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BULLETIN 122

GENERAL ACCOUNT OF THE CHATHAM ISLANDS 1954 EXPEDITION

By

G. A. KNOX

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Frontispiece: M.V. *Alert* at the Waitangi wharf.

Photo: J. M. Moreland

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INTRODUCTION

Up to 1949 very little oceanographic research apart from marine biological studies had been carried out in New Zealand. In that year the Department of Scientific and Industrial Research set up a small unit to work in physical oceanography, and following the arrival of H.M.N.Z.S. *Lachlan* to commence survey operations in New Zealand waters in late 1949 there arose an increasing interest in oceanographic problems. This increase in oceanographic research was stimulated by the offer of the Commanding Officer of the *Lachlan,* Commander J. M. Sharpey-Shafer, R.N., to undertake the collection of scientific data and material for New Zealand workers. At first an interdepartmental committee in Wellington arranged for the distribution of the material obtained by the *Lachlan,* but in October 1950 a more widely representative National Committee on Oceanography was set up under the auspices of the Department of Scientific and Industrial Research. One of the functions of this committee was to coordinate, correlate, and assist oceanographic work in New Zealand, and to sponsor the publication of results.

The present expedition arose directly from the stimulus given to oceanographic research in New Zealand by this committee. In October 1951 the committee defined several research areas to which priority should be given as facilities and finance became available. One of these was the Chatham Rise between Banks Peninsula and the Chatham Islands. In November 1953 a grant of £800 towards the cost of an oceanographic expedition to this area was received from the Department of Scientific and Industrial Research through the New Zealand National Committee on Oceanography.

Objectives of the Expedition

The expedition's main objectives were to explore the area of the Chatham Rise and the Chatham Islands. The Chatham Rise is a well defined seafloor feature whose crest lies mostly in less than 300 fathoms and from which few dredgings had been obtained. What little was known of the marine fauna of the Chatham Islands indicated that it was an interesting mixture of northern and southern species together with a strong endemic element.

The expedition's work was planned to throw some light on the distribution of benthic and pelagic animals between the New Zealand coast and the Chatham Islands and to trace the transition from a typical "southern" fauna to the mixed faunas of the Islands.

The following programme was defined when application for a grant-in-aid was made:

1. To occupy a series of stations between Banks Peninsula and the Chatham Islands to obtain dredgings of bottom fauna, sediment samples, plankton tows, temperatures, and water samples.
2. To spend about fourteen days dredging and bottom sampling the shelf round the islands.
3. To obtain continuous echo soundings on the route followed.
4. To investigate the intertidal region of the Chatham Islands and collect intertidal plants and animals.
5. To observe the sea birds of the Chatham Islands.

It was later decided to make general invertebrate land collections, particularly on the outlying islands, as these had not previously been visited by a scientific party.

Acknowledgments

As the leader of the expedition the author thanks all members of the expedition for their hard and enthusiastic work, often under trying conditions. Special thanks are due to Mr A. J. Black, the

owner and master of M.V. *Alert,* who did not spare himself to ensure the success of the expedition. The satisfactory results obtained were largely due to his skill in handling the boat and equipment, and his trawling experience was invaluable in the deep-sea work.

The expedition is greatly indebted to the Council of Scientific and Industrial Research, through the New Zealand National Committee on Oceanography, for the financial support afforded, and also to Canterbury University College, Canterbury Museum, the Dominion Museum, and the Canterbury and Southland branches of the Royal Society of New Zealand for additional financial assistance. Thanks are also extended to the many institutions that lent equipment, to the Director, Canterbury Museum, for providing facilities for the handling and storage of the collections and to the Director, Dominion Laboratory, for salinity determinations.

Reversing water bottles and thermometers were lent by the Fisheries Division, C.S.I.R.O., Cronulla, Australia; without this equipment hydrological work in deep water would not have been possible.

Valued assistance was received on many occasions from the people of the Chatham Islands. In particular the Commissioner, Mr J. Patterson, was very helpful, arranging transport to Titirangi to collect fossils, and a boat to trawl on Te Whanga Lagoon. The master of the *Port Waikato* (Holm Shipping Co.) generously provided much-needed fresh water on two occasions.

PREVIOUS INVESTIGATIONS

Apart from the efforts of the individual collectors mentioned below, there has been little in the way of organised marine research in the area covered by the expedition.

The first recorded investigator was Ernst Dieffenbach (1843), who visited the Chatham Islands and made collections in 1840. In 1868 H. L. Travers, during a short stay at the Chatham Islands, collected plants and animals, particularly Mollusca. The most comprehensive of the early collections was made by Dr Schauinsland who visited New Zealand and the Chatham Islands in 1896–97, partly for the purpose of collecting specimens for the museums of Bremen and Berlin. Material collected by Schauinsland at the Chathams is listed in many of the early accounts of the New Zealand fauna. Other early collectors mentioned in the literature include A. Shand and Miss S. D. Shand of the Chatham Islands, Professor H. B. Kirk, and Dr A. Dendy.

The New Zealand Government Trawling Expedition in the *Nora Niven* visited the Chatham Islands in 1907 (Waite, 1909). During their stay at the islands several stations were worked in depths from 16 to 50 fathoms, but the greater part of the time was spent in line fishing. The *Nora Niven* stations are listed below.

No.	Position	Depth in Fathoms	Bottom
64	2 miles north-west of Waitangi	16–24	sand, shell
65	3 miles south-east of Port Hutt	24–33	yellow sand
66	5 miles west of Clatchie Point	33–42	fine yellow sand
67	5 miles north-west of Durham Point	42–50	yellow sand
68	3½ miles north-west of Soames Point	45	coarse shell sand
69	Hanson Bay	16–25	sand, shell
70	Hanson Bay, 8 miles north-east of Cape Fournier	33–45	fine sand.

At all the above stations a commercial fishing trawl only was used and no dredging was carried out.

In the summer of 1924 a scientific party sponsored by the Otago Institute visited Chatham Island and Pitt Island. The members of the party, R. S. Allan, W. Martin, J. Marwick, and M. W. Young, were concerned primarily with the structural geology of the Chathams and the collection of fossils. Recent Mollusca were also collected and Young made general collections of marine fauna, especially fishes, on the western and northern coasts of Chatham Island.

In November 1936 the N.Z.G.S. *Matai* investigated the Mernoo Bank, the position of which had been roughly reported by S.S. *Mernoo* in June 1935. In the course of sounding operations three bottom samples in 43, 52, and 57 fathoms were obtained.

A. W. B. Powell spent three weeks at Chatham

Island during February 1933, collecting intertidal and shallow-water Mollusca. He made a single dredging in 10 fathoms off Owenga. C. A. Fleming, during a stay of several months in 1933, made a survey of the bird life of the islands (Fleming, 1939) and collected Mollusca.

In February 1950, H.M.N.Z.S. *Lachlan* under the command of Commander J. M. Sharpey-Shafer, R.N., surveyed the Mernoo Bank at the request of the Fisheries Branch of the Marine Department (Dell, 1951; Fleming and Reed, 1951).

In November 1950, the R.R.S. *Discovery II*, at the request of the New Zealand National Committee on Oceanography, obtained a continuous echo-sounding profile across the Chatham Rise, about 80 miles west of the Chathams. A bottom sample with a conical dredge in 157 to 202 fathoms and a dredging in 194 fathoms, 45°48′ S., 178°58′ W., (*Discovery II* Station 2733) were obtained. Reed and Hornibrook (1952) have described the sediments and microfauna, Dell (1953) the molluscs, and Fell (1952) the echinoderms from this station.

THE AREA INVESTIGATED

Bottom Topography

The bottom topography between Banks Peninsula and the Chatham Islands is shown on Chart 1. The broad features of the sea bottom east of the South Island have been discussed by Fleming and Reed (1951). East of Banks Peninsula the continental shelf slopes gently for about 30 miles, the margin of the shelf being marked by a steepening between 50 and 200 fathoms. From 200 fathoms the continental slope gradually falls to about 315 fathoms and then rises to the Mernoo Bank, which lies some 90 miles east-north-east of Banks Peninsula. Mernoo Bank rises from the west end of the Chatham Rise which extends from the Chatham Islands towards New Zealand.

Available soundings show depths of 160 to 200 fathoms along the crest of the rise, deepening to over 300 fathoms in the central portion. South and north of the Chatham Rise the bottom falls rapidly to depths in excess of 1,000 fathoms. The northern deep is the Kermadec Trench and the southern, the Bounty Basin.

Fleming and Reed (1951) have described the topography and three sediment samples from the Mernoo Bank. The bank (Fig. 1) rises to a nearly flat summit occupying about 800 square miles of sea bottom shallower than 100 fathoms. The bank culminates in two ridges at a depth of 28 fathoms, and shallow channels cross its summit and sides.

The available information on the bottom topography of the shelf round the Chatham Islands is summarised in the Admiralty Chart of the islands (No. 1417). This chart is based on soundings made by Lieut. Fournier of the French Navy in 1840 with some additions by Mr Charles Heaphy in 1840 and subsequent minor additions in 1927, 1929, and 1932. The area is very inadequately charted, particularly on the northern and eastern coasts. Rock, sand, and shell sand are recorded on the chart, but no mud. Rough rocky bottoms with numerous shoals are common around the islands. Many of these shoals and reefs have not been charted. Extensive areas of sandy bottom, down to 100 fathoms, are to be found in Petre Bay and Hanson Bay.

Geology

Fleming and Reed (1951) discussed the significance of the Chatham Rise as an anticlinal structure with an axis trending westward to meet the north-east trending folds of the South Island. Banks Peninsula is apparently part of the west end of this broad geanticline, which occupies the position of a nucleus around which the arcuate folds of the central South Island are disposed. Fleming suggested that the Mernoo Bank is probably a tectonic dome. Reed studied sediment samples from the Mernoo Bank and found them to include pebbles of indurated sandstone and argillite similar to the late Paleozoic to early Mesozoic rocks of New Zealand. The absence of volcanic constituents in the sediment samples makes it unlikely that the bank is of volcanic origin, while the absence of quartz pebbles shows that it is not composed of schist such as constitutes the undermass of the Chatham Islands.

Reed (1952) has analysed the sediment sample obtained by *Discovery II* from the Chatham Rise in 157 to 170 fathoms. It was a well sorted gravelly sand consisting of rock fragments, phosphorite nodules, mineral grains, and Foraminifera. The rock fragments and pebbles were composed of schist which can be correlated with the schists on the Chatham Islands, and petrographically were identical with quartz-feldspathic schists from the chlorite zone of metamorphism in Otago, New Zealand. Volcanic material was absent, in marked contrast with the abundance of volcanic rocks on the Chatham Islands. Hornibrook (1952) found that the abundant phosphatic nodules present in the sediment contained Miocene Foraminifera. He

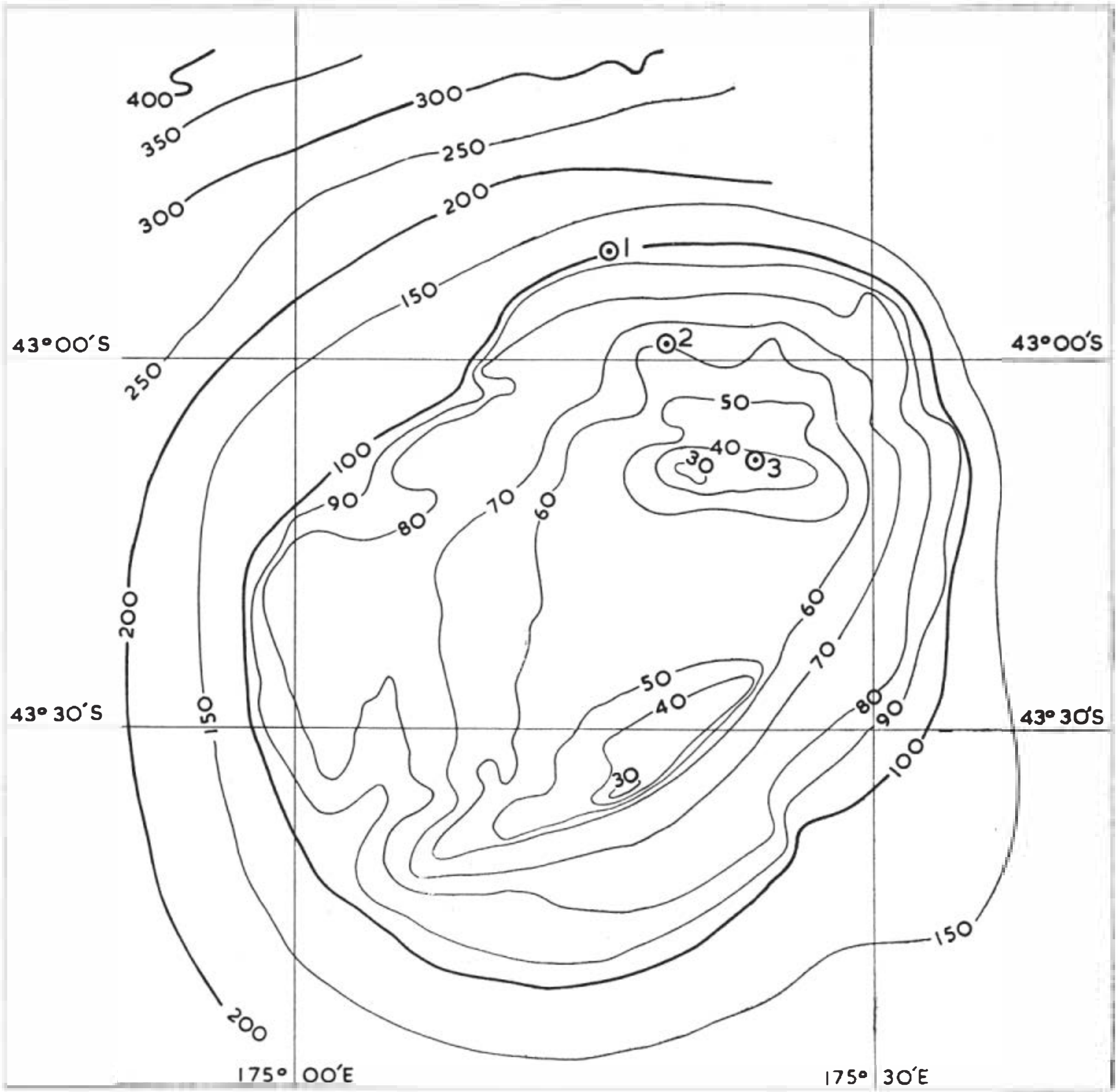

Fig. 1: The topography of the Mernoo Bank (after Fleming and Reed, 1951). (Depths in fathoms.)

concluded that the nodules were the residue of Miocene sediments that have been eroded since the uplift of the Chatham Rise.

Allan (1925, 1929) has given an excellent account of the physical features and structure of the Chatham Islands, which lie at the other end of the geanticline. These islands lie between the parallels 43°31′ and 44°30′ S. and the meridians 175°40′ and 177°15′W. The largest member of the group, Chatham Island, is about 350 square miles in area, but of this about 70 square miles is occupied by the shallow salt-water Te Whanga Lagoon. It is roughly T-shaped, extending some 30 miles in each direction. The southern portion of the island expands to a roughly rectangular block, the much dissected remnant of a plateau area which reaches a height of nearly 1,000 ft. along the southern coast. This plateau is composed almost entirely of a succession of horizontal basaltic lavas, post-Oligocene and pre-Pleistocene in age.

In strong contrast to the southern block, the central and northern areas are low-lying. Over most of the central area horizontal Oligocene bryozoan limestone either crops out or immediately underlies the surface deposits. In the northern area a central volcanic region of limburgite flows and tuffs separates schist areas to the east and west. In the main, the schist strikes in an east-west direction. This schist forms the undermass of the Chatham Islands, and Reed (1952) concluded that it extends westwards for a distance of at least 80 miles.

There is little of the surface of the island that has not at least a superficial covering of peat, which is over 40 ft. thick in places. Originally much of the surface was in forest, but little of this remains except on the southern plateau.

Fourteen miles to the south-east of Chatham Island lies a group of volcanic islands and rocks of which Pitt Island, with an area of about 24 square miles, is the largest. Of the others, Mangere, lying off the north-west coast of Pitt, and South East Island (Fig. 2), 2 miles off the east coast, are the most important. Smaller rocky islands such at Little Mangere, Round Rock, and The Pyramid (Fig. 3) abound, and numerous stacks are scattered throughout the group. Two other groups of rocky islets, The Sisters (Fig. 4) and the Forty Fours (Fig. 5) lie respectively 26 miles to the north-east and 20 miles to the east of Chatham Island.

For its size the Chatham Islands group has a great extent of coastline, with a great variety of coastal profile. On the north there are rugged broken coasts cut in quartz-mica schists. Sedimentary and tuffaceous rocks crop out on the central north coast, near Waitangi and Owenga, various places on Pitt Island, and on the north and east coasts of South East Island. South of Waitangi, wide, flat, regular wave-cut platforms are beautifully developed. Sand dunes form large stretches of the coastline, especially on the northern and eastern coasts.

Hydrology

The broad pattern of the circulation off the east coast of the South Island has been described by Deacon (1937) and related to the general pattern of southern oceanic circulation. In the south Tasman Sea the Subantarctic Surface Water of the West Wind Drift meets the subtropical East Australian Current and gives rise to a belt of mixed water near southern New Zealand. Here the current divides, part flowing north along the west coast of the South Island, the rest round the southern end of the South Island and north-east towards the Chathams. The northern boundary of this latter branch impinges on a tongue of warm subtropical water, passing southwards from East Cape, described by Fleming (1952) as the East Cape Current. Where the two water masses meet there is an area of intermingling, the Subtropical Convergence. Immediately east of New Zealand the convergence is clearly defined at times, ill defined at others, and varies considerably in position seasonally and from year to year (Garner, 1953, 1954). Subtropical water offshore may reach the latitude of Dunedin in February and Kaikoura in August. Much work remains to be done before the details of the circulation, particularly that of the deeper water, can be worked out.

