COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 20

F.R.V. "DERWENT HUNTER"

Scientific Report of Cruise DH9/57
August 19 - 25, 1957

Scientific Report of Cruise DH10/57
September 4 - 11, 1957

Scientific Report of Cruise DH11/57
September 18 - 21, 1957

Scientific Report of Cruise DH12/57
September 26 - October 11, 1957

Marine Biological Laboratory
Cronulla, Sydney
1959

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	-	J. Staniforth

Cruises DH9/57 and DH12/57 were tuna longlining cruises off the New South Wales south coast. These are the last tuna cruises carried out from "Derwent Hunter;" subsequent tuna investigations are being concentrated at Eden and the cruises are being carried out from F.R.V. "Marelda" based on that port.

Cruise DH10/57 was the fourth of the series of cruises arranged to study the East Australian Current. Cruise DH11/57 was a productivity cruise concerned with the measurement of CO_2 uptake by the ^{14}C method.

When citing this report abbreviate as follows:
C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 20.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH9/57

August 19-25, 1957

SCIENTIFIC PERSONNEL

J.P. Robins (in charge)

ITINERARY

Stations occupied during this cruise are shown in Figure 1.

(a) TUNA - J.P. ROBINS

The object of this cruise was to fish in waters whose surface temperature characteristics (as gauged from previous longline cruises) indicated conditions (a) favourable and (b) unfavourable for southern bluefin tuna.

Favourable environmental conditions were found at Stations DH9/167-169/57 but unfortunately weather became adverse at Station DH9/170/57, although temperature conditions at that station were favourable. It was therefore decided to fish in an area further north where environmental conditions were expected to be different from those at the first three stations. It was intended that the second series of longline operations should be carried out in a region where the Coral Sea water mass or one of its components, was effective to depths greater than the effective fishing depth of the tuna longline.

However due to ship damage and loss of fishing gear by heavy seas en route, the vessel returned to port for repair and the cruise was terminated.

CATCH RESULTS:

Station	No. of southern Bluefin Tuna	No. of hooks	Catch/100 hooks	Breakages /100 hooks
DH9/167/57	4	150	2.67	1.00
DH9/168/57	9	150	6.00	8.67
DH9/169/57	3	150	2.00	14.67

No conclusions regarding the distribution of southern bluefin, nor its relation to water mass types (see Table 1, Hydrology) can be drawn, because so few fishing stations could be occupied.

(b) <u>HYDROLOGY - D.J. ROCHFORD</u>

Two regional surface water masses were distinguished from the data collected on this cruise (Table 1) on the basis of their temperature-chlorinity relationships (Fig. 2).

TABLE 1

<u>Regional Water Masses</u>

Water Mass	Temp. °C	Chlorinity °/oo	Total P μg/l
Central Tasman	16-17	19.65 - 19.70	13
Coral Sea	20-20.5	19.70	13

Their distribution is shown in Figure 1. The arrows in the Coral Sea water mass indicate a probable easterly drift along the boundary between the two water masses.

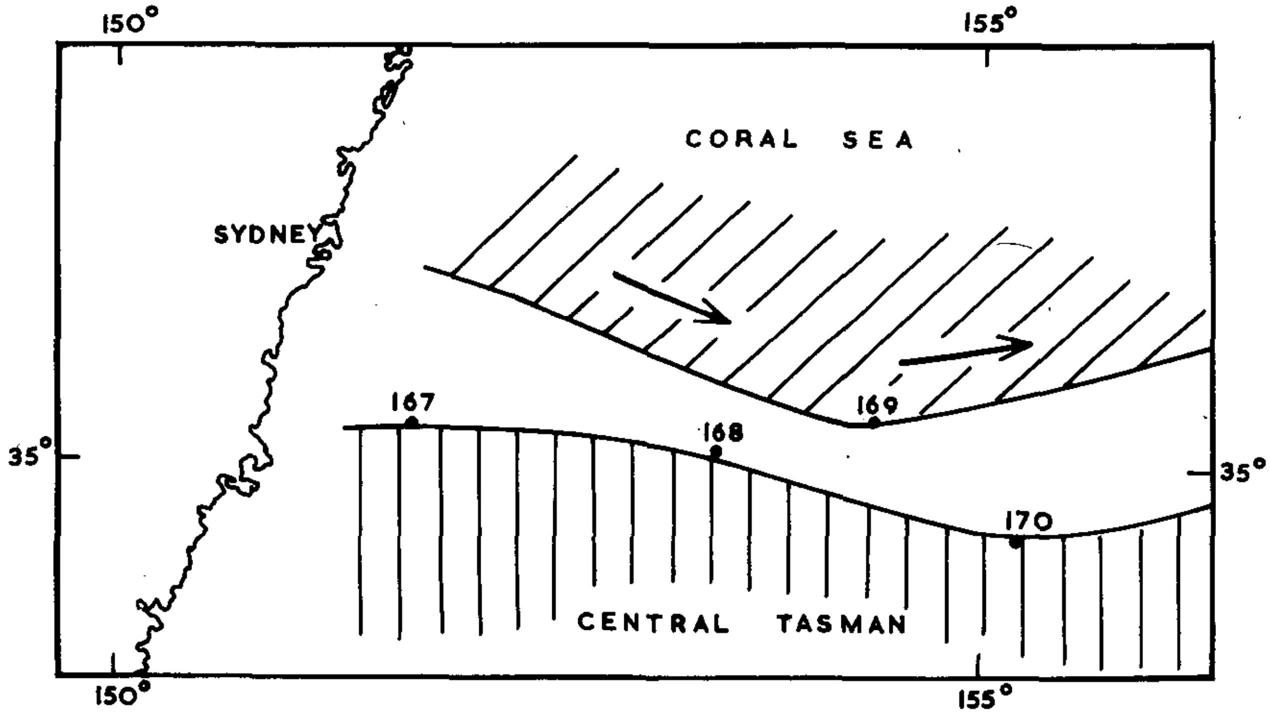

Fig.1. Cruise DH9/57. Track chart showing positions of stations and boundaries of Coral Sea and Central Tasman water masses.

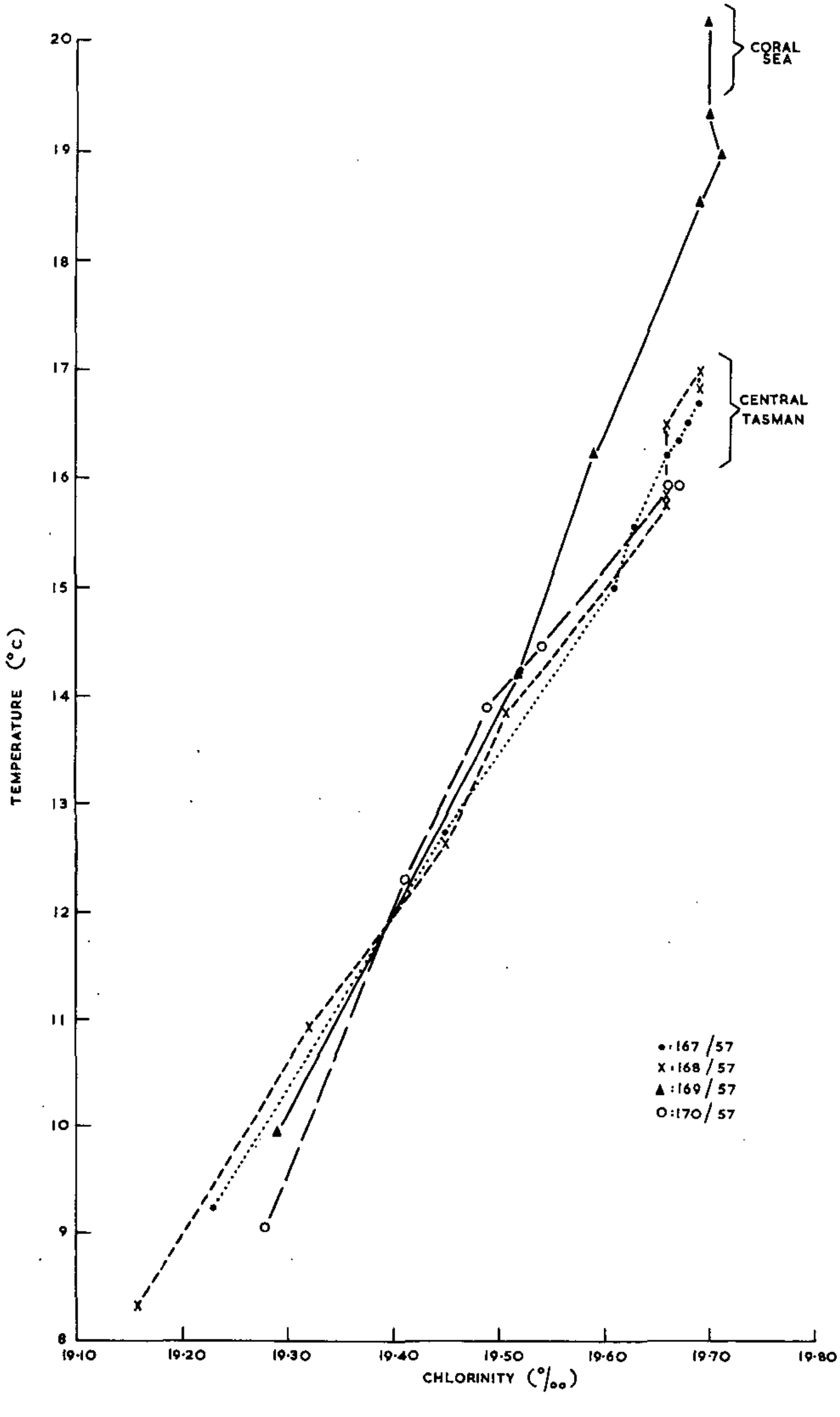

Fig.2. Chlorinity-temperature relationships of water sampled during cruise.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH10/57

September 4-11, 1957

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)

ITINERARY

This cruise is the fourth of the series of cruises studying the structure and circulation of the East Australian Current off Sydney. Figure 1 shows the positions of stations.

SCIENTIFIC REPORTS

Hydrological sampling was carried out at the depths of previous cruises in this series but only to 750 m. Thermometric depths were calculated at all depths below 200 m and at most of the sampling levels above 200 m. Greater reliance can therefore be placed upon the vertical distribution of properties from this cruise compared with earlier cruises in this series.

The zooplankton and phytoplankton collections were made as described in previous reports of this series of cruises.

(a) HYDROLOGY - D.J. ROCHFORD

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

At Station DH10/174/57 at the surface a zone of cold water (16°C) separated warmer onshore (18.38°C) and offshore (20.75°C) regions. No thermocline was present. Below about 200 m the thermal structure was fairly uniform along the section.

(2) Temperature - 290°T Section Line (Fig. 3)

Along this section temperatures varied from 16.88 to 21.03°C at the surface with the warmest waters occupying the same position relative to the coast as on the 110° line (Fig. 2). The deep penetration of warm waters at Stations DH10/182-183/57 and the sharp internal thermal boundary along their western side are to be noted.

(3) Density (σ_t) - 110°T Section Line (Fig. 4)

A broad band, about 150 miles wide, of waters less than σ_t 26.00 dominated the upper 100 m of this section. Within these waters a pycnocline (maximum 0.018 σ_t/m) was found. Below 400 m the density structure was almost uniform along the section.

(4) Density (σ_t) - 290°T Section Line (Fig. 5)

The rapid deepening of the isopycnal surfaces between Stations DH10/185/57 and DH10/183/57, and the marked variation in deeper density structure from that of the 110° section, are to be noted on this section line.

(5) Percentage Oxygen Saturation - 110°T Section Line (Fig. 6)

At the surface saturation or near saturation values prevailed except at Station DH10/174/57, where the temperature (Fig. 2), and density structure (Fig. 4), indicated dynamic uplift. The subsurface oxygen saturation values followed the density field except at Station DH10/177/57 where oxygen values were much lower in the 100-400 m stratum than the general saturation to density relationship would indicate.

(6) Percentage Oxygen Saturation - 290°T Section Line (Fig. 7)

Except for Stations DH10/185-186/57 undersaturation was general at the surface. The oxygen saturation and density fields (Fig. 5) are closely related. At Station DH10/184/57 the lowering of oxygen saturation values at 300 m was not associated with dynamic uplift.

(7) Total Phosphorus - 110°T Section Line (Fig. 8)

A band of low total phosphorus waters (10 µg/l) was associated with the region of high temperature (Fig. 2) and minimum density (Fig. 4) between Stations DH10/175/57 and DH10/177/57.

Below 300 m the total phosphorus distribution paralleled that of density. However, in the 100-300 m layer, total phosphorus values at Stations DH10/173/57 and DH10/177/57 were higher than expected. Station DH10/177/57 also exhibited a similar anomaly in oxygen saturation (Fig. 6).

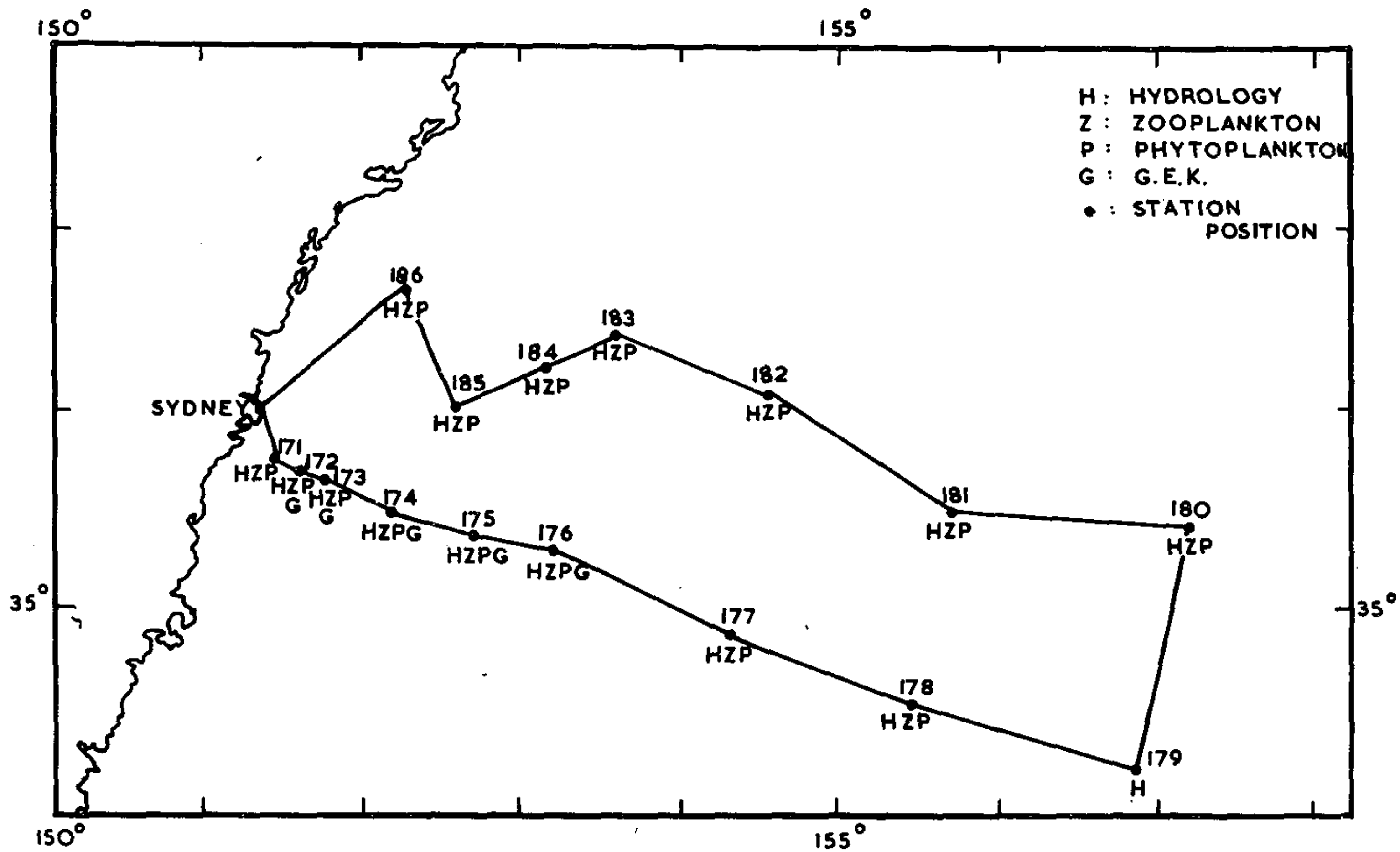

Fig.1. Cruise DH10/57. Track chart showing positions of all stations.

