COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 15

F.R.V. "DERWENT HUNTER"

Scientific Report of Cruise 1/57
March 16 - March 24, 1957

Scientific Report of Cruise 2/57
March 26 - April 12, 1957

Scientific Report of Cruise 3/57
April 17 - April 27, 1957

Scientific Report of Cruise 4/57
May 2 - June 3, 1957

Marine Biological Laboratory
Cronulla Sydney
1958

F.R.V. "DERWENT HUNTER"

F.R.V. "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

At the beginning of 1957 it was decided to undertake a two year study of the structure and dynamics of the East Australian current off Sydney. Scientific reports of Cruises DH1/57 and DH3/57 deal with the section planned for this study. They describe the features of the East Australian current observed each cruise, but neither these reports nor those which will deal with this section in the future will attempt to relate the data to those of previous cruises or of other regions of the Tasman Sea. That will be done in a scientific paper to be published elsewhere.

Cruise DH2/57 was a tuna long lining cruise off the New South Wales and Tasmanian coasts and DH4/57 was a cruise in Bass Strait to study barracouta occurrences and their relationship to *Nyctiphanes australis* and the water masses of the area.

When citing this report abbreviate as follows:
C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 15.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH1/57

March 16 - March 24, 1957

SCIENTIFIC PERSONNEL

Scientific Officer-in-Charge of Cruise - C. Walker.

ITINERARY

Figure 1 shows the track chart for this cruise, indicating the area sampled and the positions of the stations.

SCIENTIFIC REPORTS

This cruise forms part of a two year study of the structure and dynamics of the East Australian current off Sydney. Stations were sampled on a line 110°T from Port Hacking for hydrology and plankton. Some G.E.K. tows were made on the outward trip and on the return only G.E.K. stations were occupied (Fig. 1).

Samples for chlorinity, dissolved oxygen, and total phosphorus were collected at depths of 0, 25, 50, 75, 100, 150, 200, 300, 500, 750, 1000, and 1500 m. The total phosphorus results were discarded because of an abnormal perchloric acid blank.

As it is impossible to lower more than eight bottles on a single cast from F.R.V. "Derwent Hunter," two lowerings are required to 1500 m. Difficulties sometimes arise in the interpretation of the depth information from unprotected thermometers when the two casts overlap. Other properties such as dissolved oxygen have been used to resolve such anomalies. The graphical method of Pollak (1950)* has been used to compute true depths. On cruise 1/57, three unprotected thermometers only were available for each cast of eight bottles. On this cruise only an estimate of the wire angles was made. Under these circumstances the possibility of errors in the vertical distribution of properties for this cruise must be accepted.

*Pollak, M.J. (1950).- Notes on determining the depths of sampling in serial oceanographic observations. J. Mar. Res. 9: 17-20.

For zooplankton studies one oblique haul from 200 m to the surface was made at each station using a Clarke-Bumpus plankton sampler with silk mesh 25/cm. As a basis of comparison each haul was adjusted to equal 10 cubic metres of sea-water.

No phytoplankton hauls were made on this cruise.

(a) HYDROLOGY - D.J. ROCHFORD

(1) Temperature (Fig. 2)

A mixed stratum of water with temperature greater than 23°C extended east from about 152° to 154°30'E., down to about 60 m. Within this stratum the maximum temperature of 24-25°C was found along its western boundary. A zone of colder water (22°C) at station 23/57 separated these warm offshore waters from slope waters in which surface temperatures were again higher than 22°C. At about longitude 153°E. the warmest waters were found at all levels below 200 m. A marked thermocline was found during this cruise in the region to the west of the high temperature offshore water where a vertical gradient of 0.15°C/m was found.

(2) Density (σ_t) (Fig. 3)

A homogeneous low density ($\sigma_t < 24.00$) stratum of water occupied the greater part of the surface region down to about 60 m. A very marked pycnocline with a vertical gradient of 0.05 (σ_t) /m was found along the western boundary of the section. Some degree of dynamic uplift of slope waters into the coastal region was evident.

(3) Percentage Oxygen Saturation (Fig. 4)

In the surface layer there was undersaturation in oxygen. At a lower level a zone of near saturated water (98 per cent. at Stations 21, 22, 23, 25, 27/57) occurred along the dashed line of Figure 4. The 95 per cent. saturation value was found along the upper and the 85 per cent. along the bottom limits of the pycnocline.

(b) PHYSICS - B.V. HAMON

(1) Dynamics

Figure 5 shows the dynamic height anomalies, in dynamic centimeters, relative to the 1000 decibar surface. The anomalies were computed from thermosteric anomalies.

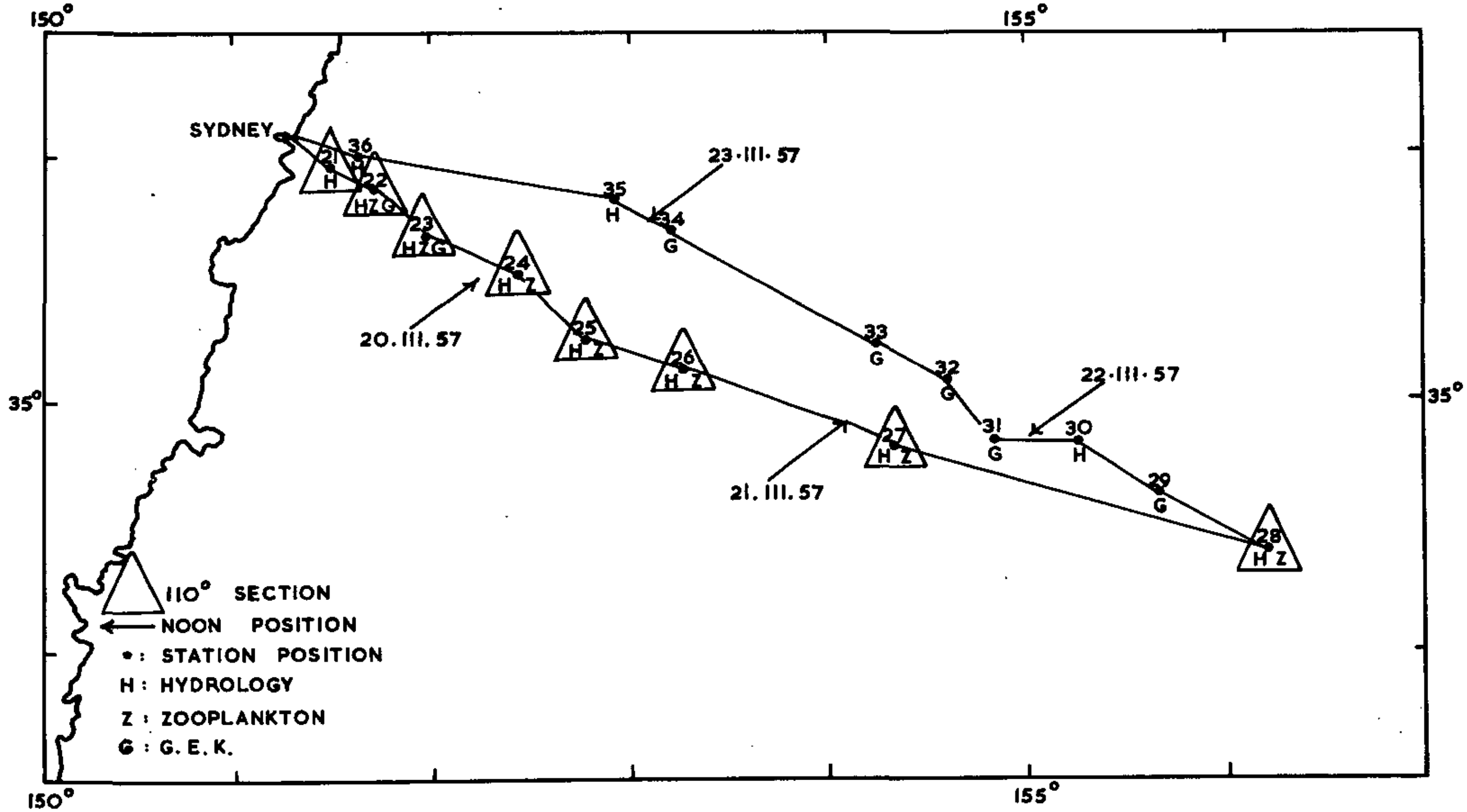

Fig. 1. Cruise DH1/57. Track chart showing all stations.

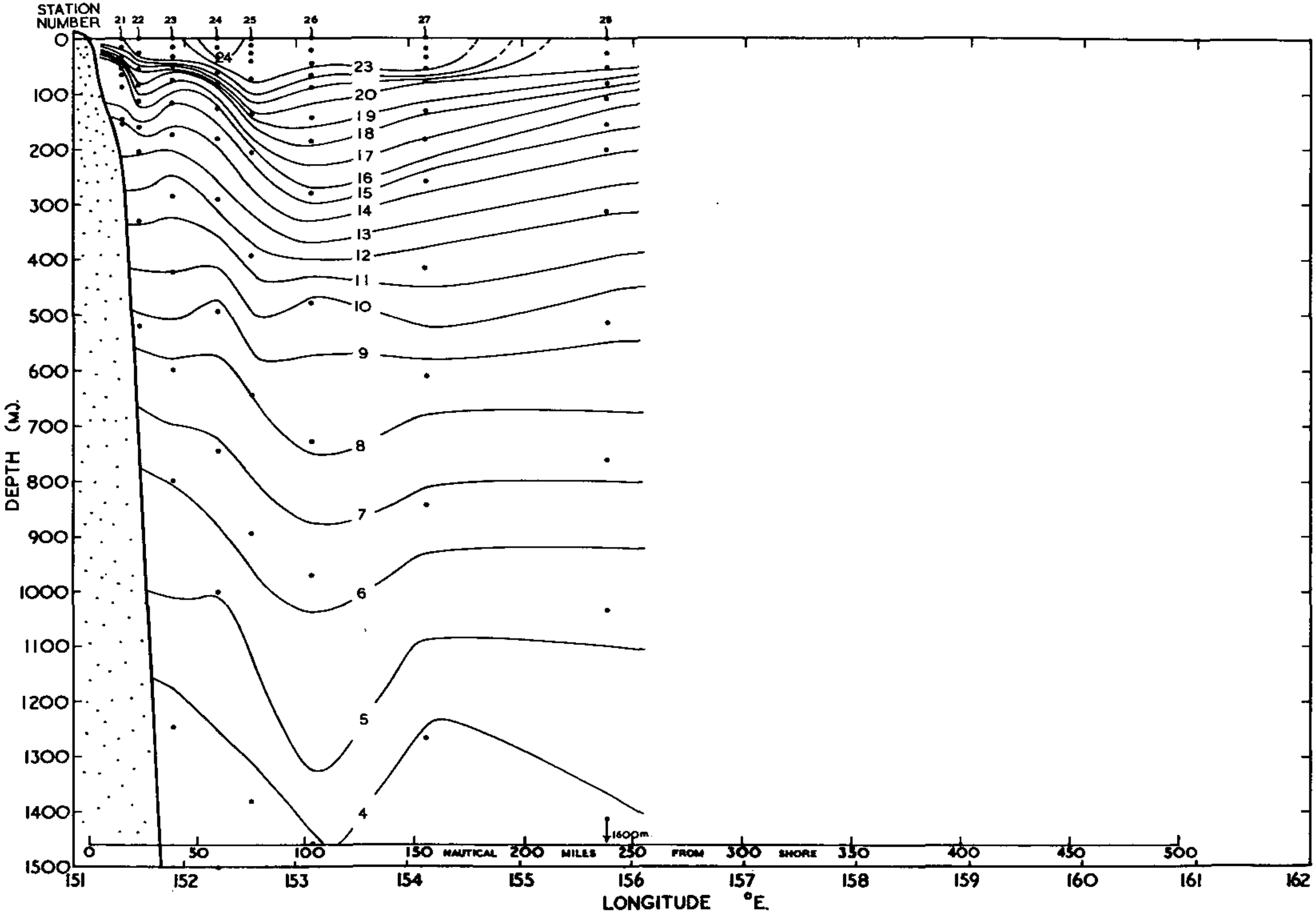

Fig. 2. Sectional distribution of temperature (°C) along 110°T. line to 1600 m.

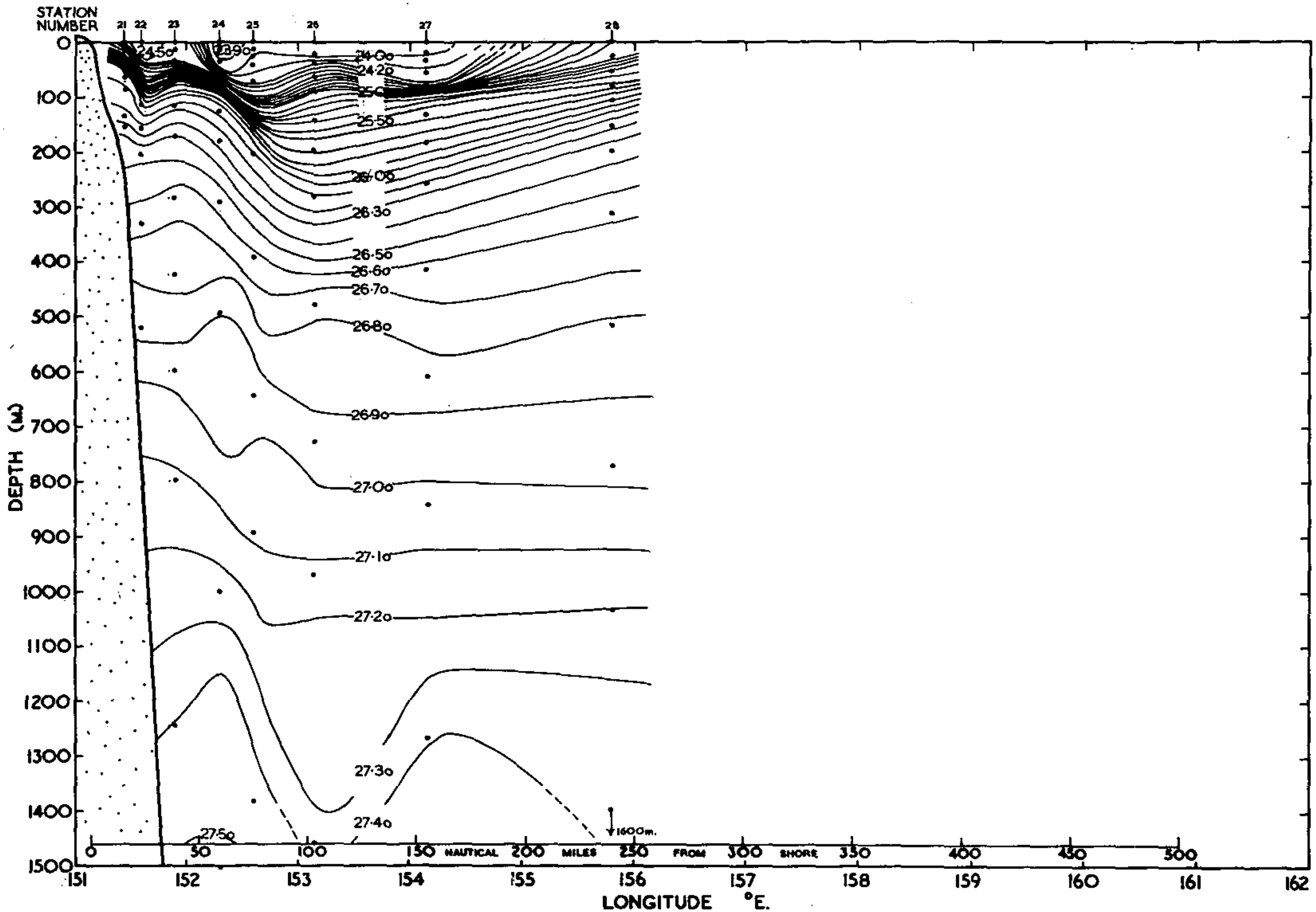

Fig. 3. Sectional distribution of σ_t along 110°T. line to 1600 m.

