COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 12

F.R.V. "DERWENT HUNTER"

Scientific Report of Cruise 6/56
December 29, 1956 - February 11, 1957

Marine Biological Laboratory
Cronulla, Sydney
1957

F.R.V. "DERWENT HUNTER"

Fisheries Research Vessel "Derwent Hunter" is the Division's 72 ft. research vessel operating from Sydney. She is an auxiliary schooner powered with a 68 H.P. Gardner diesel. She has two Kelvin Hughes echosounders, a Type 24D and a Type 24E. The deck winch is hydraulically operated.

CREW

Master	- Captain R.M. Davies
Mate	- R. W. Spaulding
Engineer	- C. F. Hill
Deckhands	- G. A. Ross
	- W. Elsmore
Cook	- A. Jackson
Oceanographical Assistant	- D. Black

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F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE 6/56

December 29, 1956 - February 11, 1957

PERSONNEL

Scientific Officer-in-Charge of Cruise

December 29 - January 7 - D. J. Rochford
January 23 - February 11 - R. Spencer

ITINERARY

The track followed during this cruise is shown in Figure 1. Because of almost continuous south-west gales and heavy seas, only one vertical station was worked in the first three days, but despite hazardous conditions surface sampling was maintained. On January 1, the boom of the mainsail broke and as several crew members were injured when repairing the damage, it seemed unwise to continue with the cruise as planned, which would have meant keeping a disabled ship in the southern Tasman Sea until weather conditions abated. A course to the N.N.E. was therefore set, and by the following day sea conditions had moderated sufficiently for oceanographical stations to be worked. From then on a series of vertical stations and two hourly surface samplings were worked on passage to Wellington.

On the return to Sydney the scheduled programme, with only minor deviations, was followed to Norfolk Island. Soon after the ship left Norfolk Island the rudder was lost and, for safety reasons, all vertical stations were abandoned, though surface sampling was continued on a direct course to Sydney.

The position of vertical stations for hydrology, phytoplankton and zooplankton and the extent of surface sampling and Hardy indicator tows are shown in Figure 1. Trolling for tuna was carried out whenever conditions permitted.

SCIENTIFIC REPORTS

(a) HYDROLOGY.- D. J. Rochford

The major objectives of this cruise were (1) to plot the course of the sub-tropical convergence in the southern Tasman Sea; (2) to investigate the probable path of entry of the Western South Pacific water mass into the north-eastern Tasman Sea; (3) to determine the horizontal and vertical extent of the East Central New Zealand water mass; (4) to complete the record of the early summer distribution of the surface Tasman Sea water masses previously restricted to data from the middle Tasman collected by M.V. Wanganella, and the northern Tasman collected by F.R.V. "Derwent Hunter" in December 1955.

1. Regional Water Masses

From the Cl‰ - Temperature relationship the following regional water masses were determined.

TABLE 1

Code Symbol	Probable Identity	Month	Cl‰	Temp.	Total P
A	"Heated"	Jan.	19.28	12.8	18-22
	Sub-Antarctic	Feb.	19.28	14.3	
B	? "A" + "E"	Jan.	19.48	17.1	15
		Feb.	19.48	18.6	
C	Deep Sub-Antarctic	Jan.-Feb.	19.22	9.5	27-30
D	South West	Jan.	19.53	13.8	---
	Tasman	Feb.	19.33	15.3	
E	Coral Sea	Feb.	19.70	23.3	9
F	East Central	Jan.	19.25	17.2	17
	N.Z.	Feb.	19.19	18.1	
G	Central Tasman	Feb.	19.68	17.1	15-18
H	South Equatorial	Feb.	19.54	25.9	15

The geographical position of these is shown in Figure 2. Water mass F was sampled at the beginning and end of January to the west of Cook Strait. The Temperature difference of 1.5°C between the January value and that at the same chlorinity on the mixing line (2) and (7) during February (Fig. 3) has been used to adjust all temperature values to the February value in Table 1.

The chlorinity-temperature relationships of the regional water masses listed in Table 1, adjusted to a February temperature value, are shown in Figure 3. Data from "Wanganella," "Tulagi," and "Tui" (New Zealand) have been used

