COMMONWEALTH OF AUSTRALIA

Commonwealth Scientific and Industrial Research Organization

Division of Fisheries and Oceanography

REPORT 32

F.R.V. "DERWENT HUNTER"

Cruise 1/59
February 4 – 5, 1959

Cruise 2/59
March 2 – 13, 1959

Cruise 3/59
April 7 – 22, 1959

Cruise 4/59
April 25 – 29, 1959

Cruise 5/59
May 5 – 6, 1959

Cruise 6/59
May 9 – 27, 1959

Cruise 7/59
June 3, 1959

Cruise 8/59
June 4 – 13, 1959

Cruise 9/59
July 7 – 9, 14 – 16, 1959

Cruise 10/59
July 24 – 30, 1959

Marine Biological Laboratory
Cronulla, Sydney
1961

CONTENTS

INTRODUCTION

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 (February 4 - June 13, 1959)
	- R. Spaulding (July 7-16, 1959)
Mate	- R. Spaulding (February 4 - June 13, 1959)
	- W. Elsmore (July 7-16, 1959)
Engineer	- H. O'Donovan (February 4 - March 13, 1959)
	- W. Smith (April 7 - July 16, 1959)
Deckhands	- G. Ross (February 4 - June 13, 1959)
	- W. Elsmore
	- J. McVeagh (July 7-16, 1959)
	- T. Norhede
Cook	- A. Jackson (February 4 - June 13, 1959)
	- A. Hubbard (July 7-16, 1959)
Oceanographical Assistant	- J. Staniforth

The study of the structure and dynamics of the East Australian Current off Sydney was continued. Scientific Reports of Cruises DH1/59, 2/59, 6/59, and 8/59 deal with data collected during this study. No attempt is made here to relate the data from these cruises; that will be done in scientific papers published elsewhere.

Cruise 3/59 was planned to study the East Australian Current in the region of its strongest development off the central and southern coast of Queensland.

Cruises 4/59 and 9/59 were concerned with zooplankton.

When citing this report abbreviate as follows.-
C.S.I.R.O. Aust. Div. Fish. Oceanogr. Rep. No. 32

Cruises 5/59, 7/59, and 10/59 were planned to measure the rate of CO_2 uptake at the Port Hacking 100 m station during 24-hour sampling.

The results of hydrological, primary production, pigments, and quantitative zooplankton studies appear in C.S.I.R.O. Aust. (1961).- Oceanic investigations in Eastern Australian Waters, F.R.V. Derwent Hunter, 1959. C.S.I.R.O. Aust. Div. Fish. Oceanogr. Sta. List 48.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH1/59

February 4-5, 1959

SCIENTIFIC PERSONNEL

F.N. Davies

ITINERARY

This was planned as the fourth of the extended cruises to study the structure and circulation of the East Australian Current. Owing to the need for hull repairs, the ship had to return to port when only five stations had been worked. There is no report on the hydrology of this cruise because so few stations were worked. Tables 1 and 2 show the diatoms and dinoflagellates collected at the five stations worked. Zooplankton collections made at Station DH1/3/59 are discussed in the scientific report of Cruise DH8/59.

TABLE 1

DIATOMS - CRUISE DH1/59

SPECIES	Stations 1	2	3	4	5
Amphiphora			+		
Cerataulina pelagica				+	
Chaetoceros coarctatum	+		+		
Ch. eibenii	+				
Ch. lorenzianum	+				
Ch. vanheurckii	+				
Climacodium frauenfeldianum			+	+	+
Eucampia zoodiacus			+		
Hemiaulus membranaceus				+	
Lauderia annulata	+				
Leptocylindrus danicus				+	
Mastogloia rostrata				+	
Melosira granulata				+	
Nitzschia closterium			+		
N. longissima			+		
N. seriata			+		
Rhizosolenia acuminata	+				
R. alata	+		+	+	
R. delicatula				+	
R. fragilissima			+		
R. imbricata			+		
R. robusta				+	
R. stolterforthii	+		+	+	
R. styliformis v. latissima				+	
Streptotheca indica			+		
S. thamesis				+	+
Thalassiothrix frauenfeldii	+		+		+
T. nitzchioides	+		+	+	+
Trachyneis aspera				+	

TABLE 2

DINOFLAGELLATES - CRUISE DH1/59

SPECIES	Stations 1	2	3	4	5
					+
Amphisolenia bidentata					+
Ceratium arietinum	+				
C. breve	+		+	+	+
C. carriense			+		
C. deflexum	+		+	+	+
C. furca			+	+	+
C. fusus			+		+
C. karstenii			+		+
C. kofoidi					+
C. macroceros			+		+
C. massiliense					+
C. pulchellum					+
C. schmidtii			+		
C. setaceum	+				
C. symmetricum			+		+
C. teres			+		
C. trichoceros	+		+	+	+
C. tripos			+		+
C. vultur	+		+	+	+
Ceratocorys horrida			+		
Dinophysis caudata	+				
D. tripos	+			+	+
Diplopsalis lenticula			+		
Goniodoma polyedricum					+
Peridinium crassipes	+				+
P. grande			+		
Prorocentrum micans			+		+
Pyrophacus horologicum					

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH2/59

March 2-13, 1959

SCIENTIFIC PERSONNEL

Part I F.N. Davies (in charge)

Part II J. Staniforth (in charge)
W. Prothero

ITINERARY

This is the fifth of the extended cruises to study the circulation of the East Australian Current. Figure 1 shows the positions of stations. Hydrological sampling, B.T. casts, G.E.K. tows, phytoplankton sampling, and zooplankton sampling were done as indicated in Figure 1. The zooplankton samples taken on this cruise are discussed in the scientific report of Cruise DH8/59.

(a) HYDROLOGY - D.J. ROCHFORD

Because of adverse weather many stations could not be worked and the data collected were insufficient to plot the distribution of hydrological properties along the regular section lines. Only the following general conclusions can be drawn from the surface distribution of certain properties.

Surface temperatures show (Fig. 2) a band of high temperature ($>26.0^{o}C$) water parallel to the coast with centres about 50 miles offshore in the north and about 100 miles offshore in the south. Much cooler water was found elsewhere with the coldest ($22.5^{o}C$) in the south-eastern limits of the area. The salinity-temperature relations (Fig. 3) separate the surface waters into three regional water masses (Table 1) and their mixtures. Figure 2 shows the boundaries of these water masses.

TABLE 1

REGIONAL WATER MASSES FOUND ON CRUISE DH2/59

	Salinity ‰	Temperature °C
1	34.55 - 34.70	22 - 27
2	35.80	22.5
3	35.40	22.7 - 24.6

The total phosphorus distribution at the surface (Fig. 4) indicates that the coastal region, dominated by water mass 3 has the highest total phosphorus and the extreme offshore region, dominated by water mass 2, has the lowest. At 300 m much warmer water was found along the boundary of water mass 1 (A and B, Fig. 5). The warmest water was found at the northern boundary of the strong flow to the north-east (C, Fig. 5) and is caused by an accumulation of high temperature surface waters and downward mixing (see Section (b) Dynamics).

(b) DYNAMICS - B.V. HAMON

Figure 6 shows the dynamic heights (in dyn. cm) relative to the 1000 decibar level (upper numbers) and the 500 decibar level (lower numbers).

There is evidence of appreciable flow to the south off Sydney, between Stations 9 and 11 (A and B, Fig. 6) and a strong flow to the north-east further offshore (Stations 16 and 18, C and D, Fig. 6).

There was a flow to the north between the only two stations occupied off Coffs Harbour, but there was probably an appreciable flow to the south between the edge of the continental shelf and the nearer of the two stations.

The computed volume transports and geostrophic surface currents are as follows:-

Stations	Current	Transport	Direction
9, 11	30 cm/sec	10×10^6 m^3/sec	S.W.
16, 18	70 "	32×10^6 "	N.E.

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

Table 2 shows the species of diatoms and Table 3 the species of dinoflagellates collected on this cruise. Ceratium dens was collected at Station DH2/16/59; this species is regarded as an indicator of Indian Ocean water and has been recorded from the east Australian coast on only one previous occasion.

Stations DH2/12-14/59 were characterized by poor collections of phytoplankton. Stations 12 and 14 had species of Climacodium typical of Coral Sea collections but Station 13 had only two species. This lack of organisms could be associated with upwelling.

(d) BIOCHEMISTRY - G.F. HUMPHREY

Because the vacuum pump failed during the first station, results were obtained only for DH2/8/59. These results are of questionable value since up to six hours were needed to filter as little as two litres

TABLE 2

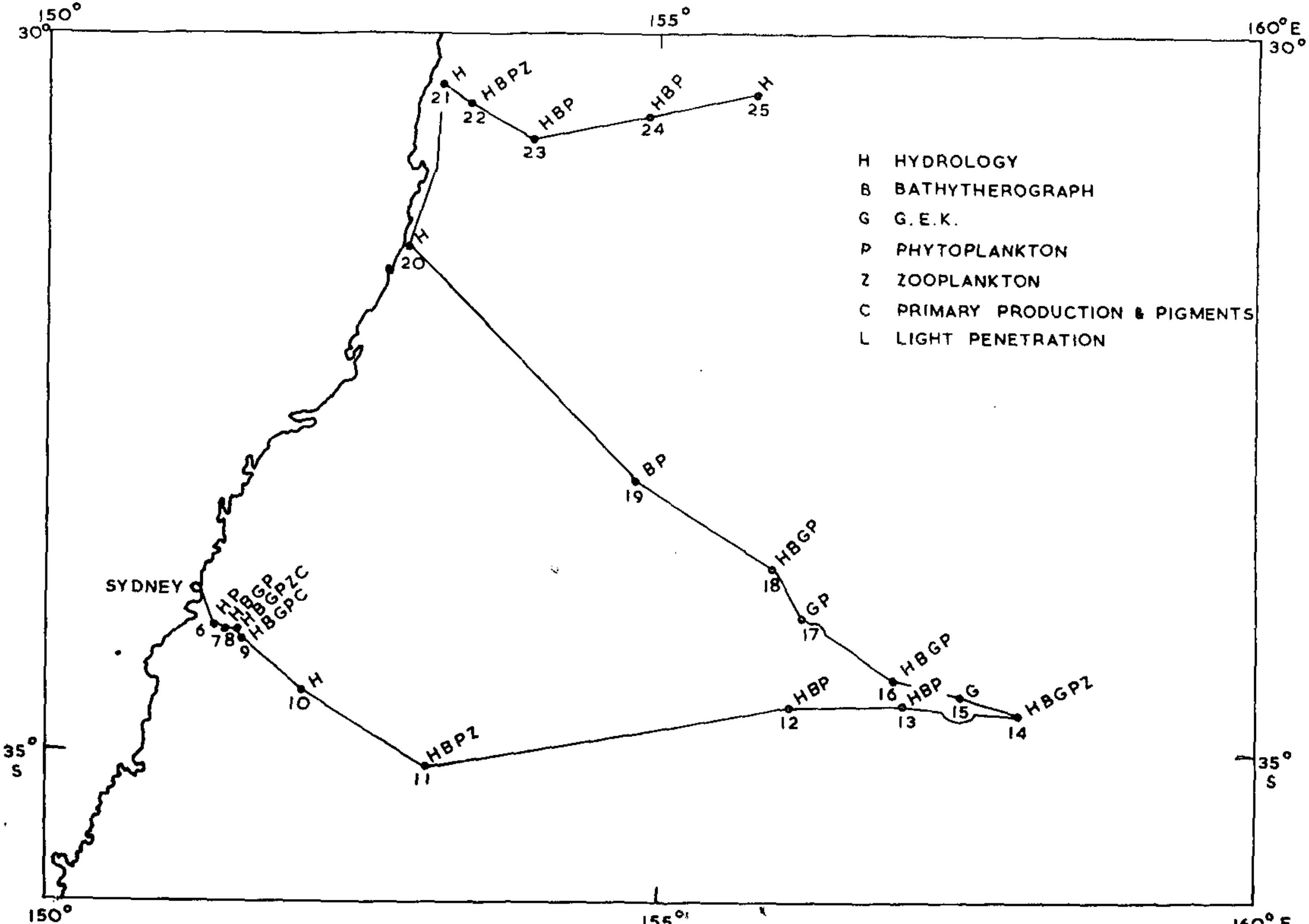
DIATOMS - CRUISE DH2/59

SPECIES	Station														
	6	7	8	9	11	12	13	14	16	17	18	19	22	23	24
Asterionella japonica	+	+	+	+	+										
Climacodium frauenfeldianum	+	+	+	+		+		+	+				+		+
Chaetoceros coarctatum									+						
Ch. peruvianum											+				
Lauderia annulata		+													
Mastogloia rostrata															+
Melosira moniliformis		+													
Nitzschia closterium				+				+							+
N. longissima			+	+											
N. seriata			+	+											+
N. sublinearis									+						+
Rhizosolenia alata	+		+	+	+	+	+	+	+	+	+				+
R. acuminata										+					
R. fragilissima			+	+										+	
R. imbricata											+				
R. stolterforthii			+												
R. styliformis										+					
Streptotheca indica									+						
Thalassiothrix longissima							+								
T. nitzschioides				+											

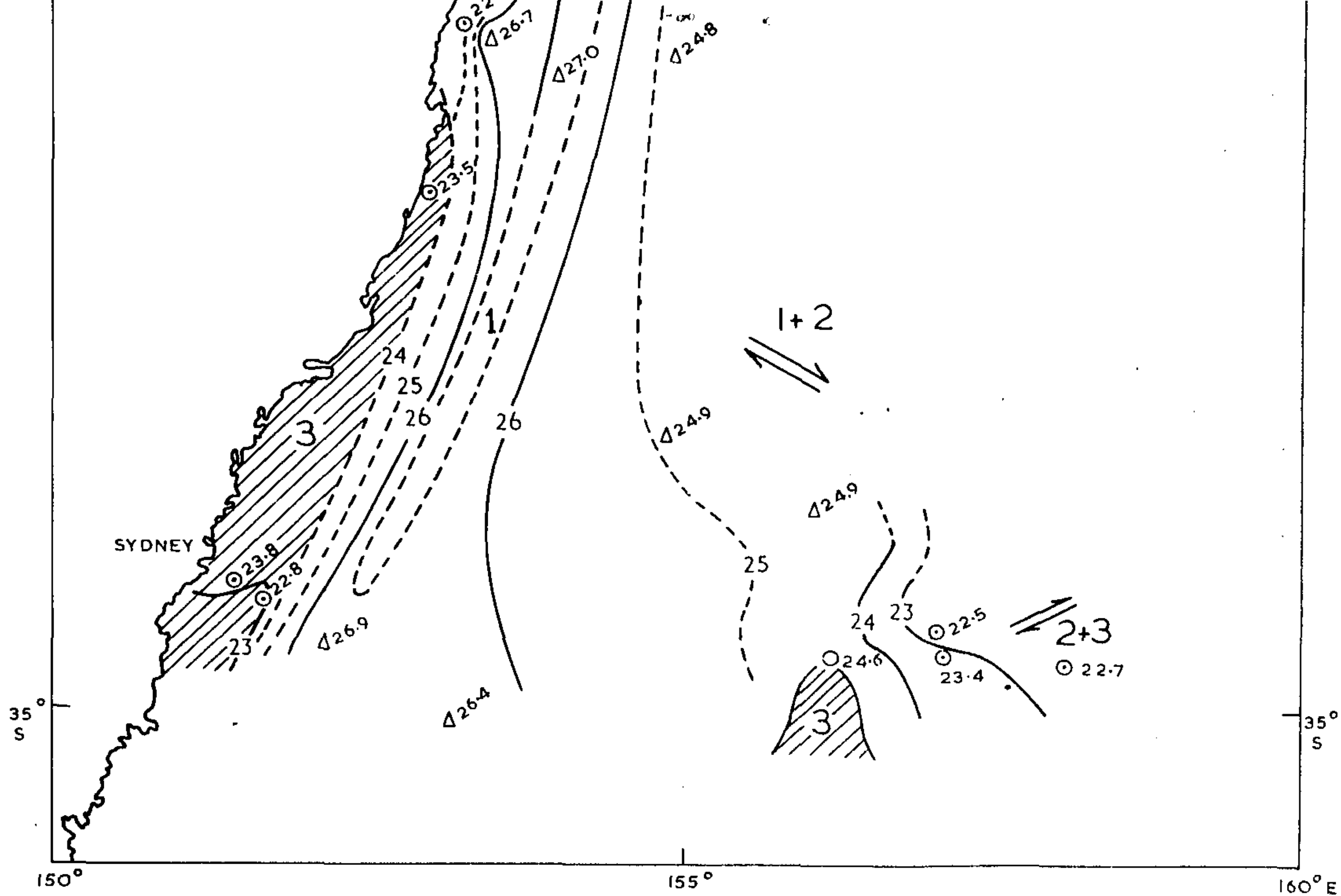
TABLE 3

DINOFLAGELLATES - CRUISE DH2/59

SPECIES	Station														
	6	7	8	9	11	12	13	14	15	17	18	19	22	23	24
Amphisolenia bidentata									+						
Ceratium arietinum									+	+					
C. belone											+				
C. breve		+													
C. candelabrum					+	+						+			
C. carriense	+		+												
C. concilians											+				
C. contortum			+							+					
C. contrarium					+										
C. declinatum											+			+	
C. dens									+						
C. furca	+	+	+			+			+		+				
C. fusus	+	+	+						+	+	+	+	+	+	
C. hexacanthum				+											
C. karstenii									+						
C. kofoidii			+	+						+					
C. lunula									+						
C. massiliense	+	+	+					+	+						
C. pulchellum	+					+					+				
C. schmidtii			+							+	+				
C. symmetricum		+													
C. teres										+	+				
C. trichoceros	+	+	+		+				+	+	+		+		
C. tripos	+	+	+	+		+			+	+	+			+	+
C. vultur		+							+		+				
Ceratocorys horrida	+									+	+		+		
Diplopsalis lenticula	+			+							+				
Peridinium grande	+													+	
Podolampas bipes										+					
P. spinifer			+												+
Pyrocystis pseudonoctiluca											+				
Pyrophacus horologicum			+												

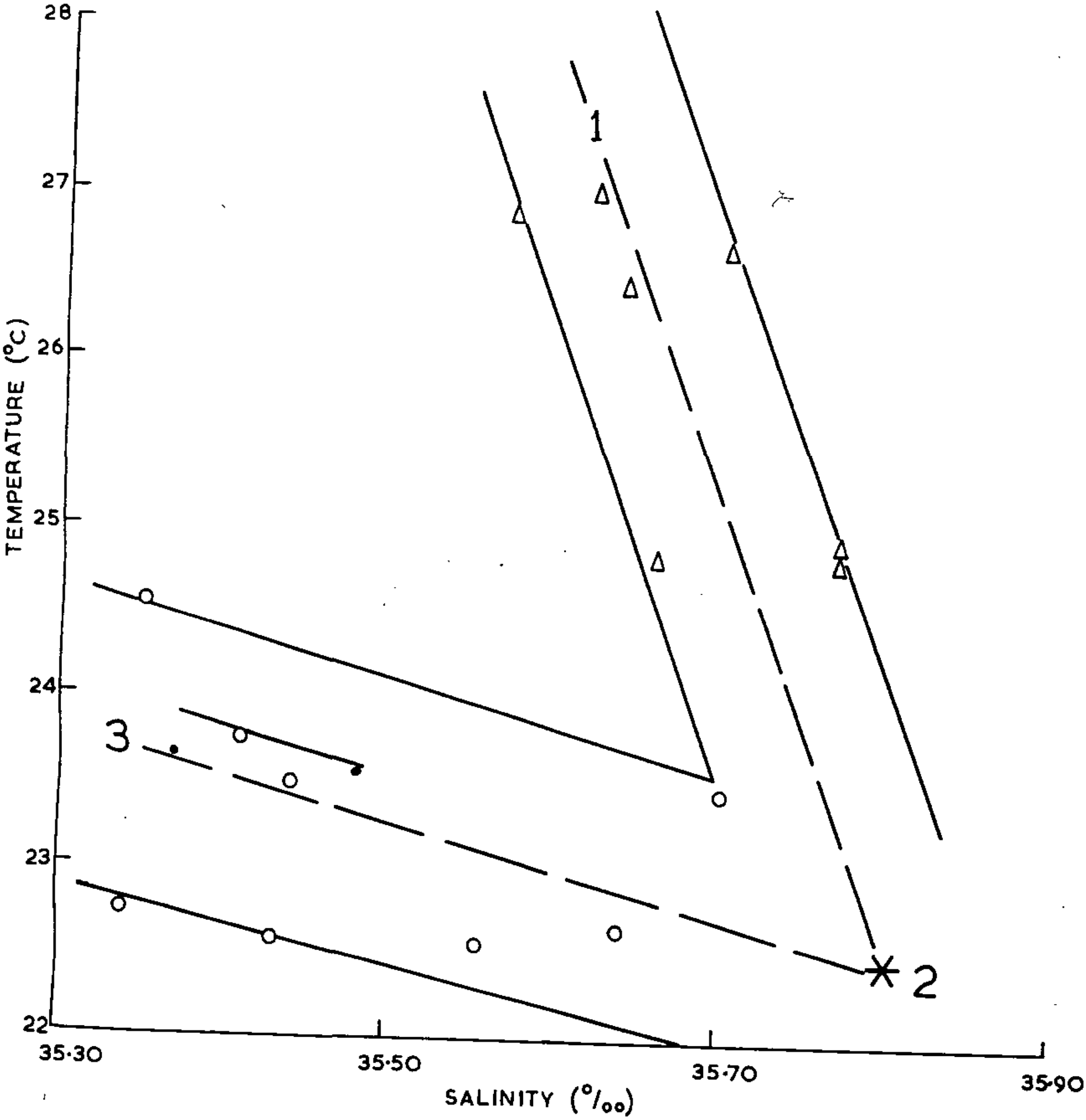


150°
155°
160° E
30°
35° S
SYDNEY
H HYDROLOGY
B BATHYTHEROGRAPH
G G.E.K.
P PHYTOPLANKTON
Z ZOOPLANKTON
C PRIMARY PRODUCTION & PIGMENTS
L LIGHT PENETRATION
21 H
22 HBPZ
23 HBP
24 HBP
25 H
20 H
19 BP
18 HBGP
17 GP
16 HBGP
15 G
14 HBGPZ
13 HBP
12 HBP
11 HBPZ
10 H
6 HP
7 HBGP
8 HBGPZC
9 HBGPC



Δ26·7
Δ27·0
Δ24·8
23·5
1
1+2
24
25
26
26
3
Δ24·9
Δ24·9
SYDNEY
23·8
22·8
25
24
23
22·5
2+3
23
Δ26·9
24·6
23·4
22·7
Δ26·4
3
35°
S
35°
S
150°
155°
160° E

Fig. 2



28
27
26
25
24
23
22
TEMPERATURE (°C)
1
2
3
35·30
35·50
35·70
35·90
SALINITY (°/oo)

