COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 21

F.R.V. "DERWENT HUNTER"

Cruise 13/57 cancelled owing to winch failure
November 6 - 7, 1957

Scientific Report of Cruise 14/57
November 13 - 16, 1957

Scientific Report of Cruise 15/57
November 27 - December 1, 1957

Scientific Report of Cruise 16/57
December 4 - 14, 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 a Type 24D and a Type 24E Kelvin Hughes echosounder. The deck winch is hydraulically operated.

CREW

Master	- Captain R.M. Davies
Mate	- R.W. Spaulding
Engineer	- C.F. Hill (to November 16)
	- G. Reid (from November 27)
Deckhands	- G.A. Ross
	- W. Elsmore
Cook	- J. MacDonald
Oceanographical Assistant	- J. Staniforth

Cruise DH13/57 was designed to compare the results obtained with the temperature-chlorinity depth recorder with those obtained from conventional sampling and analytical procedures. Only one station (33°45'S 152°50'E) was worked because of winch failure.

Cruises DH14/57 and DH16/57 were the fifth and sixth cruises of the series arranged to study the East Australian Current. Cruise DH15/57 was 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. 21.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH14/57

November 13-16, 1957

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)

ITINERARY

This is the fifth of the series of cruises studying the structure and circulation of the East Australian Current off Sydney. Figure 1 shows the positions of stations. The cruise was not completed because of the illness of the Engineer, who had to be returned to port.

SCIENTIFIC REPORTS

Hydrological sampling was carried out as reported for previous cruises of this series. Four unprotected thermometers were used on two casts. Depths are considered reliable.

Zooplankton and phytoplankton were sampled as previously recorded for this series of cruises.

(a) HYDROLOGY - D.J. ROCHFORD

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

The warmest water (>19.0°C) was found near the coast. around latitude 152°E at all depths, down to 1500 m. No thermocline was observed.

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

The lightest water was centered around 152°E and at depths of 100-300 m. It was separated from the coastal region by a sharp internal boundary. At the surface a minor pycnocline (max. 0.02 σ_t/m) was developed offshore around longitude 154°E.

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

The light, higher temperature waters around 152°E were undersaturated in oxygen. Offshore oxygen saturation values were higher than 100 per cent. The subsurface oxygen saturation values paralleled the dynamic field (Fig. 3), except for some departure along the continental slope at 300-400 m.

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

The low density water around 152°E (Fig. 3) had a total phosphorus content of 10 $\mu g/l$. The oxygen supersaturated zone east of 153°E had values between 10 and 20 $\mu g/l$. The subsurface distribution of total phosphorus followed closely the density field (Fig. 3).

(5) Regional Water Masses

The total phosphorus to density relationships on this cruise (Fig. 6) show that three regional water masses were present. These were similar to those found on cruise DH10/57 (see Report No. 20) with the mid density component weaker on this cruise.

(b) PHYSICS - B.V. HAMON

Dynamics

Dynamic height anomalies for the surface relative to 1000 decibars are shown in Figure 7, together with G.E.K. surface current vectors. The dynamic heights indicate a strong current towards the coast between Stations DH14/210/57 and DH14/211/57 (Fig. 1) (approximately 100 miles offshore).

(c) ZOOPLANKTON - W. DALL

Figure 8A indicates the distribution of copepod species along 110°T section line. Figure 8B gives the quantitative distribution of zooplankton along the same section line.

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

In this November cruise (Fig. 9), Coral Sea species were mixed with neritic species on the continental shelf. East of this was a mixed Coral Sea- East Australian Current flora with purer Coral Sea flora further east. The area of Stations DH14/210-12/57 contained few species and no characteristic indicators. This was bounded on the east by water with some Coral Sea and East Australian Current flora. The diatoms and dinoflagellates present in the collections are listed in Table 1.

TABLE 1

DIATOMS AND DINOFLAGELLATES IN COLLECTIONS OF PHYTOPLANKTON

	206	207	208	209	210	211	212	213
Rhizosolenia alata f. gracillima	+	+	+			+		+
R. styliformis			+	+				
R. imbricata			+	+				
R. calcar-avis			+	+				
Chaetoceros eibenii	+							
C. coarctatum			+	+				
C. lorenzianum						+		
Detoñula confervacea				+				+
Stephanopyxis palmeriana	+							
Guinardia flaccida	+							+
Planktoniella sol				+			+	+
Nitzachia seriata	+							
Climacodium frauenfeldianum				+				
Ceratium pulchellum	+			+				
C. pentagonum	+							
C. fusus			+				+	+
C. gallicum			+					
C. tripos			+					+
C. gravidum			+					
C. candelabrum			+	+				
C. praelongum			+					
Diplopsalis lenticula								
D. minor		+						
C. hexacanthum			+					
C. trichoceros			+	+				
C. karstenii			+		+			
C. arietinum				+				
C. massiliense							+	
Goniodoma polvedricum			+					
Peridinium divergens			+					
P. murrayi				+				
C. gibberum				+				
P. cerasus						+		
P. curtipes							+	
Goniaulax monacantha							+	

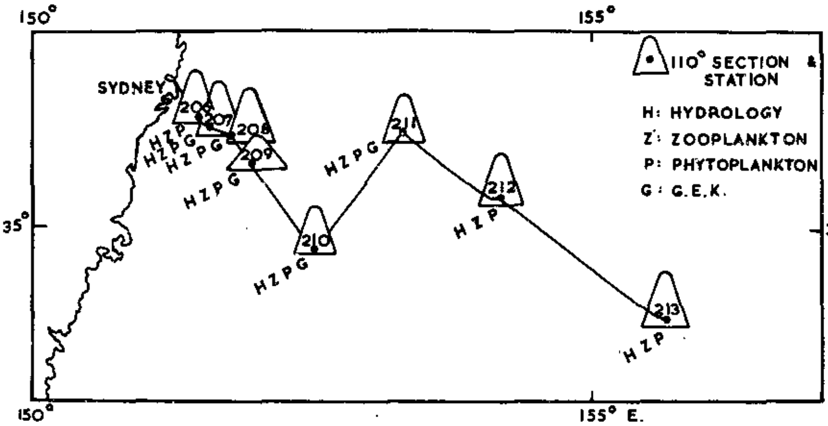

Fig.1. Cruise DH14/57. Track chart showing positions of all stations.

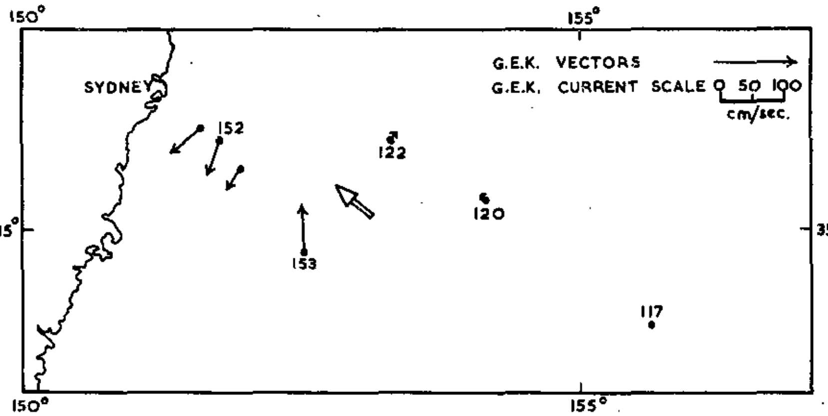

Fig.7. Dynamic height anomalies for the surface relative to 1000 decibars (dyn.cm). Current directions indicated by broad arrow.

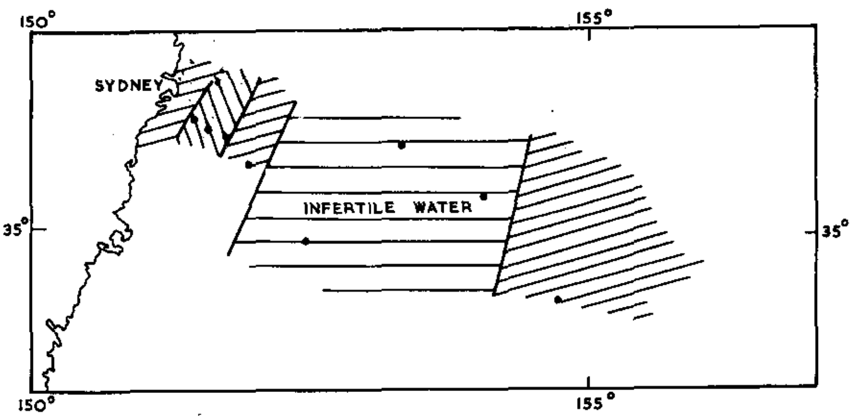

Fig.9. Phytoplankton communities as determined from collections made during Cruise DH14/57.

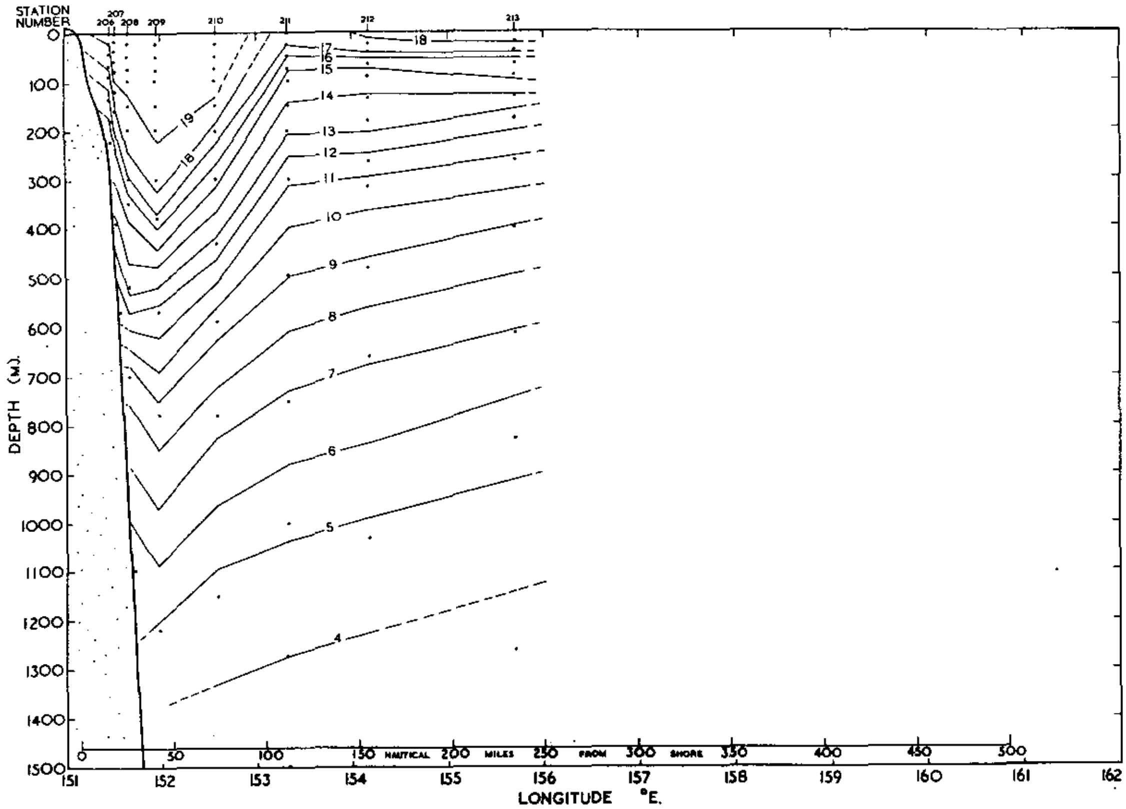

Fig.2. Sectional distribution of temperature (°C) on 110°T section line.