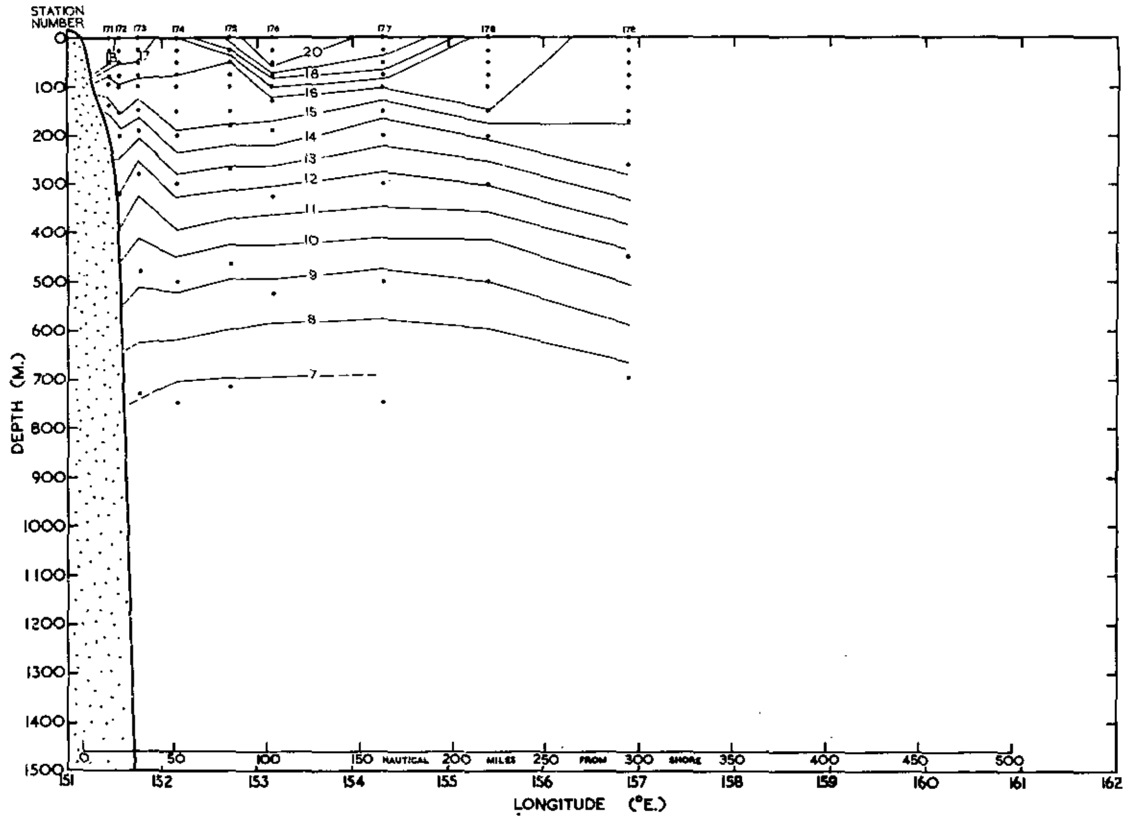

Fig.2. Sectional distribution of temperature (°C) along 110°T line to 750 m.

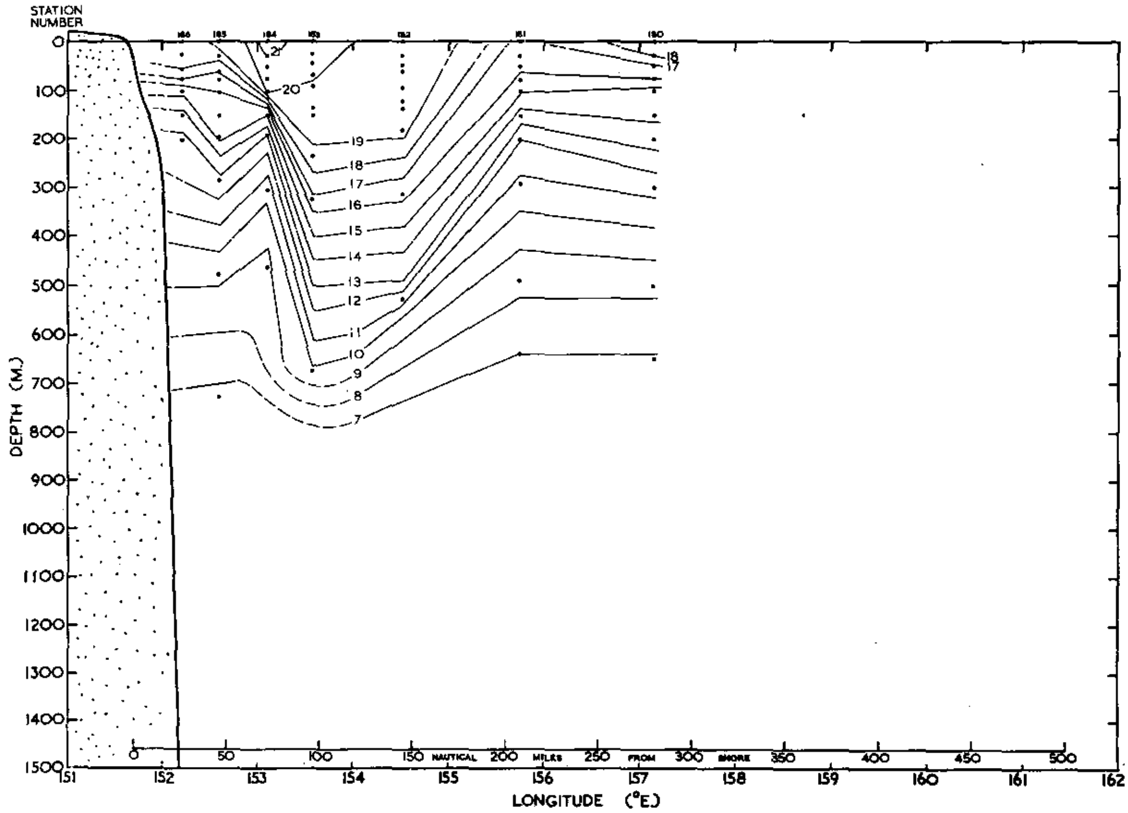

Fig.3. Sectional distribution of temperature (°C) along 290°T line to 750 m.

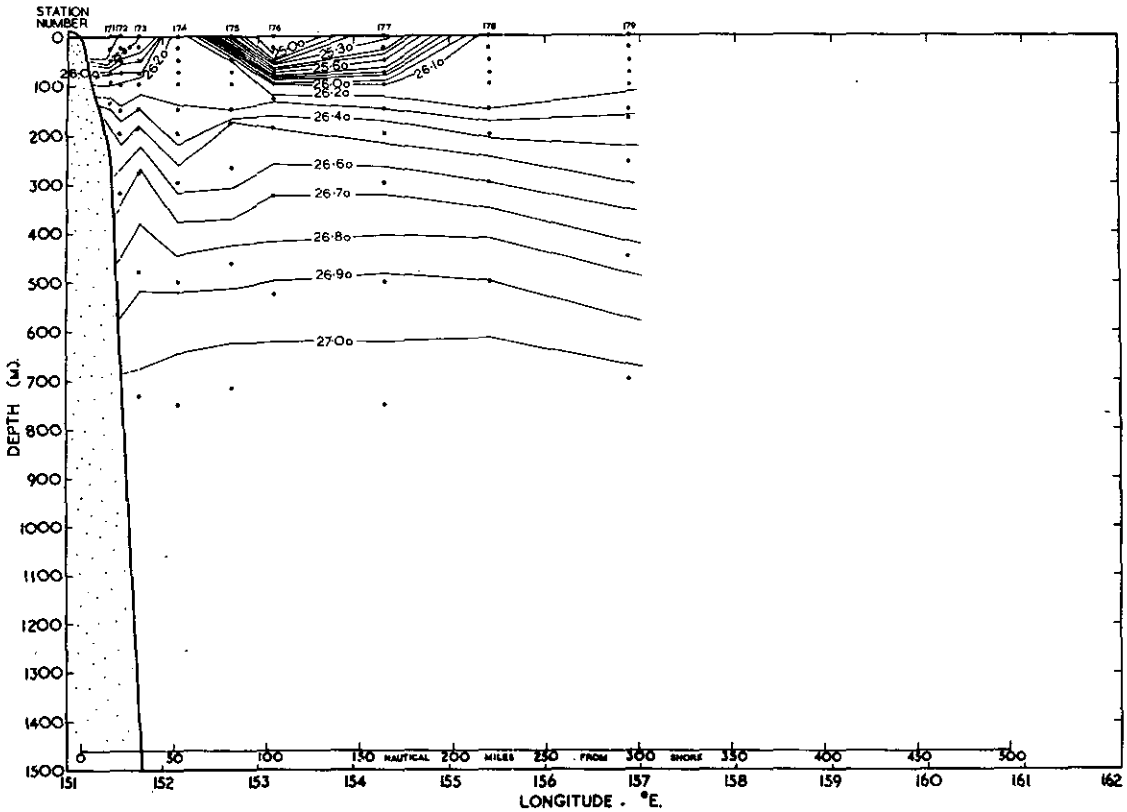

Fig.4. Sectional distribution of σ_t along 110°T line to 750 m.

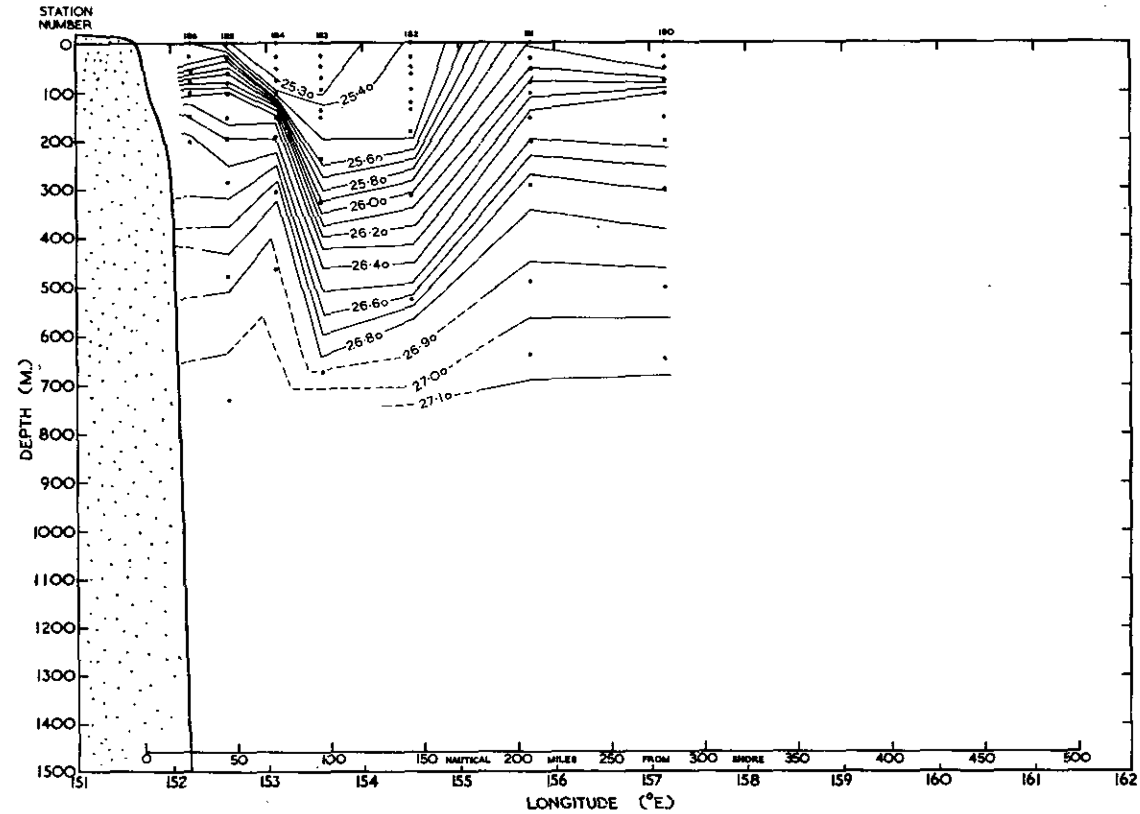

Fig.5. Sectional distribution of σ_t along 290°T line to 750 m.