Fig. 3

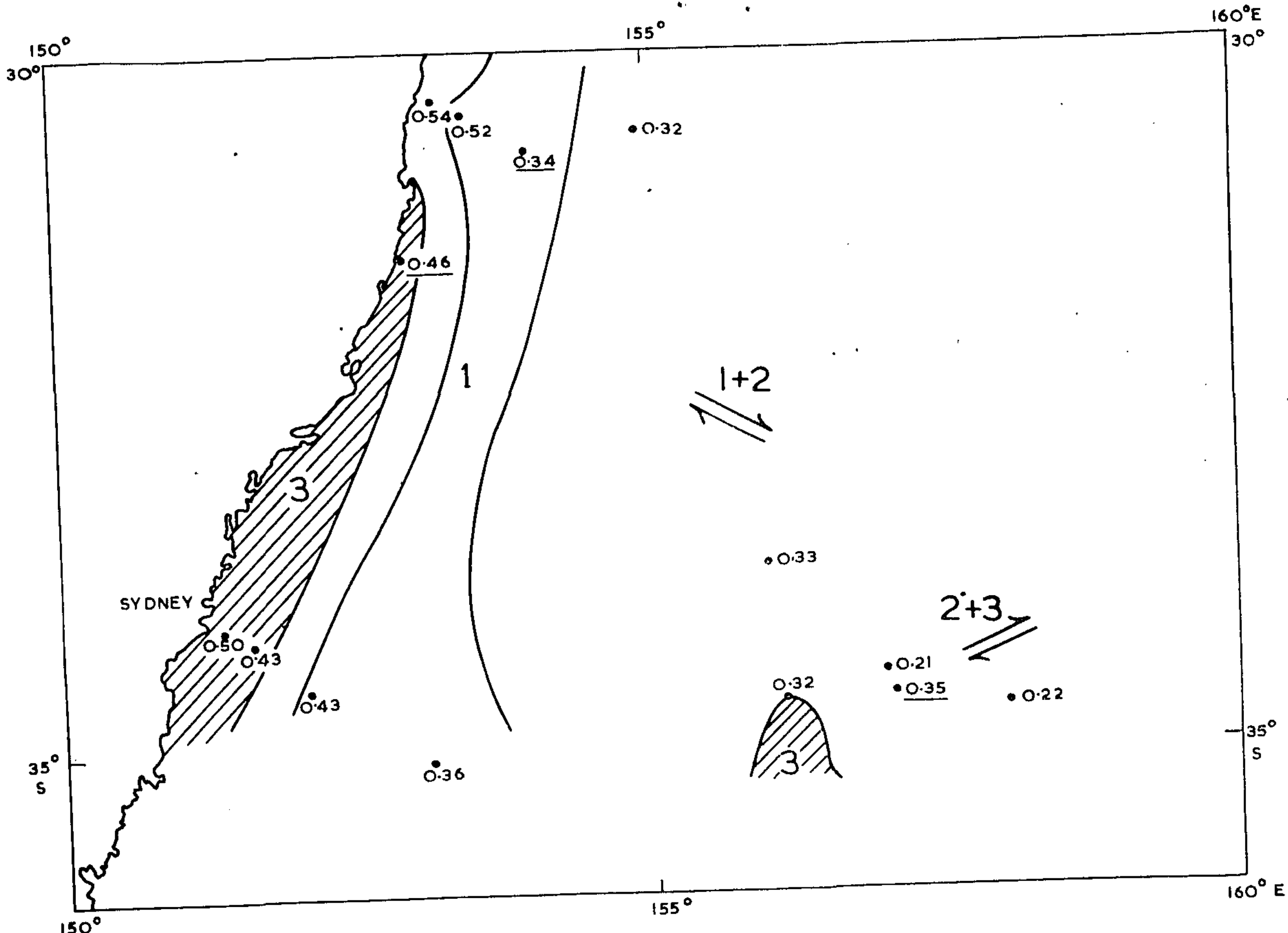
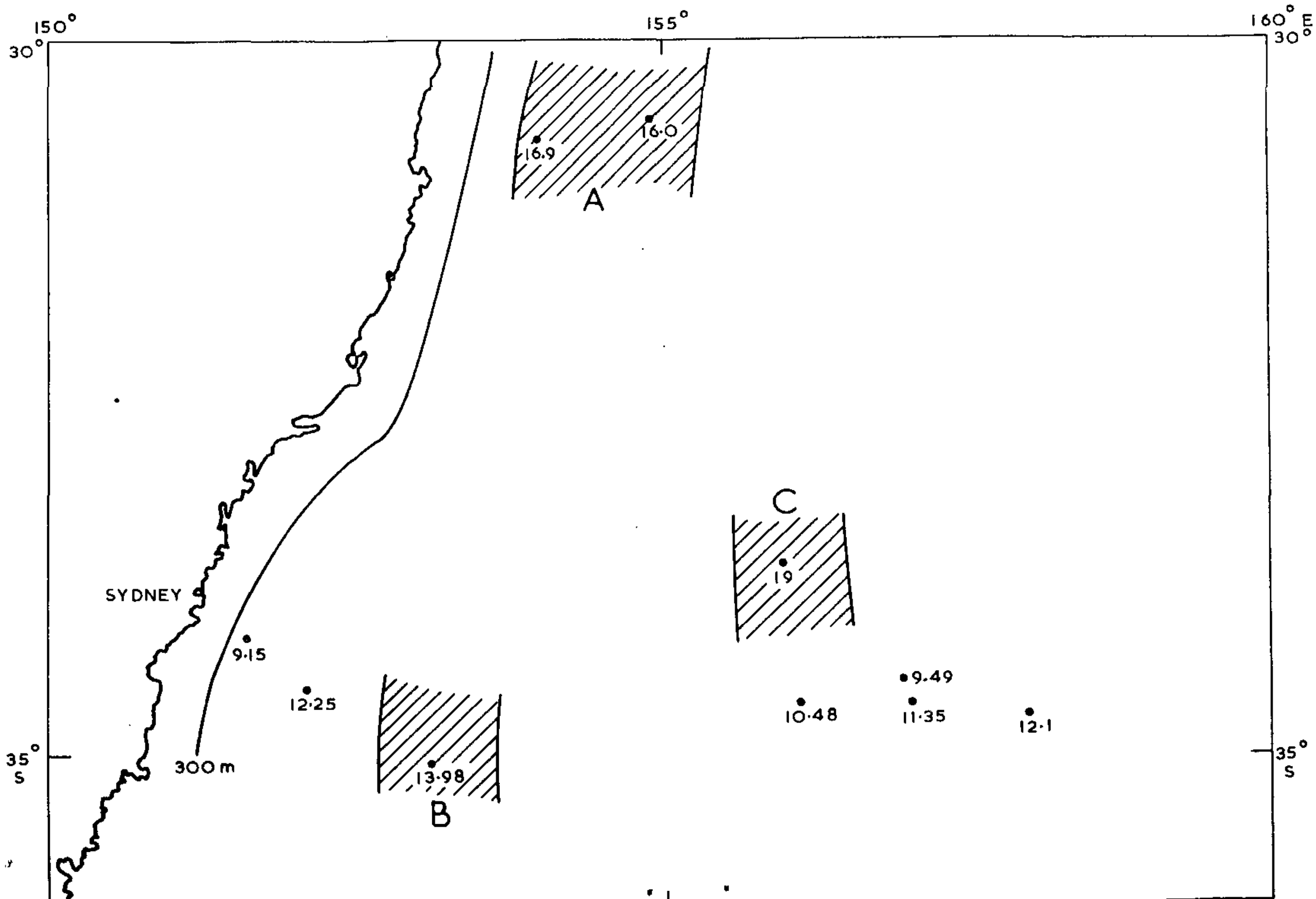
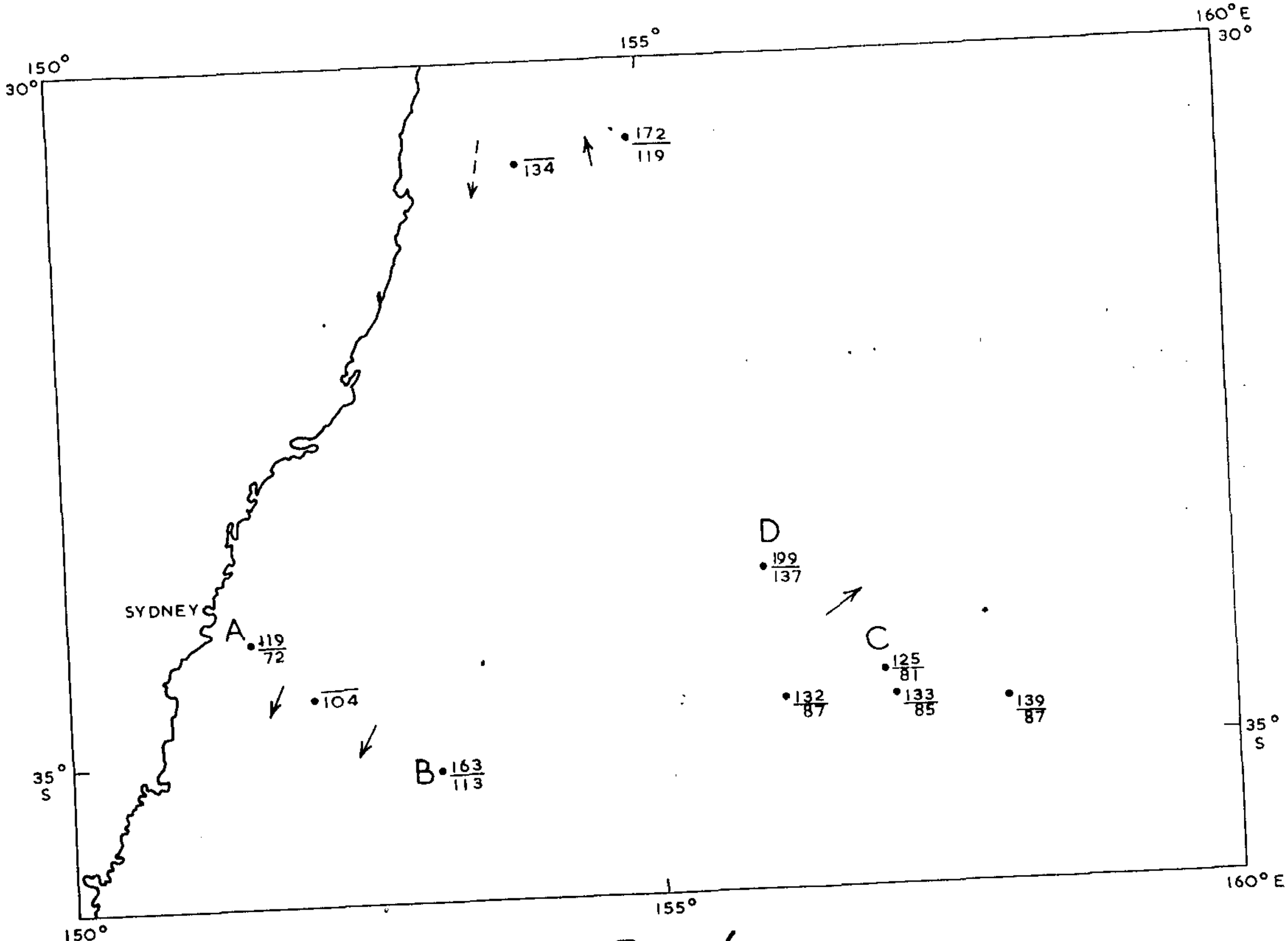

150°
155°
160°E
30°
30°
0.54
0.52
0.32
0.34
0.46
1
1+2
3
0.33
SYDNEY
2+3
0.50
0.43
0.21
0.32
0.35
0.22
0.43
35°
S
35°
S
0.36
3
160° E
155°
150°

Fig. 4


150°
155°
160° E
30°
30°
A
16.9
16·0
C
19
SYDNEY
9·15
12·25
9·49
10·48
11·35
12·1
35° S
35° S
300 m
13·98
B



150°
30°
155°
160° E
30°
134
172
119
D
199
137
SYDNEY
A
119
72
104
C
125
81
132
87
133
85
139
87
35°
S
B
163
113
35°
S
150°
155°
160° E

Fig. 6

LEGENDS FOR FIGURES

Cruise DH2/59

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

Fig. 2.- Temperature distribution at the surface. Boundaries of regional water masses are indicated.

Fig. 3.- Surface temperature-salinity diagram showing sub-division into regional water masses.

Fig. 4.- Surface distribution of total phosphorus (μg at./l.) in relation to regional water mass distribution.

Fig. 5.- Temperature distribution at 200 m. A. B. and C. indicate regional water mass boundaries (see text).

Fig. 6.- Dynamic heights in dynamic centimetres; upper figure in relation to 1000 decibars, lower figure to 500 decibars.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH3/59

April 7-22, 1959

SCIENTIFIC PERSONNEL

Dr K. Wyrtki (in charge)

J. Staniforth.

ITINERARY

This cruise was planned to investigate the East Australian Current in the region of its strongest development with sections vertical to the coast of Queensland and northern New South Wales.

Owing to the failure of the G.E.K. and the deep echosounder, it was not possible to carry out the work planned. Only five hydrology stations were worked and no report has been prepared on these.

Six phytoplankton collections were made.

PHYTOPLANKTON - E.J.F. WOOD

Table 1 shows the diatoms and Table 2 the dinoflagellates collected on this cruise. The species in the collections such as *Mastigloia rostrata*, *M. capitata*, *Asterolampra dallasiana*, *Ornithocercus biclavatus*, *Podolampas spinifera* and *Ceratium deflexum* are characteristic of the eastern Coral Sea flora.

TABLE 1

DIATOMS - CRUISE DH3/59

SPECIES	Stations					
	24	28	30	31	32	33
Asterolampra dallasiana					+	
Chaetoceros coarctatum	+		+			
Ch. lorenzianum		+		+		
Ch. peruvianum					+	
Climacodium frauenfeldianum	+	+	+			+
Coscinodiscus lineatus					+	
Fragilaria sp.		+				
Hemiaulus hauckii			+	+		
Mastogloia capitata					+	
M. rostrata			+		+	
Nitzschia closterium		+				
N. seriata			+			
Planktoniella sol				+		
Rhizosolenia alata	+	+	+	+		+
R. delicatula		+				
R. setigera					+	
R. stolterforthii					+	
R. styliformis			+			+
Thalassiothrix frauenfeldii	+	+	+			
T. nitzschioides						+
Trachyneis aspera				+		

TABLE 2

DINOFLAGELLATES - CRUISE DH3/59

SPECIES	Stations					
	24	28	30	31	32	33
Amphisolenia astragalus						+
A. bidentata	+		+	+		
Ceratium arietinum	+			+		
C. carriense	+	+				
C. candelabrum			+			
C. contortum					+	
C. declinatum		+	+	+	+	
C. deflexum				+		
C. fusus	+	+	+	+	+	
C. gibberum				+		
C. hirundinella						+
C. karstenii	+			+		
C. kofoidi		+	+			
C. massiliense	+			+		
C. pavillardii						+
C. pentagonum			+			
C. schmidtii		+		+		
C. setaceum	+					
C. teres	+			+		+
C. trichoceros	+	+	+	+	+	
C. tripos	+	+	+	+	+	+
C. vultur				+	+	
Ceratocorys horrida		+	+		+	
Ornithocercus biclavatus						+
O. magnificus				+		
O. steinii				+		+
Oxytoxum milneri				+		
Peridinium conicum						+
P. hirobis						+
P. palmipes				+		
P. murrayi				+		
Podolampas spinifera	+				+	
Pyrocystis lunula					+	
P. pseudonoctiluca		+			+	

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH4/59

April 25-29, 1959

SCIENTIFIC PERSONNEL

D.J. Tranter (in charge)
A.G.W. Hammick

ZOOPLANKTON - D.J. TRANTER

The cruise was designed to study the vertical distribution of the zooplankton above and below a thermocline. The Eden area was chosen for the investigation where it is known that a thermocline persists during the summer months.

On April 28, 1959 a position was taken up due east of Eden (37°02'S. 150°19'E.) the depth of water being approximately 115 metres. Bathythermograph casts failed to show a distinct thermocline except for a slight discontinuity near 100 m; the summer thermocline was apparently breaking down. Table 1 gives temperature and salinities at Eden 16 mile station during April and May 1959.

TABLE 1

TEMPERATURES AND SALINITIES AT THE EDEN 16 MILE STATION DURING APRIL AND MAY 1959

Depth (m)	Temperature °C 3/4/59	Temperature °C 26/5/59	Salinity ‰	
0	22.5	19.5	35.66	35.79
10	22.2	19.4	35.66	35.79
20	22.0	19.5	35.66	35.79
30	21.6	19.4	35.66	35.79
40	21.3	19.4	35.66	35.79
50	20.3	19.5	35.61	35.79
75	17.0	19.3	35.43	35.77
100	14.8	19.4	35.35	35.77

Thermograph records April 29 and 30, 1959
Average surface temperature : 21°C
Bathythermograph traces (average of 4 casts)

Surface	20.7°C
100 m	19.4
110 m	18.3
115 m	16.8

Nevertheless, the sampling programme was carried out as originally planned and the results examined to see if there was a change in the vertical distribution over a 24-hour period.

Commencing at 1400 hours, eight series of samples were taken with closing type Clarke-Bumpus samplers at the following standard depths: 0, 35, 71, 107 m. Each series was arranged as follows:-

Haul 1	:	horizontal	: 35 m : 71 m
Haul 2	:	"	: 0 m : 107 m
Haul 3	:	"	: 70-100 m (two samples)
Haul 4	:	oblique	: 53-0 m : 107-0 m.

The three horizontal hauls took two hours from start to finish, but for purposes of plotting vertical distribution they are treated as having been simultaneous.

On their return to the laboratory, the samples were first weighed and then tenthed to facilitate counting. The following species and species groups occurred in sufficient numbers to merit consideration:

COPEPODS:

Small Calanid group (principally Clausocalanus arcuicornis and Ctenocalanus vanus), Oncaea venusta, Acartia danae, Nannocalanus minor, Oithona spp., Calanus tenuicornis, Pleuromamma spp., Undinula darwinii, Euchaeta marina, Mecynocera clausi.

OIKOPLEURA
SALPS (principally Thalia democratica)
CHAETOGNATHA
EUPHAUSIIDS
GASTROPOD LARVAE

Results

BIOMASS: The depth distribution of zooplankton biomass (Fig. 1) appears to suggest a diurnal cycle of vertical migration: there would appear to be an aggregration towards the surface at and after dusk and a downward dispersal after midnight; at dawn, the zooplankton would appear to be concentrated in deep water, rising to the surface at midday.

This latter unusual feature is actually misleading. The late morning ascent is really a separate sequence, due to a swarm of salps and not to the zooplankton as a whole (Fig. 2).

Salps: The salp swarm responsible for this erroneous impression consisted predominantly of Thalia democratica. The vertical distribution pattern of this group is very variable.

TOTAL COPEPODS: When copepods alone are considered (Fig. 3) it is obvious that, far from there having been a surface aggregation at midday as the distribution of biomass might suggest, there was an avoidance of the surface throughout the day; nevertheless, the maximum density was not in deep water as one would expect, but at 35 m (except in the 0800-0900 hour series).

Among the copepods, the most common species were as follows:-

(1) Oncaea venusta: an upper water species, the vast majority congregating above 50 m; within this layer, the distribution is constant, although there is a slight tendency to avoid the surface in the late morning and to concentrate at the surface in the evening.

(2) The small calanid group: fairly evenly distributed throughout the water column sampled; slight concentration towards the surface in the evening and at dawn, and possibly a descent between these times; in Ctenocalanus vanus an obvious descent towards midday; in Clausocalanus arcuicornis this was less marked; a heavy patch (both species) occurred at 35 m just after midday.

(3) Acartia danae: tended to concentrate between 50 m and 100 m at all times; distribution fairly constant; no evidence of a diurnal migration cycle.

(4) Nannocalanus minor: distributed fairly evenly throughout the water column; some evidence of an ascent during the hours of darkness, a surface concentration round about dawn, and slight descent towards midday.

(5) Oithona: greatest frequency below 25 m; distribution moderately constant; no evidence of vertical migration.

The following species were less common than those mentioned above, but their distribution was sufficiently continuous to show whether or not vertical migration had occurred.

(6) *Calanus tenuicornis*: predominantly, in some cases exclusively, below 50 m (Fig. 4); below this level, apparently an ascent towards midnight and towards midday and a descent in the early morning.

(7) *Pleuromamma* spp.: distribution similar to that of *Calanus tenuicornis*; occurred below 50 m with a similar but more definite migration cycle.

(8) *Undinula darwinii*: in contrast to *Pleuromamma* and *Calanus tenuicornis*, an upper water species; few specimens taken below 75 m; distribution suggests a vertical migration of the following pattern; continuous ascent from 75 m during the day reaching the surface in the evening: dispersal after midnight; sudden ascent at dawn followed immediately by an equally sudden descent (Fig. 5).

(9) *Euchaeta marina*: also an upper water species, occurring mainly above 75 m; an irregular distribution which could be due either to patchiness or to vertical migration; tended during the day to be absent from the surface and densest at 55 m.

(10) *Mecynocera clausi*: fairly even distribution down to 100 m; no evidence of vertical migration.

OIKOPLEURA: an upper water group found in highest concentrations above 50 m; depth distribution changed distinctly from series to series but difficult to decide whether this is the result of vertical distribution or of patchiness; heavy concentrations at the surface during the middle of the day.

CHAETOGNATHS: evenly distributed down to 100 m where the density rapidly decreased; concentrated in the 50-100 m layer towards dawn, dispersing towards midday particularly surfacewards; otherwise the distribution showed little change with time; behaviour similar to that of *Oikopleura* and the salps.

EUPHAUSIIDS: occurred throughout the upper 100 m, and probably extended well below this; towards midnight the centre of distribution moved surfacewards and after midnight descended; a proportion stayed at 35 m during the middle of the day.

GASTROPOD LARVAE: occurred in dense patches, the heaviest being found at the surface at 9 p.m.: this swarm made a slight descent towards midnight and stayed at this level through the early hours of the morning; the denser patches occurred in the upper 50 m and were extremely stratified.

The results of this cruise are discussed at the end of the report on Cruise DH9/59.

LEGENDS FOR FIGURES

Cruise DH4/59

Fig. 1.- Depth distribution of biomass during 24-hour period.

Fig. 2.- Depth distribution of salps (principally *Thalia democratica*) during 24-hour period.

Fig. 3.- Depth distribution of total copepods during 24-hour period.

Fig. 4.- Depth distribution of *Calanus tenuicornis* during 24-hour period.

Fig. 5.- Depth distribution of *Undinula darwinii* during 24-hour period.

