COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 27

F.R.V. "DERWENT HUNTER"

Scientific Report of Cruises 1/58
January 3 - January 10, 1958

Scientific Report of Cruise 2/58
February 5 - February 14, 1958

Scientific Report of Cruise 3/58
February 19 - February 21, 1958

Scientific Report of Cruise 4/58
February 27 - March 7, 1958

Scientific Report of Cruise 5/58
March 12 - March 16, 1958

Scientific Report of Cruise 6/58
April 9 - April 16, 1958

Scientific Report of Cruise 7/58
April 27 - April 25, 1958

Scientific Report of Cruise 8/58
April 30 - May 13, 1958

Scientific Report of Cruise 9/58
May 13 - June 1, 1958

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	- G. Reid (January 3 - February 27, 1958)
	- H. Davenport (February 28 - June 1, 1958)
Deckhands	- G. Ross
	- W. Elsmore
Cook	- A. Jackson
Oceanographical Assistant	- J. Staniforth

The study of the structure and dynamics of the East Australian Current off Sydney was continued. Scientific reports of Cruises DH1/58, 2/58, 4/58, 6/58, and 8/58 deal with data from the sections planned for this study. These reports do not attempt to relate the data from these cruises to those of previous cruises, that will be done in scientific papers to be published elsewhere.

Cruises DH3/58, 5/58, 7/58 were cruises planned to measure the rate of uptake of CO_2. Owing to faulty equipment the CO_2 uptake results of Cruise DH7/58 could not be used. Cruise DH9/58 was carried out in Port Phillip Bay by the Division of Meteorological Physics.

When citing this report abbreviate as follows:
C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 27

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH1/58

January 3-10, 1958

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)

ITINERARY

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

SCIENTIFIC REPORTS

Hydrological sampling was carried out at 0, 25, 50, 75, 100, 150, 200, 250, 300, 500, 750, 1000, and 1500 m. Thermometric depths were calculated at all sampling depths below 100 m and the accepted depths are considered accurate to within the limits of this method. Phytoplankton was sampled as on previous cruises of this series.

(a) HYDROLOGY - D.J. ROCHFORD

(1) Temperature

(a) 110° Section Line (Fig. 2)

Surface temperatures of 25.0°C were found on this section, around longitude 154°E. These warm waters were separated by a very sharp temperature boundary (4°C in 10 miles) from much colder (19°C) waters at the eastern end of the section. To the west of the warm water, temperatures decreased less sharply with a secondary region of warm waters (> 23°C) developed at Station DH1/5/58. No thermocline was found along this section. The sub-surface changes in temperature were probably due to eddy formation along the southern boundary of the predominantly easterly flow (Fig. 13).

(b) 290° Section Line (Fig. 3)

A surface band of warm water with temperature between 23° and 25.75°C was found between 153° and 155°E. This formed part of the easterly flow of tropical water (Fig. 13).

The relatively high subsurface temperatures at Station DH1/17/58 in particular were caused by the dynamic transfer of warm water from the surface.

(2) Density (σ_t)

(a) 110° Section Line (Fig. 4)

A strongly developed pycnocline (maximum 0.04 σ_t/m) was centred around 154°E., and extended west with varying intensity almost to the coastal region. Offshore from 154°E. the intensity of the pycnocline decreased rapidly. A boundary, as sharp as that for temperature in Figure 2, probably occurred, but it is not drawn in. A deeper level pycnocline was found at Station DH1/12/58.

(b) 290° Section Line (Fig. 5)

The lightest water was found on the western end of the section where a well developed pycnocline (maximum 0.03 σ_t/m) at depths from 20-120 m marked its onshore boundary. At Station DH1/15/58 a pycnocline occurred of the same intensity but shallower in extent. The deepening of the isopycnal surfaces between Stations DH1/15/58 and DH1/21/58 was an effect of the transport of lighter tropical waters.

(3) Percentage Oxygen Saturation

(a) 110° Section Line (Fig. 6)

At the surface, saturation or near-saturation in oxygen occurred at each end of the section. Between Stations DH1/5/58 and DH1/8/58 a near surface doming of waters less than 75 per cent. saturated, created a region of surface undersaturation. This doming of undersaturated waters was not paralleled by changes in the density field (Fig. 4) and may therefore have been caused in part at least by biological demand. Below about 600 m the fields of density and oxygen saturation agree reasonably well.

(b) 290° Section Line (Fig. 7)

Undersaturation in oxygen was found along the entire section, with saturation values occurring only at Station DH1/15/58 at a depth below the pycnocline (Fig. 5). At Station DH1/21/58 the very low saturation values at 40 m were probably caused by dynamic uplift or the occurrence of a subsurface water mass with very different density - oxygen saturation relationships. The relatively higher

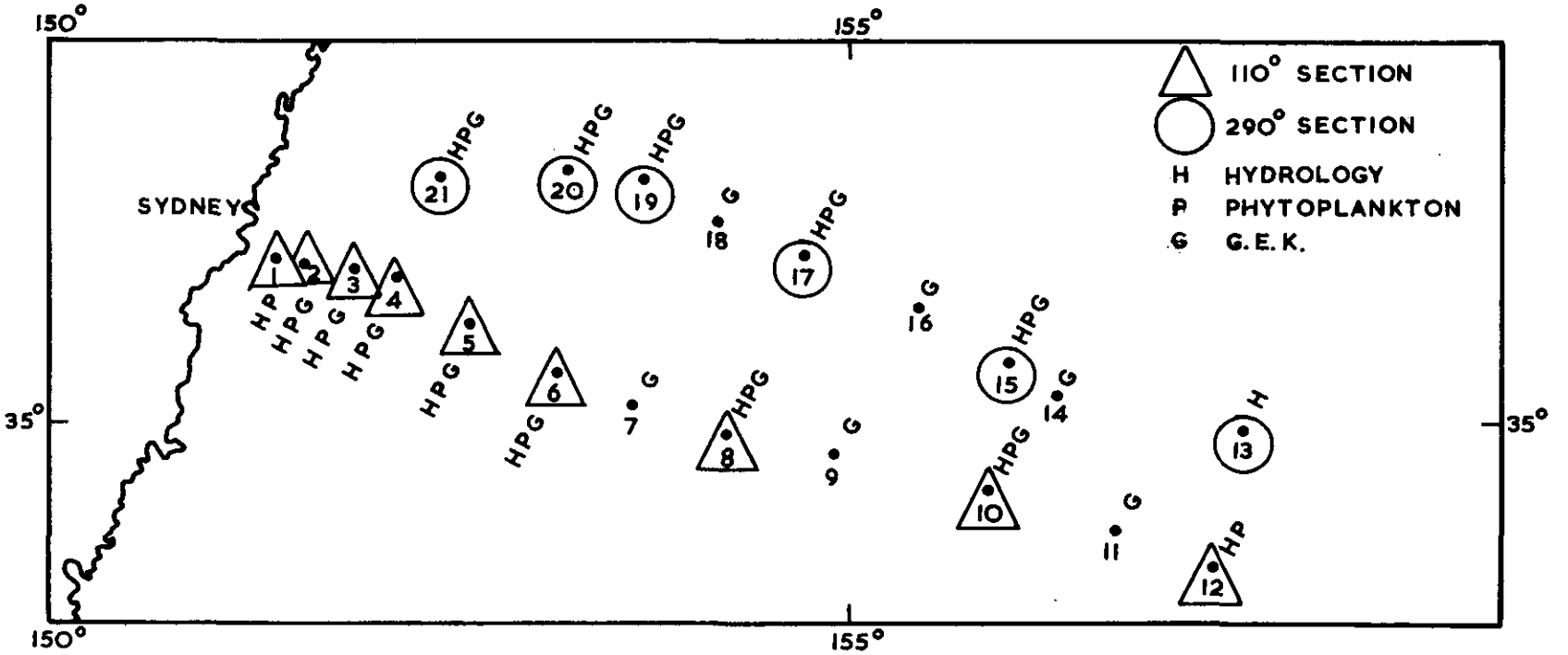

Fig. 1.- Cruise DH1/58. Track chart showing positions of stations.

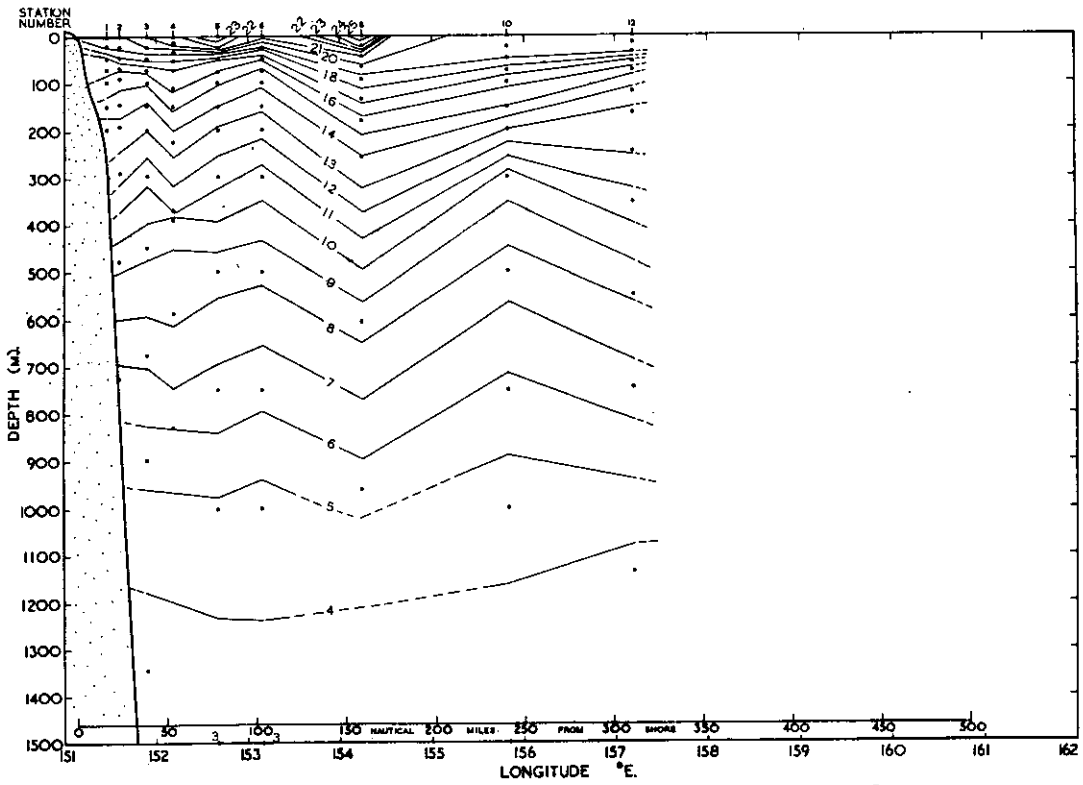

Fig. 2.- Sectional distribution of temperature (^{o}C) along 110^{o}T line to 1500 m.

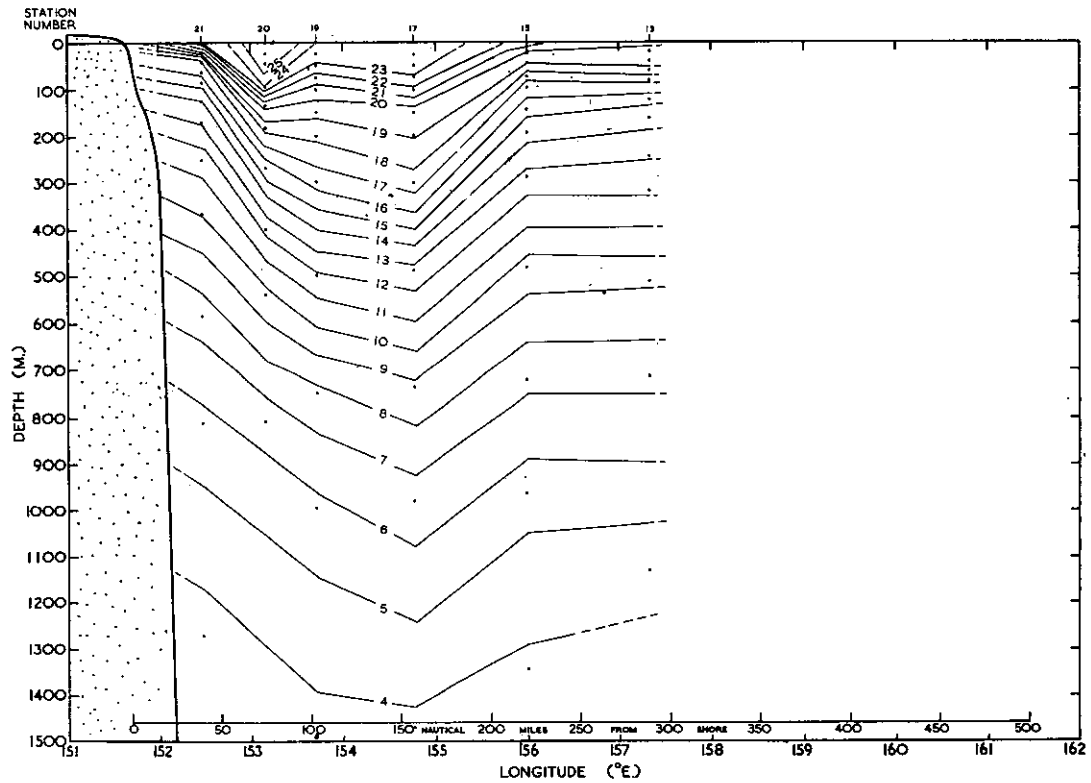

Fig. 3.- Sectional distribution of temperature (^{o}C) along 290^{o}T line to 1500 m.

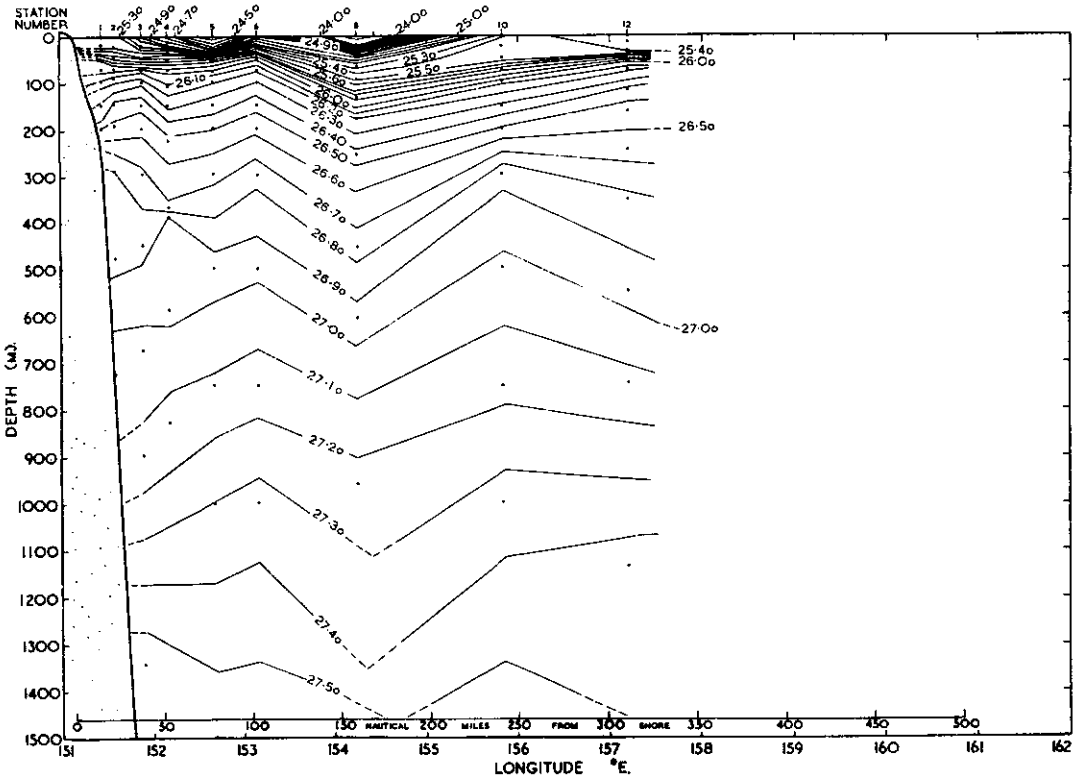

Fig. 4.- Sectional distribution of density (σ_t) along 110°T line to 1500 m.

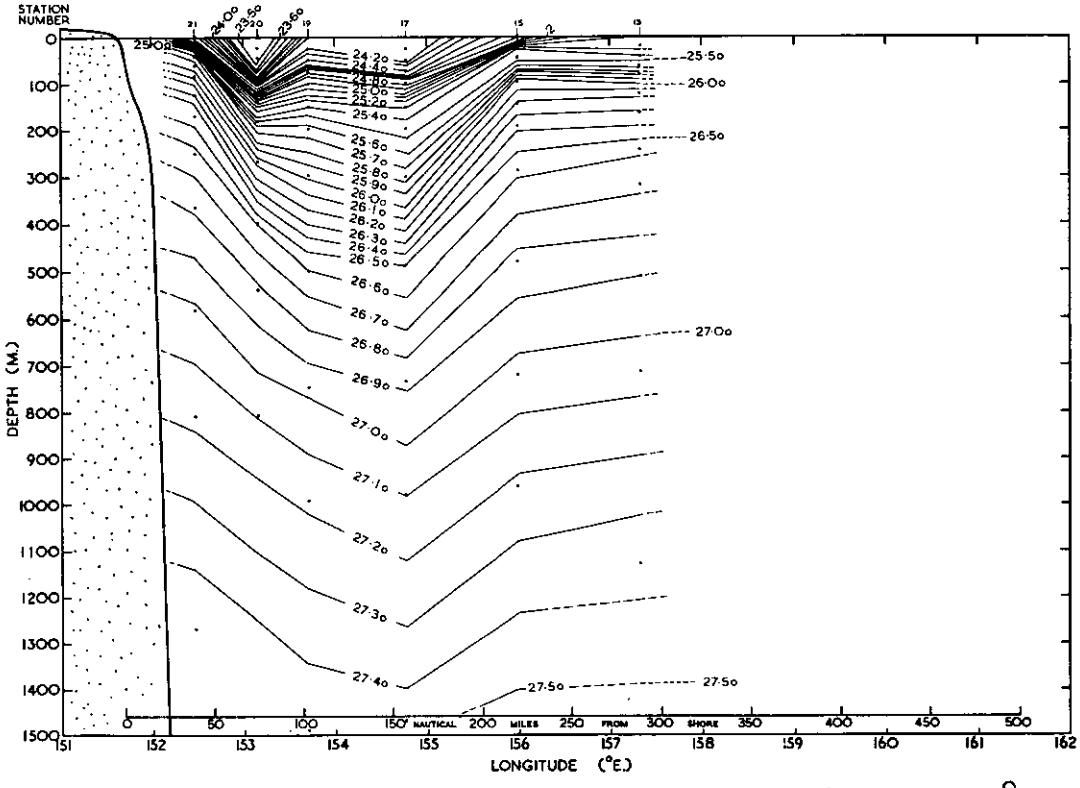

Fig. 5.- Sectional distribution of density (σ_t) along 290°T line to 1500 m.

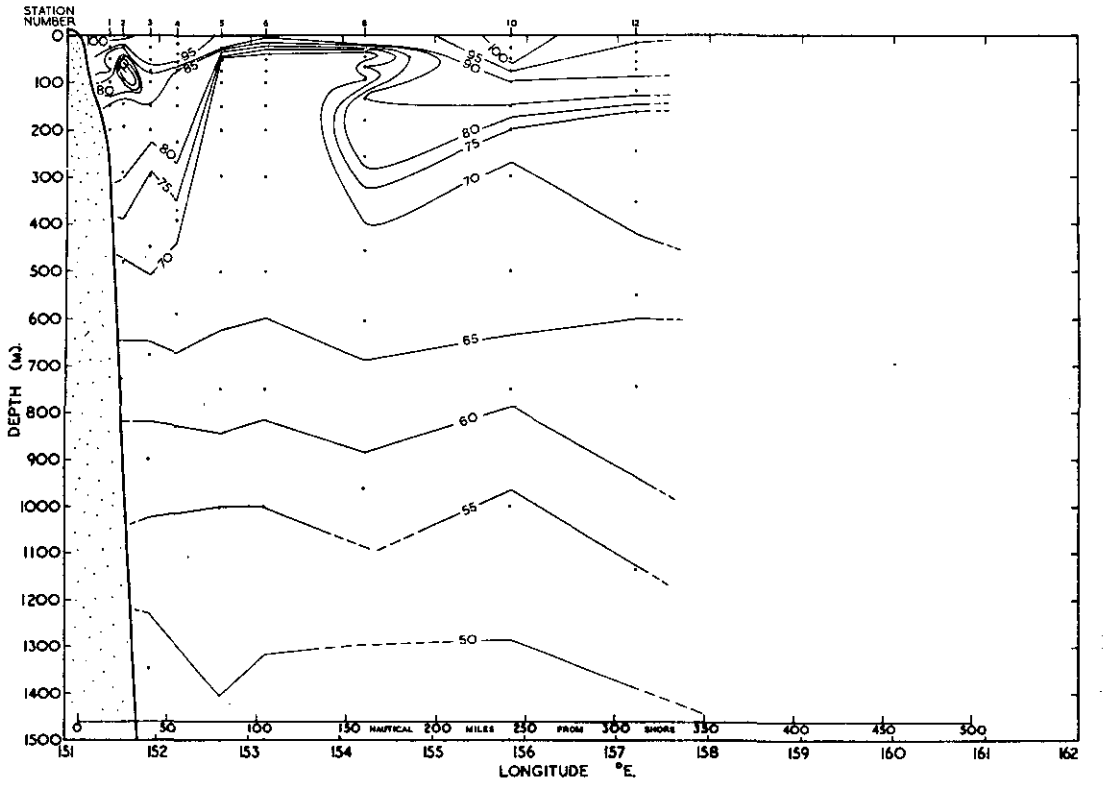

Fig. 6.- Sectional distribution of oxygen saturation (%) along 110°T to 1500 m.

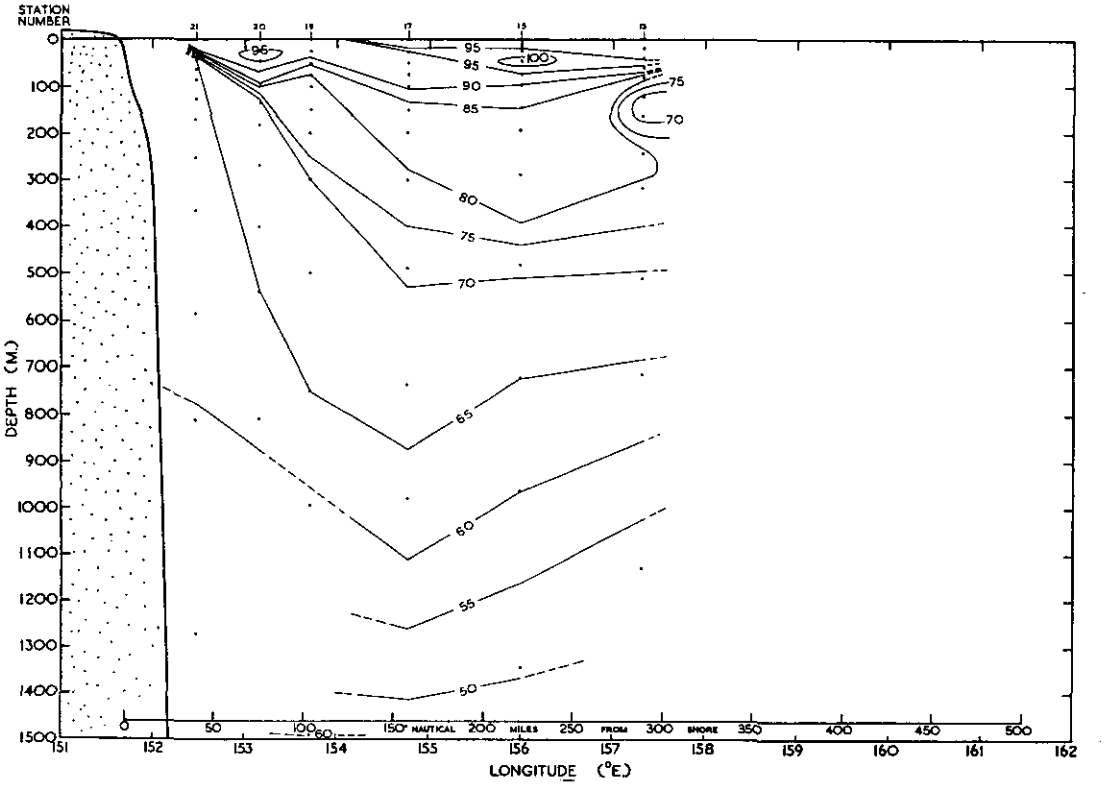

Fig. 7.- Sectional distribution of oxygen saturation (%) along 290°T to 1500 m.

saturation values at Station DH1/17/58 below 600 m were associated with a deepening of the isopycnal surfaces (Fig. 5) and were therefore caused by dynamic processes.

(4) Total Phosphorus

(a) 110° Section Line (Fig. 8)

The most striking feature in the upper layers was the doming of high total phosphorus waters at Station DH1/6/58 paralleling a similar doming of low oxygen content waters in the same region (Fig. 6). The total phosphorus and density fields (Fig. 4) are in agreement below about 600 m except at Station DH1/12/58.

(b) 290° Section Line (Fig. 9)

Minimum subsurface total phosphorus values were found beneath Station DH1/17/58 in agreement with relatively higher oxygen content (Fig. 7) and the deepening of the isopycnal surfaces (Fig. 5).

(5) Horizontal Distribution of Properties

(a) Percentage oxygen saturation (Fig. 10)

At the surface (Fig. 10A) undersaturated waters entered the region at Station DH1/20/58 and flowed east with the general surface circulation. The oxygen content of these waters increased along the path of easterly flow. At 100 m (Fig. 10B) the waters entering the north were low in oxygen content, but along the path of surface flow, entry of oxygen rich waters along the left hand boundary rapidly decreased their degree of undersaturation. At 300 m (Fig. 10C) the waters entering from the north maintained a low oxygen content along their path of flow.

(b) Total phosphorus (Fig. 11)

The waters entering the region from the north at the surface had a minimum total phosphorus content of 10-12 $\mu g/l$. (Fig. 11A). At 100 m (Fig. 11B) the waters along the path of surface flow decreased rapidly in total phosphorus from west to east and this appeared to be caused by an entry of waters of low total phosphorus in the region of Station DH1/17/58. At 300 m (Fig. 11C) the maximum total phosphorus values lay along the region of minimum oxygen content (Fig. 10C) in the direction of the surface flow.

(6) Regional Water Masses

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

TABLE 1

REGIONAL WATER MASSES

Water Mass	Density	Total Phosphorus	Temp. °C (From station data)	Chlorinity ‰
A	23.48	13	25.75	19.63
B	25.35	10	19.70	19.70
C	26.47	20	13.90	19.55
D	27.55	63	3.05	19.15

Water mass A, at the surface, appears to be the Coral Sea of Rochford (1957)* and forms the core of the major flow. Water mass B, at levels between 0 and 200 m, had the properties of the Central Tasman and was found at the majority of stations. Water mass C, the South-west Tasman of Rochford (1957),* was found between 200 and 500 m at most stations. Water mass D was part of the deepest layers of the Sub-Antarctic Intermediate Water, and generally occurred between 1300 and 1600 m.

*Rochford, D.J. (1957).- The identification and nomenclature of the surface water masses in the Tasman Sea (data to the end of 1954). Aust. J. Mar. Freshw. Res. 8: 369-413.

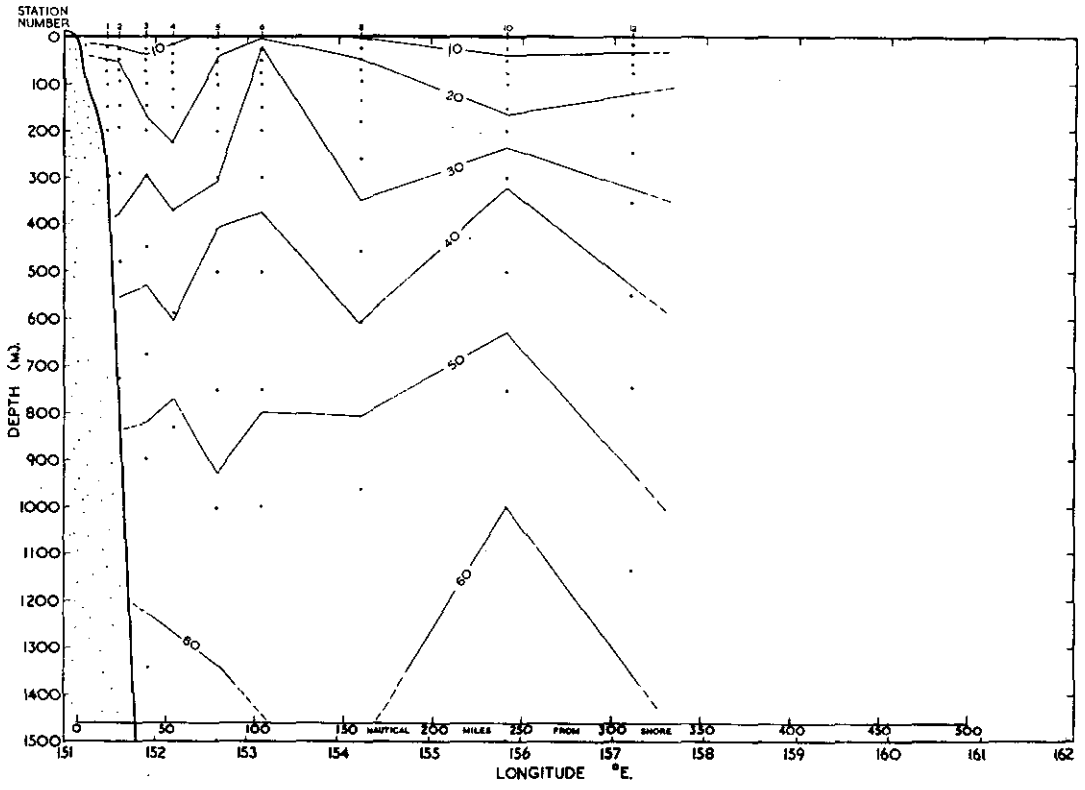

Fig. 8.- Sectional distribution of total phosphorus along 110°T to 1500 m.

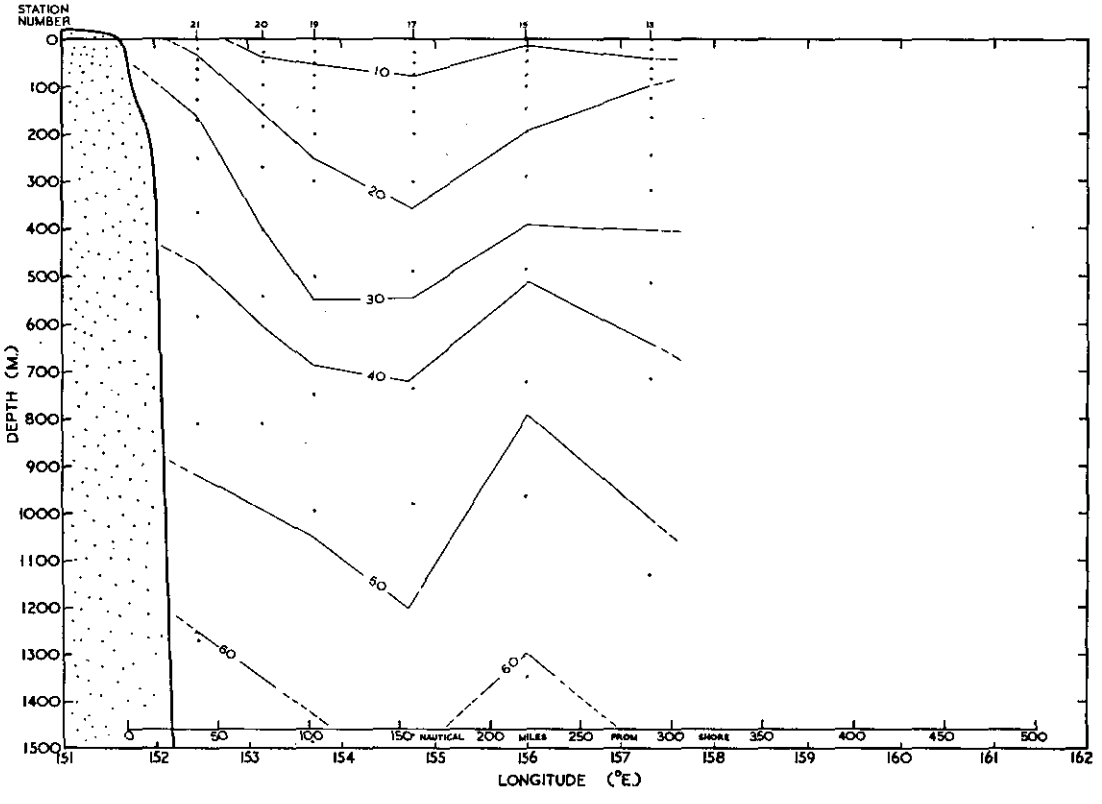

Fig. 9.- Sectional distribution of total phosphorus along 290°T to 1500 m.