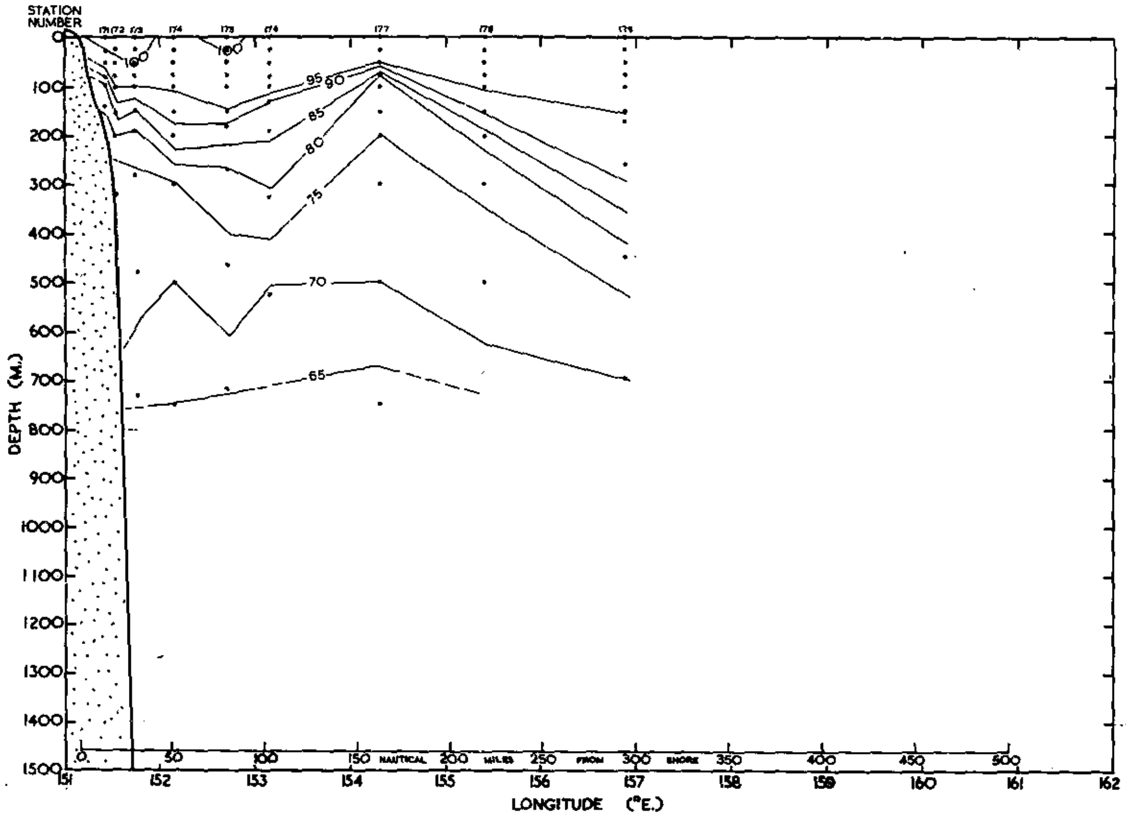

Fig. 6. Sectional distribution of oxygen saturation (%) along 110°T line to 750 m.

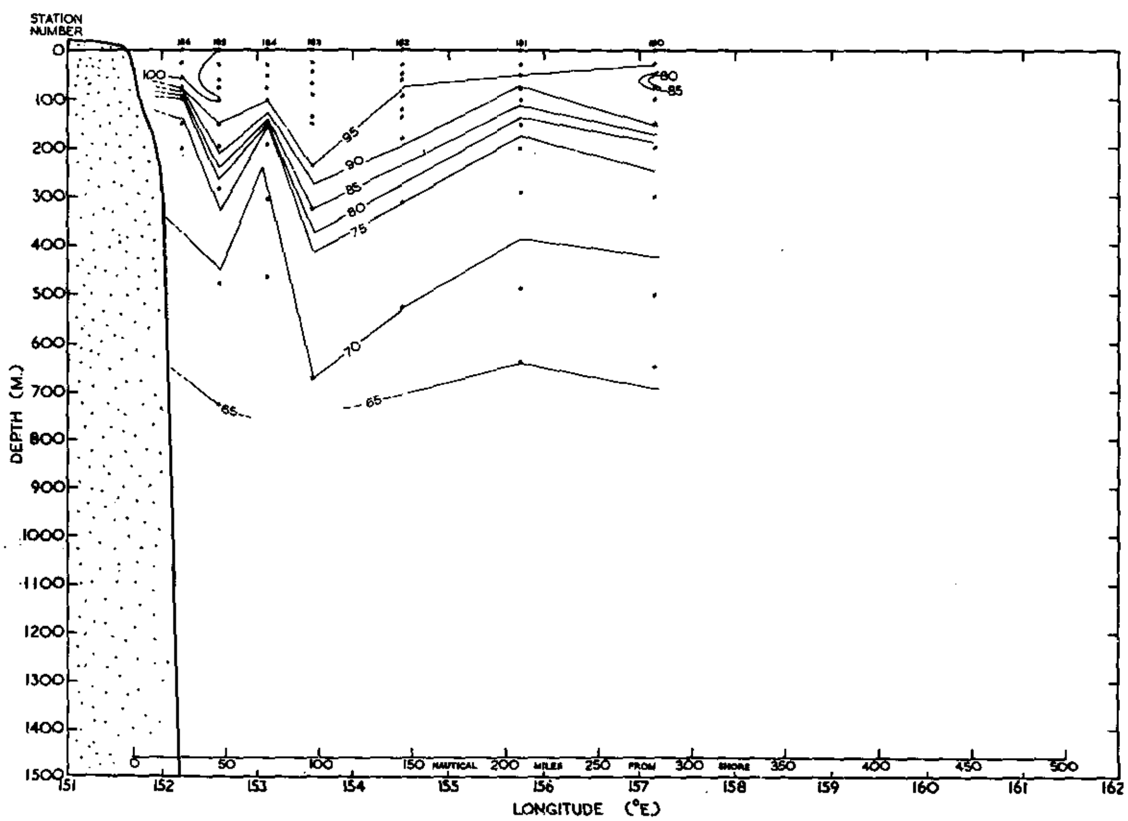

Fig. 7. Sectional distribution of oxygen saturation (%) along 290°T line to 750 m.

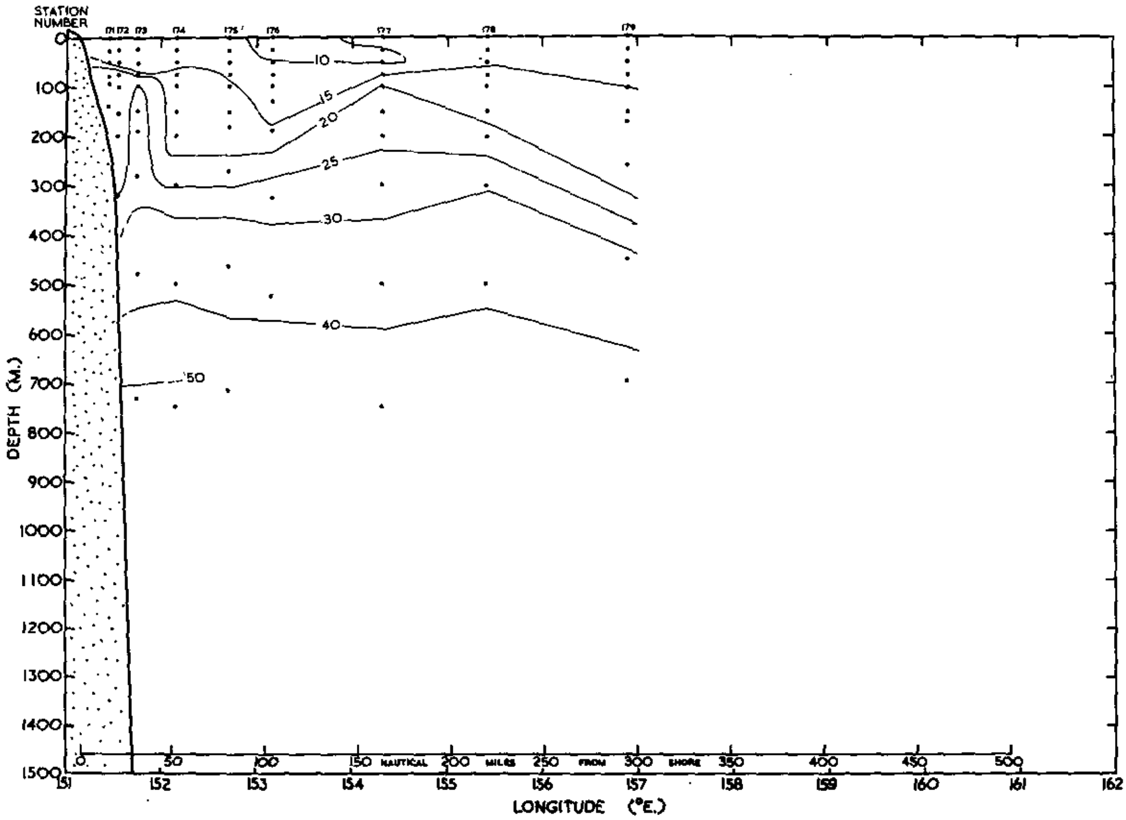

Fig.8. Sectional distribution of total phosphorus along 110°T line to 750 m.

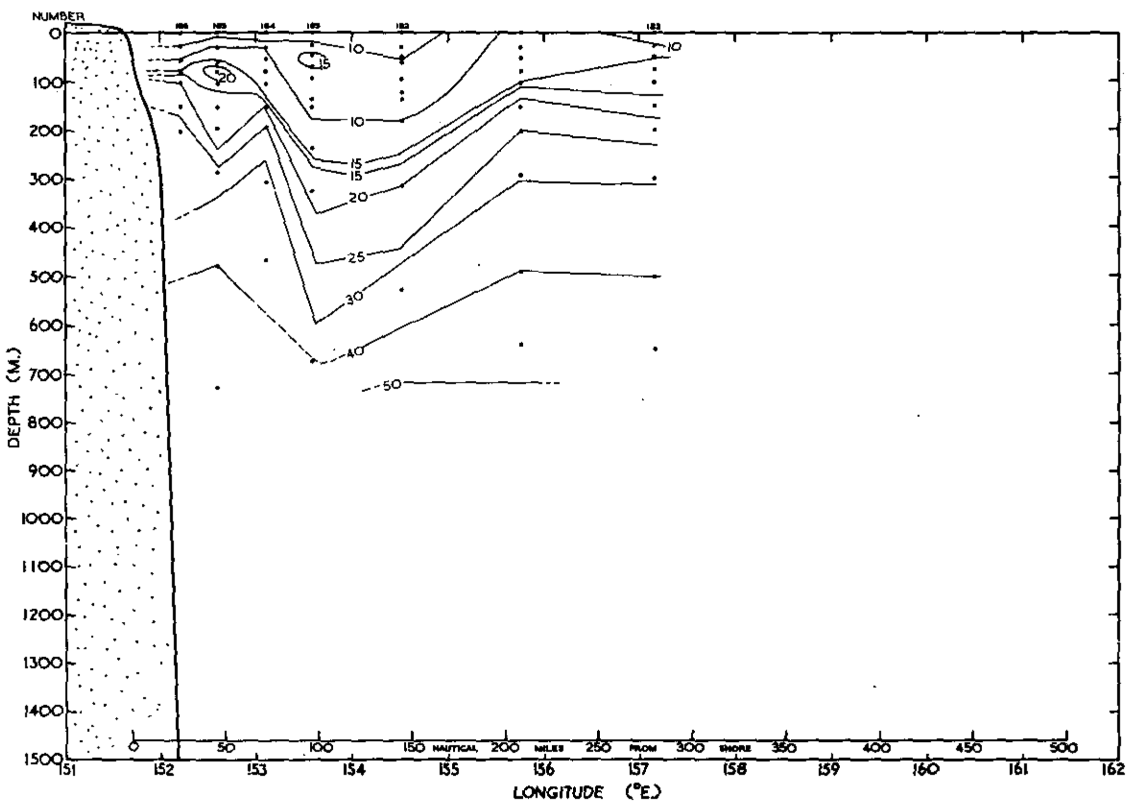

Fig.9. Sectional distribution of total phosphorus along 290°T line to 750 m.

(8) Total Phosphorus - 290°T Section Line (Fig. 9)

A marked lowering of total phosphorus values at all depths occurred in the region of Stations DH10/182-3/57 where increased temperatures (Fig. 3) and lowered density values (Fig. 5) were previously noted. In general the total phosphorus distribution was closely related to the density field on this section.

(9) Horizontal Distribution of Properties

(a) Percentage Oxygen Saturation (Fig. 10)

At the surface (Fig. 10A) the oxygen saturated water seemed to be associated with the right hand boundary of the general surface circulation (arrows taken from dynamic contours, Fig. 13).

At 100 m (Fig. 10B) the saturated waters were confined to an inner zone, and further east very undersaturated waters were found associated with the general surface circulation denoted by the arrows.

At 300 m (Fig. 10C) the maximum values of oxygen saturation were found east of the saturated zone at 100 m but the general pattern elsewhere was similar.

(b) Total Phosphorus (Fig. 11)

Figure 11A shows that the surface distribution of total phosphorus was determined by circulation and that the waters from the north had total phosphorus values of 10-12 μg/1.

At 100 m the waters from the north determined the total phosphorus distribution in the middle of the sections (Fig. 11B) but to either side very high values were recorded. At this depth the minimum value occurred to the east of its position at the surface. The onshore high values were associated with dynamic uplift but the offshore values were independent of the density field.

At 300 m (Fig. 11C) the minimum values were found in the same position as at 100 m, except for an isolated high value at Station DH10/184/57 along the western boundary.

(10) Regional Water Masses

The total phosphorus to density relationships on this cruise (Fig. 12) show that three regional water masses were present (Table 1).

TABLE 1

REGIONAL WATER MASSES

Water Mass	Density σt	Total Phosphorus ($\mu g/l$)	Temperature °C	Chlorinity ‰
A	25.00	10	20.75	19.63
B	26.50	10	15.00	19.75
C	27.00	40	8.00	19.15

Water mass A originated to the north of the section and flowed at the surface. Water mass B was generally distributed at very variable depths. Water mass C was part of the sub-Antarctic intermediate water circulation.

(b) PHYSICS - B.V. HAMON

(1) Dynamics

The dynamic heights have been computed from thermosteric anomalies. Since only 750 metres of cable were available for the hydrographic casts, the dynamic heights were computed relative to the 600 decibar level instead of the more usual 1000 decibar level.

The dynamic heights are shown in plan in Figure 13, on which contours have been drawn at intervals of 10 dynamic centimetres. The two values shown in brackets involved extrapolation of the graph of σ_t against depth.

The main features of the circulation pattern shown in Figure 13 are the absence of appreciable currents normal to the 110° section line, and the existence of currents inshore and north-easterly currents further offshore along the 290° section line.

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

G.E.K. measurements were obtained at Stations DH10/172-176/57 and are plotted on Figure 13. They show little agreement with the surface currents to be expected from the contours of dynamic height.