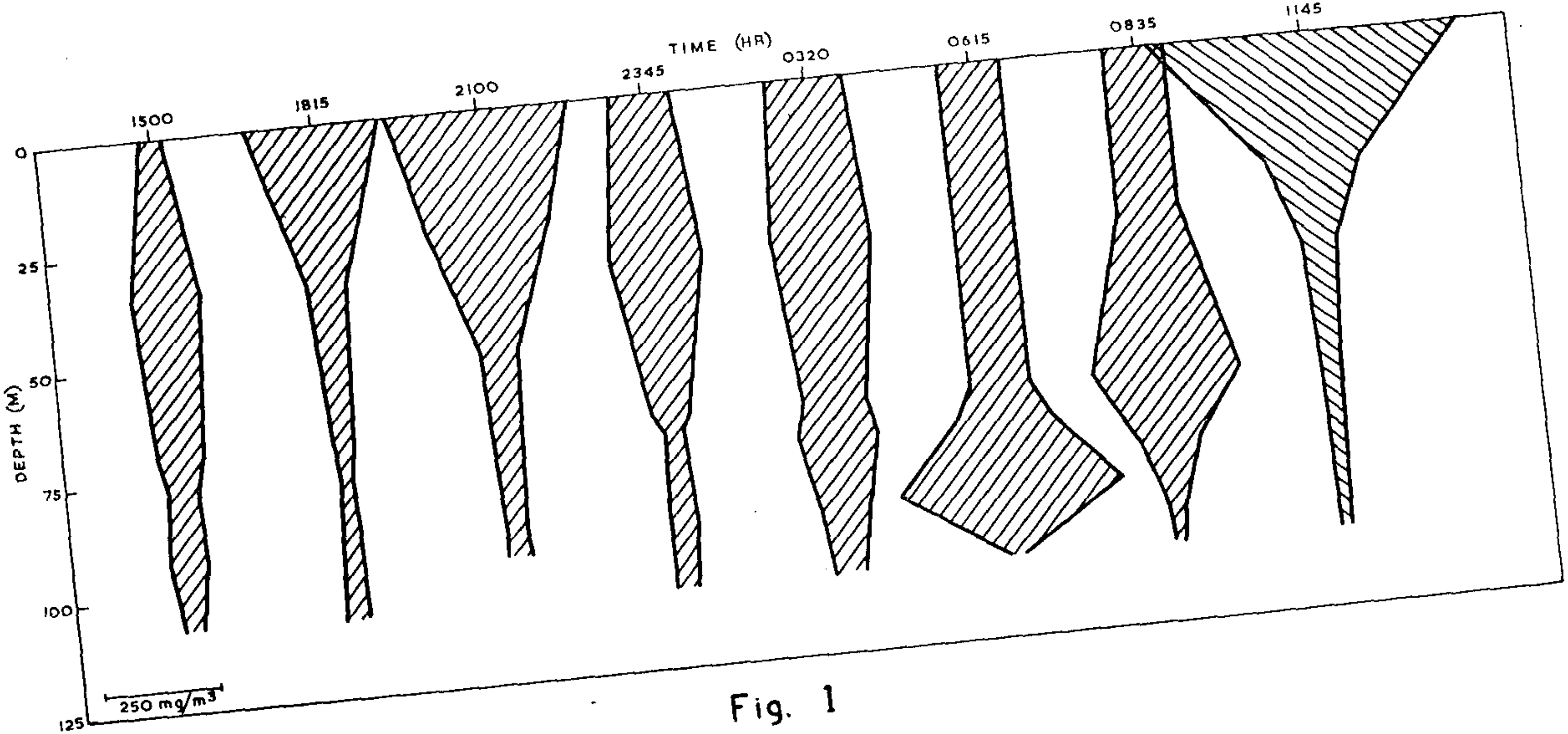
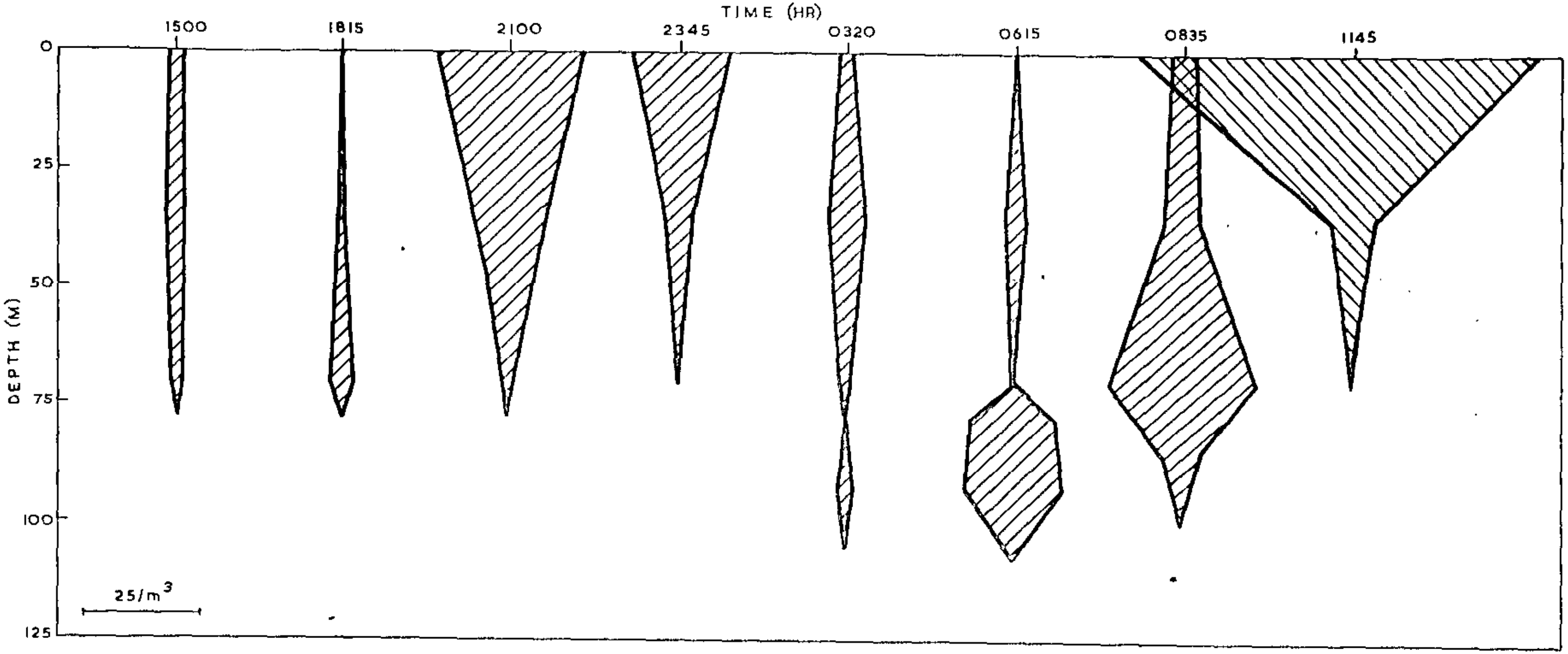
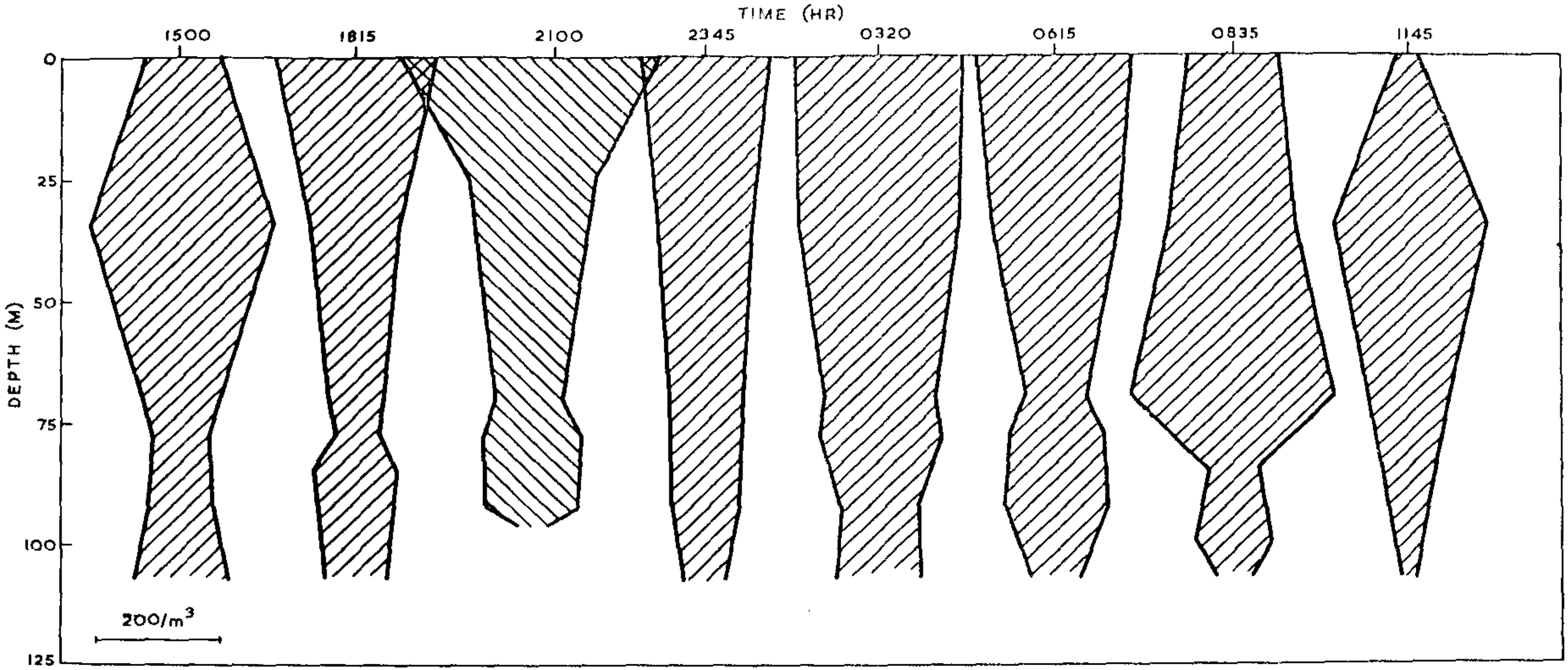

TIME (HR)
1500
1815
2100
2345
0320
0615
0835
1145
DEPTH (M)
0
25
50
75
100
125
250 mg/m3

Fig. 1



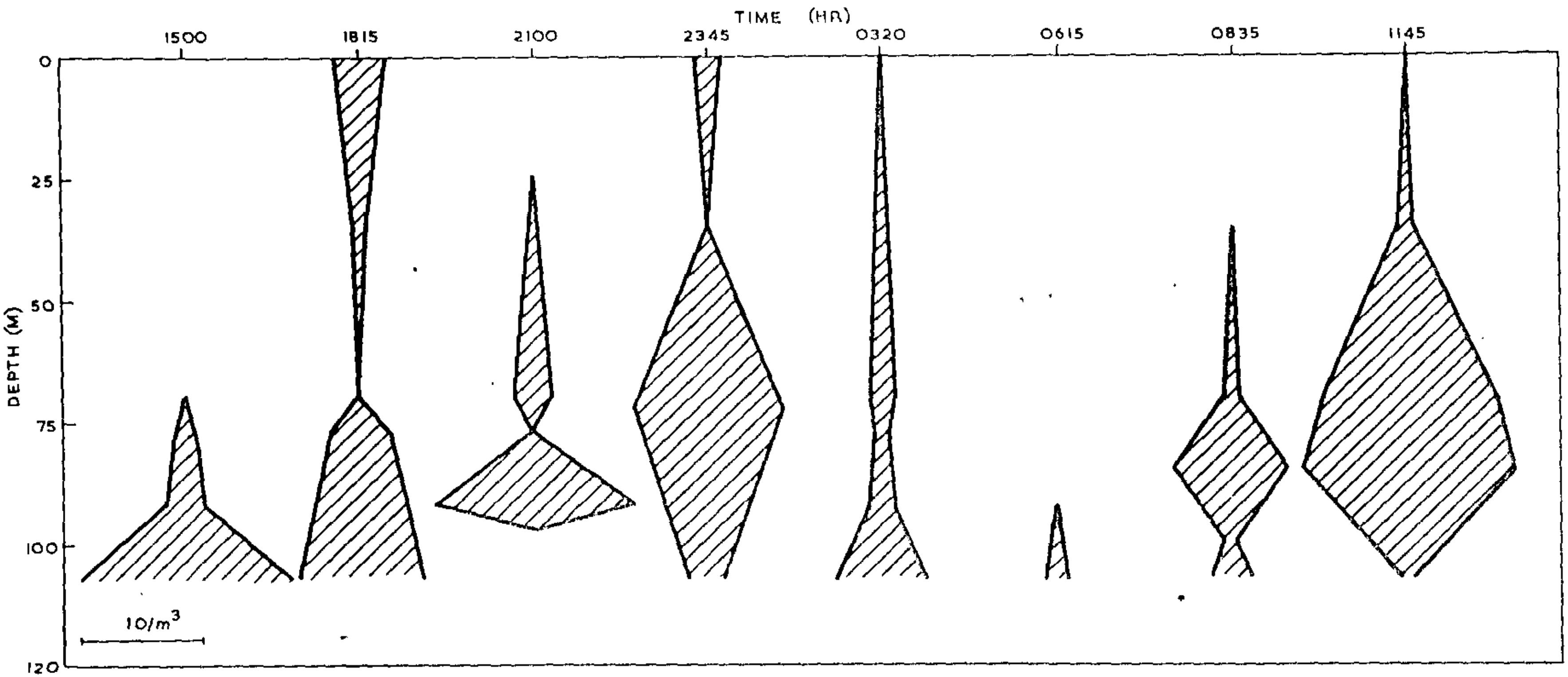
TIME (HR)
1500
1815
2100
2345
0320
0615
0835
1145
0
25
50
75
100
125
DEPTH (M)
25/m³

Fig. 2



TIME (HR)
1500
1815
2100
2345
0320
0615
0835
1145
DEPTH (M)
0
25
50
75
100
125
200/m^3

Fig. 3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1815
2100
2345
0320
0615
0835
1145
DEPTH (M)
0
25
50
75
100
120
10/m3

Fig. 4

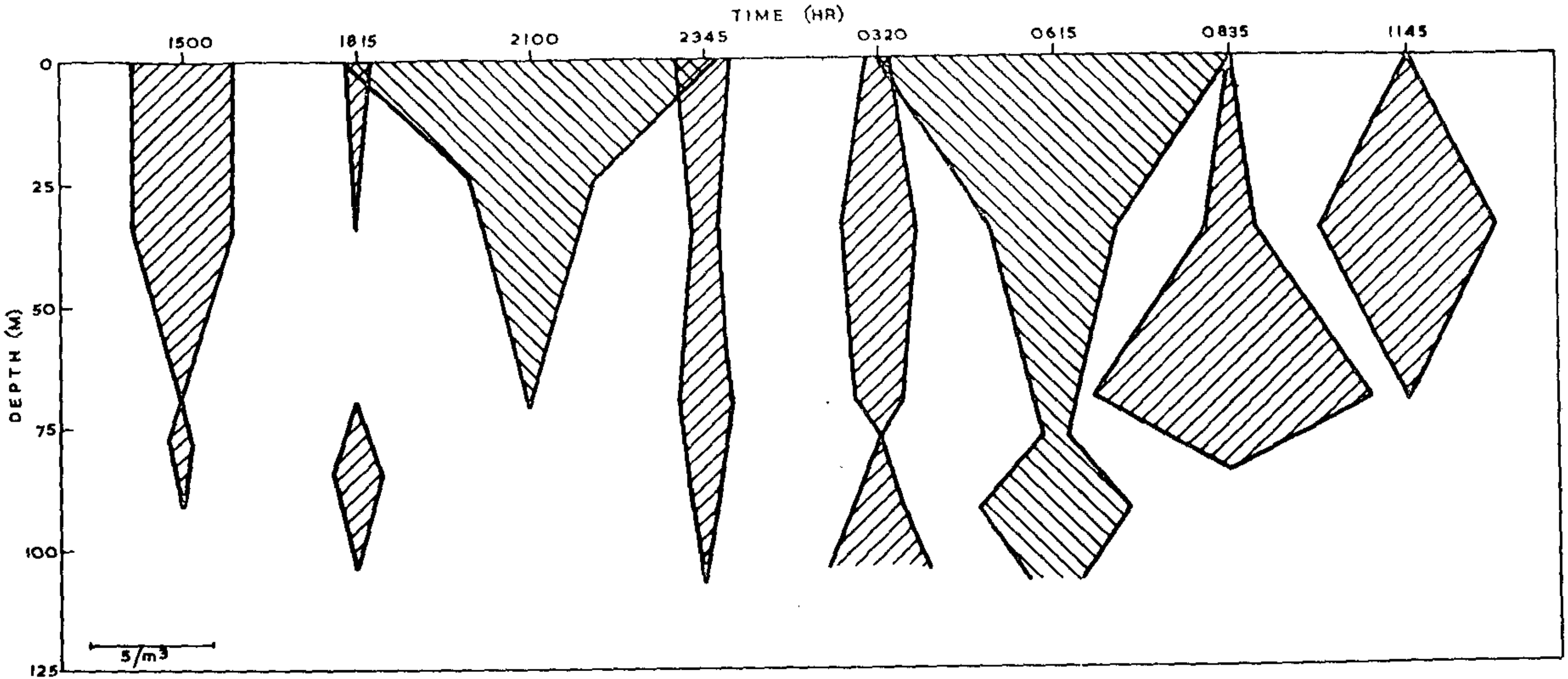

TIME (HR)
1500
1815
2100
2345
0320
0615
0835
1145
0
25
50
75
100
125
DEPTH (M)
5/m³

Fig. 5

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH5/59

May 5-6, 1959

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

J. Staniforth

ITINERARY

This was a cruise to carry out primary production studies at the Port Hacking 100 m station (Position 34°05'30"S. 151°15'30"E.).

SCIENTIFIC RESULTS

Primary Production

Samples in duplicate were taken from 0, 25, 50, and 100 m at 0530 hours. These were incubated both in light bath and in situ.

Light penetration measurements were taken at two-hourly intervals from 0800 hours.

Biochemistry

Pigment samples were collected at 0, 25, 50, and 100 m.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH6/59

May 9-27, 1959

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)
R. Bradley

ITINERARY

This is the sixth of the extended cruises from F.R.V. "Derwent Hunter" to study the circulation of the East Australian Current. Figure 1 shows the positions of stations. Hydrological sampling, B.T. casts, G.E.K. tows, and sampling for phytoplankton, primary production, pigments, and zooplankton was done as indicated in Figure 1. The zooplankton taken at Stations DH6/43, 45, 48, 59, 64/59 is discussed in the scientific report of Cruise DH8/59.

SCIENTIFIC REPORTS

(a) HYDROLOGY - D.J. ROCHFORD

Sampling was carried out at 0, 25, 50, 75, 100, 150, 200, 250, 300, 500, 750, 1000, and 1500 m.

The distribution of hydrological properties along Sections 1, 2, and 4 (Fig. 1) is discussed here.

(1) Temperature

(i) Section 1. (Fig. 2)

The highest surface temperature (22.76°C) was found at the western end of this section and the lowest (19.80°C) in the middle. No thermocline was present.

(ii) Section 2. (Fig. 3)

Surface temperatures greater than 22°C were found along this section with the highest (22.8°C) towards the eastern limit. No thermocline was found.

(iii) Section 4. (Fig. 4)

Surface temperatures greater than 22°C were found towards the western end of the section at Stations DH6/60-61/59 with a maximum of 22.97°C. No appreciable development of a thermocline was found.

(2) Density σ_t

(i) Section 1. (Fig. 5)

Much lighter surface waters were found at the western end of this section associated with the high temperature water of this region (Fig. 2). The maximum vertical gradient of density (0.01σ_t/m) was observed at Station DH6/45/59 at about 80 m.

(ii) Section 2. (Fig. 6)

The lightest surface waters were found at the coastal Station DH6/56/59 where a surface density of 24.14 and a vertical density gradient occurred of 0.045 σ_t/m. Elsewhere the greatest extent of light waters (less than 29.90 σ_t) was found at Stations DH6/52-53/59.

(iii) Section 4. (Fig. 7)

The lightest surface waters were found at Station DH6/61/59. A vertical gradient of 0.13 σ_t/m occurred at about 100 m between Stations DH6/60 and 61/59.

(3) Salinity

(i) Section 1. (Fig. 8)

Salinities along this section were highest (35.75-35.84‰) at the surface and decreased with depth to the salinity minimum at about 1000 m.

(ii) Section 2. (Fig. 9)

Salinities on this section were highest (35.81-35.84‰) at the surface and decreased with depth to the salinity minimum at about 1000 m. The coastal station DH6/56/59 had a much lower surface salinity (35.68‰).

(iii) Section 4. (Fig. 10)

Surface salinities varied from 34.77-34.84‰ and decreased with depth at all stations. The coastal station had surface salinities of 35.93‰.

(4) Percentage Oxygen Saturation

(i) Section 1. (Fig. 11)

Surface waters varied from 98-102 % saturation along this section. The coastal Station DH6/41/59 had a value of 106 % saturation. Values decreased with depth at all stations.

(ii) Section 2. (Fig. 12)

Surface values ranged from 97-103 % oxygen saturation. The values decreased with depth at all stations except DH6/55/59 where a secondary maximum value occurred at about 80 m.

(iii) Section 4. (Fig. 13)

At the most easterly station, DH6/63/59, supersaturated waters extended down to about 160 m, with a maximum value of 110 % at 141 m. A subsurface saturation maximum was also observed at other stations along this section at depths of 20-40 m and with values between 102 and 104 %. Below this maximum values decreased everywhere with depth.

(5) Total Phosphorus

(i) Section 1. (Fig. 14)

Surface values varied from 0.03 - 0.47 µg at./l. In the eastern half of the section, values decreased from the surface to a minimum between 30 and 100 m and then increased to the deepest levels. In the western half, values increased from the surface to a maximum between 30 and 70 m and then increased in the deeper waters.

(ii) Section 2. (Fig. 15)

Surface values ranged from 0.31 - 0.42 µg at./l. Throughout the section values decreased with depth to a minimum at about 30-80 m. Below this minimum values increased with depth. At Stations DH6/59 and 56/59 a marked maximum (0.54 - 0.55 µg at./l.) was found in the upper 30 m.

(iii) Section 4. (Fig. 16)

Surface values varied from 0.32 - 0.43 µg at./l. A minimum was found at all stations at depths between 30 and 90 m. Below these depths values increased with depth.

(6) Horizontal Distribution of Properties

(i) Temperature (Fig. 17)

Surface temperatures greater than 22.5°C were recorded in the north-west and south-east along the path of the anticlockwise gyral (see Section (b) Dynamics).