The Chatham Islands lie near this Subtropical Convergence zone and are subject to both subtropical and subantarctic influences in varying degrees. This has an important bearing on the composition of the flora and fauna of the Chatham Islands, which show both subtropical and subantarctic affinities. Published maps of surface temperature isotherms show the group lying approximately in the 50°F. isotherm in winter and the 59°F. isotherm in summer. During the 1954 cruise, surface temperatures round the islands varied from 57°F. to 59°F.

The following weather data for the Chatham Islands are taken from the *New Zealand Pilot*, 1946.

MEAN DAILY AIR TEMPERATURES (°F.)

	Daily Max.	Daily Min.	Highest in Month	Lowest in Month
Jan.	64	52	70	42
Feb.	63	52	69	41
Mar.	62	51	67	41
Apr.	59	48	65	38
May	55	45	61	36
June	51	42	58	34
July	50	41	56	33
Aug.	51	41	57	32
Sept.	53	43	58	34
Oct.	56	45	62	35
Nov.	58	47	64	37
Dec.	61	50	68	40

The highest recorded temperature is 76°F. and the lowest 28°F. The monthly mean relative humidity varies from 76 per cent to 84 per cent. Throughout the year the amount of cloud averages 8 on a 0–10 scale. The average annual rainfall is 33·4 in., falling on 181 days. Wind frequencies show a predominance of south-westerlies and the number of calm days averages 3 per year. The main features of the weather are overcast skies and south-westerly winds alternating with northerly conditions which often bring fog and rain.

Marine Flora and Fauna

Very little was previously known about the bottom fauna of the Chatham Rise. Dell (1951) has listed 73 species of Mollusca from the *Matai* dredgings on the Mernoo Bank. Six of these were new species and the fauna was a central New Zealand shallow-water fauna showing little relationship with the Chatham Islands.

Of the deep-water bottom fauna of the Chatham Rise the only previous information was from the *Discovery II* dredging in 194 fathoms some 80 miles to the east of the Chathams. From this dredging Dell has listed 23 species of Mollusca of which 10 were new, and Fell (1952) five new species of ophiuroids.

On the shelf round the Chatham Islands there had previously been no dredging apart from the single 10-fathom dredging made by Powell (1933). A number of surface dwellers were obtained by the *Nora Niven* and others have been obtained from fish stomachs. Shelf Mollusca are also represented in the records by cast-up shells obtained from beaches by various collectors.

Young (1929) has listed the marine fauna of the Chatham Islands, apart from the Mollusca. This list was based on material collected by Young when a member of the Otago Institute party of 1924. He also studied every paper procurable and appealed to all authorities and museums for specimens and records. The number of species in different groups in Young's list are as follows:

Pisces	50	species
Coelenterata	3	„
Crustacea	47	„
Echinodermata	18	„
Polychaeta	25	„
Tunicata	12	„

Powell (1933) has published a revised list of the Chatham Islands Mollusca, based on the summary published by Finlay in 1928, with the addition of material collected by himself in 1933. In this revised list 256 species are recorded, of which 47 were endemic. He also stated that there is an approximate equality in numbers of marine species that definitely show either a northern or southern New Zealand origin. Thus the total number of marine animal species recorded from the Chatham Islands is 408 and of these, five-eighths are Mollusca.

Moore (1949) noted that 190 species of Algae are recorded from the Chathams. Of these, 10 are not otherwise known from the New Zealand region and the rest are a mixture of northern and southern Algae.

The Chatham Islands are recognised as a separate faunal province of the New Zealand region, the Moriorian Province. The affinities of the marine flora and fauna lie with the northern and southern parts of New Zealand rather than with the central region. The findings of the present expedition support this conclusion.

ORGANISATION

Expedition Members

Scientific Staff:

- G. A. Knox, Canterbury University College; leader.
- E. J. Batham, Portobello Marine Biological Station.
- E. W. Dawson, Canterbury University College.
- R. K. Dell, Dominion Museum.
- R. R. Forster, Canterbury Museum.
- D. M. Garner, Oceanographic Institute, D.S.I.R.
- J. R. MacIntyre, Canterbury University College.
- J. M. Moreland, Dominion Museum.

Ship's Staff:

- A. J. Black, Dunedin; master and owner.
- D. Marshall, Otago University; photographer.
- J. C. Yaldwyn, Victoria University College.

D. M. Garner was responsible for the collection of hydrological data with the assistance of the other expedition members. E. W. Dawson collected information on the bird life of the islands. The following were specially concerned with particular groups: R. K. Dell, molluscs; J. Moreland, fishes; J. C. Yaldwyn, crustaceans; R. R. Forster, terrestrial invertebrates; G. A. Knox, polychaetes. All members assisted with the dredging and trawling, the bulk of the sorting and preservation being done by R. K. Dell, J. M. Moreland, E. J. Batham, and G. A. Knox.

Ship and Scientific Equipment

M.V. *Alert* (Frontispiece) is a 72-ft. modified harbour-defence motor launch, with a draught of 5 ft. There is sleeping accommodation for fourteen.

One drawback was the lack of a sizable hold. However, the gear was stowed and lashed on the deck without interfering with the operation of the ship or scientific equipment.

The *Alert* proved to be an admirable vessel for the type of work carried out by the expedition. Her shallow draught and extremely good manoeuvrability enabled work to be carried out in difficult sea conditions and in shallow, dangerous waters where a larger or smaller vessel would have been at a disadvantage.

The main winch was designed and constructed by Mr A. J. Black and with the $4\frac{1}{2}$ h.p. petrol motor forms a compact unit that could be mounted on any vessel temporarily used for scientific work. The drum carries 580 fathoms of $\frac{3}{8}$-in. diameter wire rope with 30 ft. of heavy chain at the end. With modification the drum could take 1,000 fathoms of wire.

The wire was led over a wide block suspended from a pair of sheerlegs fitted to the stern. These were of 6 in. × 6 in. hardwood, well braced, with the block suspended over the stern about 12 ft. from the deck.

Before the expedition, four days were spent testing the winch and other equipment in depths down to 250 fathoms. In the light of this experience some modifications were made and it was possible to commence the voyage with the knowledge that the equipment was adequate for the proposed work. The winch proved very satisfactory, working easily and smoothly under all conditions. It handled large hauls in heavy seas and stood up to the strain when the dredge stuck fast on the bottom. A full station in deep water took about three hours.

The main winch was used primarily for biological work; a hand winch with 500 fathoms of $\frac{3}{32}$-in. stainless-steel wire and a Kelvin sounding machine with 300 fathoms of wire were used for hydrological work.

The following were the main items of collecting and recording equipment used:

Hydrological

- Surface thermographs (2)
- Bathythermographs (200 ft. and 450 ft.) (2)
- Nansen-Pettersen insulated water bottle (1)
- Nansen reversing water bottles and thermometers (6)

Geological

- Worzel bottom samplers (2)
- Kelvin-Hughes recording echo sounder, M.S. 22, 0–120 fathoms range

Biological

- Dredge, 3 ft. × 1 ft. and two smaller, naturalist's dredges
- "Salpa" pattern dredge, width 1 ft. 10 in.
- Anchor dredge, 2 ft. × 1 ft.
- Young-fish trawl (stramin)
- Beam trawl, width 5 ft.
- Otter trawls (2)
- Metre nets, circular mouth, 3 m. long, with graded mesh (2)
- Plankton nets, 50 cm. diameter, circular mouth, fine silk

Techniques

1 *Hydrological equipment*

This was operated mainly from the Kelvin hand-driven sounding machine fixed on the port side about 15 ft. from the stern. The wire was led over a block on the end of a boom extending about 6 ft. over the side. This arrangement made it possible to operate the bathythermograph and water bottles while the dredge was being hauled. The bathythermograph could also be operated while dredging or trawling at low speeds.

Water samples and temperatures were taken at the surface and at depth at the stations round the islands, and a series of stations at 40-mile intervals was occupied on the return trip to New Zealand.

2 *Biological equipment*

(a) Dredges. A 3 ft. × 1 ft. dredge constructed by Mr Black was used chiefly and proved highly satisfactory. The frame of the dredge was $\frac{3}{16}$-in. steel plate in the form of a box section with the bottom plate twice the area of the top one. Its strong construction enabled dredging to be carried out on rough bottoms, and rock samples were secured on several occasions. On sandy, muddy, and shell-sand bottoms it usually secured a full bag.

(b) Trawls. Both the beam trawl and the otter trawl were fished with success down to 330 fathoms. They rarely came up empty and secured exceptional hauls on many occasions.

(c) Handling the catch (Figs. 6 to 9). A sediment sample was taken immediately the dredge came on board. The catch was emptied directly on to the coarse sieve of the sorting table. This was of solid construction with three movable sieves, 4 ft. × 2 ft. 6 in. The sieve meshes were 2, 5, and 12 meshes to the inch respectively. Large specimens were picked out from the top tray and the sediment washed through the sieves with a low-pressure hose. Specimens retained in the sieves were sorted into flat enamel or plastic trays for finer sorting and preservation later. The sorting table proved invaluable. Four or five people could work round it and the material suffered little damage.

(d) Preservation of the catch. The degree of sorting depended on the time available, but an endeavour was made to sort into at least the following groups: fish, molluscs, echinoderms, sponges, crustaceans, and worms and other soft-bodied animals. Soft-bodied animals were anaesthetised in chlorbutol and this proved excellent for all groups. Animals were preserved either in formalin neutralised with hexamine or in 75 per cent alcohol. Sponges were preserved in 96 per cent alcohol and colonial ascidians in special fixatives provided by Miss B. Brewin, University of Otago. Special specimens were preserved in Bouins. Specimens too large for jars, and bulk collections of echinoderms, etc., were wrapped in cheesecloth and stowed in 10-gallon cans in neutral formalin. Any large amount of shell left in the trays was kept, and the contents of the bottom fine-mesh tray were preserved if worms and small crustaceans were present.

(e) Plankton. No systematic collection of plankton was attempted. Several tows were made and preserved in bulk by the addition of neutral formalin.

(f) Colour notes. Dr Batham was responsible for all colour notes, Munsell's standard colour charts being used.

NARRATIVE OF THE VOYAGE

22 January. Left Lyttelton at 1705 for Mernoo Bank.

23 January. Mernoo Bank was reached at 0705, and stations 1, 2, and 3 worked in 100, 61, and 41 fathoms on the bank. Station 4 was worked in 200 fathoms to the east of Mernoo Bank.

24 January. Stations 5, 6, and 7 were worked in 300, 220, and 280 fathoms.

At the 220-fathom station an exceptionally rich beam-trawl haul was obtained (Figs. 6, 9). This haul has yielded a large number of species not previously known in the New Zealand fauna, and a starfish (*Hippasteria* sp.; Fig. 9), previously known only from a single fossil specimen from the late Cretaceous of North Canterbury.

25 January. Heavy seas. Sighted the Pyramid (Fig. 3) at 1155 and passed within 30 yards in 30 fathoms of water. Anchorage at Waipawa on the east of Pitt Island. 1730, shore collecting. Party of three landed to spend the night ashore for land collecting. Light station at night.

26 January. Heavy seas. Collected shore party and sailed for Owenga. 1700, shore collecting at Owenga. Light station at night.

27 January. To Kaingaroa, stations 13, 14, and 15 on the way. 1500, shore collecting at Kaingaroa. Light station at night.

28 January. 0500, further intertidal collecting. Party of five ashore for the day. Others went to Waitangi West in *Alert* to take on fresh water from *Port Waikato.* On return trip to Kaingaroa, stations 18 to 21 worked.

29 January. Kaingaroa to The Sisters (Fig. 4), where a very profitable day was spent ashore on one of the islands making general collections and observations on birds. Stations 23 and 24 worked. To Waitangi, arriving 2000.

The prolific bird life on The Sisters included breeding royal albatrosses (Fig. 10) and Buller's mollymawks, nellies, skuas, and pipits. A census was made of the royal albatrosses, and 44 Buller's mollymawks and 17 juvenile nellies were ringed. A census was made of a seal colony.

30 January. 0800, shore collecting at Waitangi. Party ashore while stations 26 and 27 worked in Petre Bay. Light station at night.

31 January. 0600, further intertidal collecting at Waitangi. Sailed 0930 for dredging and trawling in Petre Bay, stations 29 to 32. Party ashore collected fossils at Titirangi and trawled and collected in Te Whanga Lagoon. Light station and collection off wharf piles in the evening.

1 February. Left Waitangi 0400 for Forty Fours (Fig. 5). Two of the party went ashore and made general shore collections and observations on birds. Station worked in 130 fathoms to the east of the Forty Fours. Anchorage in Waihere Bay, Pitt Island.

On the Forty Fours were found 2,000 pairs of breeding royal albatrosses (Figs. 11 to 14); 400

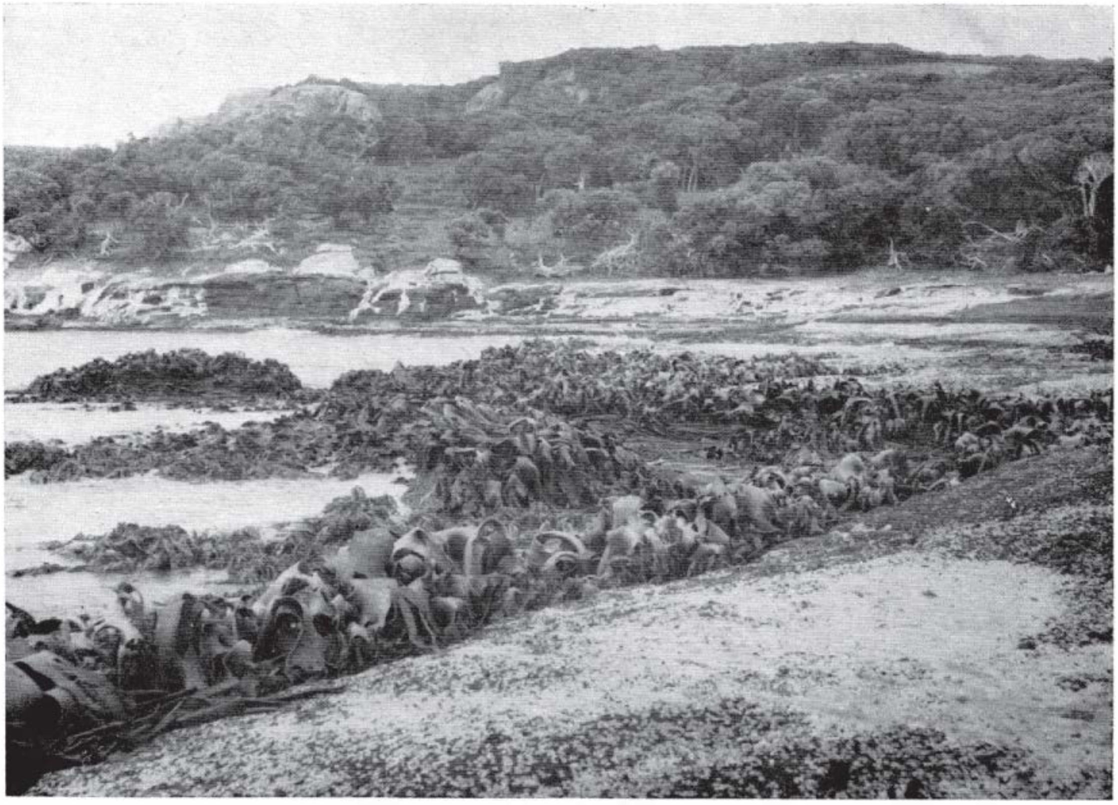

Fig. 2: The intertidal zone on the north coast of South East Island with a well developed band of *Durvillea antarctica*. This shore platform is the haunt of the rare shore plover *Thinornis novaeseelaniae,* which is now confined to this island.