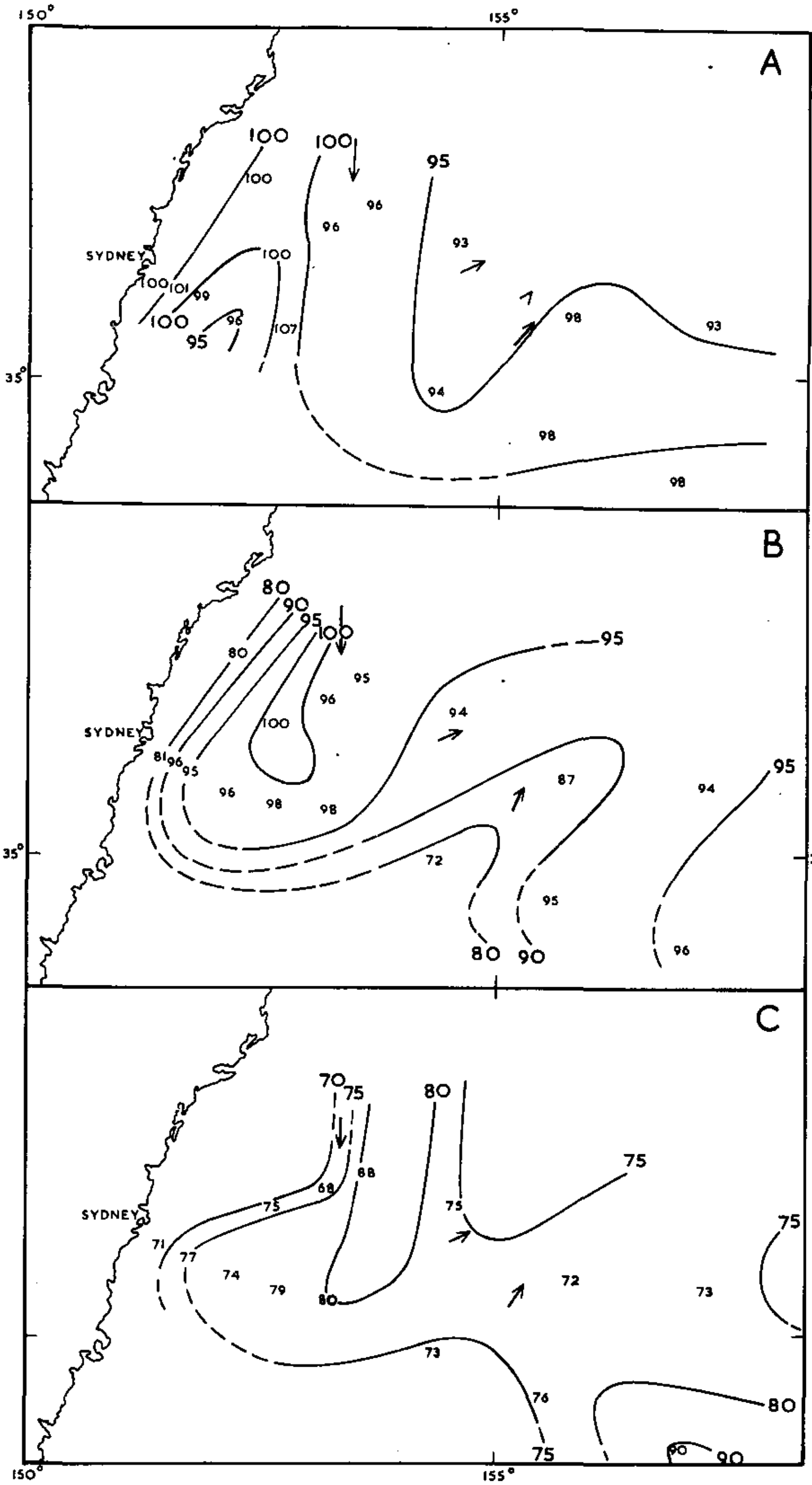

Fig.10. Horizontal distribution of oxygen saturation (%) A. at 0 m, B. at 100 m, C. at 300 m.

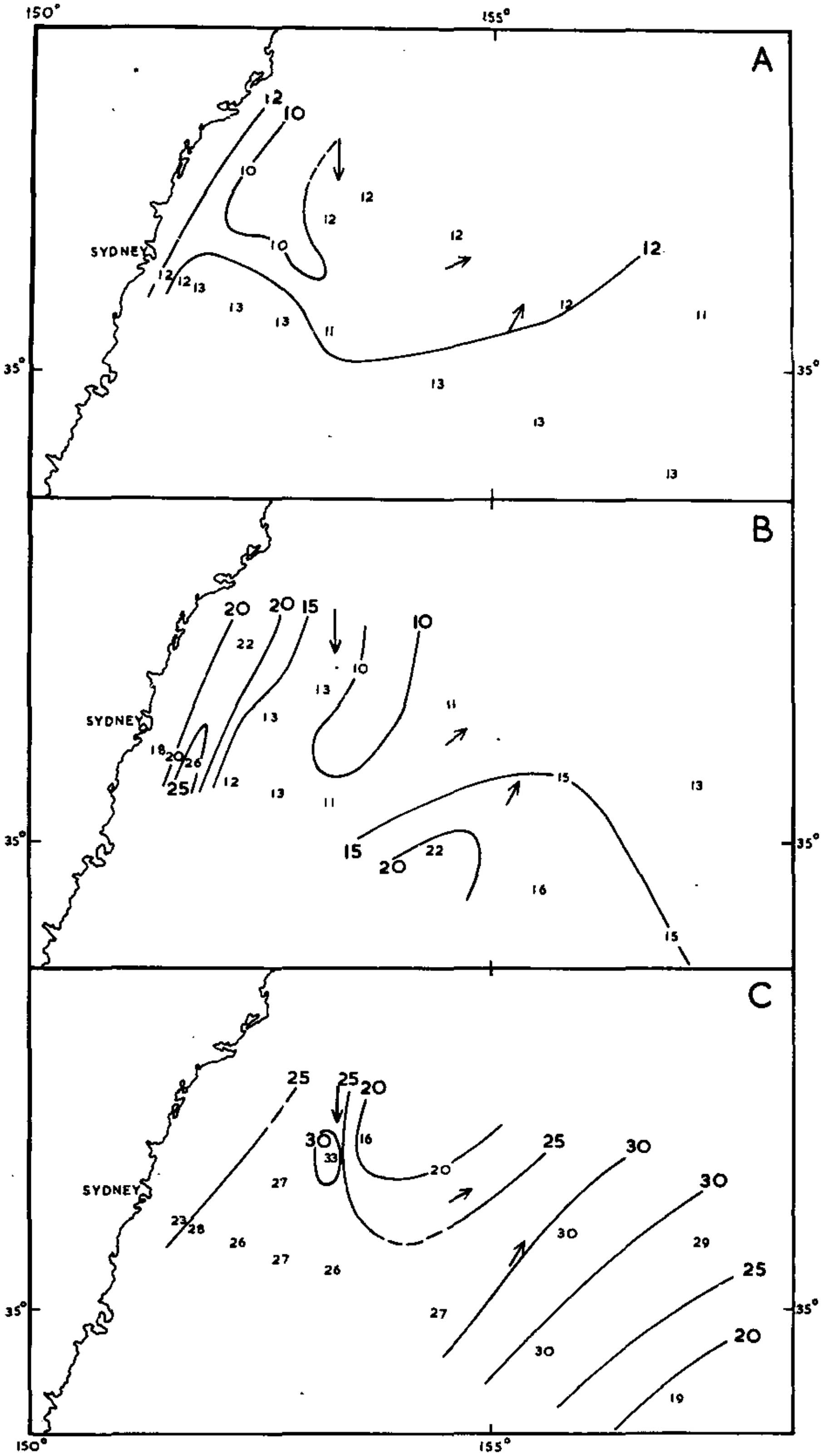

Fig.11. Horizontal distribution of total phosphorus
A. at 0 m, B. at 100 m, C. at 300 m.

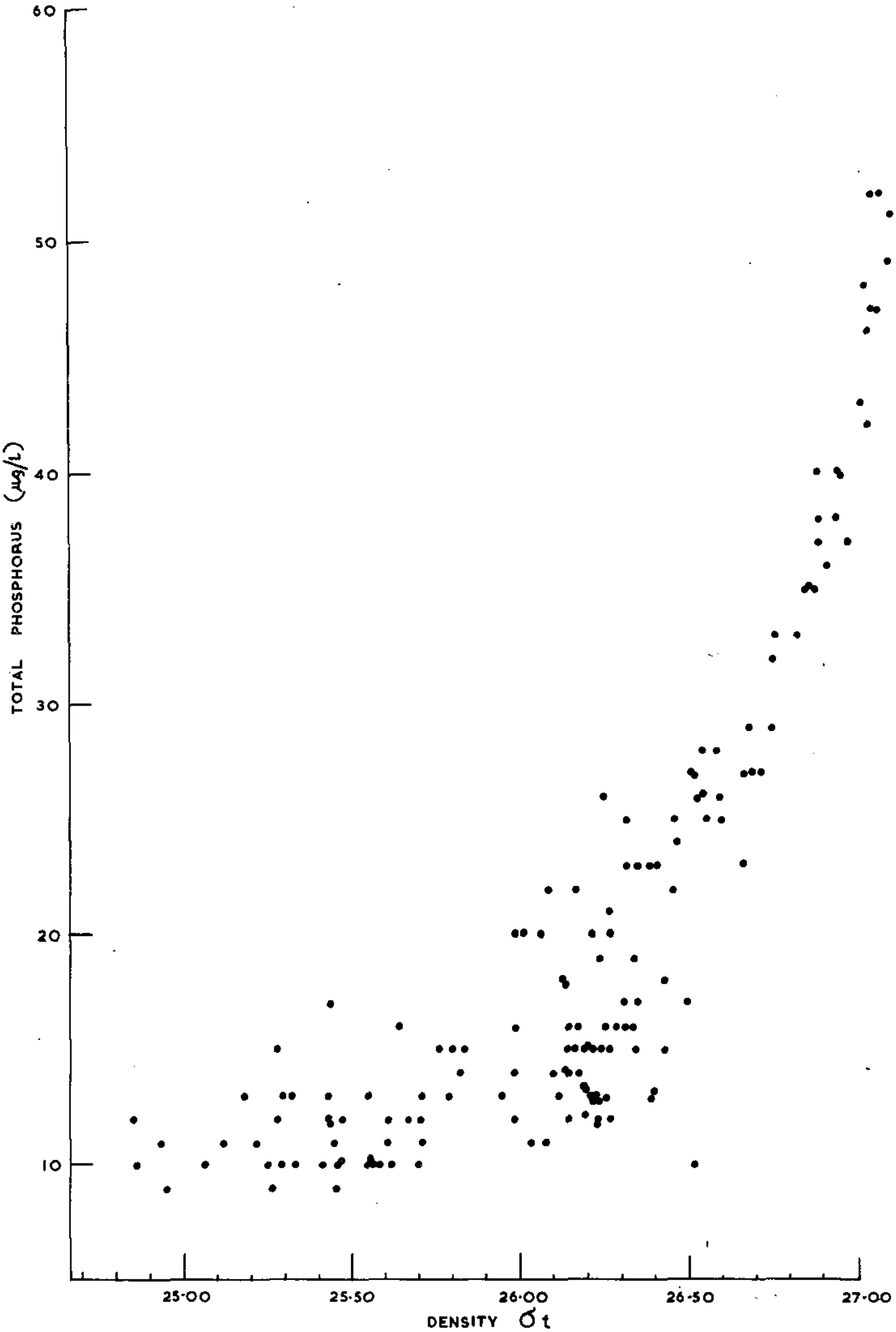

Fig.12. Total phosphorus to density relationships.

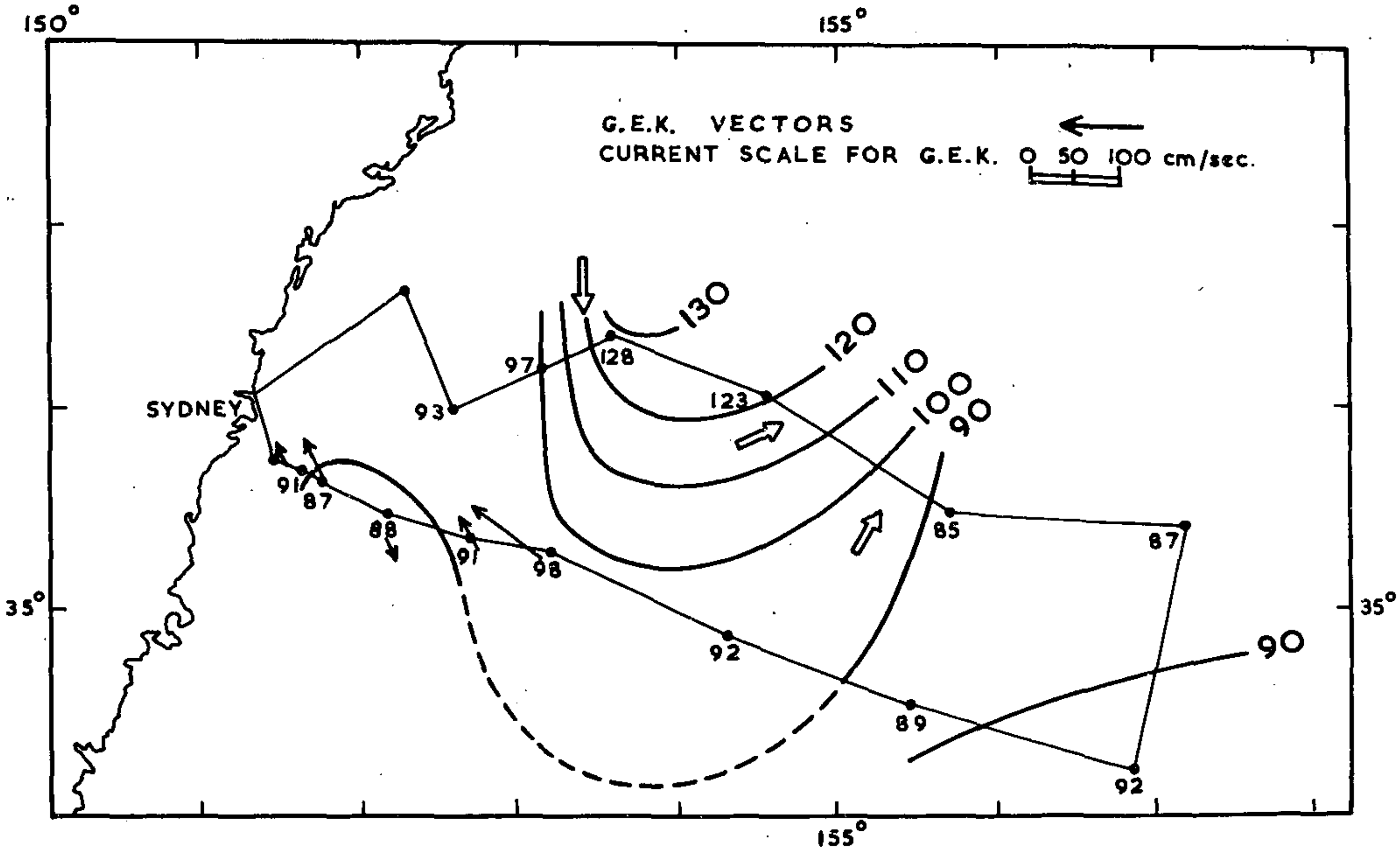

Fig.13. Contours of dynamic height (in dym. cm.) relative to 600 decibars. Surface current vectors from G.E.K. readings indicated.