(ii) Regional Water Masses

The salinity-temperature relations of surface waters (Fig. 18) have been interpreted as mixtures of two regional water masses (Table 1) with local modifications in coastal regions (A and B, Fig. 18).

TABLE 1

REGIONAL WATER MASSES

	Temperature °C	Salinity ‰
1	22.5 - 23.0	35.79 - 35.84
2	19.8 - 20.1	35.75 - 35.77

The location of these two regional water masses is shown in Figure 7. Water mass 1 was entering from the north and mixing with water mass 2 in the region east of Sydney. The mixed waters occupied the south-eastern and eastern limits of the region.

(iii) Total Phosphorus

Figure 19 shows the distribution of total phosphorus at the surface in relation to the water masses of Figure 17. It appears probable that the regional water mass from the north had a total phosphorus content of 0.30-0.35 μg at./l. and that to the east of Sydney one of 0.38 - 0.42 μg at./l.

(b) DYNAMICS - B.V. HAMON

Figure 20 shows the contours of dynamic height (in dyn. cm) relative to the 1000 decibar level.

There is evidence of appreciable easterly flow 150 miles east of Sydney, but the observations are scattered, and the contours shown should not be interpreted too rigidly.

The volume transport and mean geostrophic surface current between Stations 45 and 53 (A and B, Fig. 20) were found to be 19.5×10^6 m^3/sec and 31 cm/sec respectively, relative to 1000 decibars.

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

Table 2 lists the diatoms and Table 3 the dinoflagellates from the samples taken on this cruise. The flora is essentially tropical with several species, for example *Ceratium geniculatum* and *C. digitatum*, recorded from the South Pacific, but not previously found in these investigations.

(d) PRIMARY PRODUCTION - N. DYSON

Figure 21 shows the positions of the stations where the productivity sampling was carried out.

At four stations the rate of CO_2 uptake was determined by the *in situ* incubation method together with the light bath incubation method. At the remainder of the stations the light bath incubation method was used.

Light penetration measurements were also made whenever convenient at the productivity stations.

Results

Figure 21 shows the estimated daily rate of production per m^3 of the water column as calculated from the hourly rate of production. On both sections the highest figures were obtained at the stations farthest from the coast. High results were also obtained in the middle of both section lines.

Figures 22, 23, 24, and 25 show the rates of CO_2 uptake as determined by the two methods of incubation. In most cases the rate of uptake as determined by the *in situ* incubation is greater than the light-bath incubation method but not as high as expected, nor is the correlation very good.

(e) BIOCHEMISTRY - G.F. HUMPHREY

Weighted averages for pigments were calculated according to Humphrey (1960) for the water column to 100 m. The results are given in Table 4, which contains also the corresponding values for the 100 m station off Sydney. It can be seen that there was no great variation in pigment concentration over the whole region from Sydney to Lord Howe Island. The depth profiles (Fig. 26) do not show any consistent change with position or time of sampling.

TABLE 2

DIATOMS - CRUISE DH6/59

SPECIES	Stations																			
	41	42	43	46	47	49	50	51	52	53	54	55	56	59	60	61	62	63	65	66
Amphiprora alata																			+	
Bacteriastrum comosum											+							+		
B. delicatulum														+		+	+		+	+
B. hyalinum																	+			
B. varians		+																		
Bellerochea malleus										+										
Biddulphia chinensis														+						
Cerataulina pelagica								+						+						+
Chaetoceros affinis														+					+	
Ch. coarctatum	+					+			+			+	+	+		+			+	
Ch. concavicorne										+									+	+
Ch. decipiens															+					
Ch. denticulatum	+			+		+		+	+					+	+	+		+	+	
Ch. didymus														+						
Ch. lorenzianum															+					
Ch. neapolitanum																	+			
Ch. peruvianum	+					+		+			+			+	+	+				+
Ch. teres		+		+					+			+		+	+		+			+
Ch. vanheurckii		+																		
Climacodium frauenfeldianum		+	+	+	+	+			+			+	+	+	+	+	+		+	+
Climacosphenia moniligera													+							
Corethron criophilum						+														
Dactyliosolen mediterraneum														+						
Ditylum brightwellii														+						
Eucampia zoodiacus										+									+	
Gossleriella tropica														+						

DIATOMS - CRUISE DH6/59

SPECIES	41	42	43	46	47	49	50	51	52	53	54	55	56	59	60	61	62	63	65	66
Guinardia flaccida		+						+		+					+			+		+
Hemiaulus hauckii														+						
Lauderia annulata		+		+								+				+				
Leptocylindrus danicus								+					+	+	+					
Melosira crenulata	+																			
M. granulata														+						
Navicula membranacea						+														
Nitzschia closterium																		+		
N. longissima v. parva									+	+			+		+					+
Planktoniella sol	+	+			+			+		+	+		+	+	+	+				
Rhizosolenia alata	+	+		+	+		+	+	+	+		+	+	+	+	+	+	+	+	
R. bergonii	+													+		+			+	
R. calcar-avis														+						
R. clevei		+												+	+		+		+	
R. delicatula	+													+						
R. hebetata f. semispina				+	+	+						+								
R. imbricata	+	+	+											+	+			+		
R. setigera																	+			
R. stolterforthii	+	+		+	+	+		+	+	+		+	+	+	+			+	+	
R. styliformis	+	+																		
Stephanopyxis palmeriana														+						
Streptotheca thamesis								+												+
Thalassiosira frauenfeldii						+							+	+		+				
T. hyalina		+																		
T. longissima		+																		
T. nitzschioides	+	+						+				+			+		+			+
T. rotula								+						+						
T. subtilis						+														

TABLE 3

DINOFLAGELLATES - CRUISE DH6/59

SPECIES	41	42	43	46	47	49	50	51	52	53	54	55	56	59	60	61	62	63	65	66
Amphisolenia astragalus														+						
A. bidentata	+				+	+		+	+	+	+		+		+	+			+	+
A. curvata														+						
A. lemmermannii																				+
A. palaeotheroides														+						
A. thrinax										+										
Ceratium arietinum													+		+				+	+
C. axiale																	+			+
C. belone					+	+	+						+		+					
C. breve									+					+						
C. buceros	+	+					+	+	+				+				+		+	+
v. claviger				+																
v. molle																		+		
C. candelabrum					+	+			+					+	+					+
C. carriense						+					+		+	+	+		+		+	+
C. cephalotum						+														
C. concilians	+								+		+			+	+					
C. contortum		+					+			+						+			+	+
C. contrarium	+												+							
C. declinatum		+	+			+				+				+	+			+		+
C. deflexum				+		+				+			+	+			+		+	+
C. digitatum														+				+	+	
C. euarcuatum		+	+										+	+						
C. extensum	+	+	+	+		+		+	+	+	+		+	+	+	+				+
C. falcatiforme						+														+
C. falcatum						+				+	+			+					+	+

TABLE 3 - Contd.

DINOFLAGELLATES - CRUISE DH6/59

SPECIES	41	42	43	46	47	49	50	51	52	53	54	55	56	59	60	61	62	63	65	66
	Stations																			
tium furca		+	+	+	+	+		+	+	+		+	+		+	+	+			+
fusus	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+
gallicum																		+		
geniculatum								+		+	+									
gibberum			+																	
gravidum											+									
hexacanthum											+						+			+
incisum				+		+		+		+		+				+			+	
inflatum						+														
karstenii						+							+	+	+					+
kofoidi	+			+	+	+	+		+	+	+	+	+	+	+					
longinum								+												
longirostrum														+				+	+	
lunula						+								+						
macroceros	+	+				+		+			+			+	+	+		+	+	
massiliense	+	+		+	+					+	+	+	+	+	+	+	+	+	+	
pavillardii																+			+	
pentagonum	+		+		+	+	+				+		+	+	+	+	+			+
platycorne																+				
praelongum						+		+												
pulchellum		+					+			+							+			+
ranipes																+				
setaceum	+	+				+		+					+	+	+		+			
symmetricum	+							+						+	+					
schmidtii														+		+	+	+		
teres	+	+	+	+	+	+	+		+	+			+	+	+	+	+			
tripos	+	+	+	+	+			+		+	+		+	+	+	+	+	+		
trichoceros	+		+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
vultur	+																			

DINOFLAGELLATES – CRUISE DH6/59

SPECIES	41	42	43	46	47	49	50	51	52	53	54	55	56	59	60	61	62	63	65	66
Ceratocorys horrida			+			+	+		+	+			+	+	+	+		+	+	
C. armata								+												
Cladopyxis brachiolata																				+
Dinophysis similis													+							
Ornithocercus magnificus										+		+		+				+	+	
Oxytoxum subulatum			+																	
O. scolopax										+										
Parahistioneis rotundata															+					
Peridinium claudicans													+							
P. elegans	+					+				+										
P. grande													+							
P. hirobis																		+		
P. latispinum														+						
Phalacroma cuneata											+									
Podolampas bipes														+						
P. palmipes	+					+				+				+		+			+	
P. spinifer											+		+	+		+				
Pyrocystis acuta															+					
P. fusiformis									+		+									
P. hamulus v. semicircularis	+								+	+	+								+	+
P. lunula							+													
P. pseudonoctiluca							+													
P. robusta											+									

TABLE 4

WEIGHTED AVERAGES FOR PIGMENTS IN THE WATER COLUMN TO 100 m

		Chlorophyll a	Chlorophyll b	Chlorophyll c	Astacin	Non-astacin
11/5/59	0630	0.329	0.101	0.815	0.166	
	1200	0.509	0.188	0.755	0.260	0.008
12/5/59	0730	0.440	0.118	0.576	0.349	0.101
	1930	0.801	0.144	0.864	0.179	0.090
13/5/59	0630	0.456	0.144	0.673	0.210	0.060
	1200	0.466	0.111	0.533	0.049	0.141
19/5/59	1245	0.414	0.103	0.624	0.080	0.084
	2000	0.298	0.085	0.331	0.050	0.074
20/5/59	0645	0.329	0.103	0.413	0.065	0.079
	1430	0.346	0.138	0.598	0.105	0.073
21/5/59	0900	0.415	0.165	0.760	0.168	0.045
23/5/59	0630	0.373	0.178	0.790	0.134	0.028
	1120	0.369	0.154	0.779	0.189	0.020

LEGENDS FOR FIGURES

Cruise DH6/59

Fig. 1. Track chart showing positions of stations.

Fig. 2. Section 1. Distribution of temperature (°C), surface to 1500 m.

Fig. 3. Section 2. Temperature.

Fig. 4. Section 4. Temperature.

Fig. 5. Section 1. Distribution of density (σ_t), surface to 1500 m.

Fig. 6. Section 2. σ_t

Fig. 7. Section 4. σ_t

Fig. 8. Section 1. Distribution of salinity (‰), surface to 1500 m.

Fig. 9. Section 2. Salinity.

Fig. 10. Section 4. Salinity.

Fig. 11. Section 1. Distribution of percentage oxygen saturation, surface to 1500 m.

Fig. 12. Section 2. Percentage oxygen saturation.

Fig. 13. Section 4. Percentage oxygen saturation.

Fig. 14. Section 1. Distribution of total phosphorus (μg at./l.), surface to 1500 m.

Fig. 15. Section 2. Total phosphorus.

Fig. 16. Section 4. Total phosphorus.

Fig. 17. Temperature distribution at the surface. Boundaries of regional water masses are indicated.

Fig. 18. Surface temperature-salinity diagram showing subdivision into regional water masses.

Fig. 19. Surface distribution of total phosphorus (μg at./l.) in relation to regional water mass distribution.

Fig. 20.- Contours of dynamic heights in dynamic centimetres (1000 decibars).

Fig. 21.- Rate of production of CO_2 (mgC/day/m^2). Top figure is Station number, lower figure is rate of production.

Fig. 22.- Rate of CO_2 uptake at Station DH6/45/59.

Fig. 23.- Rate of CO_2 uptake at Station DH6/48/59.

Fig. 24.- Rate of CO_2 uptake at Station DH6/62/59.

Fig. 25.- Rate of CO_2 uptake at Station DH6/64/59.

Fig. 26.- Vertical profiles for pigments.

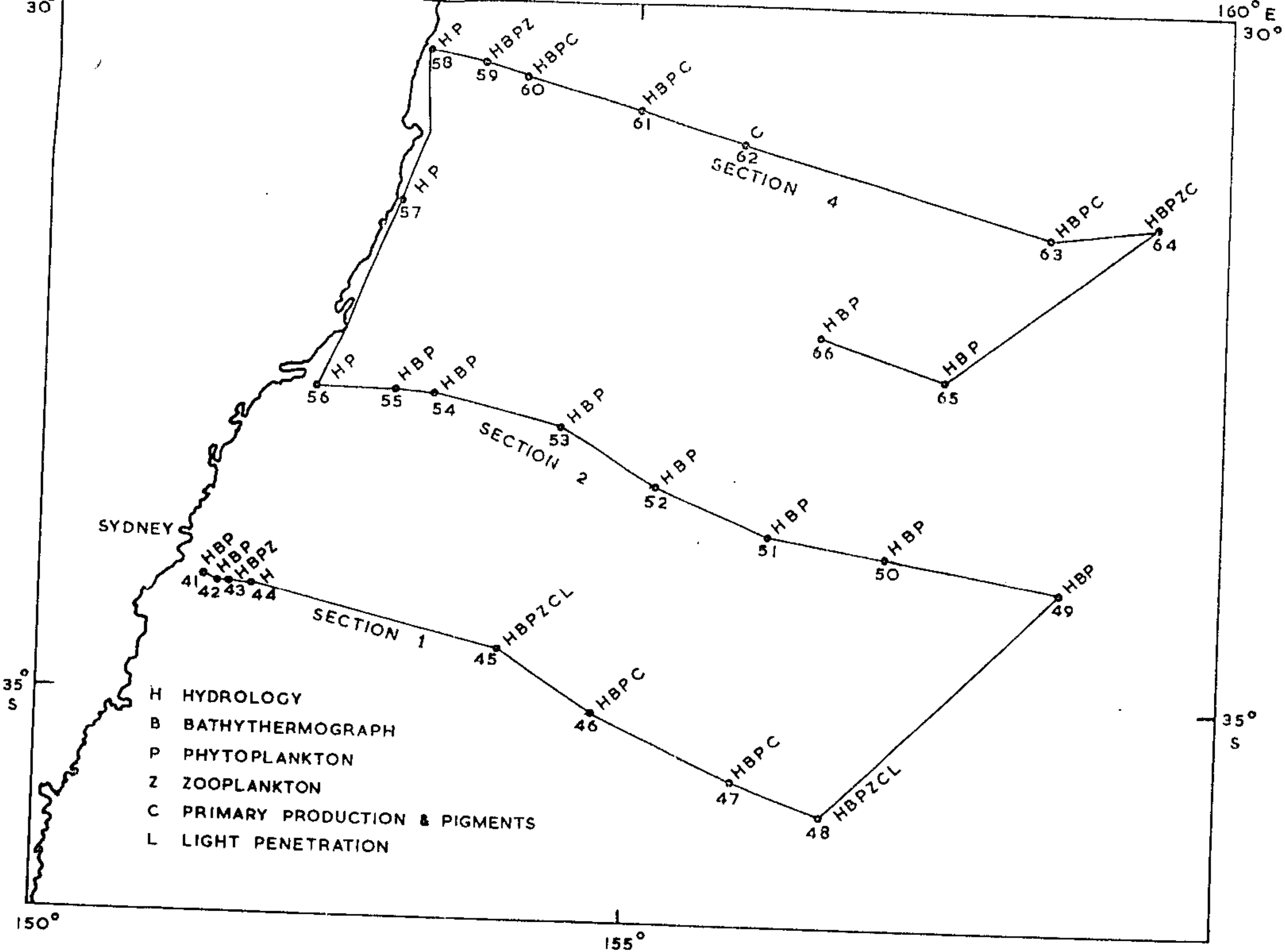
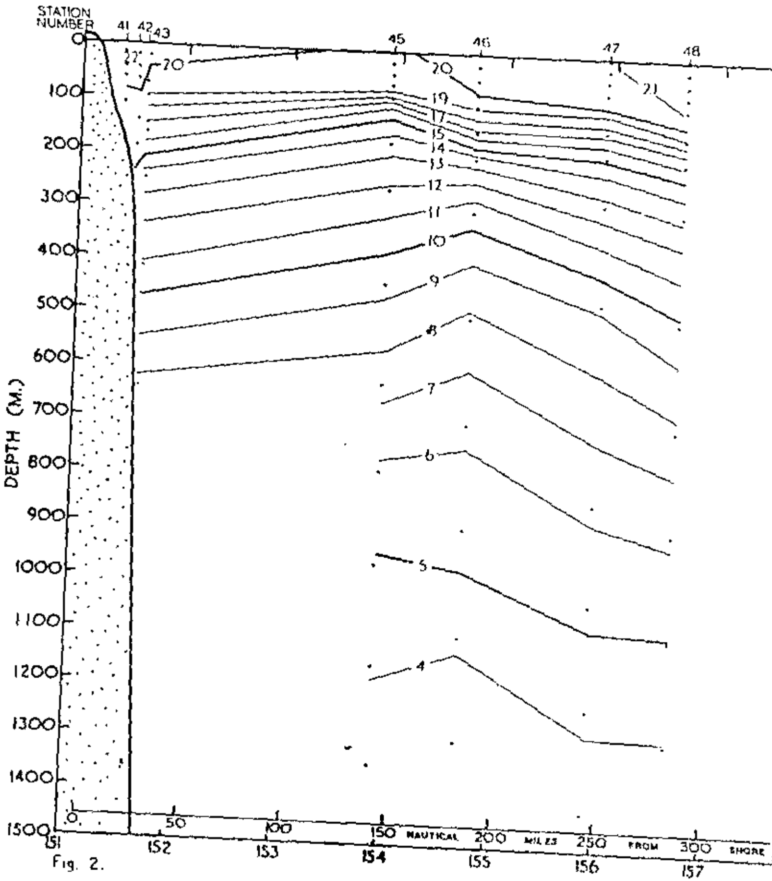

30°
160° E
30°
HP
58
HBPZ
59
HBPC
60
HBPC
61
C
62
SECTION 4
HBPC
63
HBPZC
64
HP
57
HBP
66
HBP
65
HP
56
HBP
55
HBP
54
HBP
53
SECTION 2
HBP
52
HBP
51
HBP
50
HBP
49
SYDNEY
HBP
41
HBP
42
HBPZ
43
H
44
SECTION 1
HBPZCL
45
HBPC
46
HBPC
47
HBPZCL
48
35° S
35° S
H HYDROLOGY
B BATHYTHERMOGRAPH
P PHYTOPLANKTON
Z ZOOPLANKTON
C PRIMARY PRODUCTION & PIGMENTS
L LIGHT PENETRATION
150°
155°
160° E

Fig. 1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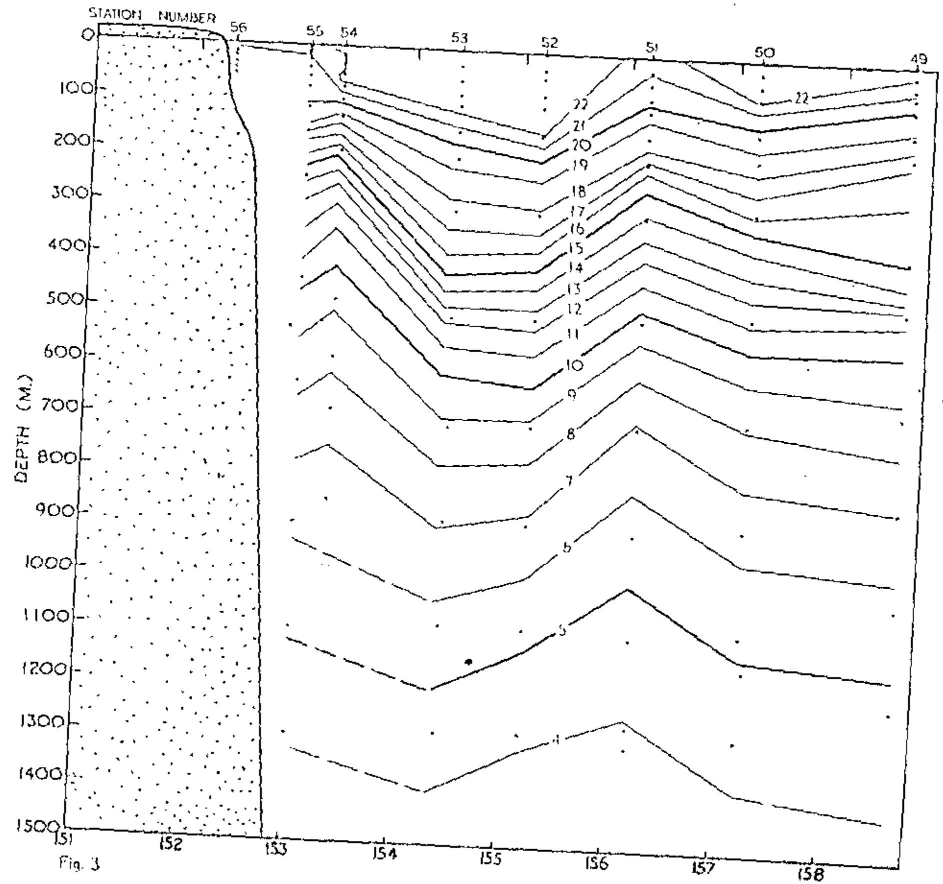
0 50 100 150 NAUTICAL 200 MILES 250 FROM 300 SHORE
151 152 153 154 155 156 157

Fig. 2.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56 55 54 53 52 51 50 49
DEPTH (M.)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4
151 152 153 154 155 156 157 158