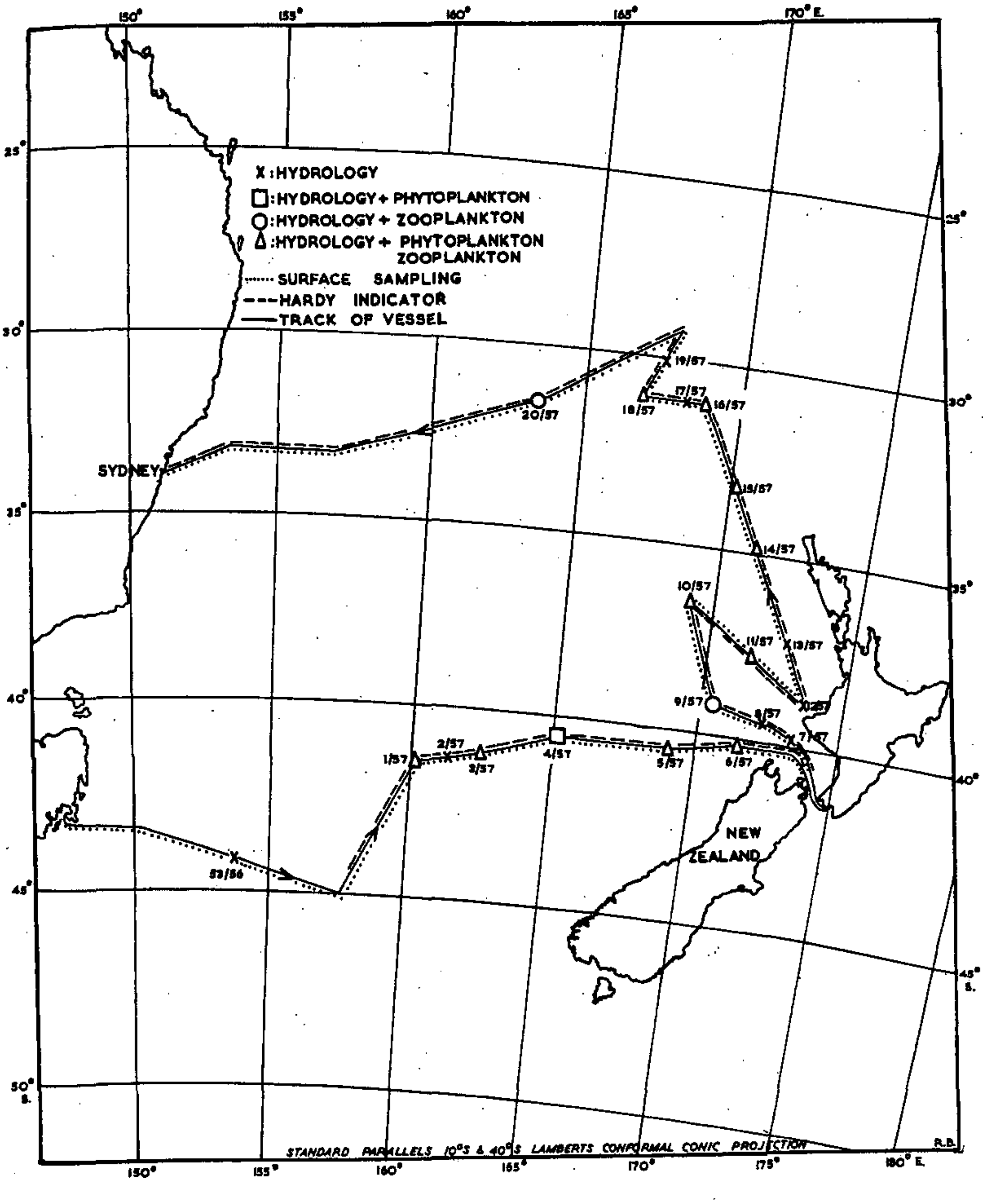

Fig. 1. Cruise DH6/56. Track chart and stations.