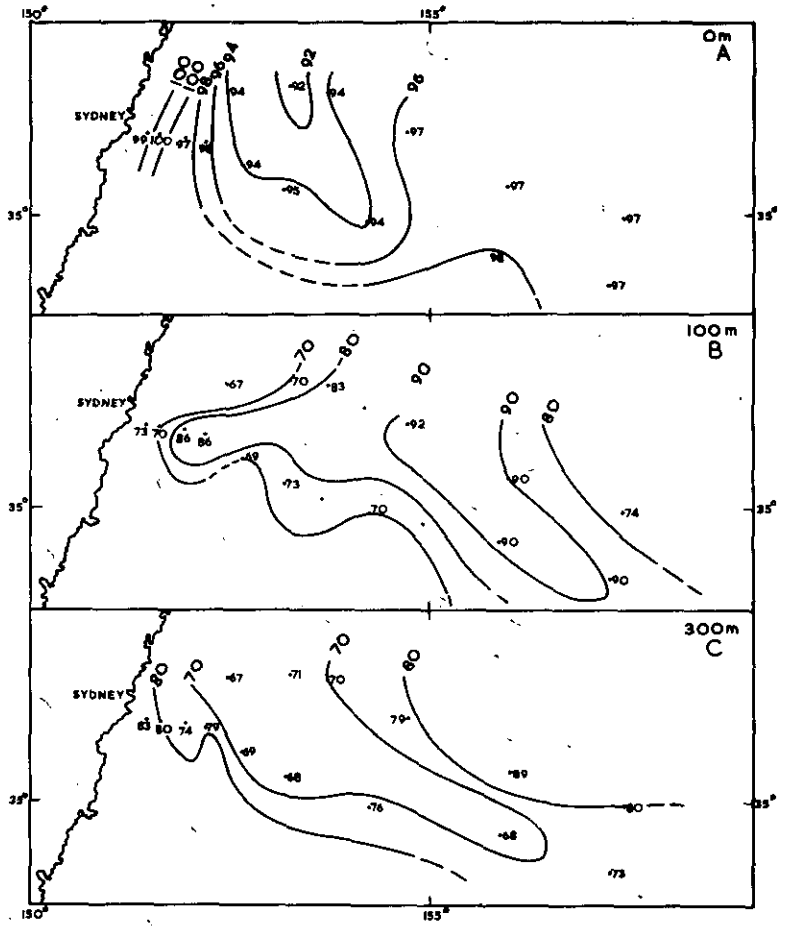

Fig. 10.- Horizontal distribution of oxygen saturation (%). A at 0 m, B at 100 m, C at 300 m.

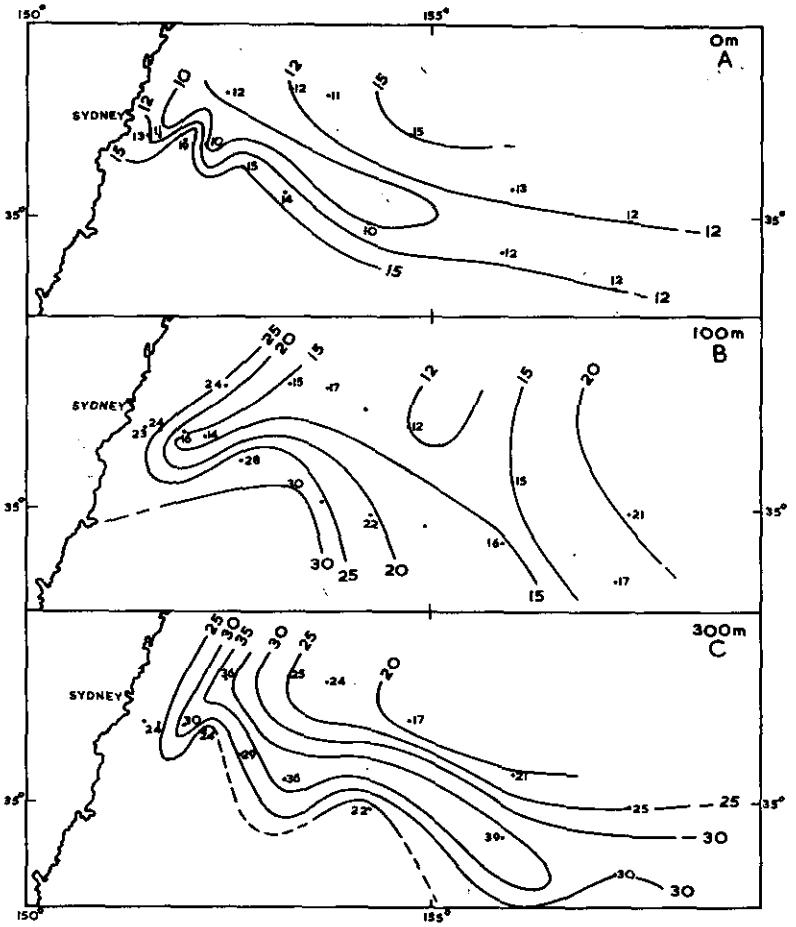

Fig. 11.- Horizontal distribution of total phosphorus A at 0 m, B at 100 m, C at 300 m.

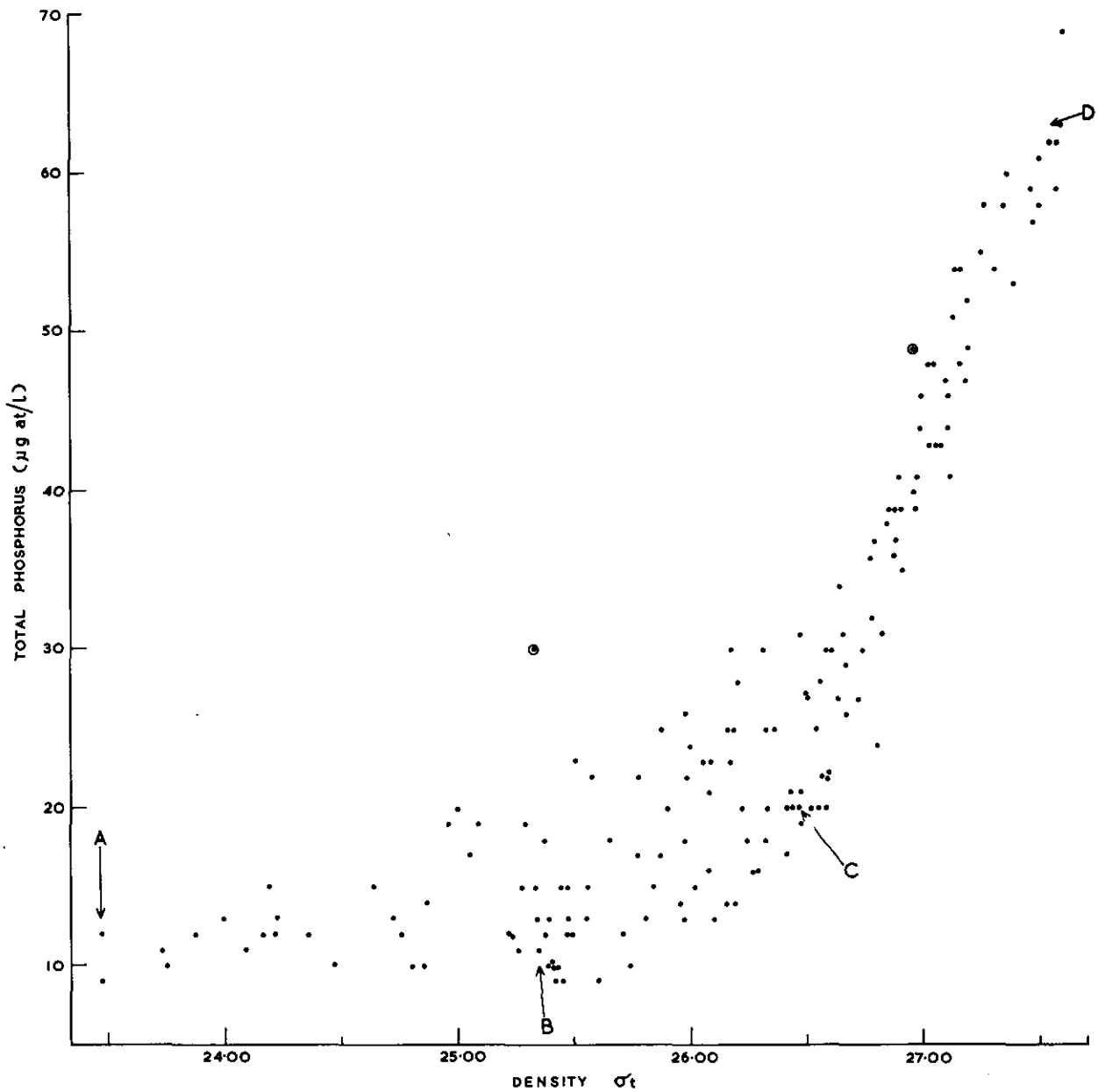

Fig. 12.- Total phosphorus to density (σ_t) relationships.

(b) PHYSICS - B.V. HAMON

Dynamics

Figure 13 shows the surface dynamic heights at each station, with approximate contours at intervals of 10 dynamic centimetres. Figure 14 shows the G.E.K. vectors.

There was evidence of a narrow swift southerly current about 80 miles E.N.E. from Sydney. The current turned towards the east and finally towards the north-east or north when about 200 miles east of Sydney.

The volume transport towards E.S.E. in the upper 1000 metres, between Stations 6 and 19 was found to be 18×10^6 m^3/sec.

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

Table 2 lists the dinoflagellates and Table 3 the diatoms taken at each station where phytoplankton hauls were made on this cruise. These indicate that the phytoplankton community of the Coral Sea water mass was predominant at the time of this cruise. In Figure 15 certain areas have been defined. In Area I the Coral Sea flora and the neritic flora are mixed, in Area 2 the Coral Sea flora alone occurs, and in Area 3 it is mixed with flora of the cooler water from Bass Strait, Tasmania. In Area 4 occurred Coral Sea forms plus the rare Coscinodiscus rex and Dinophysis miles, which has not previously been found south of latitude 15° S., and Ceratium vultur, Peridinium grande, and Ceratocorys horridum which are frequent in the Arafura Sea phytoplankton. A previous record of Ceratium dens in New South Wales waters (Wood 1954)* together with data from this cruise suggests that, at times, the phytoplankton community moving east through Torres Strait may not lose its identity completely in the Coral Sea, and may persist as far south as latitude 34°S. Area 5 is an area of low occurrence of phytoplankton, particularly of the larger organisms, but still contains a few representatives of the Coral Sea community.

*Wood, E.J.F. (1954).- Dinoflagellates in the Australian region. Aust. J. Mar. Freshw. Res. 5: 171-351.

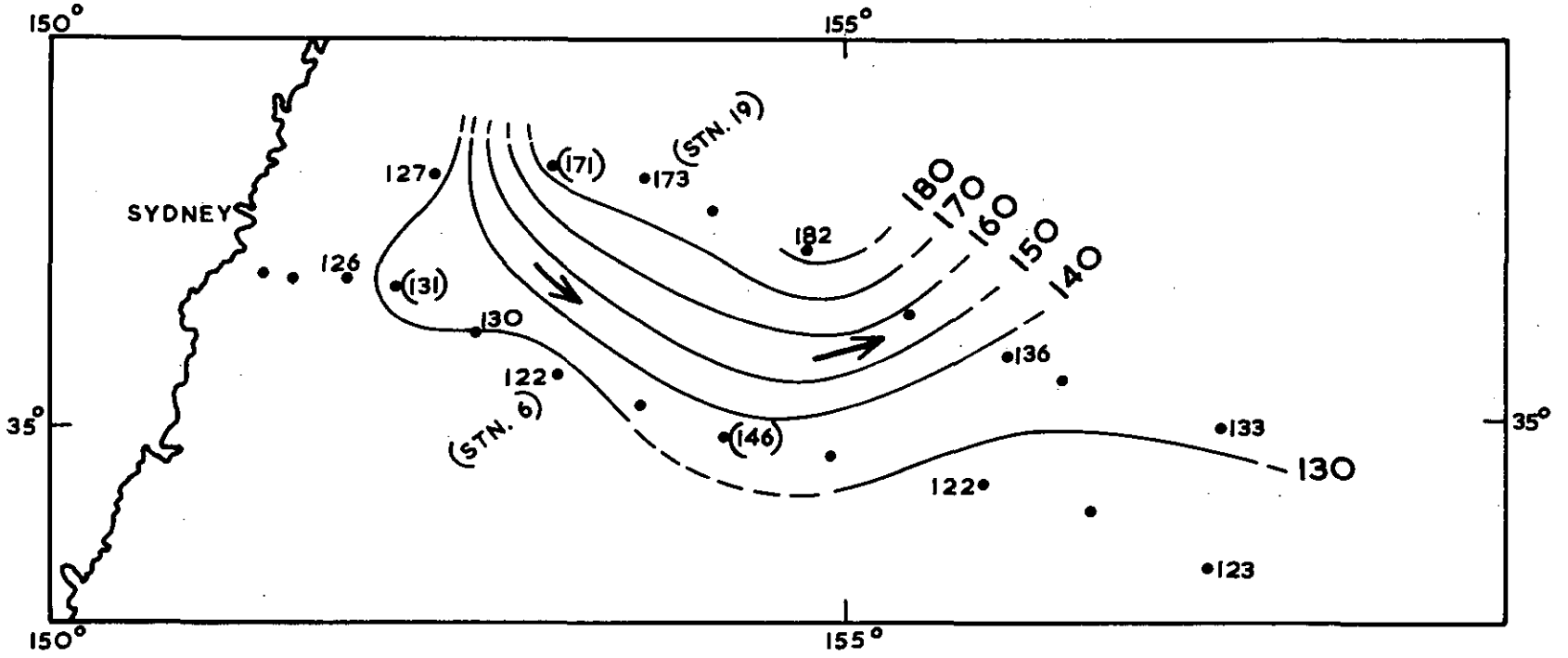

Fig. 13.- Contours of dynamic heights in dynamic centimetres (0/1000 decibars).

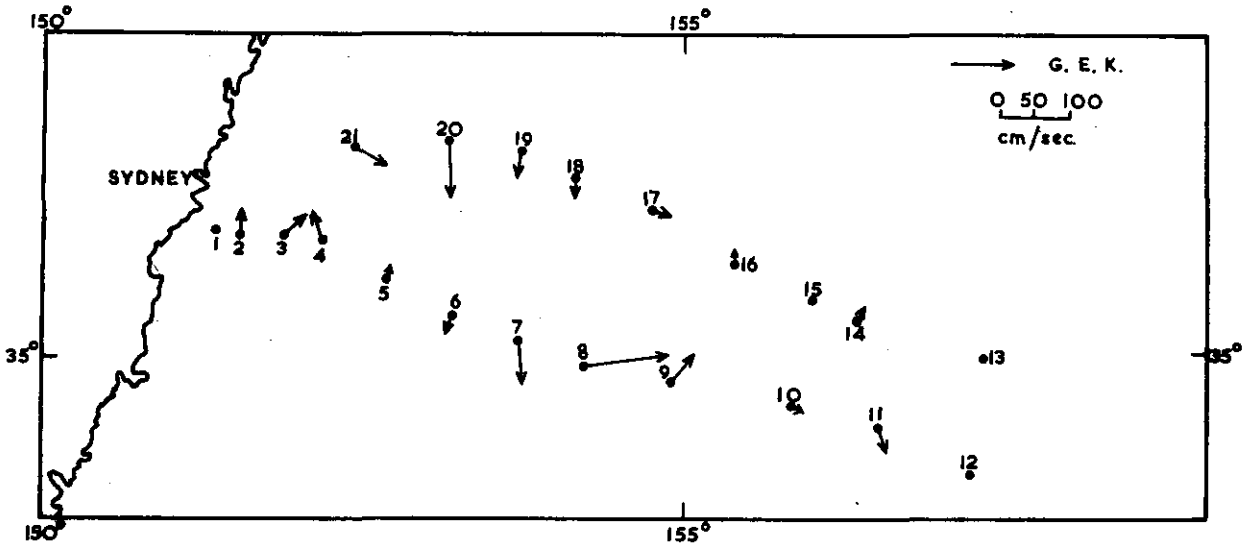

Fig. 14.- Surface current vectors from G.E.K. readings.

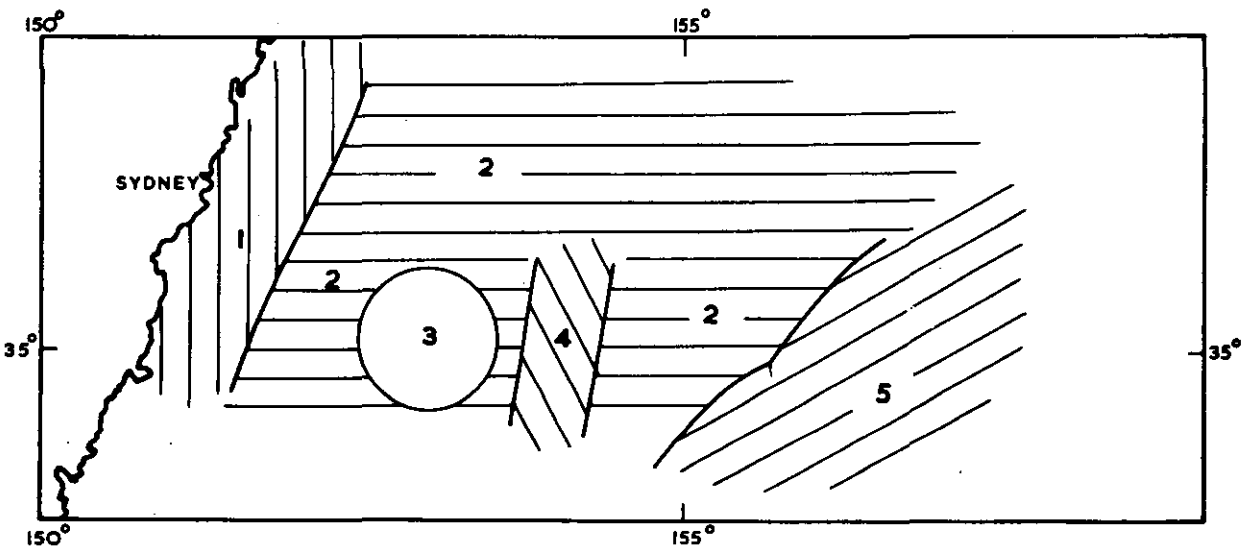

Fig. 15.- Phytoplankton communities determined from collections on 110°T and 290°T section lines. 1. Coral Sea and neritic flora, 2. Coral Sea flora, 3. Coral Sea and Bass Strait, 4. Coral Sea and Arafura Sea flora, 5. Little phytoplankton.

TABLE 2

DINOFLAGELLATES COLLECTED AT STATIONS

SPECIES	STATION													
	1	2	3	4	5	6	8	10	13	15	17	19	20	21
Diplopsalis minor										++	+	+	+	+
D. lenticula	+	+	+	+	+	++	+				+	+	+	+
Pyrophacus horologicum				+	+	++		+		+		+	+	+
Dinophysis tripos				+								+	+	
D. caudata			+	+		+								
D. miles						+								
Phalacroma mitra														+
Ceratocorys horridum						+								
Ceratium furca				+										
C. fusus	+	+	+	+		+				+				+
C. euarcuatum						+						+		
C. tripos	+	+		+	+					+	+	+	+	+
C. macroceros	+													
C. massiliense f. macroceroides		+	+		+	+								+
C. carriense														
C. teres		+		+			+	+						
C. horridum		+			+									
C. falcatum			+							+				
C. buceros			+	+	+			+			+			
C. trichoceros			+		+	+		+		+	+	+	+	+
C. contrarium				+			+	+				+		+
C. extensum				+							+	+		
C. gibberum				+										
C. karsteni				+			+			+				+
C. candelabrum				+	+							+		
C. vultur v sumatrana				+										
C. lunula						+								
C. symmetricum						+								
C. concilians						+								
C. pavillerdi							+							
C. kofoidi							+							

TABLE 3

DIATOMS COLLECTED AT STATIONS

SPECIES	STATION													
	1	2	3	4	5	6	8	10	13	15	17	19	20	21
Skeletonema costatum	+											+		
Coscinodiscus concinnus			+							+		+		
C. centralis												+		
C. rex						+								
Stephanopyxis palmeriana			+			+				+				+
Leptocylindrus danicus					+									
Rhizosolenia alata			+		+		+					+		+
f. gracillima	+	+	+	+	+	+	+		+	+	+	+	+	
f. corpulenta										+				
R. setigera				+								+		
R. bergonii					+		+			+		+		
R. styliformis							+			+	+	+		
R. cylindrus							+			+				
R. stolterforthii							+			+		+		
R. fragilissima									+					
Planktoniella sol											+			
Chaetoceros lorenzianum	+				+					+		+		
Ch. peruvianum	+				+		+				+	+		
Ch. teres		+			+							+		
Ch. concavicorne	+	+												
Ch. secundum	+						+			+		+		
Ch. coarctatum	+													
Ch. convolutum							+							
Ch. lauderi										+				
Ch. simplex										+		+		
R. delicatula										+				
R. clevei										+				
Guinardia flaccida					+						+	+		
Nitzschia seriata					+		+		+	+	+	+		
N. closterium										+				
N. longissima				+				+		+				
Fragilaria sp.				+			+							
Climacodiun frauenfeldianum		+	+	+	+	+	+	+		+	+			+
Hemiaulus membranaceus				+			+							
H. hauckii														
Thalassiothrix longissima	+	+												
H. sinensis				+										
Thalassiosira condensata										+				
Oscillatoria														
Bactermastrum varians										+				
Thal. nitzschioides											+			
Ch. paradoxa														+

TABLE 3 (cont.)

SPECIES	STATION													
	1	2	3	4	5	6	8	10	13	15	17	19	20	21
C. gallicum								+						
C. hexacanthum										+				
C. schmidtii										+	+			
C. divaricatum											+	+		
C. setaceum													+	
Goniaulax pacifica	+													
Peridinium latispinum		+		+		+								
P. brochii			+			+	+					+		+
P. abei				+		+								
P. steinii					+	+								
P. globulus					+				+	+		+		
P. pyriforme					+					+				
P. curtipes						+					+			
P. quarnerense						+							+	
P. grande						+						+		
P. murrayi						+								
P. orbiculare											+		+	
P. conicum										+				
P. okamurai							+			+				+
P. oceanicum										+	+		+	+
P. divergens						+					+			
P. ventricum											+	+		
P. pedunculatum											+	+		+
P. granii														+
Goniodoma polyedricum						+				+				
Amphisolenia bidentata				+										
Ornithocercus steinii					+									
Noctiluca miliaris							+							
C. pentagonum										+				
C. pulchellum												+		
Gonialuax monacantha												+		
P. oblongum												+		
Oxytoxum scolopax													+	

+ present ++ abundant

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH2/58

February 5-14, 1958

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)

ITINERARY

This is the eighth of the series of cruises to study the physical and chemical structure and circulation of the East Australian Current off Sydney. Owing to bad weather the 290°T Section Line was not worked on this cruise. Figure 1 shows the positions of stations, and indicates the work done at each station.

SCIENTIFIC REPORTS

Samples for chlorinity, dissolved oxygen, and total phosphorus were taken at the usual depths down to 1500 m. Temperatures from paired, protected and unprotected, thermometers were used to calculate thermometric depth below 100 m. G.E.K. tows and B.T. lowerings were done on some stations. Phytoplankton samples were taken as indicated in Figure 1.

(a) HYDROLOGY - A.D. CROOKS

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

The maximum surface temperature of 26.50°C occurred at Station DH2/23/58 and the minimum of 20.96°C at Station DH2/31/58. There was a layer of homogeneous water, 30 m in depth, between 151°30'E. and 153°E. East of Station DH2/27/58, there was a sharp drop in surface temperature, to Station DH2/28/58, after which the surface temperature remained fairly constant.

There was a well developed thermocline between 30 m and 130 m at Stations DH2/22 and 23/58 (vertical temperature gradient of 0.1°C/m). East of Station DH2/28/58 another thermocline was found whose average depth varied between 20 m at Station DH2/29/58 and 70 m at Station DH2/32/58. The average vertical temperature gradient was 0.08°C/m. The maximum temperature for all depths occurred at Station DH2/26/58 and the minimum at Station DH2/28/58.

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

Between 151°30'E. and 153°E. there was a homogeneous 30 m stratum of low density water with a minimum of 23.22 sigma-t at Station DH2/23/58. Maximum surface density of 24.99 sigma-t occurred at Station DH2/31/58.

A well developed pycnocline occurred east of 154°E. Its average depth varied between 30 m at Stations DH2/28 and 29/58 and 80 m at Station DH2/31/58. Its vertical gradient varied between 0.01 at Station DH2/30/58 and 0.03 sigma-t at Station DH2/28/58. A pycnocline also occurred between 130 and 160 m at Station DH2/23/58. (Vertical gradient 0.02 sigma-t/m). Maximum density for all depths was observed at Station DH5/29/58 and minimum at Station DH2/26/58. Generally the heavy water occurred between Stations DH2/28 and 29/58 with lighter water to the east and west, the coastal water being relatively dense.

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

Maximum surface chlorinity (19.71‰) occurred at the most easterly Station DH2/31/58 and minimum (19.50‰) at Stations DH2/24 and 29/58. Between Stations DH2/23 and 27/58 a sub-surface maximum occurred, the depth of which varied between 75 m at Station DH2/23/58 and 130 m at Station DH2/27/58. The depth of the chlorinity minimum varied between 950 m at Station DH2/29/58 and 1225 m at Station DH2/27/58. For all depths maximum chlorinity occurred at Station DH2/26/58 and minimum at Station DH2/28/58.

The distribution of chlorinity was closely related to that of sigma-t except above 200 m at the coastal stations and above 300 m between Stations DH2/30 and 31/58.

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

The surface was generally well undersaturated with an oxygen minimum of 78 per cent. at Station DH2/27/58. Only at two stations (DH2/22 and 30/58) was the surface water saturated, 100 per cent. and 102 per cent. respectively. The dotted line in Figure indicates a possible oxygen maximum. The oxygen values were at a maximum at all depths at Station DH2/26/58, 80 per cent. being found at 530 m.

(5) Total Phosphorus - 110°T Section Line (Fig. 6)

Maximum surface values (14 µg/l.) were found at Stations DH2/22, 29, and 31/58, and minimum (10 µg/l.) at Stations DH2/24, 25, and 27/58. A maximum of total

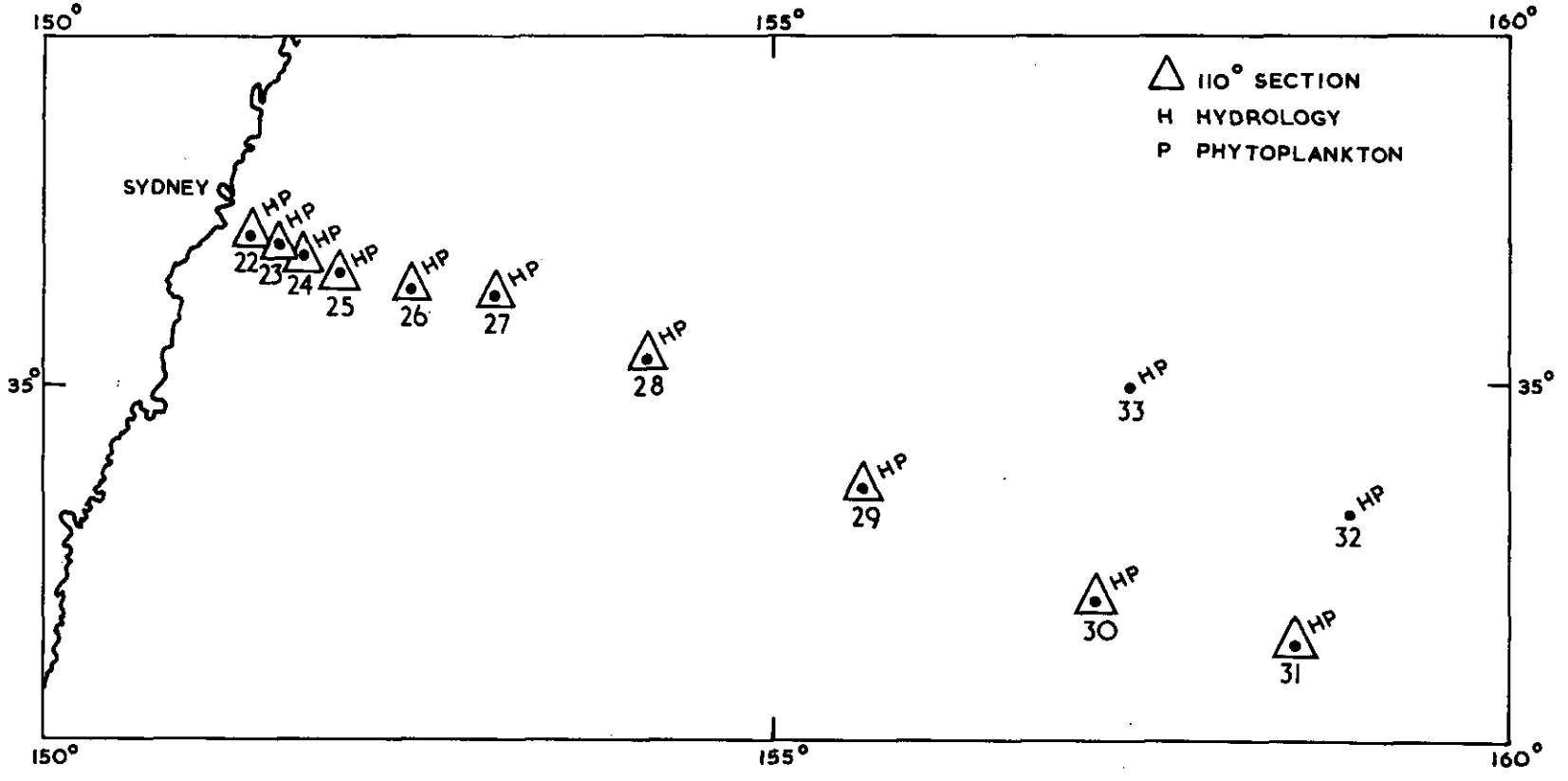

Fig. 1.- Track chart showing positions of stations.

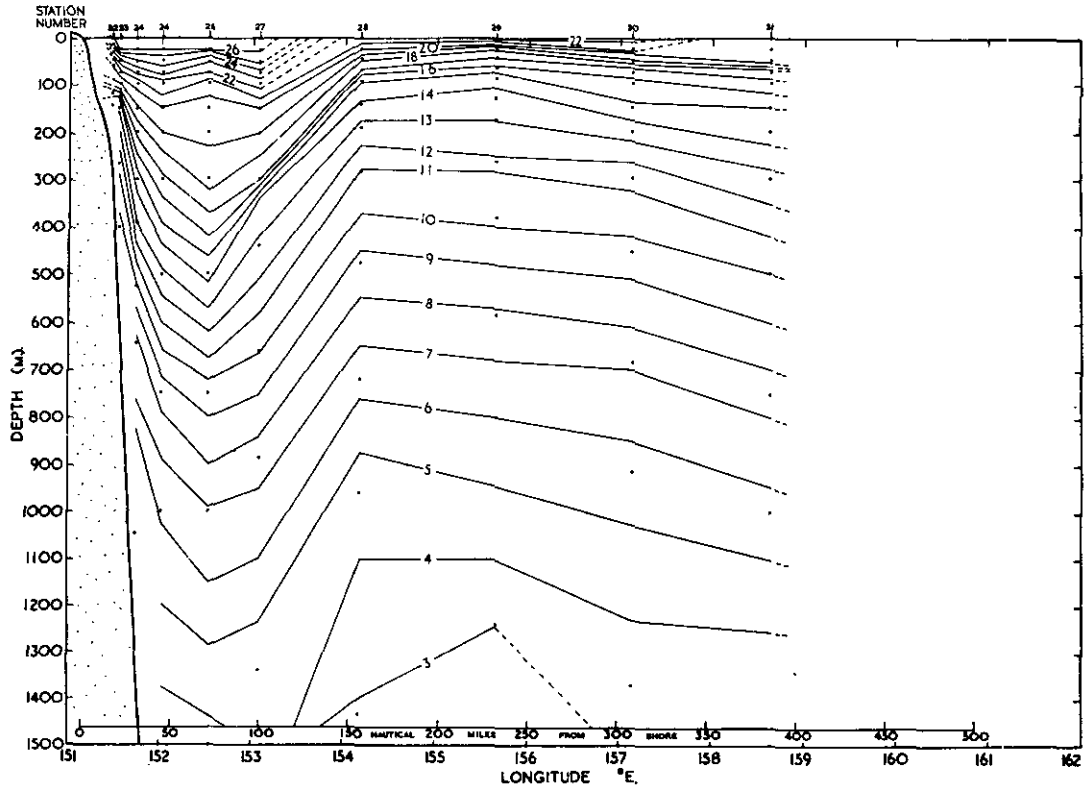

Fig. 2.- Sectional distribution of temperature (^{o}C) along 110^{o}T line to 1500 m.

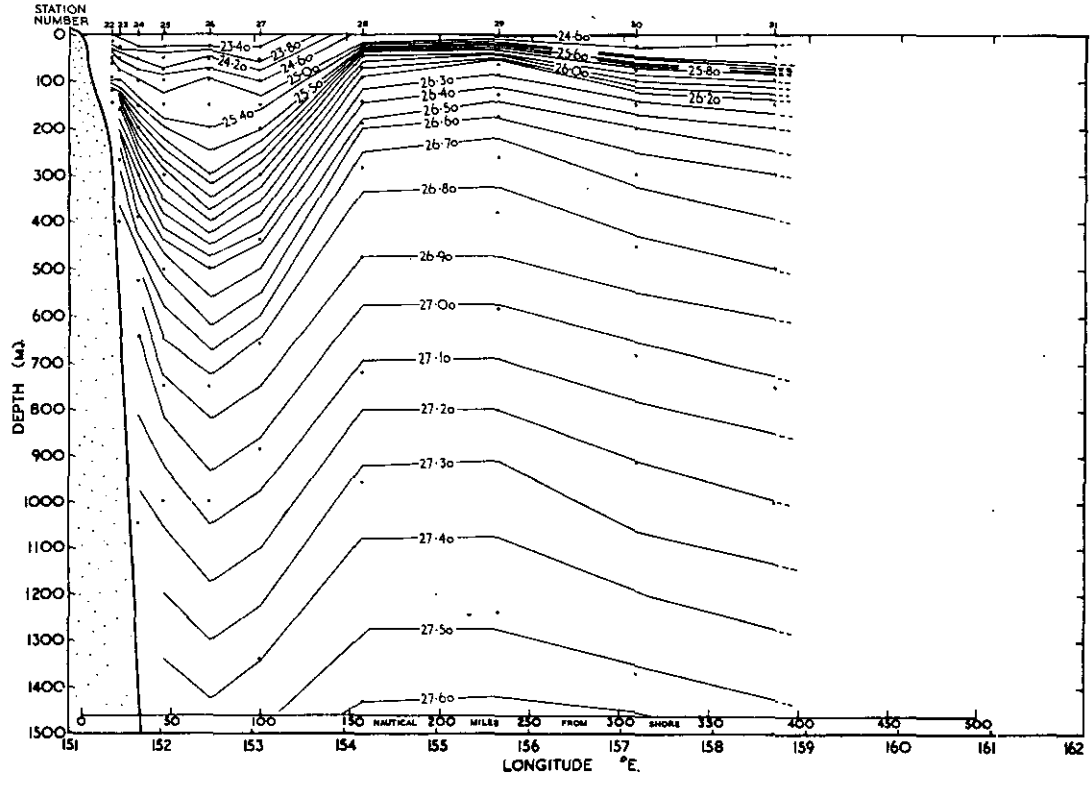

Fig. 3.- Sectional distribution of density (σ_t) along 110^{o}T line to 1500 m.