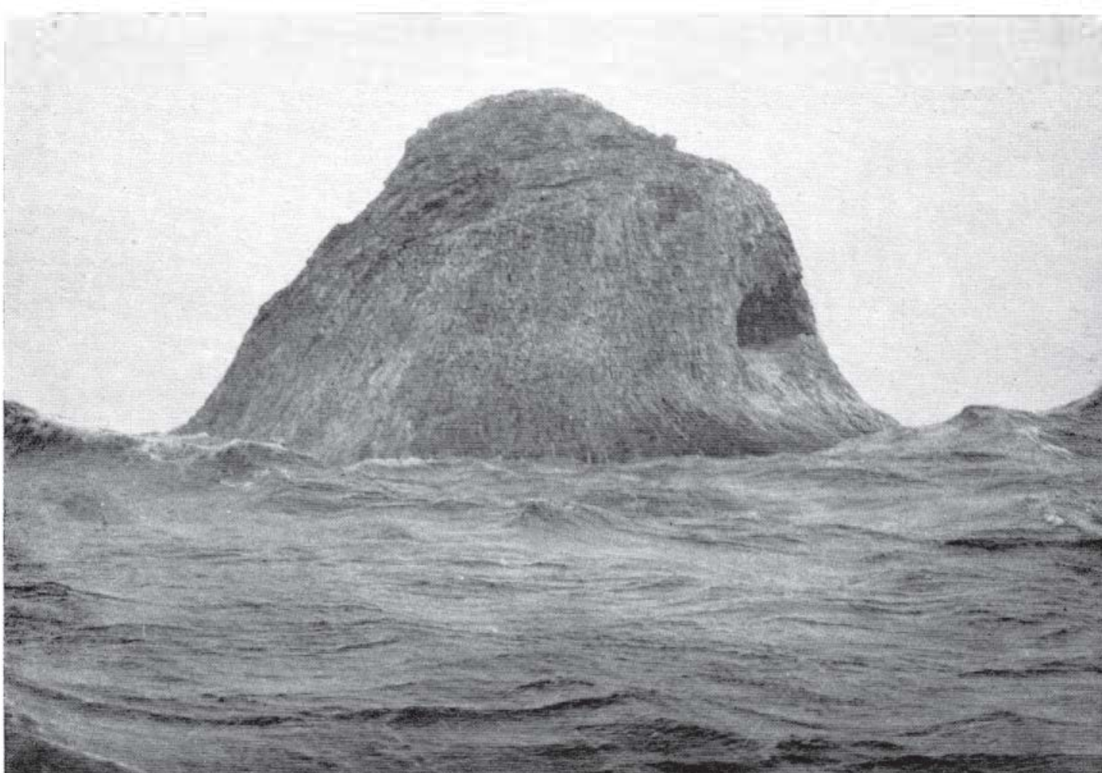

Fig. 3: The Pyramid (height 566 ft.). This rock is the sole nesting place of the Chatham Island mollymawk.

Fig. 4: The Sisters islets from the low-lying reef.

Fig. 5: The Forty Fours.

Fig. 6: A beam trawl dominated by the polychaete, *Hyalinoecia tubicola*, from station 6 in 220 fathoms.

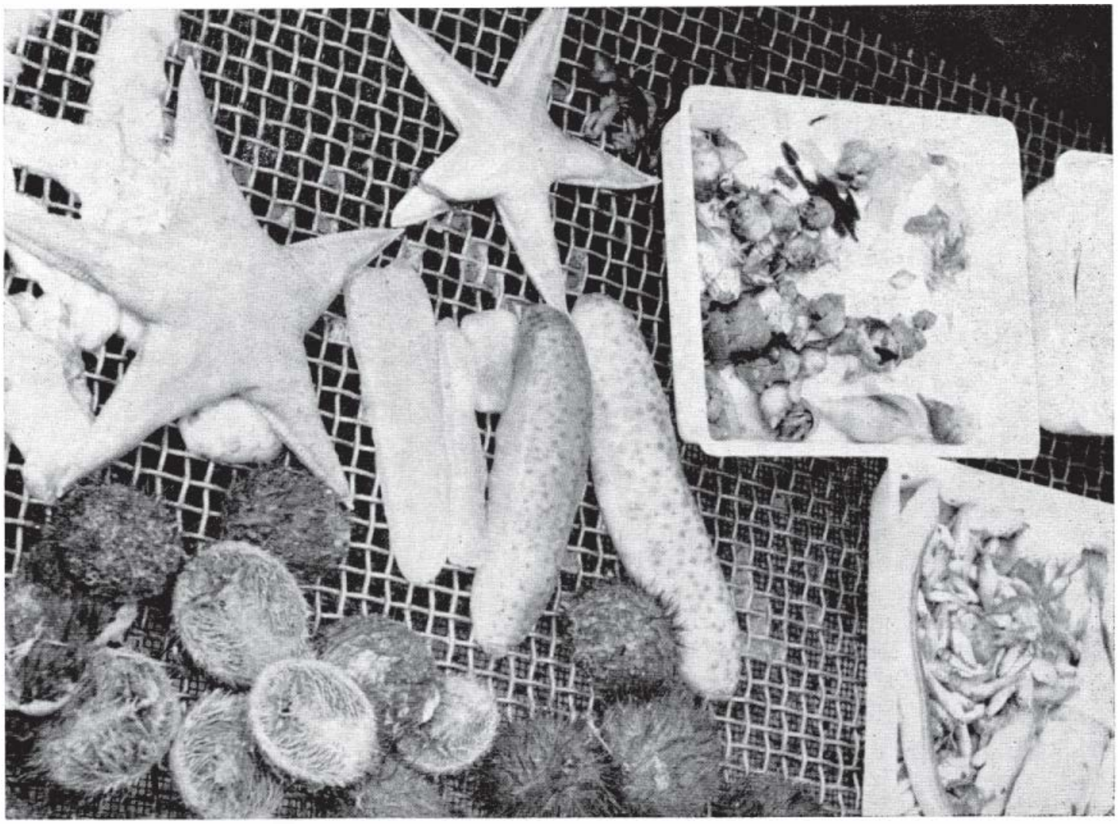

Fig. 7: A beam trawl haul from station 7 in 280 fathoms dominated by the echinoid *Spatangus multispinus*, with a large unknown species of holothurian in the centre.

Fig. 8: Sorting a trawl haul on the after deck. *Photo: D. Marshall*

Fig. 9: A portion of the trawl haul from station 6 in 220 fathoms. The large starfish in the upper left is *Hippasteria* sp., previously known from a single fossil specimen from the Late Cretaceous.

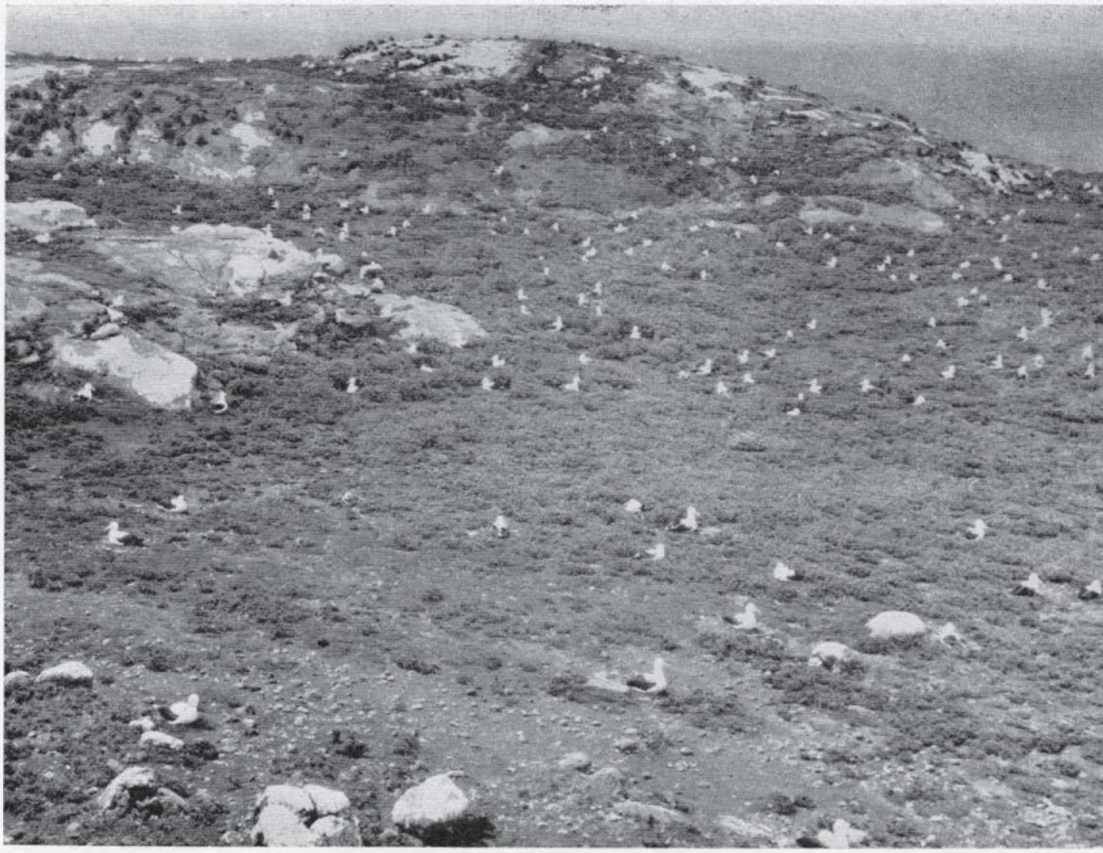

Fig. 10: Royal albatrosses nesting on The Sisters.

Fig. 11: Royal albatrosses, nesting on the Forty Fours. Note the large size of the plants (*Cotula renwicki*) compared with those on The Sisters.

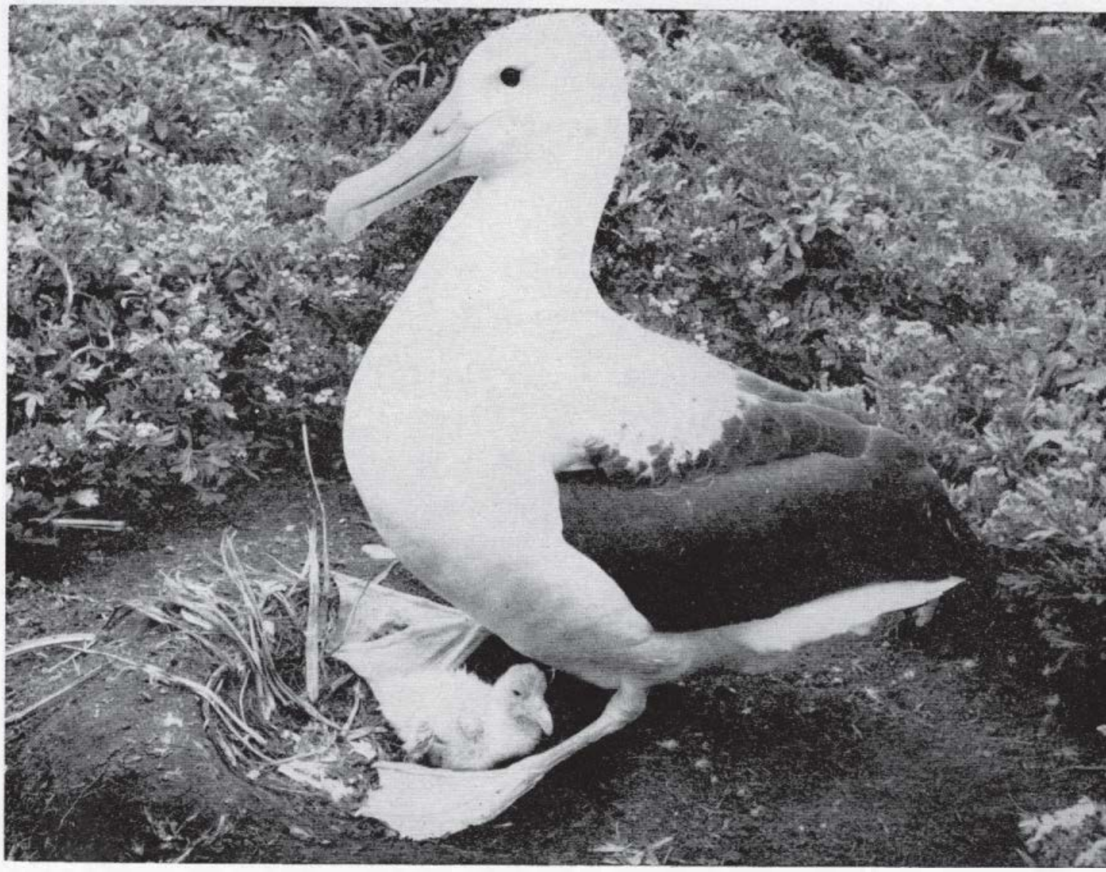

Fig. 12: A royal albatross with a young chick on the Forty Fours.

Fig. 13: Nesting Buller's mollymawks on the Forty Fours.

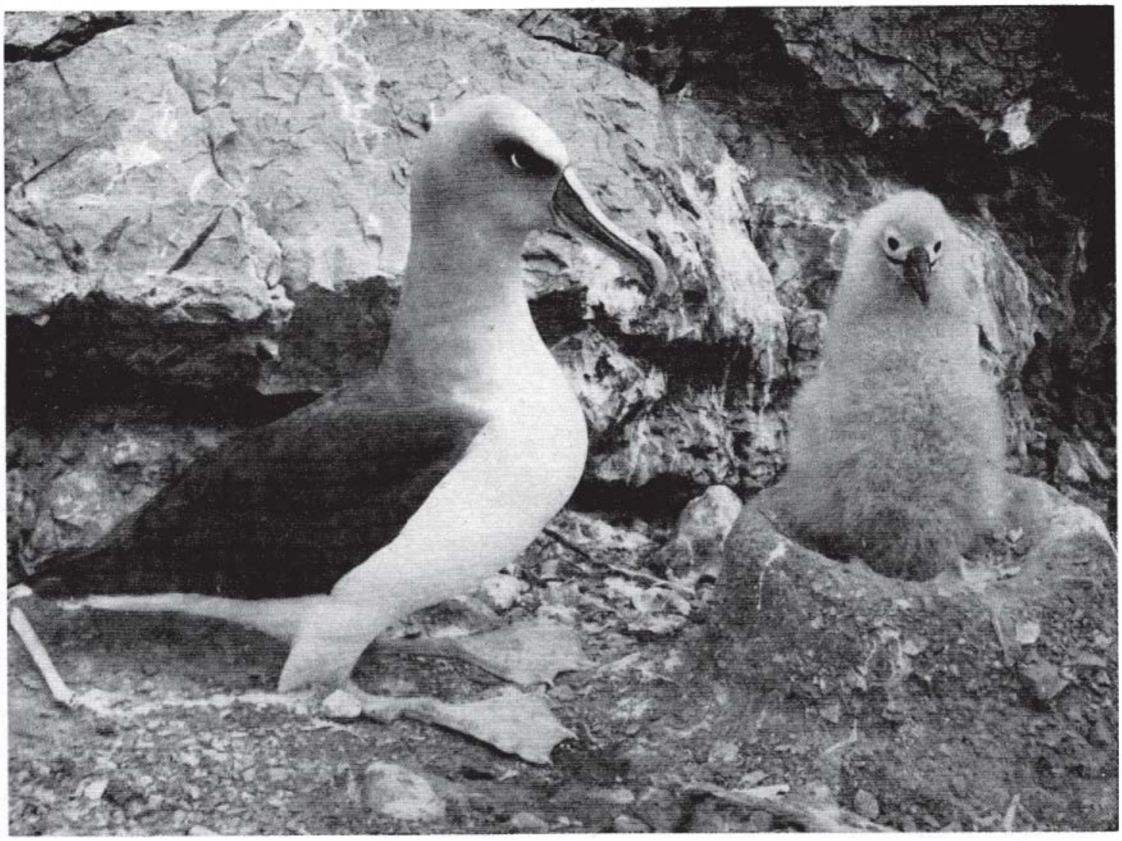

Fig. 14: A Buller's mollymawk with chick on the Forty Fours.