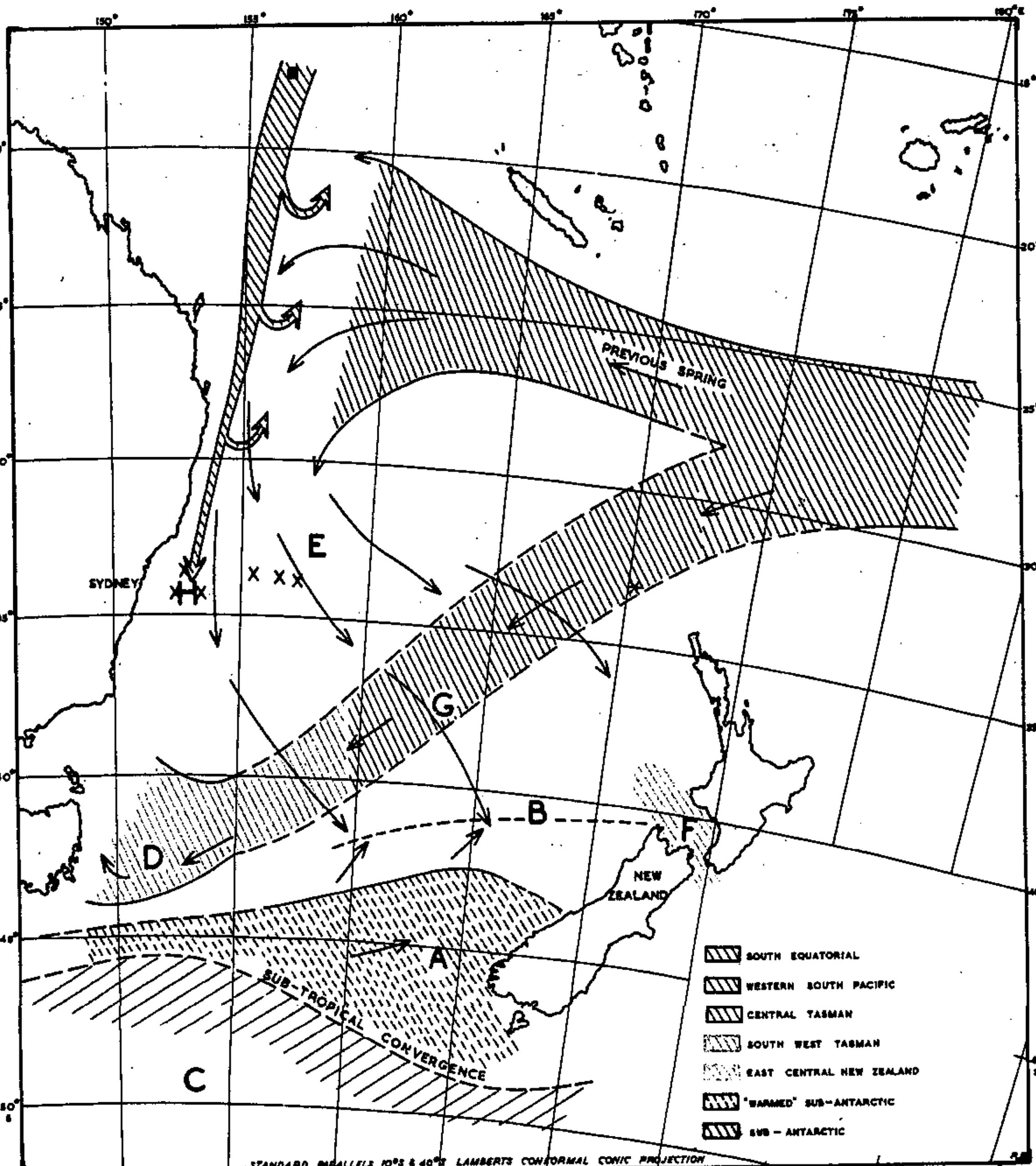

Fig. 2. Geographical positions and probable circulation of regional water masses.

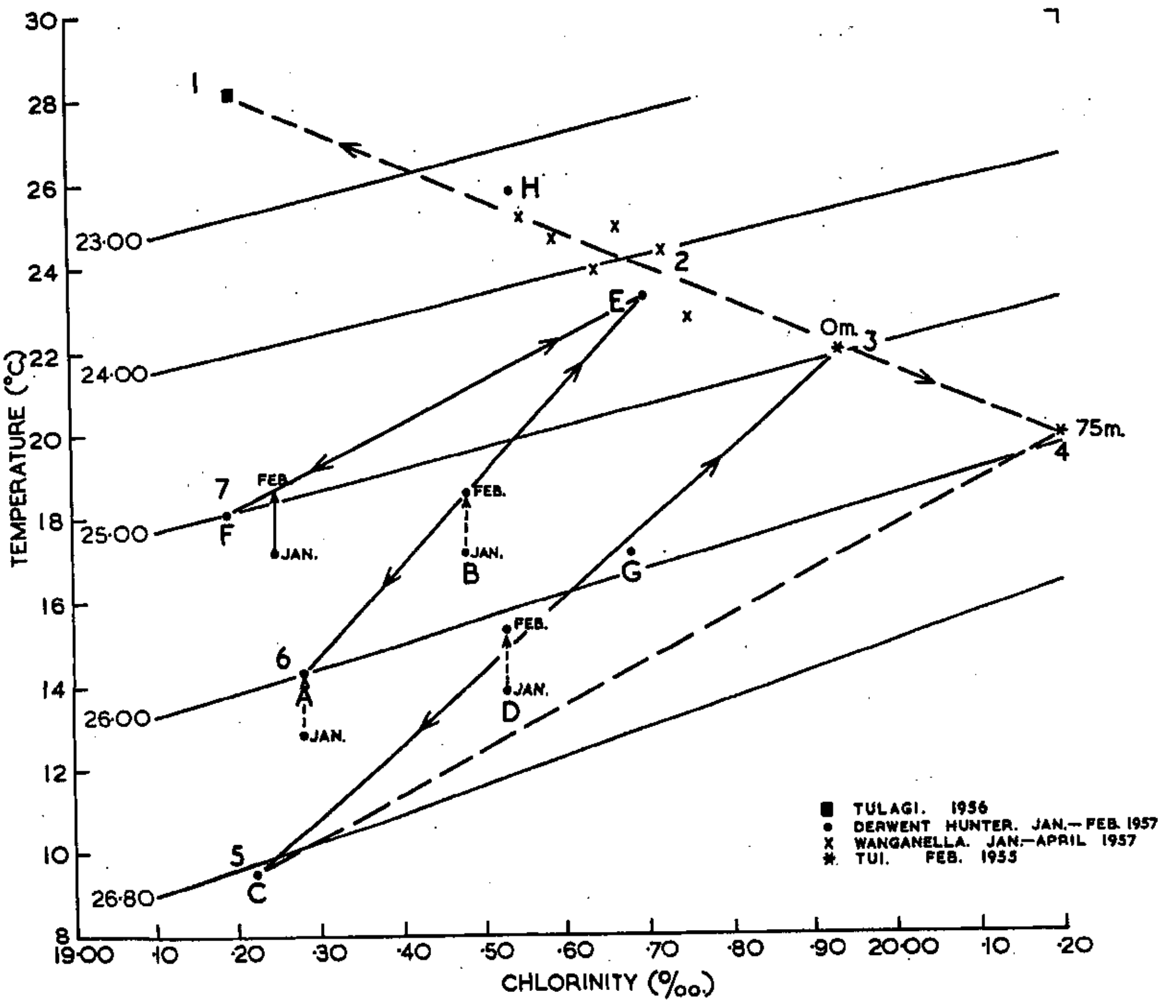

Fig. 3. Temperature-chlorinity diagram showing relationships of regional water masses listed in Table 1. Equal density (t) lines shown in red.