Fig. 3

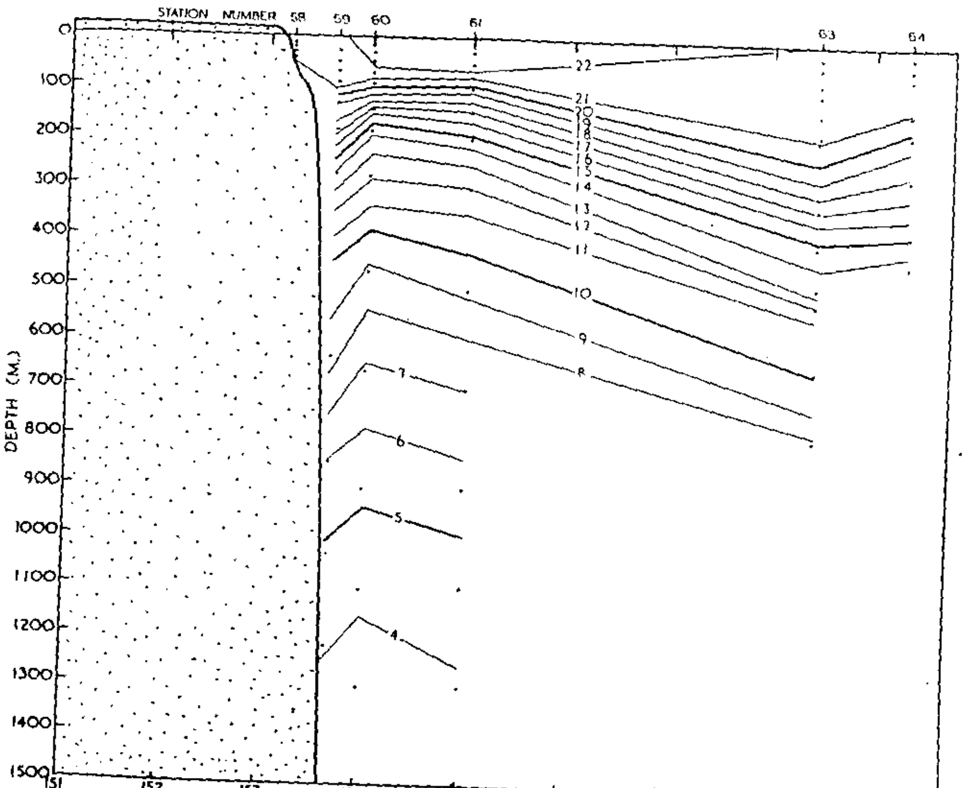

STATION NUMBER
58
59
60
61
63
64
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
151
152
153
154
155
156
157
158
159

Fig. 4

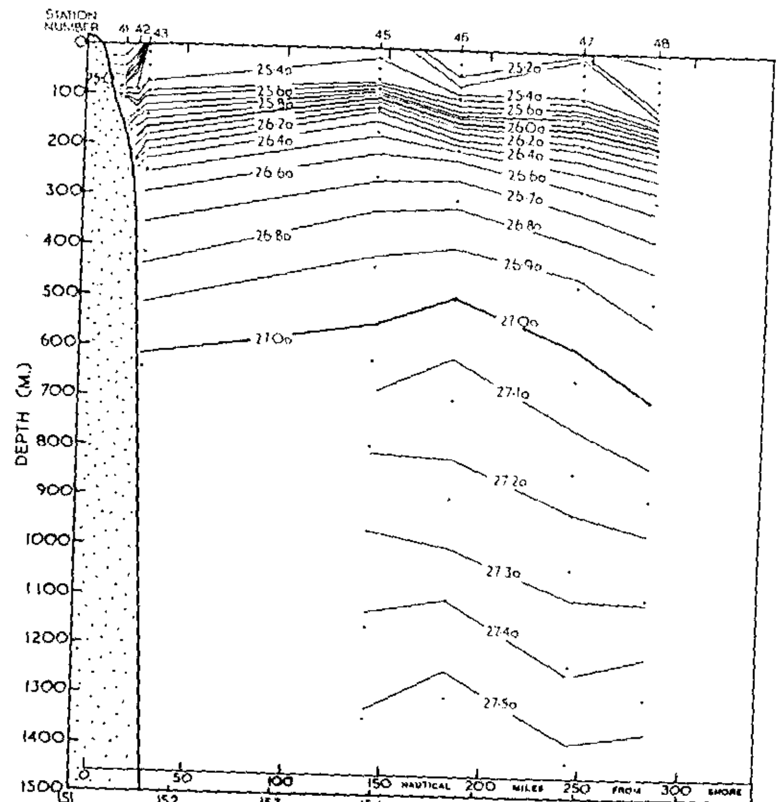
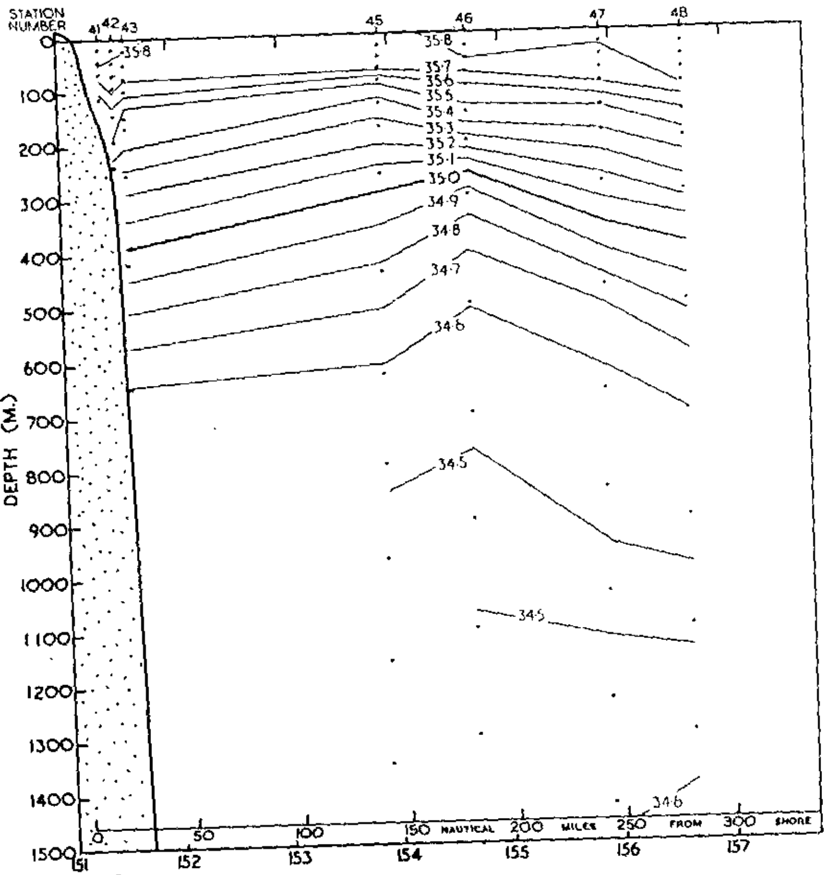
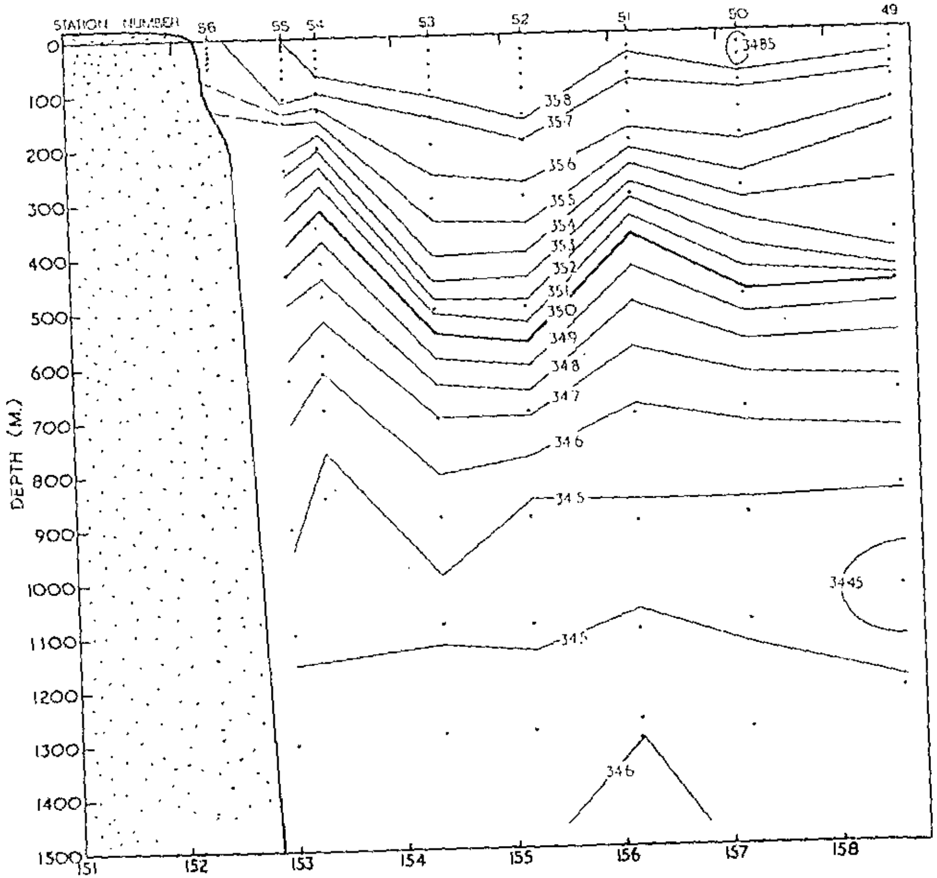
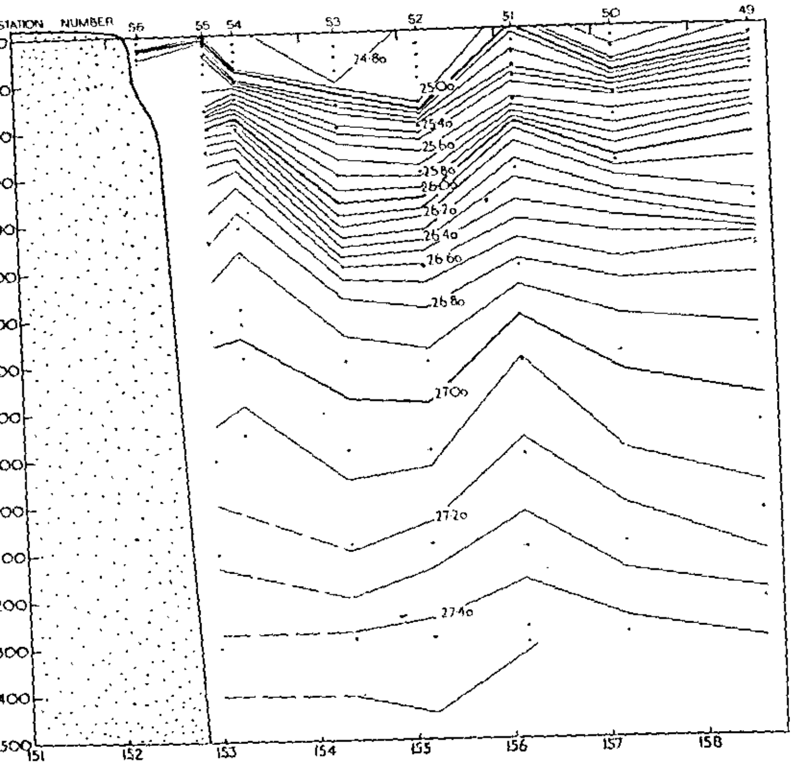

STATION NUMBER
41
42
43
45
46
47
48
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
25·4σ
25·2σ
25·6σ
25·8σ
26·0σ
26·2σ
26·4σ
26·6σ
26·7σ
26·8σ
26·9σ
27·0σ
27·1σ
27·2σ
27·3σ
27·4σ
27·5σ
0
50
100
150 NAUTICAL
200 MILES
250 FROM
300 SHORE
151
152
153
154
155
156
157

Fig. 5

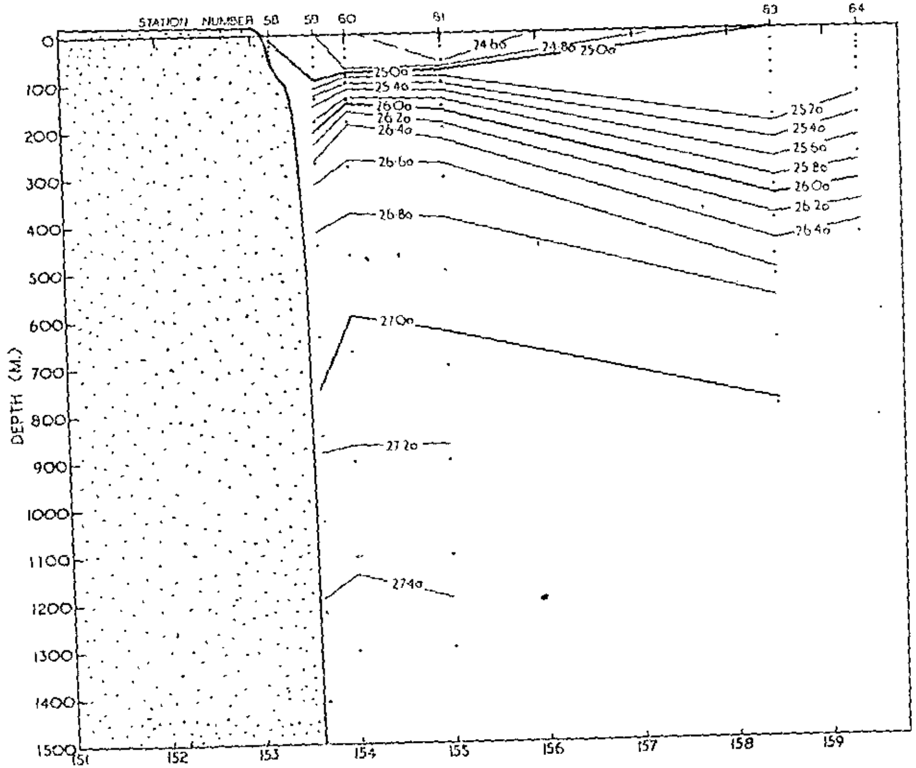

STATION NUMBER
DEPTH (M.)
NAUTICAL MILES FROM SHORE
Fig. 8


STATION NUMBER
DEPTH (M.)
Fig. 9



STATION NUMBER
56
55
54
53
52
51
50
49
24·8σ
25·0σ
25·4σ
25·6σ
25·8σ
26·0σ
26·2σ
26·4σ
26·6σ
26·8σ
27·0σ
27·2σ
27·4σ
151
152
153
154
155
156
157
158

Fig 6



STATION NUMBER
58
59
60
61
63
64
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
24·6σ
24·8σ
25·0σ
25·4σ
25·6σ
25·8σ
26·0σ
26·2σ
26·4σ
26·6σ
26·8σ
27·0σ
27·2σ
27·4σ
151
152
153
154
155
156
157
158
159

Fig 7

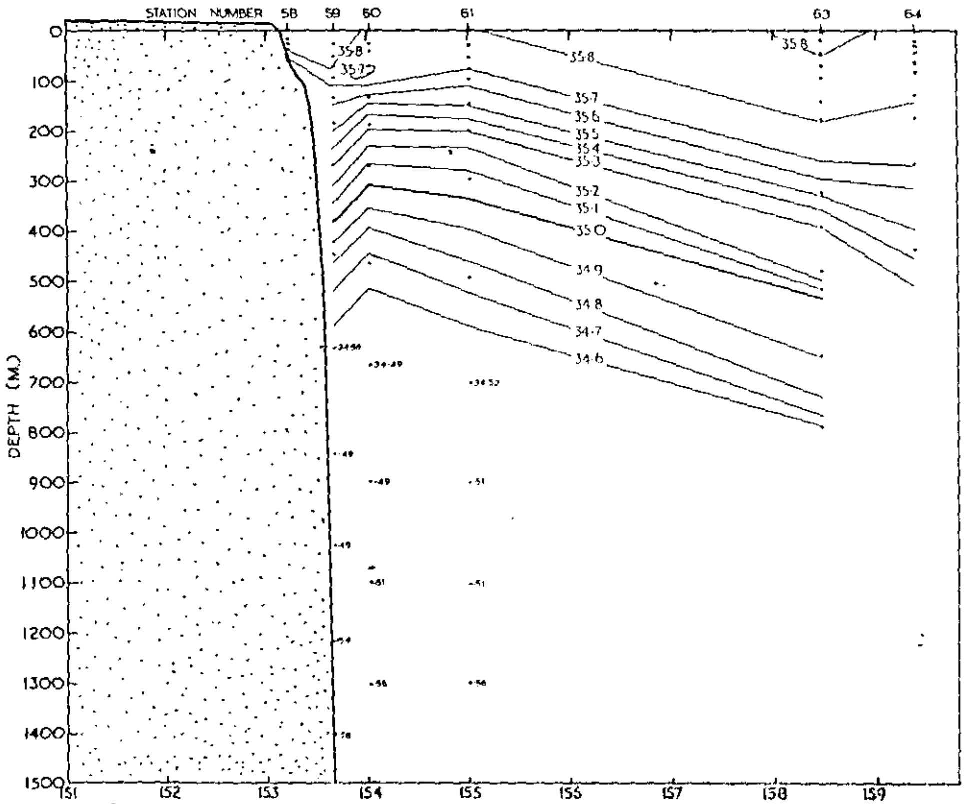

STATION NUMBER
58
59
60
61
63
64
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
35.8
35.7
35.6
35.5
35.4
35.3
35.2
35.1
35.0
34.9
34.8
34.7
34.6
151
152
153
154
155
156
157
158
159

Fig. 10

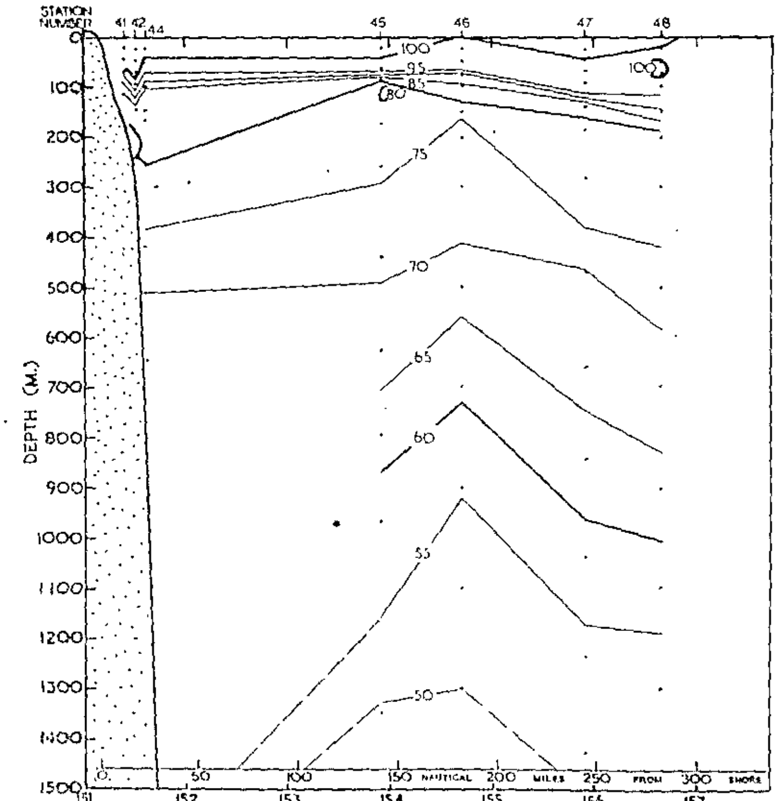

STATION NUMBER
41
42
44
45
46
47
48
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
100
95
85
80
75
70
65
60
55
50
0
50
100
150
NAUTICAL
200
MILES
250
FROM
300
SHORE
151
152
153
154
155
156
157

Fig. 11

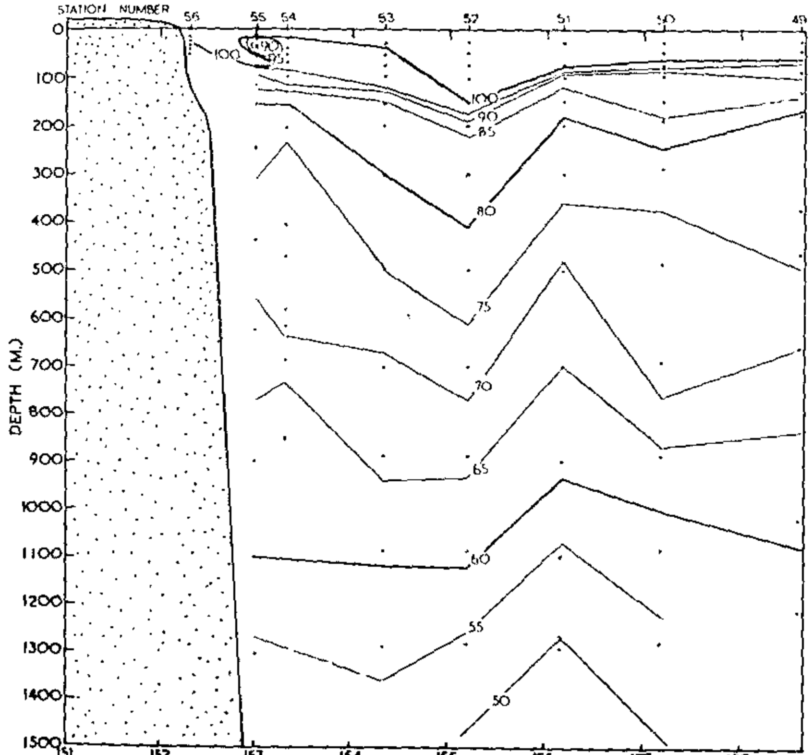

STATION NUMBER
56
55
54
53
52
51
50
49
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
151
152
153
154
155
156
157
158
100
95
90
85
80
75
70
65
60
55
50