TABLE 1: Station List

[illegible]	Position		[illegible]	Date	Depth		Wind		Swell		Air Temp.	Hydrological Observations				Nature of Bottom	Biological Observations			Remarks
				1954			Direc-tion	Force	Direc-tion	Force		Depth		Temp.	Salinity		Gear	Time (N.Z.S.T.)		
	S.	E.			fm.	m.					°F.	fm.	m.	°F.	‰			Shot	Hauled	
1	42° 51·9′	175° 26·5′	Mernoo Bank	23.i	100	103	E.	1–2	S.E.	[illegible]	60·6	0	0	50·3		c.bry.sh.s.	D.L. D.L. D.N.	0730 0825 0846	0710 0835 0906	Empty
[illegible]	42° 59·4′	175° 30·5′	Mernoo Bank	23.i	61	112	E.	1–2	S.E.	[illegible]	60·4	[illegible]	0	50·3		f.bry.sh.s.	D.N. O.T.	1105 1145	1125 1158	
[illegible]	43° 10·1′	175° 36·5′	Mernoo Bank	23.i	41	75	E.	1–2	S.E.	[illegible]	60·6	[illegible]	0	50·3		c.bry.sh.s.	D.L.	1305	1320	L.H.
[illegible]	43° 14′	176° 11′	Chatham Rise	23.i	200	366	E.	3–4	S.E.	[illegible]	58·6	[illegible]	0	58·3		f.gn.s.	D.L.	1705	1720	
[illegible]	43° 32′	179° 38′	Chatham Rise	24.i	300+	549+	N.E.	1	S.E.	[illegible]	59·9	[illegible]	0	50·6		f.gn.s.	D.L.	0635	0655	
[illegible]	43° 40′	179° 28′	Chatham Rise	24.i	220	403	N.E.	1	S.W.	[illegible]	59·9	[illegible]	0	58·6		f.gy.s.m.	B.T. B.T. D.L.	1115 1136 1216	1130 1206 1231	
7	43° 42′	179° 55′	Chatham Rise	24.i	280	512	W.	3–4	S.W.	[illegible]	59·0	[illegible]	0	58·5		f.gy.s.m.	B.T.	1755	1815	
	S.	W.																		
8	43° 47′	179° 30′	Chatham Rise	24.i	100	103	W.	3–4	S.W.	[illegible]	[illegible]	[illegible]	0	50·5			M.N.	2100	2120	(N.B. Position on Chart 1 is in error)
9			Glory Bay, Pitt Id.	25.i													Sh. Coll.			
10			Glory Bay, Pitt Id.	26.i								0	0	58·6			N.H.			Light L.H.
11			Owenga	26.i													Sh. Coll.			
12			Owenga	26.i							56·5	0	0	58·5			N.H.			Light L.H.
13			Owenga	27.i	4–6	0–11	S.W.	6	S.	[illegible]	57·0	0	0	57·0		f.br.s.	D.L. O.T.	[illegible] 0940	0915 1005	A few jellyfish only
14	[illegible]	176° 21′	Hanson Bay	27.i	15	27	S.W.	[illegible]	S.	[illegible]	50·0	0 15	0 27	57·0 57·0	31·07 34·81	c.sh.s. limestone	D.L.	1015	1030	B.
15	[illegible]	176° 18·5′	Hanson Bay	27.i	30	55	S.W.	[illegible]	S.	[illegible]	55·0	0 30	0 55	57·7 57·7	35·01 34·87	f.gy.s.	D.L.	1200	1215	B.
16			Kaingaroa	27.i													Sh. Coll.			
17			Kaingaroa	27.i							57·6	0	0	57·2			N.H.,H.L.			Light L.H.
18	43° 41′	176° 48′	Off Cape Pattison	28.i	15	27	S.W.	3	S.	[illegible]	57·6	0 15	0 27	57·2 56·9	34·88 34·00	r.	D.L. D.L.	1425 1440	1435 1450	B.
19	43° 38·2′	176° 30′	Off Cape Young	28.i	25	46	S.W.	[illegible]	S.	[illegible]	57·4	0 20	0 37	57·2 56·5	34·88 34·92	r.	D.L.	1514	1524	B.
20	43° 39′	176° 34·5′	Off Cape Young	28.i	20	37	S.W.	[illegible]	S.	[illegible]	57·2	0 20	0 37	57·0 57·0	34·92 34·92	c.sh.s.	D.L.	1604	1611	B.
21	43° 42′	176° 22′	N. of French Reef	28.i	15	27	S.W.	[illegible]	S.	[illegible]	57·0	0 15	0 27	57·0 56·9	34·94 34·94	f.gy.s.	D.L. O.T.	1655 1712	1700 1727	B. A few jellyfish only
22			The Sisters	29.i													Sh. Coll.			L. H.
23	43° 32·5′	176° 47·5′	N. of The Sisters	29.i	33	60	S.	2	S.	4	57·0	0 33	[illegible] 60	57·0 56·9	34·83 34·85	c.sh.s.	D.L.	1552	1605	B.
24	43° 36·2′	176° 48·5′	S. of The Sisters	29.i	38	70	S.S.E.	[illegible]	S.	[illegible]	56·9	0 38	0 70	57·0 56·5	34·83 34·05	c.sh.s.g.	D.L.	1638	1648	B.
25			Waitangi Wharf	29.i							56·1	0	0	57·2			N.H.			Light L.H.
26			Waitangi	30.i													Sh. Coll.			
27	43° 57·5′	176° 44·5′	Petre Bay	30.i	45	82	S.W.	2	S.W.	3	56·5	0	0	58·3		r.	D.L. D.L.	1612 1632	1625 1642	B.
28	43° 57′	176° 47′	Petre Bay	30.i	50	92	S.W.	2	S.W.	3	57·2	0	0	58·0		f.gy.s.	O.T. O.T.	1645 1710	1700 1730	Empty
29	[illegible]	177° 08′	Petre Bay	31.i	[illegible]	172	S.	[illegible]	S.	[illegible]	57·0	0 94	0 172	57·7 53·8	34·85 34·85	f.gn.s.	D.L. O.T. B.T. M.N.	1257 1318 1403 1403	1307 1338 1419 1419	B. Net lost
30	43° 56′	176° 53′	Petre Bay	31.i	70	128	S.	[illegible]	S.	[illegible]	57·2	0 70	0 128	57·4 55·7	34·90 34·88	f.gn.s.	B.T.	1630	1645	Net torn B.
31	43° 56·5′	176° 37′	Petre Bay	31.i	22	40	S.	[illegible]	S.	[illegible]	57·2	0 22	0 40	57·0 56·9	34·80 34·81	f.gn.s.	D.L.	1815	1825	B.
32			[illegible]	31.i	[illegible]	13	S.	[illegible]	S.	[illegible]	57·0	0	0	57·2	34·60	f.gy.s.	D.A.	1845	1850	
33			Te Whanga Lagoon	31.i	1–2	2–4											O.T.			
34	[illegible]	[illegible]	E. of Forty Fours	1.ii	130	238	N.	[illegible]	S.	[illegible]	[illegible]	0 130	0 238	57·9 51·9	34·76 35·00	f.s.g.	D.L. O.T. D.S.	1300 1325 1413	1305 1340 1428	B
35			Forty Fours	1.ii													Sh. Coll.			L.H.
36			Waihere Bay	1.ii							56·1	0	0	57·2	34·95		N.H.			Light
37	[illegible]	[illegible]	Between South East Id. & Pitt Id.	2.ii	30	55	N.	5	[illegible]	[illegible]	60·6	0 30	0 55	56·9 56·9	35·01 35·01	r.c.sh.s.	D.L.	1003	1018	B.
38			S. of Little Mangere	2.ii	43	79	N.W.	[illegible]	[illegible]	[illegible]	50·5	0	0	57·2	34·92	c.sh.s	D.L.	1140	1155	
39			South East Id.	3.ii													Sh. Coll.			
40	[illegible]	[illegible]	S.E. of Pitt Id.	3.ii	155	302	W.	3	N.W.	4	61·0	0 155	0 302	57·9 50·4	34·94 34·97	f.gn.s.	D.L. O.T.	1316 1425	1332 1455	B.
41	44° 35·5′	176° 04′	S.E. of Pitt Id.	3.ii	330	604	N.W.	4	N.W.	[illegible]	61·2	0 275	0 488	57·9 47·5	31·85 34·71	f.gn.m.s.	O.T.	1605	1630	B.
42			Owenga	5.ii							58·1	[illegible]	0	59·9			N.H.			Light L.H.
43			Owenga	6.ii	3–4	5–7	N.W.	5	N.W.	[illegible]	58·5	0	0	59·9		c.s., sandstone	D.S. Y.F.T.	1400 1418	1405 1425	also N.P. at 0–2 fm.
44	43° 35′	176° 03·5′	N. 30° E. of Kaingaroa	7.ii	120–125	220–229	[illegible]	[illegible]	S.	[illegible]	50·3	0 120	0 220	58·0 52·5	35·14 34·94	f.gn.s.m.	D.L. O.T.	1122 1215	1132 1230	0.
45	43° 34′	176° 02′	N. 30° E. of Kaingaroa	7.ii	155	284	N.W.	[illegible]	S.W.	[illegible]	50·1	[illegible] 155	[illegible] 284	57·9 51·9	35·07 35·01	f.gn.s.m.	O.T. D.L.	1305 1345	1325 1355	Trawl lost B.
46			Kaingaroa	7.ii	[illegible]	[illegible]					58·5	0	0	59·4		f.gy.s.	D.L.	1645	1650	
47			Kaingaroa	7.ii							57·9	0	0	57·9			N.H.			Light L.H.
48			Port Hutt	8.ii							57·7	0	0	58·3			N.H.			Light L.H.
49			Port Hutt	8.ii													Sh. Coll.			
50			Port Hutt	9.ii	3–4	5–7	N.W.	[illegible]			58·3	0	0	58·5		f.gy.s.	Y.F.T.			Also N.P. from 0–1 fm
51	44° 02′	[illegible]	Chatham Rise	10.ii	125	229	W.	[illegible]	[illegible]	4	57·9	0 125	0 229	57·9 50·2	34·78 35·00	f.gn.s.	N.P. D.L. B.T.	0026 0026 0043	0041 0038 0059	B. N.P. from 0–1 fm.
52	44° 04′	178° 04′	Chatham Rise	10.ii	260	476	W.	[illegible]	S.W.	[illegible]	55·0	0 260	0 476	57·9 43·5	34·69 34·97	f.gn.s.m.	N.P. D.L. B.T.	0632 0632 0716	0647 0645 0736	B. N.P. from 0–2 fm.
53	44° 07′	179° 02′	Chatham Rise	10.ii	160	293	N.W.	[illegible]	S.W.	[illegible]	55·9	0 160	0 293	57·5 45·8	34·78 34·02	f.gn.s	D.L. B.T.	1300 1331	1318 1346	B.
[illegible]	44° 09′	179° 59′	Chatham Rise	10.ii	300+	549+	N.W.	1	S.W.	[illegible]	57·9	0 300	0 549	57·2 44·1	34·83 34·48		N.P. D.L.	1915 1915	1930 1930	B. N.P. from 0–2 fm. Empty did not reach bottom
	S.	E.																		
55	44° 11′	179° 11′	Chatham Rise	11.ii	380	710	W.	[illegible]	S.W.	[illegible]	50·1	0 388	0 710	57·3 42·1	34·47 34·40		D.L.	0630		Dredge did not reach bottom
56	44° 14′	178° 23′	Chatham Rise	11.ii	360	650	W.	[illegible]	S.W.	[illegible]	50·3	0 360	0 650	57·1 42·1	34·45 34·44					
57 & 58	43° 40′	177° 59′	Chatham Rise	11.ii	320	507	N.W.	[illegible]	W.	5	57·7	0 320	0 507	57·3 43·2	34·65 34·45	f.gn.m.	N.P. D.L. B.T.	1220 1220 1245	1235 1232 1300	B. A little mud only N.P. from 0–1 fm.
59	43° 38′	177° 19′	Chatham Rise	11.ii	290	531	W.	[illegible]	W.	5	57·7	0 290	0 531	57·7 45·5	34·77 34·48	f.gn.s.m.	D.L. B.T.	1730 1750	1742 1807	B.
59A	43° 37′	176° 20′	Chatham Rise	12.ii	230	421	W.	[illegible]	W.	[illegible]	57·0	0 230	0 421	60·1 45·7	34·81 34·59					B.
60	43° 36′	175° 31′	Chatham Rise	12.ii	205	375	W.	[illegible]	W.	4	55·4	0 205	0 375	61·0 47·3	34·81 34·70	f.gn.s.	B.T.	0630	0650	B.

pairs of breeding Buller's mollymawks; 150 juvenile nellies; 30 pairs of pipits; 3 pairs of skuas; gulls, shags, and starlings.

2 February. Weather rough. Left Waihere Bay 0800 for South East Island. Conditions too rough for landing. Stations 37 and 38 worked before anchoring on east side of Pitt Island.

3 February. 0700, left for South East Island (Fig. 2). Landed 0900 for general shore collecting. Left party of three to spend night ashore and set off at 1200 to work stations 40 and 41, in 155 and 330 fathoms. The otter-trawl haul from station 41 took two hours to get on board, owing to the heavy catch. Anchorage on east side of Pitt Island at 2120.

4 February. 0800, left for South East Island. Picked up shore party and moved round to Whalers Bay on the north-east end of South East Island. Spent rest of day sorting and packing the catch.

5 February. Heavy seas. 0800, set off for the Pyramid but forced to turn back. Set course for Star Keys, approached within 50 yards but conditions were too rough for landing. To Owenga, arriving at 1320. Shore collecting in the afternoon. Light station at night.

6 February. 0800, anchorage untenable so shifted out into the bay. Station 43 in 3 to 5 fathoms. Set off for Waitangi to collect stores from *Port Waikato,* turned back on learning she was going to Kaingaroa, and anchored in Hanson Bay north of Owenga.

7 February. 0415, to Kaingaroa, where we received fresh water from *Port Waikato*. Stations 44 and 45 in 125 and 150 fathoms. Station 46 in 2 fathoms at Kaingaroa. Light station at night.

8 February. 0745, Left Kaingaroa for Port Hutt where the rest of the day was spent stowing gear. Shore collecting in the afternoon. Light station at night.

9 February. Most of day spent in preparation for the passage to Lyttelton. Further shore collecting; young-fish trawl and plankton net towed from the dinghy. Sailed 2100.

10 February. Stations 51 to 54, Chatham Rise.

11 February. Stations 55 to 59, Chatham Rise.

12 February. Station 60, Chatham Rise. Reached Lyttelton 2100.

STATION LIST

Details of the marine stations worked by the expedition are given in Table 1.

The times given are New Zealand standard time. The entry under "shot" gives the time when all the wire had been paid out and towing actually commenced; that in "hauled", the time when hauling had actually commenced. An entry B in the remarks column indicates that the bathythermograph was used.

All station depths under 120 fathoms were obtained by the echo sounder; those over 120 fathoms are wire soundings taken with the Kelvin sounding machine.

Abbreviations used in denoting the nature of the bottom are:

br.	brown.	gn.	green	s.	sand
bry.	bryozoan	gy.	grey	sft.	soft
c.	coarse	h.	hard	sh.	shell
f.	fine	m.	mud	st.	stones
g.	gravel	r.	rock		

The directions of wind and swell are true bearings and the strengths are expressed in terms of Beaufort's scales. The air temperatures were recorded in the shade with a mercury-in-glass thermometer protected from direct wind; sea temperatures were measured variously with mercury-in-glass thermometer, mercury-in-steel surface-recording thermograph, bathythermograph, and reversing thermometer. All thermometers used were intercompared and the readings reduced to correspond to a common standard. Water samples were collected in 250-ml. glass-stoppered, narrow-mouth reagent bottles and were subsequently analysed for salinity by the Dominion Laboratory, D.S.I.R., Wellington, using the standard Knudsen method. Subsurface values of temperature and salinity quoted in the station list refer to bottom values only. Vertical profiles of these quantities, where measured, are discussed in Appendix 2.

The following symbols denote the type of gear used:

B.T.	beam trawl
D.A.	anchor dredge
D.L.	large dredge, 3 ft. × 1 ft.
D.N.	naturalist's dredge, 2 ft. × 9 in.
D.S.	Salpa-pattern dredge
L.H.	hand lines
N.P.	plankton net
N.M.	metre net
N.H.	hand nets
O.T.	otter trawl
P.S.	pile scraper
Sh. coll.	shore collecting
Y.F.T.	young-fish trawl

RESULTS

Summary of Observations

During the voyage a distance of about 1,700 nautical miles was covered, about 700 of these being round the Chatham Islands, during which continuous echo-sounding records were made.

In the three weeks the expedition collected at 58 marine stations and 11 terrestrial localities and occupied 36 hydrological stations. Only marine localities have been allocated station numbers.

Bottom-sediment samples were obtained from 35 localities and rock samples from a number of stations, including the top of Mernoo Bank and east of the Chathams in 135 fathoms.

Dredging and trawling were carried out in depths up to 330 fathoms on a variety of bottoms. Down to 100 fathoms 23 stations were occupied, from 100 to 200 fathoms 8 stations, and from 200 to 300 fathoms 10 stations. The dredge was used on 39 occasions, the otter trawl on 12, and the beam trawl on 11.

Collections

The collections brought back by the expedition have been sorted and are now being studied by specialists. The deep-water dredgings and trawlings are proving particularly informative and serve to indicate how meagre our knowledge of the deep-water fauna has been.

Material collected by the expedition will be deposited as follows: rock specimens and microfaunal preparations extracted from the sediments, in the New Zealand Geological Survey, Wellington; fish and molluscan type material and bulk collections, in the Dominion Museum, with paratypes and duplicate collections in the Canterbury Museum; all other type material and bulk collections will be deposited in the Canterbury Museum, with paratypes and duplicate collections in the Dominion Museum. The hydrological records, sediment samples, and echo-sounding traces are held by the New Zealand Oceanographic Institute, Wellington.

Reports

The results of studies of the expedition material will be published in various journals. Up to the present, six papers have appeared (Yaldwyn, 1954; Knox, 1954; Dawson, 1955; Russell, 1955; Brewin, 1956; Dell, 1956).

Brief accounts of the hydrology and bottom topography, and of the echinoderm, mollusc, and fish collections are appended to this general account.

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APPENDIX 2

HYDROLOGY OF CHATHAM RISE

by D. M. Garner, New Zealand Oceanographic Institute, Wellington

Introduction

Observations of temperature and salinity were recorded during the course of the Chatham Islands 1954 Expedition, primarily to provide a description of the hydrological environment at the dredging and trawling stations. Apparatus and methods used have been described by Mr Knox on p. 13 of this bulletin. Reference should also be made to Charts 1 and 2 for the position of stations and the route followed. The expedition station list (Table 1) gives temperature and salinity for the surface and bottom at each station where observations were made.

Surface Conditions Around the Islands

Surface temperature was measured continuously by recording thermograph and numerous water samples collected for salinity analysis. The range in both temperature and salinity was small, 57°F. to 59°F., and 34·6‰ to 35·1‰, with no pronounced gradients. Surface isotherms and isohalines drawn from the observations are shown in Fig. 15. The extent to which contouring is controlled is evident from the track of the observing vessel. No significant changes in surface conditions were evident when the same route was traversed on different days.

An area of relatively colder and less saline water was found over the shallower area north-west of Cape Young, off the northern coast of Chatham Island.

The warmest and least saline water was found around Waitangi, its presence probably being due to the sheltering effect of Petre Bay and the outfall of the Nairn River.

There appears to be a marked intrusion from the north of relatively warm and saline water towards Hanson Bay on the east coast of Chatham Island, although observations are lacking northwards from the Forty Fours which are necessary to substantiate fully this interpretation.

The occurrence of relatively warm and saline water around the south of Pitt Island is difficult to explain except as an isolated pocket of water left from some previous intrusion from the north. It might be noted here that in mid December 1953, M.V. *Port Waikato* (Holm Shipping Co.) collected a surface sample from Pitt Strait giving a salinity of 35·0‰, suggesting that such an intrusion may have taken place.

Subsurface Conditions Around the Islands

North Coast A vertical temperature section constructed from observations taken between Cape Pattison and Kaingaroa (see ships track between stations 18 and 21, Chart 1), is shown in Fig. 16. This section crosses the colder area off the north coast (Fig. 15) and shows how the temperature contrast between the colder mass and its warmer surroundings increases with depth, suggesting an upward movement in the cold water.