to relate the properties of the regional water masses to those of the primary external water masses of the Tasman and Coral Seas. The isopycnals have been drawn on Figure 3 to indicate the degree of probability of certain mixing combinations.

It is proposed to consider water masses E and H (Table 1) as mixtures formed in the northern Tasman Sea outside the limits of this cruise, of northern South Equatorial waters ("Tulagi" data) and Coral Sea waters, which subsequently moved south and east into the southern Tasman Sea by December. E and H are within the limits of the Coral Sea water mass (Rochford 1957)* and have been named accordingly in Table 1. Along a front extending west from Cook Strait mixing occurred between E and the warmed Sub-Antarctic water mass A, resulting in regional water mass B.

In the western approaches to Cook Strait the East Central New Zealand water mass (F) was found but only to quite shallow depths (35-40 m) and of very limited extent. Mixing occurred between this and the Coral Sea water mass along the west coast of North Island, New Zealand. (Mixing path 2 to 7).

The Western South Pacific water mass was apparently moving south-west at intermediate levels into the Tasman Sea, and mixing with deep sub-Antarctic water. The regional water masses G and D along the mixing path 3 to 5 were formed during this movement. D is the South-west Tasman and G is the Central Tasman water mass. G is heavier than the various mixtures of E and A and during this cruise was found only at depths of between 100 and 200 m in the north-east Tasman.

Off east Tasmania the South-west Tasman (D) was found at the surface because the lighter waters derived from mixtures of E and A were absent from the area. Between 155°E and the Australian coast, mixtures were found of the South-west Tasman (D) and the Coral Sea (E).

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* Rochford, D.J. (1957).- The identification and nomenclature of the surface water masses in the Tasman Sea. Aust. J. Mar. Freshw. Res. 8 (4): (in press).

2. The Probable Summer Circulation of the Surface Water Masses of the Southern Tasman Sea

Figure 2 illustrates diagrammatically the distribution of the regional water masses and their mixtures.

It now seems probable that the sub-Antarctic waters encountered in the southern Tasman Sea on previous cruises of the "Derwent Hunter" at about 156°E off the Tasmanian coast and by "Wanganella" off Cook Strait, New Zealand, lay well to the north of the sub-tropical convergence in summer. These sub-Antarctic waters had an average temperature 4-5°C higher than the deep sub-Antarctic waters, and lay at a depth of about 100 m off Tasmania and about 300 m off New Zealand.

The Coral Sea water mass (E) seemed to be moving south on a broad front into the southern Tasman Sea with maximum penetration between 155° and 160°E. Between 150° and 170°E a convergence occurred of water masses (E) and (A).

The subsurface drift of the Western South Pacific water mass into the Tasman Sea has been inferred from the subsequent water flow of its derivatives the Central Tasman and South-west Tasman (Rochford 1957)*. The spring flow of this water mass into the northern Tasman Sea has been postulated on other evidence (Rochford in preparation). It has been included in Figure 2 of this report because the chlorinity-temperature properties at intermediate levels of certain stations sampled at the northern limits of this cruise indicated some degree of its entrainment into the southerly flowing tropical waters in December-January.

3. Surface Winds

The direction and velocity of the wind measured by a cup anemometer at a height of 16 m above the sea surface, and corrected for ship's speed and heading, are given in Figure 4.