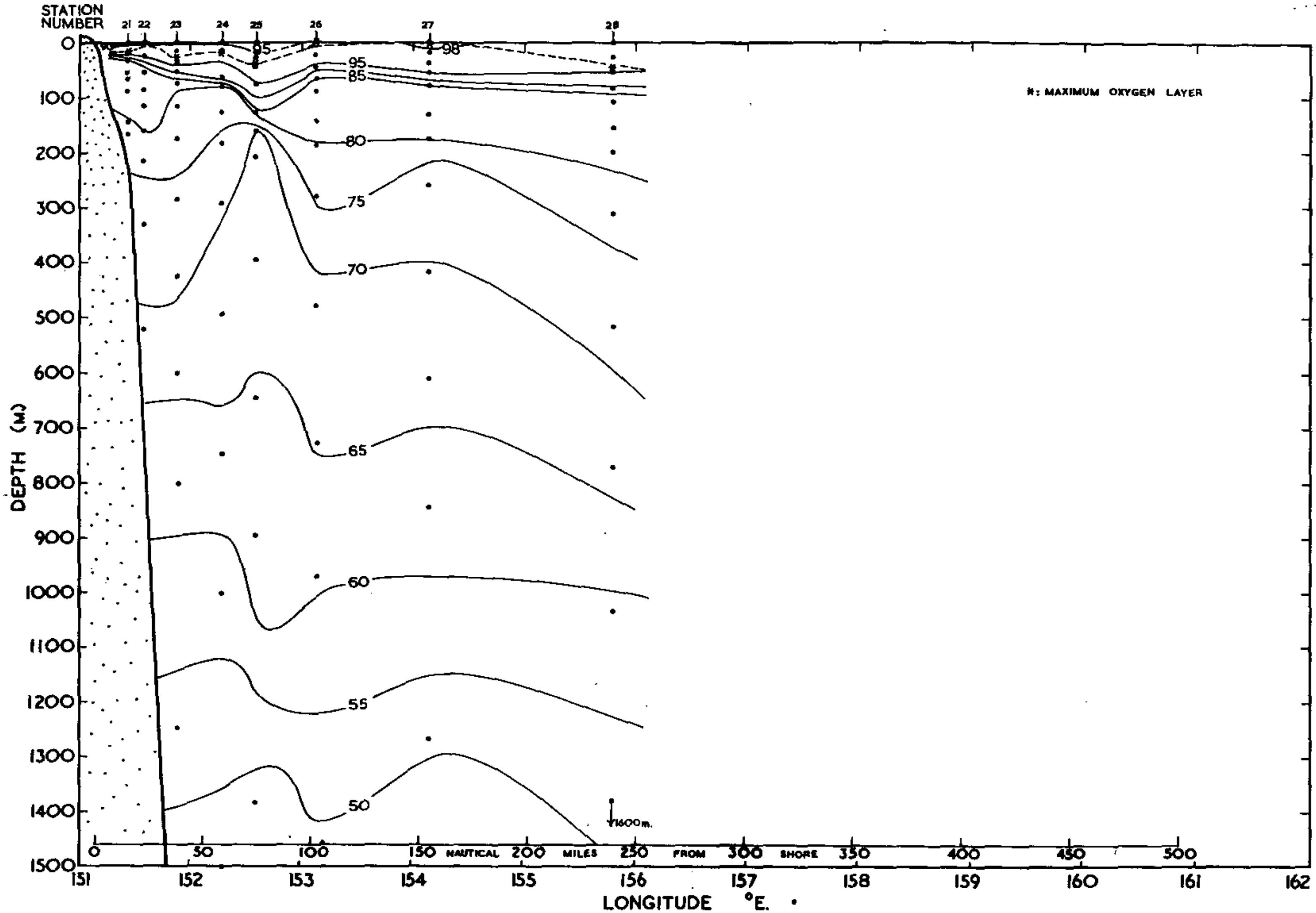

Fig. 4. Sectional distribution of oxygen saturation along 110°T. line to 1600 m.

Figure 6 shows the dynamic height anomalies as a function of longitude. There is a southerly inshore surface current, and northerly surface currents east of 153°E.

The net volume transport to the south between the edge of the continental shelf and 153°08'E. was found to be 1.2×10^7 m^3/sec, and the transport to the north between 153°08'E. and 155°42'E. was 0.5×10^7 m^3/sec.

(2) Surface Current Measurements (G.E.K.)

Few measurements were made, due to rough weather. The measurements are shown in Figure 5, but there is little agreement between measured and computed surface currents.

(3) Temperature - Chlorinity - Depth Recorder

This instrument was tested at three stations. Operation was satisfactory at the first station, but instability in the chlorinity circuit appeared at the second and third stations. This instability was later traced to a wire-wound resistor in the under-water unit. There was also some evidence of trouble from poor contact in the slip rings. Rough weather prevented servicing the equipment at sea.

(c) ZOOPLANKTON - W. DALL

Of the species taken in zooplankton hauls, the copepods gave the most useful information. Composition of copepod species in hauls is shown in Figure 7 (a) and quantitative distribution in Figure 7 (b).

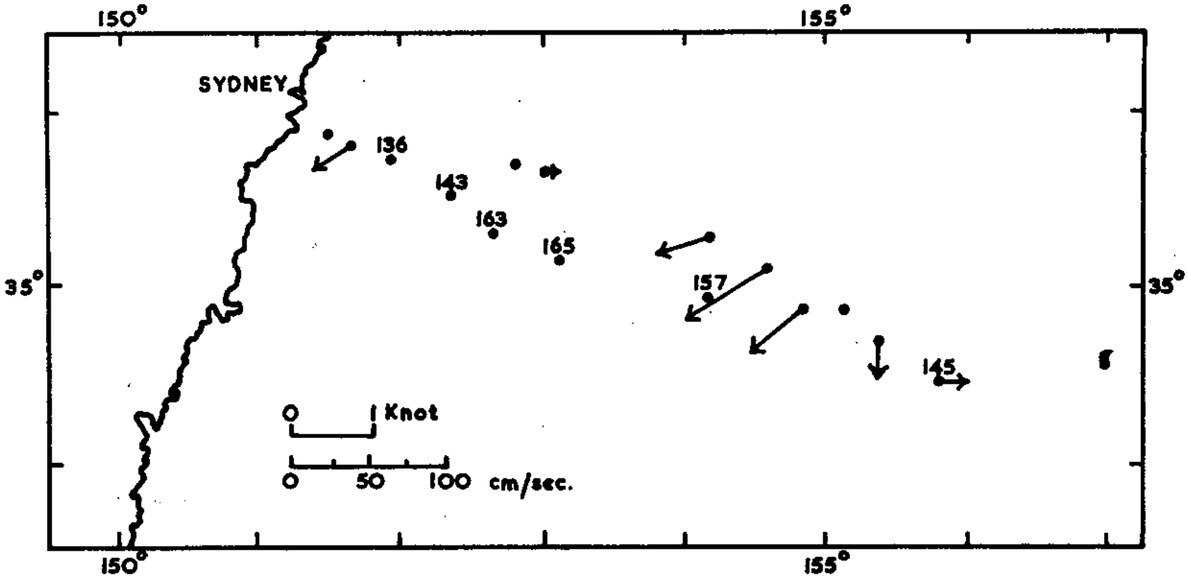

Fig. 5. Dynamic height anomalies relative to the 1000 decibar level. G.E.K. vectors shown by arrows.

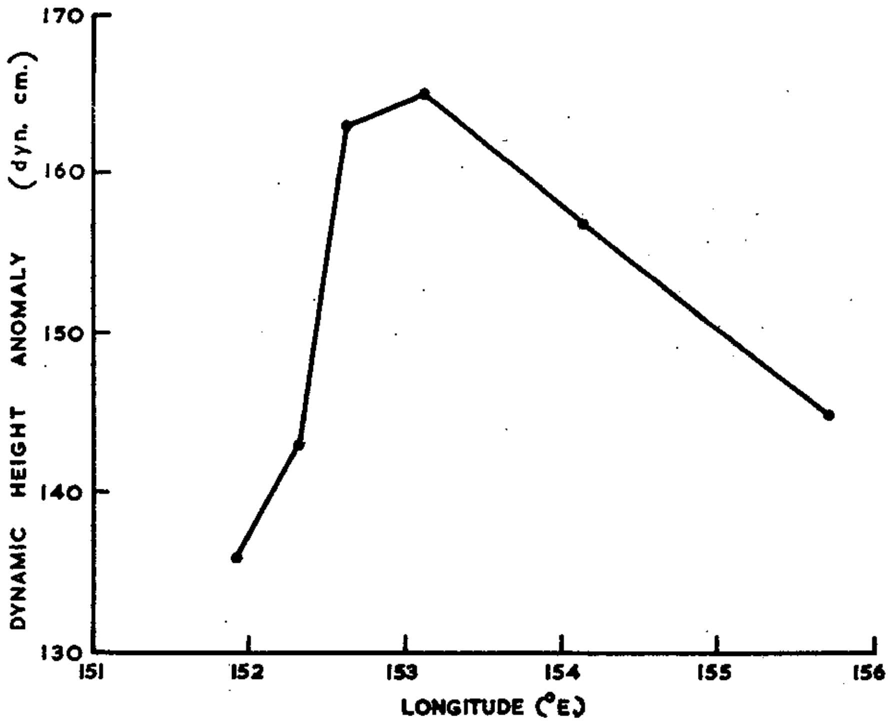

Fig. 6. Dynamic height anomaly as a function of longitude.

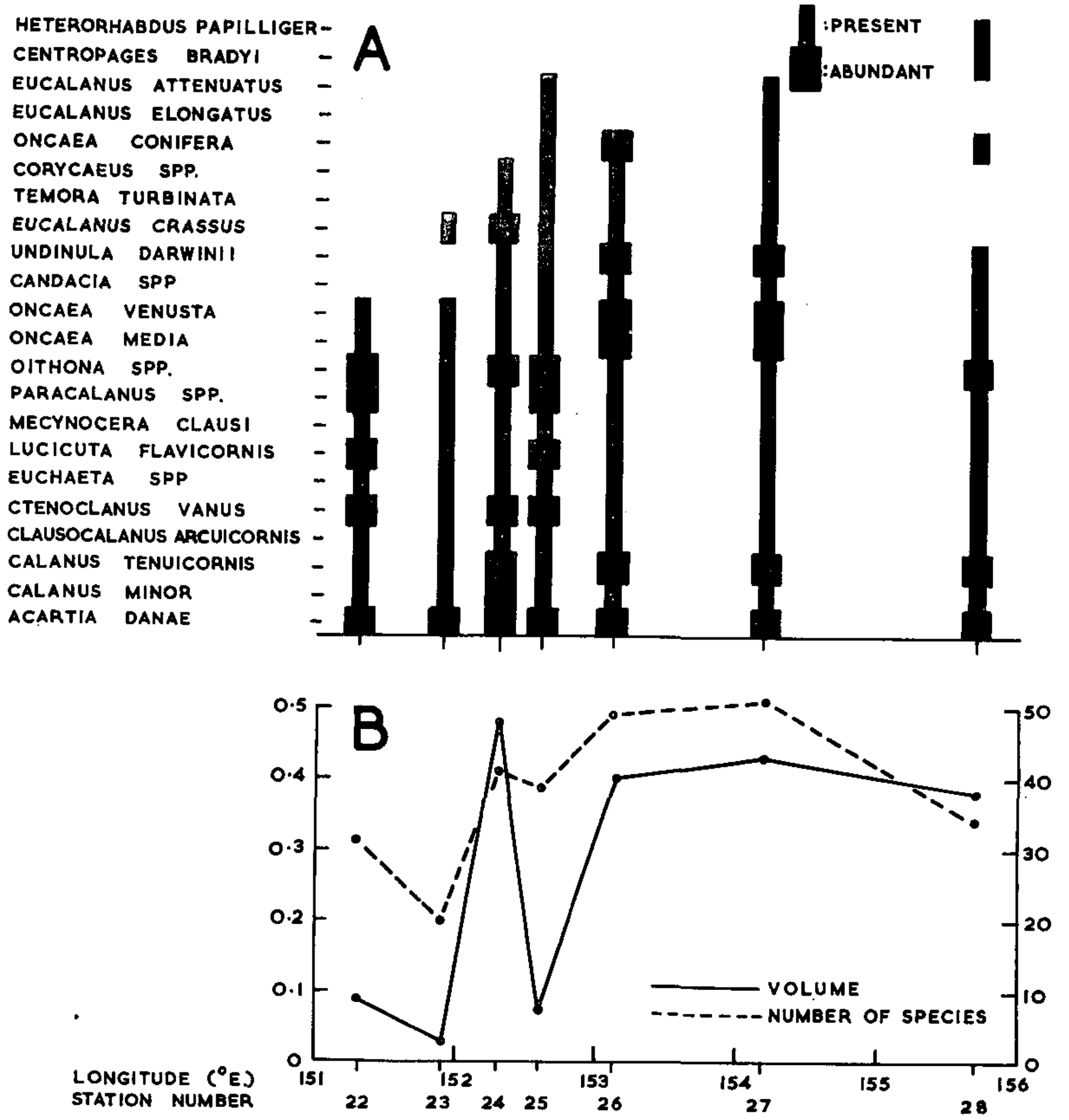

Fig. 7. (a) Copepod distribution at each station (b) Volumes and total number of species (excluding rare species).

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT ON CRUISE DH2/57

March 26 - April 12, 1957

SCIENTIFIC PERSONNEL

Scientific Officer-in-Charge of Cruise - J.P. Robins

ITINERARY

This was a repetition of tuna long-line cruise DH3/56 which was described in Report 5 of this series. Figure 1 shows the positions of the hydrology stations and the track followed.

SCIENTIFIC REPORTS

(a) TUNA - J.P. ROBINS

The main objective of this cruise was to test the hypothesis that southern bluefin tuna occur in a particular water mass and that their distribution is controlled by movements of this mass and its interaction with other water masses.