Stations 22 and 23, near The Sisters and apparently close to the centre of the cooler area, were worked in fairly shallow water, and their temperature and salinity characteristics (see station list) were similar to those of the water column to the same depth over the cold core to the west of station 19 (Fig. 16). The stations nearest to this in deeper water were 44 and 45 (Fig. 17) at the shelf edge north-east of Kaingaroa. At these stations, water with the characteristics of the cold core was found at about 120 ft. in the deeper water, and about 260 ft. on the shelf. The colder water off Cape Young is probably derived from deeper waters off the shelf.

Hanson Bay The surface plots of Fig. 15 suggest a deflection of water into Hanson Bay from the north. Stations 13, 14, and 15 occupied in the bay were isothermal and practically isohaline. A plot of surface temperature and salinity against depth at station 34, worked on the seaward side of the shelf edge east of the Forty Fours, is shown

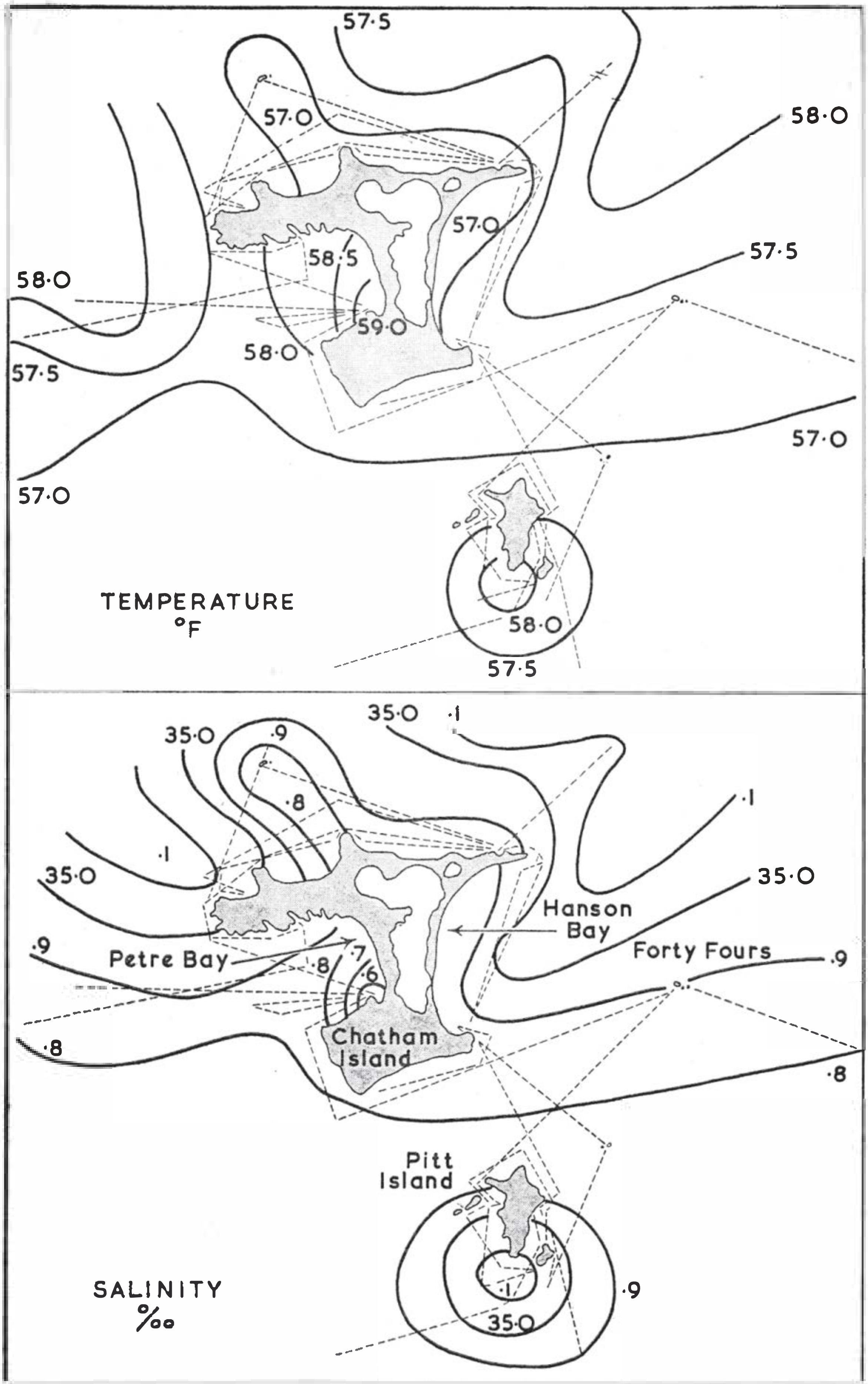

Fig. 15: Estimated distribution of surface temperature (°F.) and salinity (‰) around the Chatham Islands during the period of the expedition. The track of the observing vessel is shown as broken lines.

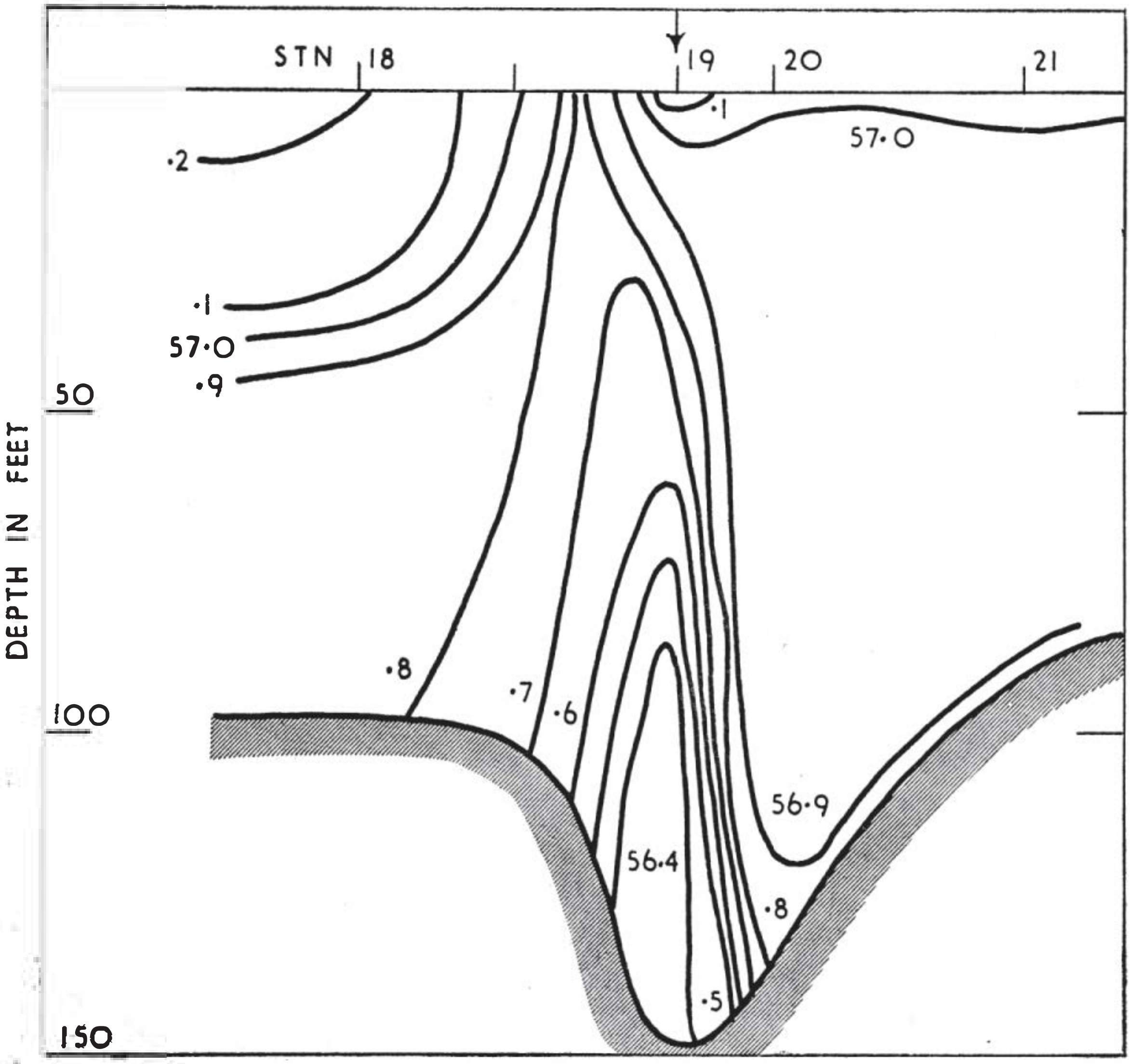

Fig. 16: Vertical temperature cross section (°F.) constructed from five bathythermograph soundings off the north coast of Chatham Island between Cape Pattison and Kaingaroa, 28 January 1954. The arrow near Station 19 shows where a marked change in course was made (see Chart 3).

in Fig. 18. The salinity shows a weakly defined minimum at about 200 ft. similar to that observed at station 44 (Fig. 17). This is perhaps due to the presence of a shallow layer of subtropical water of higher salinity overlying a water mass whose salinity increased slowly with depth.

Pitt Island Isothermal and almost isohaline conditions were found in the shallow-water stations 37 and 38 close to Pitt Island.

The curves of Fig. 18 describe conditions close to the shelf edge south of Pitt Island. A subsurface salinity minimum is still just evident. It is noteworthy that below about 400 ft., the water at each of the deep stations 34, 40, and 44 was isohaline at practically the same salinity. At station 41, on the seaward side of the shelf edge, the temperature and salinity showed essentially the same variation with depth as given in Fig. 19 for station 40. Below 900 ft. the only observations made at this station were at 1,500 ft. and 1,650 ft. at which depths temperature and salinity were, respectively, 49·8°F. and 34·7‰ and 47·5°F. and 34·7‰ (much higher values, incidentally, than were found at comparable depths on the Chatham Rise).

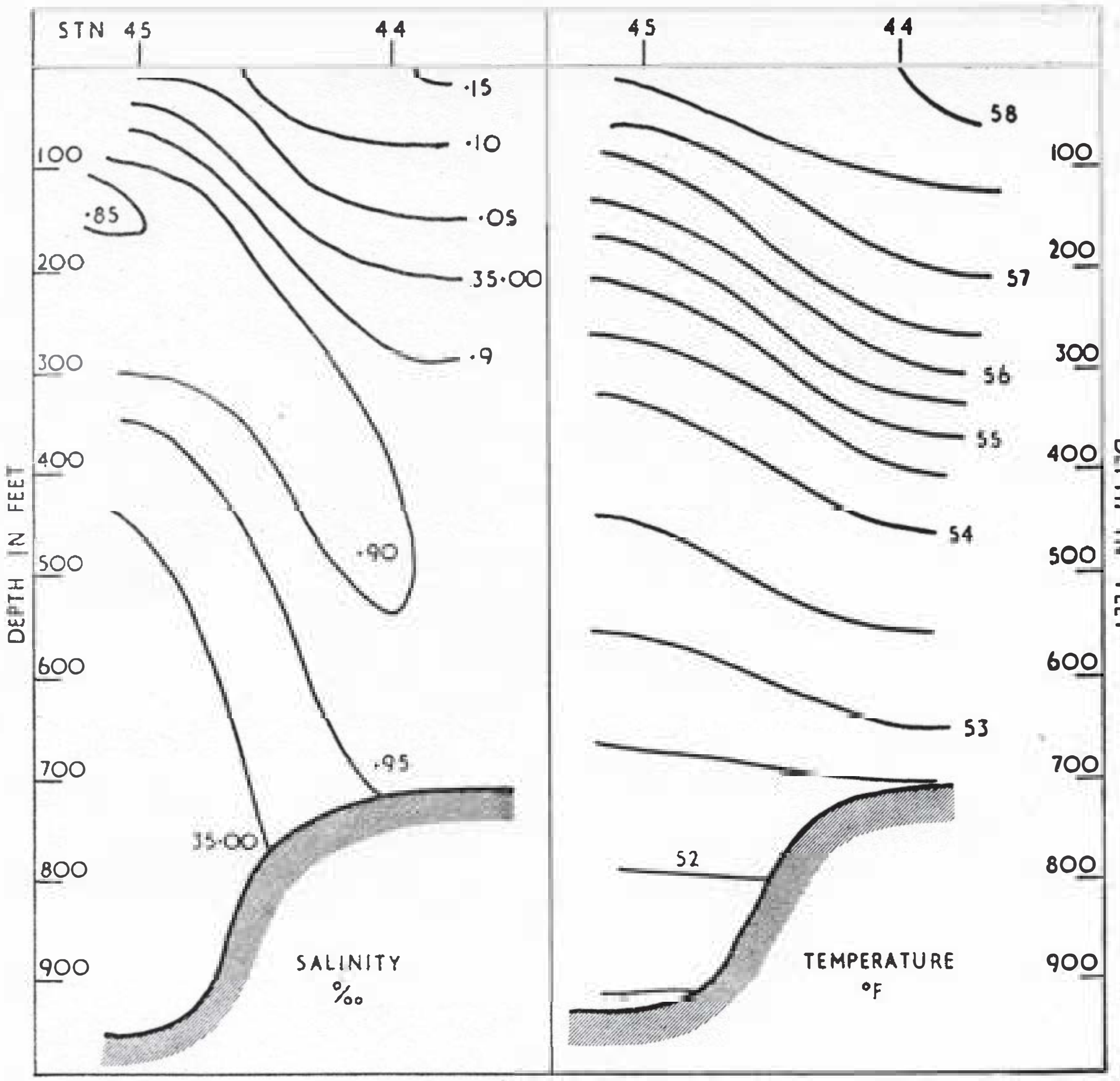

Fig. 17: Temperature and salinity as a function of depth for stations 44 and 45 at the shelf edge north-east of Kaingaroa, 7 February 1954.

Petre Bay The temperature section into Petre Bay from the east reproduced in Fig. 20 shows how the warmer water in the bay noted on the surface-temperature plot is distributed in depth. There is no well marked thermocline over most of the section; this feature is traced approximately by the 55°F. isotherm, becoming evident at the seaward end of the section, in depths greater than about 500 ft. Perhaps the mixing effect of tidal streams is felt inshore from this point.

The Chatham Rise A series of full hydrological stations was worked along the Chatham Rise during the return voyage to Lyttelton from the islands. Reference should be made to Chart 1 for a plot of the station positions. The course followed took the vessel from Petre Bay on to the southern flank of the Chatham Rise where the bottom begins to fall away into the Bounty Basin. About midway between the Chathams and Banks Peninsula, a north-easterly course was followed back to the summit of the rise, and thence to Lyttelton. These changes in course should be kept in mind when examining the temperature and salinity sections shown in Fig. 21. The total range in salinity

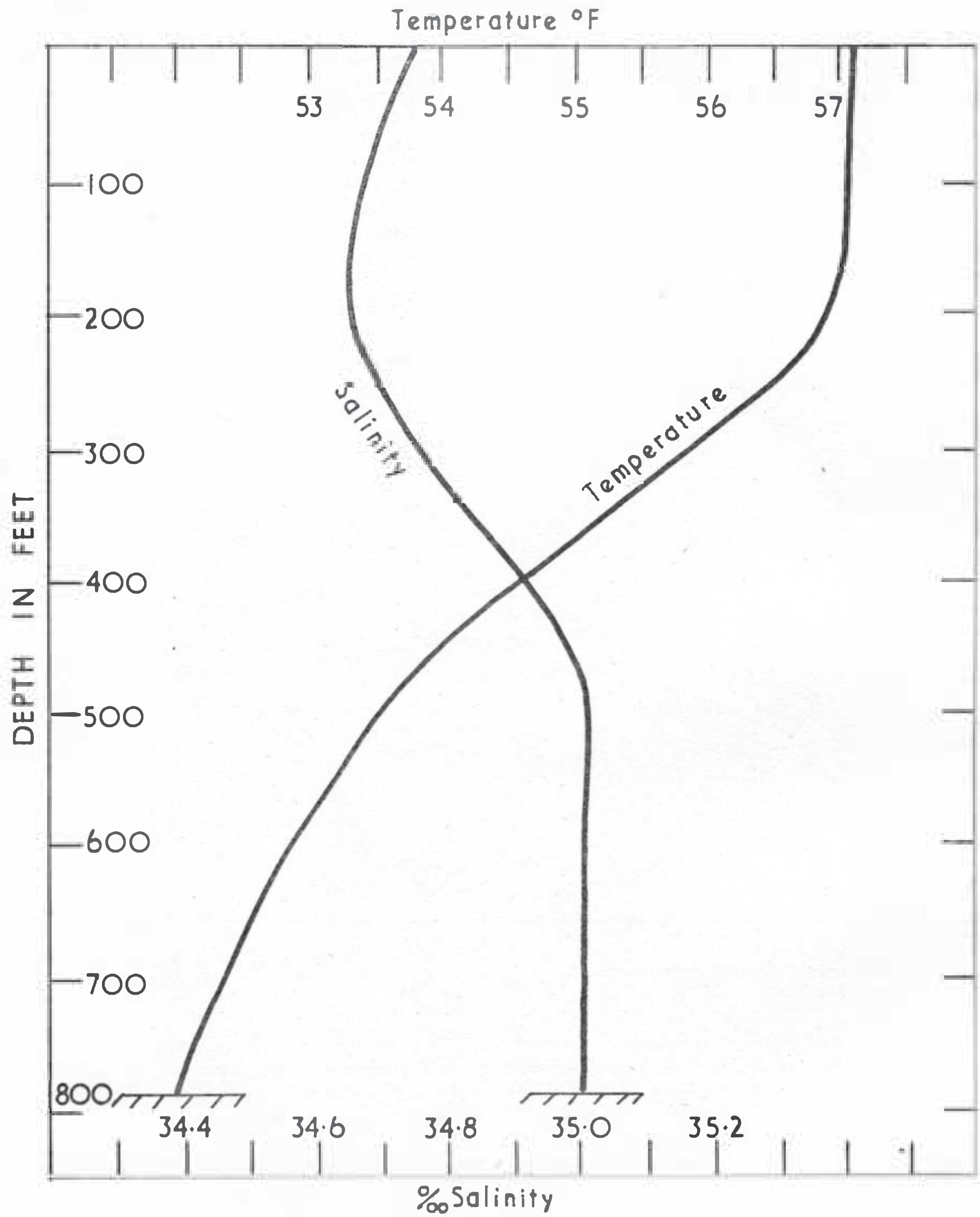

Fig. 18: Temperature and salinity as a function of depth for station 34, east of the Forty Fours, 1 February 1954.