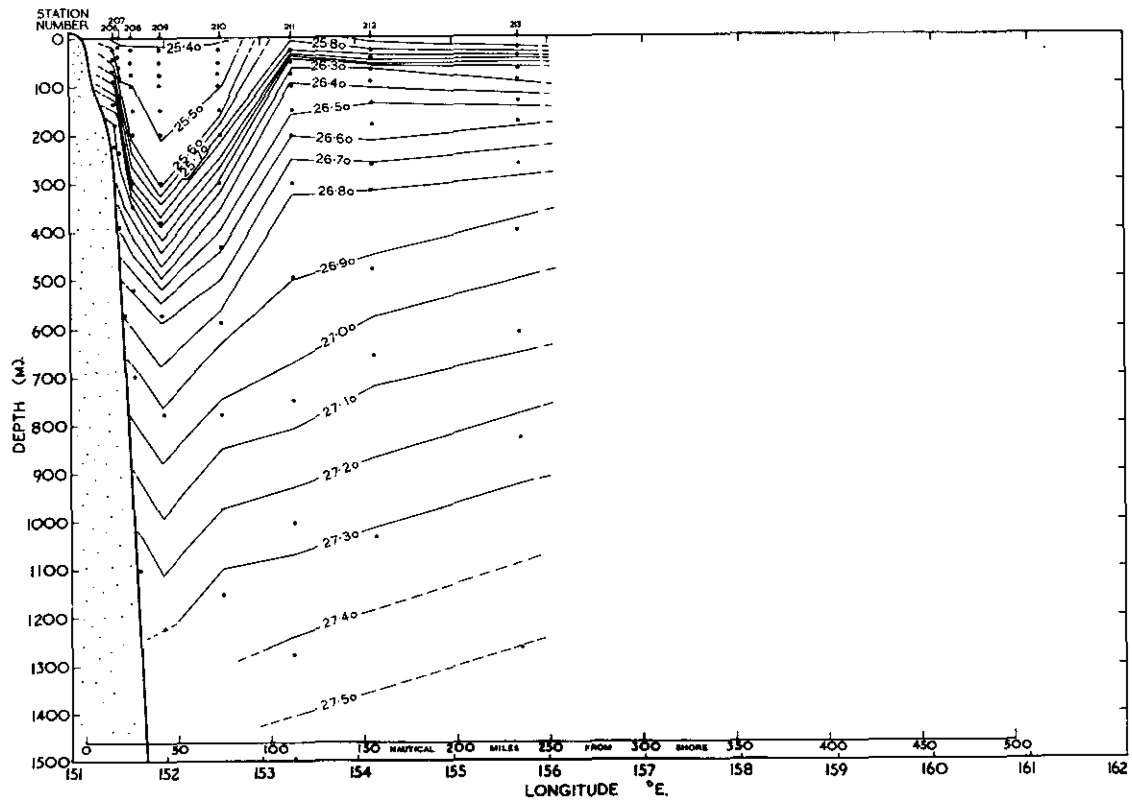

Fig.3. Sectional distribution of density (σ_t) on 110°T section line.

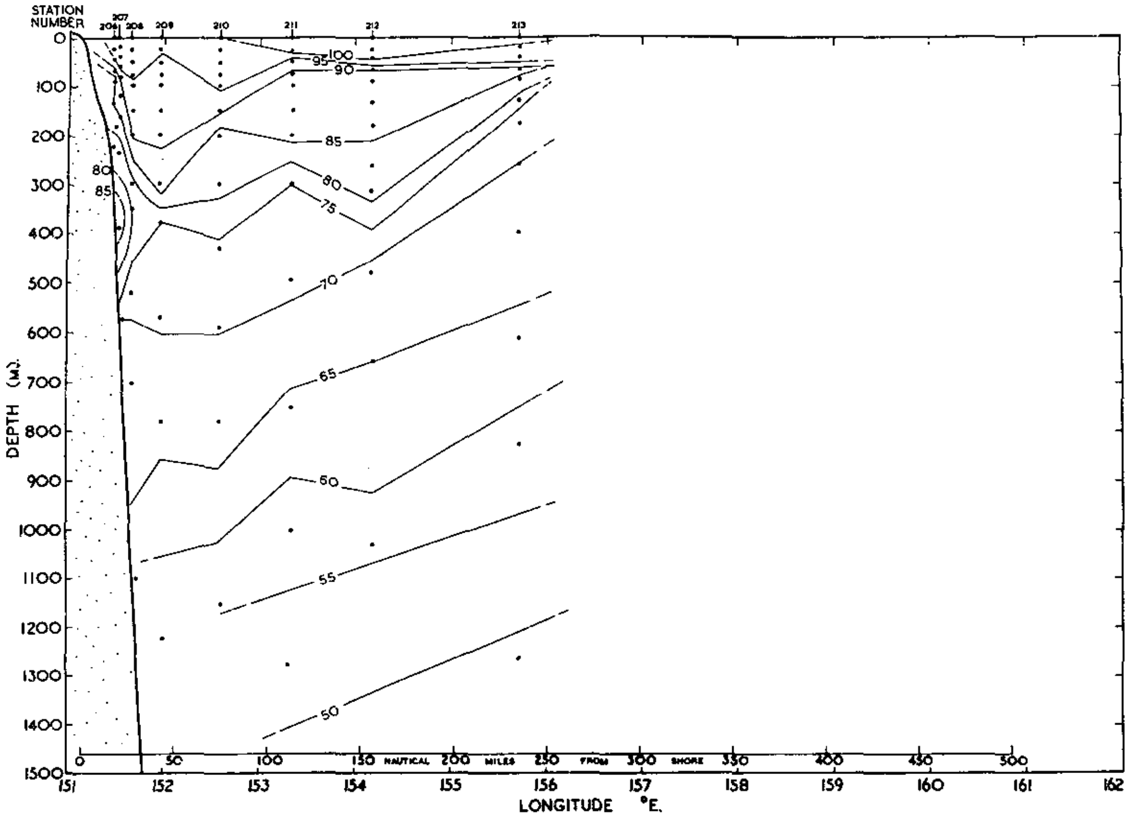

Fig.4. Sectional distribution of oxygen saturation (%) on 110°T section line.

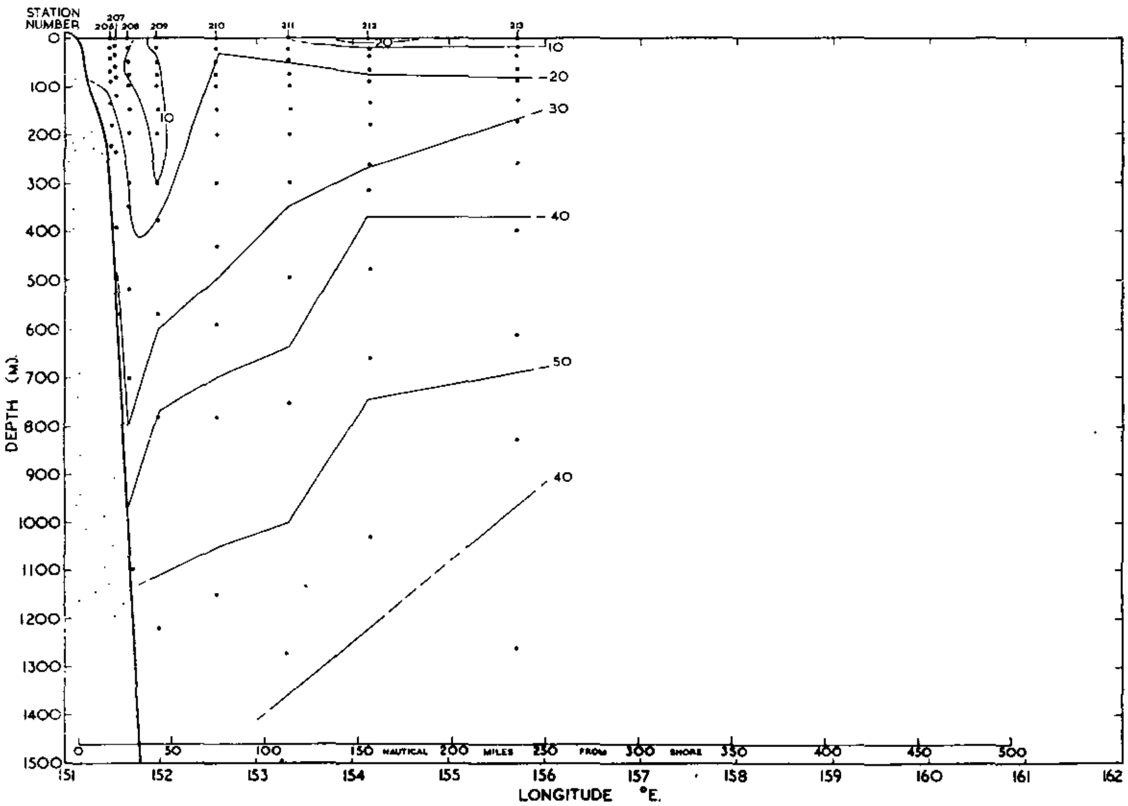

Fig.5. Sectional distribution of total phosphorus on 110°T section line.

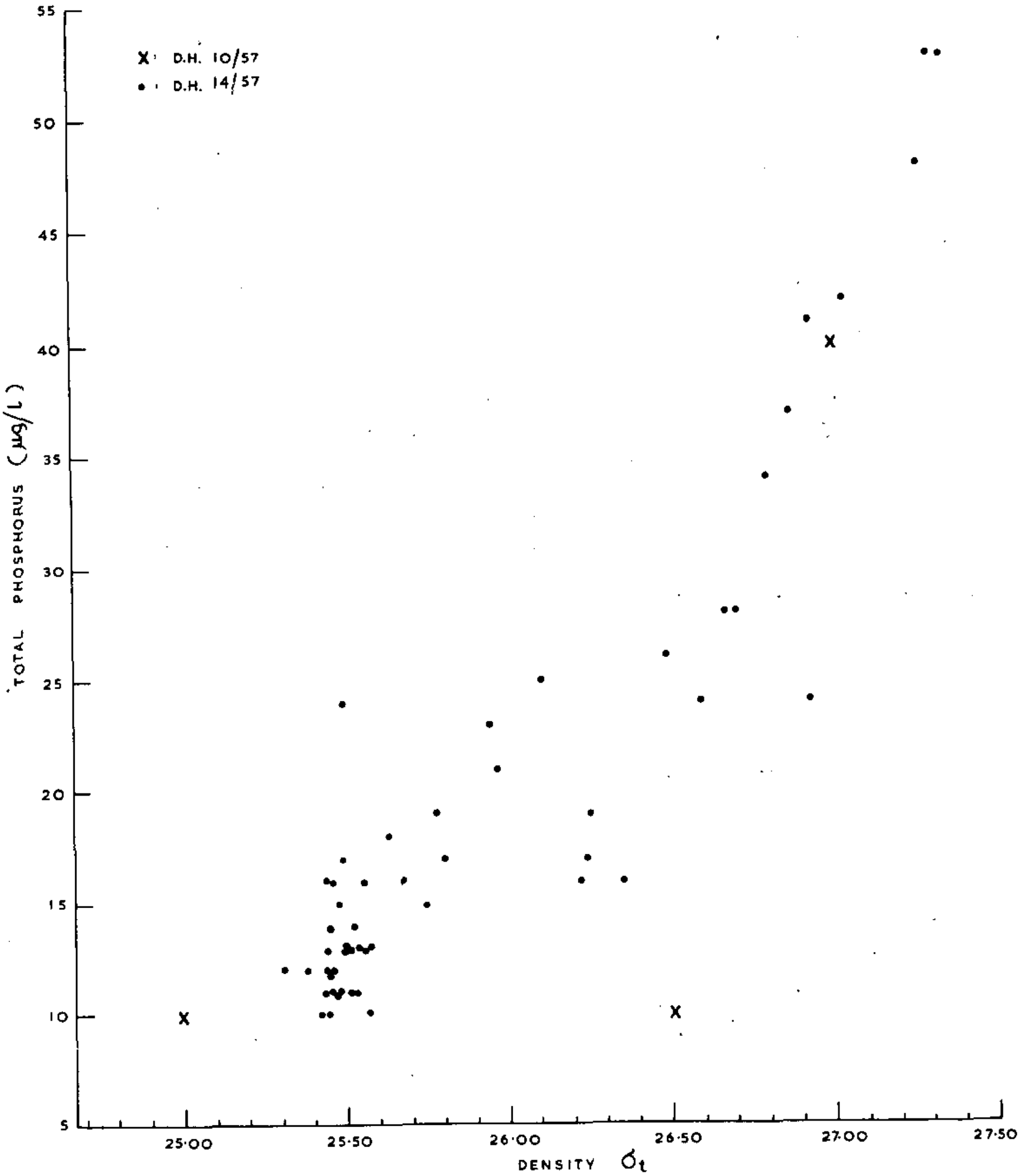

Fig. 6. Total phosphorus to density relationships.