(1) Results

Due to inclement weather and sea conditions only five fishing stations were occupied. Long lining was carried out at the following stations with the results indicated in brackets.

DH2/36/57 (Nil)
DH2/37/57 (1 fish lost, 3 droppers broken)
DH2/39/57 (1 blue whaler shark)
DH2/40/57 (1 albacore)
DH2/42/57 (1 blue whaler shark)

Identification of the tuna at DH2/37/57 was not made as the fish broke free at sub-surface. It probably was a large southern bluefin tuna as the only breakages which had occurred on the line on previous cruises had been caused by either large southern bluefin tuna or large sharks.

(2) Comments

In Report 5 it was shown that the best southern bluefin tuna fishing results were obtained in regions where the Sub-Antarctic water mass predominated in depths above 100 m, which are the depths sampled by the longline. Reference to Table 2 (Hydrology) indicates the depths at which the Sub-Antarctic water mass occurred. Except at the fishing Station DH2/37/57, the Sub-Antarctic water mass was below the maximum depth at which the line could fish. It was shown in Report 5 that the best tuna catches were made in the region of vertical mixing which had introduced Sub-Antarctic water to the surface. On Cruise DH2/57 no such vertical mixing zones were encountered whilst fishing; results and plankton analysis indicate that the area covered was biologically poor.

Tentative conclusions drawn from the results of cruises DH3/56 and DH2/57 are:-

(i) Tuna "home" in water with Sub-Antarctic water mass properties.

(ii) Tuna are aggregated in regions of mixing (vertical mixing more favourable than horizontal mixing) between Sub-Antarctic and other water masses.

(iii) Vertical mixing has a marked effect on plankton abundance, and the combination of (ii) and (iii) provides conditions necessary for tuna aggregation.

(b) HYDROLOGY - D.J. ROCHFORD

On this cruise 10 stations were occupied. Of these five were worked on the outward and five on the homeward track at very similar positions (Fig. 1).

(1) Results

The regional water masses found on this cruise are shown in Table 1.

TABLE 1

REGIONAL WATER MASSES

Water Mass	Temperature	Cl‰
Coral Sea	21.4	19.69
Central Tasman	18.4	19.71
South-west Tasman	16.4	19.58

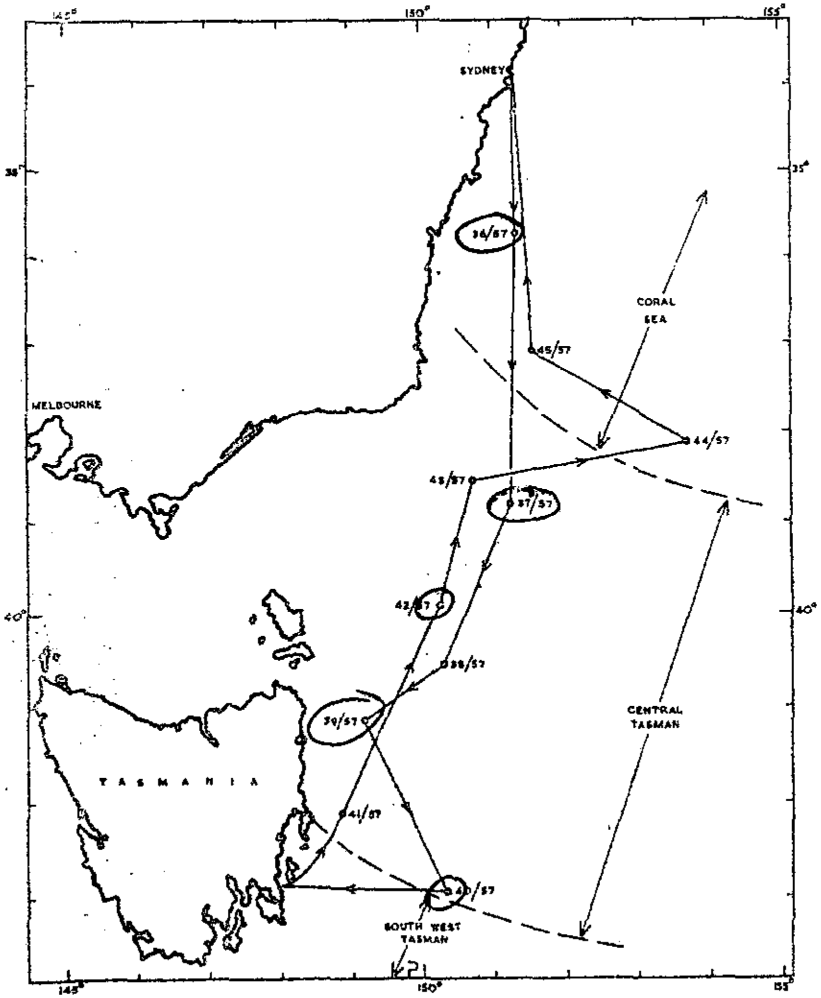

Fig. 1. Track chart showing stations and boundaries of water masses (adjusted to a mean cruise date, 4.4.57. Boundaries moving north at the rate of c. 8 miles/day). Coral Sea Chlorinity 19.69‰. Temperature 21.4°C. Central Tasman Chlorinity 19.71‰. Temperature 18.4°C.

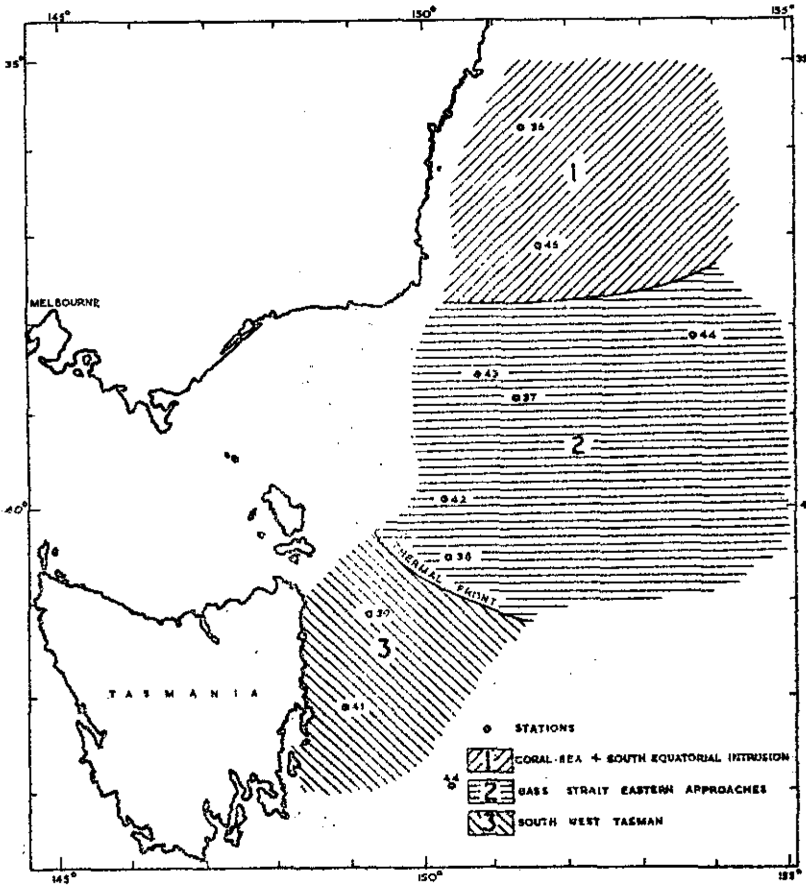

Fig. 2. Regional zooplankton distribution.

Figure 1 shows the boundaries of these water masses adjusted to a mean cruise date (4/4/57). From a comparison of conditions at Stations 37/57, 43/57, and 45/47 (Fig. 1) it was deduced that the boundary between the Central Tasman and Coral Sea water masses was moving north at the rate of about 8 miles per day. Table 2 shows the percentage composition of these waters in terms of the three regional water masses already used in Report No. 5.

TABLE 2

PERCENTAGE OF WATER MASSES AT THREE STATIONS

Station	Depth	% S. Equatorial	% Central Tasman	% S.W. Pacific
37/57	0	25	55	20
	27	18	65	17
	53	18	70	12
	79		Sub-Antarctic influence	
40/57	0	-	-	-
	23	5	80	15
	47	5	82	13
	70	5	82	13
	99	5	82	13
	140		Sub-Antarctic influence	
41/57			Vertical mixing ?	
			Sub-Antarctic influence at all depths	

(c) ZOOPLANKTON - W. DALL

In November 1956 the zooplankton on either side of a thermal front at Eden was examined. Striking differences were found, and for cruise DH2/57 it was decided to sample zooplankton down to 100 m depth above and below any thermoclines detected by the bathythermograph. The Clarke-Bumpus sampler was not fitted with a closing device and hence properly divided hauls could not be made. Instead, one haul was made above the thermocline and another standard haul was made to 200 m.

Results are shown in Table 3. All stations were occupied between 0900 and 1100 hours. Hauls up to 200 m have been converted to organisms per 10 cu. m. of sea-water.

Thermoclines at 60-70 m were found at Stations 36, 37, 38, 42, and 43. In order to be comparable with the 200-0 m hauls, the 60 or 70-0 m hauls have been converted to organisms per 3.3 cu.m. of water. The total number of organisms for the 60-0 m haul at Station 36 is about one-third that of the 200-0 m haul, and more species were present in the deeper haul. At this station the thermocline was not exerting any appreciable effect on the zooplankton which showed a vertical distribution usual for oceanic stations at this time of day. On the other hand, at Stations 37, 38, 42, 43, numbers for each 60 or 70-0 m haul are comparable with the corresponding 200-0 m haul, and the deeper hauls do not contain a larger number of species. This indicates that the zooplankton was almost absent below the thermocline.

TABLE 4

REGIONAL DISTRIBUTION OF ORGANISMS

Characteristic Organisms	Coral Sea + S. Equatorial Intrusion	Eastern Approaches	South-west Tasman
Calanus minor	+	+	-
Clausocalanus arcuicornis	+	+	-
Ctenocalanus vanus	+	few	-
Eucalanus elongatus	-	-	+
Paracalanus aculeatus	+	-	-
P. parvus	+	+	-
Oncaea media	+	-	-
Oncaea venusta	+	+	-
Pleuromamma spp.	+	-	-
Scolecithrix danae	-	+	-
Thysanoessa gregaria	+	+	-
Thalia democratica	+	few	-
Brachyscelus spp.	+	-	-

In Figure 2 and Table 4 regional distribution is shown. Differences between (1) and (2) are small, both regions having many species in common. (1) is established on the presence of minor, but typical, warm water species. The boundary between the regions is fixed arbitrarily. Station 37 in region (2) is anomalous. Only a small number of organisms could be identified. Either the catches were insufficiently preserved or some unusual water movement was occurring. Station 38, close to a thermal front (Fig. 2),

TABLE 3

NUMBER OF ZOOPLANKTON ORGANISMS TAKEN ABOVE AND BELOW THERMOCLINE

STATION NO.	36		37		38		39	41	42		43		44	45
DEPTH (metres)	60-0	200-0	70-0	200-0	60-0	200-0	200-0	200-0	60-0	200-0	60-0	200-0	200-0	200-0
COPEPODS														
Acartia danae	30	32	7		13	14	5		31	20	18	10	29	50
Calanus minor					20	10								3
C. tenuicornis		5			1	3	1		1	3	1	5		3
Centropages bradyi					1	2								1
Clausocalanus arcuicornis		3			1				1	2	1		10	3
C. furcatus		5			3	2	4							1
Ctenocalanus vanus	1	9								2		1	1	18
Eucalanus attenuatus					3									
E. elongatus							1							
Euchaeta spp.											1			3
Lucicuta flavicornis					1									1
Mecynocera clausi	4	1			5	4	4	3	4	8	17	6	32	16
Paracalanus aculeatus	1	20												8
P. parvus	4	2			41	38			5	12	16		6	
Corycaeus spp.	1			2	1	2			1					
Oithona spp.		9	2		1	15	4		4	9	10	46	50	34
Oncaea conifera														
O. media	1	13												3
O. venusta		5	2	8	1									13
Sapphirina spp.						2								
Other copepods		2												1
EUPHAUSIACEA														
Thysanoessa gregaria	1	1			3	2			1		5	1		
Euphausia recurva							1							
Other spp.						2						2	6	
TUNICATA														
Thalia democratica	1	59				2								
Oikopleura spp.	1	1			9	12	1				6		9	4
Fritillaria spp.	1													
OTHER ORGANISMS	11	12			9	12	1	1	1	8	3	12	31	18
TOTAL	57	179	11	10	113	122	22	4	48	64	78	83	174	180

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yielded greater numbers and more species than any other in region (2), and has features in common with stations in (1). The boundary between (2) and (3) was sharply defined by the thermal front. The plankton obtained in region (3) was extremely poor, and this water mass may have associations with the barren water below the thermocline in region (2).

The zooplankton collected on this cruise exhibits two unusual features:-

(a) Thermoclines are common at 50-150 m in warm seas, and often form a boundary between two communities, but extreme poverty of organisms below a thermocline is unusual in the open ocean, though common in lakes in late summer.

(b) The amount of zooplankton at all stations, both above the thermocline and from hauls to 200 m, is exceptionally small (Table 3). The greatest numbers found, 180 per 10 cu.m., is much less than 0.1 ml per 10 cu.m. Even at oceanic stations considered "poor," several hundred organisms are normally collected, and at other stations numbers commonly run into thousands. These conditions may be the result of a general early autumn reduction in zooplankton abundance, plus the intrusion of an extremely barren water mass.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH3/57

April 17 - April 24, 1958

SCIENTIFIC PERSONNEL

Scientific Officer-in-Charge of Cruise - B.V. Hamon.

ITINERARY

Figure 1 shows the track chart for the cruise, indicating the area sampled and the positions of the stations.

SCIENTIFIC REPORTS

This cruise is the second of a series extending over two years to study the structure, dynamics, and certain biological features of the East Australian current off Sydney. On this and future cruises of this series stations were and will be worked to 1500 m on two section lines from 34°04.8'S., 151°11.75'E. on a 110°T course to 400 miles east of Sydney, and the other on a parallel course 60 miles to the north. These will be referred to as the 110° and 290° section lines.

On this cruise, owing to very variable currents, it was not possible to obtain accurate dead reckoning positions, and the stations were scattered around the 110° and 290° courses (Fig. 1).

The thermometer arrangements, sampling depths, and properties analysed were the same as for cruise 1/57 and the same reservations must be applied to the vertical distribution of properties.

The track chart indicates that zooplankton and phytoplankton hauls were made at certain stations. Unfortunately there was some confusion in labelling the hauls, and it was therefore decided to omit the zooplankton and phytoplankton sections of this cruise report.