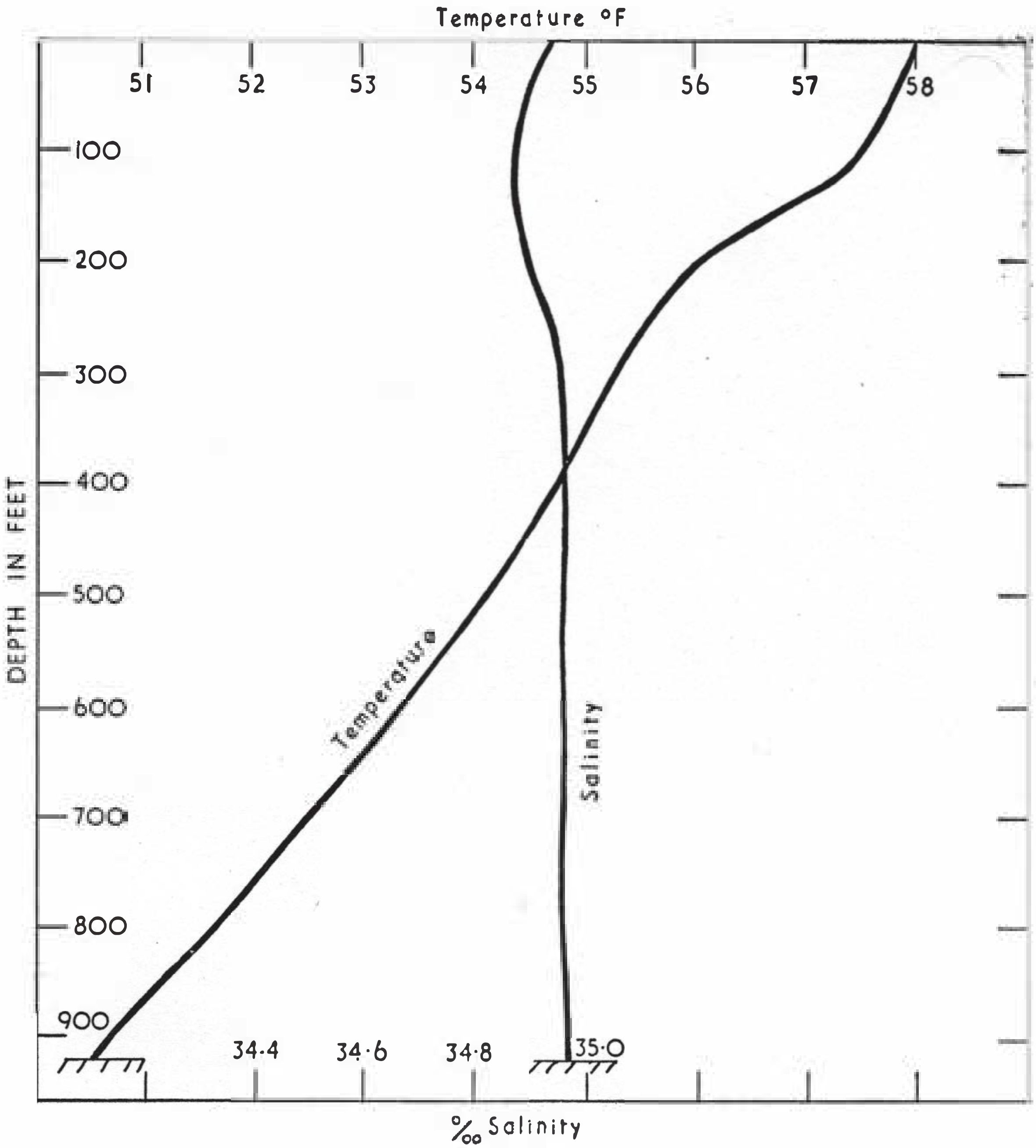

Fig. 19: Temperature and salinity as a function of depth for station 40, south of Pitt Island, 3 February 1954.

over the Chatham Rise was small (34·4°/₀₀ to 35·0°/₀₀) and tended to show small variation in depth. Because of this, the density pattern will be closely similar to that of temperature, and the temperature section is used as a basis for a discussion of circulation over the rise.

The most striking feature of the section is the "dome" of colder (and less saline) water centred between stations 55 and 56. Because of the relative steepness of the isotherms defining this feature, it appears possible that it represents water with a northward component of flow which has received an upward thrust at the southern flank of the Chatham Rise. Based chiefly on a small minimum in surface temperature recorded on the thermograph between stations 55 and 56, the upward

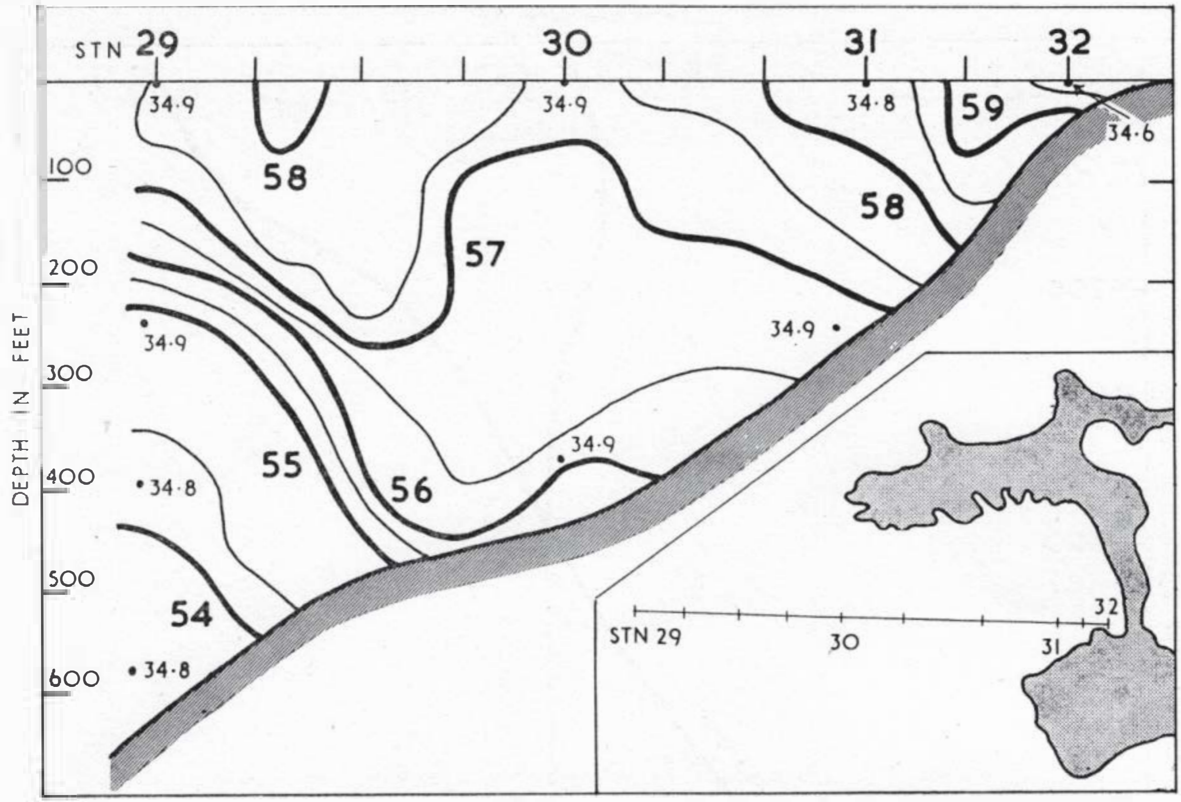

Fig. 20: Vertical temperature cross section, constructed from ten bathythermograph soundings, extending from the west of Chatham Island into Petre Bay towards Waitangi (31 January 1954). The salinity of a few water samples taken on this line are entered at the appropriate depths. An inset map, lower right, shows the position of this line relative to the island.

curvature has been continued in the isotherms nearer the surface (where this feature would not otherwise have been suspected owing to the spacing of stations) although, necessarily, to a smaller degree. This suggests a retardation of upward movement because of the stability of the thermocline layer. This interpretation, then, places a cyclonic eddy between stations 55 and 56.

At the eastern end of the section, the isotherm slope, downwards to the east, suggests a relatively weak component of flow southwards normal to the section, confirming the interpretation of hydrological influence from the north about the island group.

At the western end of the section, a pronounced rise in surface temperature was recorded just to the east of station 59A. Isotherms plotted in vertical section suggest a relatively strong component of flow normal to the section towards the north in this area, extending to a depth of about 150 ft. The relatively high temperature and salinity of this water, however, labels it as of northern origin, so here there presumably existed an anticyclonic eddy. Several small temperature inversions, represented in the section by small kinks in the isotherms, were recorded on bathythermograph traces at the base of the thermocline layer beneath this feature.

With these suggestions derived from a study of the vertical section in mind, the probable general form of the surface temperature and salinity patterns over the Chatham Rise was sketched in Fig. 22, and the suggested main trend of the surface circulation is added. It was possible to extend the sketch of surface isotherms over a wide area, through the timely receipt of thermograms from T.E.V. *Hinemoa* (Union Steam Ship Company, Lyttelton to Wellington) and H.M.N.Z.S. *Lachlan* (on survey between Cape Kidnappers and Cape Palliser) close to the period of the expedition's work on the Chatham Rise. (Considerable detail was apparent in the *Lachlan* data, but in essentials, the surface pattern was as sketched in Fig. 22.)

The surface temperature plot of Fig. 22 (c),

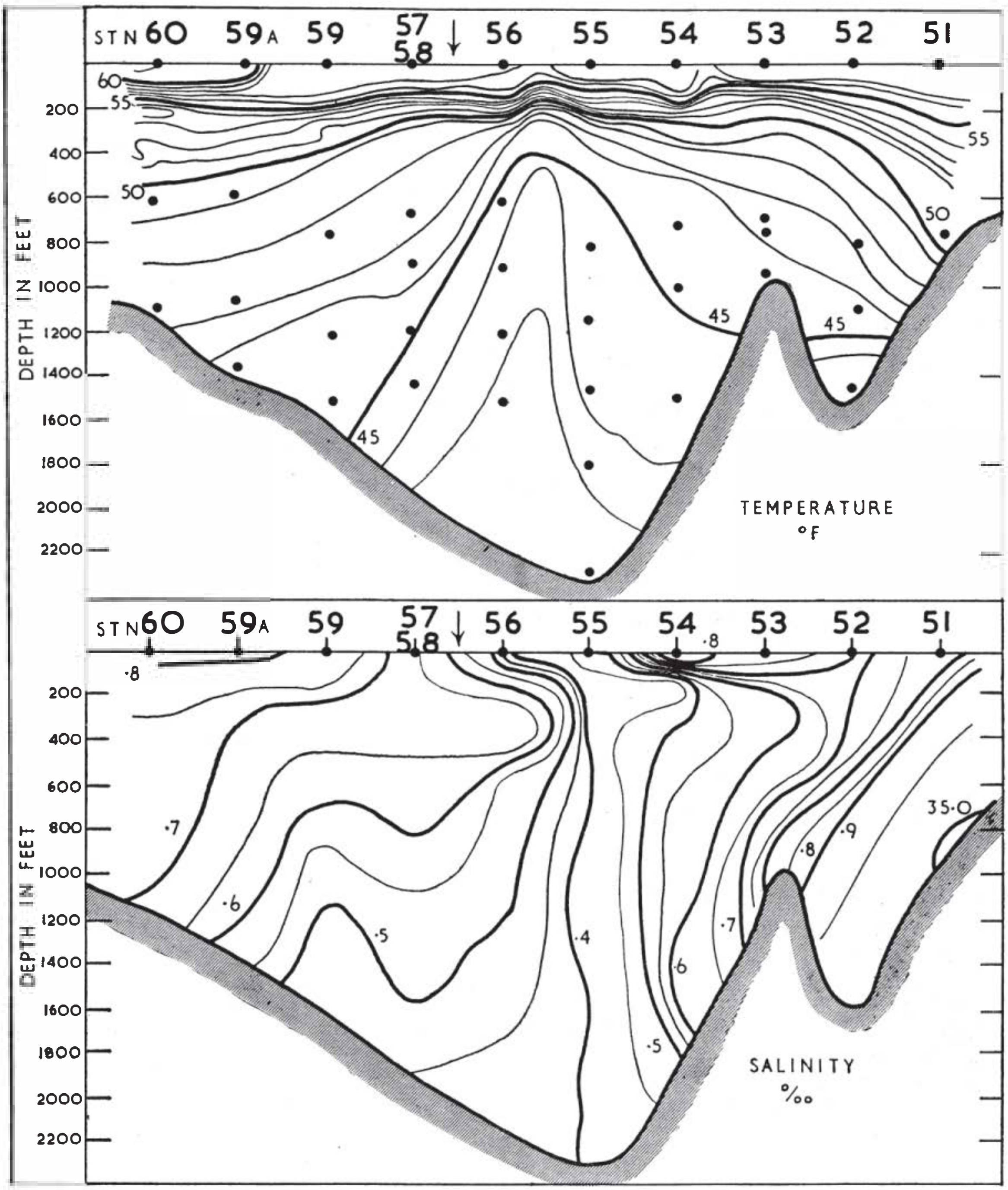

Fig. 21: Vertical cross sections of temperature and salinity along the Chatham Rise between Chatham Island and Banks Peninsula (10–12 February 1954). The arrow between stations 56 and 57/58 shows where a marked change of course was made. See Chart 1 for a plot of station positions.

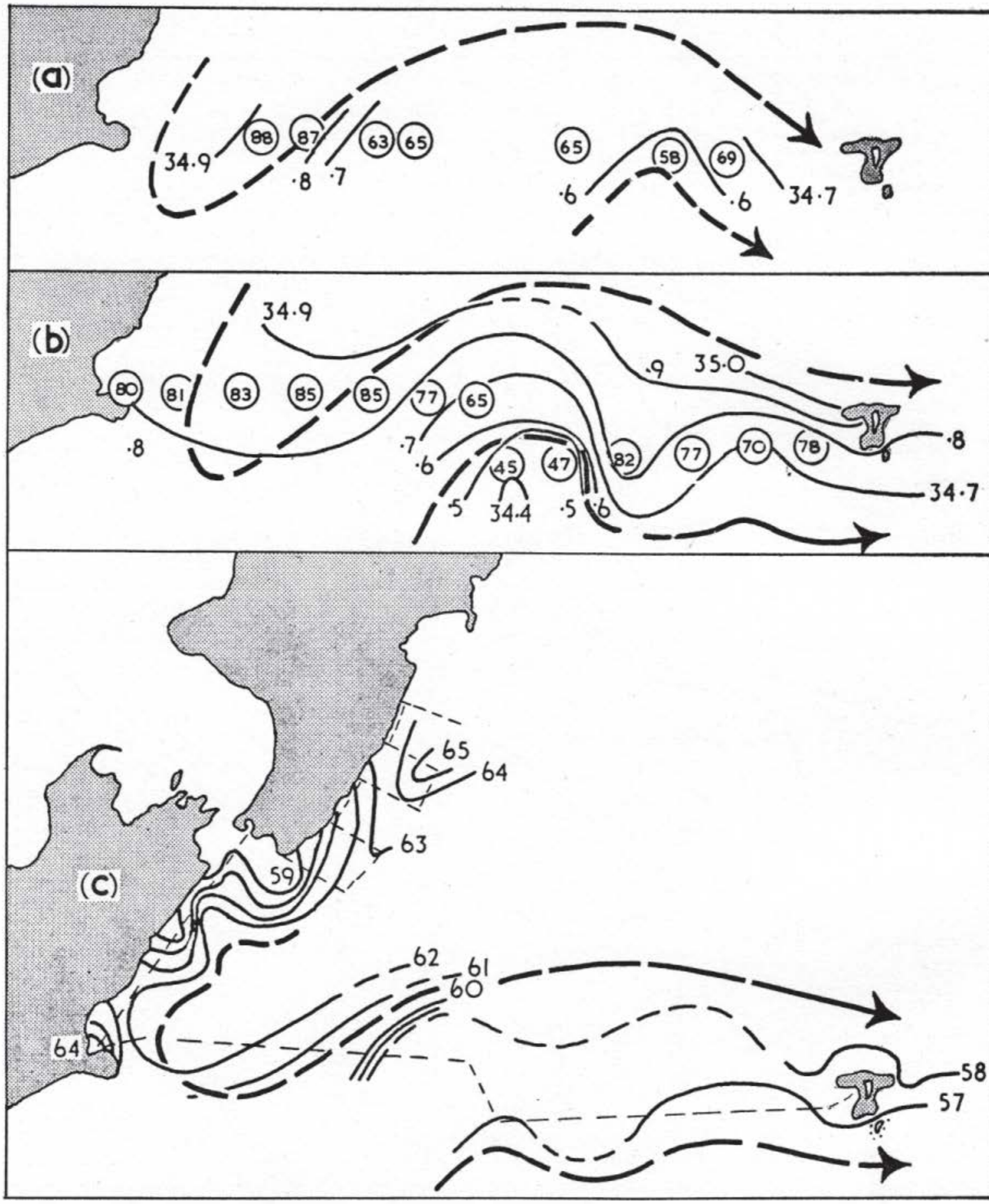

Fig. 22: Surface temperature and salinity over the Chatham Rise:
(a) Salinity (⁰/oo), early January 1954 (from M.V. *Port Waikato*).
(b) Salinity (⁰/oo), early February 1954 (from expedition stations).
(c) Temperatures (°F.), early February 1954 (from expedition stations extended by data from *Hinemoa* and *Lachlan*).
Suggested flow patterns, in very general form only, are sketched as heavy broken lines, subtropical water to the north, subantarctic water to the south. Salinities plotted in circles on (a) and (b) represent the first two decimal places of the salinity of samples collected, all values lying between 34 and 35⁰/oo.

shows a tongue of subtropical water extending southwards towards Banks Peninsula, the southernmost portion of this tongue being crossed by the expedition section. The cold water in the middle of the section is shown as the northernmost tip of an intrusion of subantarctic water. It appears that the surface rate of change of salinity with temperature is greater in subantarctic water than in subtropical, details of the subtropical pattern being more evident from the temperature distribution, and those of the subantarctic pattern more evident from salinity. Fig. 22 (a) shows the probable pattern of surface salinity over the Chatham Rise early in January 1954, derived from samples collected by M.V. *Port Waikato*; it is interesting to see that conditions were basically the same during the month preceding the work of the expedition. The subtropical water near New Zealand extended to a depth of about 150 ft. only, both near Banks Peninsula and off Cape Palliser (from *Lachlan* data).