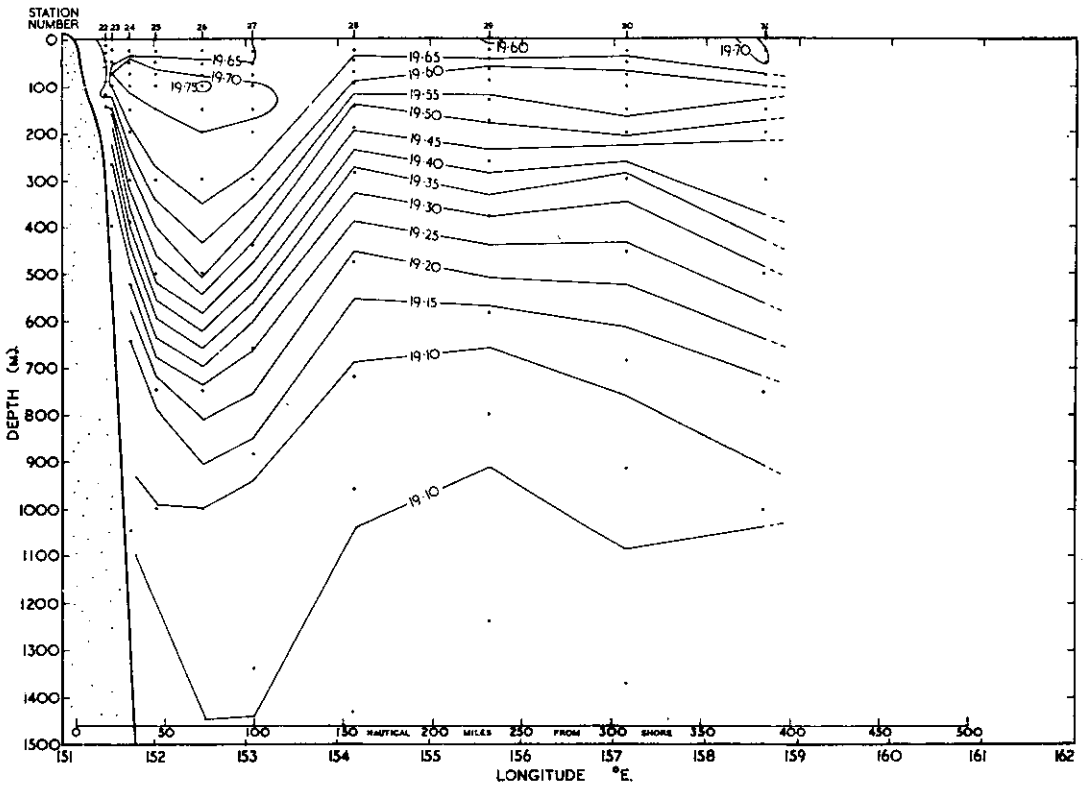

Fig. 4.- Sectional distribution of chlorinity (°/oo) along 110°T line to 1500 m.

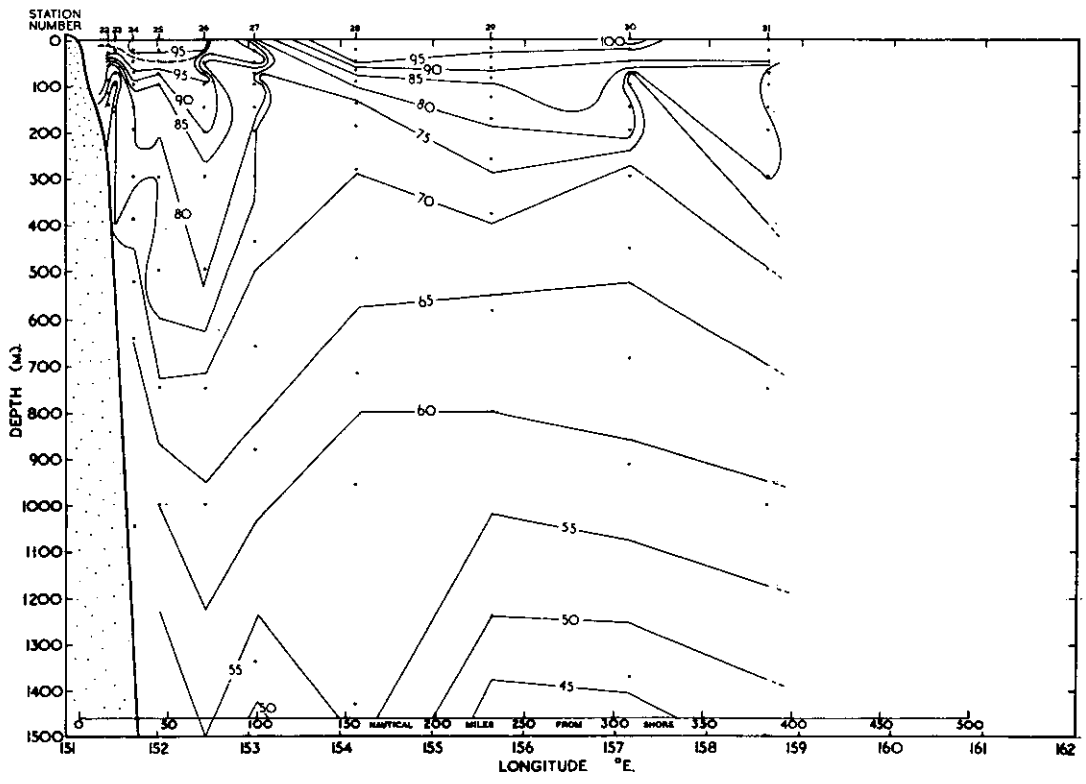

Fig. 5.- Sectional distribution of oxygen saturation (%) along 110°T line to 1500 m.

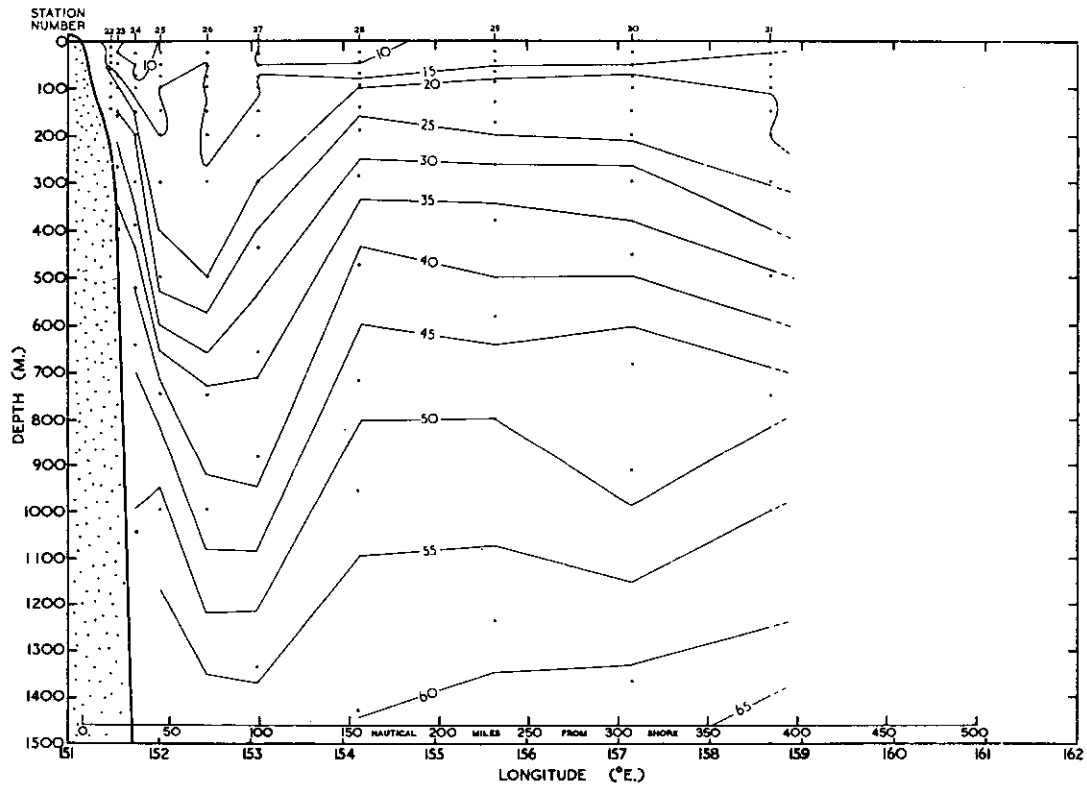

Fig. 6.- Sectional distribution of total phosphorus along 110 T line to 1500 m.

phosphorus was found at all depths at Station DH2/28/58 and a minimum at Station DH2/26/58. Reasonably close agreement was found between density and total phosphorus over the whole area, small anomalies being found only near the coast.

Horizontal Distribution of Properties

(a) Temperature (Fig. 7)

There was a tongue of high temperature water along the coast with its axis approximately parallel to the coast, and through Station DH2/26/58. This tongue appeared to be even more pronounced below the surface and the maximum temperature occurred at 0, 100, and 300 m. The minimum temperature at the surface occurred at Station DH2/31/58 but below the surface, it occurred at Station DH2/29/58. The presence of a secondary tongue of warmer water below the surface is suggested in Figure 7, the axis of this tongue being south-east. There were rather big horizontal temperature gradients between Stations DH2/27 and 28/58 at the surface, 100 and 300 m, and between Stations DH2/23 and 25/58 at 300 m.

(b) Density (σ_t) (Fig. 8)

Maximum density occurred at Station DH2/33/58 at the surface and at Station DH2/31/58 below the surface. Minimum density occurred in the high temperature tongue at Station DH2/23/58 at the surface at Station DH2/27/58 at 100 m and at Station DH2/26/58 at 300 m. A high horizontal density gradient was evident between Stations DH2/27 and 28/58 at all depths.

There was a region of lower density water in the south-east of the area, at 100 m and 300 m, but this was not prominent at the surface. Density distributions at 0, 100, and 300 m were closely related.

(c) Chlorinity (Fig. 9)

The chlorinity distribution at 0, 100, and 300 m was very similar to the temperature distribution at these depths. The higher chlorinity water was associated with the higher temperature water in the north and south-east of the area, and the lower chlorinity with the cooler water. This was particularly noticeable at 300 m where the distributions of temperature and chlorinity were identical. Also, at 300 m, there were big horizontal chlorinity gradients between Stations DH2/23 and 28/58 which closely corresponded to the high temperature gradients discussed in Section (1) of this report.

The high chlorinity, high temperature tongue towards the south-east was quite prominent at the surface and at 300 m but not conclusive at 100 m. Maximum chlorinity occurred in the high temperature tongue except at the surface, and minimum chlorinity occurred generally about the centre of the section. The chlorinity distribution at 0, 100, and 300 m levels was very similar except that at the surface, maximum chlorinity occurred further east than at other depths.

The distributions of density and chlorinity were not closely related at the surface but at 100 and 300 m a relationship was very evident.

(d) Percentage Oxygen Saturation (Fig. 10)

Saturated surface water occurred only in the south of the area, the value decreasing towards the north. Below the surface at 100 and 300 m saturation values increased northwards, giving maximum values in the northern part of the area. At the surface saturation values were found near the coast; however, below the surface, and in particular at 300 m, minimum values were found near the coast. At the surface low oxygen values were associated with high temperatures, low density, and high chlorinity, but below the surface the reverse is true. At 100 m and 300 m, good agreement was found between the oxygen and sigma-t distributions except in the tongue of low density water in the south-east, where large anomalies occurred.

(e) Total Phosphorus (Fig. 11)

Low values for total phosphorus were found in the north of the area and high values to the south at all depths. The high temperature tongue was roughly associated with lower total phosphorus values. There was no relationship between the dist ibution of total phosphorus and that of temperature, chlorinity, or sigma-t in the south east, as there was in the west of the area. However, there was some agreement between total phosphorus and oxygen in the east.

SUMMARY

1. Sectional Plots

The most important feature in the vertical section is the column bounded by the coast and 154°E. meridian. This column has a relatively high temperature, chlorinity, and oxygen and low density and total phosphorus. On the

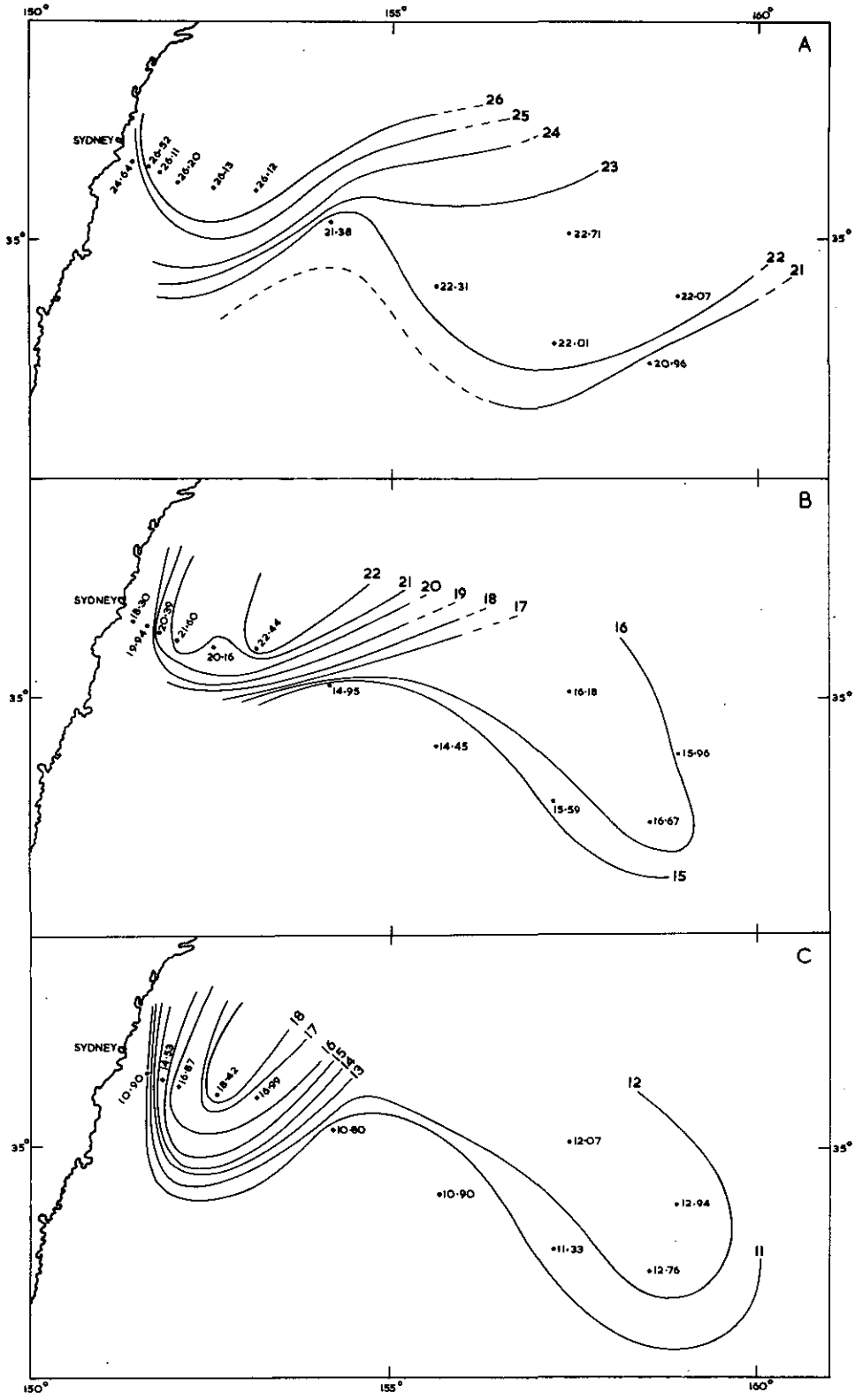

Fig. 7.- Horizontal distribution of temperature (°C), A at 0 m, B at 100 m, C at 300 m.

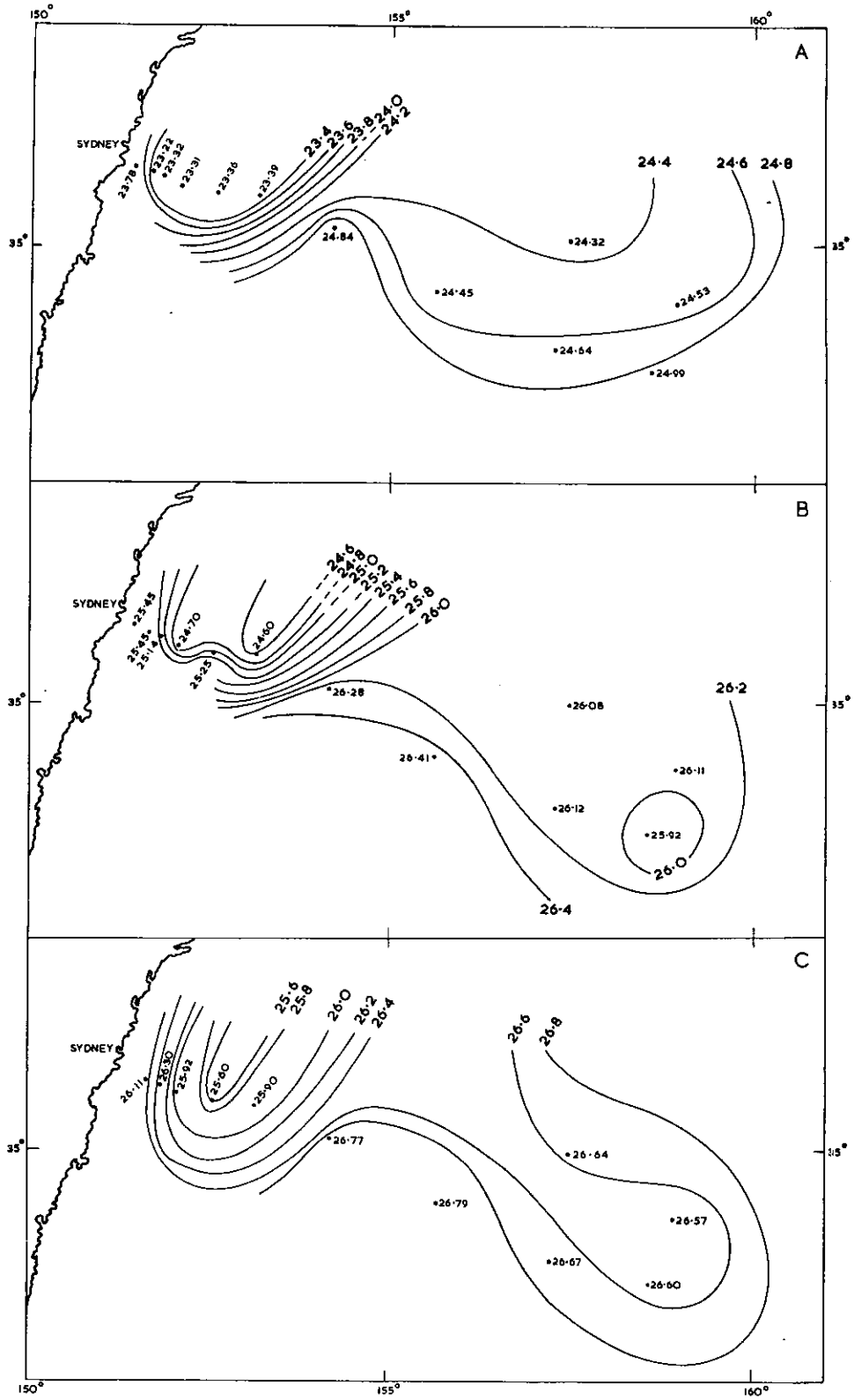

Fig. 8.- Horizontal distribution of density (σ_t), A at 0 m, B at 100 m, C at 300 m.

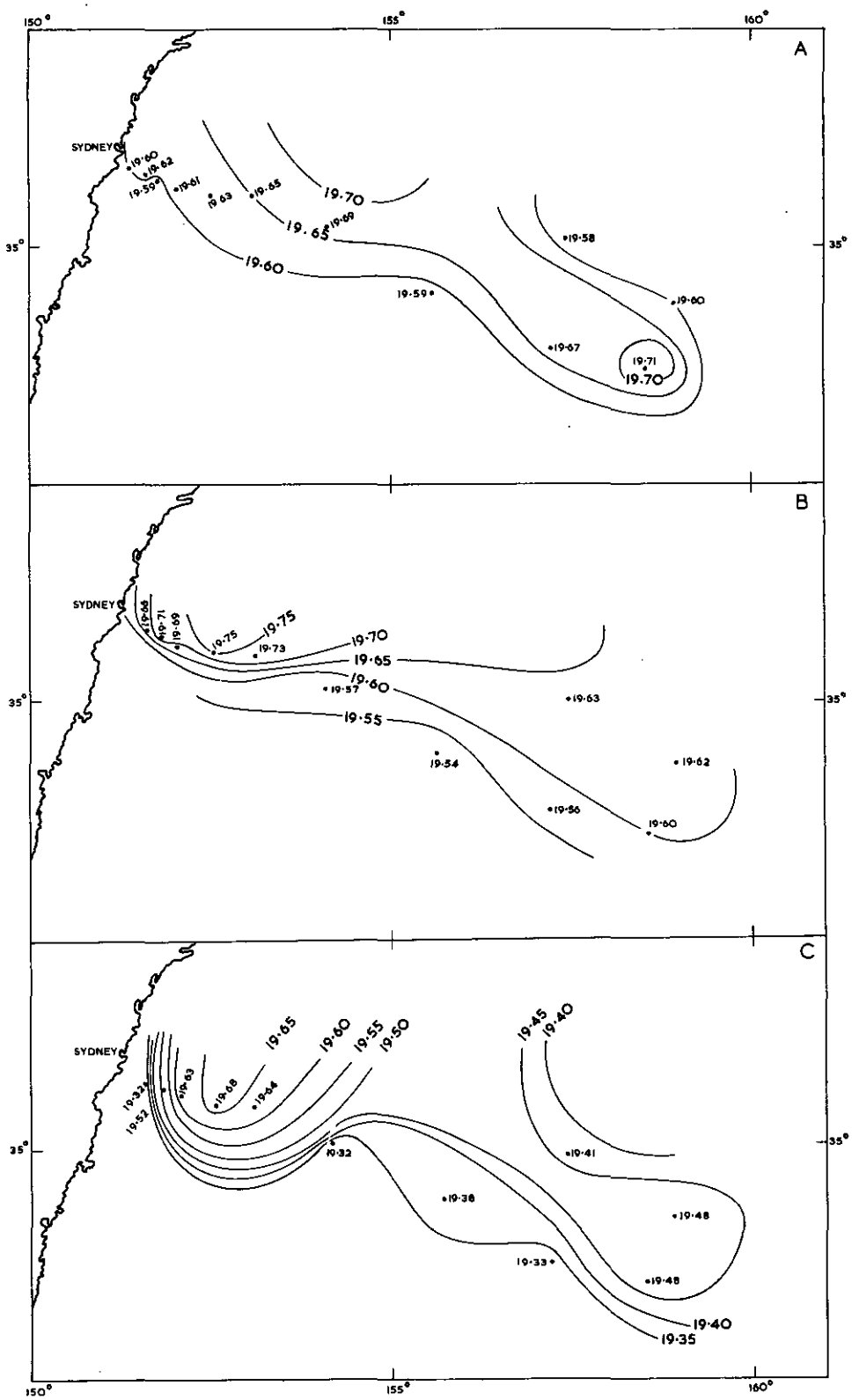

Fig. 9.- Horizontal distribution of chlorinity (°/oo)
A at 0 m, B at 100 m, C at 300 m.

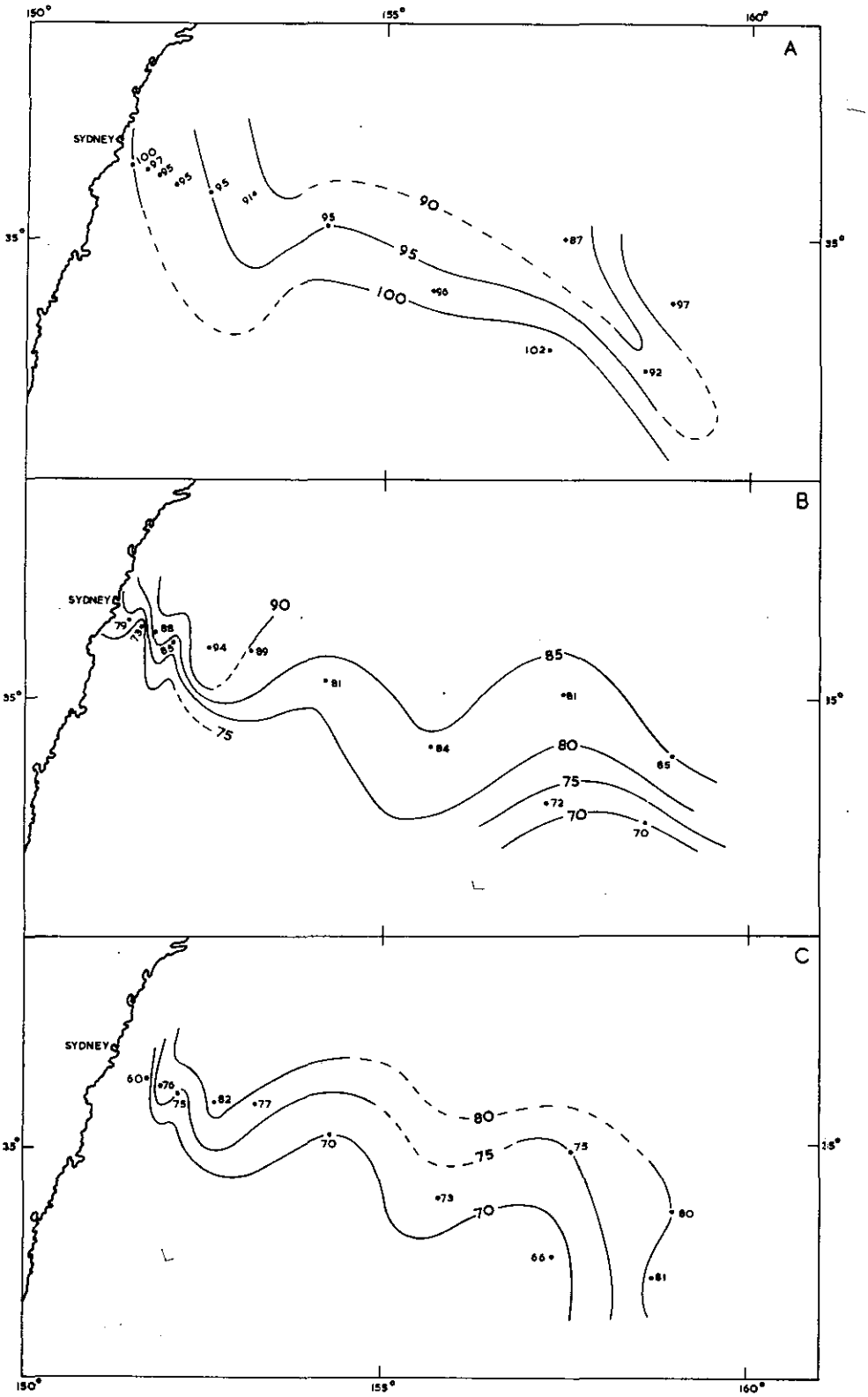

Fig. 10.- Horizontal distribution of oxygen saturation (%). A at 0 m, B at 100 m, C at 300 m.

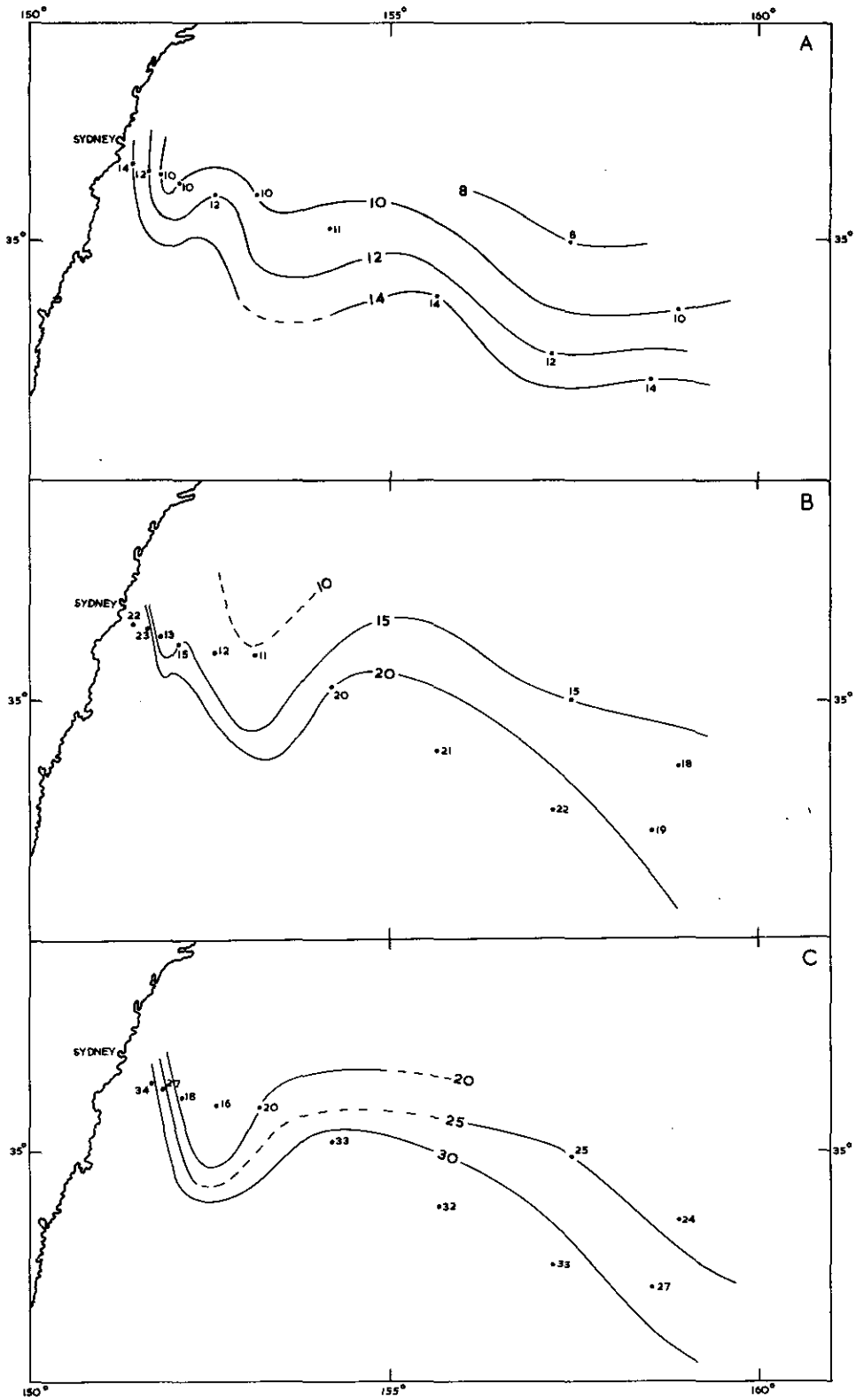

Fig. 11.- Horizontal distribution of total phosphorus
A at 0 m, B at 100 m, C at 300 m.

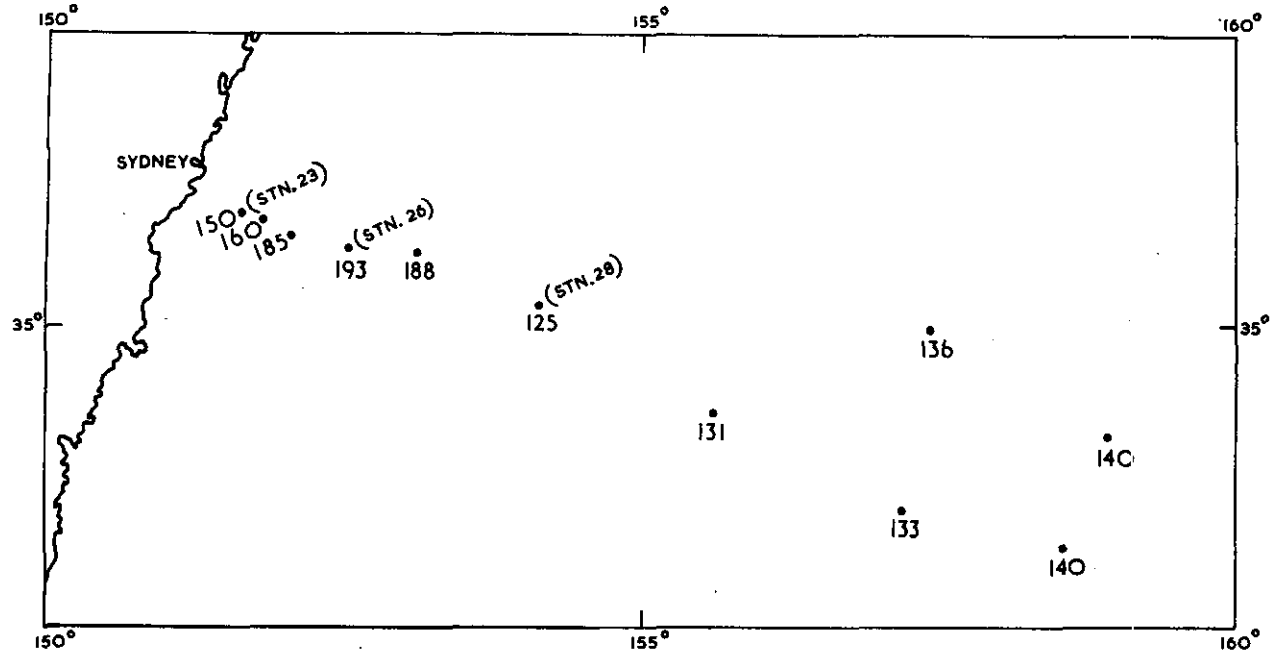

Fig. 12.- Dynamic heights in dynamic centimetres (0/1000 decibars).