(a) HYDROLOGY - D.J. ROCHFORD

(1) Temperature - 110° Section Line (Fig. 2)

The warmest surface waters ($\lesssim$ 23°C) were found in a very narrow zone over the continental shelf. Temperatures decreased offshore to a minimum of 20°C in latitude 157°E.

A thermocline (0.08°C/m) was found only at Station 53/57. At depths below 500 m the warmest water occurred at Station 49/57 in longitude 153°E., some 60 miles to the east of the warmest surface zone.

(2) Density (σ_t) - 110° Section Line (Fig. 3)

A very narrow band of light water ($\sigma_t < 24.20$) marked the western boundary at Station 47/57, of a mixed 50-100 m stratum of density less than σ_t, 24.60, extending offshore to about 154°30'E. A pycnocline occurred beneath this layer, and extended eastward. The maximum vertical gradient of 0.04 (σ_t)/m was found at Station 53/57.

(3) Percentage Oxygen Saturation - 110° Section Line (Fig. 4)

Supersaturation was found in the surface light water at Station 47/57, and a subsurface spreading of saturated waters from this region to the east and west seemed to have occurred. A saturated surface layer was also found at Station 56/57 but for the most part surface undersaturation was characteristic of this section. In the deeper layers the oxygen saturation values did not parallel the density surfaces, except between Stations 50 and 53/57 where the dynamic uplift was evidently responsible for the greatly lowered oxygen saturation values around 75 m.

(4) Total Phosphorus - 110° Section Line (Fig. 5)

The surface low density, oxygen undersaturated layer (Figs. 3 and 4) was characterized by low total phosphorus ($\lesssim 5$ µg/l). Much higher surface values (10-15 µg/l) were found around the boundaries of this low total phosphorus region. The increased values along the continental slope around Station 46/47 were caused by dynamic uplift of slope waters. In the deeper layers below 500 m the total phosphorus distribution was not always related to the density field.

(5) Horizontal Distribution of Properties

(a) Percentage oxygen saturation (Fig. 6)

At the surface (Fig. 6A) the undersaturated region extended east, between regions of saturated waters and probably was characteristic of the westward flow in this region (Physics sections 1 and 2). At 100 m and 300 m (Figs. 6B and 6C) however, saturation values were the inverse of those at the surface with relatively high values beneath the undersaturated surface layer and low beneath the surface regions of saturation.

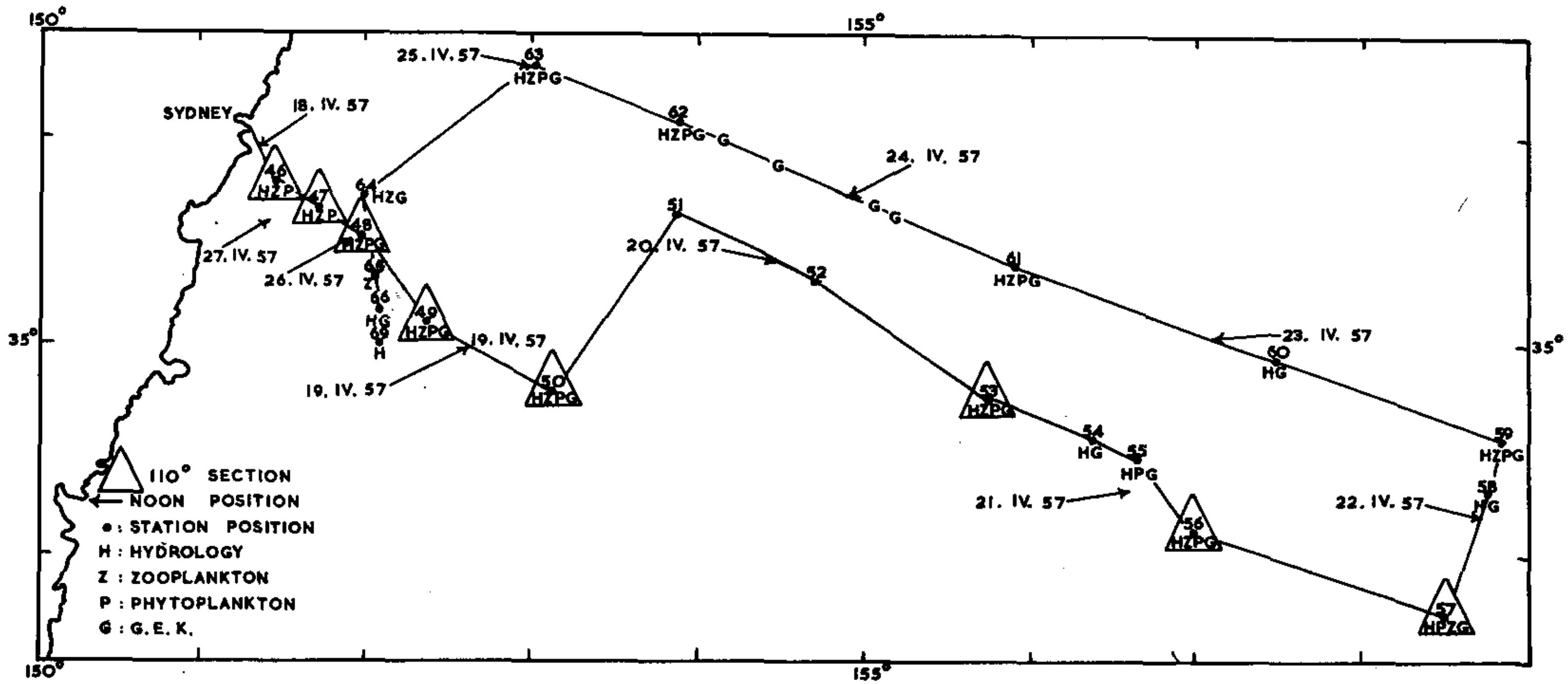

Fig. 1. Cruise DH3/57. Track chart showing all stations.

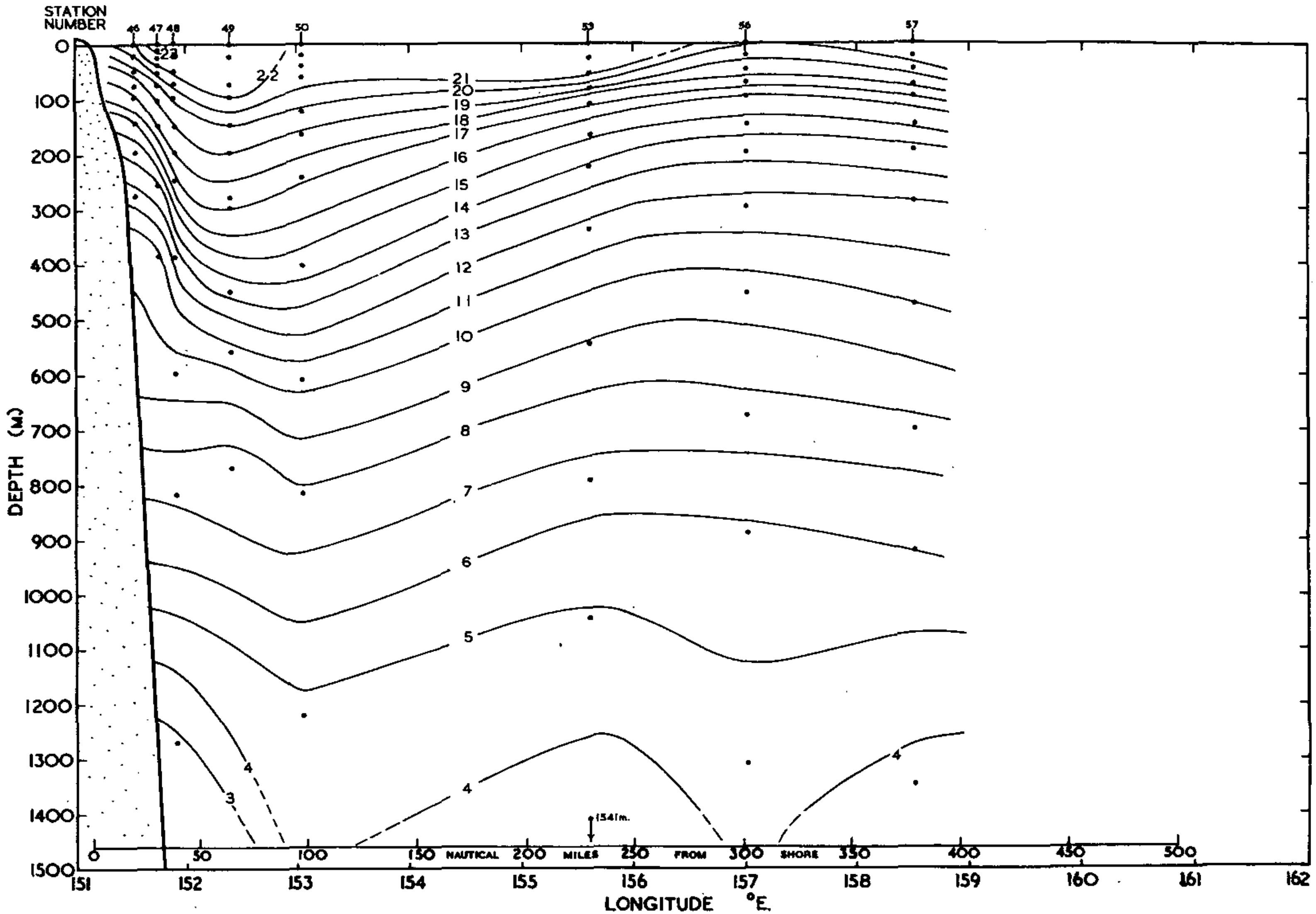

Fig. 2. Sectional distribution of temperature (°C) along 110°T. line, to 1541 m.

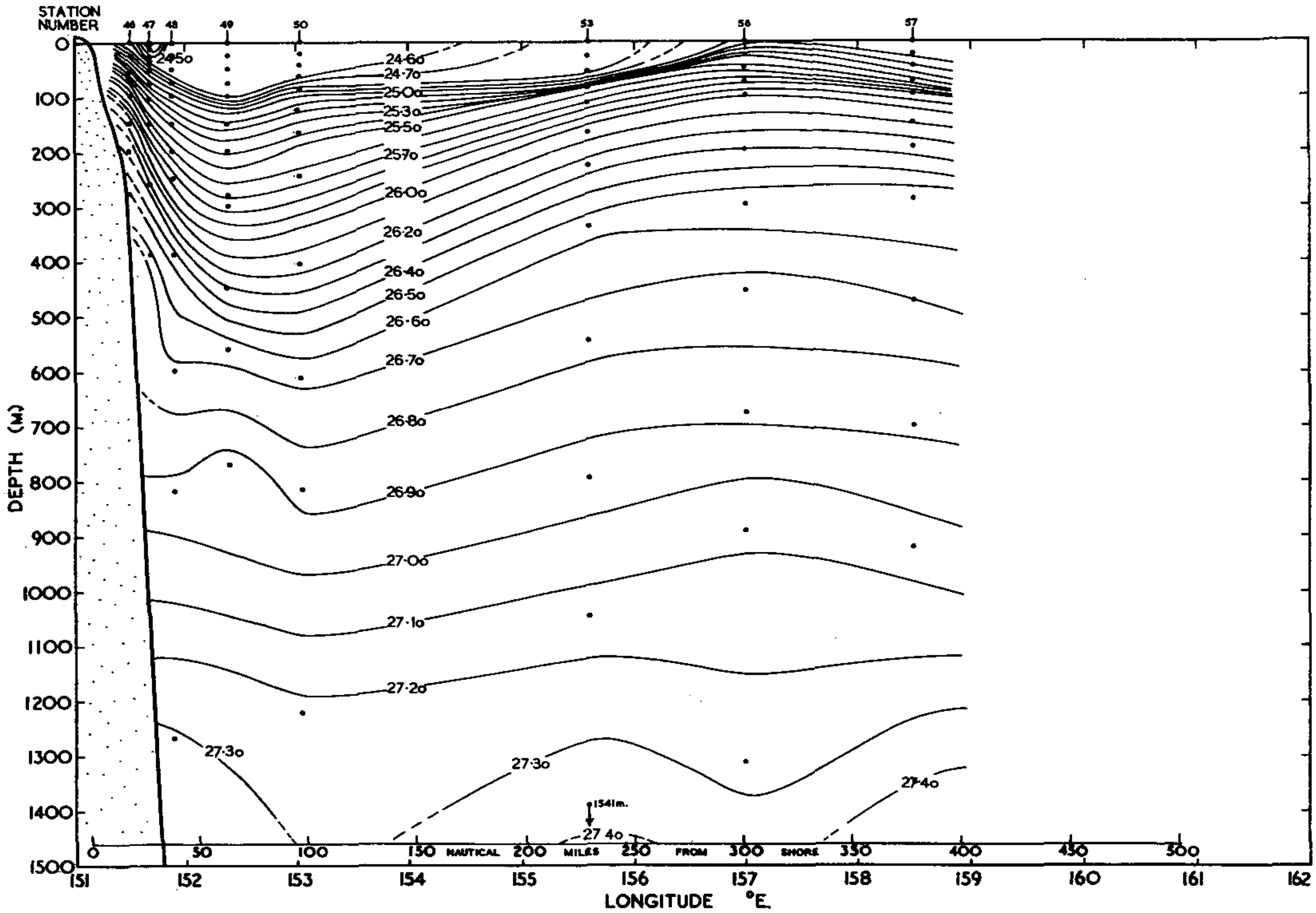

Fig. 3. Sectional distribution of σ_t along 110°T. line to 1541 m.