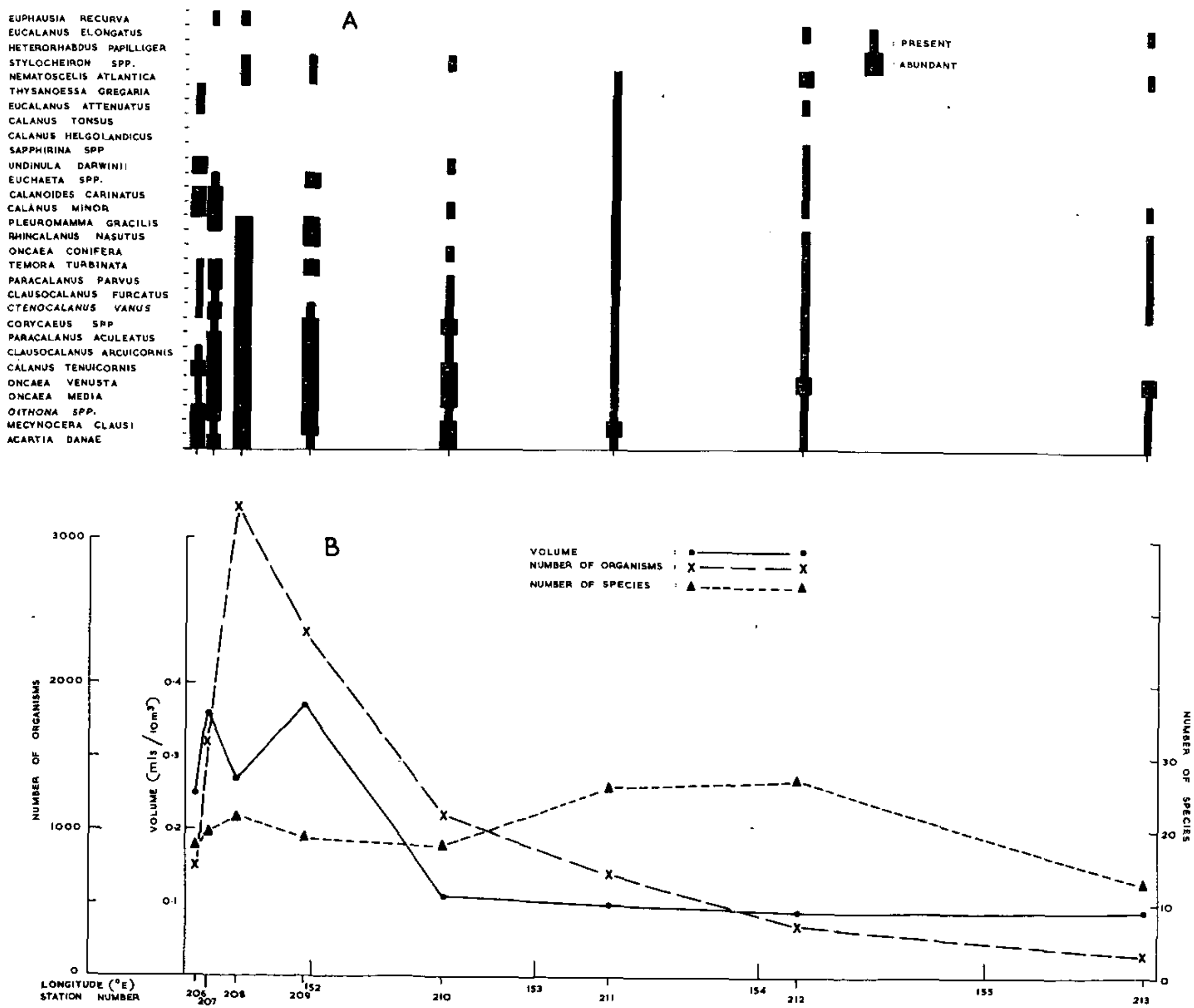

Fig.8. A. Quantitative distribution of copepod species along 110°T section line. B. Quantitative distribution of zooplankton.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH15/57

November 27 - December, 1957

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

ITINERARY

This is the third productivity cruise studying the rates of carbon uptake and submarine light distribution in relation to hydrological structure. The position and types of stations are shown in Figure 1.

(a) PRODUCTIVITY - N. DYSON

On this cruise CO_2 uptake measurements were made by the two methods of incubation at three stations. An attempt was also made to measure the daily variation at two stations. At the third station replicate sampling was carried out in an endeavour to obtain some information on the sampling error.

RESULTS

1. CO_2 Uptake

The results of the two methods of incubation are shown in Figures 2, 3 and 4. As on previous cruises the rate of uptake, as measured by the light bath incubation, was greater than that of the *in situ* incubation.

The replicate sampling results are shown in Table 1.

TABLE 1

REPLICATE SAMPLING FOR CO_2 UPTAKE

Station & Depth	Mg C/hr/m^3	Mean	Standard Deviation
DH15/217/57 Surface	0.80 0.64 0.76 0.30	0.63	0.20
DH15/217/57 25 Metres	1.92 1.69 1.93 1.04	1.65	0.36

F0301

No daily variation of CO_2 uptake was found, but as only a small number of samples was taken this may not be significant.

2. Light Penetration

Light penetration measurements were made on several occasions during each of the three all day stations to obtain information on the variability of the depth of penetration of surface light. The results are shown in Table 2.

TABLE 2

LIGHT PENETRATION

Station	Time	Depth of Penetration of 1% of surface light
DH15/216/57	0915	71
	1215	80
	1520	64
DH15/217/57	0925	73
	1200	75
	1500	68
DH15/218/57	1030	73
	1315	84

(b) HYDROLOGY - D.J. ROCHFORD

Regional Water Masses

The density to total phosphorus relationship (Fig. 5) shows that the same water masses were present as on cruises DH10, 11, and 14/57 in the same area.

However, on Cruise DH15/57 the Coral Sea water mass of DH10/57 was not found and the surface water mass distribution involved only the so called northern Central Tasman of 1956 origin and the southern Central Tasman of 1957 origin (Fig.1). All the C_{14} stations lay along the boundary of the eastward movement of these two water masses.

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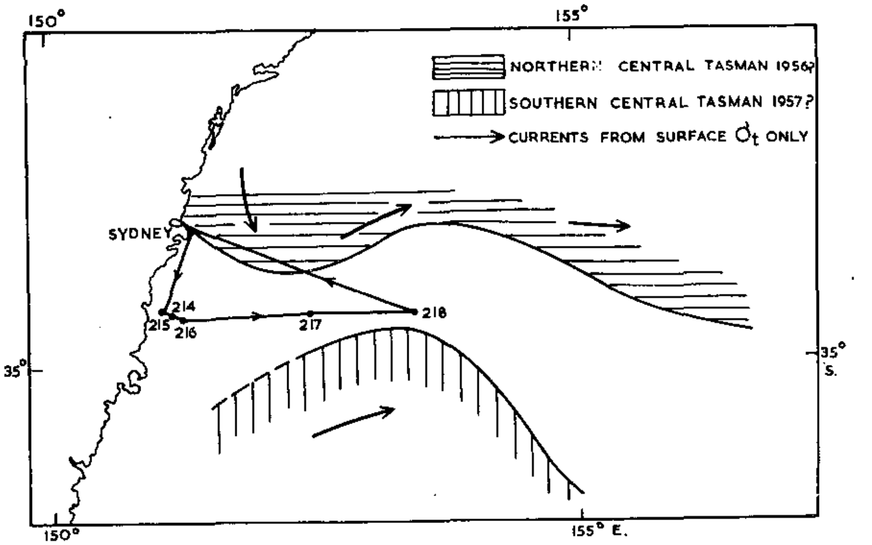

Fig.1. Cruise DH15/57. Track chart showing positions of stations and the distribution of surface water masses.

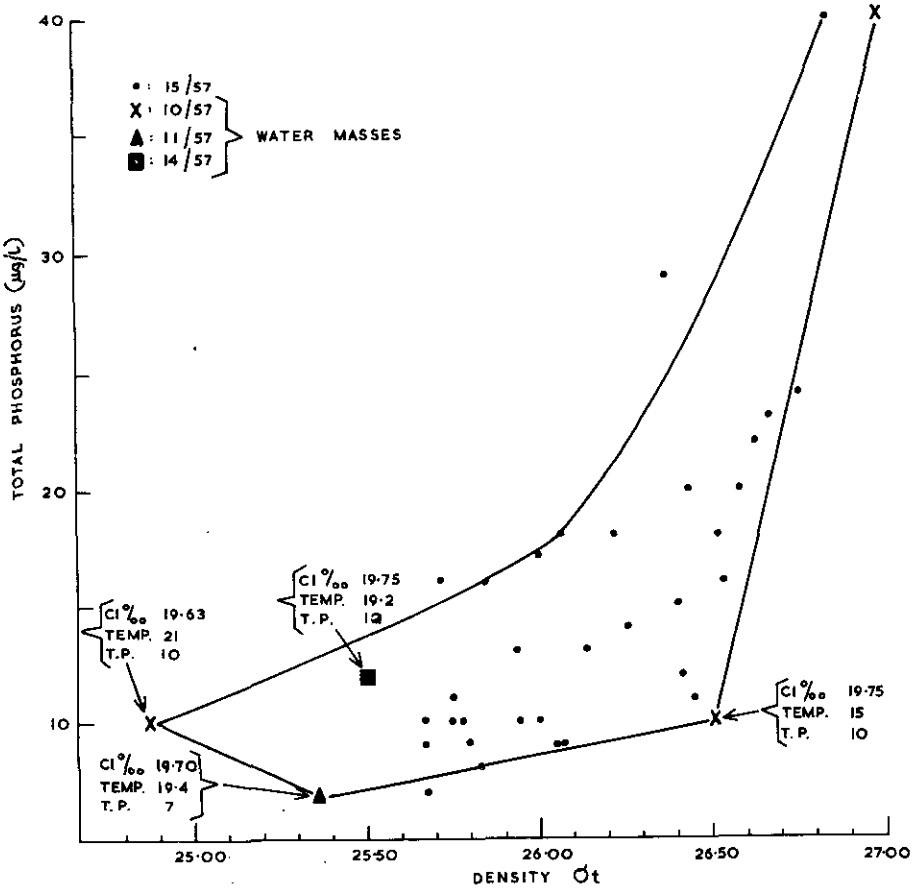

Fig.5. Relationship of density (σ_t) to total phosphorus.