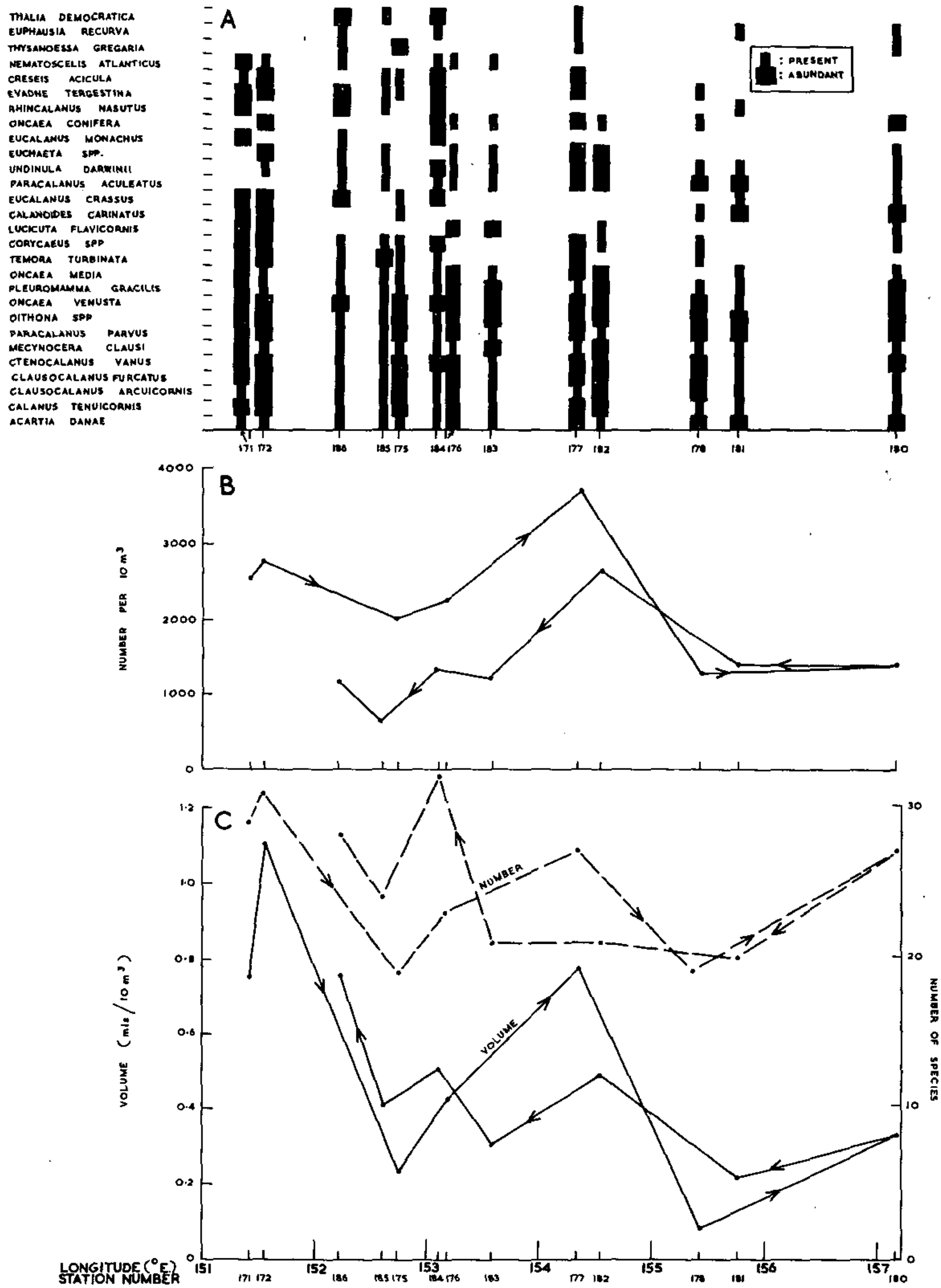

Fig. 14. A. Distribution of copepod species collected at stations on 110°T and 290°T section lines. B. Total number of organisms per 10 m^3 at stations as above. C. Number of species and volume per 10 m^3 for stations as above.

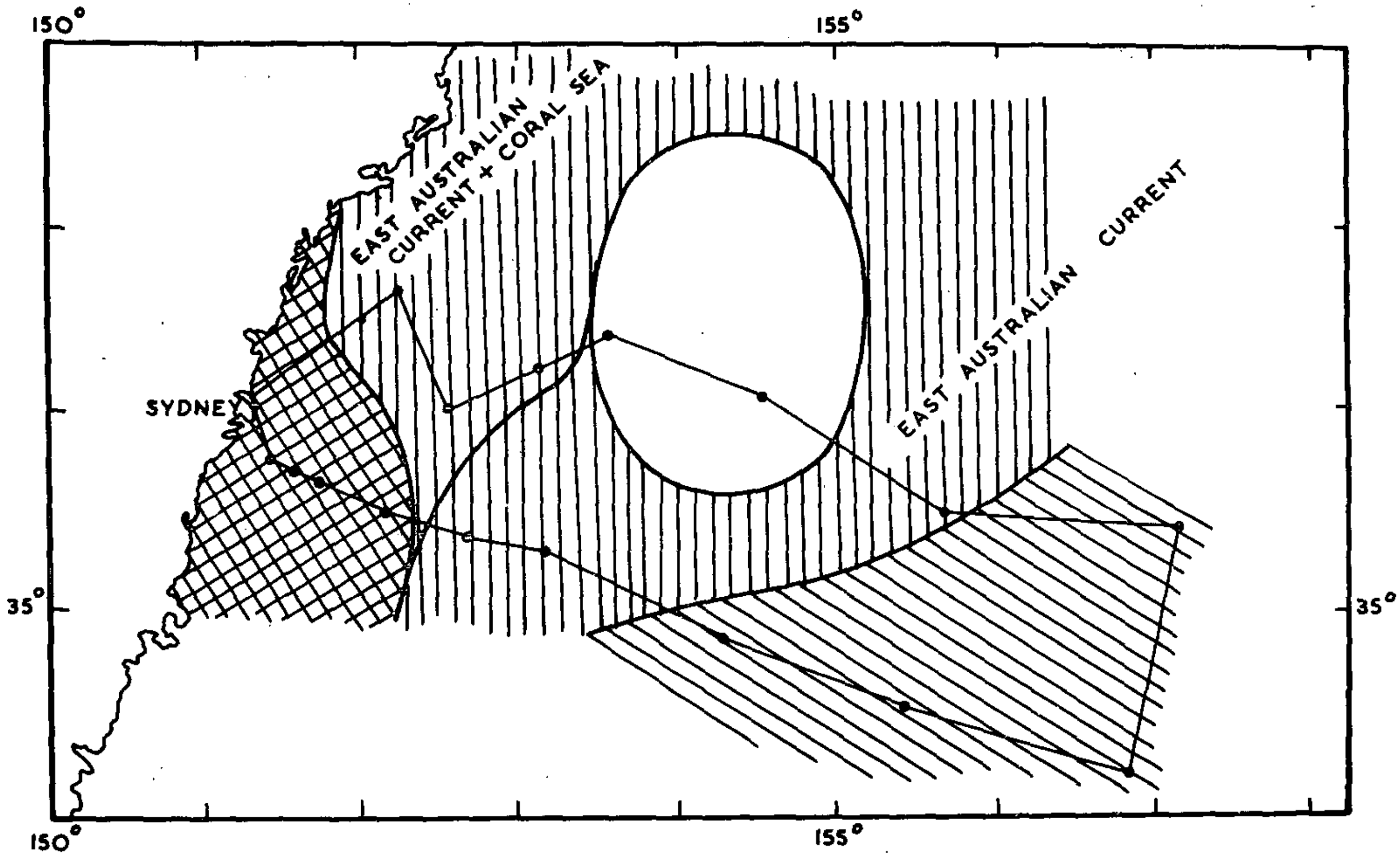

Fig.15 Phytoplankton communities determined from collections at stations on 110°T and 290°T section lines.

(c) PLANKTON - W. DALL

The graphical method of reporting zooplankton described in Report No. 19 has been used for this cruise. Figure 14A shows the distribution of copepod species in collections from stations on both the 110°T and 290°T section lines. Figure 14B shows the number of organisms per 10 m^3 on both section lines and Figure 14C shows the number of species per station and the volume per 10 m^3. The arrows in these two figures indicate the sequence of stations.

(d) PHYTOPLANKTON - E.J.F. WOOD (Fig. 15, Tables 2 & 3)

On this cruise the spring peak of diatoms was not encountered, but it may be presumed that it occurred in August, when, unfortunately, no samples were taken.

No evidence of a Coral Sea temperate flora was obtained. Stations DH10/171-174/57 were sparsely populated with diatoms and dinoflagellates and Station DH10/171/57 showed neritic influence (Ceratium buceros). It is possible that the paucity of the diatom flora in this area was due to the intrusion of cool-temperate, southern water which contained no indicator species. East of this area was a mixed Coral Sea and East Australian Current flora, while Station DH10/181/57 had East Australian characteristics. The sparse diatom and dinoflagellate flora, which seems always to be present east of Sydney, appeared at Stations DH10/177-180/57. A closed area of infertile water was surrounded by Coral Sea water (Stations DH10/182-3/57): as it contained none of the larger phytoplankton species its origin could not be determined.

TABLE 2

DIATOMS COLLECTED ON CRUISE DH10/57

	171	172	173	174	175	176	177	178	181	184	185	186
Thalassiosira decipiens		+									+	
T. subtilis		+										
Schroederella delicatula	+		+									
Lauderia annulata				+								+
Coscinodiscus concinnus						+			+			+
C. marginatus					+	+						
C excentricus											+	
C. linearis									+			
Planktoniella sol						+						
Chaetoceros vanheurckii			+			+						
Ch. lorenzianum										+	+	+
Ch. teres										+	+	+
Ch. lauderi										+	+	
Ch. atlanticum f. neapolitanum											+	+
Ch. secundum								+		+		
Ch. concavicorne					+							
Ch. peruvianum									+			
Detonula confervacea							+					
Rhizosolenia alata									+	+		
R. stolterforthii											+	
R. calcar avis						+				+	+	
R. bergonii					+	+						
R. hebetata f. semispina					+							
R. setigera										+		
Ch. aequatorialis											+	
Ch. coarctatum									+			
Thalassiothrix longissima						+	+		+		+	+
T. nitzschioides					+	+						
Nitzschia seriata				+						+	+	
N. longissima												+
N. angularis											+	
Fragilaria oceanica									+		+	
Leptocylindrus danicus												+
Bacteriastrum delicatula										+	+	
Guinardia flaccida												+
Diploneis smithii											+	

TABLE 3

DINOFLAGELLATES COLLECTED ON CRUISE DH10/57

	171	172	173	174	175	176	177	179	180	181	184	185	186
Peridinium crassipes			+									+	
P. divergens		+			+		+						
P. oceanicum													+
P. cerasus				+	+				+		+		
P. pedunculatum										+			
P. steinii					+								
Ceratium extensum		+											+
C. fusus									+		+		
C. buceros	+					+	+						
C. pulchellum			+										
C. setaceum										+			
C. arietinum										+			
C. gallicum										+	+		
Pyrophacus horologicum	+												
Podolampas bipes			+										
Phalacroma lens					+								
C. trichoceros						+							
C. candelabrum							+						
C. kofoidi											+		
Peridinium okamurai											+		
P. ventricum											+		

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH11/57

September 18-22, 1957

SCIENTIFIC PERSONNEL

H. Jitts (in charge), N. Dyson

ITINERARY

This was the second of the series of productivity cruises planned to study the rate of production of organic matter, and submarine light of the waters east of Sydney.

Figure 1 shows the stations at which all day productivity studies were made and the track followed on this cruise. Also shown are the station positions of cruise DH10/57.

SCIENTIFIC REPORTS

(a) PRODUCTIVITY - N. DYSON

It was intended that CO_2 uptake, of samples from 0, 25, 50 and 100 metres, be measured both by incubation *in situ* from sunrise to sunset, and by immediate light bath incubation. However, inclement weather prevented the *in situ* work being done at Station DH11/188/57 and faulty sampling bottles caused the loss of the 0 and 25 metre *in situ* samples at Station DH11/185/57.

CO_2 uptake was also measured by light bath incubation of samples from 0 and 25 metres at two stations 14 and 10 miles from the coast.

Depth of penetration of light was measured at each of the three all day stations.

RESULTS

1. CO_2 Uptake

Figures 2, 3 and 4 show the CO_2 uptake results obtained by the two methods of measurement. In nearly all cases the daily rate of uptake, as measured *in situ*, was only slightly greater than the hourly rate as measured by light bath incubation. This shows that the relationship between the two methods of measurement requires further study before a reliable interpretation of the results can be made.

The estimated daily rates of production per m^2 of the water column are shown in Figure 5. These results are of the same order of magnitude as those found on the previous productivity cruise.

2. Light Penetration

The depths of penetration of 1 per cent. of surface light are shown in Figure 5. The values, ranging between 92 and 104 metres are considered with the rates of production found at the respective stations.

(c) HYDROLOGY - D.J. ROCHFORD

The density to total phosphorus relationships (Fig. 6) are very similar to those of cruise DH10/57.

At the surface three water masses were present, the Coral Sea (Rochford, 1957) of 1957 origin, the Central Tasman moving with it from the north and presumably of 1956 origin, and the Central Tasman probably of 1957 origin along the southern region of cruise DH10/57 and DH11/57. Using both DH10/ and DH11/57 data the distribution of these three surface water masses, adjusted to the period of cruise DH11/57, has been plotted (Fig. 7). The circulation pattern is taken from dynamic contours of cruise DH10/57.