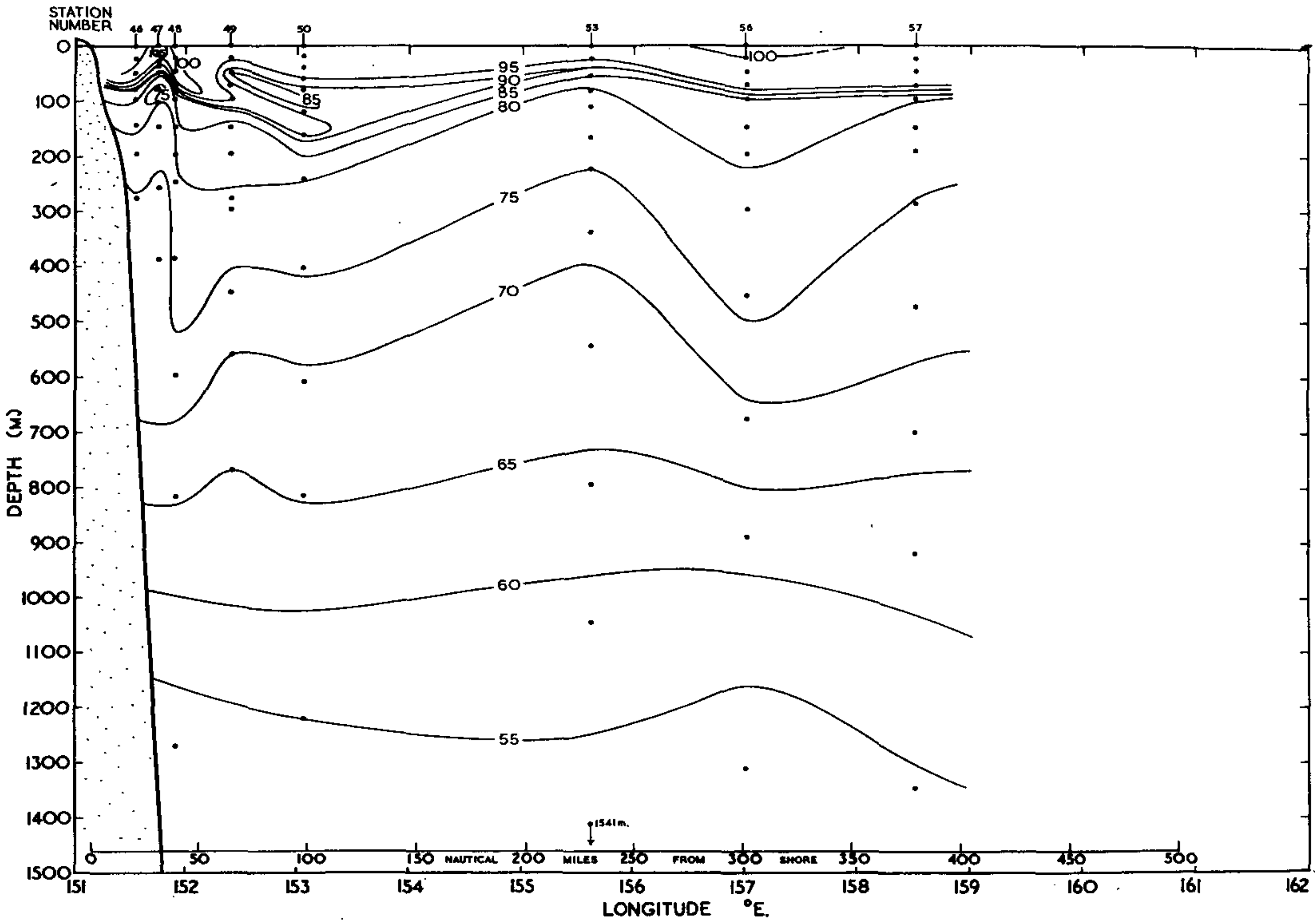

Fig. 4. Sectional distribution of oxygen saturation along 110°T. line to 1541 m.

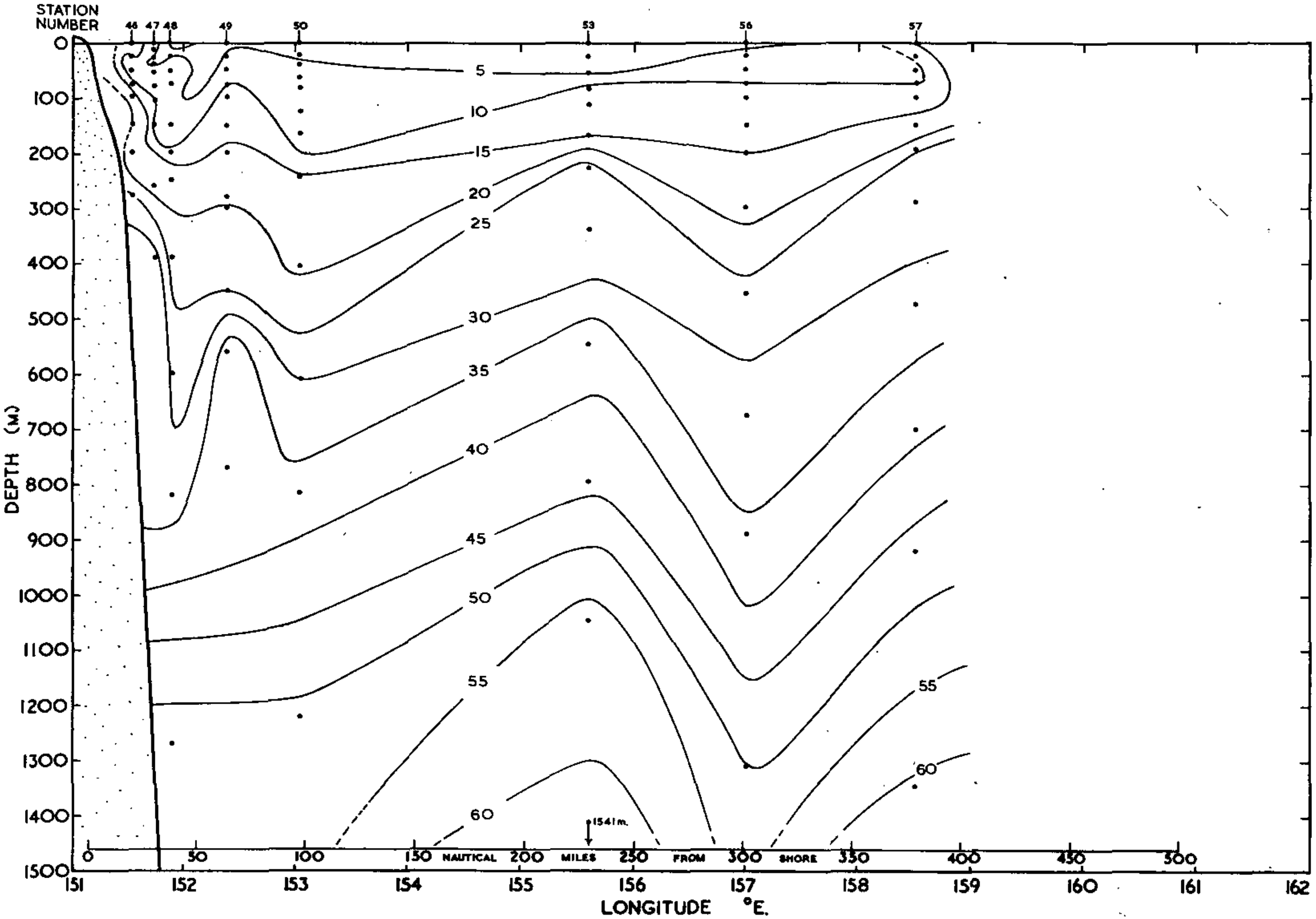

Fig. 5. Sectional distribution of total phosphorus (µg/1) along 110°T. line to 1541 m.

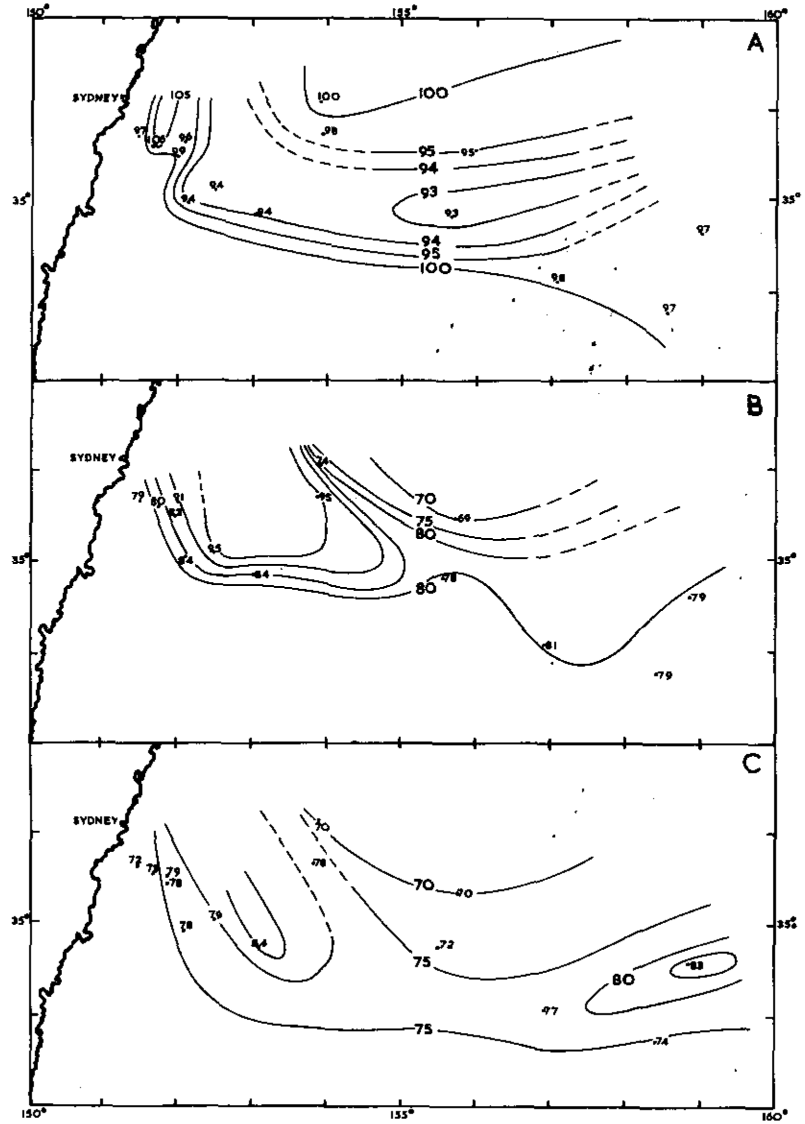

Fig. 6. Horizontal distribution of percentage oxygen saturation. A at 0 m, B at 100 m, C at 300 m.

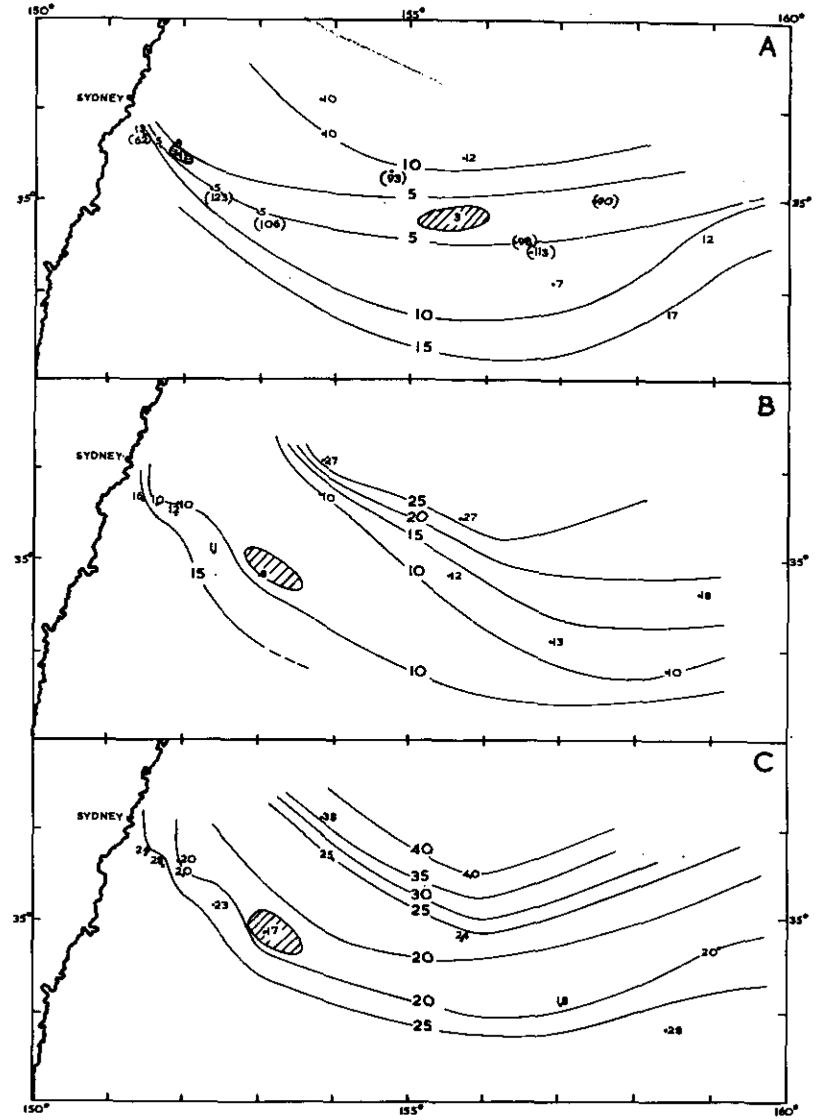

Fig. 7. Horizontal distribution of total phosphorus. A at 0 m, B at 100 m, C at 300 m. Figures in brackets show depth of penetration of 1 per cent. surface light.

(b) Total phosphorus (Fig. 7)

At the surface (Fig. 7A) a band of low total phosphorus ($\leqq$ 5 µg/l) was associated with the western flow of waters (Physics sections 1 and 2). To the north, values were increased by dynamic uplift along the boundary of the western flow. At 100 and 300 m (Figs. 7B and 7C) the relative distribution was similar to that at the surface.

(c) Submarine light

The depth of penetration of the 1 per cent. surface illumination shows a correlation with surface total phosphorus (Fig. 7). In general the most transparent waters were those lowest in total phosphorus, and formed part of the circulation of waters of northern origin. The minimum transparency at Station 46/57 was probably associated with sediment uplift along the continental slope.

(b) PHYSICS - B.V. HAMON

(1) Dynamics

Figure 9 shows the dynamic height anomalies, in dynamic centimetres relative to the 1000 decibar level, together with approximate contours at intervals of 10 dyn. cm.

The main circulation features revealed by the contours in Figure 8a are a relatively narrow and swift surface current to the south within the first 50 miles from the edge of the continental shelf, and a northerly current further to the east. Further east still (more than 156°E.) the dynamics are more complicated, and it was not feasible to draw contours of dynamic height from the number of observations available.

Calculation of volume transports gave the following results:-

Station	Longitude	Approx. distance from shore (naut.mile)	Volume transport above 1000 metres (m^3/sec)	Direction
46	151°32'E.	25		
			1.3×10^7	S.
49	152°23'E.	85		
			1.4×10^7	N.
51	153°55'E.	150		

(2) Surface Current Measurements (G.E.K.)

Surface current vectors obtained by means of the G.E.K. are shown in Figure 8b. There is general agreement between the G.E.K. currents and surface currents calculated from dynamic heights. The G.E.K. results between 152°E. and 154°E. suggest the presence of a gyral with anticlockwise rotation in this region. The fairly consistent easterly currents at about 155°E. may also be noted; these are in the opposite direction to the currents deduced from dynamic heights.

(3) 24 Hour Station - Internal Waves

The vessel was hove to approximately 50 miles offshore from 0415 hours 26.iv.57 to 0100 hours 27.iv.57. During this time a drift of about 40 miles S.S.E. was recorded (see track chart, Fig. 1, Stations 64 to 69).

The main purpose of the 24-hour station was to get preliminary information on internal waves, so that their effect on the accuracy of dynamic calculations could be estimated.