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* See footnote p.5

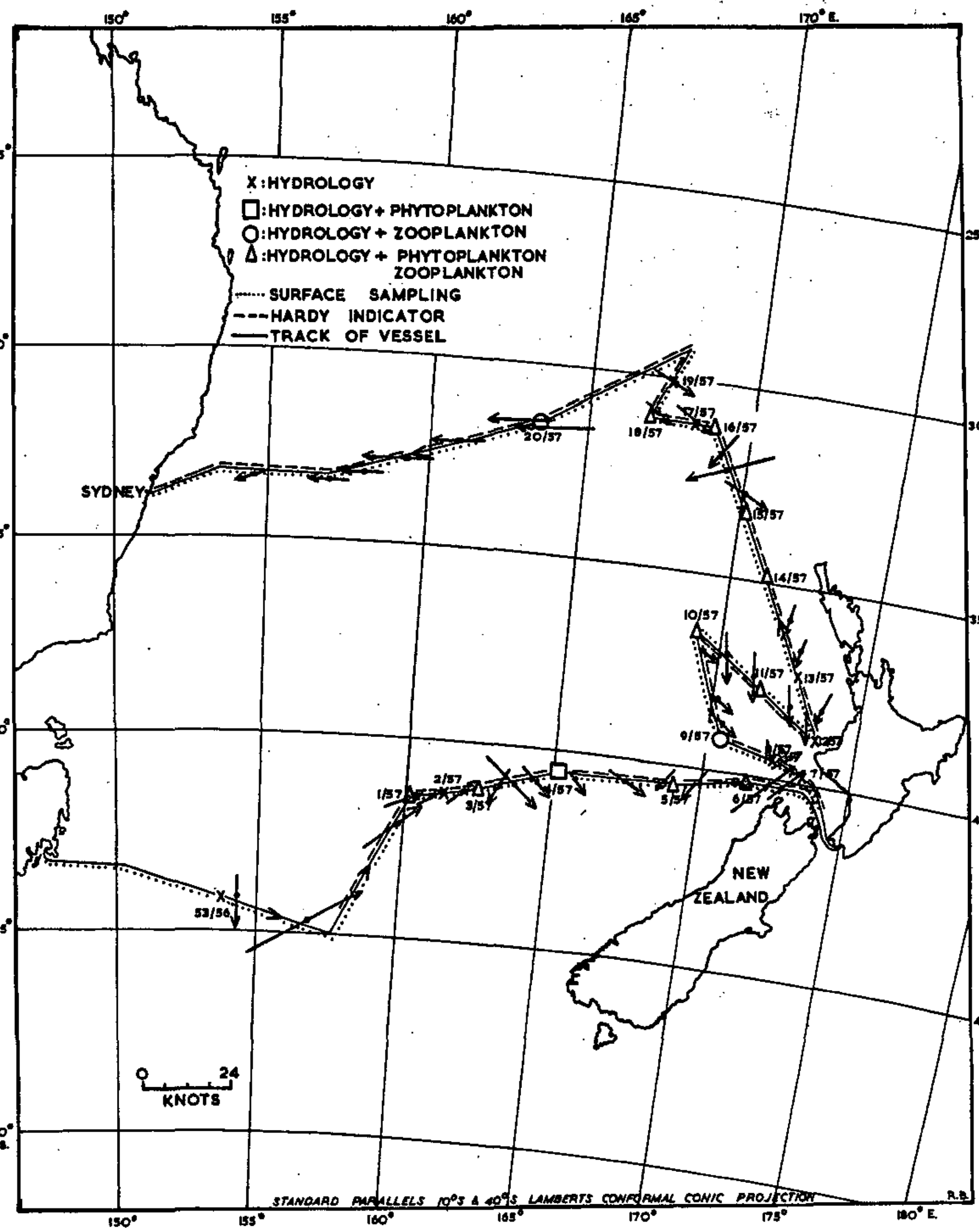

Fig. 4. Surface wind readings corrected for ship's speed and heading.

(b) ZOOPLANKTON.- W. Dall

1. Distribution

Three principal regions, the South-west Tasman, the South-east Tasman and the Central Tasman, have been distinguished on the basis of the distribution of the major Zooplankton organisms. (Table 2, Fig. 5). The boundaries of these regions have been established from the analysis of the data from the Hardy Plankton Indicator. This analysis showed, in addition, two minor regions, the Central New Zealand and the South Equatorial - Coral Sea intrusion (Fig. 5).

TABLE 2

Species Copepods	S.W. Tasman	S.E. Tasman	Central Tasman
Acartia danae	-	-	++
Calanoides carinatus	++	-	-
Calanus helgolandicus	++	-	-
C. minor	-	-	+
C. tenuicornis	++	+	++
C tonsus	++	-	-
Centropages bradyi	++	-	-
Clausocalanus arcuicornis	++	+	++
C. furcatus	++	+	+
Ctenocalanus vanus	-	+	++
Eucalanus attenuatus	++	-	-
Lucicuta flavicornis	-	-	++
Mecynocera clausi	++	+	++
Paracalanus parvus	++	+	++
Pleuromamma gracilis	-	+	+
Aetideus giesbrechti	-	-	-
Heterorhabdus papiliger	-	+	+
Corycaeus spp.	-	-	+
Oncaea conifera	-	-	+
O. media	-	+	++
O. venusta	-	-	++
Sapphirina spp.	-	-	+
THALIACEA			
Pyrosoma atlanticum	+	-	-
Doliolum sp.	-	-	+
Thalia democratica	-	-	++

\+ Present
++ Abundant

The South-west Tasman region has relatively few species, but all are abundant. It corresponds roughly with the area of occurrence of the South-west Tasman water mass (Fig. 2).

The South-east Tasman has even fewer species, and, except for Oithona spp., none was abundant. Station 6, just within the East Central New Zealand water mass, lacked some typically oceanic species, and showed evidence of coastal influence.

In addition to the species listed in Table 2, the Central Tasman region contained a number of warm water species. The plankton composition of this area is characteristic of the major part of the Tasman Sea.

The South Equatorial - Coral Sea intrusion was evident because of the increase in abundance of salps, Sapphirina spp., Oncoea mediterranea, O. conifera, the appearance of warmer water amphipods, and Euphausia recurva.