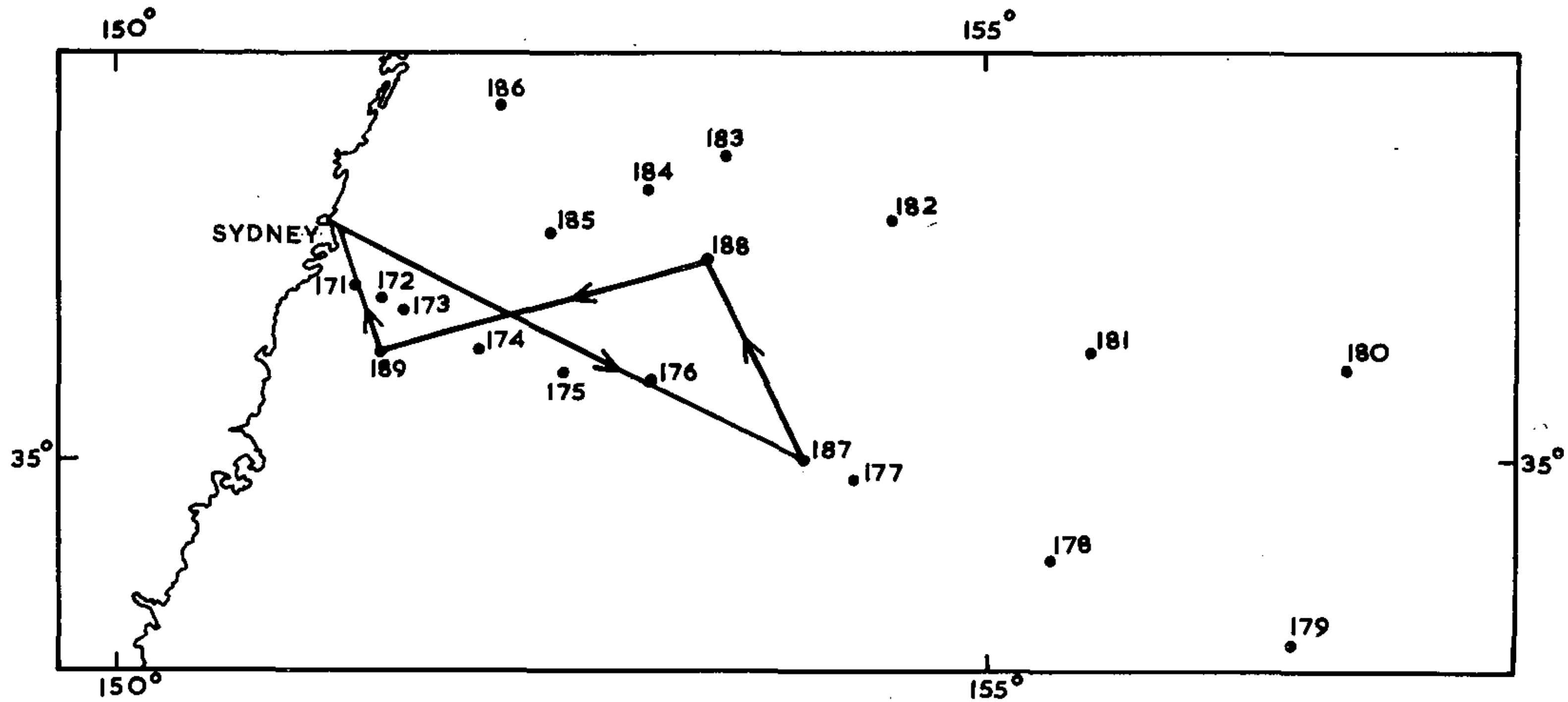

Fig.1. Cruise DH11/57. Track chart showing positions of stations. The positions of stations of Cruise DH10/57 are also indicated.

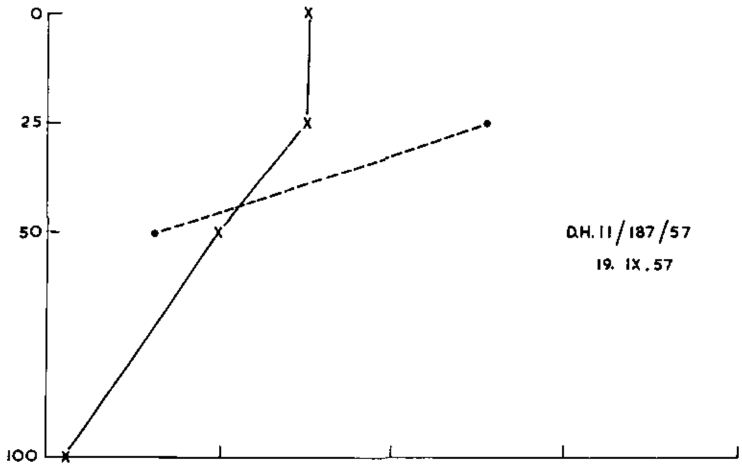

Fig. 2. Rates of CO_2 uptake at Station DH11/187/57.

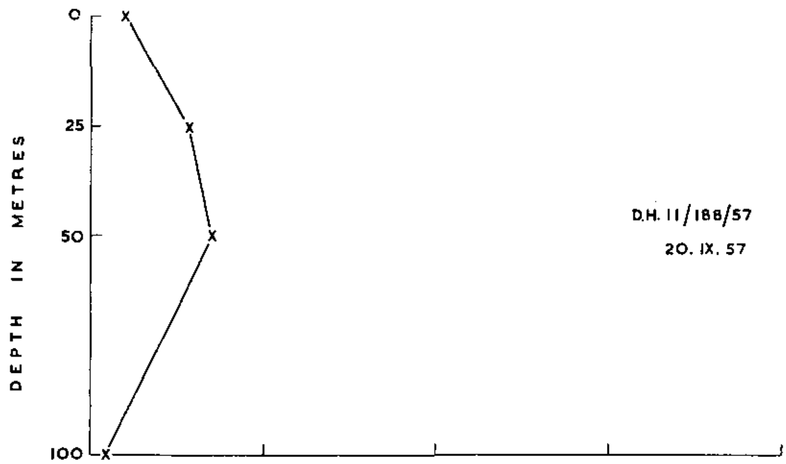

Fig. 3. Rates of CO_2 uptake at Station DH11/188/57.

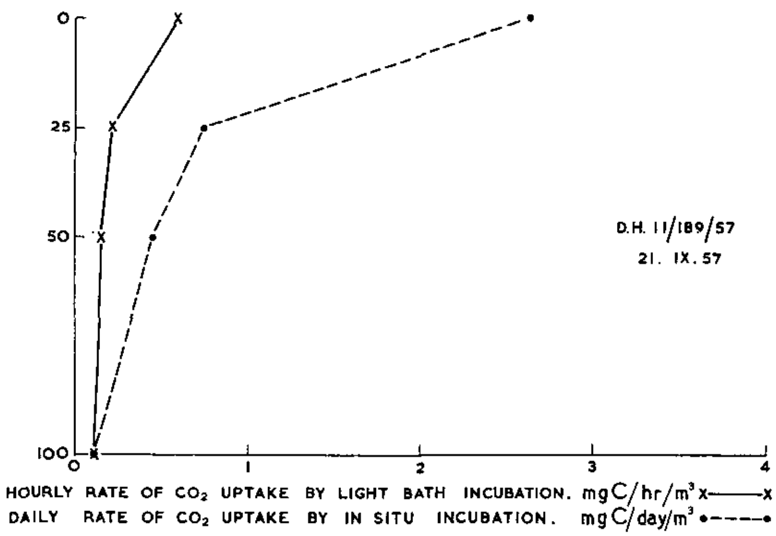

Fig. 4. Rates of CO_2 uptake at Station DH11/189/57.

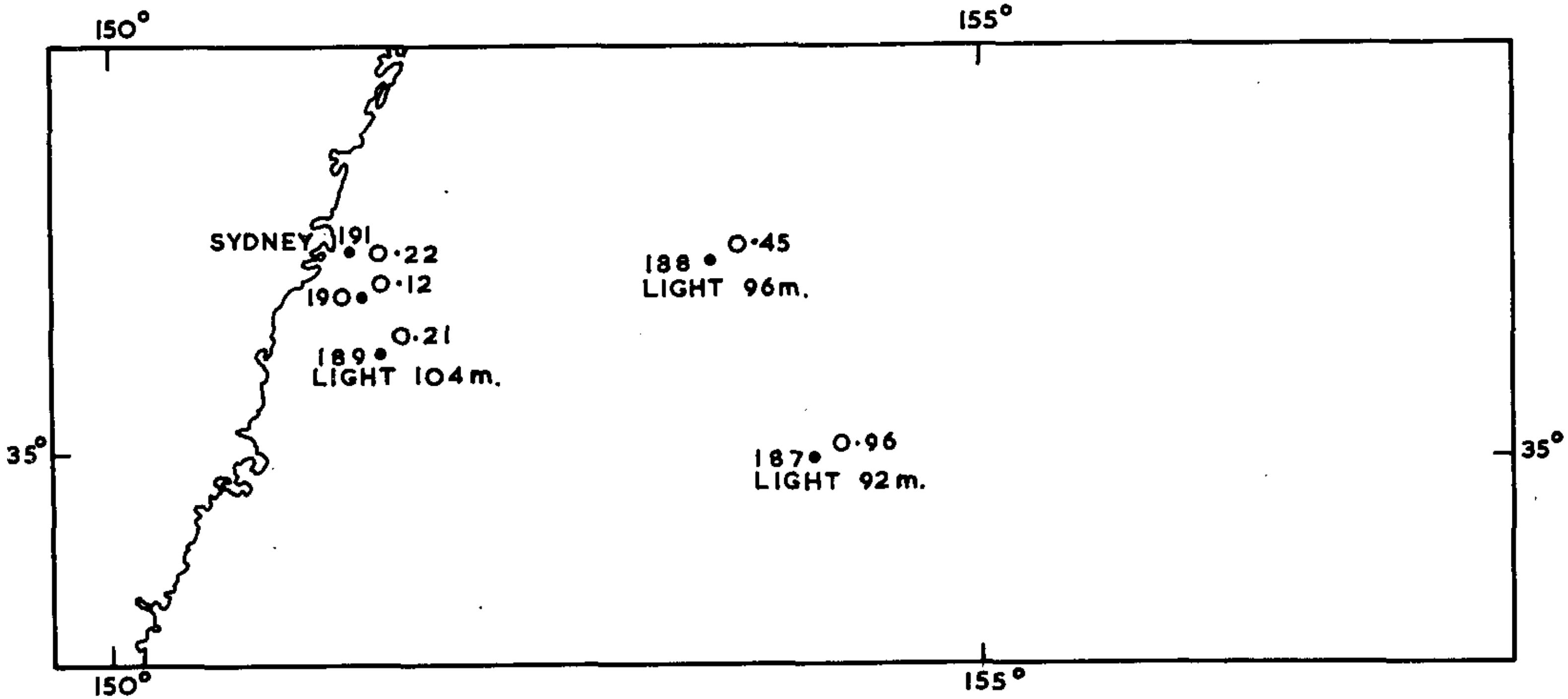

Fig.5. Rates of production per m^2 of water column and depth of penetration of 1% of surface light.

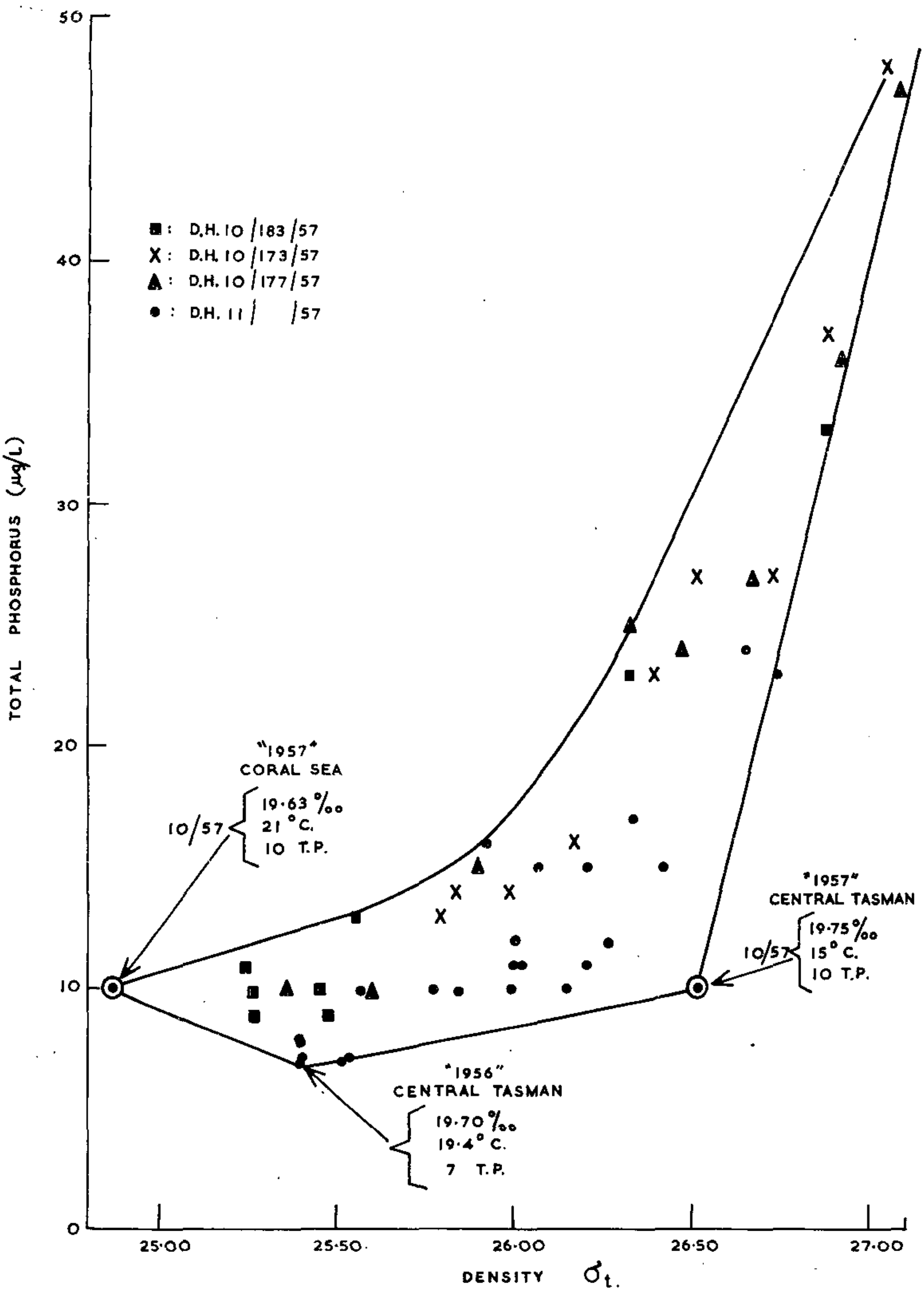

Fig. 6. Relationship of density (σ_t) to total phosphorus.