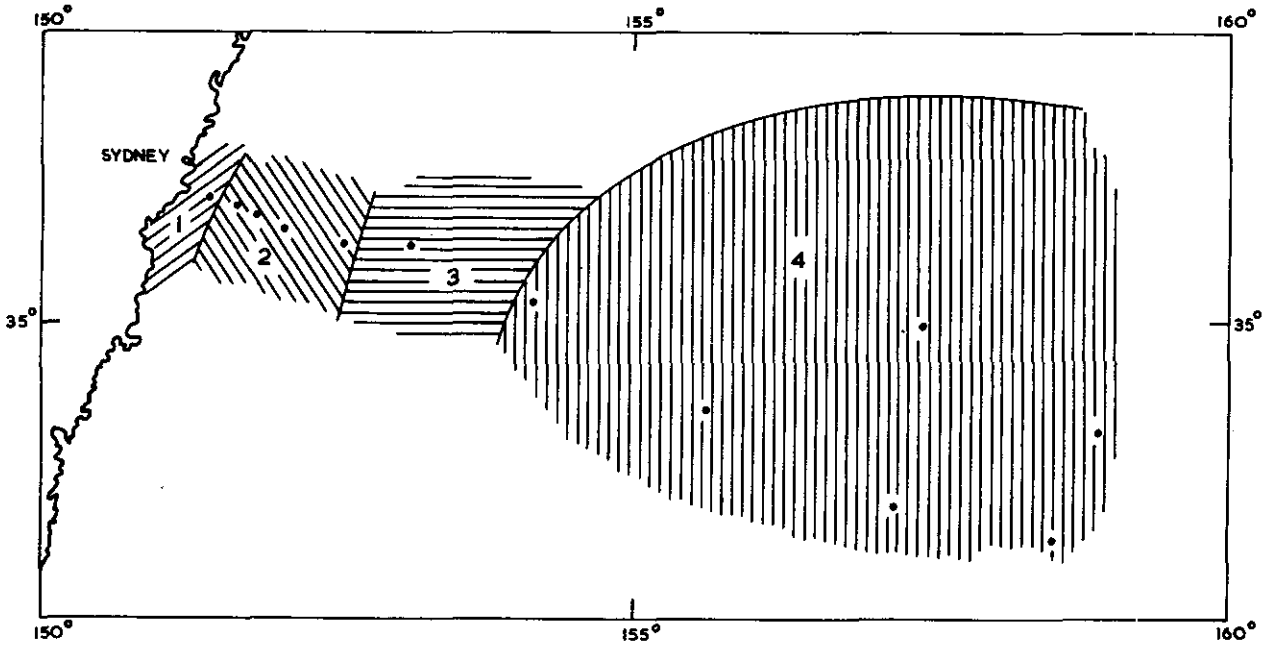

Fig. 13.- Phytoplankton communities determined from collections on 110°T line. 1. Coral Sea and neritic flora, 2. Coral Sea and slight East Australian Current, 3. Coral Sea dominant, 4. Poor phytoplankton.

eastern side of this column there is a temperature chlorinity and oxygen minimum and a density and total phosphorus maximum. East of Station DH2/28/58 the isolines slope slightly down for all properties.

2. Horizontal Plots

Closely associated with the high temperature column previously mentioned, is the tongue of high temperature water. This tongue has the properties mentioned in the Sectional Plot summary. Towards the south-east there appears to be a secondary tongue of water similar to the primary tongue.

(b) PHYSICS - B.V. HAMON

Dynamics

Figure 12 shows the surface dynamic heights at each station, in dynamic centimetres. There are not sufficient stations for contours to be drawn, but there is evidence of a strong surface current to the south between Stations DH2/23 and 26/58, and a current to the north further offshore.

The volume transports in the upper 1000 metres between two pairs of stations were as follows:-

Stations	Volume Transport	Direction
23 - 26	20×10^6 m^3/sec	S
26 - 28	28×10^6 m^3/sec	N

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

Table 1 lists the species of dinoflagellates and Table 2 the diatoms collected at each station on this cruise. Figure 13 indicates four areas in which different communities of phytoplankton were found. Area 1 (Station DH2/22/58) contained a Coral Sea community mixed almost equally with neritic flora typical of this region. This changed abruptly on the edge of the continental shelf to a pure but not rich Coral Sea community and is marked as Area 2 (Stations DH2/23 and 24/58). This became at Station DH2/25/58 predominantly a dinoflagellate flora with Coral Sea and Lord Howe characters. Station DH2/26/58 had few diatoms, those present were derived from a Coral Sea community. At Station DH2/27/58 a very large number of species of both dinoflagellates and diatoms were present. This is an unusual occurrence and differentiates this sample from others of this and previous cruises in this area. This

has been marked as Area 3. The presence of Phalacroma and Spiraulax in this area suggests upwelling in the vicinity of Station DH2/27/58 which may account for the richness of the phytoplankton. The collections from stations east of Area 3 showed few species.

The collections of phytoplankton varied greatly on this cruise suggesting that nutrients were very unevenly distributed throughout the region.

TABLE 1

DINOFLAGELLATES FROM "DERWENT HUNTER"
CRUISE 2 - FEBRUARY, 1958

SPECIES	STATION										
	22	23	24	25	26	27	28	30	31	32	33
Dinophysis caudata											
D. tripos						+					
D. fortii	+										
Phalacroma mitra						+					
Pyrophacus horologicum		+	+			+					
Peridinium divergens		+				+					
P. tenuissimum						+					
P. curtipes							+		+		
Ceratium tripos		++		+		+	+		+		
C. trichoceros		+		+		+					
C. contrarium	+			+	+	+					
C. pentagonum		+				+					
C. kofoidi						+				+	
C. teres				+							
C. karstenii				+							
C. arietinum				+							
C. schmidtii						+					
C. concilians						+					
C. carriense				+		+					
C. massiliense										+	
C. gallicum						+					
C. declinatum						+					
C. setaceum						+					
C. gibberum						+					
C. candelabrum											+
C. buceros											+
Podolampas bipes		+				+					
Ceratocorys horridum			+	+		+					
C. armatum						+					
Ornithocercus magnificus				+		+					
O. steinii						+					
Oxytoxum scolopax				+							
Oxy. subulatum											+
Goniodoma polyedricum						+					
Spiraulax jollifei						+					
Ceratium fusus											+
BLUE GREEN ALGAE											
Trichodesmium			+	+	+	++		+			+

TABLE 2

DIATOMS FROM "DERWENT HUNTER"
CRUISE 2 - FEBRUARY, 1958

SPECIES	STATION							
	22	23	24	25	26	27	31	32
Skeletonema costatum	+							
Stephanopyxis palmeriana	+					+		
Lauderia annulata	+					+		
Guinardia flaccida	+							
Detonula confervacea		+	+			+		
Rhizosolenia alata	+	+	+			+		
R. styliformis								
R. calcar avis						+		
R. clevei					+			
R. stolterforthii	+							
R. styliformis					+	+		
v. latissima						+		
R. castracanei						+		
Chaetoceros teres	+					+		
C. vanheurckii						+		
C. lorenzianum	+							
C. peruvianum		+						
C. secundum	+							
C. convolutum	?							
C. neopolitanum					+			
Climacodium frauenfeldianum	+	+		+	+	+		+
Hemiaulus sinensis	+					+		
H. membranaceus						+		
H. hauckii						+		
Eucampia zoodiacus				+				
Streptotheca thamesis	+					+		
Leptocylindrus danicus	+							
Nitzschia seriata	+							
Asterionella notata	+							
Thalassiosira subtilis	+							
Coscinodiscus curvatulus							+	

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH3/58

February 19-21, 1958

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

ITINERARY

This cruise was the fourth of the productivity series. Figure 1 shows the track followed, the positions of the stations, and the work done at each station.

(a) PRODUCTIVITY - N. DYSON

The purpose of this cruise was (1) to carry out routine measurements of the rate of photosynthetic uptake of CO_2 in samples taken on a line of stations bearing 110° from Port Hacking. (2) To measure the daily variation of CO_2 uptake at two stations 20 and 120 miles from the coast. (3) To determine the sampling error in CO_2 uptake measurements at a station 70 miles from the coast. (4) To determine the hydrological characteristics and the depth of light penetration at all stations.

Adverse weather and a mechanical defect in the vacuum pump caused the cancellation of the cruise after the 20 mile station had been completed.

RESULTS

(1) CO_2 Uptake

At the all-day Station DH3/36/58, CO_2 uptake measurements were made by both the *in situ* and light bath incubation methods. Some negative values were obtained by the *in situ* method and as they were possibly due to errors during the subsequent laboratory counting no comparison is made between the results of the two methods. The rate of uptake of CO_2 of samples from 0 and 25 m was measured four times during the day by bath incubation. These results are shown in Figure 2. Duplicate surface samples were collected at sunrise and noon and incubated *in situ* for half day periods. The results obtained were 1.32 and 1.01 mg C/day/m^3 for the sunrise and 7.17 and 6.98 mg C/day/m^3 for the noon samples.

(2) Light Penetration

Submarine light was measured at intervals from 0600 to 1800 hrs. The results have been corrected by using surface light readings recorded simultaneously with the submarine readings. The variation in the depth of penetration of one per cent. of surface light is shown in Figure 3.

(b) HYDROLOGY - A.D. CROOKS

Hydrology samples for chlorinity, oxygen, and total phosphorus were taken from 0, 25, and 50 m at Station DH3/34 and 35/58 and from 0, 25, 50, 75, 100, 150, 200, and 300 m at Station DH3/36/58.

Surface temperatures were relatively high (25°C) and a thermocline appeared between 0 and 25 m at Station DH3/34/58 and 25-50 m at Stations DH3/35 and 36/58. A chlorinity maximum occurred at 50 m at each station. There was a rapid change in oxygen between 25 and 50 m, associated with the thermocline. A rapid change in total phosphorus was also associated with the thermocline.

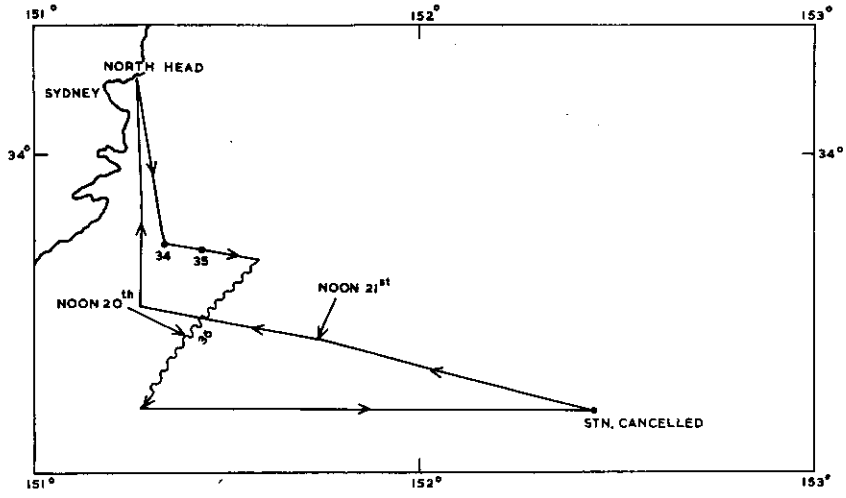

Fig. 1.- Cruise DH3/58. Track chart showing positions of stations.

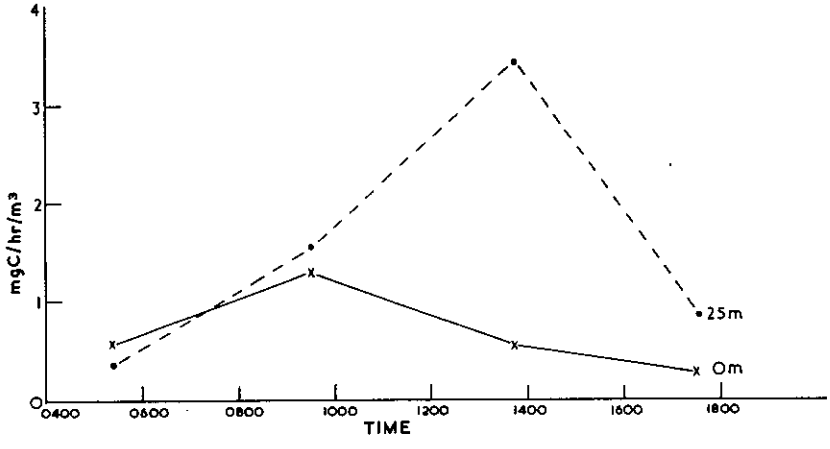

Fig. 2.- Rate of CO_2 uptake by light bath incubation at DH3/36/58.

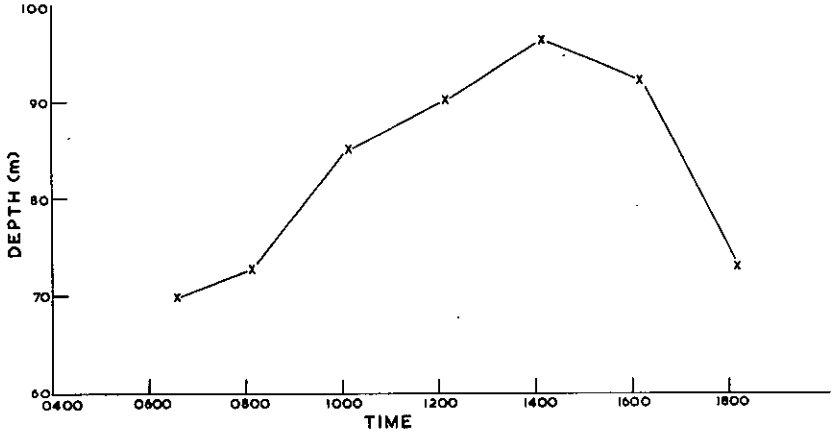

Fig. 3.- Variation in depth of penetration of 1% of surface light at DH3/36/58.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH4/58

February 27 - March 7, 1958

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)

ITINERARY

This is the ninth of the series of cruises to study the chemical and physical structure and the circulation of the East Australian Current off Sydney. Figure 1 shows the positions of stations and indicates the work done at each station.

SCIENTIFIC REPORTS

Samples for chlorinity, oxygen, and total phosphorus were taken from the usual depths down to 1500 m. Paired protected and unprotected thermometers were used below 100 m to determine the depth of sampling. G.E.K. tows, B.T. dips, and phytoplankton tows were done as indicated in Figure 1.

(a) HYDROLOGY - A.D. CROOKS

(1) Temperature

(a) 110°T Section Line (Fig. 2)

The maximum surface temperature of 26.5°C occurred at the coastal Station DH4/37/58 and the minimum of 21.2°C at Station DH4/51/58. A rapid change in surface temperature was noticeable between Stations DH4/42 and 44/58. East of Station DH4/44/58, the surface temperature was constant, varying only 0.6°C in 4½° of longitude.

Below this area of homogeneous surface water a well developed thermocline occurred, with a vertical gradient of 0.1°C/m. Maximum temperature occurred below the surface at Station DH4/42/58 and minimum at Station DH4/44/58.

(b) 290°T Section Line (Fig. 3)

Maximum surface temperature of 25.6°C occurred at Station DH4/55/58 and minimum temperature of 21.2°C at Station DH4/53/58. Below the surface, maximum temperature was recorded at Station DH4/53/58 and minimum at Station DH4/56/58.

The distribution of temperature on this section was very similar to the distribution on the previous section except that the strong thermocline, obvious in the first section, had practically disappeared in the southern section. Its maximum vertical gradient on this section was 0.08°C/m at Station DH4/56/58.

(2) Density (σ_t)

(a) 110°T Section Line (Fig. 4)

Maximum surface density (24.89 σ_t) occurred at Station DH4/51/58 and minimum (23.32 σ_t) at Station DH4/37/58. Rapid changes in density were characteristic of the surface waters between the coast and Station DH4/44/58.

A pycnocline was evident between the surface and 200 m at all stations. The maximum vertical gradient was 0.02 σ_t/m at Station 37 and minimum 0.009 σ_t/m at Station 51. The depth of the pycnocline varied from 100-200 m at Station DH4/42/58 to 0-80 at Stations DH4/44 and 49/58. Below the surface, minimum density occurred at Station DH4/42/58, and maximum at Station DH4/44/58.

(b) 290°T Section Line (Fig. 5)

Maximum surface density (24.81 σ_t) occurred at Station DH4/53/58 and minimum (23.59 σ_t) at Station DH4/55/58. Within the upper 100 m there was a well developed pycnocline of maximum vertical gradient 0.011 σ_t/m. Below the surface the maximum density was found at Station DH4/57/58 and minimum at Station DH4/53/58.

(3) Chlorinity

(a) 110°T Section Line (Fig. 6)

Maximum surface chlorinity of 19.76‰ occurred at Station DH4/39/58 and minimum of 19.60‰ at Station DH4/40/58. Between Stations DH4/37 and 40/58 a chlorinity minimum occurred between 0 and 100 m (see dotted line Fig. 6).

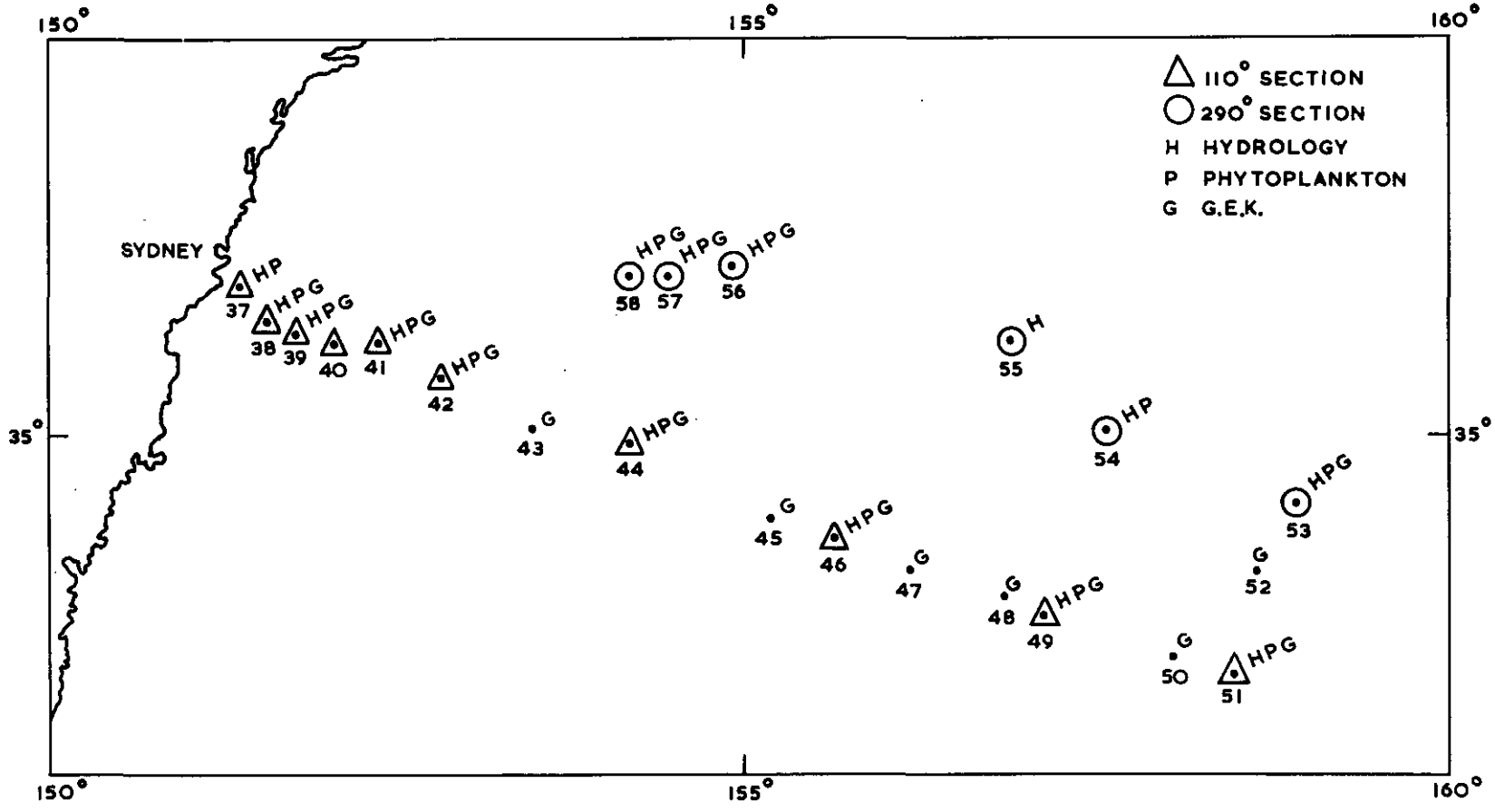

Fig. 1.- Cruise DH4/58. Track chart showing positions of stations.

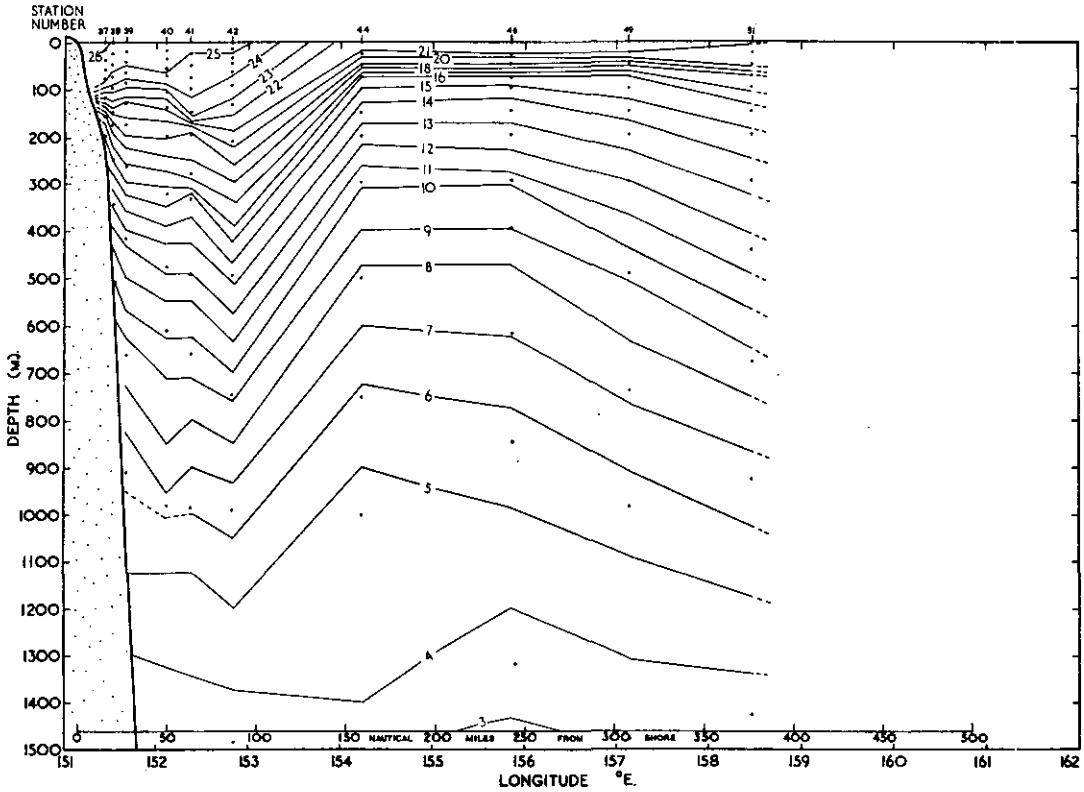

Fig. 2.- Sectional distribution of temperature (°C) along 110°T line to 1500 m.

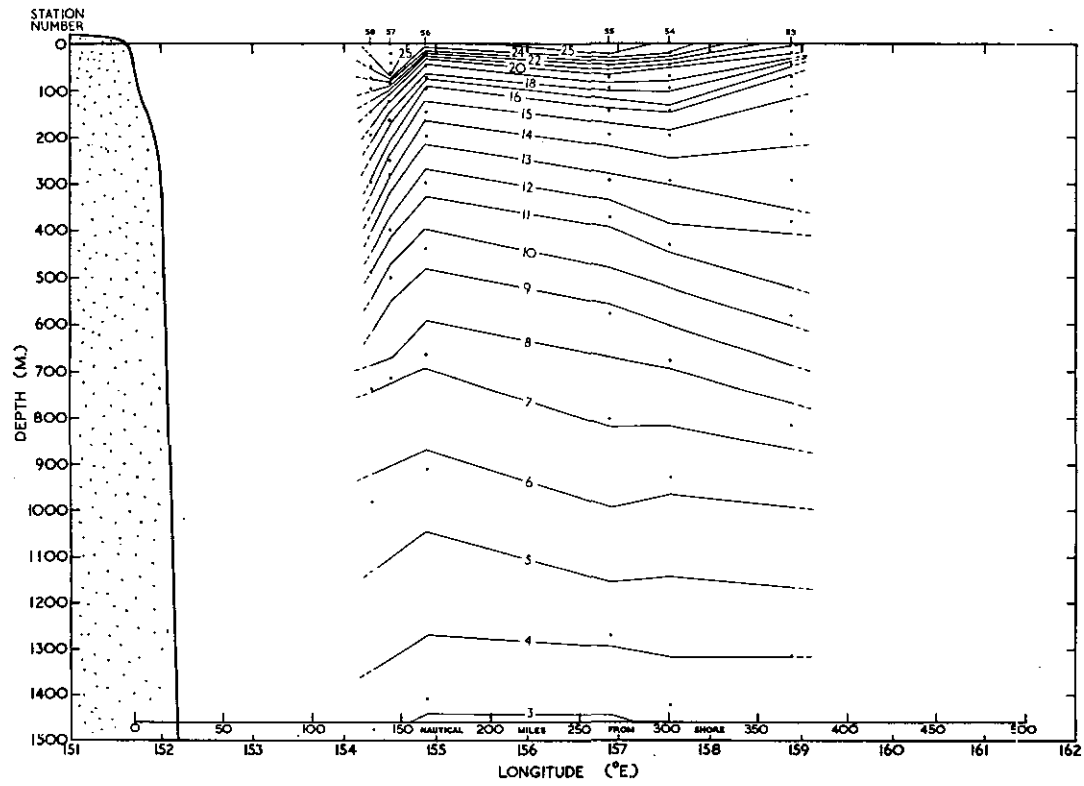

Fig. 3.- Sectional distribution of temperature (°C) along 290°T line to 1500 m.

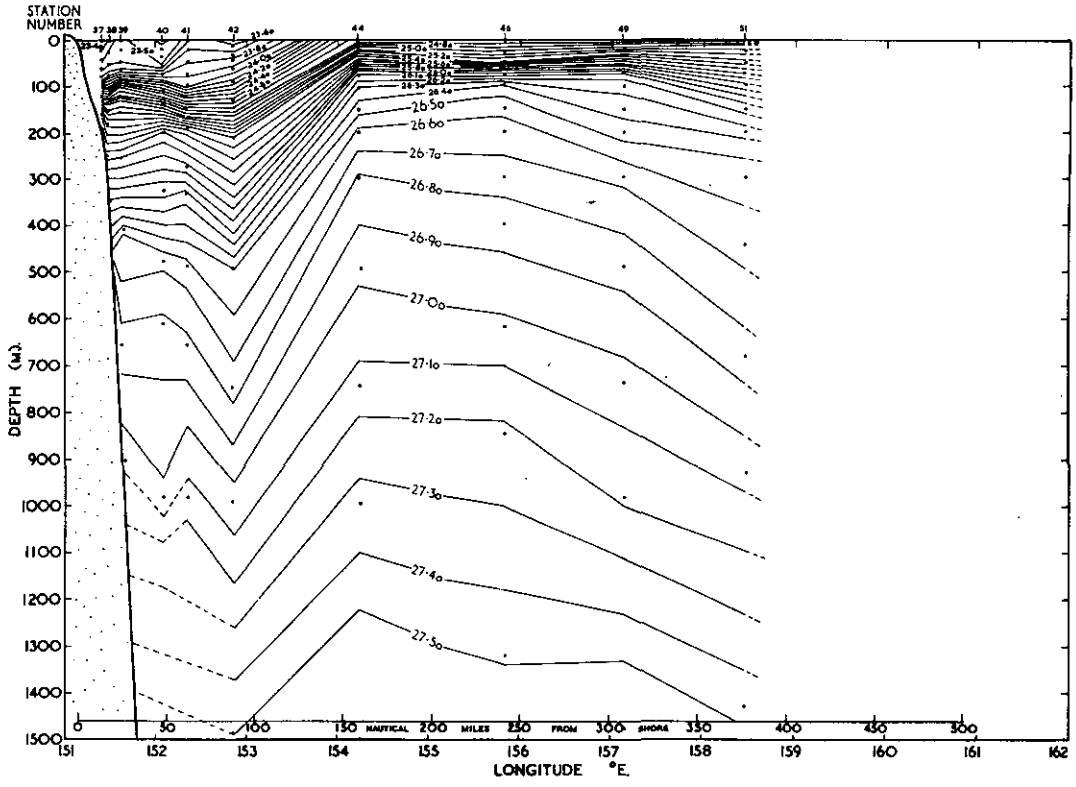

Fig. 4.- Sectional distribution of density (σ_t) along 110°T line to 1500 m.

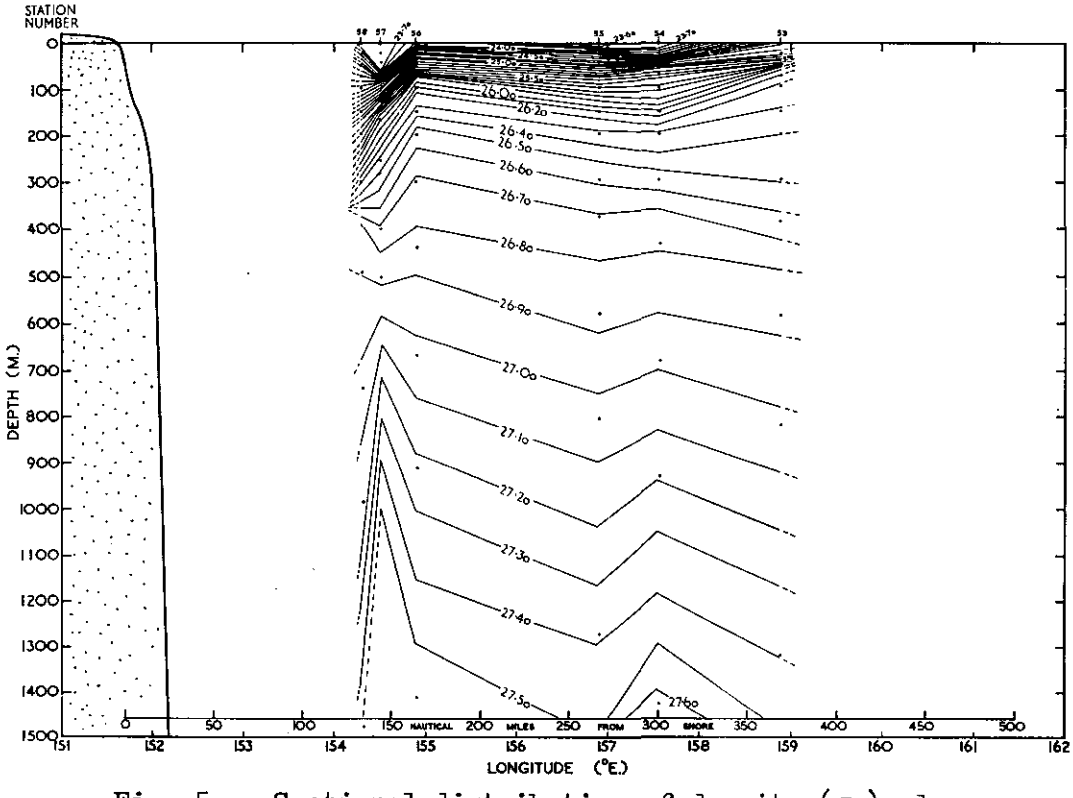

Fig. 5.- Sectional distribution of density (σ_t) along 290°T line to 1500 m.