Fig. 12

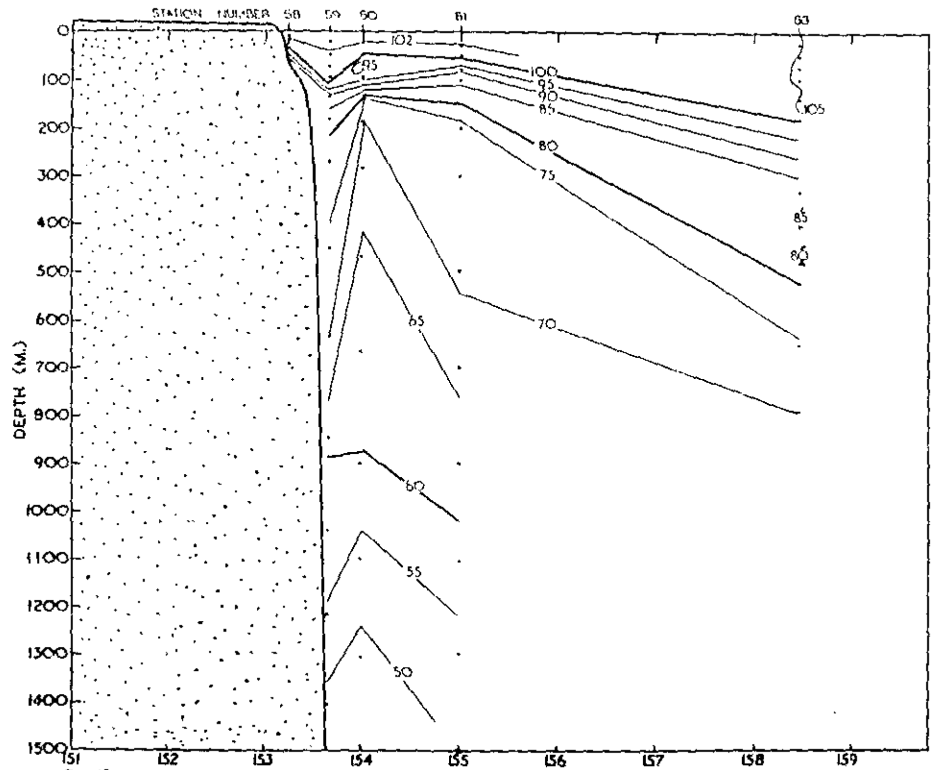
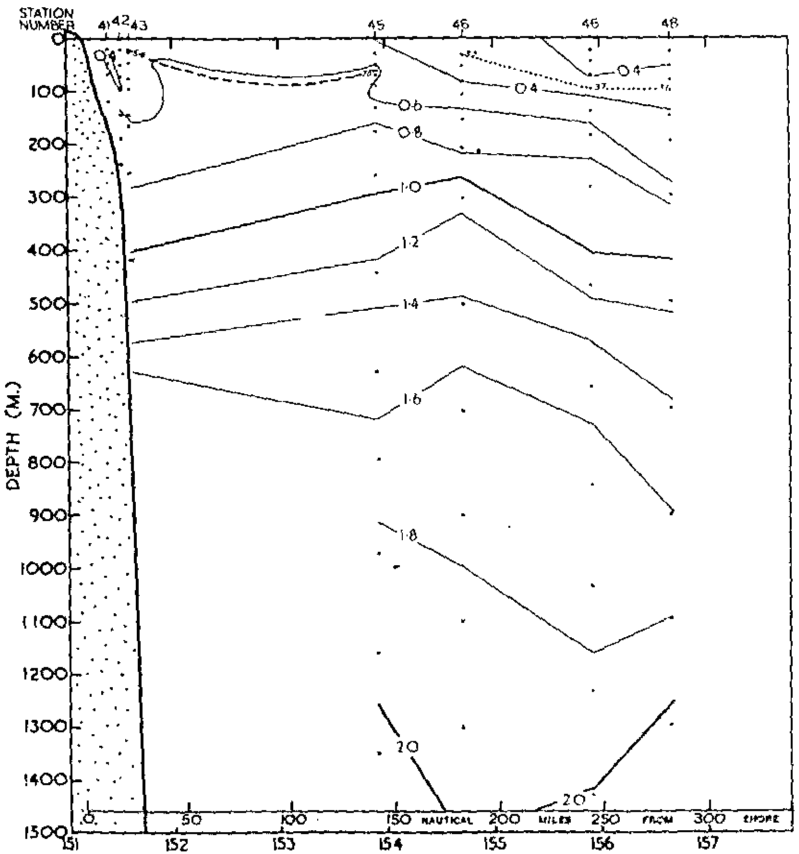
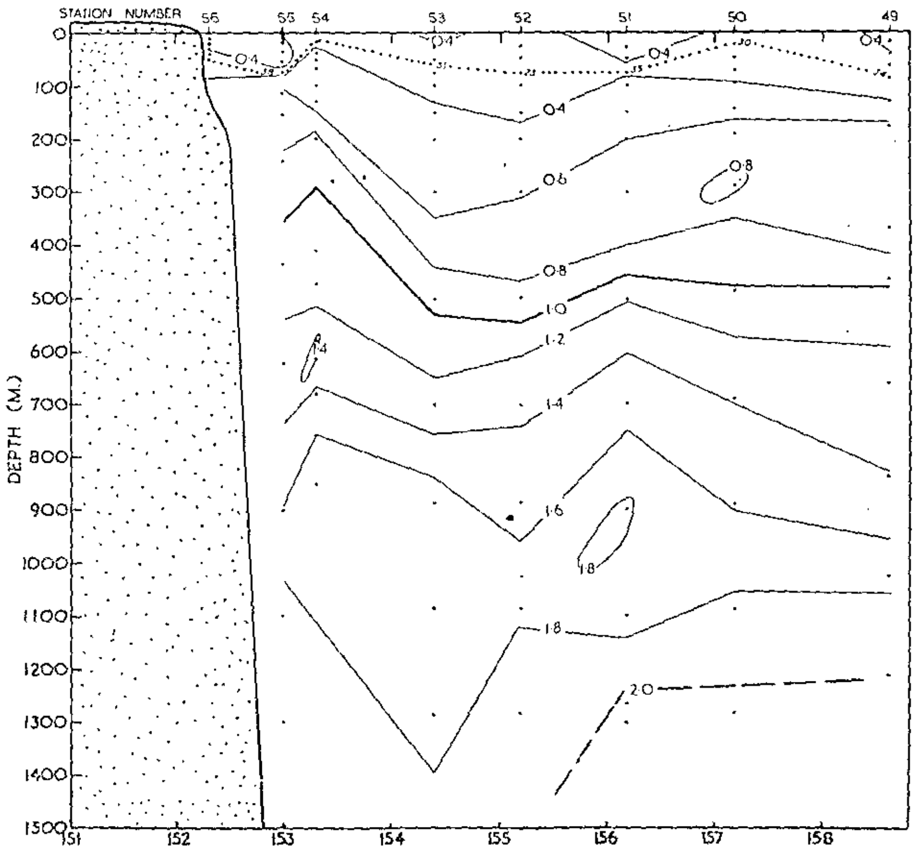

STATION NUMBER
58
59
60
61
63
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
151
152
153
154
155
156
157
158
159
102
105
100
95
90
85
80
75
70
65
60
55
50

Fig. 13



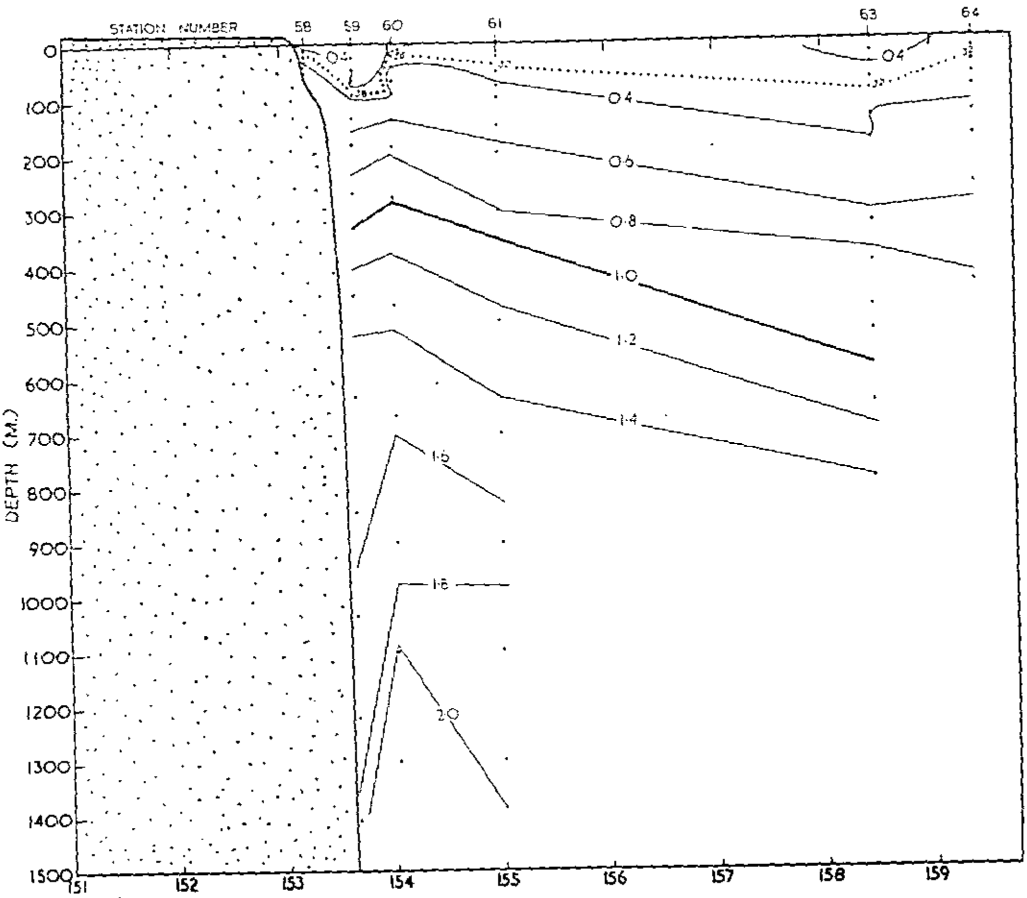
STATION NUMBER
41 42 43
45
46
46
48
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
0·4
0·6
0·8
1·0
1·2
1·4
1·6
1·8
2·0
0
50
100
150 NAUTICAL
200 MILES
250 FROM
300 SHORE
151
152
153
154
155
156
157

Fig. 14



STATION NUMBER
56
55 54
53
52
51
50
49
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
0·4
0·6
0·8
1·0
1·2
1·4
1·6
1·8
2·0
151
152
153
154
155
156
157
158

Fig 15



STATION NUMBER
58
59
60
61
63
64
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
151
152
153
154
155
156
157
158
159
0·4
0·6
0·8
1·0
1·2
1·4
1·6
1·8
2·0

Fig. 16

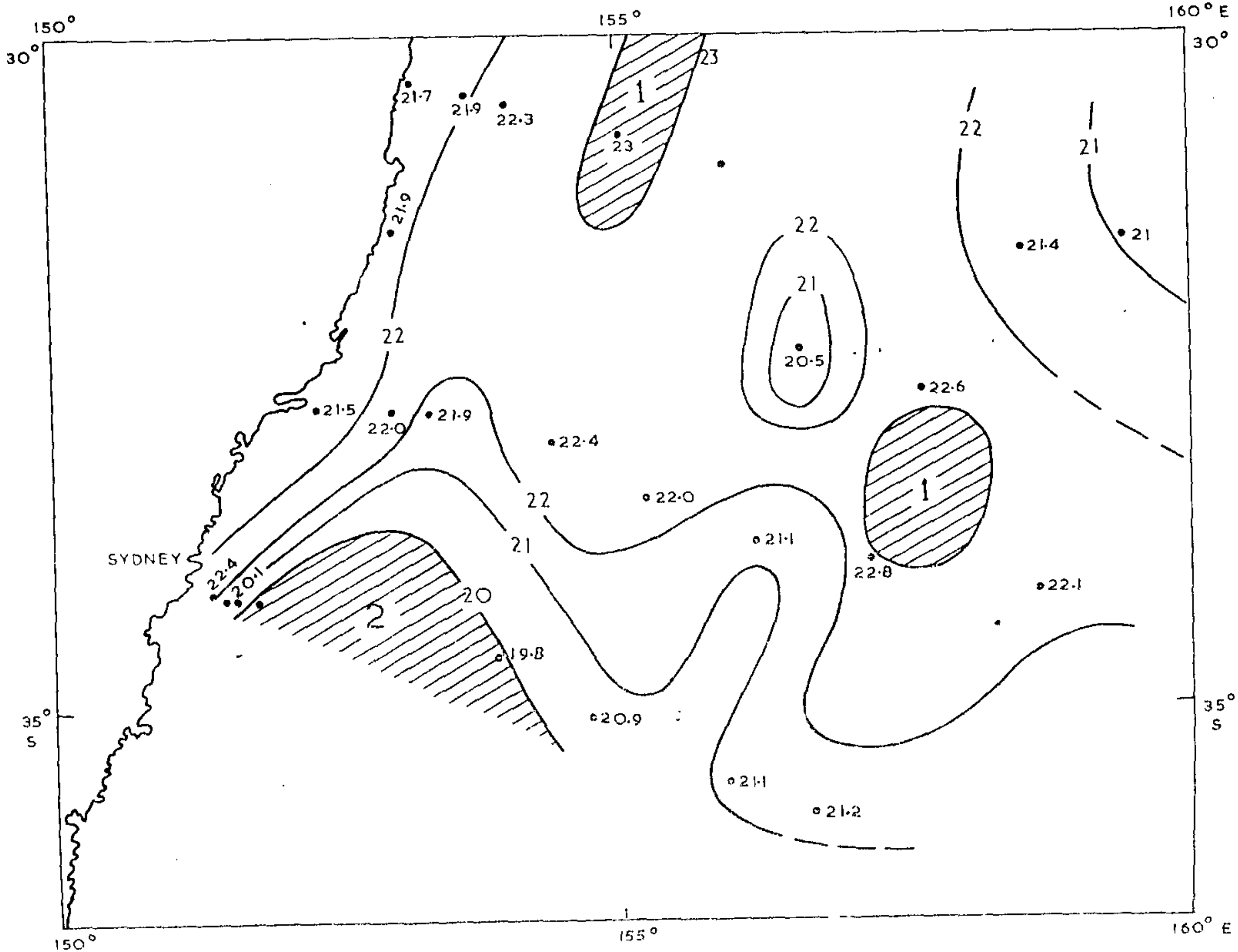

150°
155°
160° E
30°
35° S
SYDNEY
21·7
21·9
22·3
23
21·9
22
21·5
22·0
21·9
22·4
22·0
21·1
22·8
22·6
20·5
21·4
21
22·1
22·4
20·1
20
19·8
20·9
21·1
21·2
1
2

Fig. 17

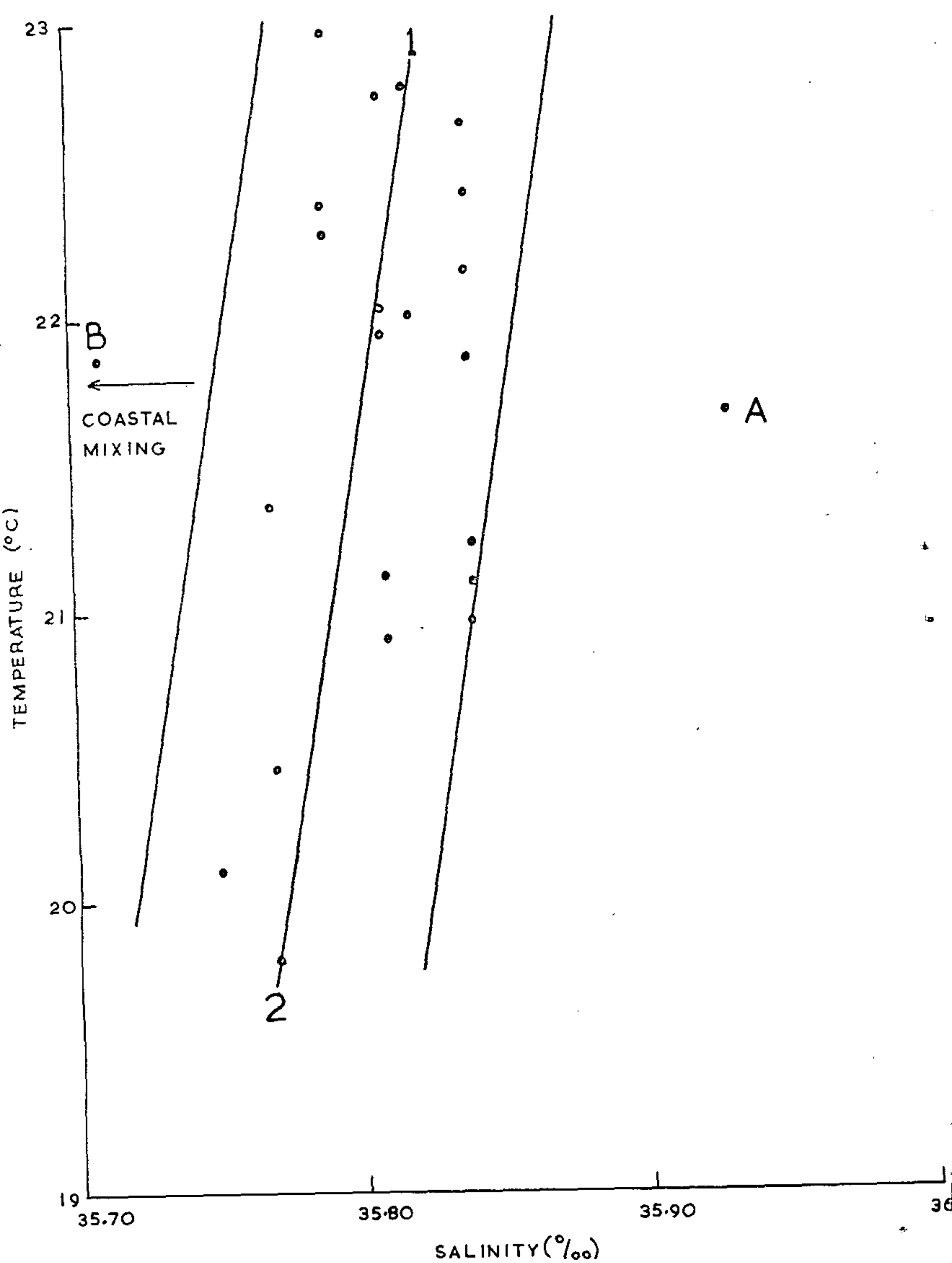
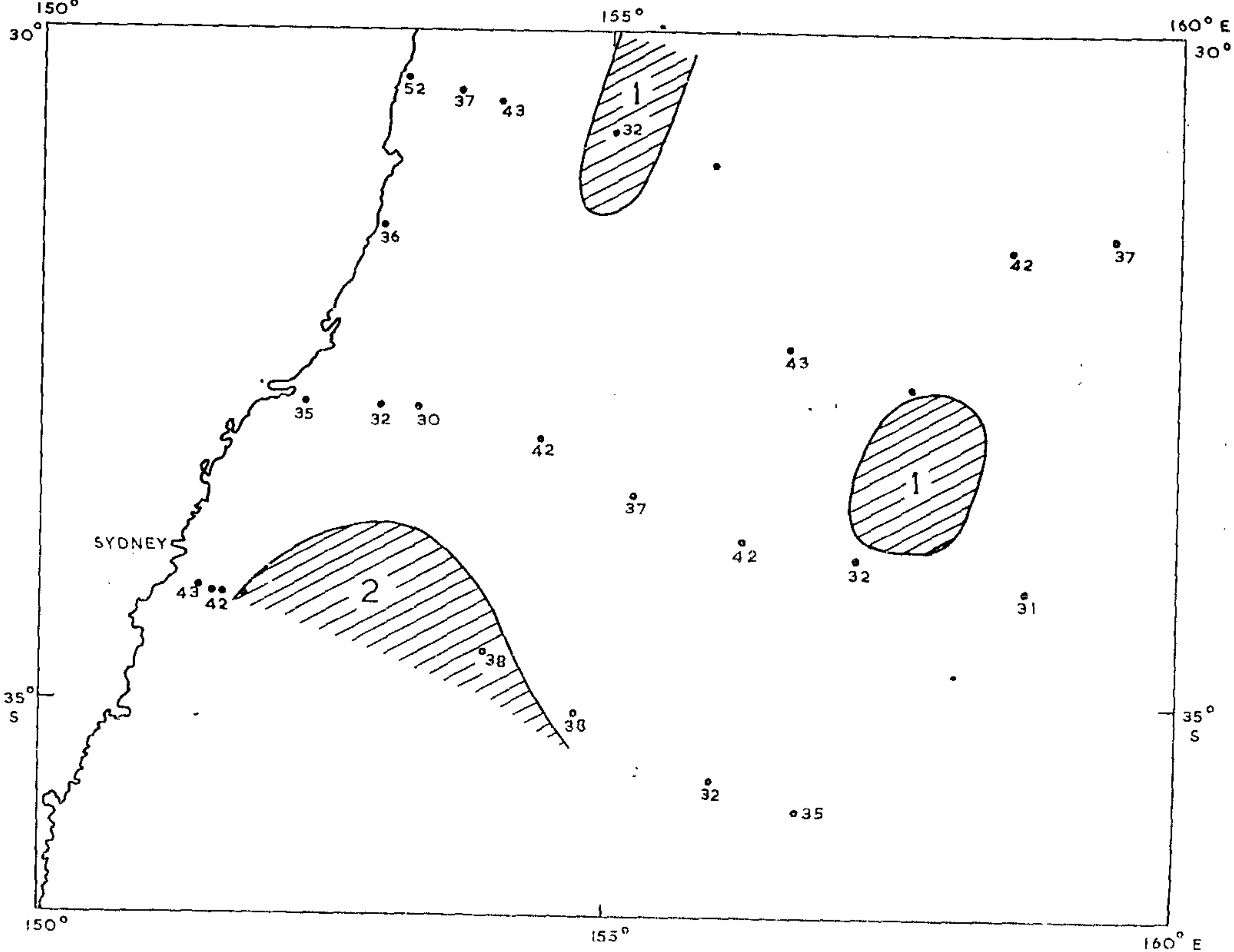
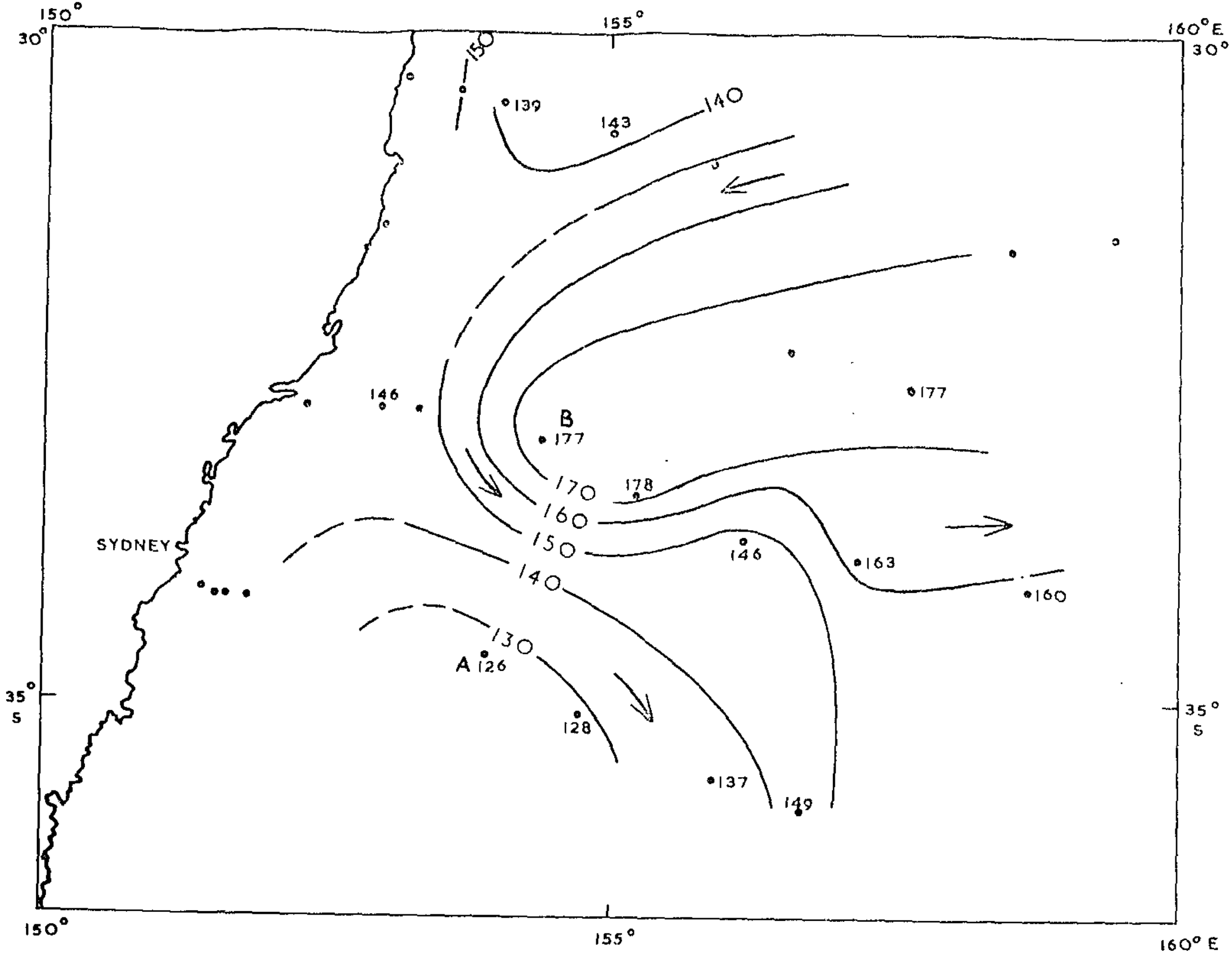