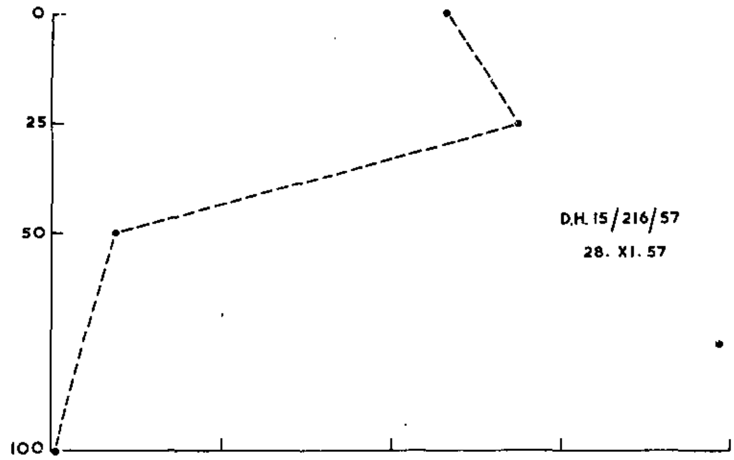

Fig. 2. Rates of CO_2 uptake at Station DH15/216/57.

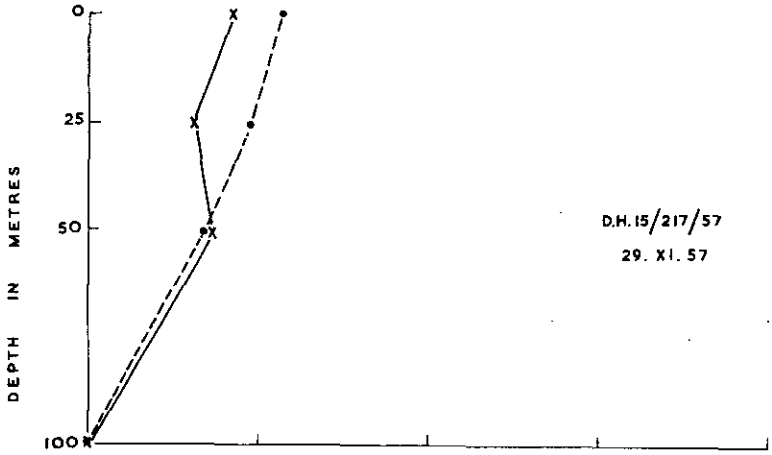

Fig. 3. Rates of CO_2 uptake at Station DH15/217/57.

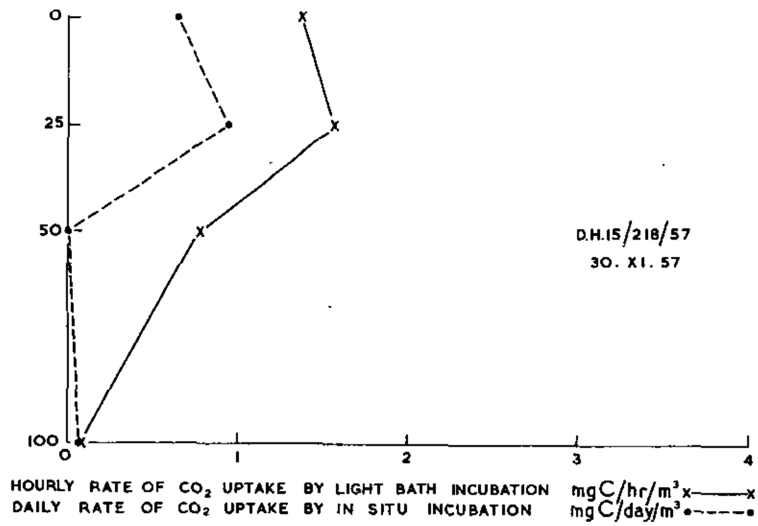

Fig. 4. Rates of CO_2 uptake at Station DH15/218/57.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH16/57

December 4-14, 1957

SCIENTIFIC PERSONNEL

C. Walker (in charge)

ITINERARY

This is the sixth of the series of cruises to study the structure and circulation of the East Australian Current off Sydney. Figure 1 shows the positions of the stations.

SCIENTIFIC REPORTS

Hydrological sampling was carried out to 1500 m at the same depths as on previous cruises. Thermometric depths were calculated at all sampling depths below 150 m, and at selected depths above that level. The accepted sampling depths therefore are considered to be accurate to within the limits of thermometric measurements. Phytoplankton was sampled as on previous cruises of this series.

(a) HYDROLOGY - D.J. ROCHFORD

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

The warmest water (>22°C) occupied a shallow region at longitude 154°E. The vertical temperature structure was uniform along the section to depths of about 200 m. Below this depth a general elevation of cold deeper layers was evident at 156°E. No thermocline was present along this section.

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

Surface temperatures in general were higher along this section than on the 110°T section line. The maximum temperatures (>23°C) were found at 157°E. In this region also the highest temperatures occurred for depths down to 1000 m and deeper. No thermocline was developed on this section.

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

In the region of maximum surface temperatures a shallow pycnocline (max. 0.02 σ_t/m) was found. Beneath the surface the maximum changes in density structure were found below 200 m, and these appeared to be caused by relative dynamic uplift at latitudes 156° and 160°E.

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

On the eastern edge of the region of maximum temperatures a pycnocline (max. 0.018 σ_t/m) was developed between 20 and 60 m. The deeper density field parallels that of temperature and shows an accumulation of lower density water at Station DH16/242/57.

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

At the surface saturation values occurred at the extreme western end of the section and in the region of the maximum temperature water. From 0-500 m changes in oxygen structure were independent of density fields, but below 500 m the oxygen and density fields agreed.

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

Saturation values were found at the extreme western end of the section. The maximum degree of undersaturation at the surface occurred at Station DH16/239/57. This appears to be an effect of lateral transfer of deeper waters to the surface along isopycnic surfaces. Below 700 m, the density (Fig. 5) and oxygen fields agreed but above this level anomalies in this relation were found.

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

The minimum values (7-10 μg/l) were found at the surface of the western half of the section. There was considerable discrepancy between the density (Fig. 4) and total phosphorus fields. However, the agreement between the total phosphorus and the oxygen fields (Fig. 6) indicates the probability that biological processes were involved.

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

Minimum values (10 μg/l) were found at the surface between longitudes 154° - 156°E. At either end of the section higher surface values were associated with the general dynamic uplift of the isopycnal surfaces (Fig. 5). There does not

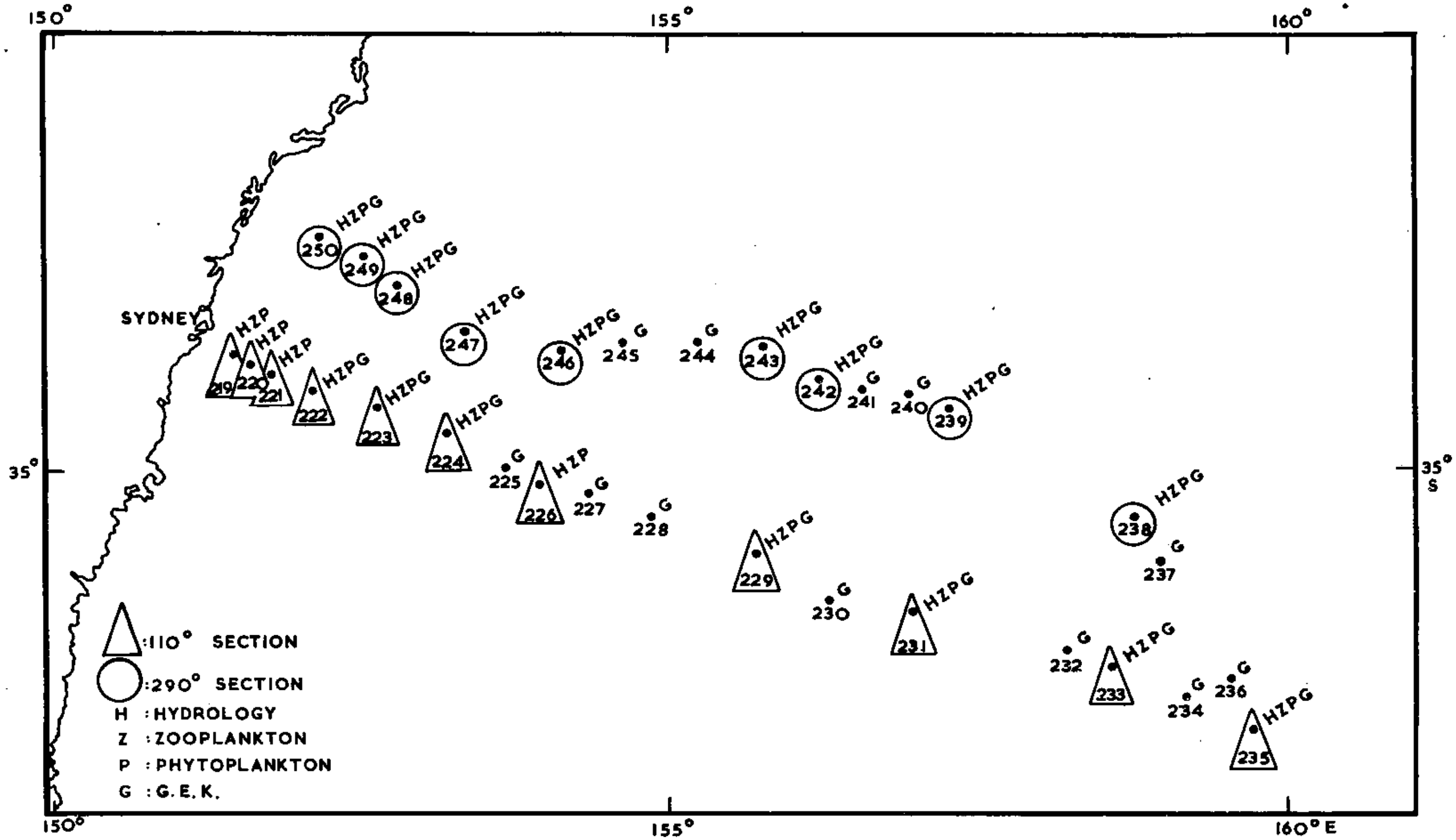

Fig.1. Cruise DH16/57. Track chart showing positions of stations.