2. Abundance

Figure 6 shows the volumes of zooplankton taken during the cruise. The hatching indicates the relative abundance, and the ringed figures at each station are the volumes in mls (excluding salps) per 10 cubic metres of sea-water.

The South-west Tasman supported the greatest standing crop. There is no difference in the plankton volumes of the Central Tasman and South-east Tasman, though these regions are faunistically distinct. Except for Station 9, which is in some respects anomalous, volumes decrease towards central New Zealand. Stations 15 and 18 have slightly higher volumes, possibly associated with the movement of the Central Tasman water mass (Fig. 2). Except for the first station of the cruise, all stations had small standing crops of zooplankton and at stations 3, 5, 6, 10, 11 and 20 they were exceptionally small.

(c) PHYTOPLANKTON.- E.J.F. Wood.

Of the eleven phytoplankton samples collected, four, those from stations DH6/3, DH6/6, DH6/10, DH6/11 as well as that from Wellington Harbour, contained no organisms (Table 3). Collections from stations DH6/4 and DH6/16

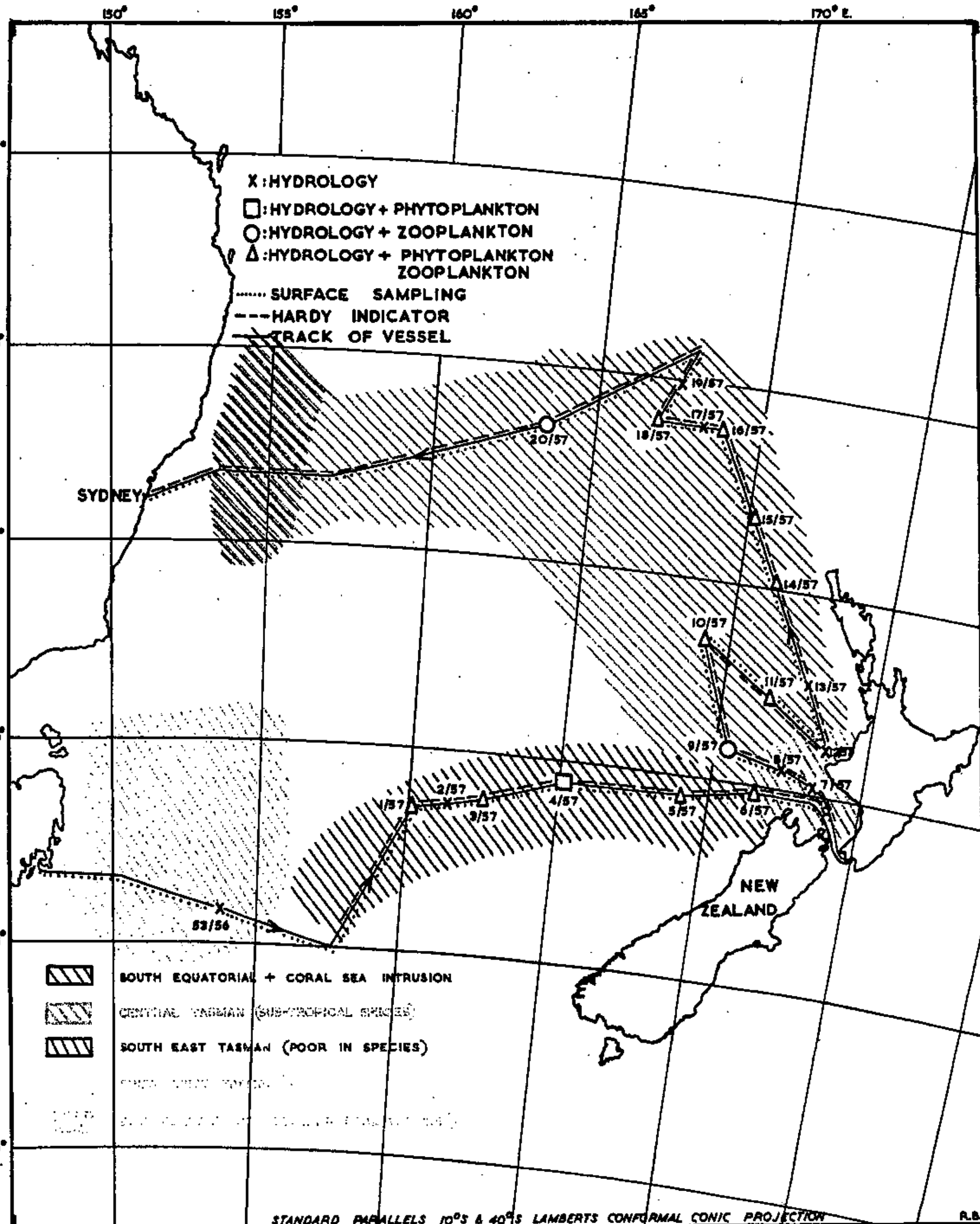

Fig. 5. Zooplankton distribution (qualitative).