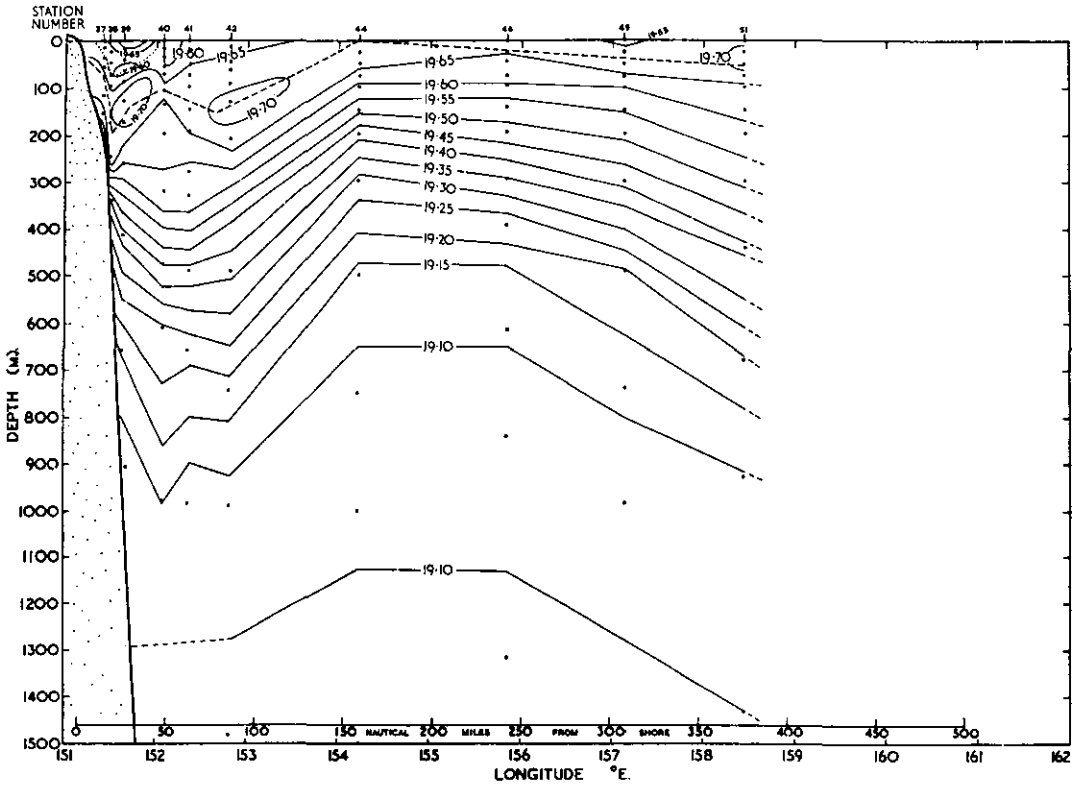

Fig. 6.- Sectional distribution of chlorinity (°/oo) along 110°T line to 1500 m.

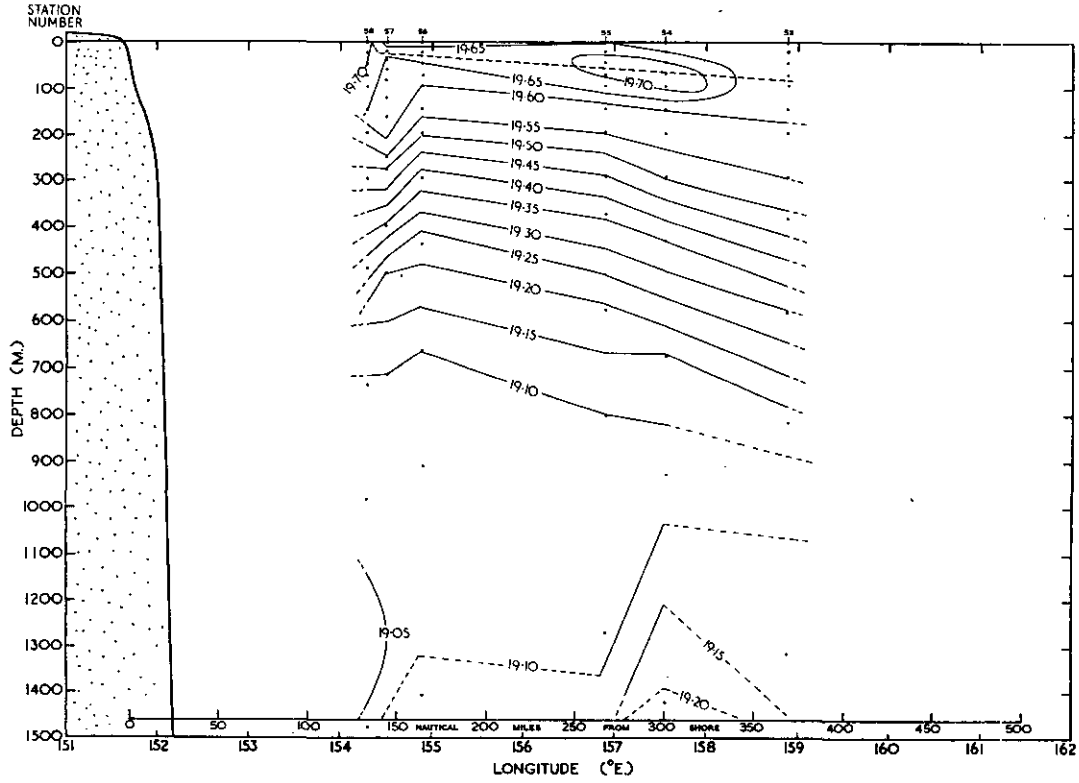

Fig. 7.- Sectional distribution of chlorinity (°/oo) along 290°T line to 1500 m.

At all stations, except Station DH4/44/58, a chlorinity maximum occurred between 0 and 200 m (see dashed line Fig. 6). This maximum was generally found at about the centre of the pycnocline. The depth of the deep chlorinity minimum varied between 1050 m at Station DH4/39/58 and 1175 m at Station DH4/49/58. Between 300 m and 500 m maximum chlorinity occurred at Station DH4/40/58 and minimum at Station DH4/44/58. Below 500 m the maximum occurred at Station DH8/42/58 and minimum at Station DH4/44/58.

(b) 290°T Section Line (Fig. 7)

Maximum surface chlorinity of 19.70‰ was found at Station DH4/58/58 and minimum of 19.62‰ at Stations DH4/54 and 53/58. A chlorinity maximum occurred in the upper 100 m between Stations DH4/53 and 58/58 as indicated by the dashed line (Fig. 7). It was found within the pycnocline between Stations DH4/53 and 57/58. The depth of the chlorinity minimum varied between 1110 m at Station DH4/53/58 and 1320 m at Station DH4/58/58.

(4) Oxygen Saturation

(a) 110°T Section Line (Fig. 8)

No saturated water was found at the surface of this section. The maximum value was 97 per cent. at the surface at Stations DH4/44 and 46/58. Minimum surface values (93 per cent.) were found at Stations DH4/39, 41, and 51/58. An oxygen minimum observed at Stations DH4/38, 39, 46, and 51/58, at 100-150 m, could have been continuous throughout the section, but was not directly observed. An oxygen maximum was observed between 0 and 100 m at Stations DH4/41 and 42/58. Below the surface maximum oxygen was found at Station DH4/51/58 and minimum at Station DH4/44/58. A rapid vertical change in oxygen was generally associated with the pycnocline, 95 per cent. saturation was observed along the upper limit and 80 per cent. along the lower limit of the pycnocline. The oxygen distribution closely resembled the density distribution except above 400 m between the coast and 154°E.

(b) 290°T Section Line (Fig. 9)

Maximum surface values of 97 per cent. were found at Station DH4/53/58 and minimum of 83 per cent. at Station DH4/55/58. At Stations DH4/55 and 56/58 an

oxygen maximum was found within the upper 50 m. No saturated waters were found at any point in the section. Below the surface, maximum oxygen was found at Station DH4/53/58 and minimum at Station DH4/56/58. The distribution of oxygen was closely related to that of density except below 600 m at Stations DH4/57 and 58/58 and between 100 m and 400 m at Stations DH4/54 and 55/58.

(5) Total Phosphorus

(a) 110°T Section Line (Fig. 10)

Maximum values (17 µg/l.) were found at the surface at Station DH4/46/58 and minimum values (9 µg/l.) at Station DH4/39/58. Minimum values occurred between 10 m and 60 m, except between Stations DH4/42 and 44/58, these were associated with the upper limit of the pycnocline. Below the surface maximum values occurred at Station DH4/44/58 and minimum values at Station DH4/42/58. A total phosphorus minimum occurred at the surface between Stations DH4/37 and 51/58 (dotted line Fig. 10). The distribution of total phosphorus followed very closely that of density except in the upper 200 m at Station DH4/49/58.

(b) 290°T Section Line (Fig. 11)

Maximum total phosphorus values (15 µg/l.) occurred at Stations DH4/54/58 and minimum values (7 µg/l.) at Station DH4/58/58. A total phosphorus minimum, as indicated by the dotted line (Fig. 11) occurred between 100 m and 200 m at Stations DH4/53-58/58. This minimum coincided approximately with the pycnocline. Below the surface maximum values of total phosphorus occurred at Station DH4/56/58 and minimum values at Station DH4/53/58. The distribution of total phosphorus was closely related to that of density except for some anomalies below 300 m at Stations DH4/57 and 58/58.

Horizontal Distribution of Properties

1. Temperature (Fig. 12)

Maximum temperatures occurred at the surface near the coast but at deeper levels to the east. There was little relationship between the surface and the 100 m and 300 m distribution of temperature. However, there was similarity between the distribution at 100 m and 300 m, with two tongues of warmer water at each end of the region, separated by a relatively very cold region.

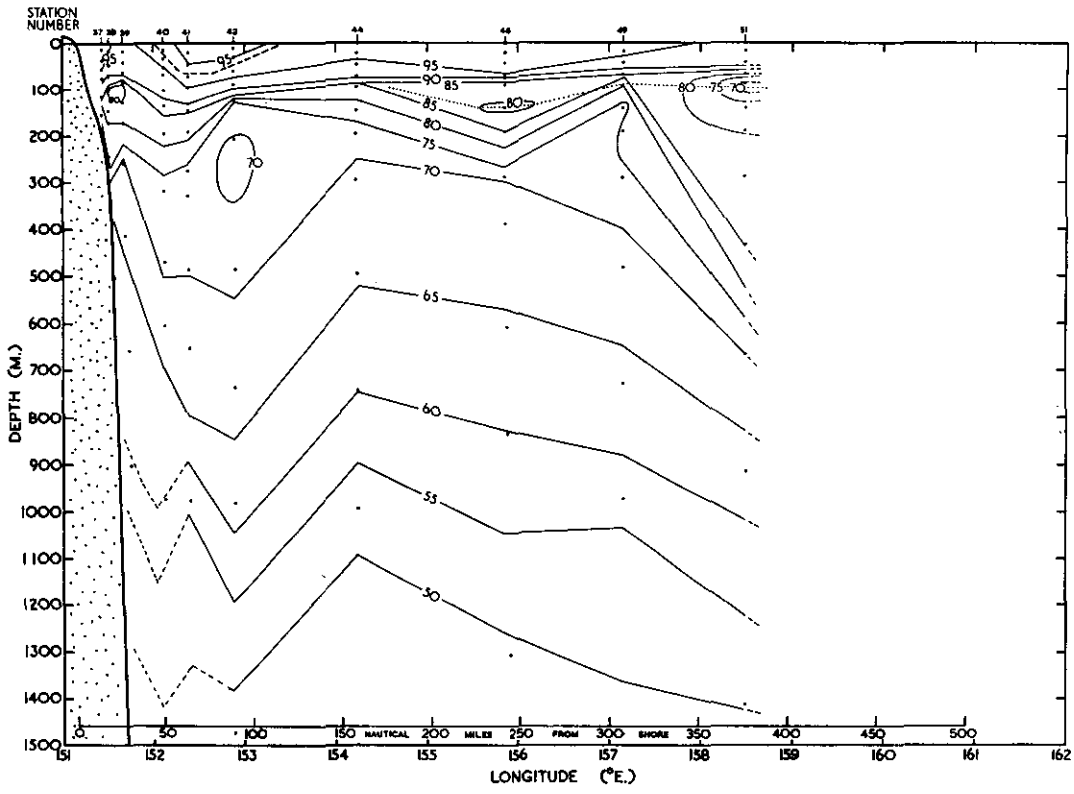

Fig. 8.- Sectional distribution of oxygen saturation (%) along 110°T line to 1500 m.

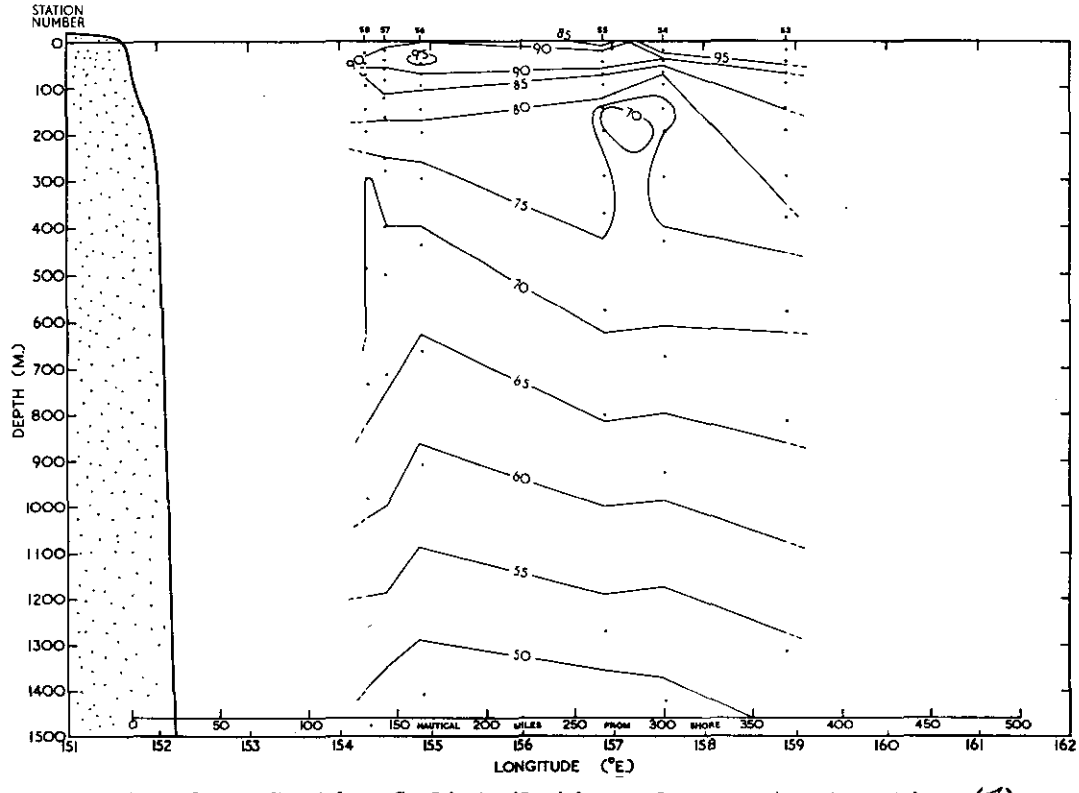

Fig. 9.- Sectional distribution of oxygen saturation (%) along 290°T line to 1500 m.

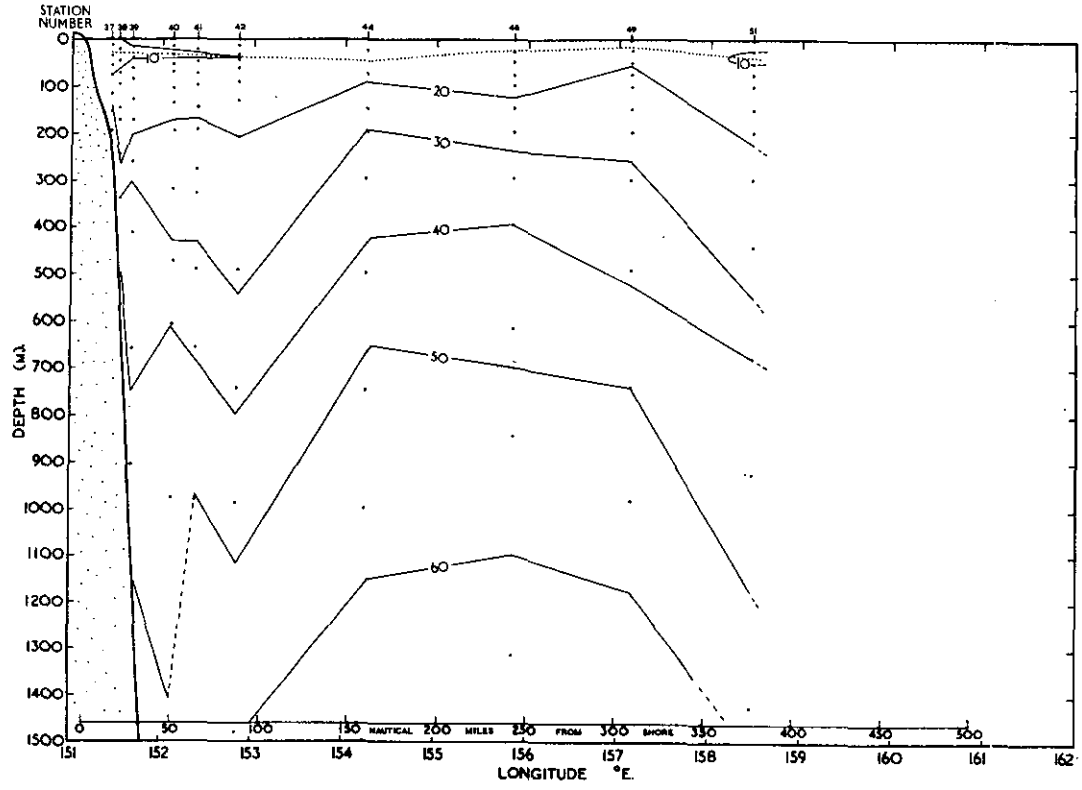

Fig. 10.- Sectional distribution of total phosphorus along 110°T line to 1500 m.

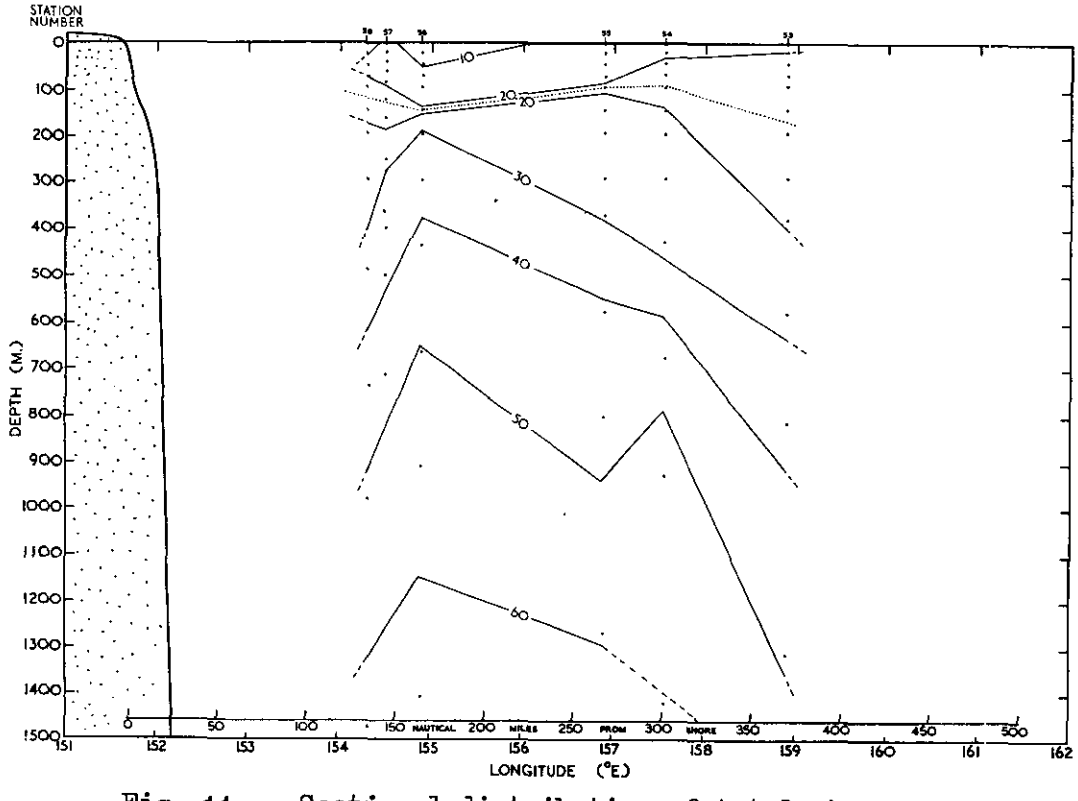

Fig. 11.- Sectional distribution of total phosphorus along 290°T line to 1500 m.

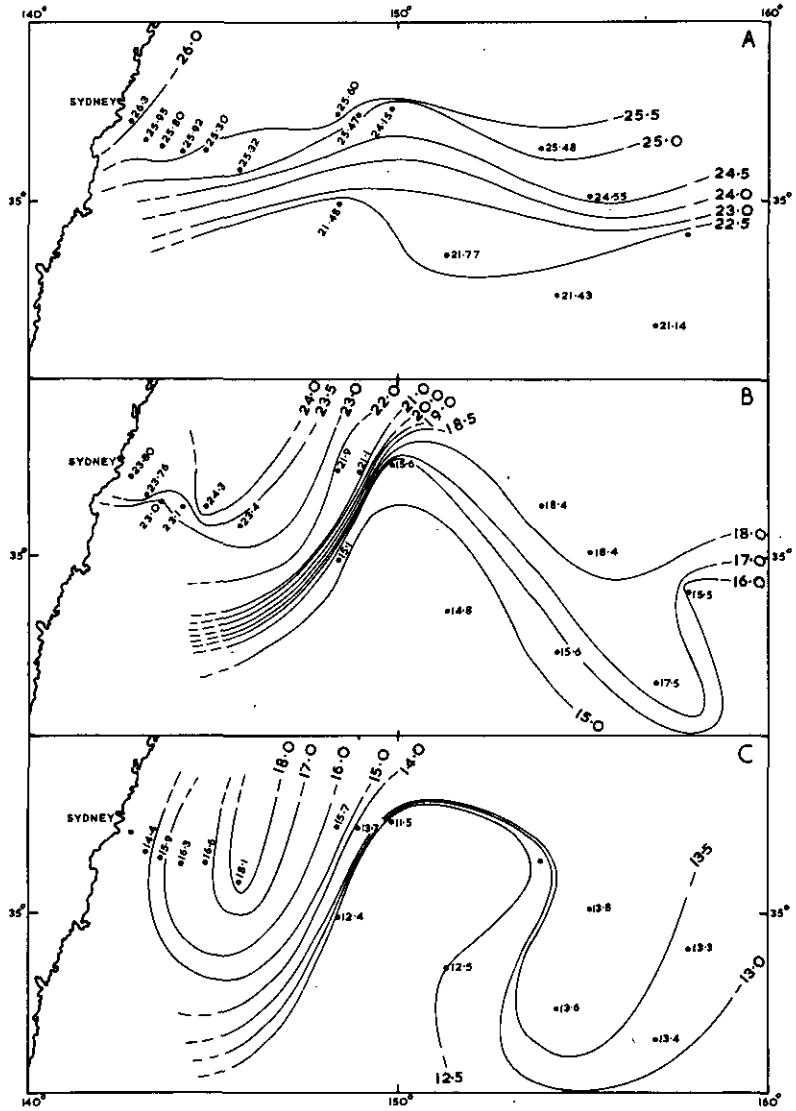

Fig. 12.- Horizontal distribution of temperature
A at 0 m, B at 100 m, C at 300 m.

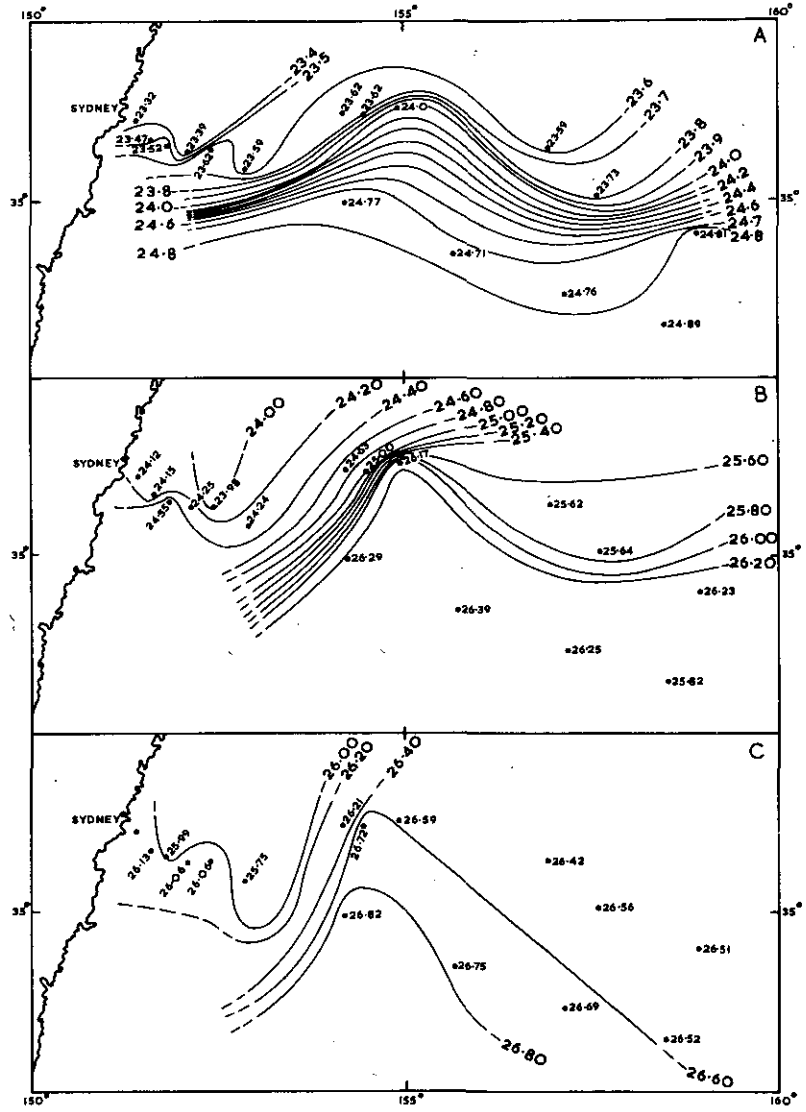

Fig. 13.- Horizontal distribution of density
A at 0 m, B at 100 m, C at 300 m.

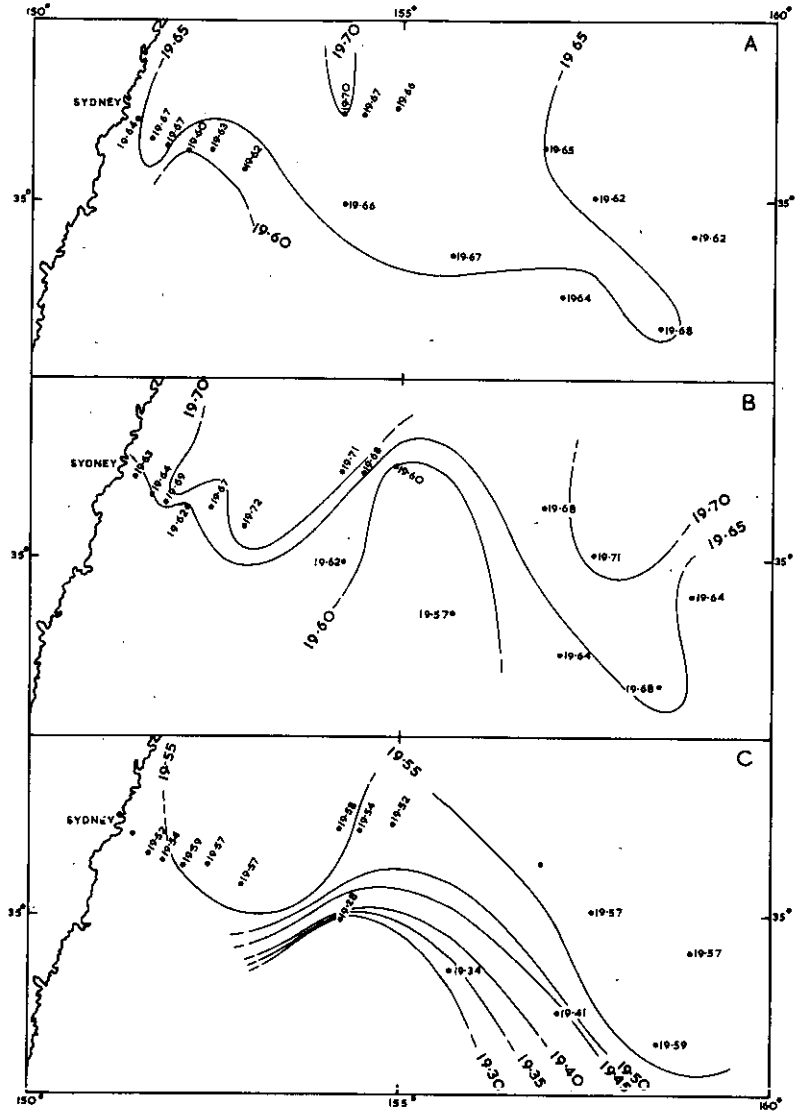

Fig. 14.- Horizontal distribution of chlorinity A at 0 m, B at 100 m, C at 300 m.

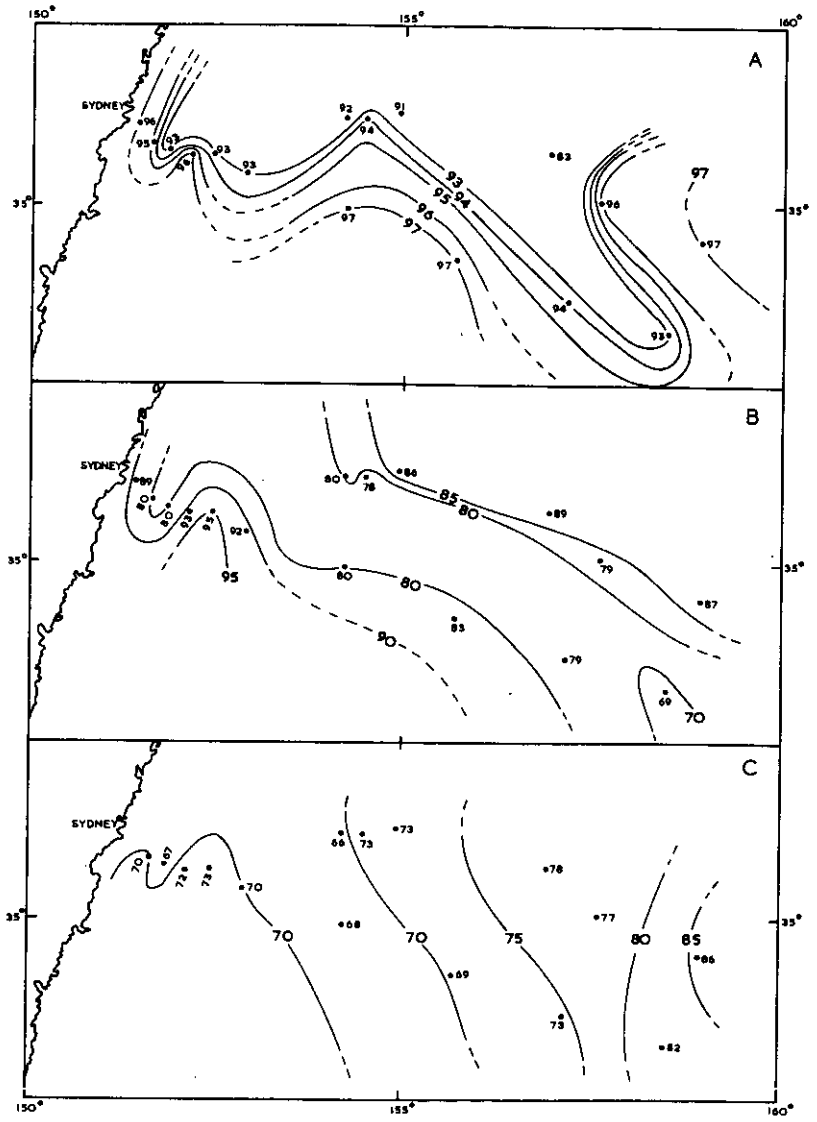

Fig. 15.- Horizontal distribution of oxygen saturation. A at 0 m, B at 100 m, C at 300 m.

2. Density (σ_t) (Fig. 13)

Maximum density occurred in the south-east and south of the area, and minimum in the coastal area. Rapid changes in density were particularly noticeable between Stations DH2/42 and 44/58, at all depths. There was not a clear relationship between the distribution at 0, 100, and 300 m; however, similarity does exist, particularly in the centre and eastern parts of the area. To the west, the distributions were similar at 0 and 100 m but somewhat different at 300 m.

3. Chlorinity (Fig. 14)

Maximum chlorinity occurred near the centre of the region, and to the east of the centre, low chlorinities were found in the south. At all depths tongues of high chlorinity water occurred with axis north-south and the secondary one to the south-east.

The distributions of chlorinity at the 100 and 300 m levels were similar, with a marked similarity between surface distributions of chlorinity in the east and west of the area. The distribution of chlorinity and density were similar except at the surface and at 100 m in the east of the area, where some anomalies existed.

4. Percentage Oxygen Saturation (Fig. 15)

The noticeable feature was the undersaturation of the entire surface water. Maximum values were associated with the colder water and minimum values with the warmer water. Though there is some similarity in the distributions at the surface and at 100 m in the western half of the area, the distribution in the eastern half and at 300 m is completely different. (The isolines at the surface and at 100 m are east-west and at 300 m are north-south). The distributions of oxygen and density are similar except at 100 m near the coast and at the surface in the west.

5. Total Phosphorus (Fig. 16)

Minimum total phosphorus was associated with the high temperature, high chlorinity tongues of water. The distributions at 0, 100, and 300 m were similar but large anomalies were found between total phosphorus and density distributions to the east at the surface and at 300 m. The chlorinity and total phosphorus distributions were similar.

Summary

(a) Sectional Plots

There was a relationship between the distribution of each property on both sections, anomalies occurring at the western end of the northern section. The low values of oxygen at the surface of the section are most noticeable.