23
22
21
20
19
TEMPERATURE (°C)
35.70
35.80
35.90
SALINITY (°/oo)
B
COASTAL
MIXING
A
1
2

Fig. 18



150°
155°
160° E
30°
30°
1
32
52
37
43
36
42
37
43
35
32
30
42
1
37
SYDNEY
42
32
43
42
2
31
38
35°
S
35°
S
38
32
35
150°
155°
160° E

Fig. 19



150°
155°
160° E
30°
30°
150
140
139
143
146
B
177
170
178
160
150
146
163
160
177
SYDNEY
140
130
A
126
128
137
149
35° S
35° S
150°
155°
160° E

Fig. 20

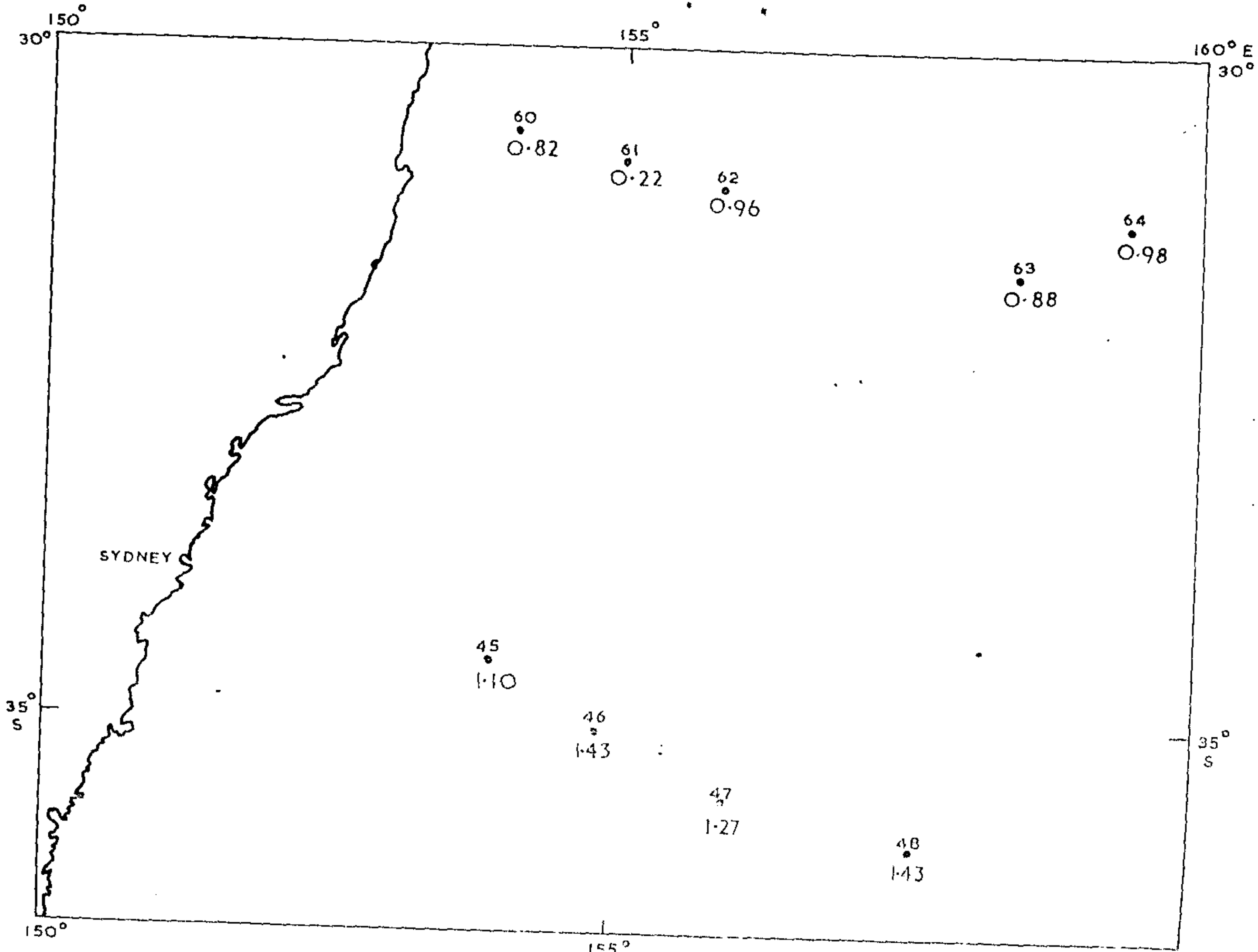
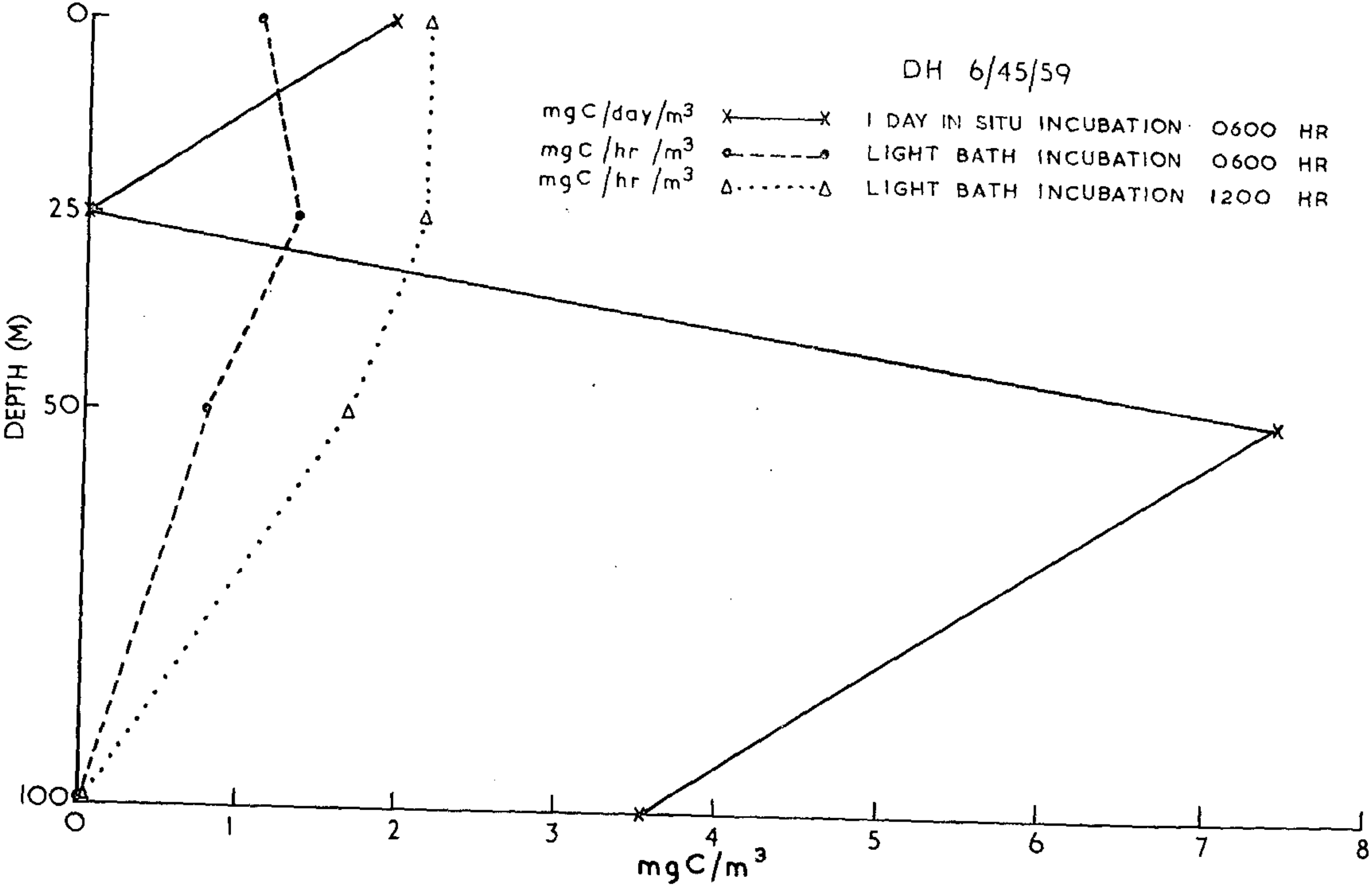

150°
30°
155°
160° E
30°
60
0·82
61
0·22
62
0·96
64
0·98
63
0·88
SYDNEY
45
1·10
35°
S
46
1·43
35°
S
47
1·27
48
1·43
150°
155°
160° E

Fig. 21



DH 6/45/59
mgC/day/m3 — 1 DAY IN SITU INCUBATION 0600 HR
mgC/hr/m3 — LIGHT BATH INCUBATION 0600 HR
mgC/hr/m3 — LIGHT BATH INCUBATION 1200 HR
DEPTH (M)
0
25
50
100
0
1
2
3
4
5
6
7
8
mgC/m3

Fig. 22

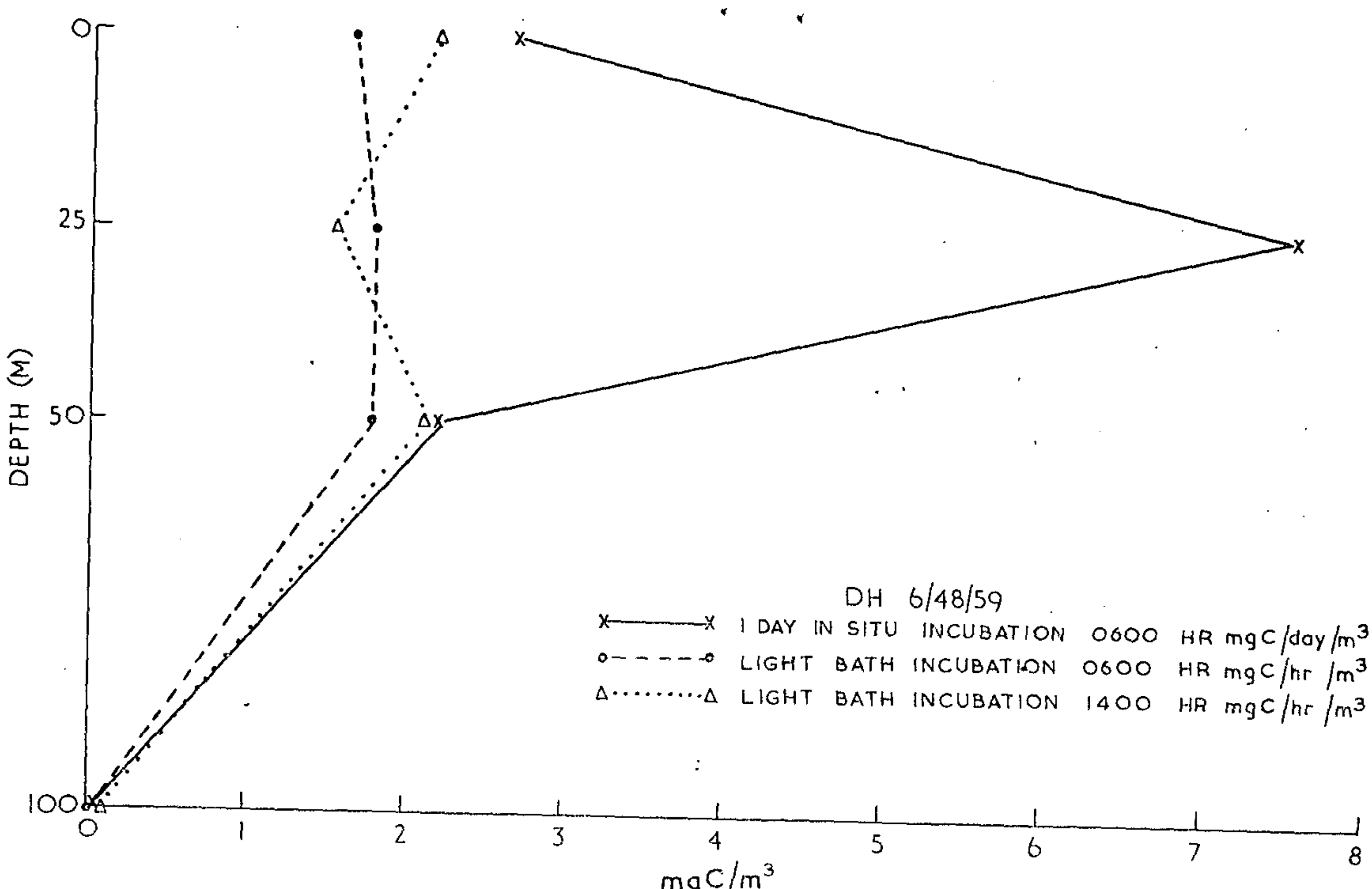

DEPTH (M)
0
25
50
100
0
1
2
3
4
5
6
7
8
mgC/m³
DH 6/48/59
1 DAY IN SITU INCUBATION 0600 HR mgC/day/m³
LIGHT BATH INCUBATION 0600 HR mgC/hr/m³
LIGHT BATH INCUBATION 1400 HR mgC/hr/m³

Fig. 23

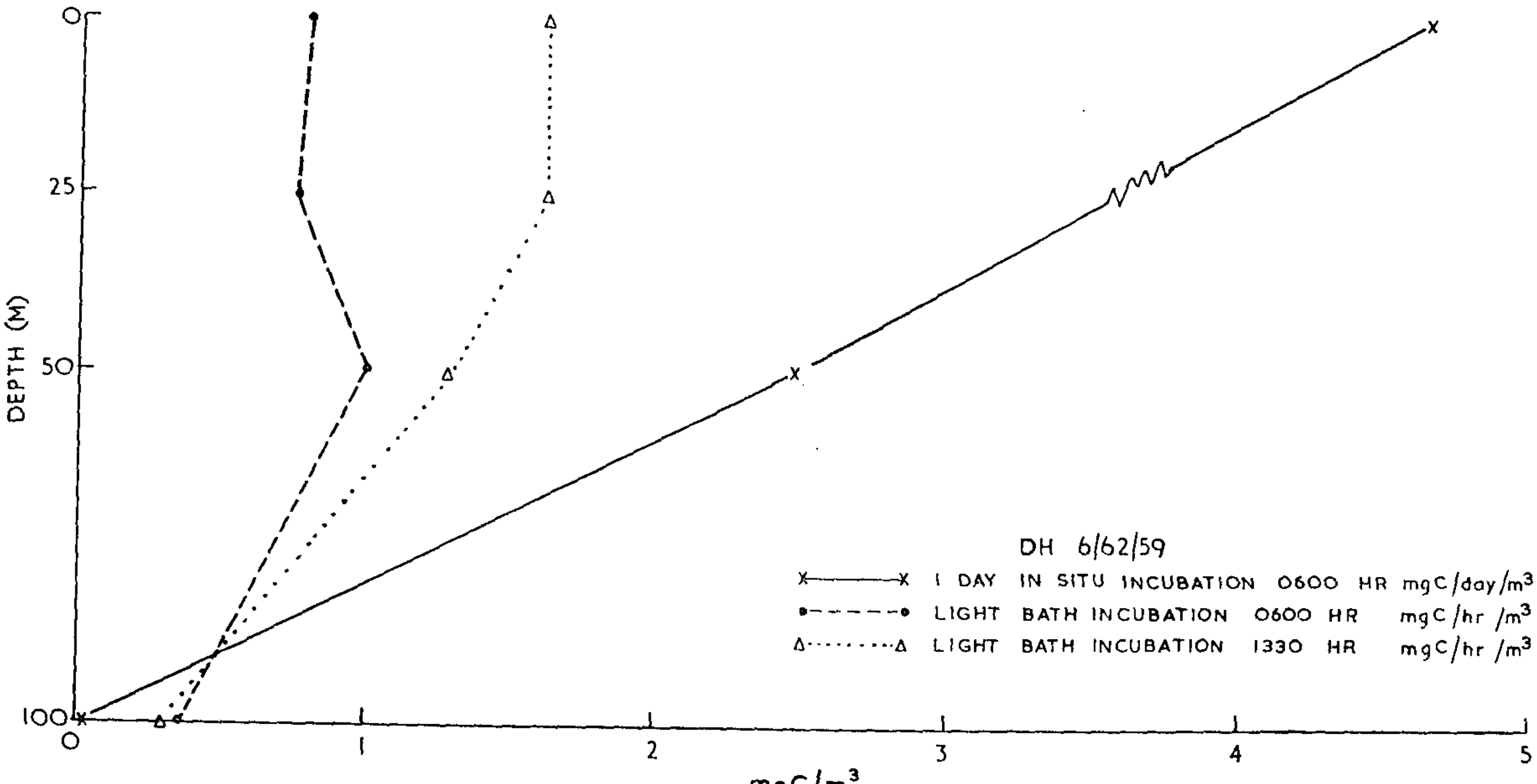

DEPTH (M)
0
25
50
100
0
1
2
3
4
5
mgC/m³
DH 6/62/59
I DAY IN SITU INCUBATION 0600 HR mgC/day/m³
LIGHT BATH INCUBATION 0600 HR mgC/hr/m³
LIGHT BATH INCUBATION 1330 HR mgC/hr/m³

Fig. 24

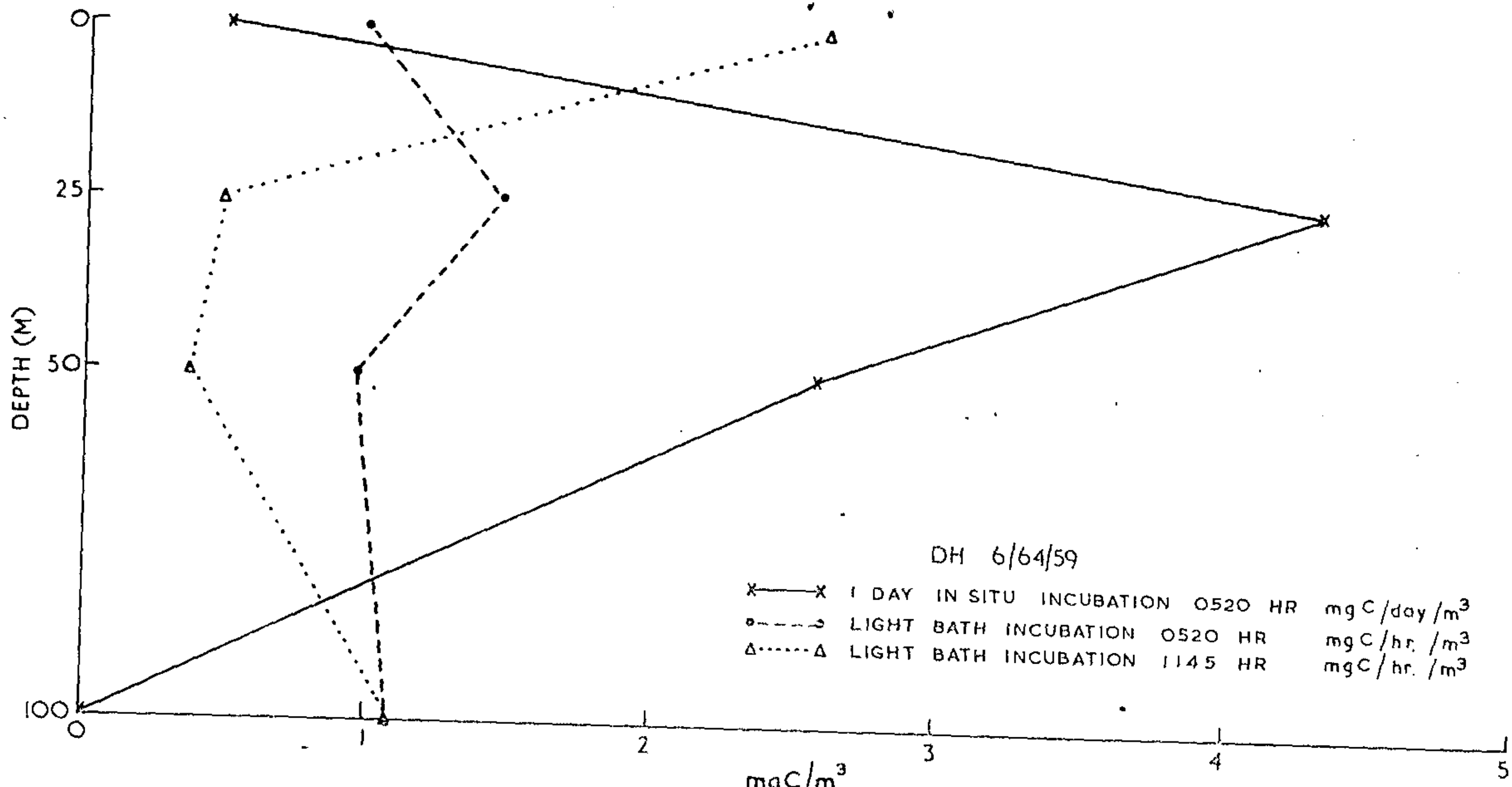
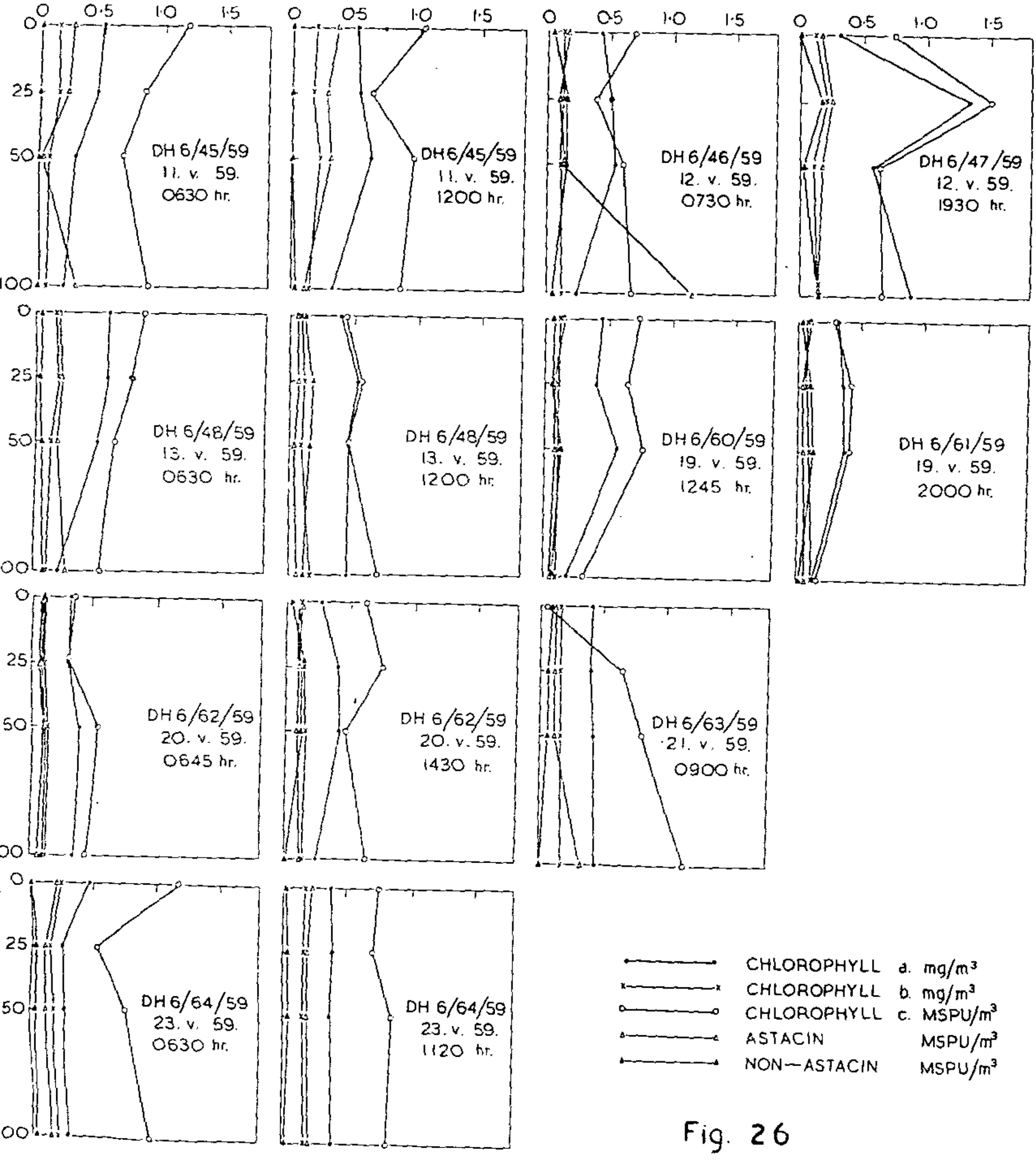