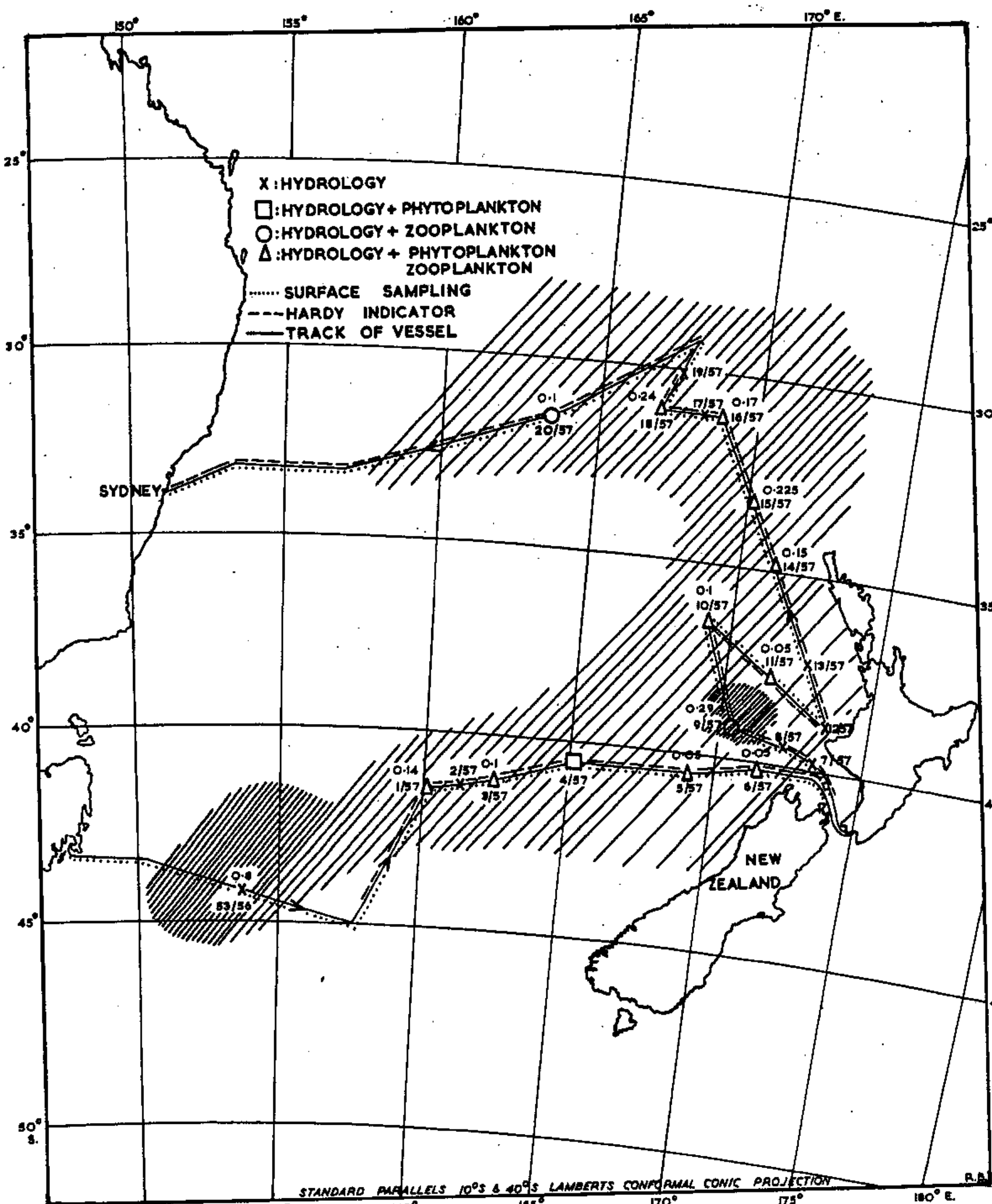

Fig. 6. Zooplankton volumes. Hatching indicates relative abundance. Ringed figures are volumes per 10 cubic metres of sea-water.

contained a dinoflagellate flora, chiefly warm water species of <u>Ceratium</u> and few or no diatoms. Collections from stations DH6/1, DH6/5, DH6/4, DH6/15 and DH6/18 contained species of <u>Rhizosolenia</u>, the last station showing a bloom of <u>R. acuminata</u> and <u>R. castracanei</u>, both tropical forms, the former being rather rare on the Australian coast.

TABLE 3

Species	Stations 1	3	4	5	6	10	11	14	15	16	18
Rhizosolenia imbricata				+	+				+		+
R. styliformis					+			+	+		+
R. alata f. gracillima					+			+			
R. hebetata f. semispina				+				+			
R. acuminata											+++
R. castracanei											+++
R. fragilissima											+
R. calcar-avis								+			
Planktoniella sol									+		
Noctiluca miliaris										+	
Peridinium divergens			+								
Goniodoma polyedricum			+								
Ornithocercus quadratus										+	
Ceratium buceros			+							+	
C. massiliense										+	
C. gallicum										+	
C. karsteni										+	
C. falcatum			+							+	
C. candelabrum										+	
C. tripos			+							+	
C. schmidti										+	
C. extensum			+								

The distribution of diatoms and dinoflagellates suggests a diminution of tropical influence between latitudes 30° and 40°S probably pushing south-east from station DH6/18 to stations DH6/14 and DH6/15. The <u>Ceratium</u> flora at station DH6/4 could have been derived from the west, that is from the east Australian mixed water (Fig. 7); it has much in common with the usual flora of that water. Stations DH6/10 and DH6/11 suggest a barren area, possibly running through Cook Strait at the time, and water at stations DH6/1 and DH6/3 was probably derived from a water mass of low fertility to the west.

