, more important in the general ecology of the area, are often ignored. If the basis of province separation be the rarer species, an "Aupourian Province", extending from the Three Kings Islands to East Cape and possibly over the northern part of the western North Island shelf, is the only clearly separable unit on the New Zealand shelf; if the basis be the commoner species, two faunas are apparent, but they are not sufficiently exclusive for complete separation, and the intermediate zone between them is as large as the zones where there is no intermingling of the faunas.

External Relationships

All species inhabiting the New Zealand Plateau are considered here except for "*Phormosoma zelandiae*" and "*Temnopleurus reynaudi*", which should be disregarded until their validity can be determined. Of the remaining species, 57% do not occur outside the New Zealand Plateau; 24% occur in Australia, but nearly half of these also occur around the islands to the north of New Zealand (Lord Howe, Norfolk, and the Kermadec Islands); 7% also occur around these islands but not in Australia; and 11% are Indo-Pacific forms. On further examination the following relationships are evident:

There is a small subantarctic element in the fauna—*Austrocidaris* sp. from the Antipodes Islands and *Brisaster* n. sp. from Bounty Island and the Campbell Plateau. On the southern portion of the New Zealand Plateau occur seven additional species known from around the New Zealand mainland, and these species are all much more common than the two named above.

The major external relationship is with Australia. There are two components of this relationship. Firstly, there are species shared only between the two areas, species from southern or south-eastern Australia being present in New Zealand. *Araeosoma thetidis* is present over much of the New Zealand Plateau while *Amblypneustes pachistus* occurs in northern waters, and *Paramaretia multituberculata* and *P. peloria* are present in central and southern waters of New Zealand. *Pseudechinus huttoni* occurs off Tasmania and in central and southern New Zealand, with one isolated occurrence in northern waters.

Secondly, there are species and genera common to Australia, New Zealand, and other areas. *Echinocardium cordatum* is widespread in temperate seas. Four species, *Coelopleurus* sp., *Clypeaster virescens*, *Laganum depressum*, and *Brissus gigas*, show general Indo-Pacific affinities, and five species are common to Australia, New Zealand, and the islands north of New Zealand: *Centrostephanus rodgersii*, *Holopneustes inflatus*, *Heliocidaris tuberculatus*, *Clypeaster australasiae*, and *Laganum depressum*.

Evechinus chloroticus, *Peronella hinemoae*, and *Echinocyamus polyporus* are common to New Zealand and the islands to the north, and *Gracilechinus multidentatus* occurs from near the Kermadec Islands.

Seven species show close affinity with the Indo-Pacific region. These are *Caenopedina novaezealandiae*, *Phormosoma* spp., *Salenocidaris hastigera*, *Brissopsis oldhami*, *Cyclaster* n. sp., and *Gymnopatagus magnus*.

The endemic group of species and genera shows varied affinities. *Goniocidaris* is of Indo-Pacific origin and *Ogmocidaris* is a local development of *Goniocidaris*; *Pseudechinus* occurs around the world in these and higher latitudes and Fell (1962) suggests Australasia as the home of this genus. *Apatopygus* occurs in New Zealand and southern Australia, while *Spatangus* is a fairly widespread genus.

Of particular interest is the relationship of the faunas of Australia, New Zealand, and the islands to the north. In a group of 20 species occurring in these three areas 30% are common only to Australia and New Zealand; 30% are common to Australia and the islands north of New Zealand; 15% are common to New Zealand and the northern islands; and 25% are common to the three areas. While trans-Tasman migration of species has obviously taken place, it is also evident that an exchange of species between the islands to the north and New

Zealand has occurred, and some of the species common to the three areas considered may have come to New Zealand via the northern islands, rather than via the Tasman Sea. It should be noted that all of the three island groups to the north—Lord Howe, Norfolk, and the Kermadecs—stand much closer to New Zealand than does Australia, and all are on submarine ridges approaching or continuous with the New Zealand Plateau. Consequently if other conditions such as temperature and oceanic drift are satisfactory, they are better placed to supply species to the New Zealand fauna.

Of the 11 species common to New Zealand and Australia which Fell (1953) suggests may have migrated to New Zealand by means of the Tasman Current, only two are present on the southern New Zealand shelf—the region closest to Australia if the Tasman Current was used as a migration route. One is probably a chiefly archibenthal species, and the other five occur on the north-eastern New Zealand shelf, and also in the islands to the north. The distance from Australia to northern New Zealand is nearly 900 miles in a straight line, and is considerably further following the course of the Tasman and East Australian Currents. The longest distance between the islands and shallow banks to the north, and northern New Zealand is only about 400 miles. Of the northern islands, the Kermadec Group stands on a submarine ridge which approaches to within 150 miles of the New Zealand Plateau in the region of the south-east- and south- flowing Trade Wind Drift, and appears to be the group most likely to supply species to New Zealand. It shares more species with New Zealand than does either Lord Howe or Norfolk Island.

Relationships of the species occurring on the New Zealand continental shelf are different. The endemic proportion is much lower at 29%; 10% occur in Australia, 10% in the islands to the north, and 17% are common to these two regions; 21% occur in the islands east and south of New Zealand; 10% are common to these islands and Australia; and 3% are common to these islands and the northern group of islands.

In the northern geographic element, 43% are endemic; 13% occur in Australia; 13% occur in the northern islands; and 31% are common to these islands and Australia. In the southern geographic element, 13% are endemic; 74% occur in the islands to the south and east; and 13% occur in these islands and Australia. Of the remaining species 20% occur in Australia; 20% occur in the northern islands; 20% occur in these islands and those to the south and east; and 40% occur in Australia and the southern and eastern islands.

Conclusions

In discussions of major faunal units, the echinoid fauna of the New Zealand area should be considered as part of the Indo-Pacific region, as compared with the Antarctic or South American regions. Within the Indo-Pacific region the New Zealand Plateau forms a distinct subregion with Australian, Indo-Pacific, and weak subantarctic affinities. Within the New Zealand subregion, three main faunal elements can be distinguished: a northern element extending more or less to the subtropical convergence zone, a southern element extending southward from about the subtropical convergence zone, and a cosmopolitan element extending throughout the area. Distinct provinces are not recognisable either on the shelf or in the archibenthal zone, although further investigations may show that they do exist. Of special interest for future study are the faunas of two as yet little-studied ridges, the Lord Howe Rise tending north and west of New Zealand, and the Macquarie Ridge which extends southward from Macquarie Island toward the Antarctic and northward towards Fiordland (Brodie and Dawson 1965). These ridges are more or less continuous with the New Zealand Plateau and may have been, or may still be, major avenues in the dispersal of many of the species occurring in the archibenthal zone.

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