(b) Horizontal Plots

Two tongues of water were noticeable below the surface, (Figs. 12, 14) with high temperature, high chlorinity, and low total phosphorus. The southern part of the area was characterized by low temperature, low chlorinity, low oxygen, and high phosphorus.

(b) PHYSICS - B.V. HAMON

Dynamics

Figure 17 shows the surface dynamic heights at each station, in dynamic centimetres. There are not sufficient stations for contours to be drawn, but there is evidence of a strong surface current to the south between Stations DH4/37 and 41/58, and a current to the north further offshore.

The volume transports in the upper 1000 metres between two pairs of stations were as follows:-

Stations	Volume Transport	Direction
37 - 41	30 x 10^6 m^3/sec	S
41 - 44	31 x 10^6 m^3/sec	N

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

Table 1 lists the dinoflagellates and Table 2 the diatoms collected at each station on this cruise. Figure 18 indicates five areas in which different phytoplankton communities occurred. Area 1, with its eastern boundary running west-south-west, contained neritic and Coral Sea species, but was poor. Area 2 held a rich Coral Sea - East Australian Current flora. South of this was Area 3, a wedge-shaped area, containing a sparse warm water flora. East of this was Area 4, which was relatively rich and contained Coral Sea species. Area 5 was south-east of this and was devoid of phytoplankton.

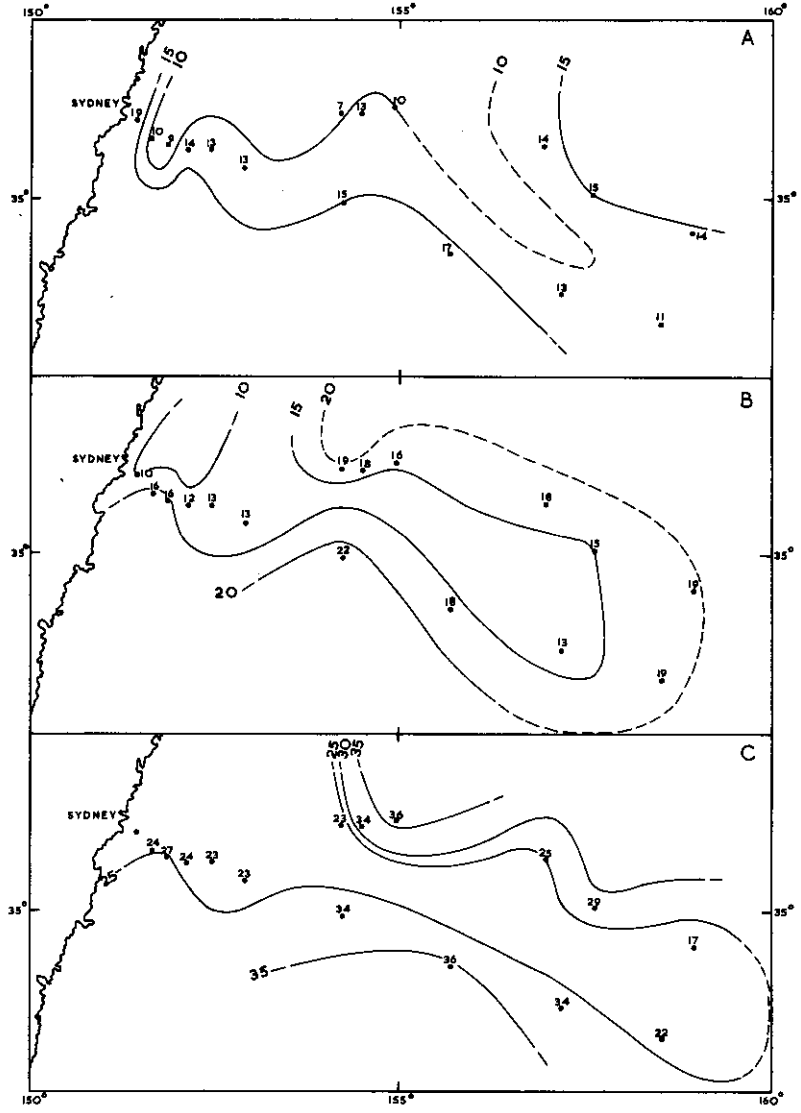

Fig. 16.- Horizontal distribution of total phosphorus. A at 0 m, B at 100 m, C at 300 m.

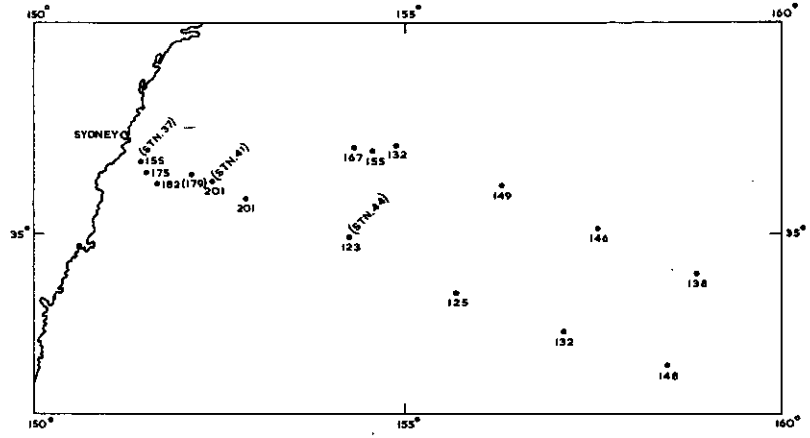

Fig. 17.- Dynamic heights in dynamic centimetres (0/1000 decibars).

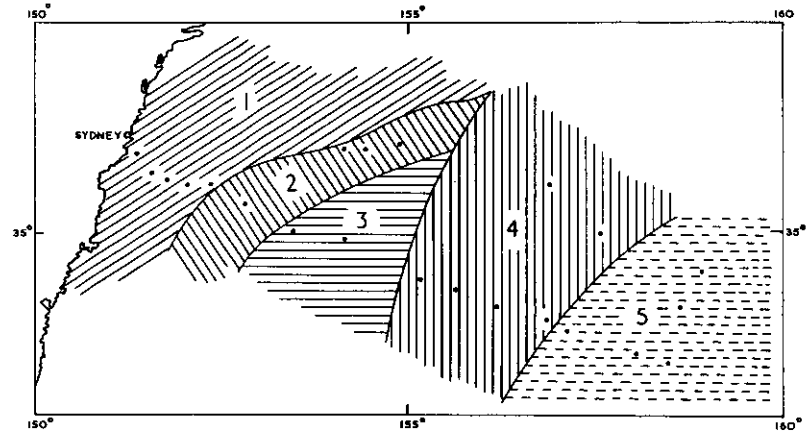

Fig. 18.- Phytoplankton communities determined from collections on 110°T and 290°T section lines. 1. Coral Sea flora, 2. Rich Coral Sea and East Australian Current, 3. Poor, 4. Coral Sea relatively rich, 5. No phytoplankton.

TABLE 1

DINOFLAGELLATES FROM "DERWENT HUNTER" CRUISE 4, 1958

SPECIES	STATION														
	37	38	39	40	41	42	44	46	49	51	53	54	56	57	58
Ceratium tripos	+	+	+	+	+	+		+						+	+
C. euarcuatum	+				+	+		+							
C. trichoceros		+			+										
C. schmidtii		+			+			+						+	
C. contrarium		+		+								+		+	
C. buceros		+			+										
C. setaceum			+			+						+			
C. pentagonum					+	+						+	+		
C. fusus					+	+	+	+	+						
C. carriense					+							+			
C. karstenii					+		+								
C. massiliense								+							
C. teres					+								+		
C. declinatum					+										
C. extensum					+										
C. hexacanthum					+										
C. candelabrum								+							
C. horridum												+			
C. pulchellum												+			
C. kofoidi					+										
C. macroceros						+									
Pyrophacus horologicum		+			+			+				+	+		
Diplopsalis minor		+							+						
Ceratocorys horridum				+											
Podolampas bipes														+	
Pod. palmipes				+											
Pyrocystis biconicum				+	+										
Peridinium pedunculatum					+			+							
P. solidicorne								+	+						
P. steinii															
P. grande					+										
P. divergens					+										
P. pellucidum									+						
P. granii															+
Ornithocercus magnificus														+	

TABLE 2

DIATOMS FROM "DERWENT HUNTER" CRUISE 4, 1958

SPECIES	STATION														
	37	38	39	40	41	42	44	46	49	51	53	54	56	57	58
Rhizosolenia alata					+	+				nil	nil	+		+	
v. gracillima			+		+							+	+		
R. styliformis	+		+	+	+								+		
R. calcar avis		+													
R. imbricata f. shrubsolei					+										
R. clevei					+										
R. bergoni					+							+	+		
R. castracanei					+										
R. hebetata f. hiemale												+			
Climacodium frauenfeldianum	+	+		+	+	+		+				+	+		+
Hemiaulus sinensis			+		+										
Chaetoceros coarctatum					+							+			
C. atlanticum						+									
C. secundum													+		
Stephanopyxis palmeriana					+										
Bacteriastrum varians					+										
Grammatophora oceanica						+									
Mastogloia cribrosa					+										
M. apiculata					+										
Fragilaria sp.					+										

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH5/58

March 12-16, 1958

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

ITINERARY

This cruise was the fifth of the productivity series. The positions of stations worked are shown in Figure 1.

(a) PRODUCTIVITY - N. DYSON

The purpose of this cruise was the same as that outlined for Cruise DH3/58 which had to be cancelled.

RESULTS

1. CO_2 Uptake

Measurements were made of the rate of CO_2 uptake both by the in situ and light bath incubation methods at the all day stations. The results are shown in Figure 2. At Station DH5/59/58 samples were collected from 0 and 25 m during the day and the rate of CO_2 uptake of these samples was measured by bath incubation. The variation is shown in Figure 3. At two stations quadruplicate samples were collected at 0600 hrs, $Na_2{}^{14}CO_3$ added to one pair, and all four resuspended in situ. At noon, $Na_2{}^{14}CO_3$ was added to the other two samples which were then resuspended in situ until 1800 hrs. The samples treated at 0600 hrs were removed and filtered at noon. In both cases the results, given in Table 1, were higher for the samples incubated for the first half of the day. Replicate sampling for incubation by the light bath method was carried out twice at each of two stations and the results are shown in Table 2.

2. Light Penetration

Submarine and surface light measurements were made at two hourly intervals at each of the three all-day stations. The variations in the depth of penetration of one per cent. of surface light are shown in Figure 4.

No corrections have been made for the angle of stray which possibly accounts for the high values at Station DH5/60/58 when the stray was greater than 50° for the deeper measurements.

(b) HYDROLOGY - A.D. CROOKS

Samples for chlorinity, oxygen, and total phosphorus were taken from 0, 25, 50, 100, 150, 200, and 300 m. Surface temperature increased eastwards. A chlorinity maximum occurred at between 50 and 75 m and an oxygen maximum roughly coincided with it.

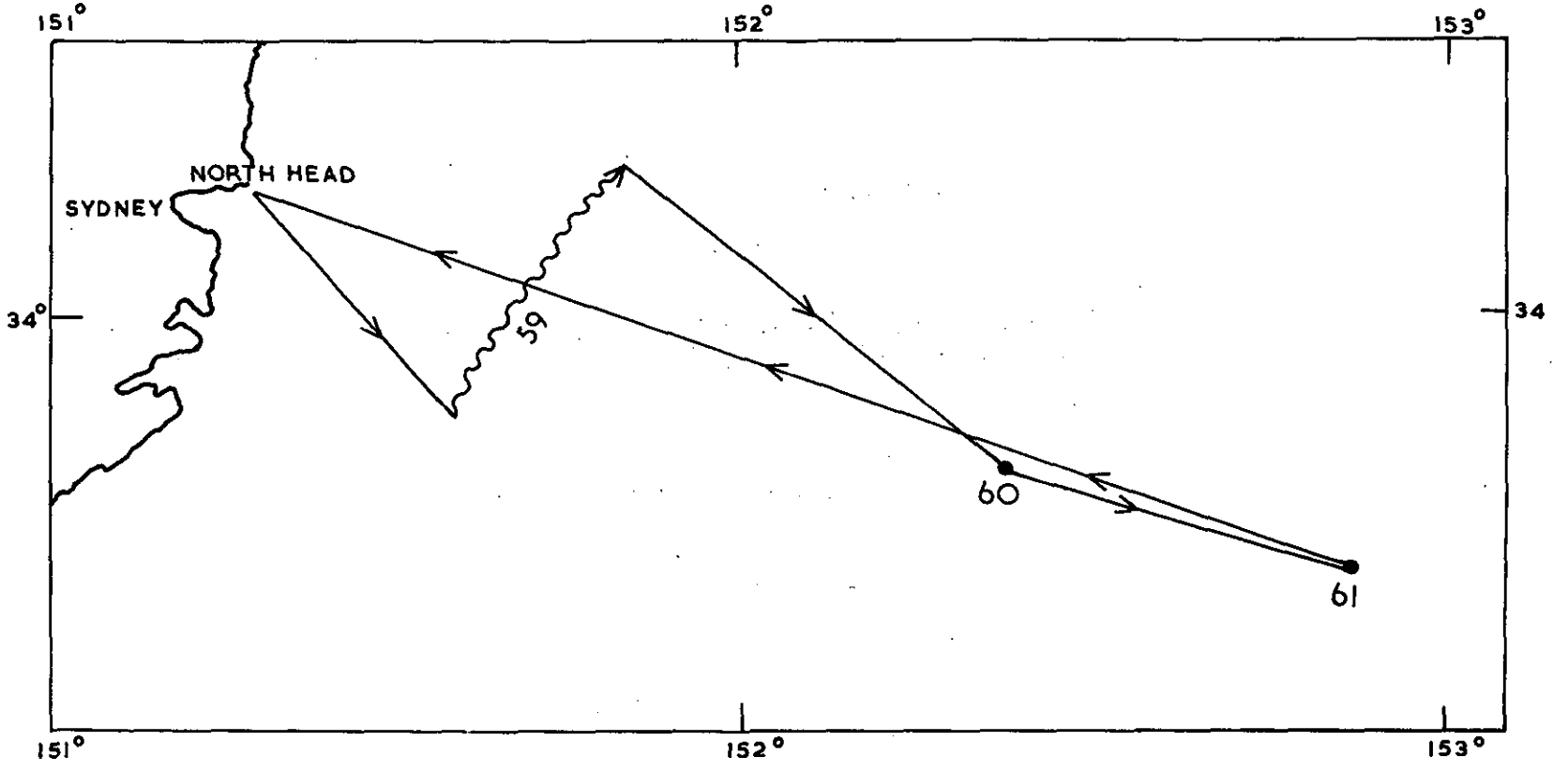

Fig. 1.- Cruise DH5/58. Track chart showing positions of stations.

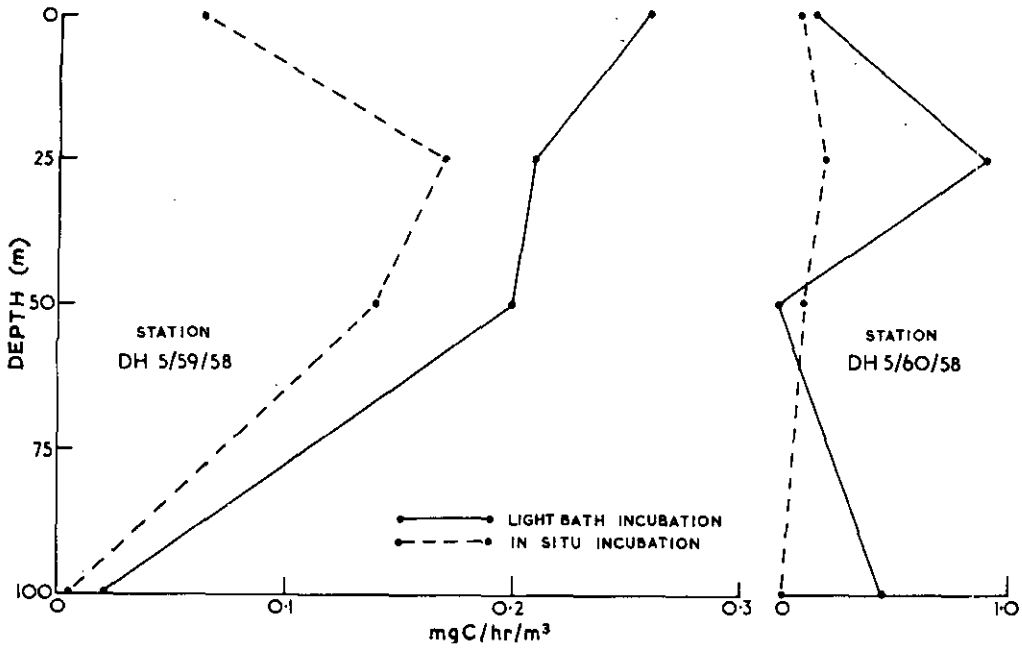

Fig. 2.- Rate of CO_2 uptake at Stations DH5/59/58 and DH5/60/58.

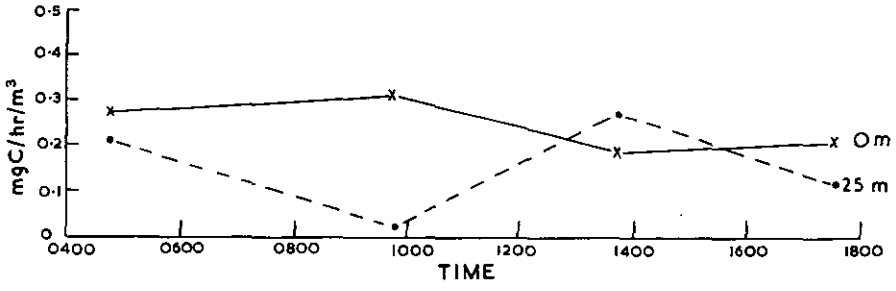

Fig. 3.- Variation of rate of CO_2 uptake by light bath incubation at Station DH5/59/58.

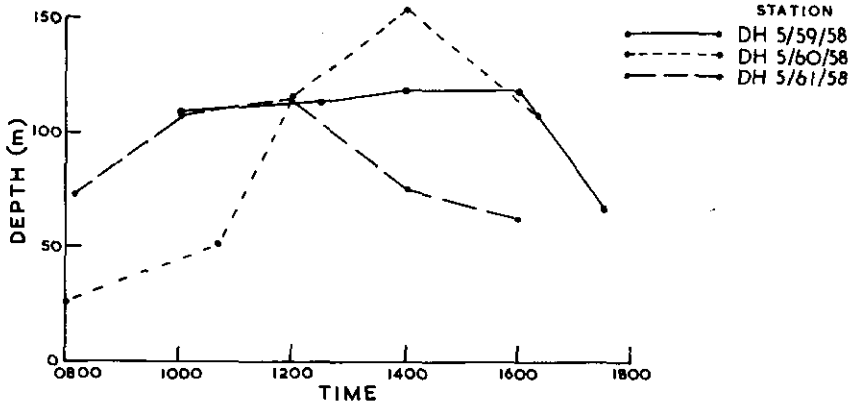

Fig. 4.- Depths of penetration of 1% of surface light at Stations DH5/59-61/58.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH6/58

April 9-16, 1958

ITINERARY

This is the tenth of the series of cruises to study the physical and chemical structure and circulation of the East Australian Current off Sydney. Figure 1 shows the positions of stations and work done at each station.

SCIENTIFIC REPORTS

Samples for chlorinity, dissolved oxygen, and total phosphorus were taken at the usual depths. Temperatures from paired protected and unprotected thermometers were used to calculate thermometric depths below 100 m. G.E.K. tows and B.T. lowerings were done at some stations. Phytoplankton samples were taken as indicated in Figure 1.

(a) HYDROLOGY - A.D. CROOKS

(1) Temperature

(a) 110°T Section Line (Fig. 2)

The maximum surface temperature of 24.47°C was observed at Station DH6/67/58 and the minimum of 19.75°C at Station DH6/65/58. East of 152°E. a minor thermocline appeared between 0 and 200 m. A maximum vertical gradient (.08°C/m) occurred at Station DH6/68/58. This thermocline was not very pronounced at Station DH6/71/58. Below 200 m the maximum temperature occurred at Station DH6/71/58 and the minimum at Station DH6/66/58. There was a general decrease in temperature from Station DH6/66/58 towards the coast.

(b) 290°T Section Line (Fig. 3)

The maximum surface temperature of 24.14°C occurred at Station DH6/82/58 and the minimum of 20.78°C at Station DH6/84/58. A layer of homogeneous surface water was observed between Stations DH6/79/58 and DH6/82/58 to a depth of 90 m. Maximum temperatures for all depths occurred at Station DH6/81/58 and minimum at Station

DH6/84/58 with warmer water at all depths between Stations DH6/79/58 and DH6/82/58. A thermocline was observed at all stations except Stations DH6/84 and 85/58 (the stations nearest to the coast). The maximum vertical gradient was 0.1°C/m at Station DH6/83/58. The depth of the thermocline varied between 120 m at Station DH6/81/58 and 60 m at Station DH6/83/58.

(2) Density (σ_t)

(a) 110° Section Line (Fig. 4)

Maximum surface density (25.27 σ_t) occurred at Station DH6/65/58 and minimum (23.78 σ_t) at Station DH6/67/58. A pycnocline was observed at all stations, its average depth varying from 70 m at Station DH6/66/58 to 120 m at Station DH6/68/58 and its vertical gradient varying from .016 σ_t/m at Station DH6/67/58 to .01 σ_t/m at Station DH6/68/58. Maximum density for all depths was observed at Station DH6/67/58 and minimum at Station DH6/71/58.

(b) 290°T Section Line (Fig. 5)

Maximum surface density (24.96 σ_t) occurred at Station DH6/84/58 and minimum (24.02 σ_t) at Station DH6/81/58. The layer of homogeneous surface water (Fig. 3) was very noticeable. A well developed pycnocline was observed at all stations except Stations DH6/84 and 85/58. The maximum vertical gradient was 0.04 σ_t/m at Station DH6/75/58. The depth of the pycnocline varied between 70 m at Station DH6/78/58 and 120 m at Station DH6/82/58. Maximum densities for all depths were observed at Station DH6/85/58 and minimum at Station DH6/79/58.

(3) Chlorinity

(a) 110°T Section Line (Fig. 6)

Maximum surface chlorinity (19.70‰) occurred at Station DH6/68/58 and minimum (19.62‰) at Station DH6/66/58. Maximum chlorinity for all depths occurred at Station DH6/71/58 and minimum at Station DH6/66/58. The depth of the chlorinity minimum varied between 850 m at Station DH6/66/58 and 1100 m at Station DH6/70/58. The chlorinity and density distributions were closely related throughout the section.

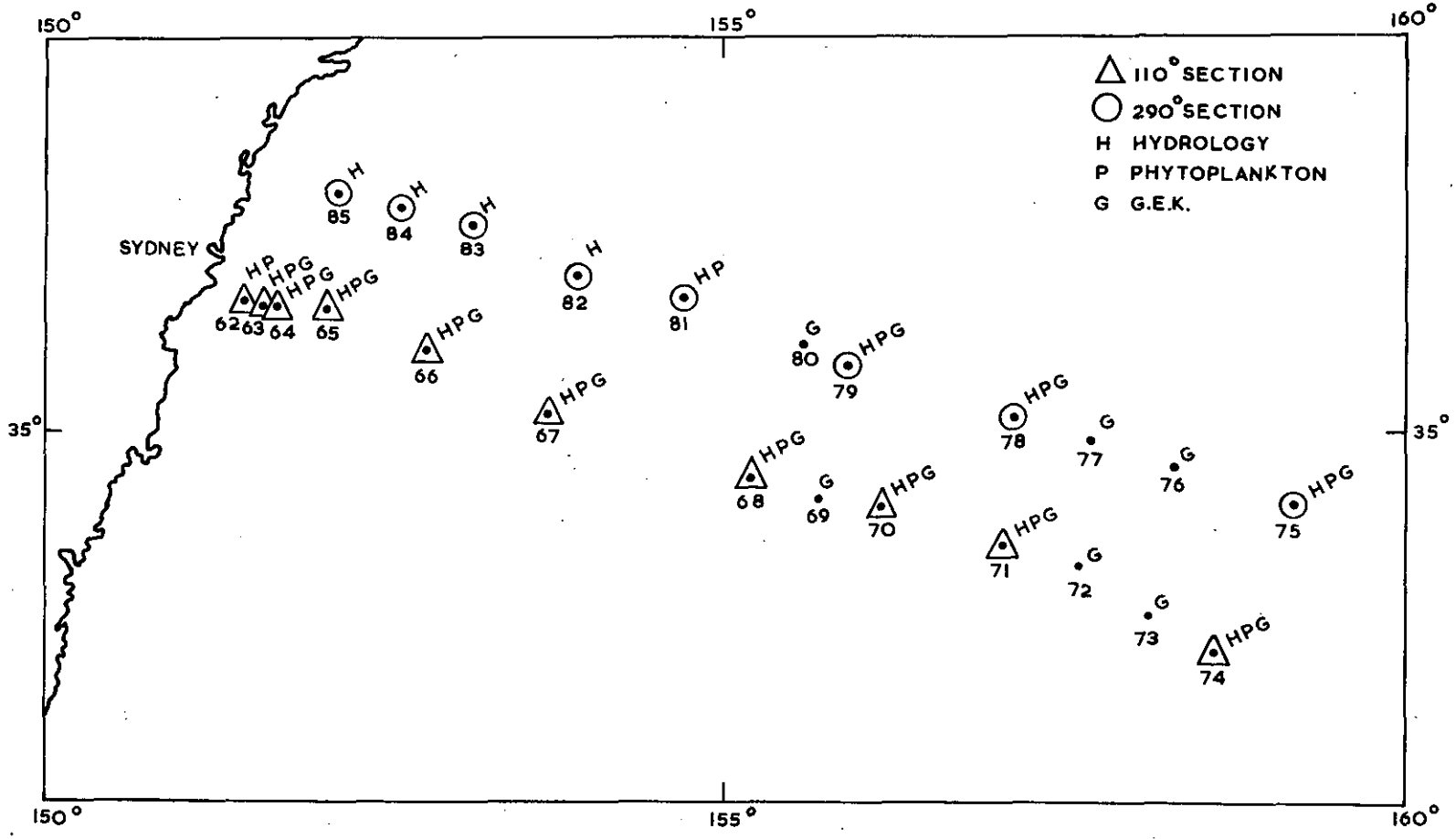

Fig. 1.- Cruise DH6/58. Track chart showing positions of stations.

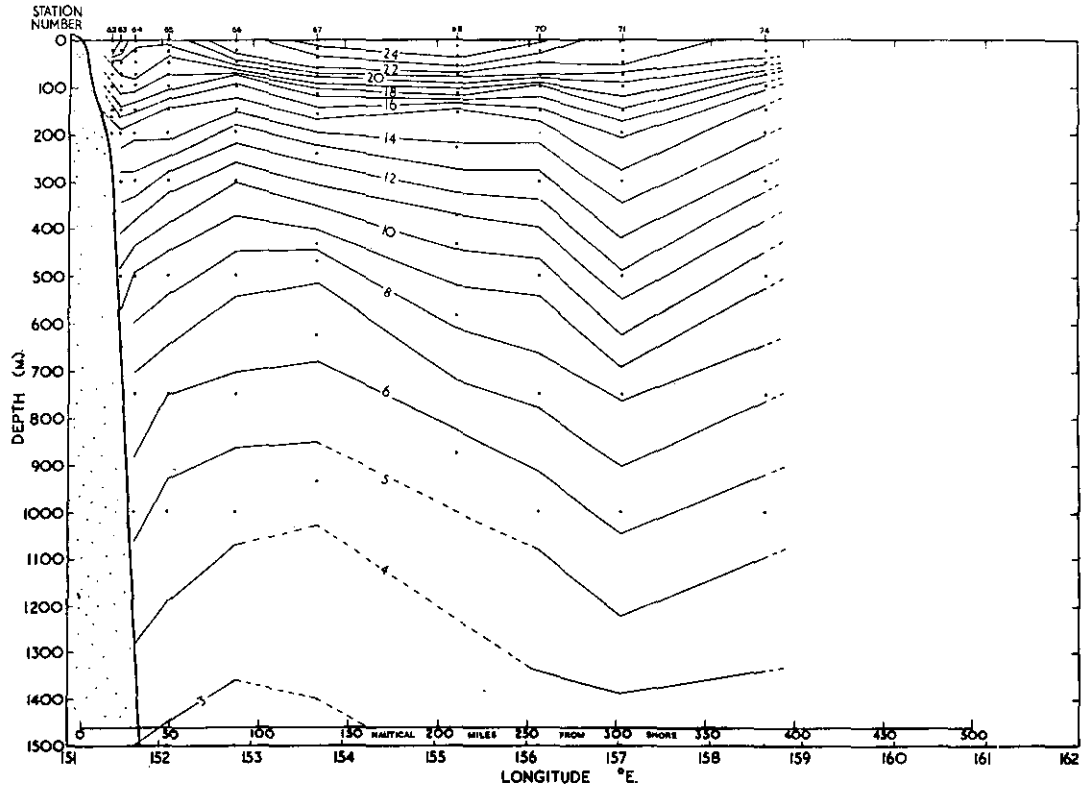

Fig. 2.- Sectional distribution of temperature (^{o}C) along 110^{o}T line to 1500 m.

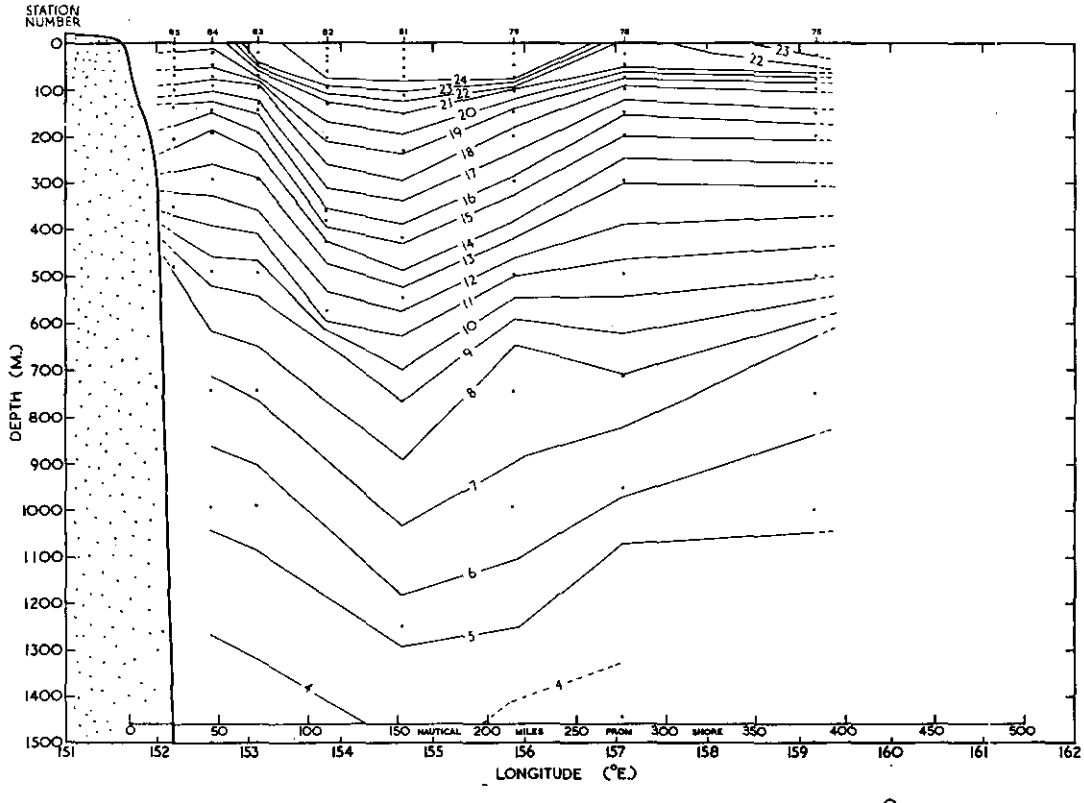

Fig. 3.- Sectional distribution of temperature (^{o}C) along 290^{o}T line to 1500 m.

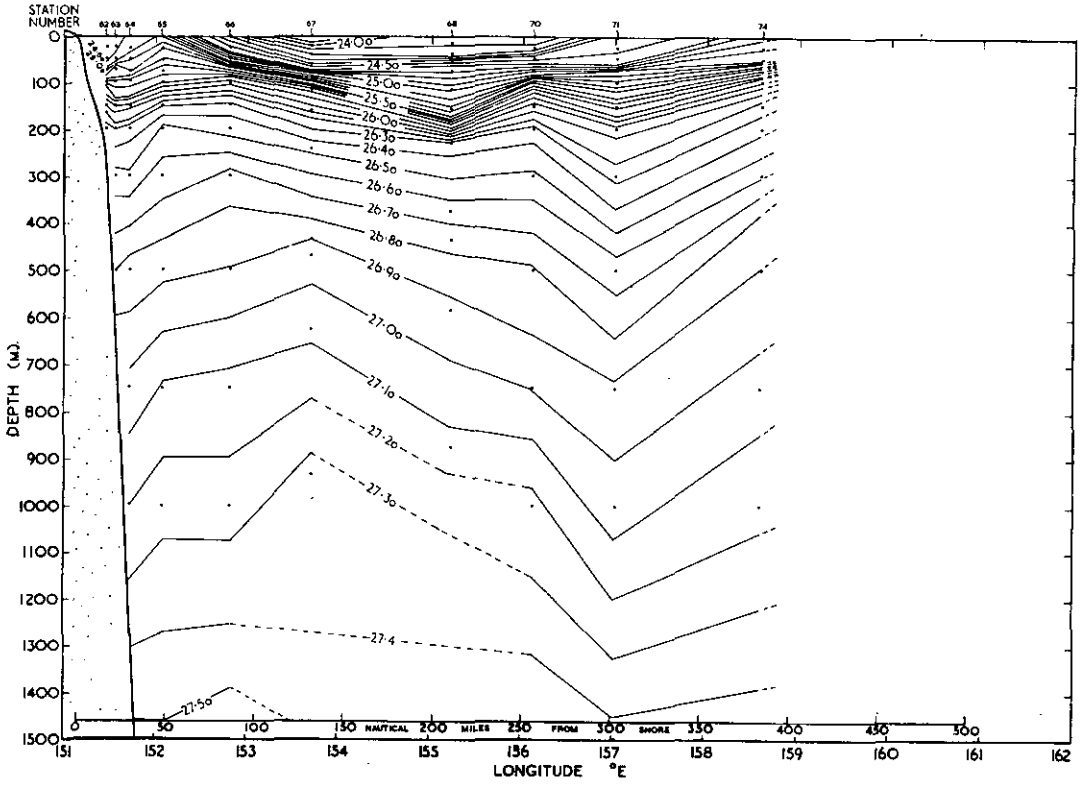

Fig. 4.- Sectional distribution of density (σ_t) along 110°T line to 1500 m.