There was a sharp thermocline at a depth of about 100 metres. The depth of this thermocline as a function of time is shown in Figure 9, which was obtained from bathythermograph records. The accuracy of relative depths was estimated to be about ± 2 metres. The figure shows a total range of variation in thermocline depth of about 15 metres. Times of high and low water at Sydney are marked on Figure 9; there is no obvious tidal periodicity in the observed variations. The observed variations in depth of thermocline would have a negligible effect on the accuracy of dynamic calculations.

(4) Meteorological Results

The air-sea temperature difference had a mean value of - 1.5°C, and a range - 6.9°C to + 0.7°C (negative sign indicates that the air is colder than the sea). The extreme value of - 6.9°C occurred at 1800 hours, 19.iv.57, about 140 miles offshore, with a west wind of about 11 knots.

(5) Temperature - Chlorinity - Depth Recorder

This instrument was tested during the cruise. The results will be discussed in more detail in a separate paper. The general behaviour of the instrument was satisfactory, and the results were obtained from the recorder at the following stations:- 52, 54, 55, 58, 60, 63, 65, 66.

April 17 - April 24.

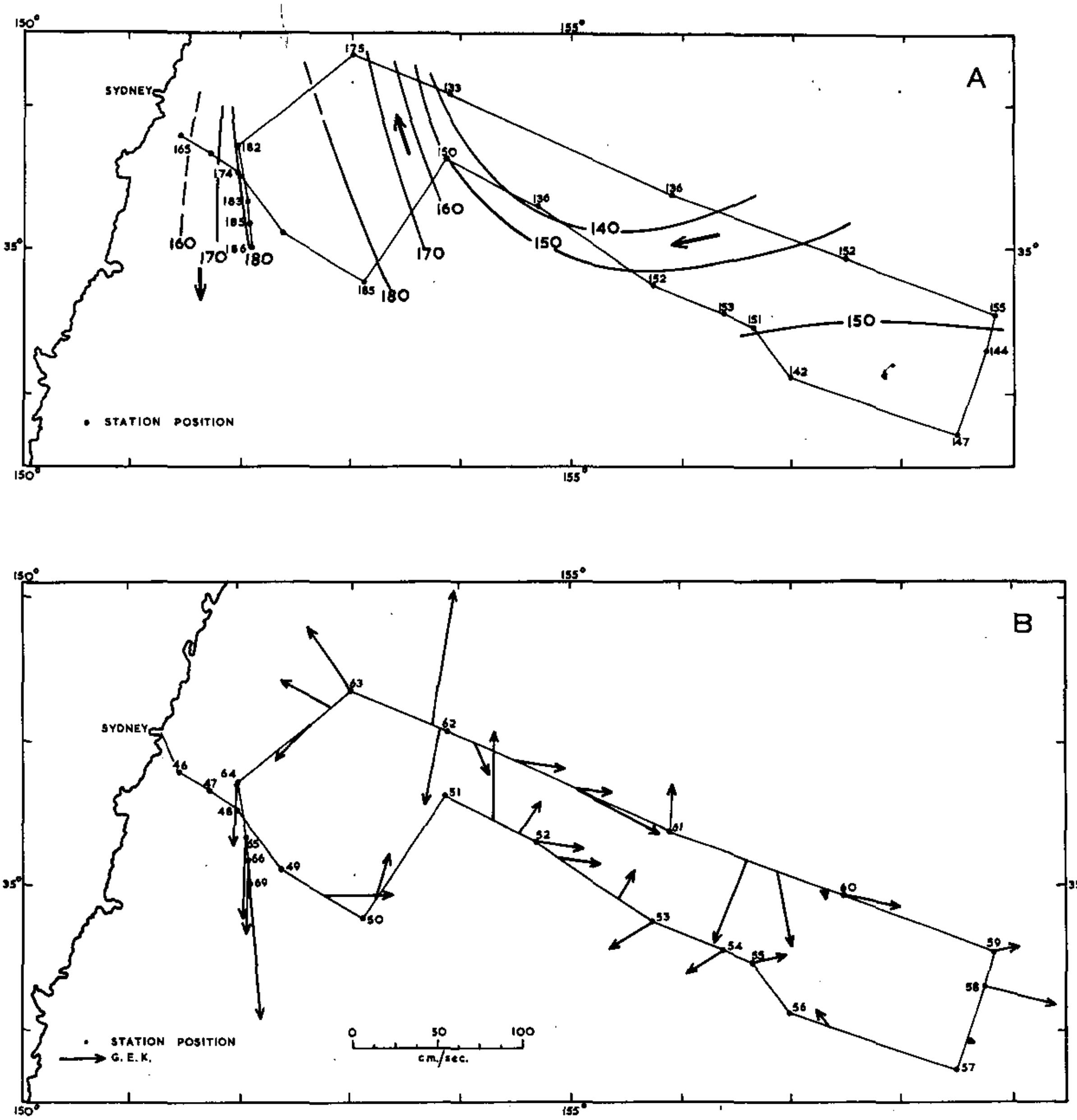

Fig. 8. (a) Contours of dynamic height anomalies relative to 1000 decibars.
(b) Surface current vectors from G.E.K. readings.

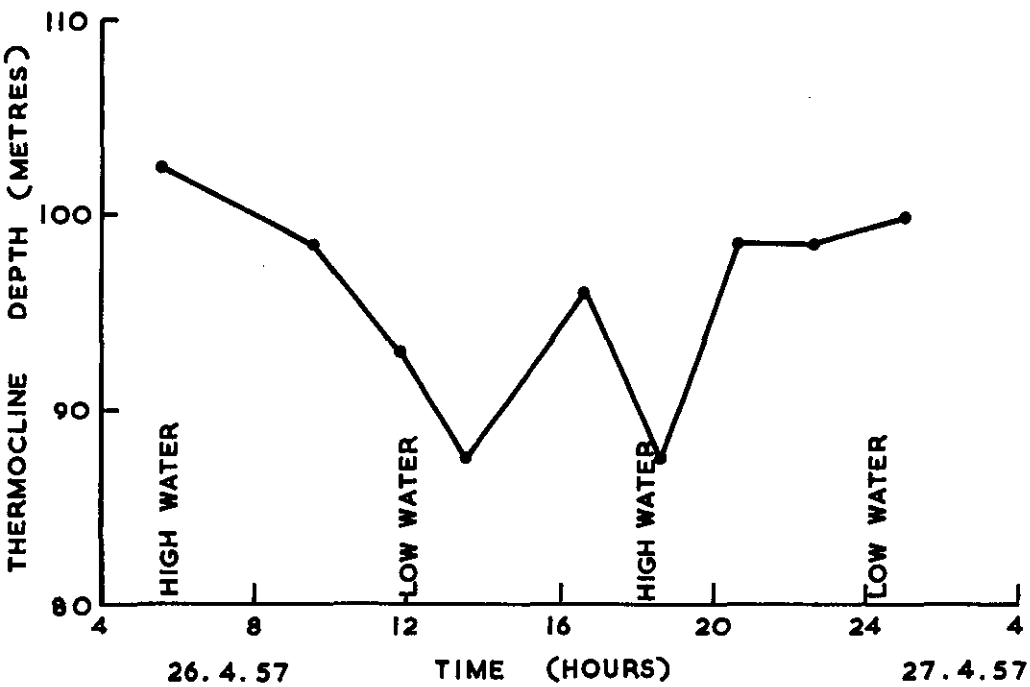

Fig. 9. Depth of thermocline as a function of time from bathythermograph records.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE 4/57

MAY 2 - JUNE 3, 1957

SCIENTIFIC PERSONNEL

Scientific Officer-in-Charge of cruise - T.R. Cowper
Scientific Officer - D.J. Dunstan

ITINERARY

Figure 1 gives the track chart and station positions. Hydrological and planktological sampling was conducted at each station, while trolling for barracouta (Thyrsites atun) was carried out for approximately one hour each morning and evening whenever possible. A Hardy plankton indicator was towed continuously throughout the cruise to sample surface euphausiids.

SCIENTIFIC REPORTS

(a) BARRACOUTA - T.R. COWPER

The purpose of the cruise was (a) to test the hypothesis that annual fluctuations in the success of the barracouta fisheries of Bass Strait depend mainly upon corresponding fluctuations in the availability of Nyctiphanes australis (krill) in the coastal waters in summer and autumn, and (b) to determine any relationship between the occurrences of barracouta and the water masses of the area.

Only 42 barracouta were taken throughout the cruise thus providing very few data for subsequent analysis. Samples of more than one specimen were taken on eight occasions and five of these samples had been feeding exclusively on krill. Of the total fish taken 20 (47.6 per cent.) had no traces of food in their stomachs, 17 (40.5 per cent.) had been feeding on krill, 4 (9.5 per cent.) on fish (Stolephorus robustus - blue sprat), and 1 (2.4 per cent.) on small squid.

Although the distribution of krill throughout the area of Bass Strait was similar to that of cruise 4/56 the abundance of this organism was very much reduced during the period of cruise 4/57.

The abundance of krill during the former cruise was determined as 90 organisms per ten cubic metres of water per station, whereas the figure obtained for the latter cruise was 28 organisms per ten cubic metres of water per station. From the stomach contents of those barracouta taken it would seem that at this time of year (autumn) they are almost entirely dependent upon krill for food. A scarcity of krill at this time, therefore, could affect the availability of barracouta in these waters. However, until commercial catch data for the periods concerned are available, analysis must of necessity be postponed.

As in the previous cruise, too few barracouta were taken to allow any attempt at correlation between the occurrence of fish and the water masses of the area.

(b) ZOOPLANKTON - W. DALL

(1) Zooplankton Communities (Table 1, Fig. 2)

The most notable feature was the invasion of western offshore plankton, which extended almost through the Strait. This intrusion consisted of predominantly oceanic species with an admixture of the shallow water species *Acrocalanus gracilis* and *Paracalanus aculeatus*, which were abundant throughout Bass Strait. For the most part the central Bass Strait community was quite distinct, except in the vicinity of the Victorian inshore region. It is probable that here the central Bass Strait community had been pushed coastwards by the offshore invasion. As a result the Victorian inshore region contained a scattering of species from both these communities. Both western and eastern offshore plankton were similar faunistically and havenot been distinguished in Figure 2. The only differences were the presence of *Corycaeus* spp. and the absence of *Oncaea venusta* in the western area.

(2) Zooplankton Abundance (Figs. 3 and 4)

There was not a direct relationship between numerical abundance and volume. The increase in numbers in the shallow waters of Bass Strait was largely due to *Paracalanus aculeatus*, whereas volumes were influenced partly by the abundance of *Nyctiphanes australis* (see Fig. 5).

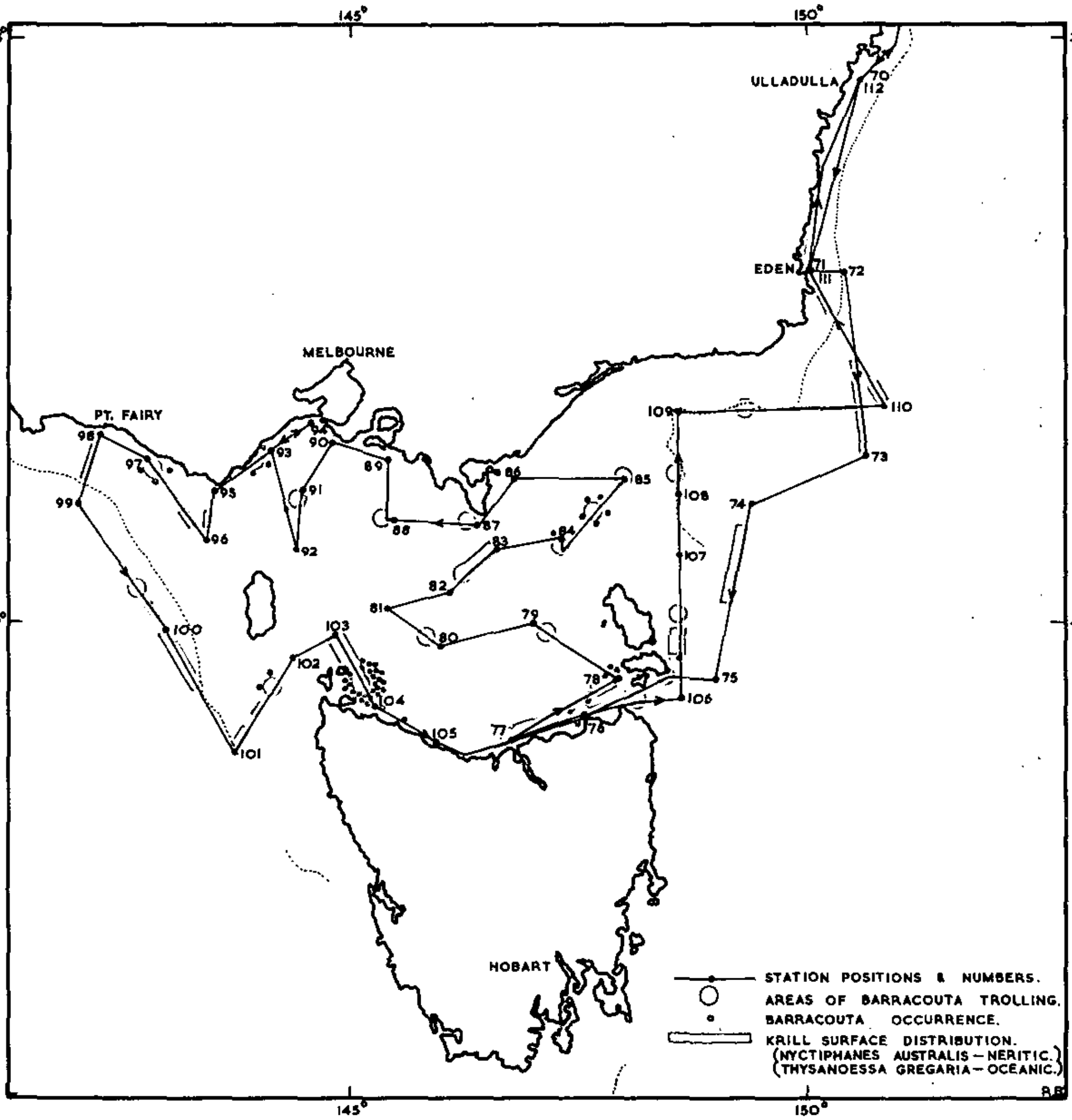

Fig. 1. Track chart showing all stations. Areas of barracouta trolling and barracouta occurrences and krill distribution at surface as determined from Hardy indicator tows.