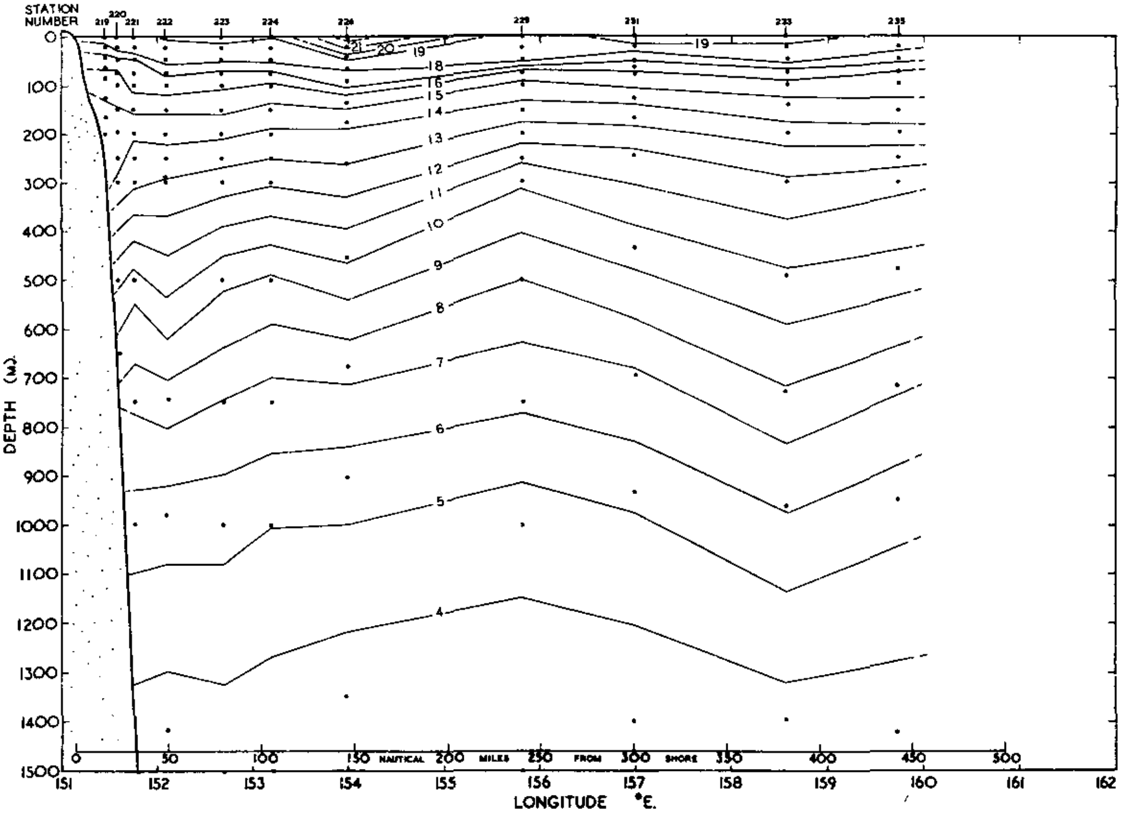

Fig.2. Sectional distribution of temperature (°C) along 110 T line to 1500 m.

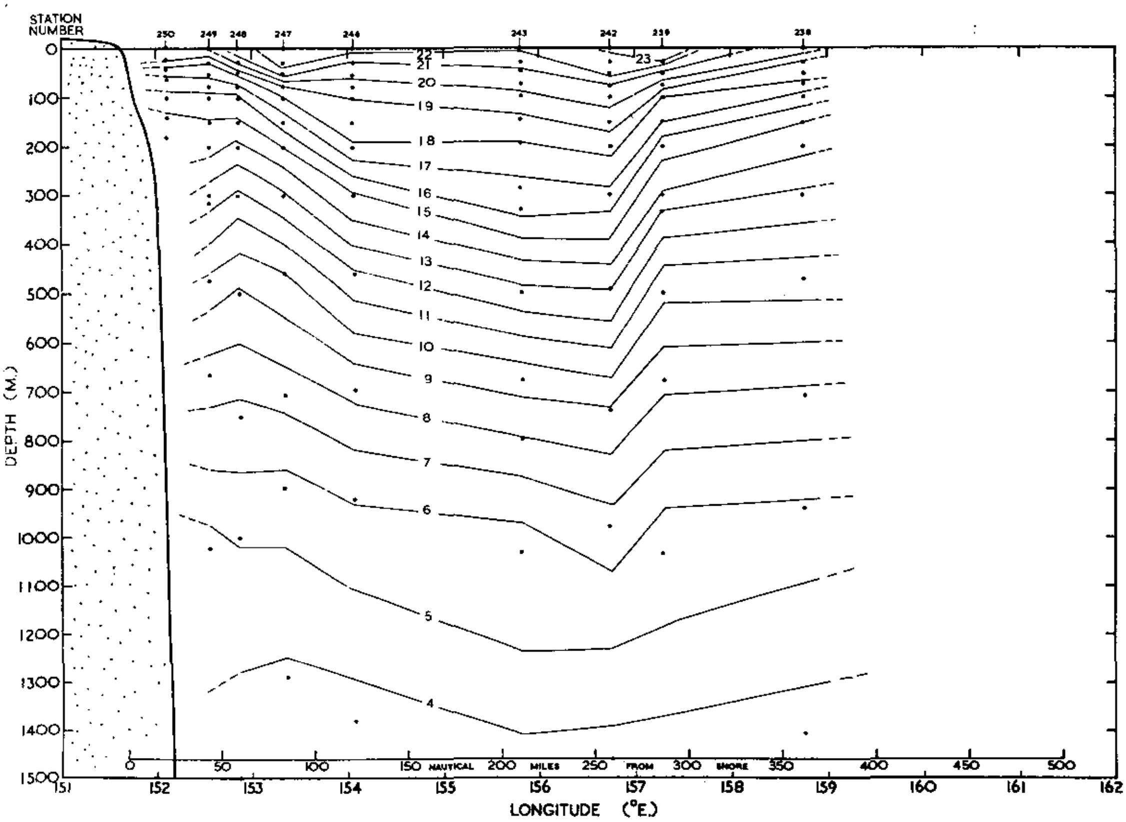

Fig.3. Sectional distribution of temperature (°C) along 290°T line to 1500 m.

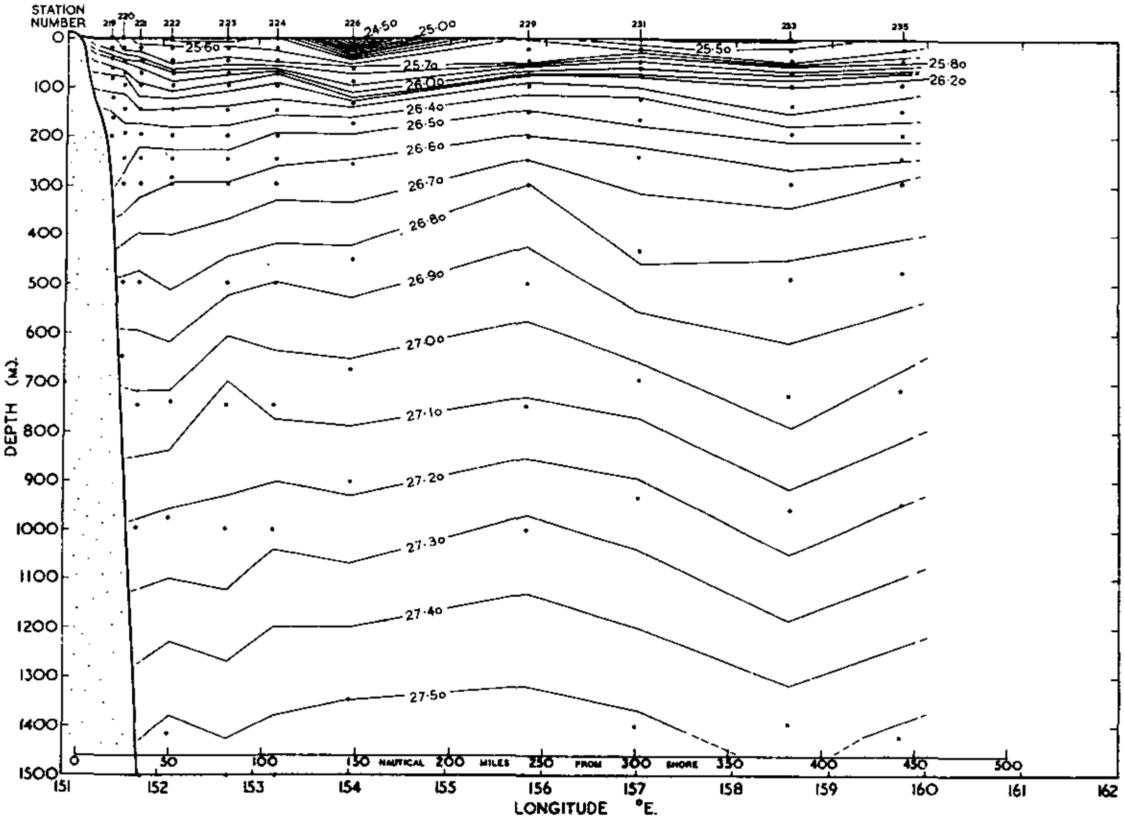

Fig.4. Sectional distribution of σ_t along 110°T line to 1500 m.

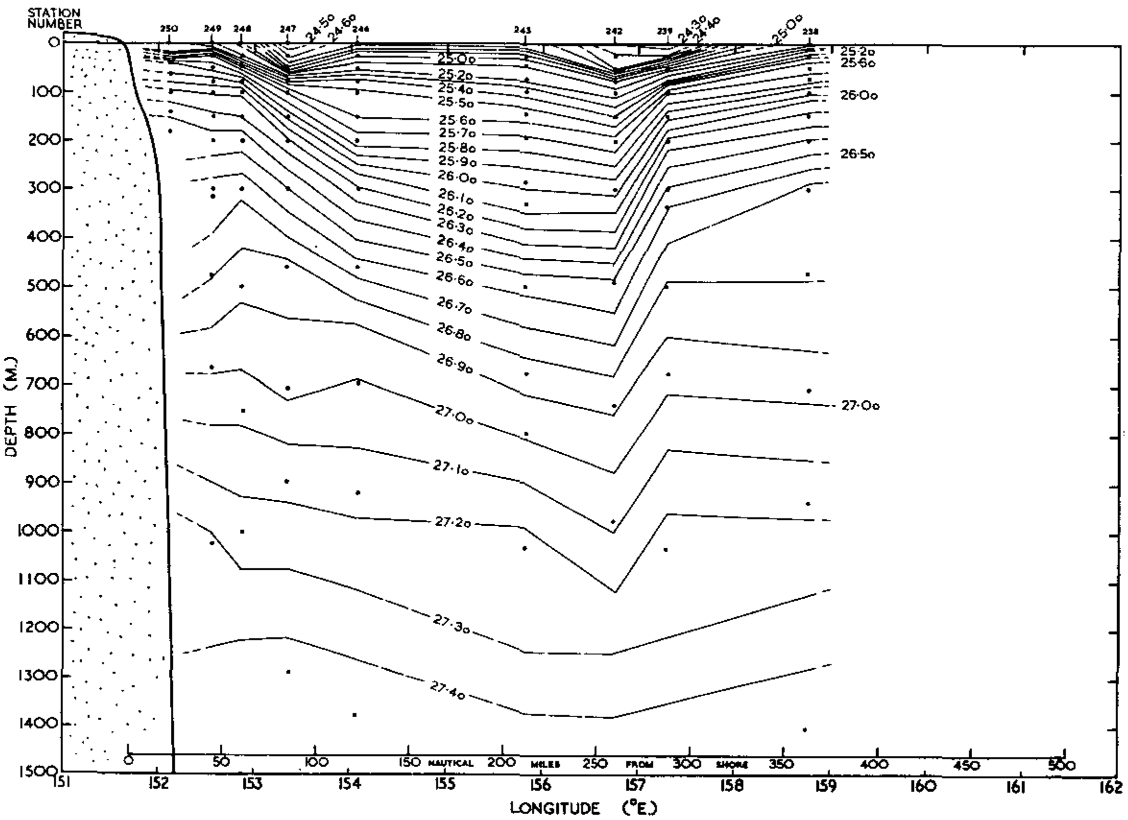

Fig.5. Sectional distribution of σ_t along 290°T line to 1500 m.