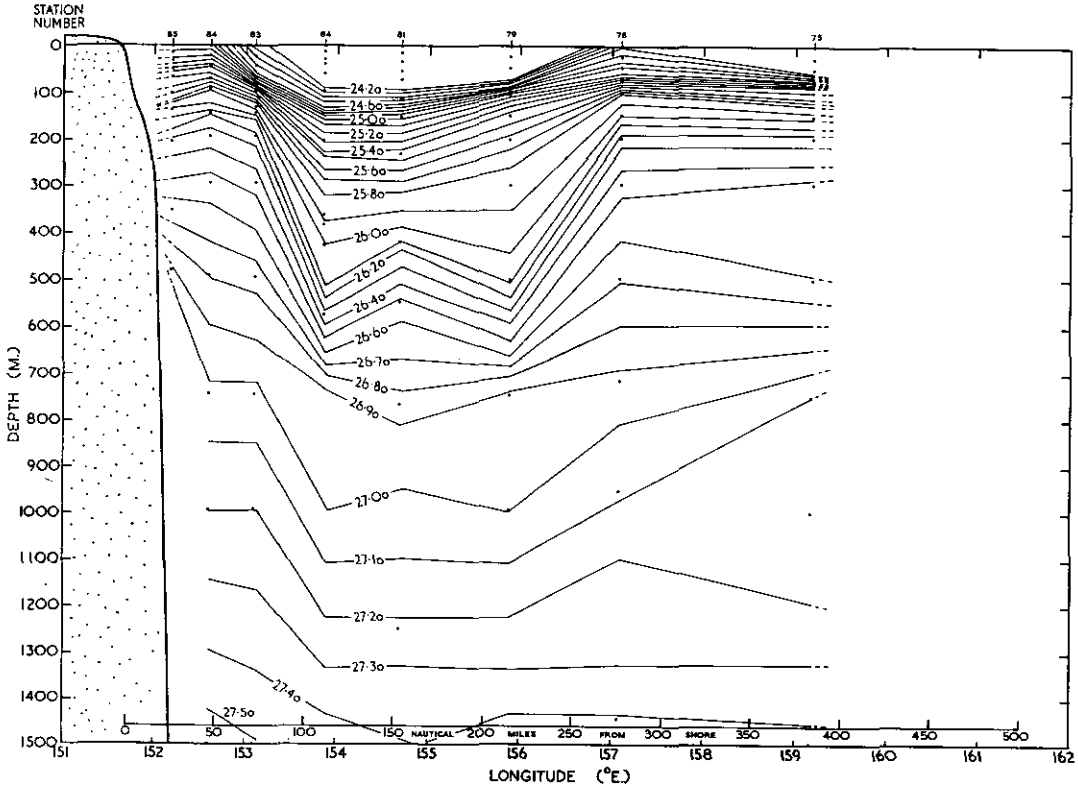

Fig. 5.- Sectional distribution of density (σ_t) along 290°T line to 1500 m.

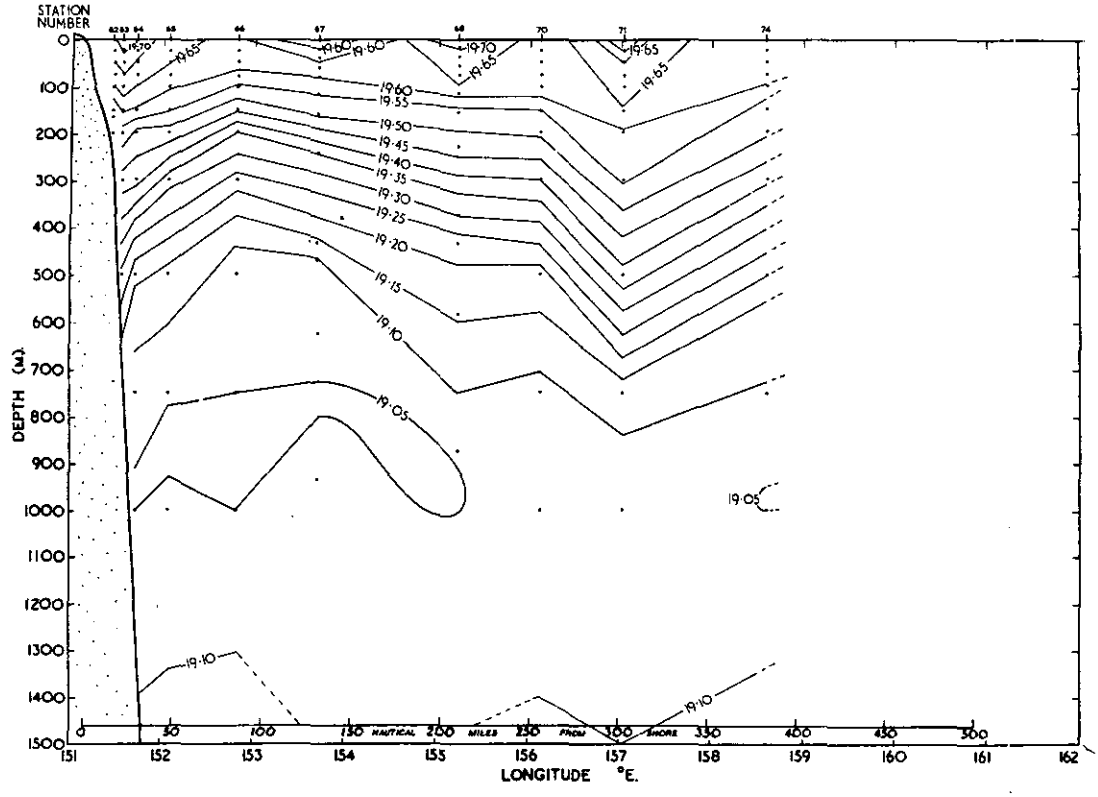

Fig. 6.- Sectional distribution of chlorinity ($^{o}/oo$) along 110°T line to 1500 m.

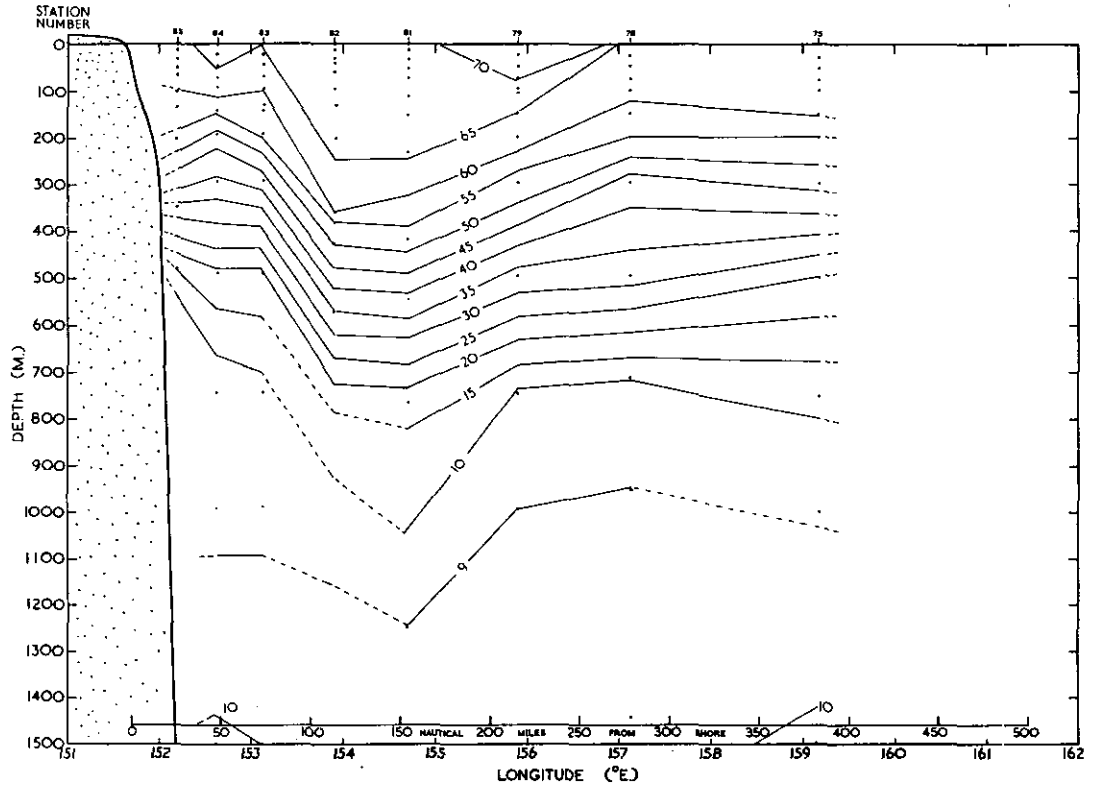

Fig. 7.- Sectional distribution of chlorinity ($^{o}/oo$) along 290°T line to 1500 m.

(b) 290°T Section Line (Fig. 7)

Maximum surface chlorinity (19.70‰) occurred at Station DH6/79/58 and minimum (19.63‰) at Station DH6/78/58. The layer of water of high temperature and low density, previously mentioned was found to be of relatively high chlorinity (19.65‰). Maximum chlorinity for all depths was found at Station DH6/81/58 and minimum at Stations DH6/84 and 85/58. The depth of the chlorinity minimum varied between 900 m at Station DH6/78/58 and 1350 m at Station DH6/81/58. The chlorinity and density distributions were generally in agreement except below 400 m between Stations DH6/78 and 81/58 where some anomalies were found.

4. Percentage Oxygen Saturation

(a) 110°T Section Line (Fig. 8)

Maximum surface oxygen (98 per cent.) occurred at Station DH6/74/58 and minimum (87 per cent.) at Station DH6/70/58. No saturated waters were found on the section. A rapid charge in oxygen was observed in the upper part of the pycnocline. Below the surface to 200 m, maximum oxygen occurred at Station DH6/65/58 and minimum at Station DH6/71/58. Below 200 m maximum oxygen occurred at Station DH6/65/58 and minimum at Station DH6/71/58. The oxygen and density fields were in agreement except at Station DH6/65/58 between 200 m and 800 m, where oxygen values were lower.

(b) 290°T Section Line (Fig. 9)

Maximum surface values (98 per cent.) were recorded at Stations DH6/78 and 81/58 and minimum (87 per cent.) at Station DH6/75/58. Large vertical gradients in oxygen occurred in the upper 100 m above the upper limit of the pycnocline. Saturated waters were found at 25 m at Station DH6/94/58. Between 300 m and 800 m at Station DH6/83/58 there was a column of water of exceptionally low oxygen content. The oxygen and density fields were in general agreement except below 100 m between Stations DH6/78 and 81/58. However, some smaller anomalies occurred below 100 m near Stations DH6/75 and 83/58.

5. Total Phosphorus

(a) 110°T Section Line (Fig. 10)

Maximum surface total phosphorus of 13 µg/l. was observed at Stations DH6/64, 65, 66/58 and minimum of 8 µg/l. at Station DH6/68/58. A total phosphorus minimum was observed throughout the section at depths between 50 m at Station DH6/70/58 and the surface at Station DH6/68/58. Below 300 m maximum total phosphorus occurred at Station DH6/67/58 and minimum at Station DH6/71/58. There was very little relationship between the total phosphorus distribution and the density distribution except west of Station DH6/70/58. The coastal stations showed large anomalies.

(b) 290°T Section Line (Fig. 11)

Maximum surface total phosphorus of 18 µg/l. occurred at Station DH6/78/58 and minimum of 8 µg/l. at Station DH6/75/58. The surface layer of homogeneous water previously mentioned was also almost homogeneous in total phosphorus (10-14 µg/l.). Below the surface maximum total phosphorus was found at Station DH6/84/58 and minimum at Station DH6/79/58 down to 700 m and Station DH6/75/58 below 700 m. The density and total phosphorus distributions were closely related except below 600 m between Stations DH6/75 and 78/58.

Horizontal Distribution of Properties

(a) Temperature (Fig. 12)

The surface distribution of temperature consisted of two main features, a tongue of cooler water parallel to the coast, and a tongue of cooler water in the extreme east of the area. Between these features was an area of water of even temperature between 24°C and 24.5°C. Below the surface, both tongues were weaker. At 100 m only the coastal tongue was observed. Between 100 m and 300 m a belt of warmer water from the north, in the centre of the region, was the most noteworthy feature.

(b) Density (σ_t) (Fig. 13)

Minimum surface values of sigma-t (24.00) occurred in the southern central part of the area, maximum values occurring in the extreme east and west. This distribution

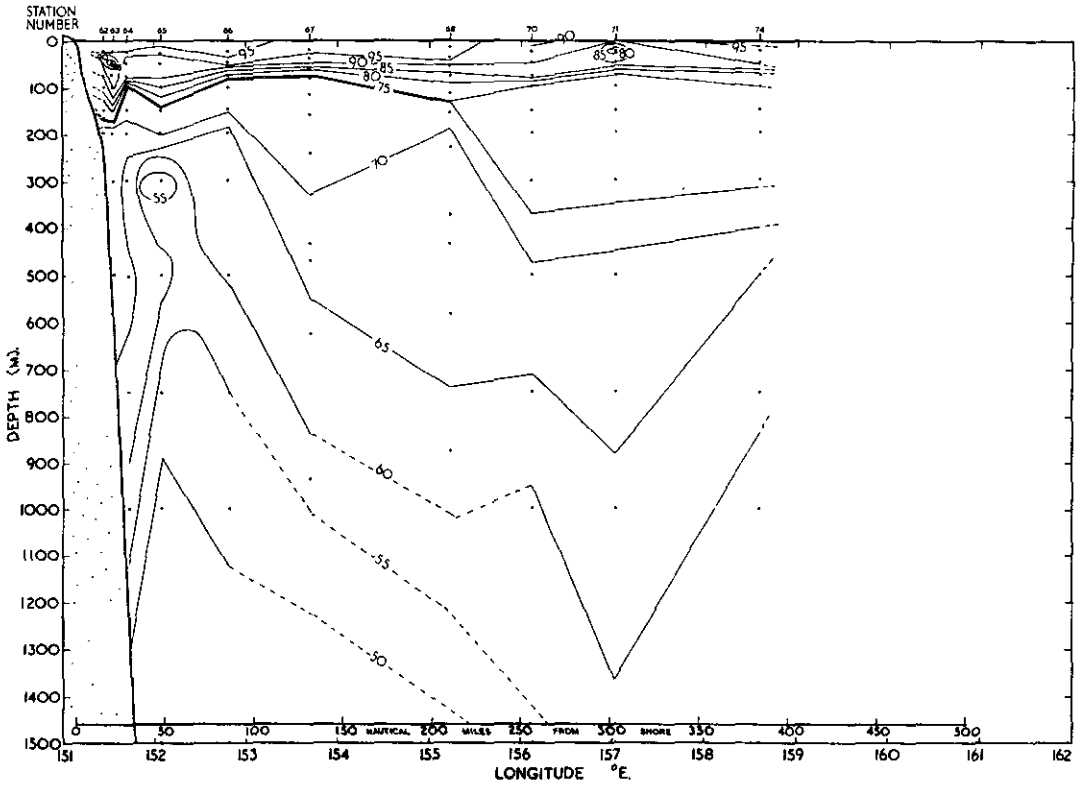

Fig. 8.- Sectional distribution of oxygen saturation (%) along 110°T line to 1500 m.

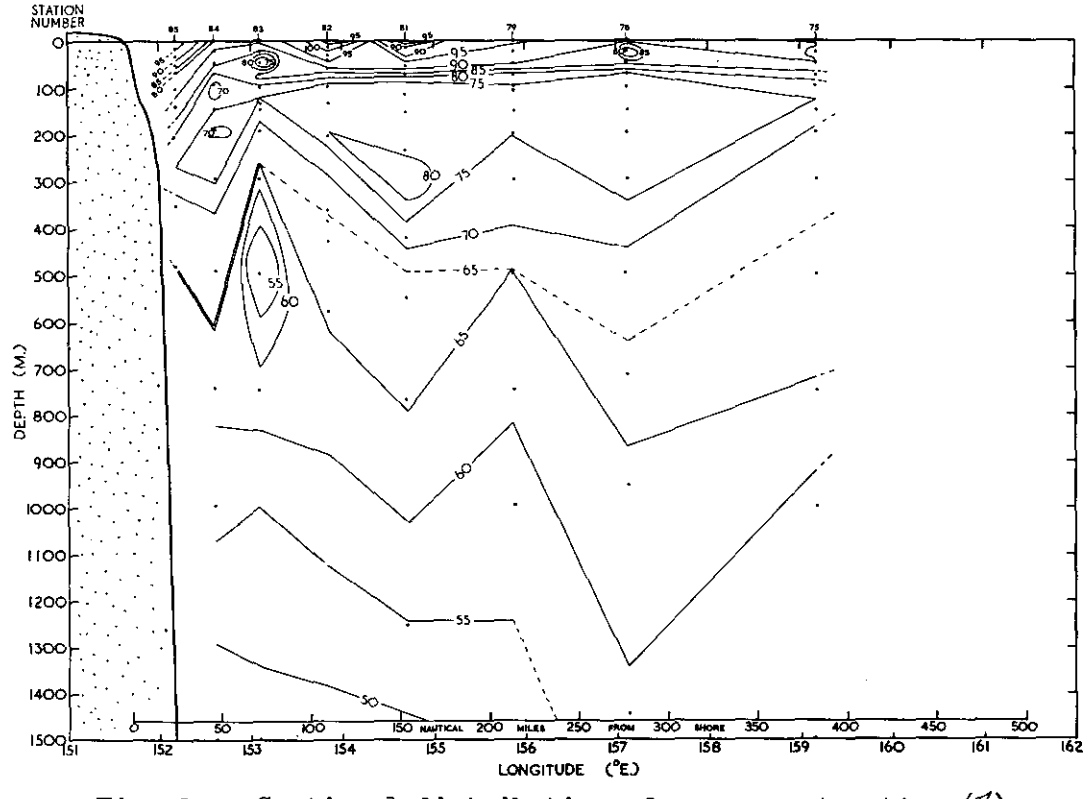

Fig. 9.- Sectional distribution of oxygen saturation (%) along 290°T line to 1500 m.

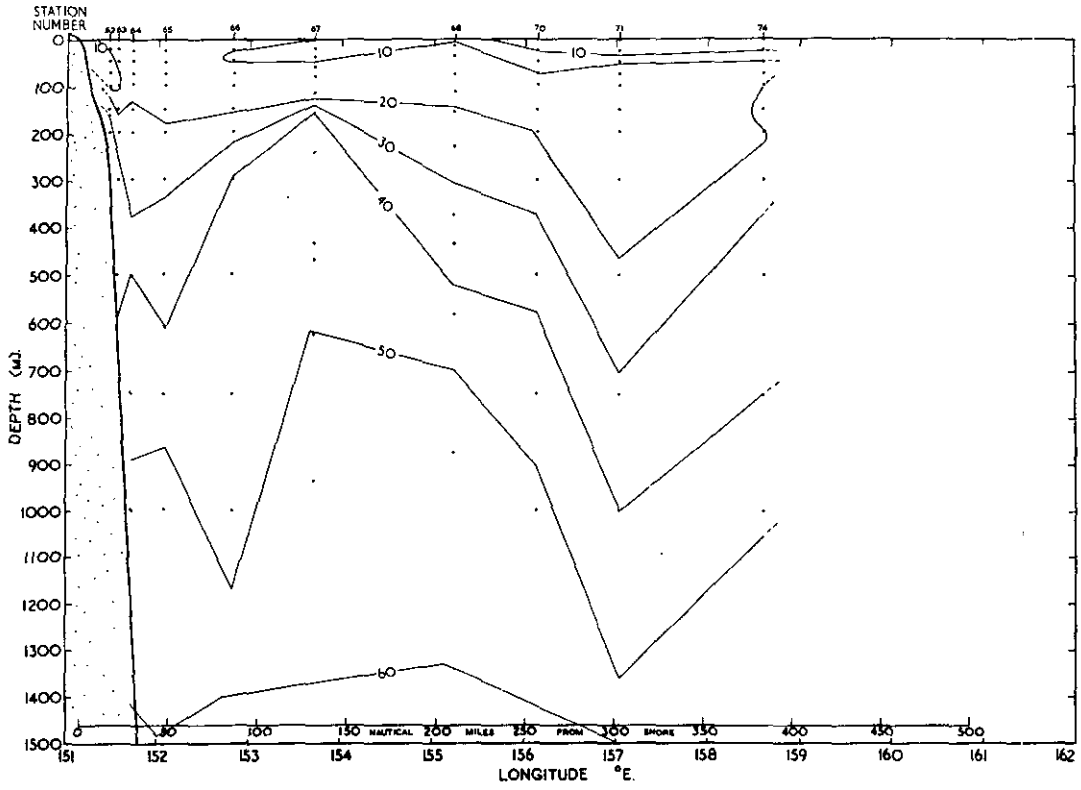

Fig. 10.- Sectional distribution of total phosphorus along 110°T line to 1500 m.

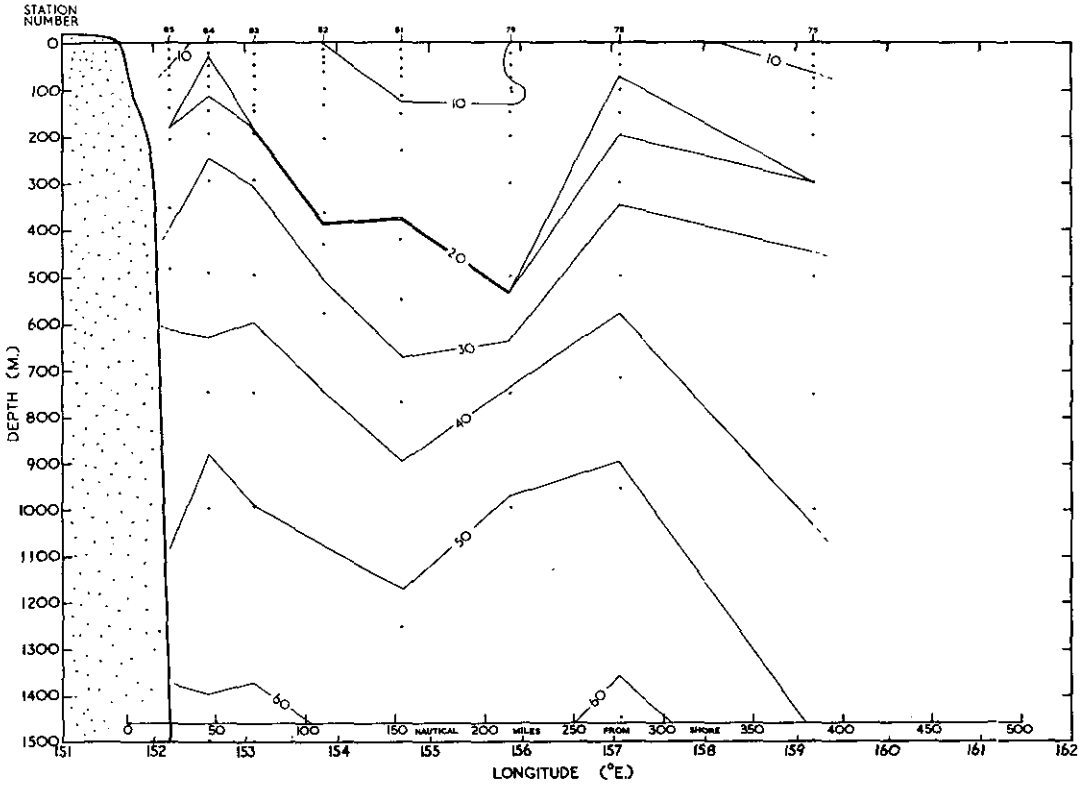

Fig. 11.- Sectional distribution of total phosphorus along 290°T line to 1500 m.

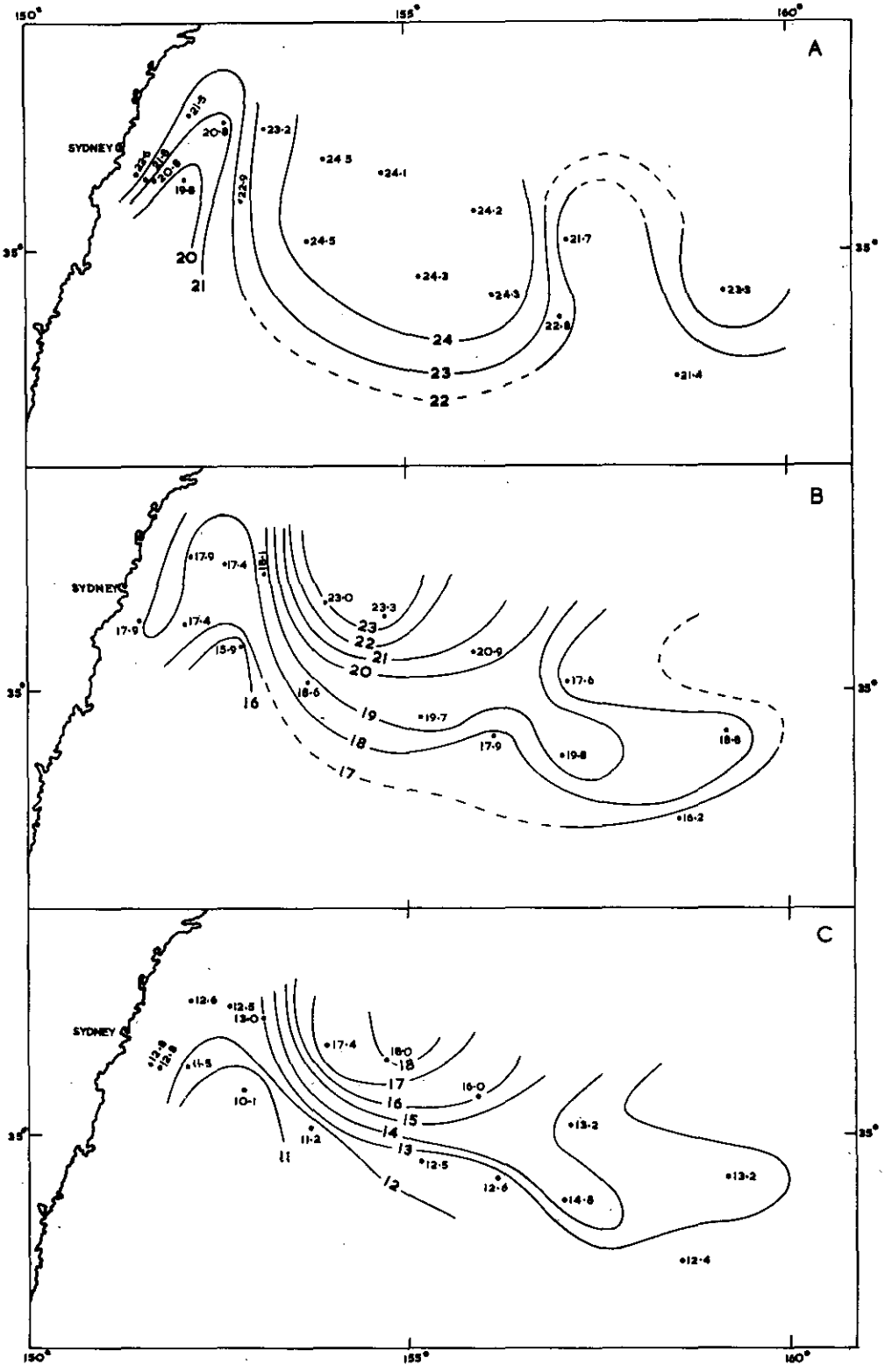

Fig. 12.- Horizontal distribution of temperature, A at 0 m, B at 100 m, C at 300 m.

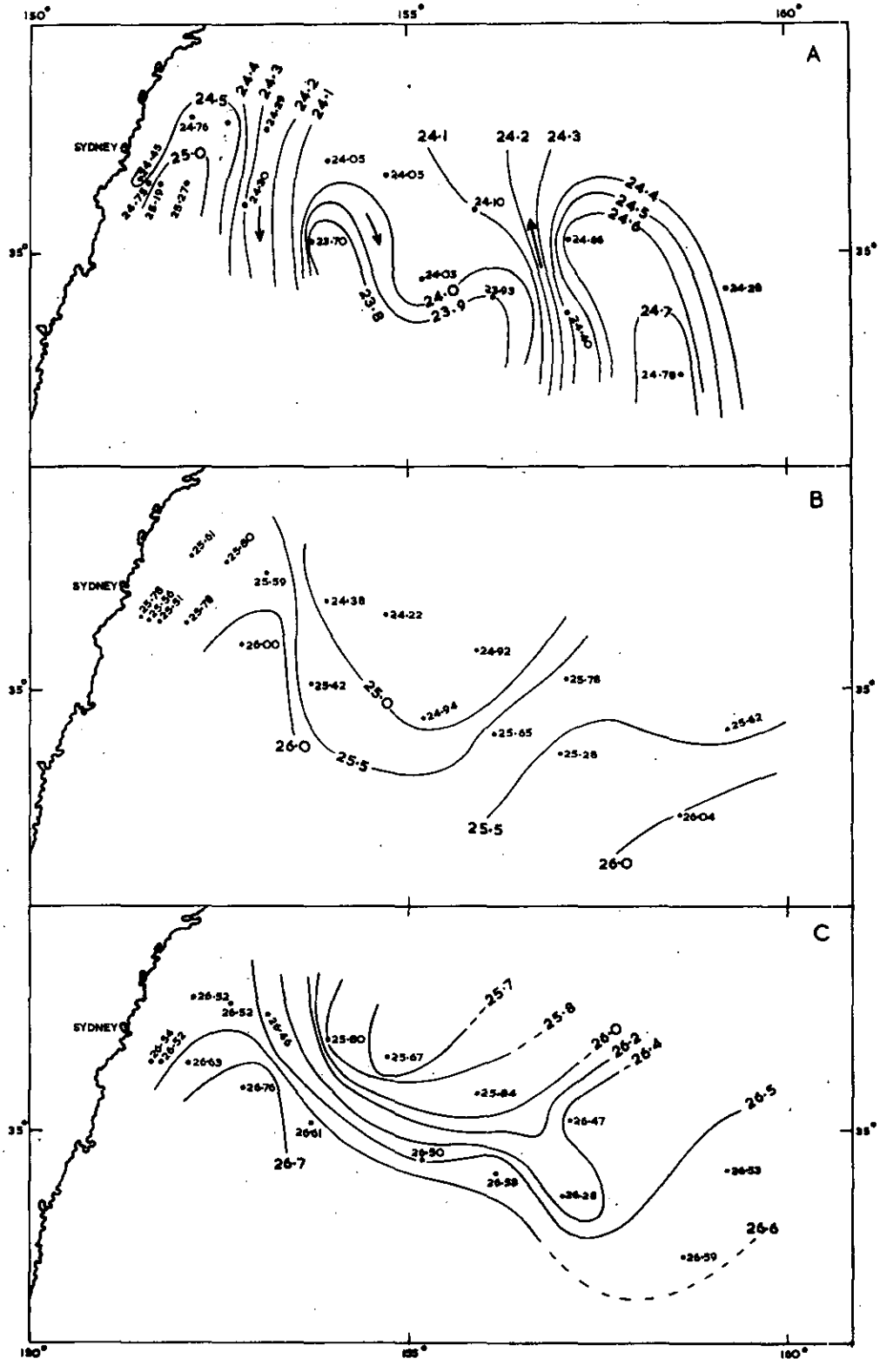

Fig. 13.- Horizontal distribution of density (σ_t), A at 0 m, B at 100 m, C at 300 m.

continued to 300 m, except that at 300 m minimum values were further north. The two cold water tongues of high density were evident at the surface but below the surface the warmer tongue of low density was the dominant characteristic. The distribution of density at the surface was considerably different from that at 100 m and 300 m.

(c) Chlorinity (Fig. 14)

At the surface the high chlorinity observed at the stations near the coast was associated with the cold tongue of water described above. At the eastern edge of the higher temperature water there was another area of high chlorinity. At 100 m there was still high chlorinity coastal water and the association of higher chlorinity water with higher temperature water was more pronounced. At 300 m low chlorinity was associated with the low temperature water and high chlorinity with the high temperature water.

(d) Percentage Oxygen Saturation (Fig. 15)

Low temperature coastal water was associated with relatively low oxygen content at the surface and at 300 m. At 100 m the warmer coastal waters had a high oxygen content and the cooler waters, slightly farther off shore, had a much lower oxygen value. The warm waters near the centre of the area were low in oxygen at the surface, but relatively high at 100 m and 300 m.

(e) Total Phosphorus (Fig. 16)

High values of total phosphorus were generally found associated with the cold water tongues, and low values with the higher temperature water. Two exceptions were found in the eastern part of the area, where high total phosphorus values were found in warmer water at 100 m and 300 m.