The surface hydrological environment of the Chatham Islands appeared to be predominantly subtropical at the time of the expedition. It is apparent, however, that the convergence region lay very close to the group and that the islands must be subject to a great variety of hydrological conditions near the surface.

Near the bottom, however, conditions will depend largely on depth, and the deeper water will be independent of seasonal changes in the balance between subantarctic and subtropical water.

Plastic-covered drift cards, in bundles of ten, were released at each station across the Chatham Rise, and at intervals of five miles between station 60 and Lyttelton Harbour. At the time of writing (August 1956) no cards had been recovered from the Chatham Rise releases, consistent with the picture of a general eastward set in the surface circulation built up from the hydrological data. From releases between a position marked on the course by the 62°F. surface isotherm (Fig. 22c) and Lyttelton, a large number of recoveries have been made, all from the shores of Pegasus Bay, north of Banks Peninsula.

APPENDIX 3

MARINE GEOLOGY OF THE CHATHAM ISLANDS AREA

by J. W. Brodie, New Zealand Oceanographic Institute, Wellington

Introduction

The Chatham Islands are located on the eastern extremity of the Chatham Rise, the crest of which lies in depths less than 500 fathoms. The flanks of the rise drop relatively steeply towards the Kermadec Trench in the north and to the Bounty Basin in the south. The area discussed here is the island shelf surrounding the group and the upper part of the island slope, and is roughly bounded by the 150-fathom isobath, about 15 miles off shore.

The bathymetry shown on Chart 2 is based on continuous echo soundings taken by M.V. *Alert* during the expedition, along courses aggregating approximately 300 nautical miles, and on the spot soundings on Admiralty Chart 1417. This chart shows only 130 soundings in the 5,000 square miles around the islands, 50 of these being in the 100 square miles of Petre Bay.

The distribution of sediments is defined from the descriptions shown on the Admiralty Chart and from shipboard descriptions of samples obtained by the expedition.

Available information on the rocks of the Chatham Islands has been summarised by Reed and Hornibrook (1952). Three main areas, each with distinctive rock types, are distinguishable: the southern plateau is composed of post-Oligocene and pre-Pleistocene horizontal basalt flows, Oligocene byrozoan limestones make up the central low-lying area, and in the northern area east-west striking schists in the eastern and western portions are separated by a central area of limburgite flows and tuffs, possibly Oligocene in age.

The submarine morphology of the Chatham Rise has been figured and briefly discussed by Fleming and Reed (1951). A sample of sediment dredged by R.R.S. *Discovery II* from a point 80 miles west of Chatham Island (station 2733) was described by Reed and Hornibrook (1952) as a well sorted gravelly sand, consisting of schist fragments, pebbles of phosphatised Miocene *Globigerina* ooze and Miocene sandstone, and Foraminifera. Allan (1925, 1929) noted a wave-cut platform 10 to 15 ft. above sea level in the north-west corner of Petre Bay and a raised marine terrace now 50 ft. above sea level in the Cape Pattison area. South of Waitangi he observed wave-cut platforms that terminated seaward in a vertical drop to six fathoms below sea level. Allan considered the group owes its present form to "faulting that blocked out the main masses" and to subsequent slight uplift and formation of the extensive sand bars now linking three of the four former islands.

Morphology of the Island Shelf

All the islands of the Chatham group are enclosed within one continuous 60-fathom isobath. Shoreward of this line, echo-traces show the bottom to be irregular (Fig. 23) with a local relief averaging five fathoms. The north-western and larger part of the area (from which Chatham Island itself rises) is separated from the south-eastern portion by a five-mile-wide passage 30 to 40 fathoms deep. Though the land area rising from this south-eastern inner shelf is small, much of the area is covered by water less than 30 fathoms deep.

Six lines of echo soundings were taken across the outer shelf to depths of 100 to 135 fathoms (Fig. 24). The main break in slope at the shelf edge lies in 100 fathoms south-west of Petre Bay and Pitt Island. Echo soundings along four of these lines, off South East Island, the Forty Fours, and Kaingaroa, show that the break here occurs in 80 to 85 fathoms.

The gradient of the shelf steepens abruptly landward at an average depth of 65 fathoms. Within the area bounded by the 60-fathom isobath the echo soundings record a succession of level surfaces at average depths of 52, 32, 21, 16, 10, and 6 fathoms. The 32-, 21-, and 16-fathom levels are comparatively well documented around Pitt Island and across Pitt Strait.

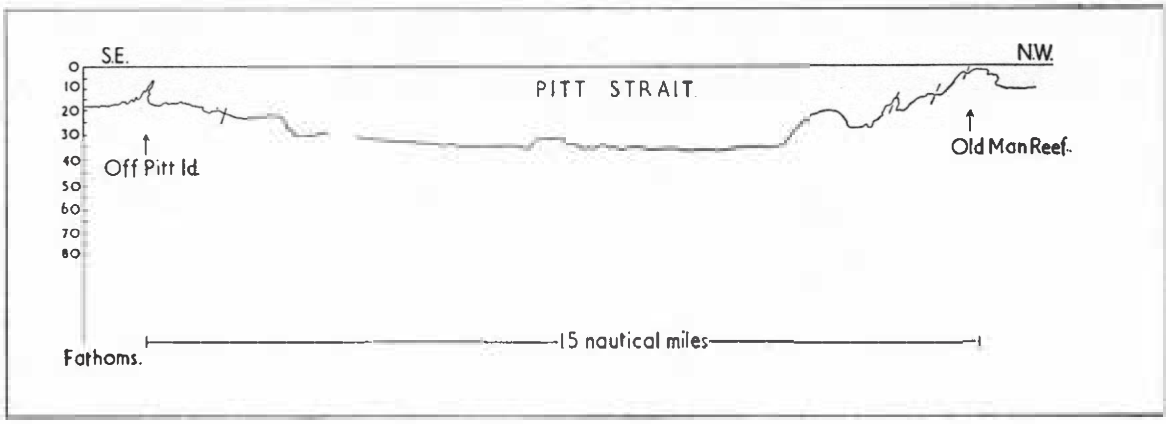

Fig. 23: Echo-sounding record across Pitt Strait.

South of the Pyramid the gradient of the island slope approaches the horizontal between 150 and 160 fathoms and east of the Forty Fours a similar flattening occurs between 120 and 130 fathoms.

Other highs on the Chatham Rise itself and near its western end exhibit similar forms. The summit of the Mernoo Bank has been ascribed by Fleming and Reed (1951) to partial truncation at a level about 60 fathoms below present sea level. Urry (1949, p. 262) shows on a bathymetric chart a single sounding of 64 fathoms in Lat. 45° S., Long. 174°14′ E. in an area generally 400 fathoms deep. Another high, the Veryan Bank, discovered by H.M.S. *Veryan Bay* in September 1950, in Lat. 44°16′ S., Long. 176°11′ E. is truncated at a depth of 80 fathoms. The main break in slope at the shelf edge off the east coast of New Zealand lies in approximately 70 fathoms.

Distribution of Sediments

Sediments described on the Admiralty Chart as sand, gravel, stones, shell, and rock lie mainly shoreward of the 50-fathom line. One notable exception is the fine sand and gravel recorded at station 34 in 130 fathoms. Fine sand occupies the zone seaward of the 50-fathom line to depths as great as 180 fathoms, though in Petre Bay fine sand extends close inshore. The three points from which mud was recorded lie in 120, 155, and 330 fathoms.

Discussion

Though the chart suggests that the major portion of the sea floor around the islands is covered with sediment, the common occurrence of rocky outcrops, particularly in shallow water, is attested by some of the chart descriptions and more particularly by the highly irregular nature of the sea bottom shown on the echo soundings. It is on these irregularities that the succession of level surfaces is in part developed and it can reasonably be inferred that they were formed by wave action at successive stands of sea level (Dietz and Menard 1951).

Since the formation of the outer shelf edge, the south-western portion has been depressed 15 to 20 fathoms relative to the eastern portion. This warping took place prior to the cutting of the 65-fathom level and shallower levels, for these do not exhibit obvious distortion.

The bathymetry shows that the coastal outline of the group had the same general form at the time of the —65-fathom sea level as at present: Allan's (1929) "blocking-out by faulting" occurred before the cutting of the 65-fathom surface.

A more critical study of the coastal features would be required before the "10 to 15 ft. wave-cut platform" and "50 ft. raised terrace" could be fitted into a late-Pleistocene chronology. However it is reasonable to suppose that the levels from —65 fathoms upward were cut during low and intermittently rising sea levels of the glacial phases of the Last Glaciation. The —65-fathom level around the Chatham Islands may be correlated tentatively with that cut on the Mernoo Bank at 60 fathoms.

Acknowledgments

Thanks are due to Mr P. C. Spence for the production of the bathymetric chart of the Chatham Islands area, and to Mr C. Webb for draughting the figures.

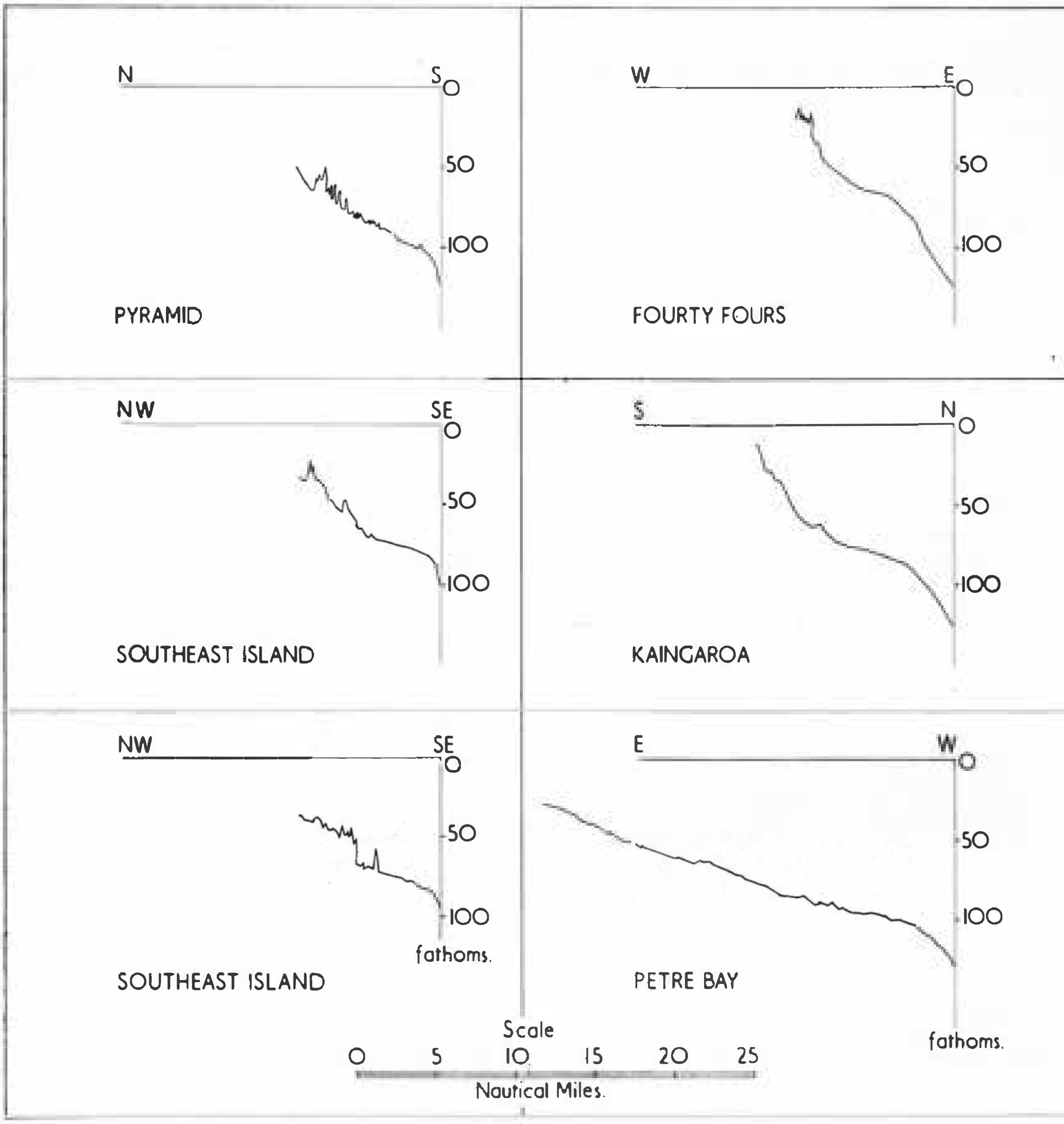

Fig. 24: Echo-sounding profiles across the shelf edge.

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APPENDIX 4

REPORT ON THE MOLLUSCA

By R. K. Dell, Dominion Museum, Wellington

The molluscan material collected by the expedition is best considered under three heads: material from the Mernoo Bank, the shallow-water and intertidal fauna from the Chathams, and the deep-water species.

The Mernoo Bank

The three stations worked in depths of 100, 61, and 41 fathoms added some species but did not alter appreciably the list previously published (Dell, 1951). The additions to this list included *Ellatrivia memorata* Finlay (previously considered northern in distribution), a large new species of *Eucominia*, and a specimen of *Chlamys delicatula* (Hutton).

The Chatham Islands Fauna

Extended shore collecting around the Chathams gave more detailed data on the distribution and relative abundance of the intertidal Mollusca. Of all groups this was the best known and the expedition added comparatively few species to previous lists. Fresh material was obtained for a re-evaluation of the endemic species present. Wider collecting has allowed confirmation of the absence of some characteristic, widely distributed, mainland species such as *Mytilus canaliculus, Volsella neozelanica, Lunella smaragda, Notoacmea* spp., *Neothais scalaris, Patelloidea* spp., *Benhamina obliquata,* and *Scutus breviculus*. The extreme paucity of species living between tide marks was noted in all areas examined.

Dredging and trawling in moderate depths (down to 100 fathoms) added a larger number of species to the faunal lists. Complete analysis has not, as yet, been carried out but the species from the shelf do not appear to show the mixture of northern and southern elements to nearly the same extent as do the intertidal forms, nor is the degree of endemism well marked. The general appearance of the dredged material is similar to that obtained in comparable depths in the Cook Strait region. Below 100 fathoms the fauna began to be influenced by the deeper-water forms, a process that will be mentioned later. At one station (34) to the east of the Forty Fours in 130 fathoms a rich fauna was obtained, some of the species being previously known only from off the Snares.

Deep Water

Apart from material from two stations worked by the *Challenger,* two by *Discovery II* and one by the *Galathea,* no Mollusca had previously been obtained from depths greater than 200 fathoms in New Zealand. The Chatham Islands Expedition occupied 10 stations in depths greater than 200 fathoms and also sufficient stations in shallower depths to show the transition from the fauna on the shelf to the archibenthal fauna. Most work has so far been carried out on the Mollusca from these deep-water stations and certain generalisations can be made. There is a well marked archibenthal molluscan fauna as distinct from a shelf fauna. The dividing line is not a narrow boundary, some shelf species occurring to various depths amongst archibenthal species and some archibenthal species occurring on the shelf. The areas of faunal mixture are greatest where the shelf edge is steep. The archibenthal fauna appears to be composed of five elements:

(a) A small number of shelf species which extend downwards as far as investigations have been carried out, e.g. *Neilo australis, Cuspidaria fairchildi, Cadulus teliger, Haliris setosa, Nucinella maoriana, Monia zelandica, Maoricrater explorata.*

(b) A small group with affinities with deep-water species off the south-east Australian coast, e.g. *Cymatona kampyla "Calliostoma"* sp., *Friginatica conjuncta, Ectorisma* sp.