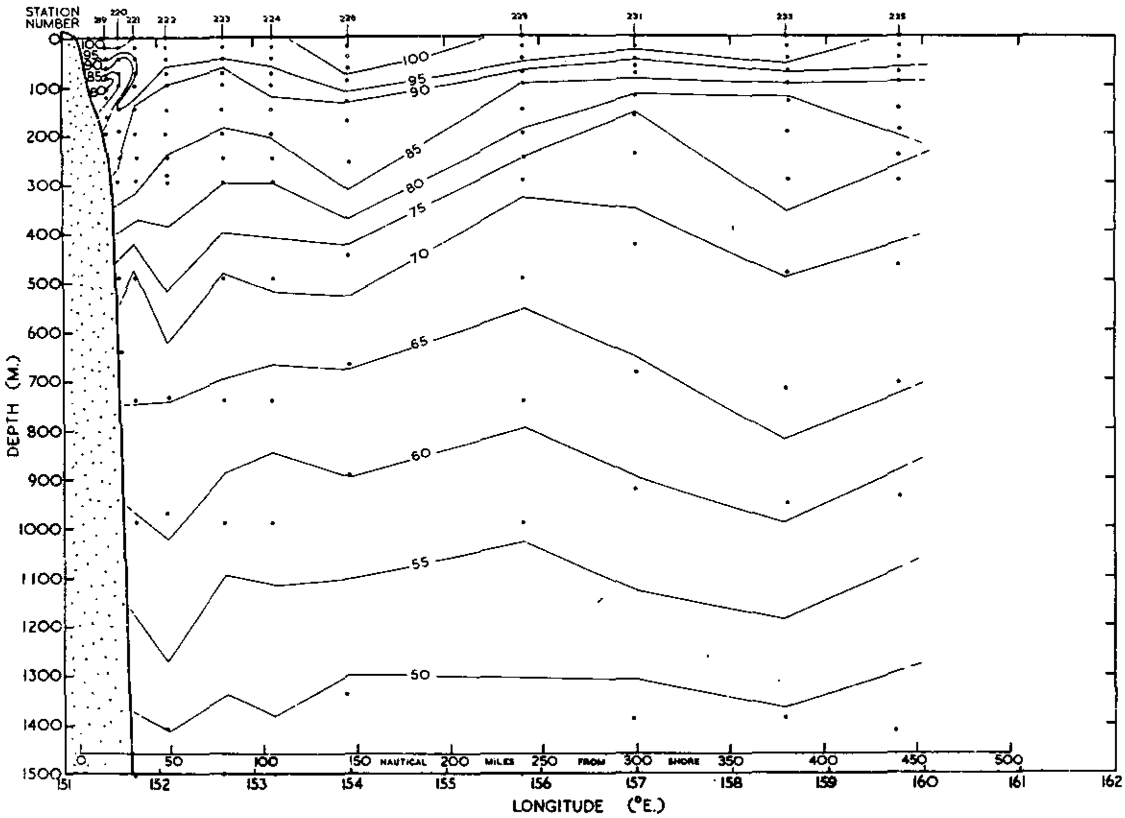

Fig. 6. Sectional distribution of oxygen saturation (%) along 110°T line to 1500 m.

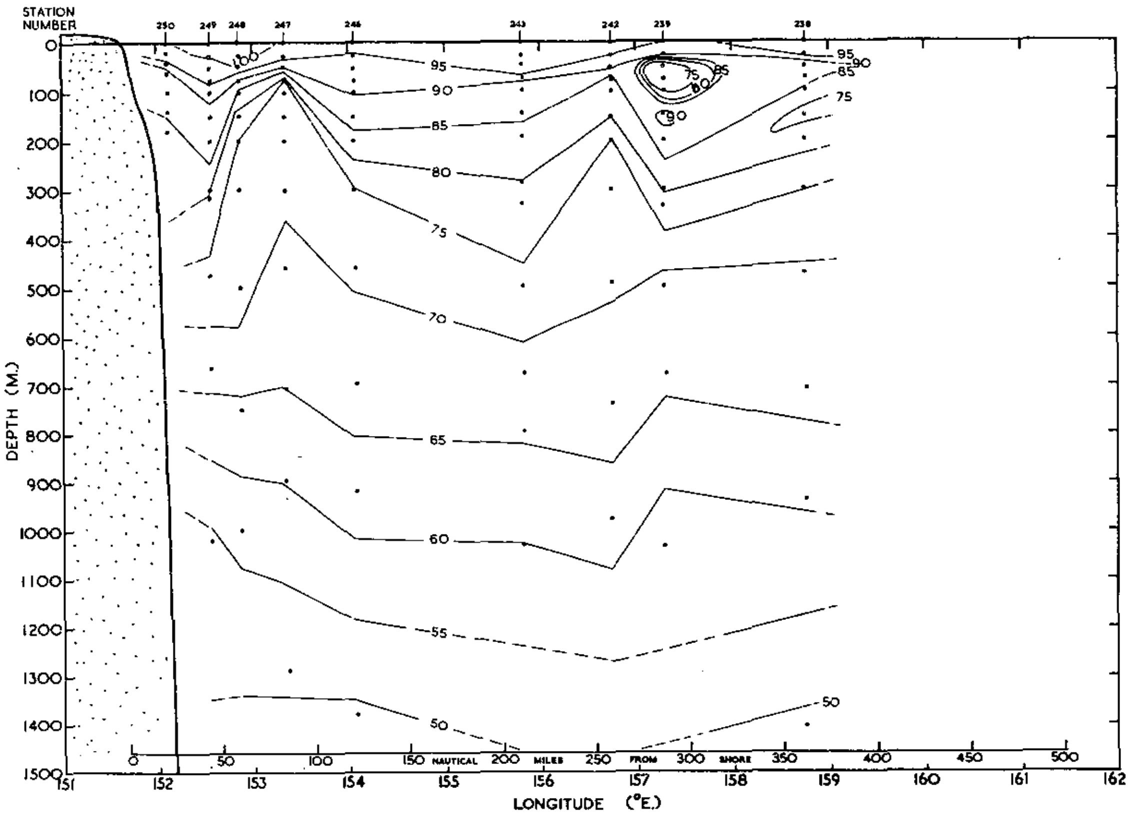

Fig. 7. Sectional distribution of oxygen saturation (%) along 290°T line to 1500 m.

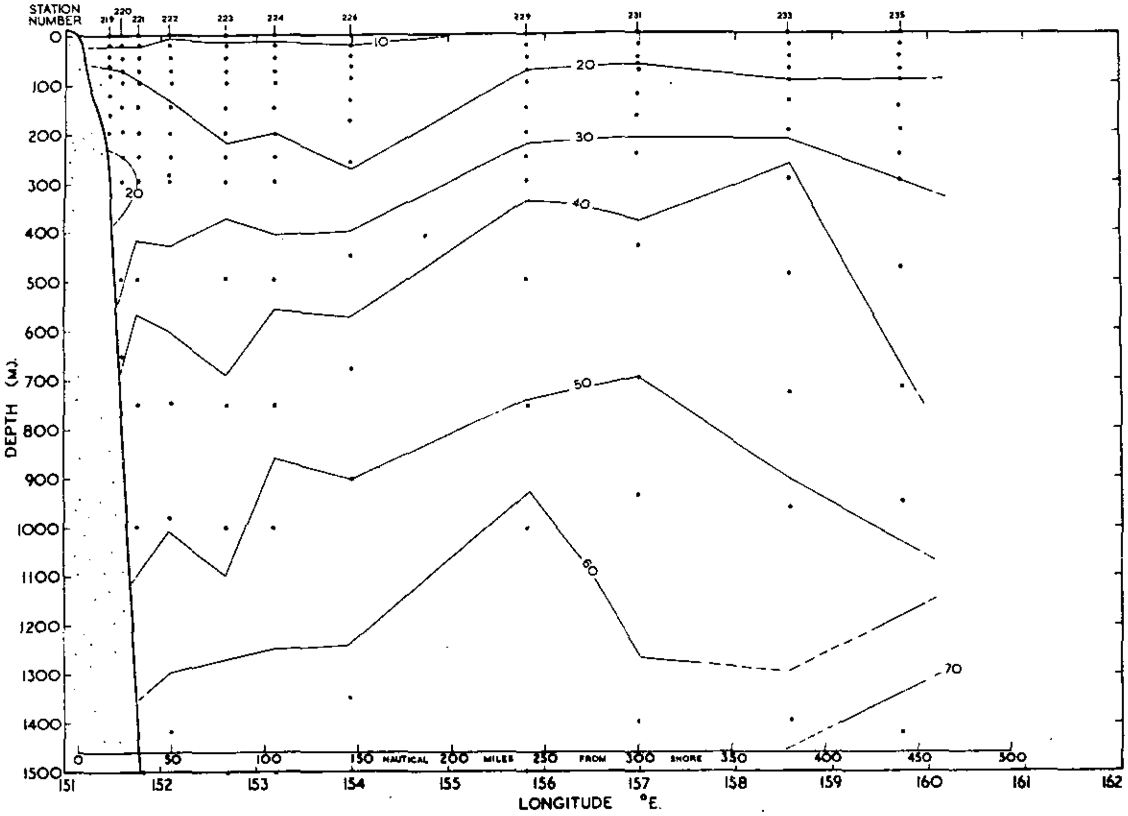

Fig.8. Sectional distribution of total phosphorus along 110°T line to 1500 m.

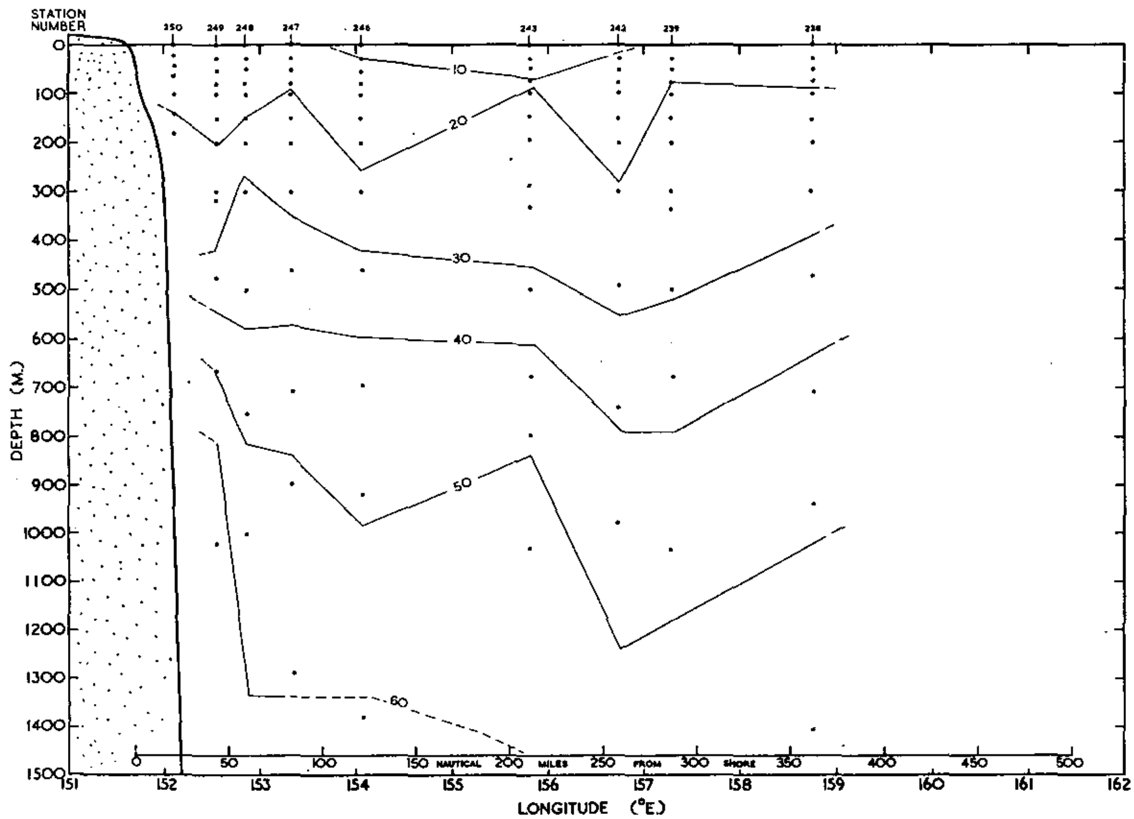

Fig.9. Sectional distribution of total phosphorus along 290°T line to 1500 m.