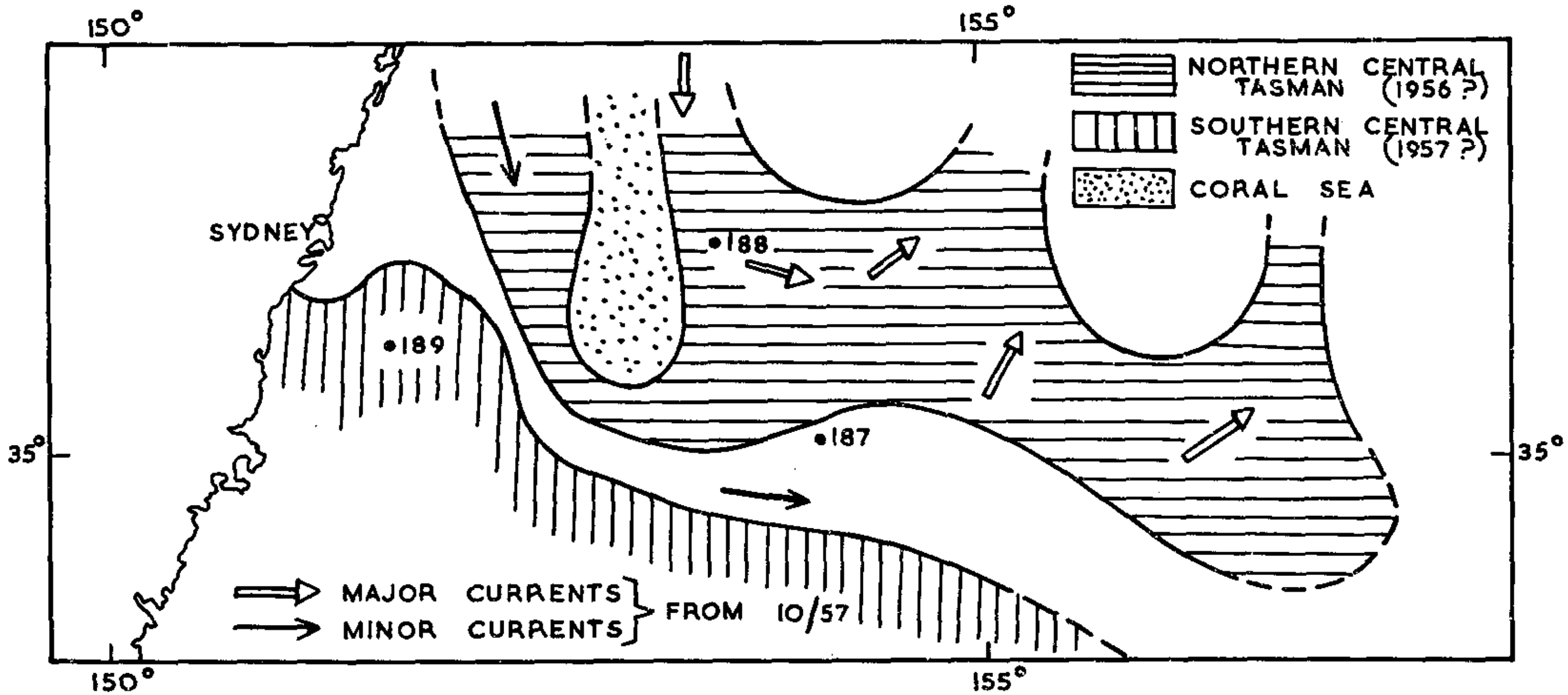

Fig. 7. Surface water mass distribution .

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH12/57

September 26 - October 11, 1957

SCIENTIFIC PERSONNEL

J.P. Robins (in charge)

ITINERARY

Figure 1 shows the stations occupied during this cruise.

(a) TUNA - J.P. ROBINS

The object of this cruise was the same as that for cruise DH9/57. Once again weather conditions prevented fishing at all but three stations. The catch results from those stations are shown in Table 1.

TABLE 1

TUNA CATCH

Station	No. of fish	No. of hooks	Catch/100 hooks	Breakage/100 hooks
DH12/193/57	-	150	-	-
DH12/196/57	1 albacore	150	0.67	-
DH12/197/57	2 southern bluefin tuna	150	1.33	-

(b) HYDROLOGY - D.J. ROCHFORD

The density total phosphorus relationships (Fig. 2) indicate that three regional water masses were present. Table 2 gives their characteristics.

TABLE 2

WATER MASSES PRESENT IN AREA

Water Mass	Density (σ_t)	Total Phosphorus ($\mu g/l$)	Temperature (^oC)	Chlorinity ($^o/oo$)
A	25.50	10	19.10	19.70
B	26.75	15	13.00	19.58
C	26.85	40	9.50	19.22

These water masses were similar to those found during cruise DH10/57.

(1) Density (σ_t) (Fig. 3)

The surface densities show a southerly movement off Sydney with the probability of easterly recurvature. South of Sydney the data are too few to show how far south the southerly movement persisted.

(2) Percentage Oxygen Saturation (Fig. 4)

At the surface (Fig. 4A) the degree of oxygen saturation decreases offshore. The waters moving from the north are undersaturated whilst those in the extreme south-west are oversaturated. At 100 m (Fig. 4B) the waters beneath the surface southerly movement had the minimum oxygen saturation. Even at this depth the onshore waters south of Sydney were oversaturated. At 300 m (Fig. 4C) the minimum oxygen saturation occurred beneath the same region as at 100 m.

(3) Total Phosphorus (Fig. 5)

The minimum total phosphorus (8 μg/l) at the surface (Fig. 5A) was associated with the southerly movement. At the deeper levels (Figs. 5B and C) this pattern was reversed, with maximum values associated with the region of surface southerly movement.

(c) ZOOPLANKTON - W. DALL

Quantitative distribution of zooplankton is shown in Figure 6. In the area to the north of the main thermal front, the zooplankton was 5 to 10 times that in the cooler water.

From a qualitative study of the zooplankton collected, the area may be divided into three regions, A.B.C. (Table 3, Fig. 7). Region A is a warm water region of abundant plankton. Region B is established on the negative features of the hauls at Stations DH12/194-5/57. The latter station was close to another front and more species were present at this station than at DH12/194/57. Region C is a region of mixed continental shelf and slope, with more species than Region B. In the southern part of Region C, Stations DH12/197/57 and DH12/201/57, the cooler water copepod *Calanus helgolandicus*, the salp *Thetys vagina*, and the amphipod *Vibilia* sp. occurred. These were absent from Stations DH12/202-3/57 which contained warm water elements characteristic of Region A. The copepods *Acartia danae Calanus minor C. tenuicornis Clausocalanus arcuicornis C. furcatus Ctenocalanus vanus Lucicutia flavicornis Mecynocera clausi*

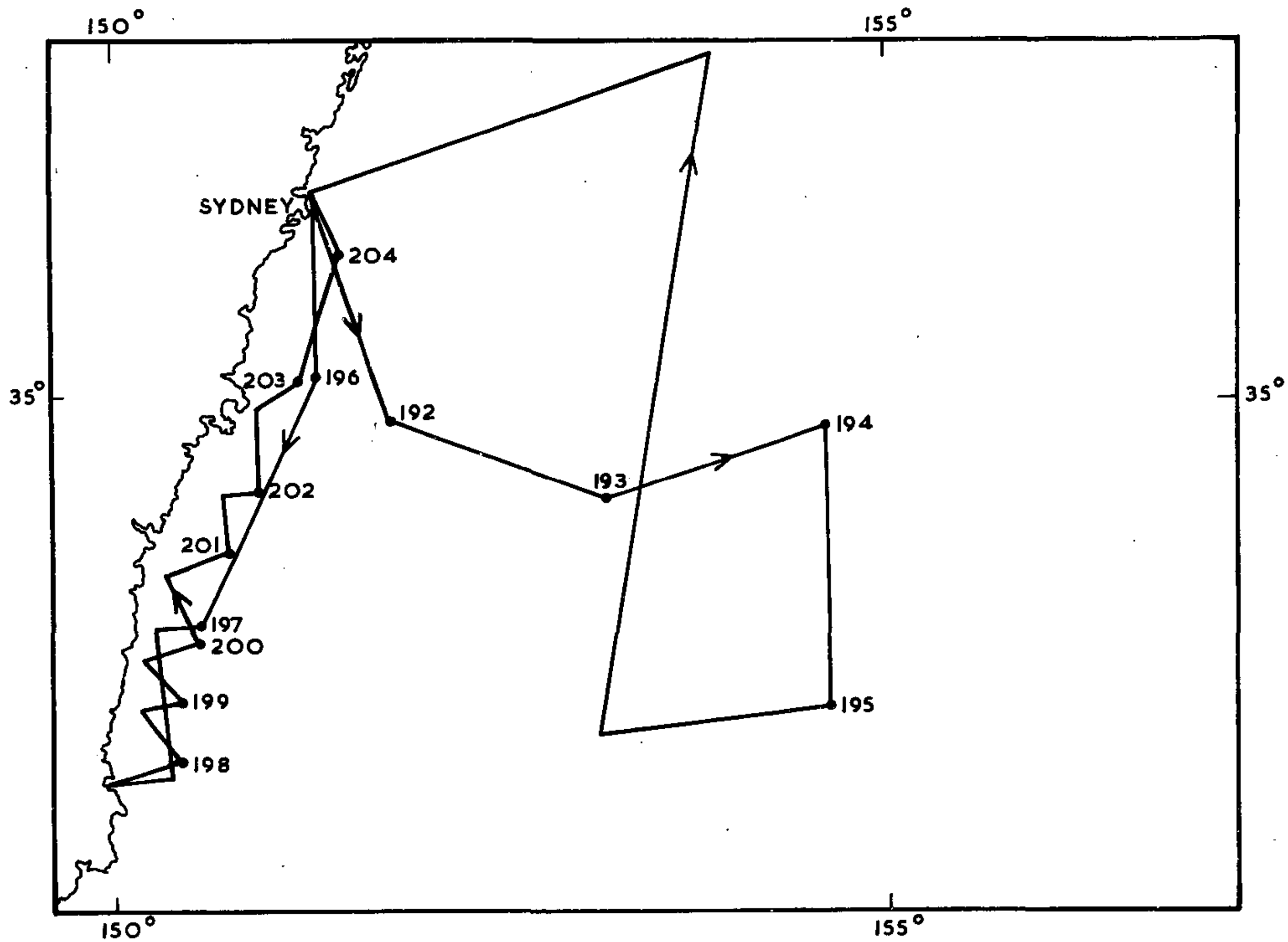

Fig.1. Cruise DH12/57. Track chart showing positions of stations.

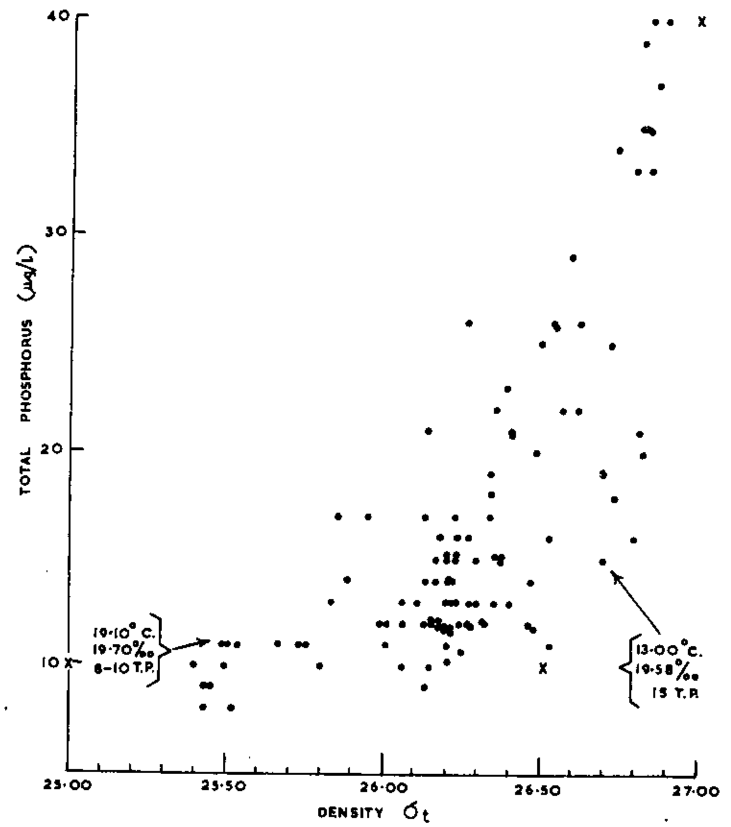

Fig.2. Density - total phosphorus relationships.

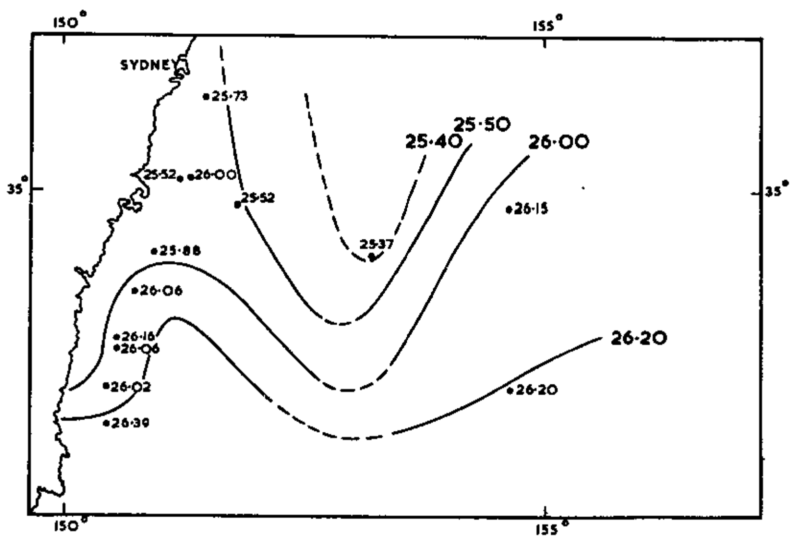

Fig.3. Distribution of surface densities (σ_t).