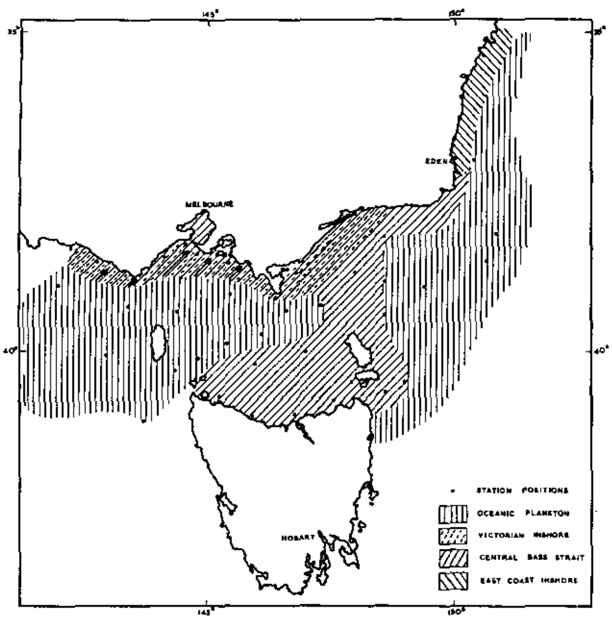

Fig. 2. Zooplankton distribution in Bass Strait - quantitative.

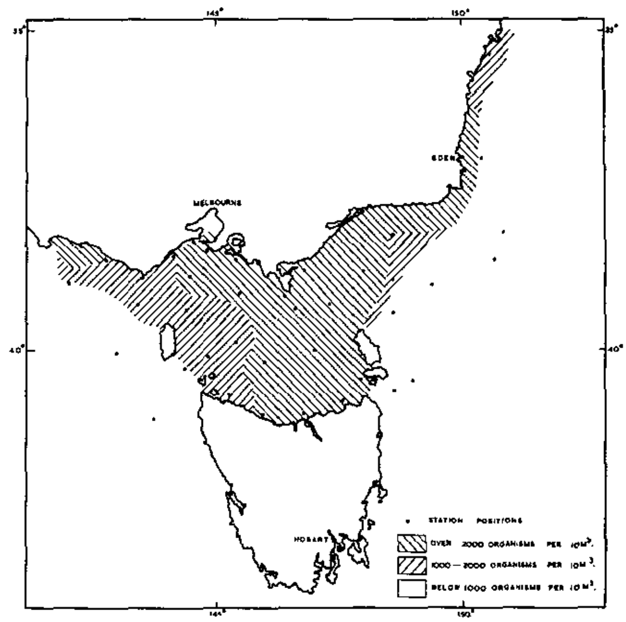

Fig. 3. Zooplankton distribution - numerical abundance.

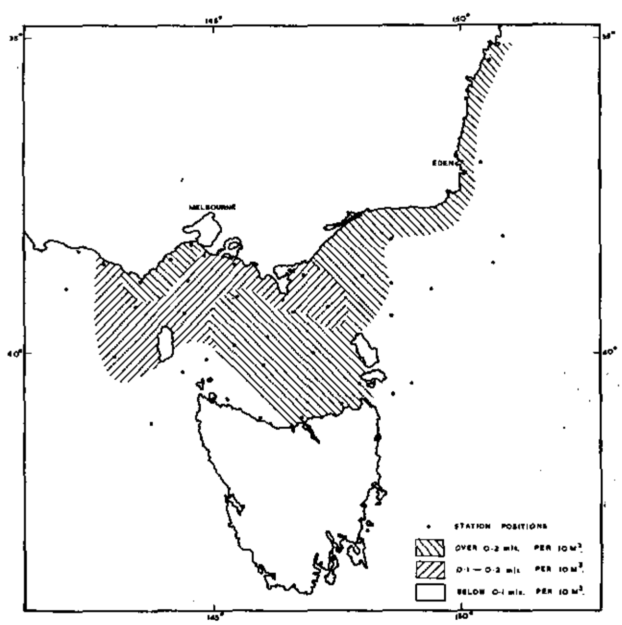

Fig. 4. Zooplankton distribution - displacement volumes (excluding salps and medusae).

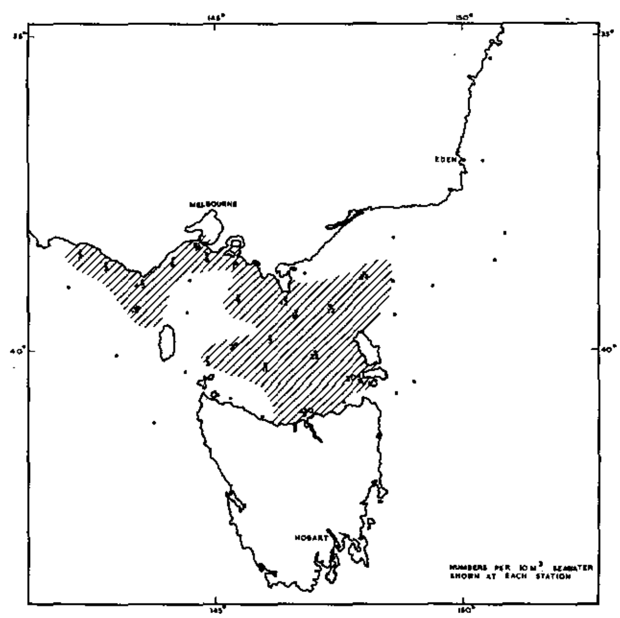

Fig. 5. Distribution of the euphausiid <u>Nyctiphanes australis</u>.

TABLE 1
(See Fig. 2)

SPECIES	PLANKTON REGION			
	Oceanic	Victorian Inshore	East Coast Inshore	Central Bass Strait
Calanoida				
Acartia clausii	-	++	+	+
A. danae	+	-	++	-
Calanus helgolandicus	-	+	-	++
C. minor	+	-	+	-
C. tenuicornis	+	-	-	-
Centropages bradyi	+	-	-	-
C. kroyeri	-	+	-	+
Claucocalanus arcuicornis	++	+	+	-
C. furcatus	+	+	++	+
Ctenocalanus vanus	+	+	++	++
Euchaeta spp.	++	-	-	-
Labidocera cervi	-	-	-	++
Lucicuta flavicornis	+	-	-	-
Mecynocera clausii	+	-	-	-
Paracalanus parvus	+	-	-	-
Pleuromamma abdominalis	+	-	-	-
P. gracilis	+	-	-	-
Temora turbinata	-	-	+	-
Undinula darwinii	+	-	+	-
Cyclopoida				
Corycaeus spp.	+	-	-	-
Oithona tenuis	++	+	+	+
O. similis	-	++	-	-
O. brevicornis	-	+	-	-
Oncaea conifera	+	-	-	-
O. media	++	+	++	-
O. venusta	+	-	++	-
Amphipoda				
Parathemisto gracilis	-	+	-	++

\+ Present
++ Abundant
\- Absent

(3) Distribution of krill, Nyctiphanes australis (Fig. 5)

This distribution was not unlike that observed on "Derwent Hunter" Cruise DH4/56, except that almost no calyptopis stages were taken, and most euphausiids were mature. In October-November 1956, calyptopis stages were predominant, and many of the larger stages were half-grown furcilia. This indicates that (a) N. australis spawns in the spring, (b) adult size is reached in either approximately six months or slightly over one year. As in DH4/56 N. australis seemed to be independent of the distribution of other zooplankton.

(4) Comparison with Cruise DH4/56, October-November 1956

Except that the north-Tasmanian inshore plankton was not apparent the general qualitative distribution was similar. This may indicate that the zooplankton distribution was fairly static over the warmer months of the year. The species composition changed slightly, Calanus tonsus being absent, whereas formerly it was dominant. Calanus helgolandicus, which formerly was fairly uniform throughout Bass Strait, was on this occasion more abundant in the central Bass Strait region.

The standing crop of zooplankton was uniformly higher over the eastern half of Bass Strait, whereas formerly it was patchily distributed in two main areas, one occupying the central region and the other the north and west.

The most striking feature of this cruise is the absence of relationship between either qualitative or quantitative zooplankton distribution, and phytoplankton, and hydrological conditions.

(c) PHYTOPLANKTON (E.J. FERGUSON WOOD)

Notes on the Stations

70, 71 Phytoplankton typical of the warm waters in this area with the same species groups occurring off Port Hacking at this time.

72 No phytoplankton.

73 Poor phytoplankton. Phalacroma favus suggests oceanic water, probably upwelling.

74 No phytoplankton

75 Poor phytoplankton. 72 to 75 appear to be oceanic water poor in nutrients

76 An onshore station with neritic species (pennate forms, Pyxidicula, Isthmia, etc. Several species

from this station have been recorded from the fossil beds at Oamaru, N.Z. In addition, there is evidence of warm eastern waters (*Ceratium pentagonum* and *Biddulphia sinensis*), and Bass Strait water (*Rhizosolenia hebetata* and *Chaetoceros convolutum*), the latter occurring with breaks through to Station 106 at this time.

77, 78 show weak eastern influence (*Biddulphia chinensis*, *Ch. curvisetum*).

79 *Coscinodiscus excentricus* suggests shallow water influence.

80, 82, 83 suggest infertile water, but 81 is not infertile, and contains *Pyxidicula* and some Rhizosolenias which reach bloom proportions at Station 86.

84, 85 have *Ch. convolutum*, *R. hebetata*, and other forms suggesting an infertile mixed water.

86 An interesting station with a large bloom of Rhizosolenias, chiefly *R. styliformis*, and *R. setigera* with neritic forms (pennates).

87 is on the edge of the *Rhizosolenia* bloom.

88 shows neritic influences.

89-95 Infertile water.

96-103 have a small bloom of *Corethron criophilum* which is probably derived from the Antarctic convergence to the south-west of Tasmania. This species occurred in the BANZARE material south-west of Tasmania though it may also occur in eastern waters derived from warmer latitudes.

103 The presence of *Ceratium arcticum* in tow 103 confirms the influence of the Antarctic convergence of water. In addition, some west wind drift forms, *Chaetoceros messanense*, *Biddulphia reticulata*, and *Planktoniella sol* are present. The first-mentioned has not been recorded from the east coast, while the latter two are warm water oceanic forms.

104 shows neritic influence in the number of pennate diatoms.

105 shows some mixture with east Australian water (*Ch. coractatum*).

107 is a similar water (*Schroederella*).

111,112 are typical east coast stations with such forms as *Ceratium pentagonum*, *Peridinium globulus*, and *Ceratium breve*.

Table 2 gives the detail of the occurrence of all species of diatoms and dinoflagellates taken at each station on this cruise.

Conclusions

There appears to be a tongue of water of tropical origin extending southward to Gabo I., and eastward of this tongue is a barren region which shows evidence of possible upwelling. South of Lady Barren I. is a band of water of tropical origin extending across the north of Tasmania, but mixing with water from the north (Bass Strait water) and west as it moves westward. West of a line from Lady Barren I. to Cape Everard is typical Bass Strait water, infertile, with a few representatives of *Rhizosolenia hebetata*, f. *humalis*, and *Ceratium horridum*, and extending west of the Otway Ranges in the north and to Stanley in the south.

In the Port Albert-Corner Inlet-Wilson's Promontory area is a bloom of *Rhizosolenia* with neritic influences, and probably of neritic origin. West of King I. is water associated with west wind drift, and tropical affiliations, but with some mixing in the southern portion with water derived from the Sub-Antarctic convergence.

(d) HYDROLOGY - D.J. ROCHFORD

(1) Data

On this cruise temperature, chlorinity, and total phosphorus data were collected from 43 stations (Fig. 7a). No dissolved oxygen values are available because of a reagent defect.

(2) Results

(i) Regional Water Masses

Table 3 lists the regional water masses present during this cruise.

TABLE 3

REGIONAL WATER MASSES OF BASS STRAIT - MAY 1957

Water Mass	Identity	Cl‰	Temp.	Total P.
1	Coral Sea	19.82	19.0	7.5 µg/l
2	N. Bass Strait	19.74	15.0	11 "
3	Southern Australia	19.36	12.7	14 "

FO 284

TABLE 2

OCCURRENCES OF DIATOMS AND DINOFLAGELLATES AT STATIONS ON CRUISE DH4/57

Part 1a - CENTRIC DIATOMS p.1

SPECIES	STATION																
	70	71	75	76	77	78	79	81	82	83	84	85	86	87	88	89	90
Melosira sulcata											+						
Stephanopyxis turris		+															
Skeletonema costatum										+		+					
Schroederella delicatula		+				+											
Lauderia annulata				+													
Thalassiosira hyalina		+															
T. condensata		+		+													
T. gravida		+															
T. subtilis											+				+		
Coscinodiscus radiatus	+										+						
C. concinnus		+															
C. excentricus							+										
C. marginatus											+			+			
C. centralis																	
C. gigas																	
Actinoptychus senarius									+		+						
Pyxidicula cruciata				+				+									
Auliscus sculptus				+													
Planktoniella sol													+				
Biddulphia reticulata																	
B. sinensis				++	+												
B. mobiliensis		+															
Triceratium reticulum										+			+				
T. pentacrinum								+									
T. robertsianum														+			
T. favus														+			
Isthmia enervis				+													

+ Present ++ Frequent +++ Abundant ++++ Very Abundant

Part 1a - CENTRIC DIATOMS p.2

SPECIES	STATION 91	92	94	95	96	97	99	100	102	103	104	105	106	107	109	111	112
Melosira sulcata			+														
Stephanopyxis turris																	
Skeletonema costatum		+									+						
Schroederella delicatula						+	+			+				+			
Lauderia annulata																	
Thalassiosira hyalina																	
T. condensata																	
T. gravida																	
T. subtilis				+	+									+			
Coscinodiscus radiatus																	
C. concinnus										+						+	+
C. excentricus									+								
C. marginatus					+												
C. centralis												+					
C. gigas												+					
Actinoptychus senarius	+																
Pyxidicula cruciata	+																
Auliscus sculptus																	
Planktoniella sol										+							
Biddulphia reticulata										+							
B. sinensis									+								
B. mobiliensis																	
Triceratium reticulum	+					+			+								
T. pentacrinum								+									
T. robertsianum											+						
T. favus											+						
Isthmia enervis																	

\+ Present ++ Frequent +++ Abundant ++++ Very Abundant

Part 1a - CENTRIC DIATOMS p. 3

SPECIES	STATION 70	71	75	76	77	78	79	81	82	83	84	85	86	87	88	89	90
Chaetoceros eibeni													+				
Ch. curvisetum		+			+												
Ch. lorenzianum	+	+	+	+									+		+		
Ch. convolutum				++							+	+	+		+		+
Ch. vanheurcki							+										
Ch. coarctatum								+									
Ch. peruvianum																	
Ch. messanense																	
Ch. teres															+		
Ch. affine																	
Ch. decipiens		+															
Rhizosolenia imbricata													+				
R. delicatula																	
R. alata	+							+					++				
f. gracillima	+		+					+			+						
R. stolterforthi		+															
R. setigera				+							+		+++				
R. hebetata				+							+						
R. styliformis						+		+				+	++++	++		+	
Leptocylindrus danicus	+	+				+											
Ditylum sol				++													
Guinardia flaccida																	
Streptotheca indica				+									+	+			
Climacodium frauenfeldianum		+															
Bellerochea malleus														+		+	
Detonula confervacea				+													
Corethron criophilum																	