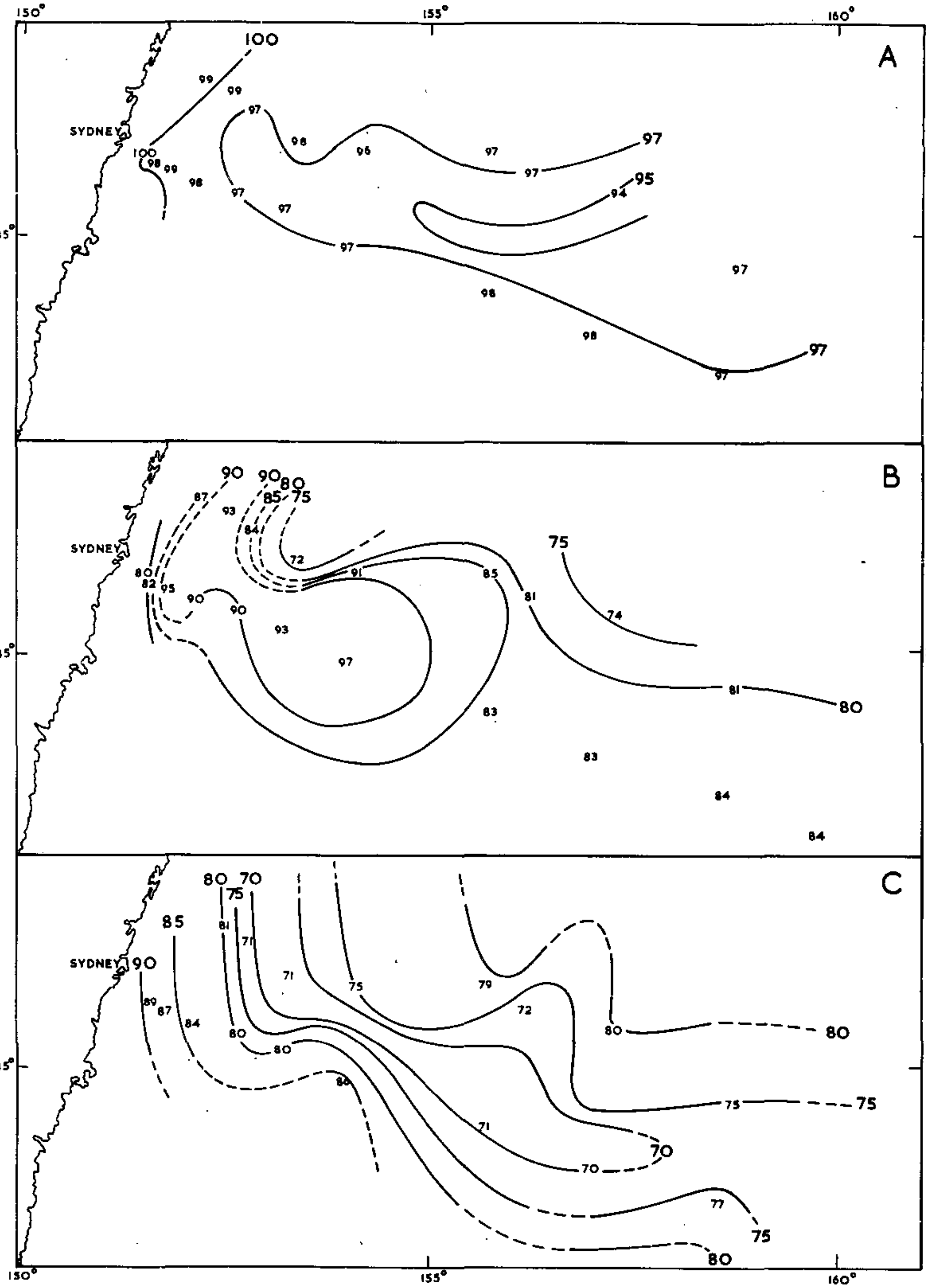

Fig.10. Horizontal distribution of oxygen saturation (%) A. at 0 m, B. at 100 m, C. at 300 m, at hydrology stations.

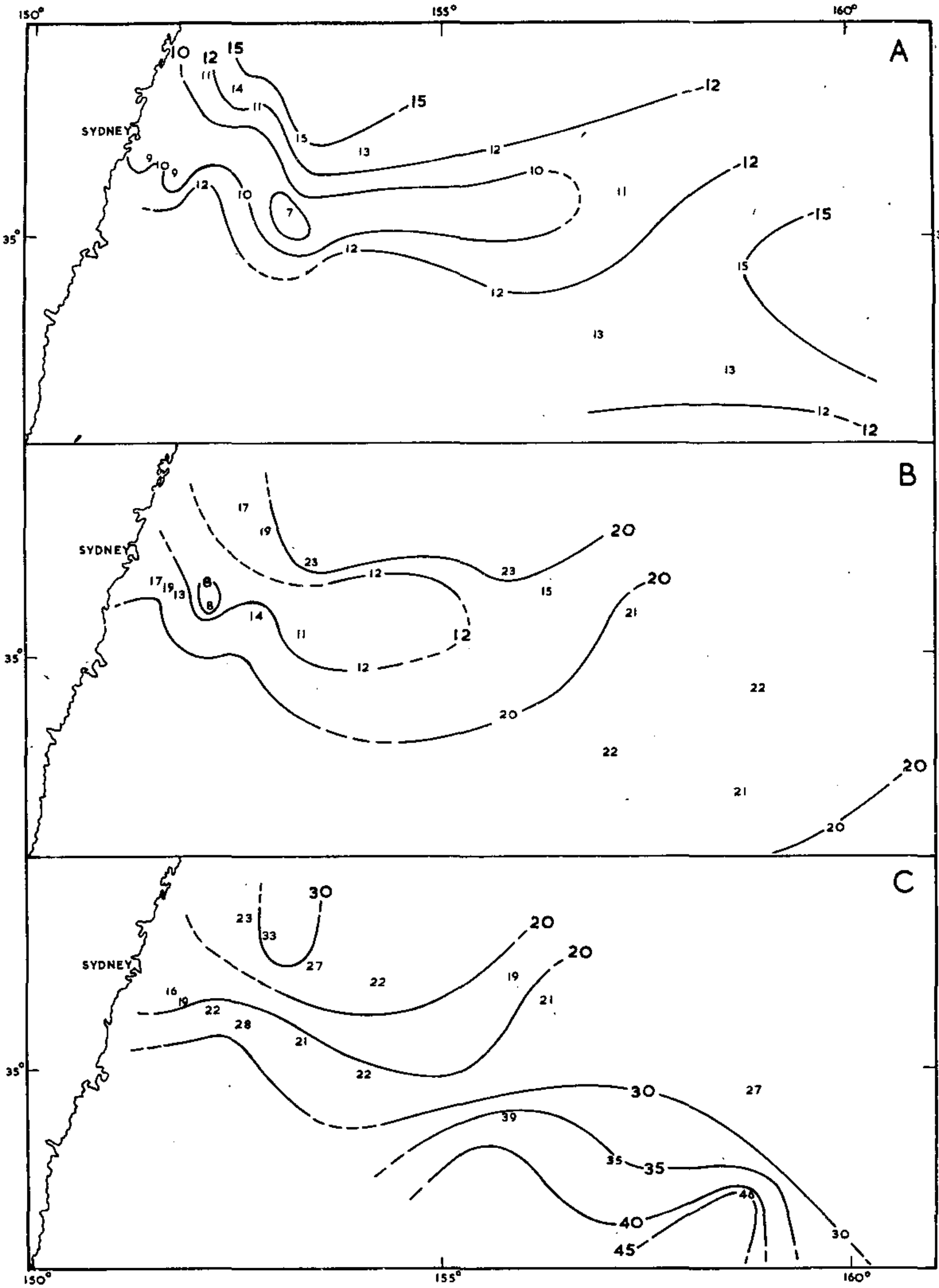

Fig.11. Horizontal distribution of total phosphorus A. at 0 m, B. at 100 m, C. at 300 m, at hydrology stations.

appear to be a dynamic explanation for the very high total phosphorus values in the deep layers at Stations DH16/243/57 and DH16/249/57. The oxygen saturation (Fig. 7) and total phosphorus fields are not in agreement. It is probable that these total phosphorus anomalies are due to the effect of bottom sediment.

(9) Horizontal Distribution of Properties

(a) Percentage Oxygen Saturation (Fig. 10)

At the surface (Fig. 10A) the oxygen saturation decreased along the path of easterly flow (Fig. 14). At 100 m however (Fig. 10B) the maximum gradient of oxygen saturation was across the direction of flow of the surface current, with the lowest values along its lefthand side. At 300 m (Fig. 10C) the oxygen saturation values were more uniform, but minimum values were found along the path of the surface current to the east.

(b) Total Phosphorus (Fig. 11)

Along the path of easterly flow, minimum values were found at the surface (Fig. 11A). The gradient of this property was the opposite to that of oxygen saturation (Fig. 10A). The highest total phosphorus values at the surface were along the western end of the easterly flow. At 100 m (Fig. 11B) the minimum values of total phosphorus were associated with the oxygen maximum (Fig. 10B). The maximum total phosphorus at this level was found along the lefthand side of the path of surface flow to the east. At 300 m (Fig. 11C) the minimum values were again associated with the path of surface easterly flow, with maximum values at the eastern end of the section. The high value at the north western end of the section was associated with a low oxygen saturation value (Fig. 10C).

(10) Regional Water Masses

The total phosphorus to density relationship on this cruise (Fig. 12) shows that four regional water masses were present (Table 1).

TABLE 1

REGIONAL WATER MASSES

Water Mass	Density (σ_t)	Total Phosphorus μg/1	Temperature °C	Chlorinity °/oo
			(From station data)	
A	24.40	12	22.95	19.70
B	25.63	11	18.55	19.72
C	26.37	20	14.66	19.58
D	27.57	66	3.03	19.14

Water mass A, the Coral Sea of *Rochford (1957) formed the core of the easterly flow, and predominated along the northern section line. Water mass B, the Central Tasman, was found along the southern section line at all stations except DH16/226/57 (Fig. 1). Water mass C the South-west Tasman, was found at about 200 m in varying strength at practically all stations. Water mass D, which formed part of the Sub-Antarctic intermediate and bottom water circulation was found at depths below 140 m. At certain stations the total phosphorus content seemed abnormally high in relation to density (Fig. 12). Figure 13 shows the position of these stations and the magnitude of the maximum anomalies in relation to the circulation. It is suspected that the previously noted very high total phosphorus values in the deep waters at Stations DH16/243/57 and DH16/249/57 (Fig.9) were part of the same effect. Bottom sediments could have been responsible for these anomalies *Rochford (1958).

*Rochford, D.J. (1957).- The identification and nomenclature of the surface water masses in the Tasman Sea. Aust. J. Mar. Freshw. Res. 8 : 369-413.

Rochford, D.J. (1958).- Total phosphorus as a means of identifying east Australian water masses. Deep Sea Res. 5 : 89-110.