It is unfortunate that material was not obtained from further east, as phytoplankton tends to transgress hydrological boundaries by 50 to 100 miles.

(d) TUNA.- J. Robins

When weather permitted tuna lines were trolled. Six albacore were caught between stations 1/57 and 5/57 in a "mixing" zone between the warmed Sub-Antarctic and Coral Sea water masses (Figs. 1 and 2). Between stations 8/57 and 14/57 albacore were taken, again in a "mixing" zone (Figs. 1 and 2). Three bonito were caught near Norfolk I.

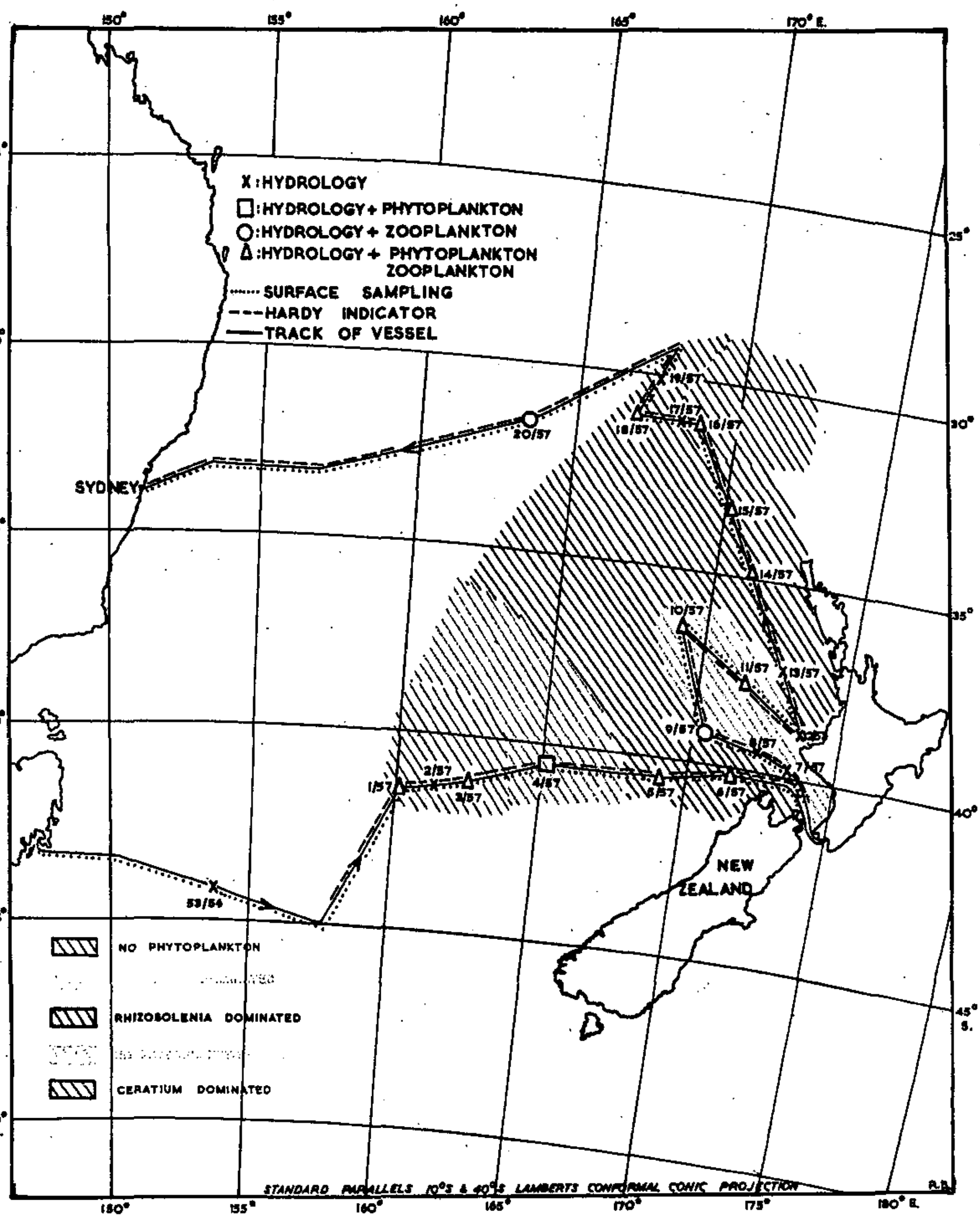

Fig. 7. Phytoplankton distribution

DIVISION OF FISHERIES AND OCEANOGRAPHY

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