(c) A small group with affinities with southern deep-water forms, e.g. *Falsilunatia* sp., *Neacteonina* sp.

(d) The majority of the species belonging either to genera still living on the shelf, e.g. *Fax, Penion, Tawera, Splendrillia, Micantapex, Comitas, Baryspira, Poirieria, Leporemax, Coluzea, Zeminolia, Aeneator,* but represented by new species, or to genera which were well represented in the New Zealand Tertiary but have been considered extinct, e.g. *Waipaoa, Parvamussium, Teremelon, Scaphander, Galeodea, Ellicea, Iredalina.*

(e) A small element representing genera that have not been known in the New Zealand area previously and which have no particular affinity with any one specific deep-sea area, e.g. *Euciroa, Stilifer, Volvulella.*

One important fact that stems from the findings of the expedition is that a number of species that have been found over recent years to occur sporadically on the shelf are almost certainly migrants from the archibenthal fauna, e.g. *Coluzea mariae, Galeodea triganceae, Iredalina mirabilis* and *I. aurantia,* and *Ellicea recens.* Off the Chatham Islands, similar faunal migrations were observed in depths between 100 and 200 fathoms. It is probable that some species that appear to be common in places on the shelf have been earlier migrants from the deeper seas, e.g. *Fusitriton laudandum,* and this factor must be borne in mind in any future discussions on molluscan faunal migrations.

Material obtained by the *Challenger* expedition, by *Galathea,* and by subsequent trawling operations off the Otago coast have shown that part at least of this archibenthal fauna is widely distributed in New Zealand seas in comparable depths and is not confined to the periphery of the Bounty Basin.

Additional work is required to show how widely distributed this distinctive archibenthal molluscan fauna may be.

The value of the results of the present expedition do not lie particularly in the new forms obtained, important as these undoubtedly are, but rather in showing that a specific archibenthal fauna does occur in New Zealand, and in supplying data to show the position of the boundary between this fauna and that of the shelf. No comparable data appear to exist for any other area in the Southern Hemisphere and full analysis of this material will give results useful not only to the molluscan specialist but also to the paleontologist and zoogeographer.

APPENDIX 5

REPORT ON THE ECHINODERMS

By H. Barraclough Fell, Zoology Department, Victoria University College

The collection comprises about 650 specimens representing at least 40 species of echinoderms. The distribution of species is indicated in the following list.

Asteroidea

	Stations
Persephonaster neozelanicus	1, 2, 29, 40
Astropecten sp.	2, 6, 7, 34, 41
Mediaster sladeni	51
Zoroaster macracantha	6, 7
Hippasteria sp. nov.	6
Peribolaster sp. nov.	34
Solaster aff. *japonicus*	6, 7, 58
Henricia cf. *compacta*	6, 7, 14, 16, 26, 49
Echinaster sp. (nov.?)	41, 59
Asterina regularis	11
Sclerasterias mollis	34
Calvasterias suteri	22
Allostichaster insignis	49
Allostichaster polyplax	49
Cosmasterias dyscrita	34
Coscinasterias calamaria	11

Ophiuroidea

Astrothorax waitei	34
Ophiomyxa brevirima	49
Ophiomyxa duskiensis	19
Ophiacantha cf. *vepratica*	5, 52
Ophiactis profundi	34
Amphiura alba	14, 15
Amphiura magellanica	3, 14, 18, 24
Amphiura norae	5, 52, 59
Amphiura sp. (nov.?)	4
Ophionereis fasciata	9, 11, 14, 49
Ophiomisidium irene	5, 34
Ophiura sp. (nov.?)	4, 6, 7, 37, 40, 41, 52, 58, 59
Ophioceres huttoni	11
Pectinura gracilis	3
Pectinura sp. aff. *maculata*	23

Echinoidea

Goniocidaris sp. nov.	34
Ogmocidaris benhami	59
Pseudechinus sp. nov.	2, 6, 28, 29, 30, 37, 41, 52
Evechinus chloroticus	9, 18
Phormosoma busarium	6, 41
Apatopygus recens	14, 20, 23, 37
Paramaretia multituberculata	7, 40, 52
Spatangus multispinus	2, 6, 7, 41, 52, 59
Brissopsis zelandiae	41, 52

Identifications should be treated as provisional.

Some 350 specimens are referable to a single species of sea-urchin, previously known only from the Pleistocene (Castlecliffian Stage), in which it is very characteristic.

Notable hauls were at station 6 (Chatham Rise, 220 fathoms) and at station 34 (E. of Forty Fours, 130 fm.). These have resulted in the addition to the New Zealand fauna of representatives of four families of sea stars not previously recorded from our waters – the Zoroasteridae, Hippasteriidae, Peribolasteridae and Solasteridae. North Pacific affinities are to be seen in *Solaster* cf. *japonicus* and in *Peribolaster* cf. *biserialis* (of California). On the other hand *Zoroaster macracantha* and *Cosmasterias dyscrita* are otherwise known only from deeper water off Australia. The discovery of a species of *Hippasteria* is of exceptional interest. The genus occurs in the late Cretaceous of north Canterbury but was hitherto unknown in existing Australasian seas, though it was recorded from Antarctica. In a paper at present in the press recording the Canterbury Museum fossil (*Hippasteria antiqua*) the possibility was mentioned that *Hippasteria* might yet be found living off the New Zealand coast. Nevertheless such early fulfilment was not expected. *Goniocidaris* is represented by an undescribed species from station 34, larger and more variable than any hitherto seen. The fine series of *Paramaretia* from station 40 is also notable. The genus has not hitherto been recorded from New Zealand, though some fragments were seen in the *Discovery II* haul from the Chatham Rise. The genus is restricted to Australasia.

APPENDIX 6

REPORT ON THE FISHES

By J. Moreland, Dominion Museum, Wellington

Fishes were freely taken at every station at which beam and otter trawls were used. The material may conveniently be considered under three heads. Mernoo Bank, intertidal and shallow-water material from the Chatham Islands, and the deep-water material.

Mernoo Bank

The only station (60 fathoms) worked with a net revealed the presence of widely distributed and characteristic mainland species. Those taken were *Kathetostoma giganteum*, *Hemerocoetes acanthorhynchus*, *Limnichthys fasciatus*, *Physiculus bachus*, and *Caulopsetta scapha*. Some blue cod, *Parapercis colias*, were taken at this station on a hand line.

Chatham Islands

Intensive shore collecting at two places and some shallow-water trawling round the coast produced more detailed data on the composition of the fauna and yielded 26 species additional to the previously published lists of the fishes of the group. There are no endemic marine species known. The whole fauna is exclusively New Zealand in character and probably continuously reinforced by drifting larval stages from the mainland. Northern and southern elements of the New Zealand fauna were represented by a dogfish, *Squalus griffini*, and *Notothenia microlepidota*, the latter widespread in the subantarctic and southern mainland waters.

List of Species not Previously Recorded from the Chatham Islands

Squalus griffini
Gonorhynchus gonorhynchus
Galaxias fasciatus
Arripis trutta
Pseudolabrus cinctus
Parapercis gilliesii
Bovichtus variegatus
Galaxias attenuatus
Centriscops obliquus
Coelorhynchus oliverianus
Lepidorhynchus denticulatus
Stigmatophora longirostris
Ichthyocampus filum
Syngnathus blainvillianus
Hemiramphus australis
Seriolella punctatus
Hemerocoetes acanthorhynchus
H. waitei
Limnichthys fasciatus
Neophrynichthys latus
Hoplichthys haswelli
Scorpaena cruenta
Tripterygion tripenne
Helcogramma medium
Gastroscyphus hectorias
Mola mola

Deep Water

With the exception of those from a few scattered stations occupied by overseas expeditions, few fishes have been described from New Zealand waters from depths greater than 100 fathoms. The Chatham Islands Expedition was able to occupy eighteen stations below this depth and to obtain a picture of the change from shelf to deep-sea faunas. A transitional zone containing elements from both the shelf and deep water was apparent between 150 and 270 fathoms. Macrurids first appeared in the upper limits of the zone while *Hemerocoetes*, a shelf genus, was absent near the lower limits of the zone.

Juvenile red cod, 4 to 5 in. long, were taken in enormous numbers in the middle and lower depths of this zone. Virtually unknown in shelf waters at this size, they have since been taken in similar depths off mainland coasts and may eventually serve as an indicator species of the middle and lower transitional zone.

Below 270 fathoms, the macrurid genera *Coelorhynchus*, *Lepidorhynchus* and *Lionurus* were taken freely. Species new to the New Zealand region are the macrurids *Coelorhynchus fasciatus*, *C. mirus*, and *Lionurus nigromaculatus*, a flatfish (*Azygopus pinnifasciatus*), an eel (*Ariosoma longicauda*), and an apogonid resembling *Hynnodus atherinoides* and belonging to a family not previously known from New Zealand waters.

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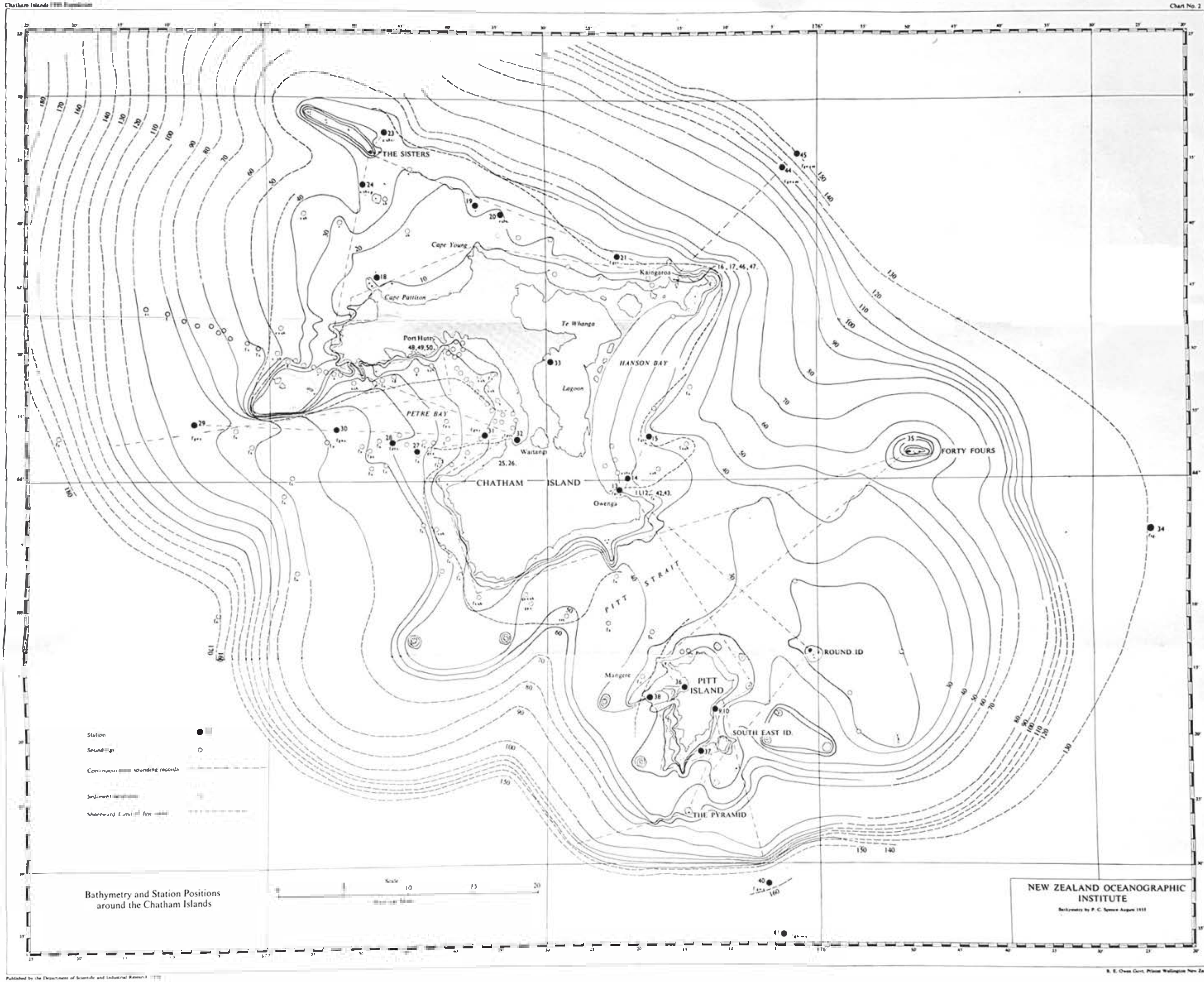
Chatham Islands
Chart No. 2
Bathymetry and Station Positions
around the Chatham Islands
Station
Soundings
Continuous sounding records
Sediment
Shoreward Limit for
Scale
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15
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NEW ZEALAND OCEANOGRAPHIC
INSTITUTE
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Port Hutt
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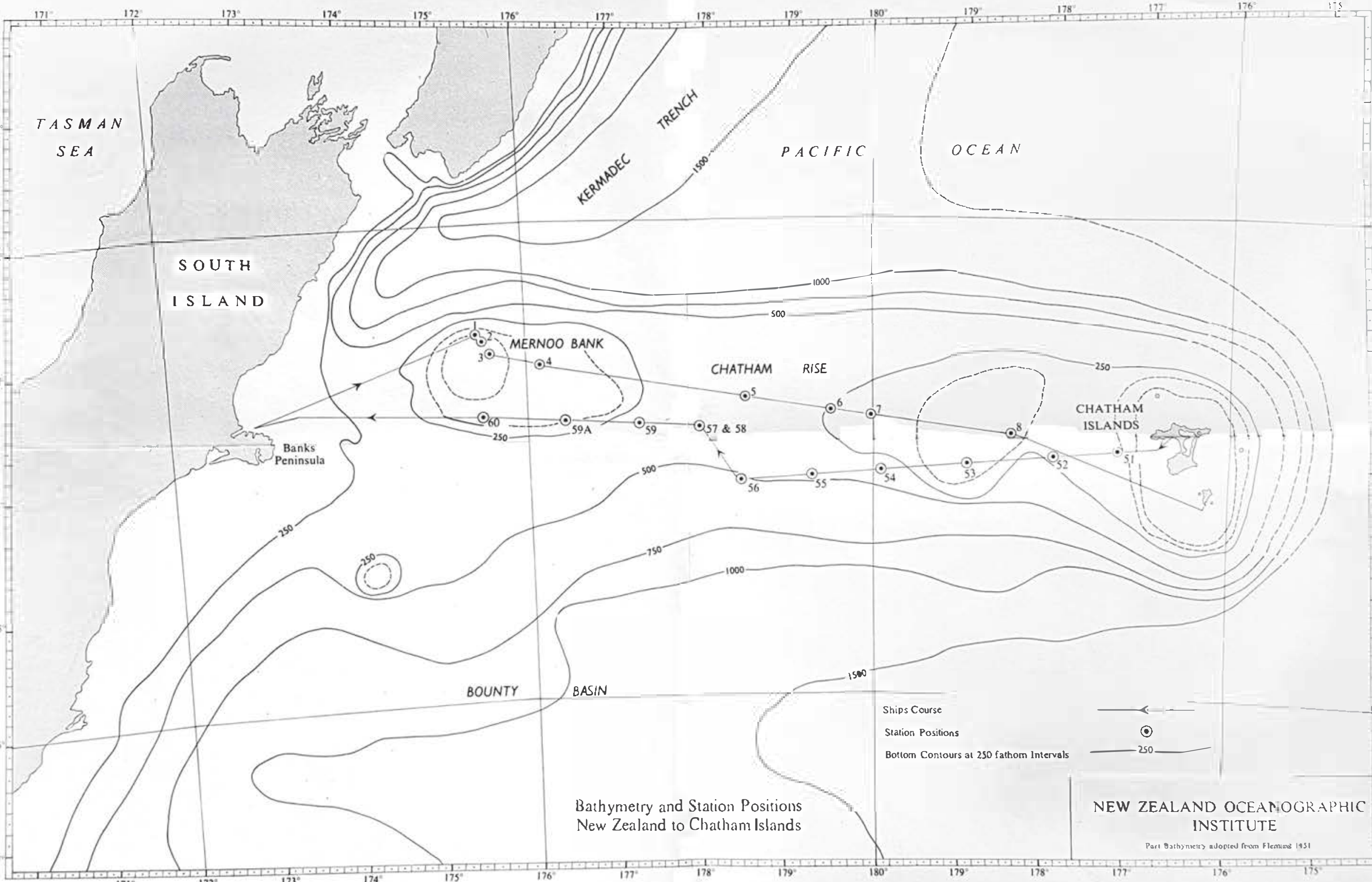
Te Whanga
Lagoon
HANSON BAY
PETRE BAY
Waitangi
25,26.
CHATHAM ISLAND
Owenga
11,12, 42,43.
16, 17, 46, 47.
Kaingaroa
FORTY FOURS
PITT STRAIT
Mangere
PITT
ISLAND
SOUTH EAST ID.
ROUND ID
THE PYRAMID

Chatham Islands 1954 Expedition

Chart No. 1



Bathymetry and Station Positions
New Zealand to Chatham Islands

NEW ZEALAND OCEANOGRAPHIC INSTITUTE

Part Bathymetry adopted from Fleming 1951

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