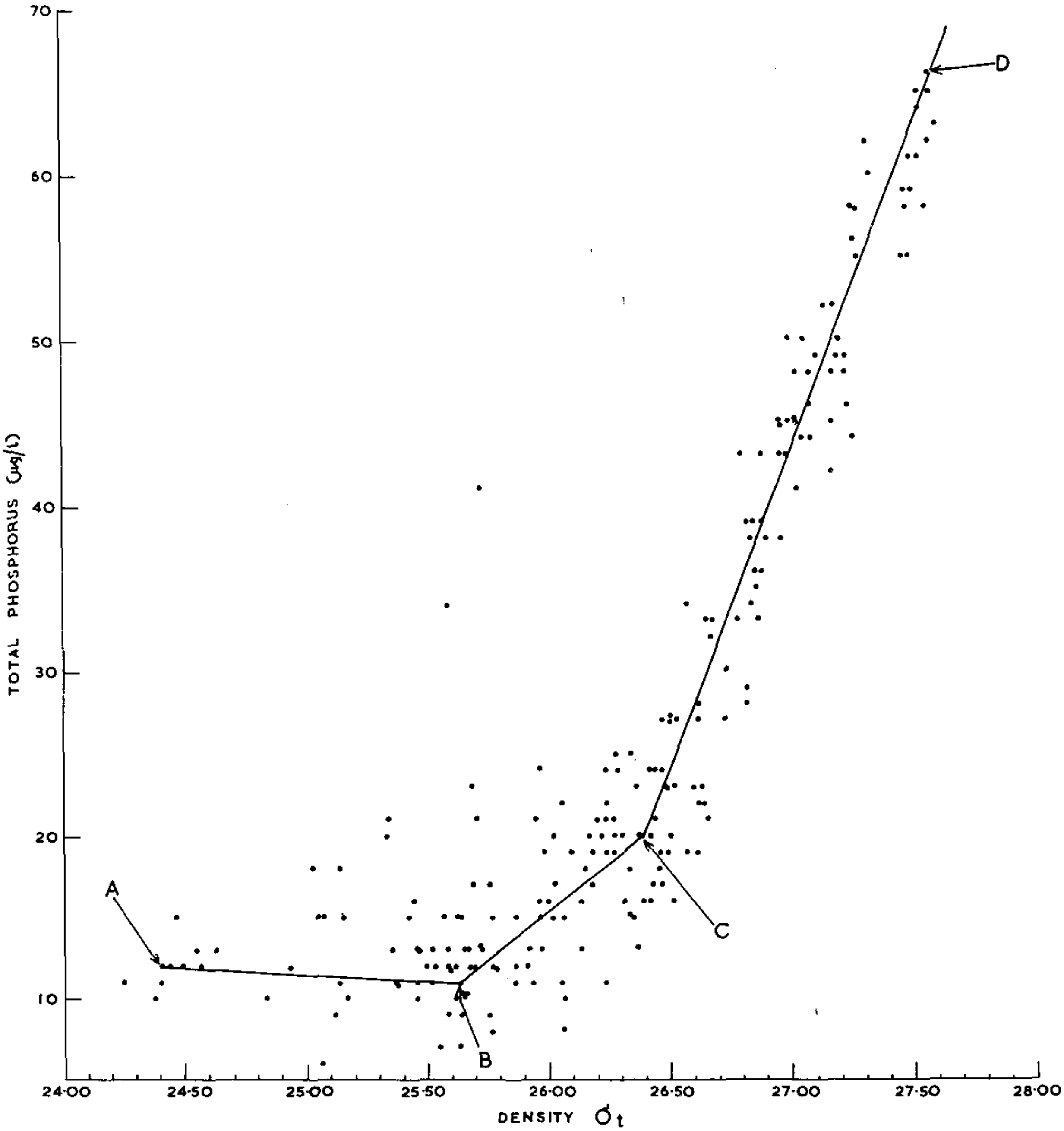

Fig.12. Total phosphorus to density (σ_t) relationships.

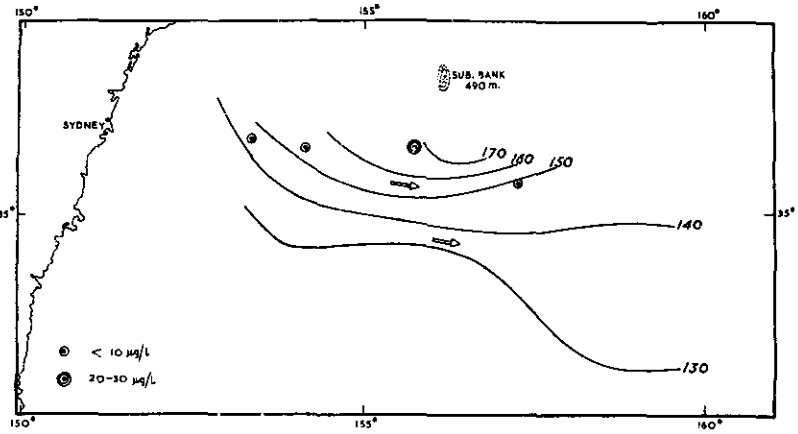

Fig.13. Magnitude of total phosphorus anomalies and contours of dynamic topography. Current direction indicated by broad arrows.

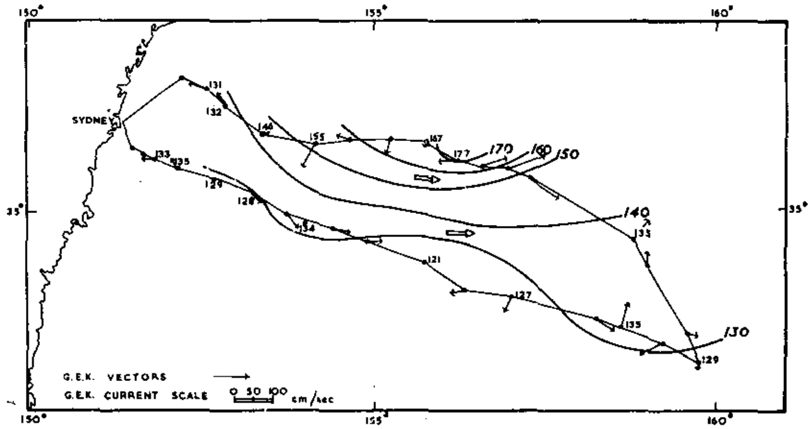

Fig.14. Dynamic topography of surface relative to 1000 decibar level. Contours at intervals of 10 dyn.cm. Surface current vectors from G.E.K. readings. Current direction indicated by broad arrows.

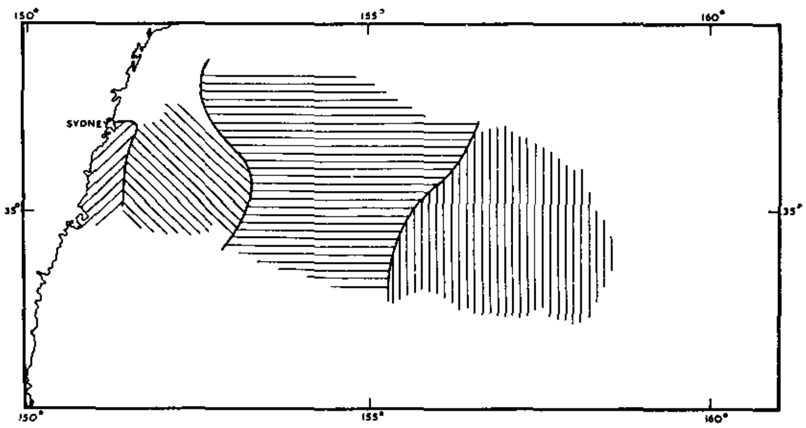

Fig.15. Phytoplankton communities determined from collections at stations on 110°T and 290°T section lines.

(b) PHYSICS - B.V. HAMON

(1) Dynamics

Dynamic height anomalies for the surface relative to the 1000 decibar level, and G.E.K. surface currents, are shown in Figure 14.

The contours of dynamic height indicate a strong off-shore movement of water throughout most of the area covered by the cruise. The volume transport to the east between Stations DH16/242/57 (dynamic height 177 dyn. cm.) and DH16/229/57 (dynamic height 121 dyn. cm.) was found to be 2.2×10^7 m^3/sec.

(2) Surface Current Measurements

G.E.K. measurements were made at a large number of stations on this cruise and the results are plotted in Figure 14. They show very variable agreement with the flow pattern from dynamic height contours.

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

At the time of this cruise the continental shelf water contained a neritic flora with slight Bass Strait characteristics. East of this lay a Coral Sea flora mixed with neritic elements and having a low phytoplankton content. Further east (Stations DH16/241 - 248/57) a Coral Sea flora occurred with a high dinoflagellate concentration more usually found in January. The Central Tasman flora occurred east of longitude 155°30'E with a boundary running approximately west-south-west. It also contained some Coral Sea elements. Figure 15 illustrates the distribution of the various communities and Tables 2 and 3 give a detailed list of the diatoms and dinoflagellates taken in the collections at the various stations.

TABLE 2

DIATOMS FROM PHYTOPLANKTON COLLECTIONS

SPECIES	219	220	221	222	223	224	226	229	231	233	235	238	239	241	242	245	246	247	248	249
Rhizosolenia setigera										+										
R. alata							+					+					+		+	+
f. gracillima	+	+		+	+	+		+	+	+					+	+	+			
R. bergonii							+						+							
R. imbricata v. shrubsolei												+								
R. hebetata													+							
R. styliformis													+			+				
Climacodium frauenfeldianum			+				+	+		+			+	++	+	+	+		+	
Streptotheca thamesis			+				++						+							
S. indica							+													
Chaetoceros concavicorne			+			+		+		+									+	
Ch. vanheurckii							+													
Ch. lorenzianum							+													
Ch. compressum							+													
Ch. simile							+						+							
Ch. secundum							+					+	+							
Ch. simplex										+			+							
Ch. lauderi													+							
Leptocylindrus danicus					+		+													
Coscinodiscus concinnus					+								+							
Lauderia annulata							+													
Stephanopyxis palmeriana							+													
R. stolterforthii							+													
R. delicatula							+													
Nitzschia seriata							+													
Thalassiotrix nitzschioides							+									+				
Bacteriastrum varians							+						+							
Guinardia flaccida							+						+							
Ch. eibenii													+				+			
Detonula confervacea														+						
Hemiaulus sinensis														+						
Planktoniella sol																				

TABLE 3 (p. 1)

DINOFLAGELLATES FROM PHYTOPLANKTON COLLECTIONS

SPECIES	219	220	221	222	223	224	226	229	231	233	235	238	239	241	242	245	246	247	248	249
Oscillatoria	+	+																		
Ceratium tripos	+						+					+	+	+		+	+	+	+	
C. furca						+														
C. fusus	+	+	+		+	+	+	+	+							+		+	+	
C. extensum	+																+	+		
C. massiliense				+										+		+			+	
C. arietinum					+												+			
C. trichoceros						+	+							+		+	+	+		
C. macroceros							+													
C. buceros													+						+	
C. carriense													+							
C. symmetricum													+	+				+		
C. breve													+	+				+	+	
C. karsteni													+							
C. pentagonum														+						
Diplopsalis lenticula		+	+		+		+			+		+					+			
D. **lenticula** f. minor						+				+			+	+++		+	+	+	+	
Goniodoma polyedricum																				
Dinophysis tripos							+													
Ceratocorys horridum														+						
Amphisolenia bidentata								+												
Peridinium steinii	+	+			+	+	+						+	++		+		+	+	

F0301

TABLE 3 (p. 2)

DINOFLAGELLATES FROM PHYTOPLANKTON COLLECTIONS

SPECIES	219	220	221	222	223	224	226	229	231	233	235	238	239	241	242	245	246	247	248	249
P. roseum			+																	
P hirobis			+														+			
P. pedunculatum			+							+										
P. pentagonum				+																
P. granii				+		+							+	+					+	
P. brochii					+		+	+				+		++						
P. breve						+														
P. curtipes						+	+						+	+		+				
P. divergens							+											+		
P. grande							+													
P. abei							+						+	+						
P. oceanicum												+								
P. orbiculare													+			+				
P. pellucidum														+						
P. oblongum														+			+			
P murrayi																	+	+		
P. solidicorne																	+			
P. okamurai																		+		
Pyrophacus horologicum			+				+						+	+				+	+	
Podolampes bipes														+						
Dinophysis caudata													+	+			+			
C. contrarium																	+			
Goniaulax kofoidi																	+		+	

F0301

DIVISION OF FISHERIES AND OCEANOGRAPHY

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