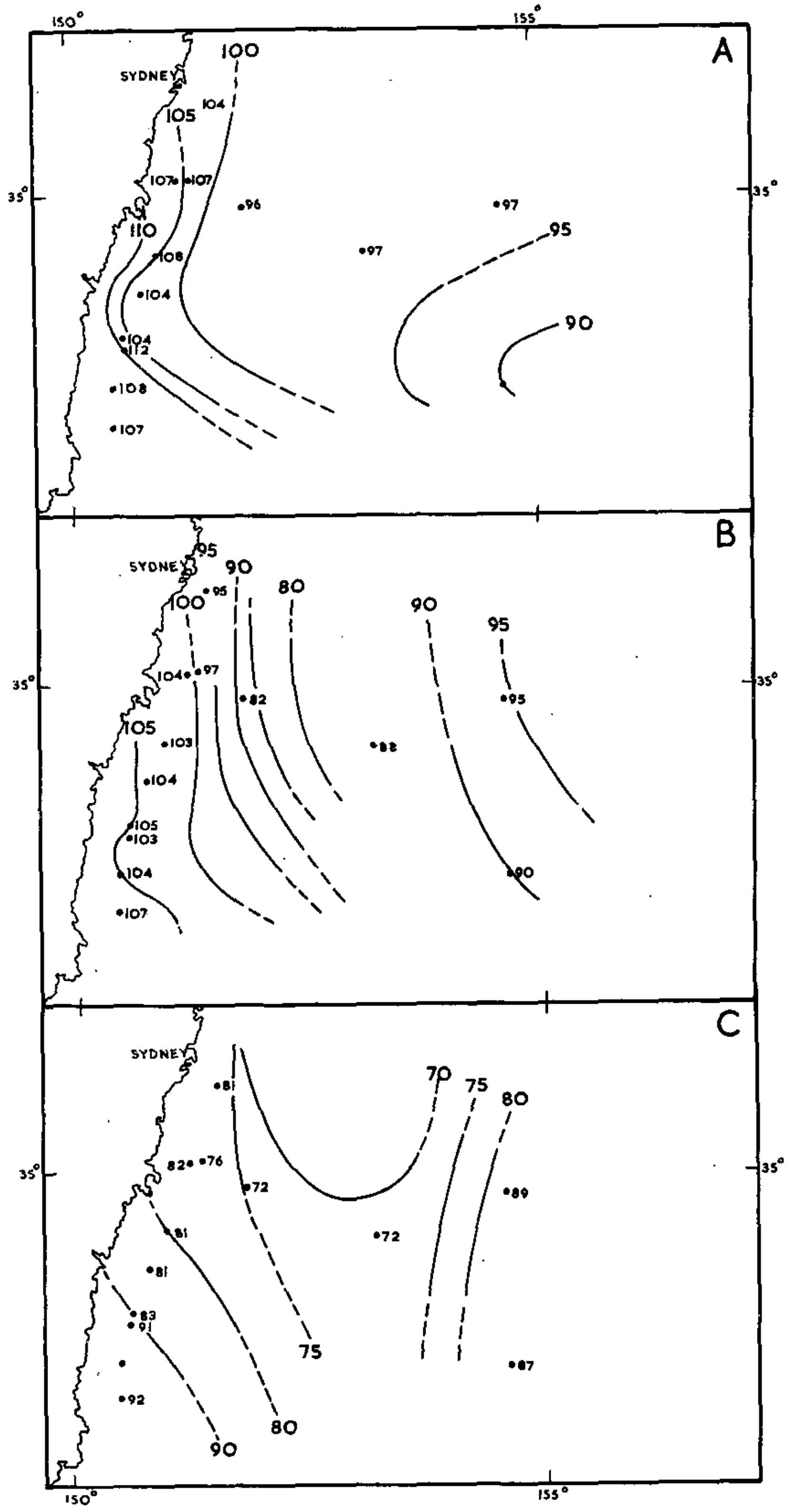

Fig.4. Horizontal distribution of oxygen saturation (%).

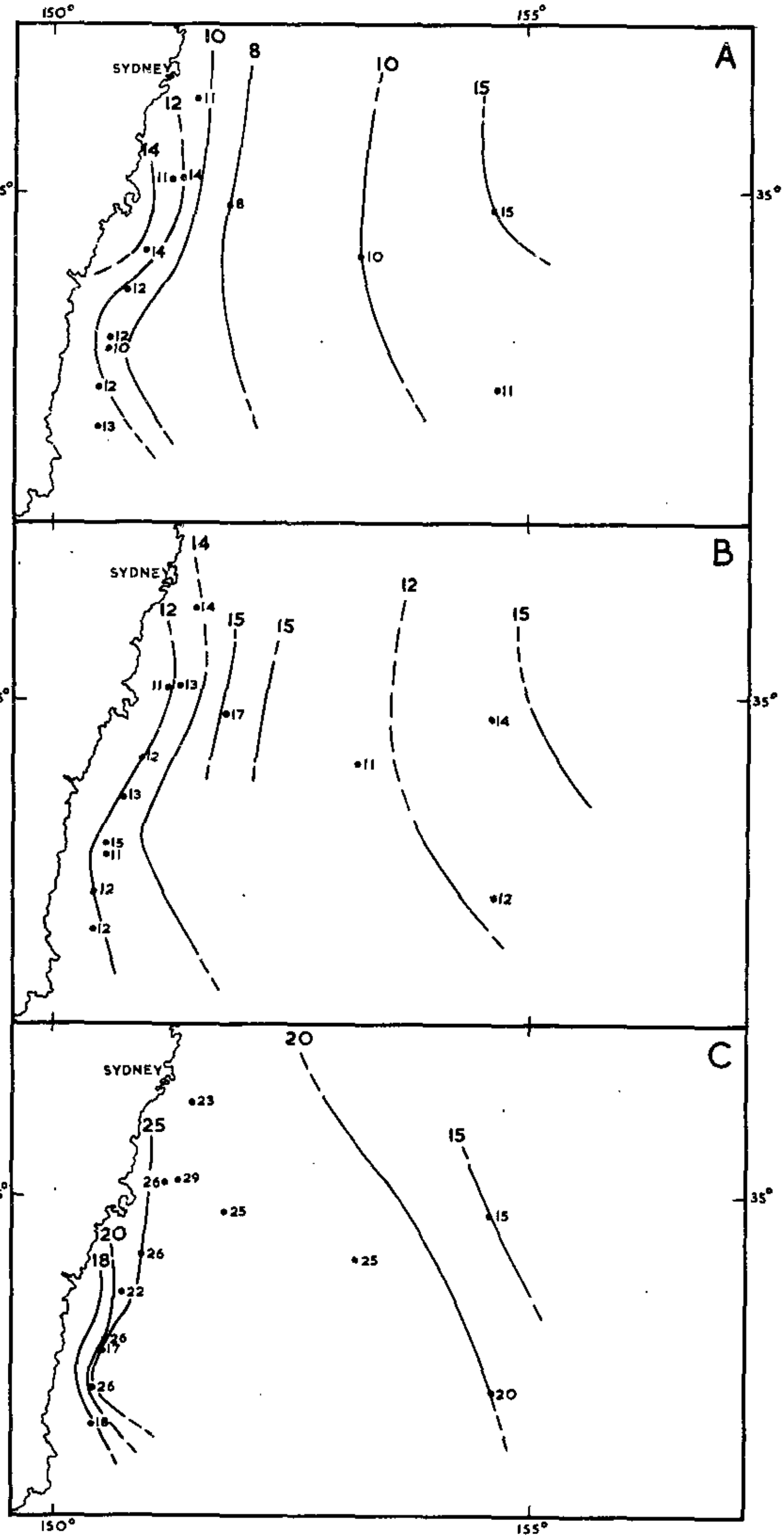

Fig.5. Horizontal distribution of total phosphorus.

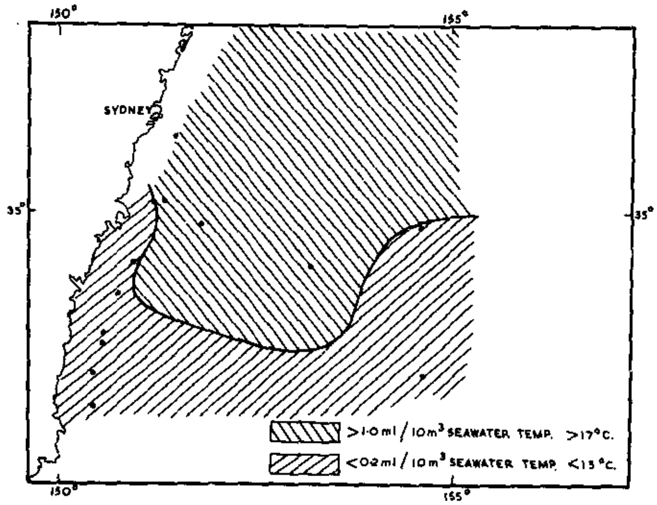

Fig. 6. Quantitative distribution of zooplankton.

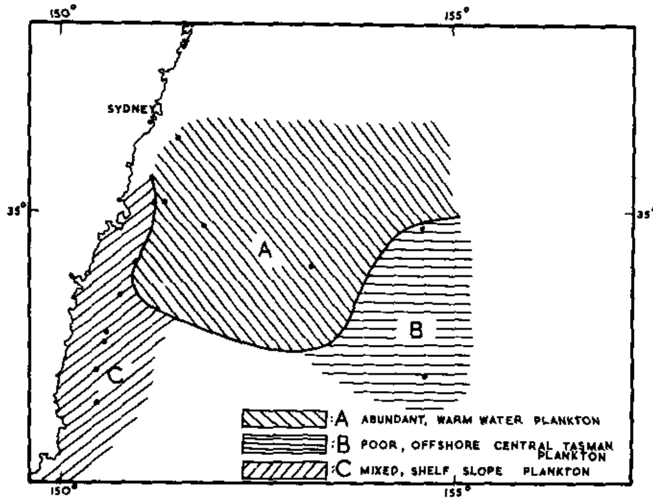

Fig. 7. Qualitative distribution of zooplankton.

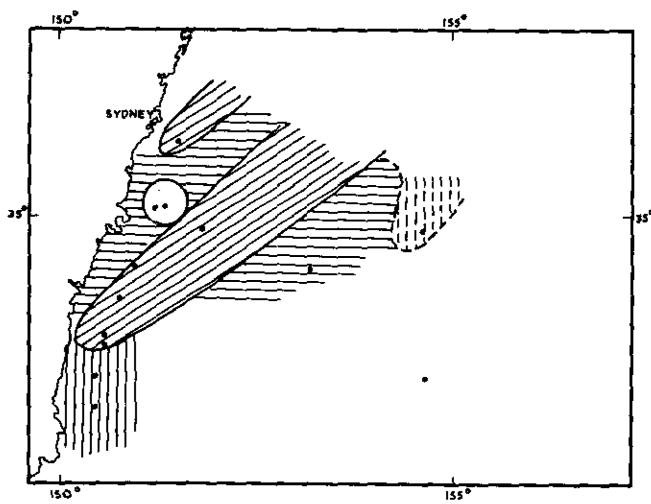

Fig. 8. Phytoplankton communities determined from collections at cruise stations.

Paracalanus spp. Temora turbinata Oithona sp. Oncaea media O. venusta were represented in the three regions, and most of them were present at all stations.

TABLE 3

DISTRIBUTION OF ZOOPLANKTON SPECIES

REGION / Species	A	B	C
Acrocalanus gracilis	x	-	-
Calanoides carinatus	x	-	x
Calanus helgolandicus	-	-	x
C. tonsus	-	x	x
Eucalanus crassus	x	-	-
E. elongatus	x	-	-
E. attenuatus	x	-	-
Undinula darwinii	x	-	-
Rhincalanus nasutus	x	-	x
Oncaea conifera	x	-	-
Sapphirina spp.	x	-	-
Thysanoessa gregaria	x	-	x
Euphausia recurva	-	-	x
Thetys vagina	-	-	x
Vibilia sp.	-	-	x

x = present

(d) PHYTOPLANKTON - E.J.F. WOOD

In this cruise, there was evidence of several tongues of Coral Sea flora (Fig. 8) one extending south near the coast to Port Kembla, one running south west to Montague Island, and a third to about 35° 20'S at 154° 40'E. A closed area with no phytoplankton occurred at Station DH12/196/57 east of Shoalhaven Bight. South of the tongues of Coral Sea flora an East Australian Current flora occurred, mixed to the east with a Central Tasman flora and forming a large diatom bloom to the south west between Bermagui and Eden. A moderately abundant neritic flora occurred from Bateman's Bay north to Port Hacking. The species of diatoms and dinoflagellates found in the collections of this cruise are shown in Tables 4 and 5.

TABLE 4

DIATOMS IN PHYTOPLANKTON COLLECTIONS

	192	193	194	195	197	198	199	200	201	202	203	204
Thalassiosira decipiens	+						+			+		+
T. rotula						+	+				+	
T. condensata							+					
T. hyalina							+					
T. subtilis								+				
Coscinodiscus rex	+(fragt)											
C. marginatus												+
C. concinnus	+					+					+	
C. lineatus			+									
Planktoniella sol	+	+										
Schroederella delicatula			+	+	+	+	+		+	+	+	+
Dactyliosolen mediterranea	+	+								+		
Skeletonema costatum						++	+					
Chaetoceros teres										+	+	
Ch. pseudocrinitus								+				
Ch. paradoxa								+				
Ch. coarctatum	+							+				+
Ch. secundum	+		+	+	+	+++	++		+	+	+	
Ch. concavicorne		+					+					
Ch. lorenzianum				+		+	+	+	+	+		+
Ch. atlanticum v. neapolitanum							+	+				
Rhizosolenia alata		+			+	+	+++	+		+		
R. setigera								+				
R. styliformis									+			
R. stolterforthii						+	++	+	+	+		
R. imbricata										+		
R. delicatula				+			+		+	+	+	
R. cylindrus	+											
R. bergonii										+		
R. calcar avis		+										
Streptotheca indica	+				+		+	+		+		
Hemiaulus hauckii	+						+					
H. membranaceus	+											
Climacodium frauenfeldianum	+	+	+		+					+		
Guinardia flaccida		+				+	+	+	+		+	
Leptocylindrus danicus		+			+		+	+		+	+	
Cerataulina bergonii				+		+						
Stephanopyxis palmeriana						+						
Asterionella japonica						+		+				
Nitzschia seriata					+		+++	+	+	+		+
N. closterium			+									
Bacteriastrum delicatulum								+				
Mastogloia cribrosa												+

TABLE 5

DINOFLAGELLATES IN PHYTOPLANKTON COLLECTIONS

	192	193	194	195	196	197	198	201	202	203	204
Ceratium fusus			+	+			+	+			
C. furca	+				+	+	+				
C. extensum	+	+									
C. buceros f. molle	+								+		
C. massiliense	+										+
C. trichoceros	+		+						+		
C. gallicum	+										
C. karstenii	+										
C. ranipes	+										
C. arietinum	+										
C. setaceum	+										
C. gravidum		+									
C. tripos		+									
C. platycorne									+		
C. pentagonum	+										
C. concilians	+										
Peridinium brochii	+										
P. depressum	+	+							+		
P. conicum	+									+	
P. orbiculare	+										
P. oceanicum	+										
P. steinii	+										
P. ovatum										+	
P. claudicans											+
Diplopsalis lenticula										+	+
D. minor	+					+					
Pyrophacus horologicum	+								+		
Ceratocorys horridum	+										
Coral Sea	+	+							+	+	+
East Aust.	+										

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