Summary

Sectional Plots

There was little relationship between the vertical distributions of properties on the two sections. On the 110°T Section the higher temperature and lighter waters occurred toward the ends of the section, whereas on the 290°T Section this water was observed near the middle around 155°E. On both sections a thermocline

was observed in the upper 200 m. Associated with this was a well developed pycnocline and a rapid vertical change in oxygen. On the 290°T Section, a column of higher temperature, low density, high chlorinity water was observed between 154°E. and 157°E. In this column there was little or no relationship between oxygen and density or oxygen and total phosphorus. The distribution of oxygen, particularly below 200 m near the coast, was very complex.

Horizontal Plots

At the surface, low temperature water was found near the coast and at the extreme east of the area. This water had high chlorinity, low oxygen, and high total phosphorus. Below the surface, this water was found near the coast but slightly further to the east. Warmer water was found in the centre of the area, at all depths and to the east at 100 m and 300 m. This water was of lower chlorinity, lower oxygen, and low total phosphorus. The eastern part of this water at 100 m and 300 m had high total phosphorus values.

(b) PHYSICS - B.V. HAMON

Dynamics

Figure 17 shows the surface dynamic heights at each station, with approximate contours at intervals of 10 dynamic centimetres.

There was a surface current towards the south or south-east about 100 miles east of Sydney. The current turned towards the east, and finally towards the north-east or north about 270 miles from the coast. The volume transport towards the south-east between Stations DH6/67 and 81/58 was found to be 30×10^6 m^3/sec.

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

Table 1 lists the dinoflagellates and Table 2 the diatoms collected at each station on this cruise. The collection from Station DH6/62/58 contained Climacodium frauenfeldianum and Rhizosolenia setigera of Coral Sea origin. The samples from Stations DH6/63-66/58 had R. hebetata v. hiemalis, a southern form, but they also contained some tropical species, thus suggesting that this is a mixing zone. Samples from Stations DH6/67-70/58 contained C. frauenfeldianum (Coral Sea)

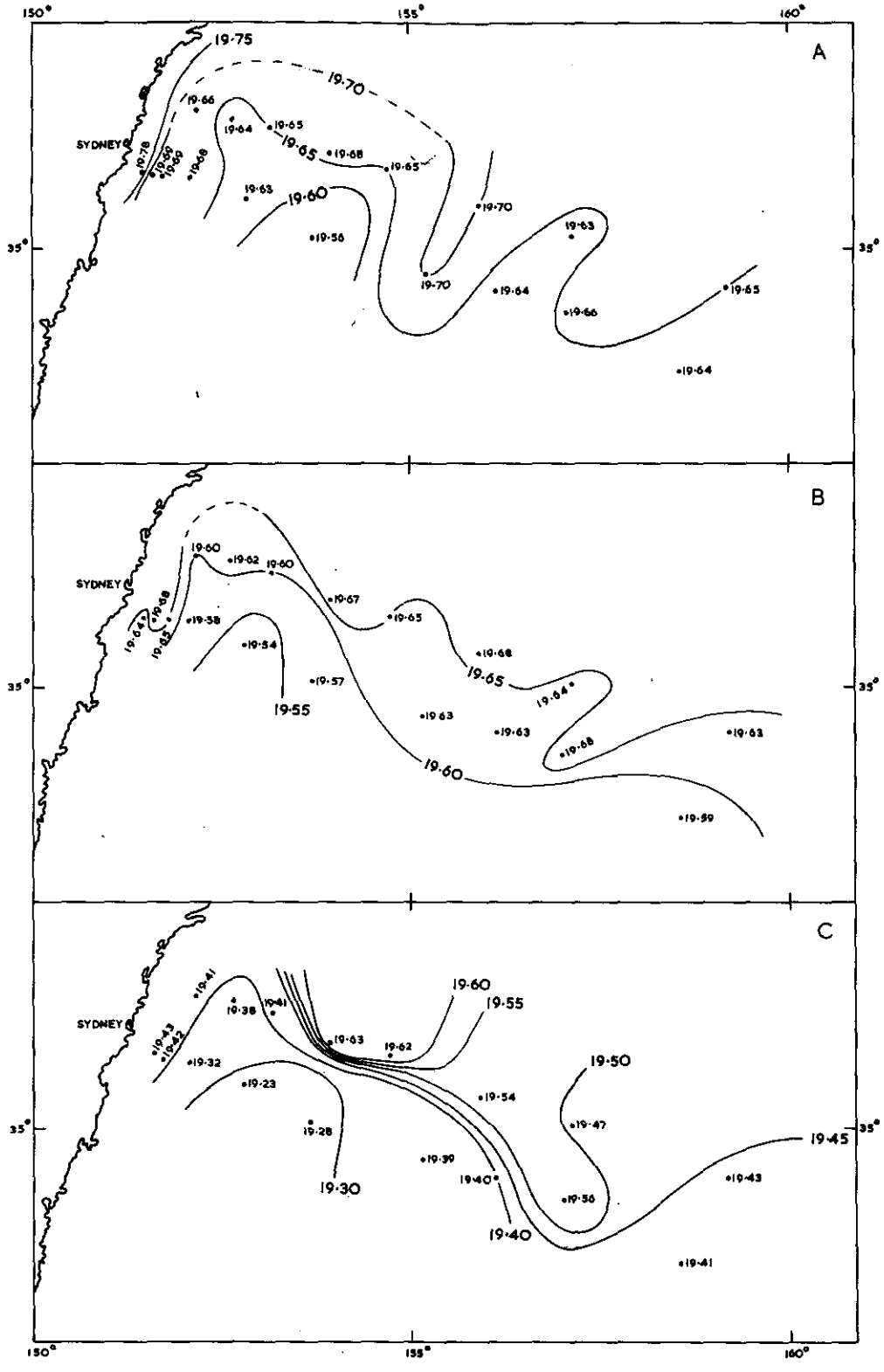

Fig. 14.- Horizontal distribution of chlorinity, A at 0 m, B at 100 m, C at 300 m.

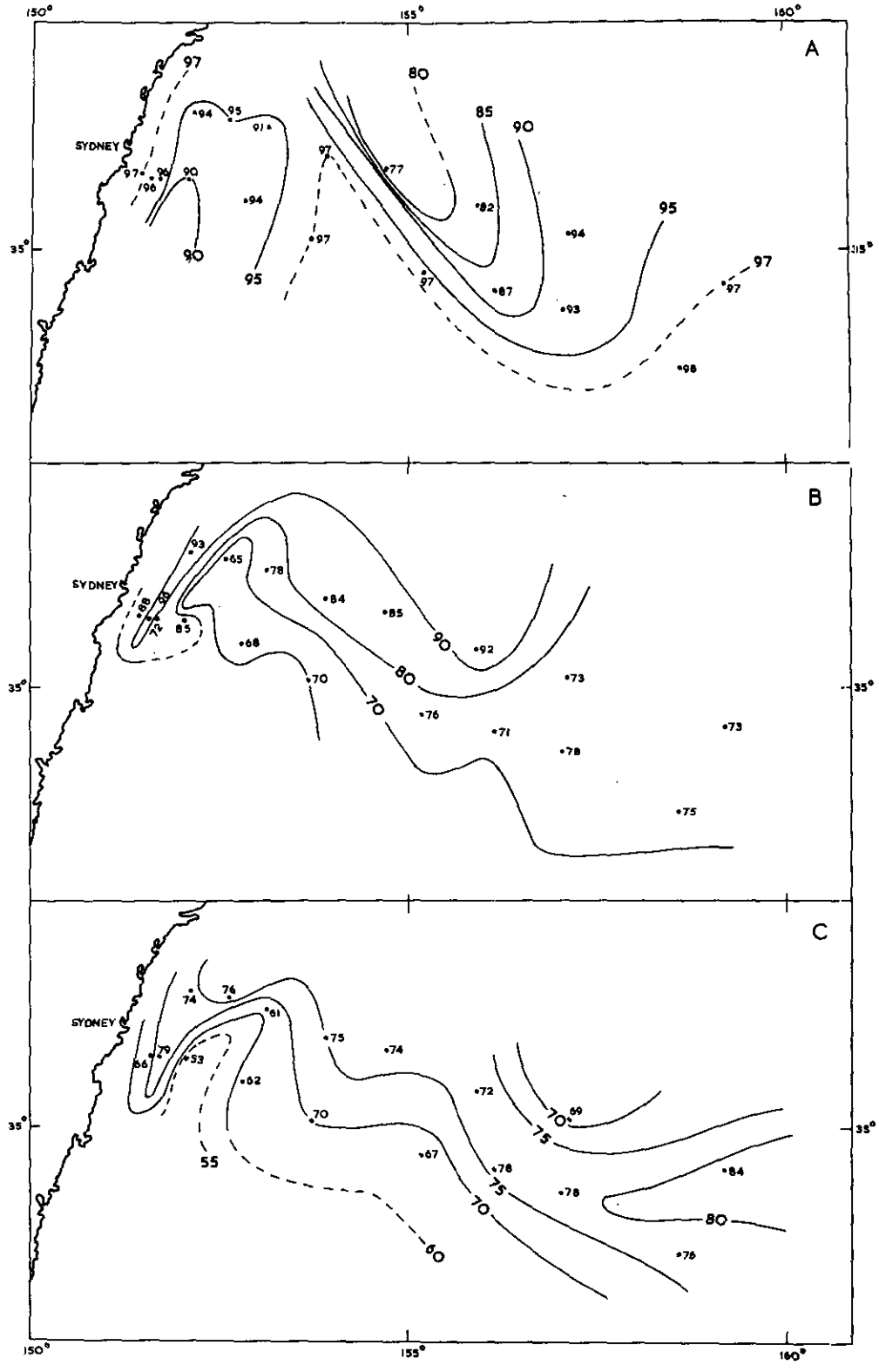

Fig. 15.- Horizontal distribution of oxygen saturation (%). A at 0 m, B at 100 m, C at 300 m.

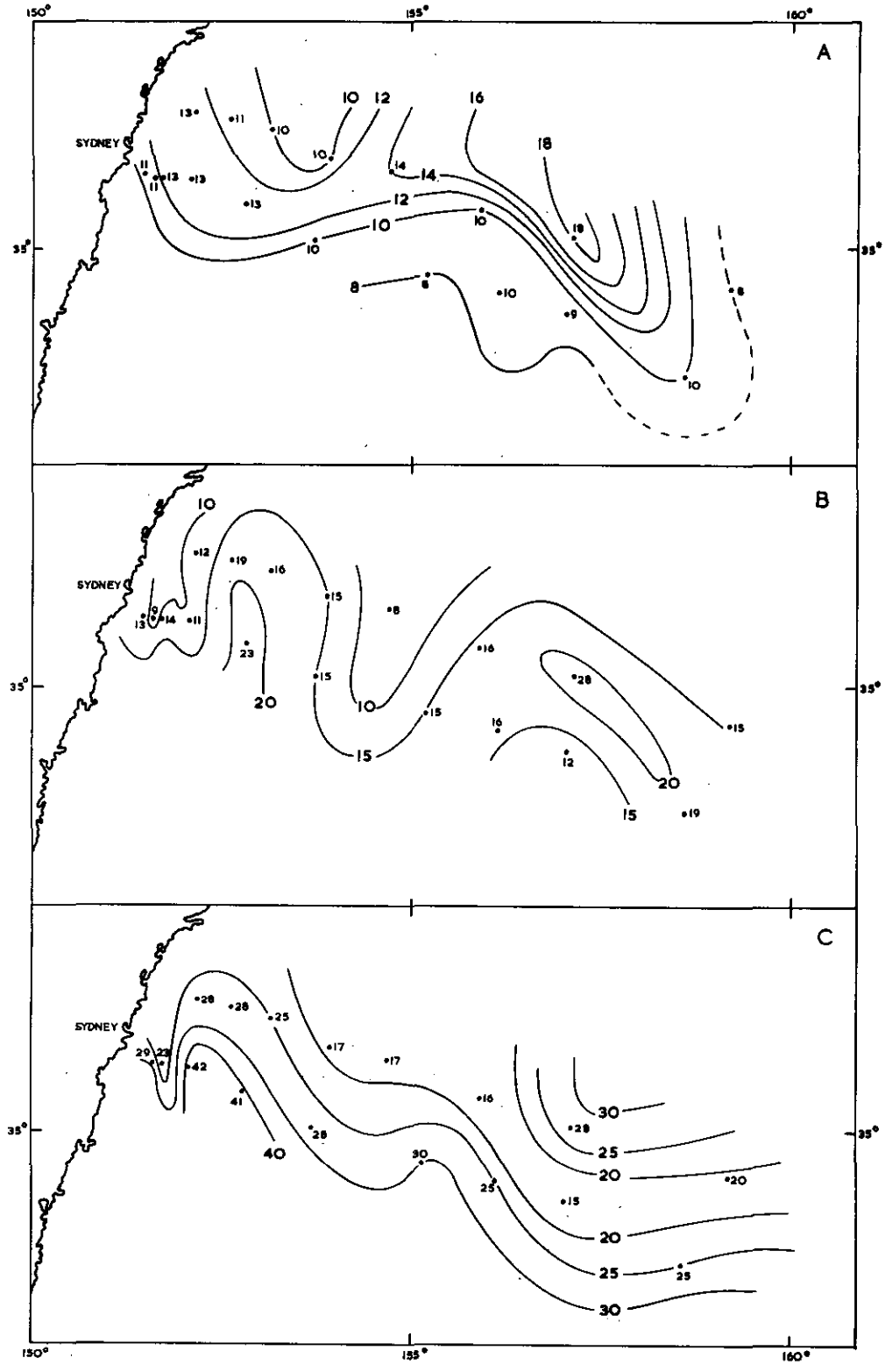

Fig. 16.- Horizontal distribution of total phosphorus, A at 0 m, B at 100 m, C at 300 m.

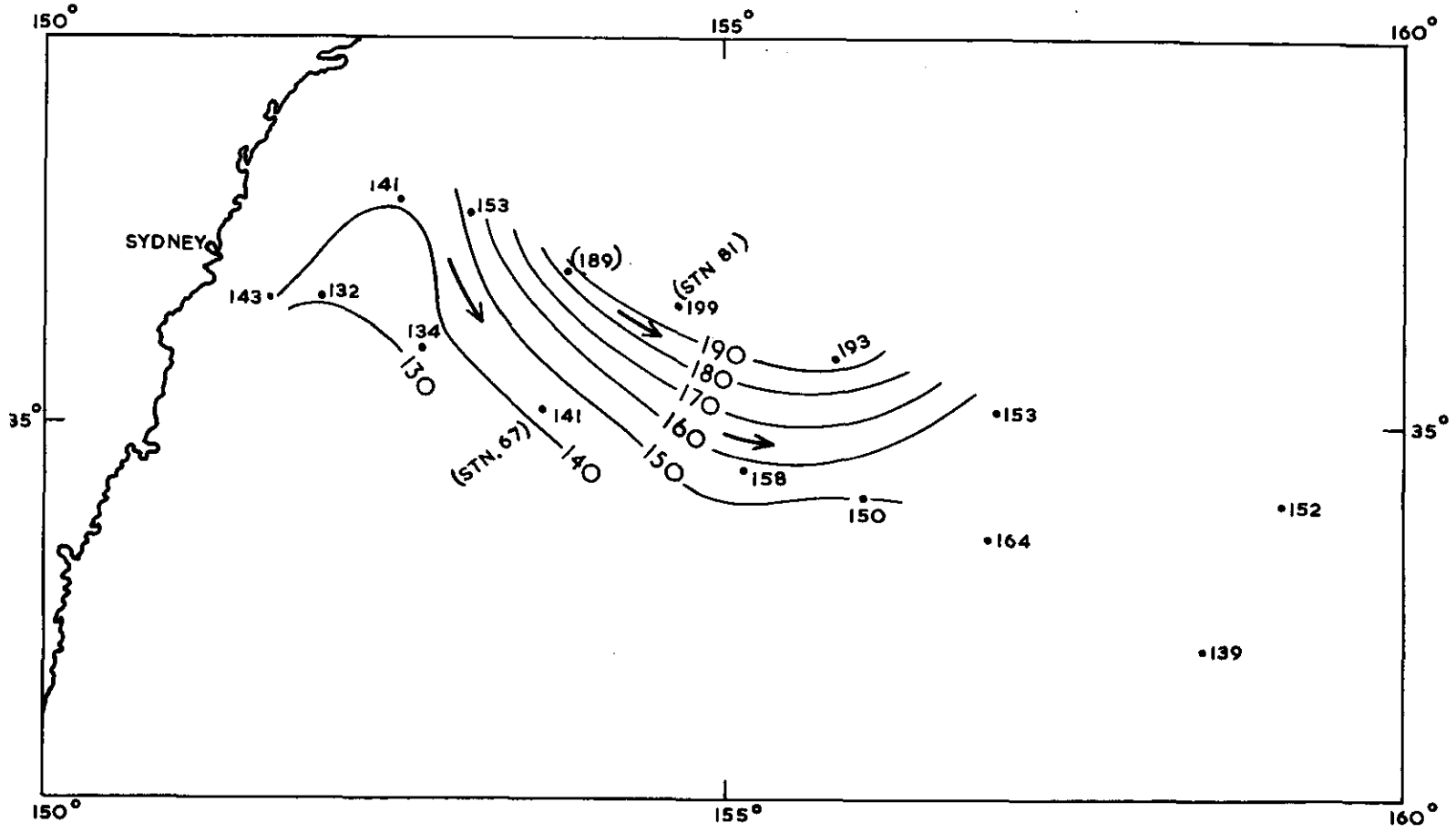

Fig. 17.- Contours of dynamic heights in dynamic centimetres (0/1000 decibars).

and those from Stations DH6/71-75/58 had this species together with R. castracanei and R. bergonii, suggesting a slightly different origin. Species from Stations DH6/78-79/58 indicate that the water mass in that area was similar to that at Station DH6/67-70/58 and also at the "Queenborough" - "Quickmatch" Stations Q1/21-22/58.*

*H.M.A. Ships "Queenborough" and "Quickmatch" Scientific Report of Cruise Q1/58 (c) Phytoplankton C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 25

TABLE 1

DINOFLAGELLATES FROM CRUISE DH6/58

SPECIES	STATION											
	62	63	64	65	66	67	70	71	74	75	78	79
Ceratium porrectum		+										
C. trichoceros		+						+	+			
C. gallicum		+	+	+					+			
C. furca				+	+				+	+		
C. teres				+				+				
C. tripos								+	+			
C. tripos v. tripodioides					+							
C. extensum					+			+	+			
C. concilians					+							
C. pentagonum							+					
C. euarcuatum								+	+			
C. declinatum								+				
C. contrarium								+				
C. setaceum								+				
C. falcatum									+			
C. schmidtii									+			
C. macroceros									+			
C. fusus									+			
Pyrocystis hamulus v. semicircularis								+				
Diplopsalis lenticula					+							
Dinophysis caudata												+
D. sacculus									+			
D. tripos											+	
Phalacroma rapa									+			
Peridinium pedunculatum								+	+			+
Pyrocystis robusta									+			
Oxytoxum scolopax									+			
Peridinium oceanicum								+	+			
P. divergens									+			
P. solidicorne								+				
P. murrayi								+				
P. quarnerense								+				
Ceratocorys horridum								+	+			

TABLE 2

DIATOMS FROM CRUISE DH6/58

SPECIES	STATIONS											
	62	63	64	65	66	67	70	71	74	75	78	79
Climacodium frauenfeldianum	+					+	+		+	+		
Coscinodiscus concinnus	+			+				+				
Leptocylindrus danicus		+									+	
Rhizosolenia alata	+	+	+		+	+	+	+		+	+	+
R. f. gracillima		+		+				+		+	+	
R. clevei										+		
R. setigera	+											
R. calcar avis	+											
R. hebetata f. hiemalis												
R. stolterforthii		+	+				+					
R. styliformis								+		+		
R. hebetata f. semispinosa						+				+		
R. pagilissima						+						
R. castracanei							+			+		
R. bergonii								+				
Hemiaulus membranaceus					+							
Hemiaulus hauckii												
Bacteriastrum hyalinum		+										
Schroederella delicatula		+										
Chaetoceros coarctatum		+										
Ch. affine					+							
Ch. decipiens							+					
Ch. teres							+					
Ch. lorenzianum								+				
Ch. vanheurckii								+				
Ch. eibenii								+		+		
Ch. concavicorne								+		+		
Ch. lauderi								+				
Ch. subsecundus										+		
Stephanopyxis turris						+						
Planktoniella sol							+	+				
Guinardia flaccida								+				
Thalassiotrix longissima								+				
Nitzschia seriata										+		+

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH7/58

April 22-25, 1958

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

ITINERARY

This cruise was the sixth of the productivity series. Only two stations were occupied because of failure of equipment, a fault in the submarine photometer, and a fire in the ^{14}C light bath. Figure 1 shows the positions of the stations worked.

(a) PRODUCTIVITY - N. DYSON

Because of the failure of equipment there is no report for this cruise.

(b) BIOCHEMISTRY - G.F. HUMPHREY

The determinations of chlorophyll for this cruise are to be found in C.S.I.R.O. Aust. (1959)*. The results obtained are plotted in Figure 2, which shows the vertical profiles for the two days on which samples were taken. The values obtained were similar in magnitude to those at the 50 and 100 m station at the end of April. The depth of distribution of the pigments did not vary greatly during the day except for chlorophyll c which was unevenly distributed in the morning and afternoon but evenly so at midday. Overnight the pigments retained their distribution patterns.

*C.S.I.R.O. Aust. (1959).- Oceanic investigations in eastern Australian waters. F.R.V. "Derwent Hunter," 1958. C.S.I.R.O. Aust. Oceanogr. Sta. List 41

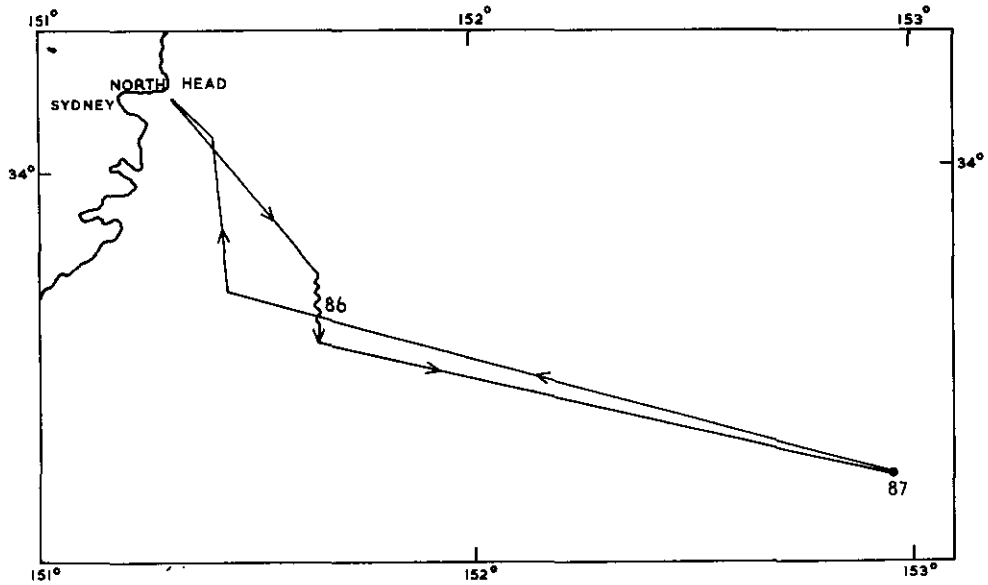

Fig. 1.- Cruise DH7/58. Track chart showing positions of stations.

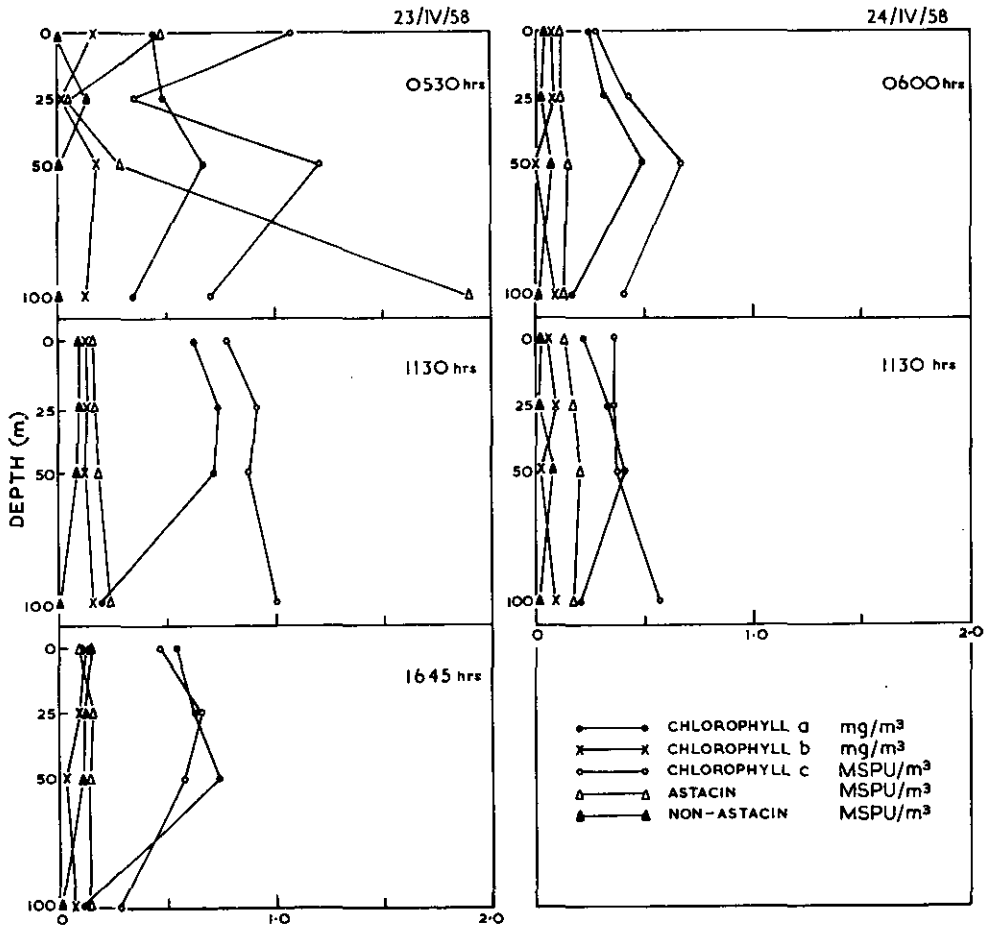

Fig. 2.- Vertical profiles for pigments for April 23-24, 1958.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH8/58

April 30 - May 13, 1958

ITINERARY

This cruise was intended to continue the study of the chemical, physical, and biological structure of eastern Bass Strait, but due to adverse weather, only five stations were worked on the coast of New South Wales and in north-eastern Bass Strait. The track chart (Fig. 1) shows stations worked.

SCIENTIFIC REPORT

(a) HYDROLOGY

Samples for chlorinity, dissolved oxygen, and total phosphorus were taken, where possible, at the usual depths to 1500 m. Phytoplankton samples were collected only at Stations DH8/88-92/58. As so few stations were worked no hydrology report has been prepared.

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

Table 1 gives a list of the dinoflagellates and Table 2 of the diatoms taken. The species collected at Stations DH8/88-90/58 represent a warm water flora derived largely from the Coral Sea flora. Collections from Station DH8/92/58 were poor, showing only two species of dinoflagellates. This low fertility is characteristic of the region north-east of Flinders I.

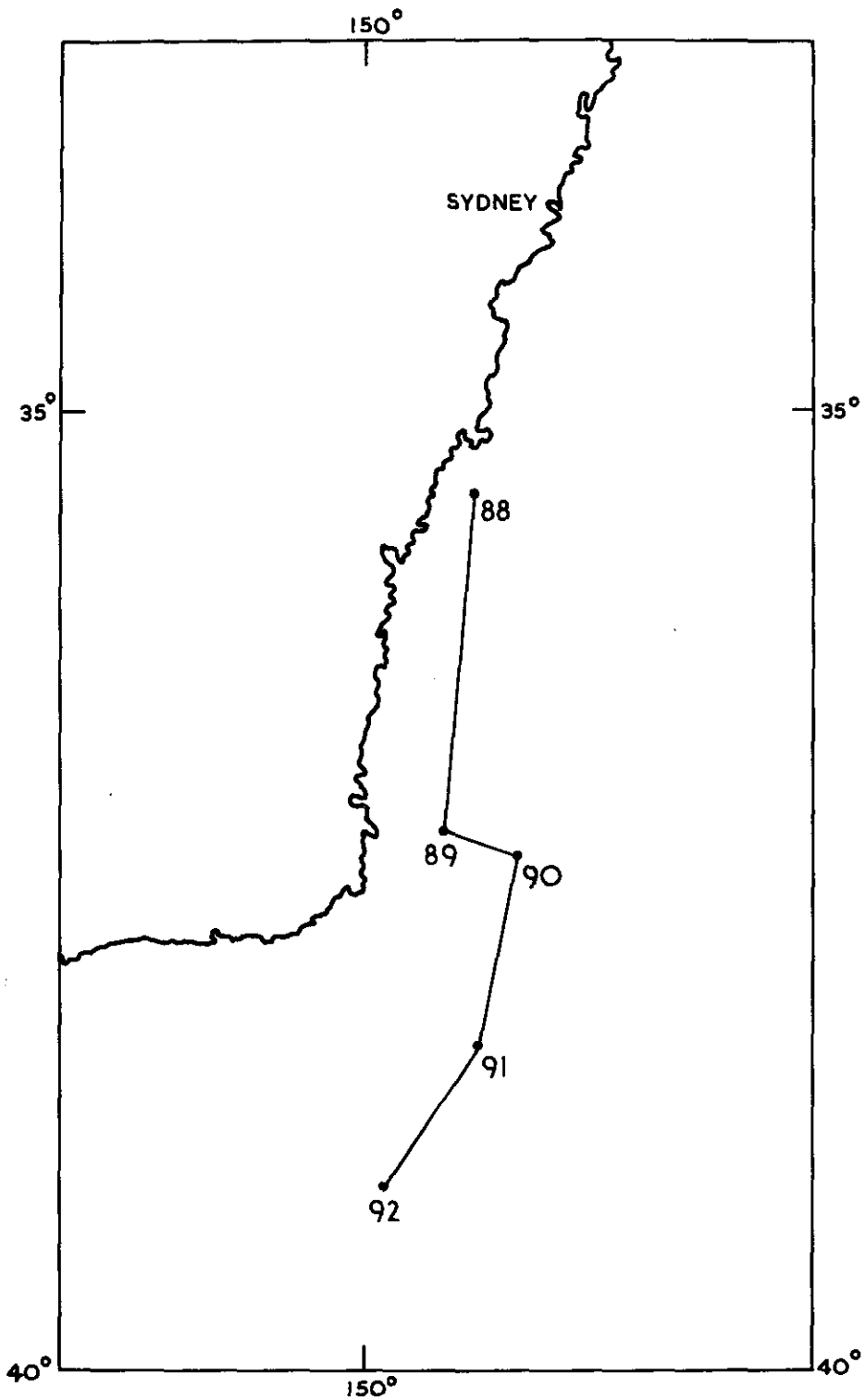

Fig. 1.- Cruise DH8/58. Track chart showing positions of stations.

TABLE 1

DINOFLAGELLATES FROM "DERWENT HUNTER"
CRUISE 8, 1958

SPECIES	STATION			
	88	89	90	92
Dinophysis tripos	+	+	+	+
Diplopsalis lenticula	+		+	
Ceratium pentagonum	+			
C. candelabrum	+			
C. buceros	+		+	
C. tricheros	+	+		
C. fusus	+		+	
C. setaceum	+			
C. porrectum	+			
C. gibberum	+			
C. tripos	+			
C. furca				+
C. minutium		+		
C. euarcuatum			+	
Peridinium oceanicum	+			
P. okamurai	+			
Phalacroma ovum			+	
Ornithocercus thurni		+		
C. magnificus	+			
Pyrocystis hamulus v. semicircularis		+		
P. fusiformis		+		
P. pseudonoctiluca			+	

TABLE 2

DIATOMS FROM "DERWENT HUNTER"
CRUISE 8, 1958

SPECIES	Stations			
	88	89	90	92
Hemiaulus membranaceus	+		+	
Schroederella delicatula	+	+	+	
Guinardia flaccida	+		+	
Stephanopyxix palmeriana	+			
S. turris	+	+		
Planktonella sol	+			
Cerataulina pelagica	+			
Thalassiosira decipiens	+			
T. subtilis	+		+	
Rhizosolenia imbricata	+			
R. castracanei	+		+	
R. stolterforthii	+	+	+	
R. alata	+	+	+	
f. gracillima		+		
R. styliformis	+	+		
R. clevei		+		
R. bergonii		+		
R. hebetata f. hiemalis			+	
Nitzschia seriata	+		+	
Chaetoceros teres	+		+	
Ch. affine	+	+		
Ch. lorenzianum	+		+	
Ch. coarctatum	+		+	
Ch. atlanticum f. audax	+			
f. neapolitanum	+			
Ch. decipiens		+		
Ch. secundum			+	
Streptotheca thamesis			+	
Chaetoceros lauderi			+	
Ch. vanheurckii			+	
Skeletonema costatum			+	
Bacteriastrum varians			+	

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH9/58

May 13 - June 1, 1959

During this period the vessel was loaned to the Division of Meteorological Physics for meteorological investigations in Port Phillip Bay.

For this cruise anemometers and electrical resistance thermometers were fitted at four heights from 4 m to 12.5 m in order to obtain profiles of wind speed, air temperature, and humidity over the sea. Apparatus for recording the turbulent structure of the wind was also installed with the sensing elements exposed on the foremast cross-trees.

After a fitting up period of three days at South Wharf, Melbourne, the vessel worked daily from either Portsea or South Wharf as dictated by the generally rather stormy weather. Observations were made on 119 experimental runs at stations giving suitably long wind fetches over the deep water areas of Port Phillip Bay. The weather was unsuitable for operations outside the Bay. Useful results were obtained on twelve days in the period May 16 - June 1, some of them in average wind speeds as high as 40 knots.

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13. Chau, Y.K. (1957).- The coastal circulation of New South Wales from drift card results 1953-56.

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19. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH5/57, DH6/57, DH7/57, DH8/57.

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