\+ Present ++ Frequent +++ Abundant ++++ Very Abundant

Part 1a - CENTRIC DIATOMS p. 4

SPECIES	STATION																
	91	92	94	95	96	97	99	100	102	103	104	105	106	107	109	111	112
Chaetoceros eibeni																	
Ch. curvisetum				+								+		+			
Ch. lorenzianum						+		+						+			
Ch. convolutum				+	+		+				+	+	+				
Ch. vanheurcki										+							
Ch. coarctatum						+?											
Ch. peruvianum		+										+					
Ch. messanense										+							
Ch. teres							+			+		+					
Ch. affine												+					
Ch. decipiens																	
Rhizosolenia imbricata																	
R. delicatula							+										
R. alata		+						+									
f. gracillima							+	+									+
R. stolterforthi																	+
R. setigera												+					
R. hebetata							+	+	+			+		+		+	
R. styliformis		+															
Leptocylindrus danicus							+	+	+	++		+		+		+	
Ditylum sol				+			+					+			+		
Guinardia flaccida							+										
Streptotheca indica							+		+	+							
Climacodium flauenfoldianum																	
Bellerochea malleus				+		+	++										
Detonula confervacea																	
Corethron criophilum					+		+			++							

+ Present ++ Frequent +++ Abundant ++++ Very Abundant

Part 1b - PENNATE DIATOMS

SPECIES	STATION 71	76	83	86	88	103	107	111
Synedra sp.		+						
Fragilaria oceanica								
Stauroneis sp.		+						
Navicula grevillei								
Asterionella japonica	+			+				
Grammatophora marina	+							
Rhabdonema adriaticum								
Amphora hyalina		+			+			
Nitzschia seriata	+	+		+			+	+
Nit. longissima		+						
Bacillaria paxillifer			+			+		

+ Present ++ Frequent +++ Abundant ++++ Very Abundant

Part 1c - DINOFLAGELLATES

SPECIES	70	73	75	76	81	83	86	87	88	89	96	97	99	100	102	103	107	111	112
Ceratium furca								+				+						+	
C. massilliense	+											+		+					
C. pentagonum	+			+														+	
C. buceros	+											+							
C. tripos		+			+		+												
C. candelabrum			+																
C. hexacanthum				+												+			
C. gallicum					+				+	+	+	+				+			
C. symmetricum					+				+			+		+					
C. macroceros					+	+													
C. horridum						+										+	+		
C. platycorne						+									+	+			+
C. kofoidi																			
C. teres																			
C. arcticum																+			
C. gibberum															+				
C. pulchellum												+							
C. conciliians												+							
C. fusus																		+	
C. breve																			+
Peridinium globulus	+																	+	
C. pellucidum	+																		
P. granii							+												
P. brevipes							+												
Dinophysis tripos	+	+										+						+	+
D. fortii																			+
Phalacroma favus		+																	
Goniaulax diegensis	+		+																
Pyrophacus horologicum												+							
Goniodoma polyedricum													+						
Ornithocercus quadratus													+						

+ Present ++ Frequent +++ Abundant ++++ Very Abundant

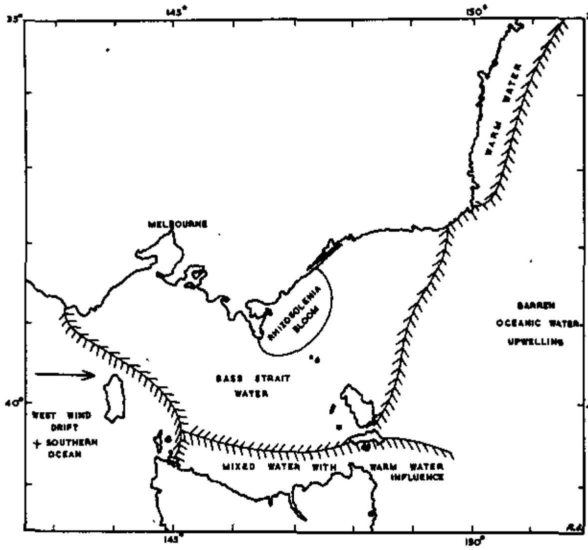

Fig. 6. Phytoplankton communities of south-east Australia and Bass Strait.

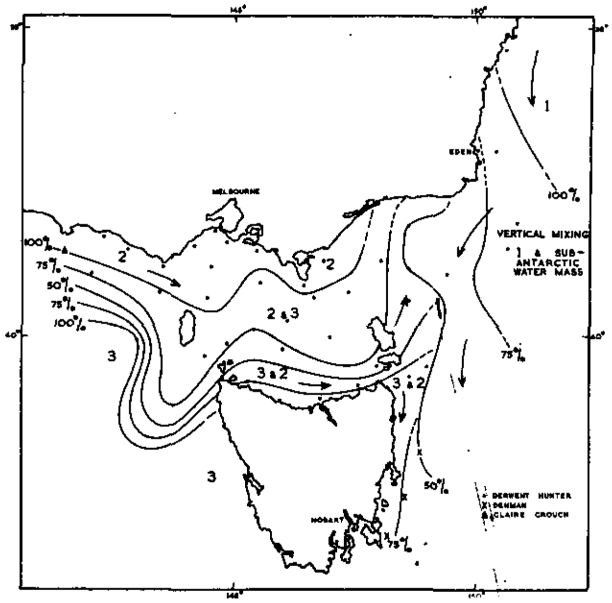

Fig. 7. Distribution of the surface regional water masses.

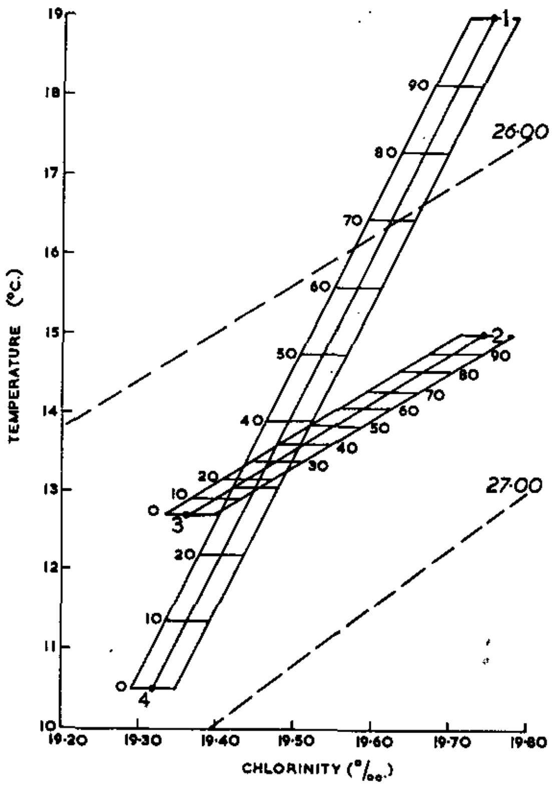

Fig. 8. Mixing diagram of surface and sub-Antarctic water masses.

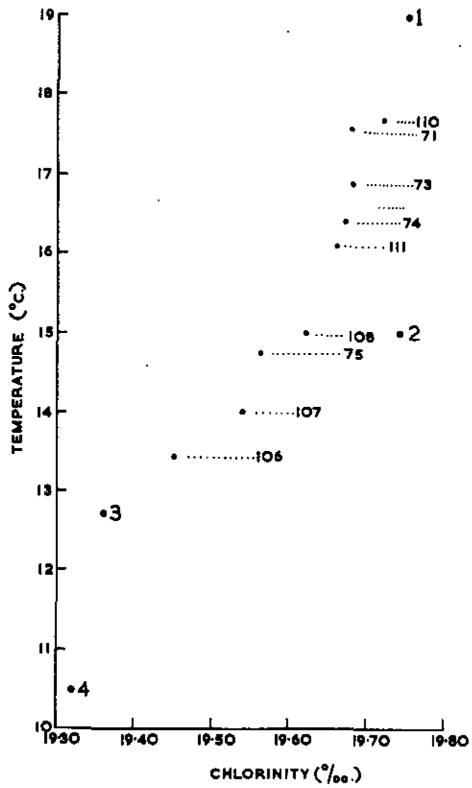

Fig. 9. Mean chlorinity-temperature (0-50 m) relationships at selected stations.

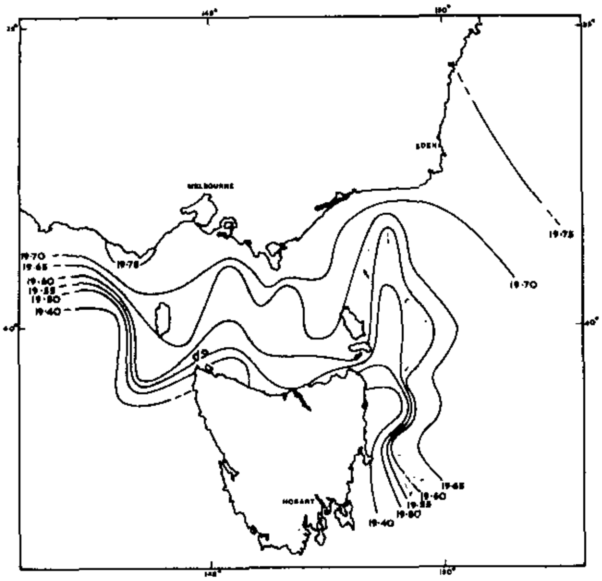

Fig. 10. Distribution of mean chlorinity (‰), 0-50 m.

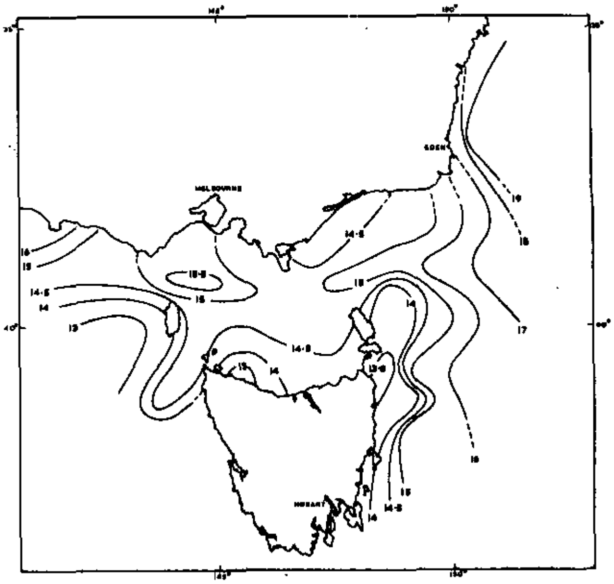

Fig. 11. Distribution of mean temperature (°C), 0-50 m.

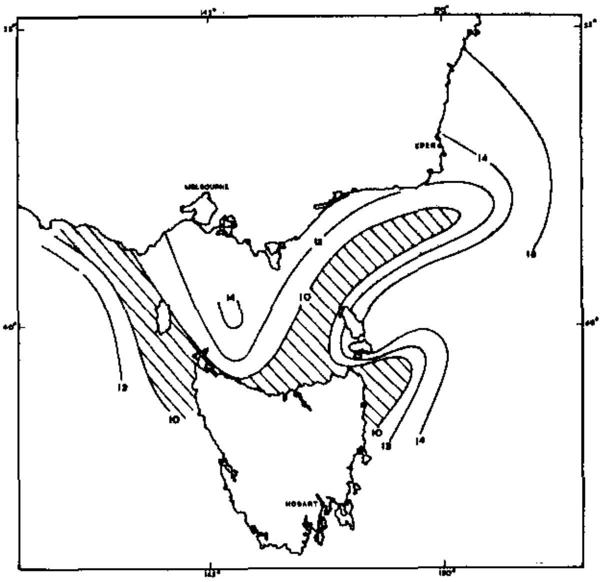

Fig. 12. Distribution of mean total phosphorus (ug/1), 0-50 m.

For comparison Table 4 lists the regional water masses in Bass Strait in April 1955.

TABLE 4

REGIONAL WATER MASSES OF BASS STRAIT, APRIL 1955

Water Mass	Identity	Cl‰	Temp.	Total P.
1	Coral Sea	19.73	20.0	15 µg/l
2	N. Bass Strait	19.67	14.7	15 "
3	Tasmanian Coastal	19.26	15.0	-
4	Deep Sub-Antarctic	19.35	11.4	>30 "

The Coral Sea, deep Sub-Antarctic, and North Bass Strait water masses had very similar properties in April 1955 and in May 1957. There was a considerable difference between the properties of water mass 3. In April 1955 it was the Tasmanian Coastal water mass but in May 1957 it was different and is considered as a derivative of the surface oceanic waters of southern Australia. Its northern penetration to the west of King Island is further evidence of such an oceanic rather than a coastal origin.

(ii) Distribution and Circulation of Regional Water Masses

Figure 7 shows the distribution of the regional water masses of the upper 50 m, using the mixing diagram of Figure 8 to establish the degree of mixing between them. Surface data, collected by M.V. "Denman" on the east coast of Tasmania and by M.V. "Claire Crouch" on the west coast of Victoria, have been used to extend the distribution of the water masses beyond the limits of the area worked by "Derwent Hunter" (Fig. 7a).

In the eastern approaches to Bass Strait several stations were worked in about the same position at the beginning and at the end of the cruise. Figure 9 shows that in the middle and southern portions of this area (Stations 75 and 106, and 74, 107 and 108) the chlorinity-temperature structure progressively changed during May, by the advection of the North Bass Strait water mass.

In the northern portion of Bass Strait, the changes in the same period were much smaller and were probably caused by local heat exchanges. Figure 7 shows the circulation causing the changes in water mass structure in the area.

During the period before the May survey the North Bass Strait water mass must have moved into Bass Strait through the northern portion of the western approaches. Associated with this was a general easterly drift of various mixtures of the North Bass Strait and southern Australian water masses, which flowed through Bank's Strait and, by the end of May, were spreading into the south-eastern approaches and east Tasmanian waters.

(iii) Distribution of Chlorinity (Fig. 10)

Maximum chlorinities were found along the northern portion of Bass Strait extending into southern New South Wales coastal waters. Minimum chlorinities were found west of King Island and off north-east Tasmania. The tongue of comparatively low chlorinity water extending north along longitude 149°E. was probably caused by the circulation of southern Bass Strait waters (Fig. 7).

(iv) Distribution of Temperature (Fig. 11)

The warmest waters were found off the southern New South Wales coast and the coldest west of King Island and off the north-west coast of Tasmania.

A tongue of comparatively cold water extended north along longitude 149°E. although not to the same northern limit as chlorinity (Fig. 10). The comparatively high (15-15.5°C) temperature waters to the north of King Island probably represent the last survival of the autumn penetration of sub-tropical waters from the eastern approaches.

(v) Distribution of Total Phosphorus

Figure 12 shows the distribution of total phosphorus during May 1957. In general the minimum values were encountered along the mixing boundary of water masses (2) and (3). Higher values were found in the approaches and centre of Bass Strait and are probably an effect of the autumn movement of waters rich in total phosphorus through the eastern approaches. The temperature distribution (previous section) also agrees with such a supposition.

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