Fig. 25

DEPTH (m)



0 0·5 1·0 1·5
0
25
50
100
DH 6/45/59
11. v. 59.
0630 hr.
DH 6/45/59
11. v. 59.
1200 hr.
DH 6/46/59
12. v. 59.
0730 hr.
DH 6/47/59
12. v. 59.
1930 hr.
DH 6/48/59
13. v. 59.
0630 hr.
DH 6/48/59
13. v. 59.
1200 hr.
DH 6/60/59
19. v. 59.
1245 hr.
DH 6/61/59
19. v. 59.
2000 hr.
DH 6/62/59
20. v. 59.
0645 hr.
DH 6/62/59
20. v. 59.
1430 hr.
DH 6/63/59
21. v. 59.
0900 hr.
DH 6/64/59
23. v. 59.
0630 hr.
DH 6/64/59
23. v. 59.
1120 hr.
CHLOROPHYLL a. mg/m³
CHLOROPHYLL b. mg/m³
CHLOROPHYLL c. MSPU/m³
ASTACIN MSPU/m³
NON—ASTACIN MSPU/m³

Fig. 26

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH7/59

June 3, 1959

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

ITINERARY

This was a cruise to carry out primary production studies at the Port Hacking 100 m station (position 34°05'30"S., 151°15'30"E.).

SCIENTIFIC RESULTS

Primary Production

Samples were taken in duplicate at 0, 25, 50, and 100 m at 0530, 1130, and 1630 hours. These were incubated in light bath and *in situ*.

Light penetration measurements were taken four times.

Biochemistry

Pigment samples were collected at 0, 25, 50, and 100 m.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH8/59

June 4-13, 1959

SCIENTIFIC PERSONNEL

J. Staniforth (in charge)
J.W. Prothero
D. Llewellyn

ITINERARY

This is the last of the series of extended cruises by F.R.V. "Derwent Hunter" to study the circulation of the East Australian Current. Figure 1 shows the positions of stations. Only two sections were worked on this cruise. Hydrological sampling, B.T casts, G.E.K. tows, samples for primary production, pigment, phyto-plankton, and zooplankton studies were taken. The zooplankton taken from certain stations on Cruises DH1/59, 2/59, 6/59, and 8/59 are discussed in this report.

(a) HYDROLOGY - D.J. ROCHFORD

Samples were taken at 0, 25, 50, 75, 100, 150, 200, 250, 300, 500, 750, 1000, and 1500 m. Paired protected and unprotected thermometers were used below 100 m to determine the depth of samplin

(1) Temperature

(i) Section 1. (Fig. 2)

The maximum surface temperature (19.72°C) was found close to the western end of the section. Eastward from this region surface temperatures decreased to 18.70°C and then increased again to 19.44

(ii) Section 2. (Fig. 3)

The maximum surface temperature (21.30°C) occurred towards th western end of the section and was separated from another comparive high temperature region to the east by waters with a temperature of 19.37°C.

(2) Density (σ_t)

(i) Section 1. (Fig. 4)

Surface waters at the western end of the section were lighter than elsewhere. These predominated down to about 120 m. However, towards the eastern end of the section lighter waters were found deeper. A weak pycnocline ($0.012\sigma_t$/m) was found between Stations DH8/71 and 72/59 at 75 to 175 m.

(ii) Section 2. (Fig. 5)

The lightest surface water (σ_t25.06 was found towards the western end of the section and at Stations DH8/78-79/59 near the eastern end. No pycnocline of any magnitude occurred.

(3) Salinity

(i) Section 1. (Fig. 6)

Surface salinities varied between 35.73 and 35.81‰ and decreased with depth to a minimum at between 900 and 1000 m.

(ii) Section 2. (Fig. 7)

Surface salinities were high, ranging from 35.71 to 35.91‰ and decreased with depth to a minimum at 1000-1100 m.

(4) Percentage Oxygen Saturation

(i) Section 1. (Fig. 8)

The surface waters were generally undersaturated. Percentage saturation values decreased from the surface except at Station DH8/76/59 where several inversions occurred.

(ii) Section 2. (Fig. 9)

Surface waters were predominantly supersaturated. Percentage saturation values decreased from the surface except for small inversions at Stations DH8/77 and 78/59.

(5) Total Phosphorus

(i) Section 1. (Fig. 10)

Surface values varied from 0.37-0.50 µg at./l. A subsurface minimum occurred at Stations DH8/70, 71, and 76/59 at depths of 75 to 100 m. Below this minimum values increased with depth.

(ii) Section 2. (Fig. 11)

Surface values varied from 0.32 to 0.55 µg at./l. There was a subsurface maximum between 40 and 150 m at all Stations except DH8/77/59.

(6) Horizontal Distribution of Properties

(i) Temperature (Fig. 12)

Surface temperatures were highest (21.30°C) in the north-west. Minimum surface temperatures (18.70°C) occurred towards the south-east limit of the region.

(ii) Total phosphorus (Fig. 13)

Figure 13 shows the distribution at the surface of total phosphorus.

(iii) Regional Water Masses

Temperature-salinity relations indicate (Fig. 14) that two regional water masses could be distinguished (Table 1).

TABLE 1

REGIONAL WATER MASSES

	Temperature °C	Salinity ‰
1	21.0-22.3	35.82- 35.93
2	18.5-19.0	35.68- 35.77

Regional water mass 1 was found in the north-west and was the dominant component of the mixed waters along Section 2 (Fig. 12). Regional water mass 2 occupied the central and extreme eastern limits of Section 1.

Figure 13 indicates that there was no clear association between surface total phosphorus and the regional water masses.

(b) DYNAMICS - B.V. HAMON

Figure 15 shows the dynamic heights in dynamic centimetres relative to the 1000 decibar surface. Contours have been drawn at intervals of 10 dynamic centimetres. Values in brackets were obtained by extrapolation of the observed density-depth curve.

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

Tables 2 and 3 list the diatoms and dinoflagellates collected from all stations on this cruise.

(d) PRIMARY PRODUCTION - N. DYSON

This cruise was to have repeated the programme of Cruise DH6/59 but was terminated after two sections had been worked. On the first section, two stations were occupied for 12 hours so that all day in situ measurements of the rate of CO_2 uptake could be made. Measurements of the rate of CO_2 uptake by the light bath incubation method were made at five stations including the all-day stations.

Some light penetration measurements were made but as the submarine photometer was not operating correctly the results are not reliable.

Results

Figures 16 and 17 show the results of the CO_2 uptake measurements as made by the two methods of incubation. At Station DH8/73/59 the results show good correlation although the in situ results are not as high as would be expected. The light-bath incubation results show little variation between the samples collected over a 10-hour period. At Station DH8/76/59 there is greater variation between the light-bath incubation results which is to be expected in the light of previous evidence supporting a diurnal cycle in the rate of production.

(e) BIOCHEMISTRY - G.F. HUMPHREY

Weighted averages were calculated according to Humphrey (1960) for the water column to 100 m. The results are given in Table 4, which contains also the corresponding figures for the 100 m station off Sydney. There was little variation along the line from Sydney and the values were similar to those obtained on Cruise 6 during the previous month. As for Cruise 6, the depth profiles (Fig. 18) do not show any consistent change with position or time of sampling.

(f) ZOOPLANKTON - D.J. TRANTER

In this report collections of zooplankton taken on Cruises DH1/59, 2/59, 6/59, and 8/59 are discussed. Figure 19 shows the position of each of the stations at which collections were made. These are grouped into seven areas of which two, A and G, were near the shelf.

Collections were made with Clarke-Bumpus units hauled obliquely from 300 m (in one case, 250 m) to the surface. On the average 10 M^3 of sea water was filtered and the catch from (approx.) 1 M^3 counted. The biomass of the whole sample was determined prior to tenthing. Full details are given in Tables 5 and 5a.

Duplicate samples were obtained at nine stations; of these three were from adjacent samplers, and the remainder from consecutive hauls at the one station. In general, determinations and counts for duplicates were of the same order.

The average standing stock of plankton at coastal area A was greater than that to the north at coastal area G (Table 6). Offshore stations with the exception of DH6/45 (May 11) were about half as rich as the coastal areas.

The offshore stations were characterized, in general, by Acartia danae, Oncaea venusta, Mecynocera clausi, and to a lesser extent Nannocalanus minor. During May and June, this fauna was found also at the inshore stations, replacing a fauna characterized by Temora turbinata and the Cladoceran Evadne tergestina (Table 7). This is suggestive of a coastal influence in late summer and an oceanic influence in autumn.

TABLE 8

DIATOMS - CRUISE DHS/59

SPECIES	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
	Stations																
Cerataulina pelagica		+		+	+		+	+		+							
Chaetoceros coarctatum						+							+			+	
Ch. eibenii																+	
Ch. lorenzianum															+	+	
Ch. peruvianum															+		
Ch. teres															+		
Climacodium frauenfeldianum																+	
Coscinodiscus centralis									+								
C. concinnus					+												
Dactyliosolen mediterranea							+	+									
Dinophysis schroederi				+													
D. tripos							+	+									
Guinardia flaccida		+	+	+	+		+		+	+			+				
Hemiaulus hauckii				+													
Nitzschia seriata					+	+											
Planktoniella sol														+			
Rhizosolenia alata		+	+	+	+			+				+	+		+	+	
v. gracillima								+								+	
R. bergonii																+	
R. calcar avis															+		
R. cylindrus					+												
R. imbricata				+													
R. stolterforthii	+	+	+	+			+							+	+	+	
R. styliformis			+					+			+				+	+	
v. latissima		+		+												+	
Schroederella delicatula		+					+									+	
Stephanopyxis palmeriana			+							+							
Thalassiosira subtilis	+	+	+	+					+	+				+			
Thalassiothrix longissima			+		+									+	+		
Th. nitzschioides															+	+	

TABLE 3

DINOFLAGELLATES - CRUISE DH8/59

SPECIES	Stations																
	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Amphisolenia bidentata	+	+	+														
A. thrinax									+							+	
Ceratium axiale															+		
C. buceros													+				
C. candelabrum			+						+						+	+	
C. carriense													+	+			
C. concilians					+									+		+	
C. contortum																+	
C. contrarium									+					+			
C. declinatum															+		
C. extensum																+	
C. falcatiforme		+	+	+				+		+		+		+	+	+	
C. falcatum									+								
C. furca			+	+					+								
C. fusus				+			+	+	+	+			+	+			
C. gallicum		+	+	+	+	+	+	+	+	+	+					+	
C. gravidum									+					+	+	+	
C. horridum													+				
C. incisum								+					+			+	
C. karstenii			+	+									+				
C. kofoidi		+	+					+							+		
C. lunula								+					+			+	
		+	+					+	+					+			

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TABLE 3 - Contd

DINOFLAGELLATES - CRUISE DH8/59

SPECIES	Stations																
	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Ceratium massiliense			+	+							+			+	+		
C. pavillardii				+													
C. pentagonum		+														+	
C. pulchellum				+				+									
C. ranipes				+													
C. teres		+					+								+	+	
C. trichoceros		+	+	+									+	+	+	+	
C. tripos		+	+	+				+					+	+	+	+	
C. vultur		+	+				+										
Ceratocorys horrida												+				+	
Oxytoxum scolopax									+								
Peridinium murrayi	+																
P. oblongum															+		
P. steinii							+										
Podolampas palmipes				+												+	
P. spinifer								+									
Pyrocystis fusiformis														+			
P. hamulus v. semicircularis															+		
P. pseudonoctiluca		+	+														

TABLE 4

WEIGHTED AVERAGES FOR PIGMENTS IN THE WATER COLUMN TO 100 m

		Chlorophyll a	Chlorophyll b	Chlorophyll c	Astacin	Non-astacin
5/6/59	0440	0.503	0.210	0.655	0.160	0.049
6/6/59	0630	0.483	0.219	0.666	0.110	0.056
	1145	0.299	0.200	0.400	0.078	0.163
	1655	0.539	0.185	0.610	0.114	0.060
7/6/59	0615	0.294	0.089	0.430	0.123	0.020
	1845	0.331	0.103	0.274	0.053	0.084
8/6/59	0630	0.509	0.176	0.373	0.070	0.088
	1200	0.408	0.166	0.485	0.138	0.030
	1715	0.345	0.178	0.746	0.473	0.031

TABLE 5

ZOOPLANKTON DATA : LORD HOWE ISLAND SECTIONS : DH1/59 - DH6/59

STATION DATA

Station (DH/59)	DH1/3/59	DH2/8/59	DH2/11/59	DH2/14/59	DH6/43/59	DH6/45/59
Position	34°12'S. 151°36'E.	32°08'S. 151°36'E.	35°07'S. 150°08'E.	34°43'S. 158°02'E.	34°10'S. 151°37'E.	34°37'S. 153°55'E.
Date	5.2.59	23.2.59	4.3.59	6.3.59	9.5.59	11.5.59
Time	0100	-	1600	-	1626	1855
Depth (m)	300 m - 0	250 m - 0	300 m - 0	300 m - 0	300 m - 0	300 m - 0
Temperature (°C)	24.8-24.9	10.0-23.5	14.0-26.4	12.2-22.6	13.8-20.1	11.6-19.8
Salinity (‰)	34.7-35.6	34.8-35.5	35.3-35.6	35.1-35.6	35.3-35.7	35.0-35.8
Volume filtered (M^3)	9.1 (10.8)	6.3 (10.1)	11.3 (11.7)	10.2	8.4 (6.3)	10 (10.5)
Biomass (mg/M^3)	36 (50)	95 (79)	18 (26)	20	65 (76)	44 (91)

MAJOR GROUPS

NUMBER PER CUBIC METRE (THE VALUES IN BRACKETS ARE THOSE FOR A DUPLICATE SAMPLE)

Copepods	116 (75)	105 (100)	59 (51)	81	172 (128)	164 (126)
Appendicularia	45 (52)	21 (11)	2 (3)	3	29 (19)	24 (16)
Salps	7 (6)	26 (24)	5 (11)	3		
Chaetognaths	6 (5)	(6)	4 (9)	2	8 (8)	11 (10)
Euphausiids	8 (3)			1		2 (2)
Cladocera	14 (17)	22 (20)	10 (2)	2		
Pteropods	4 (1)	3 (3)	(1)		(10)	(4)
Others	9 (14)	26 (21)	14 (11)	17	24 (16)	14 (21)
Total organisms	209 (173)	203 (185)	94 (88)	109	233 (181)	215 (179)

TABLE 5 - Contd

ZOOPLANKTON DATA : LORD HOWE ISLAND SECTIONS : DH6/59 - DH8/59

STATION DATA

Station DH/59	DH6/48/59	DH6/59/59	DH6/64/59	DH8/70/59	DH8/73/59	DH8/76/59
Position	35°46'S. 156°39'E.	30°26'S. 153°29'E.	31°32'S. 159°22'E.	34°13'S. 151°35'E.	34°13'S. 154°00'E.	35°36'S. 156°34'E.
Date	13.5.59	19.5.59	23.5.59	5.6.59	6.6.59	8.6.59
Time	1543	0505	1420	0053	1453	1350
Depth (m)	300 m - 0	300 m - 0	300 m - 0	300 m - 0	300 m - 0	300 m - 0
Temperature (°C)	13.2-21.2	14.0-21.8	17.7-20.9	13.5-19.7	12.0-19.0	12.3-19.1
Salinity (‰)	35.2-35.8	35.2-35.8	35.5-35.8	35.3-35.8	35.4-35.8	35.1-35.8
Volume filtered (M^3)	9.8	10.7	8.7 (11.6)	12.4 (9.8)	12.9 (11.7)	13.4 (13.5)
Biomass (mg/M^3)	17	46	31 (26)	59 (86)	21 (26)	49 (44)

MAJOR GROUPS

NUMBER PER CUBIC METRE (THE VALUES IN BRACKETS ARE THOSE FOR A DUPLICATE SAMPLE)

	DH6/48/59	DH6/59/59	DH6/64/59	DH8/70/59	DH8/73/59	DH8/76/59
Copepods	45	97	54 (75)	118 (206)	49 (65)	90 (85)
Appendicularia	17	17	3 (9)	15 (20)	16 (3)	16 (17)
Salps	1	3	(1)	(2)		
Chaetognaths	7	10	2 (7)	6 (13)	8 (12)	3 (12)
Euphausiids	4		1 (2)	4		3 (2)
Cladocera	-	-	-	-	-	-
Pteropods	3			2		
Others	17	21	9 (13)	13 (16)	10 (5)	14 (19)
Total organisms	94	148	69 (107)	158 (257)	83 (85)	126 (135)

TABLE 5a

ZOOPLANKTON DATA : LORD HOWE ISLAND SECTIONS : DH1/59 - DH6/59

SPECIES IDENTIFIED. NUMBER PER CUBIC METRE (THE VALUES IN BRACKETS ARE THOSE FOR A DUPLICATE SAMPLE)

SPECIES	DH1/3/59	DH2/8/59	DH2/11/59	DH2/14/59	DH5/43/59	DH6/45/59	DH6/48/59	DH6/59/59	DH6/64/59	DH8/70/59	DH8/73/59	DH8/76/59
Calanus tenuicornis	3 (3)	(2)	(2)	1	2 (2)	1		1	13 (2)	1	(1)	(5)
Nannocalanus minor		(1)	(6)	1	15 (11)	1 (5)				(9)	(1)	4 (3)
Canthocalanus pauper	(1)	(2)								3		
Undinula darwinii	(1)				6	3			1	(7)	6	(1)
U. vulgaris											(1)	
Calanus finmarchicus		(1)										
Eucalanus crassus		6 (13)	3 (1)							1		
E. mucronatus		8 (3)					1					(1)
E. attenuatus										1		
E. elongatus	1					1						
Rhincalanus cornutus										(1)		
R. nasutus							1					
Mecynocera clausi			1		10 (5)	13 (7)	6	5	1	15 (13)	3 (1)	7 (4)
Paracalanus parvus	1	2 (2)			1			2	1	1 (2)	2 (2)	2 (2)
P. aculeatus	2	5 (6)	3	1								
Acrocalanus gibber	1	3 (1)	2 (2)									
A. gracilis	(2)	(1)	2 (1)							(1)		
Calocalanus pavo			(1)			3 (3)		1	1	4	(1)	3 (2)
C. plumulosus	(2)				2	3 (5)	1	2		1 (2)	1	2 (1)
Clausocalanus arcuicornis	16 (9)	8 (7)	4 (6)	4	(3)	5 (4)		5	(4)	8	1	
C. furcatus	13 (4)	2 (2)	1 (2)	2	(5)					1 (1)		3 (1)
Ctenocalanus vanus	3	5 (8)		3	4 (8)	3 (3)	1	4	1 (9)	3 (12)	(1)	4 (1)
Euchaeta marina	3 (1)		1					1	(1)	1 (1)		

Scolecithrix danae												(1)
Aetideus giesbrechti			1 (1)						1			
Acartia danae		2 (4)	(3)	53	51 (11)	52 (33)	2	7	1 (2)	8 (33)	5 (8)	13 (8)
Centropages bradyi					4 (2)	(2)				(1)	(2)	
Temora turbinata	17 (19)	13 (17)	1 (3)				1					
T. stylifera	1											
T. discaudata	1		1		(6)							
Lucicutia flavicornis	1	(1)	4 (1)	1	(2)	(2)	1	7	1	(9)	2 (1)	3 (4)
Pleuromamma gracilis	4	2 (2)				3		5	(1)	6 (13)	1 (1)	1
P. abdominalis	1	(1)				3 (1)			(3)	7 (7)		
Pontellina plumata			1									
Oncaea venusta	6 (5)	2 (6)	2 (1)	2	21 (32)	31 (34)	7	5	1 (4)	7 (37)	6 (17)	19 (10)
O. conifera			(1)	1	1	1 (3)			(3)	2 (2)		2 (3)
O. media	4 (2)	2 (3)			4 (3)	2	1	6	1	8 (2)		4 (2)
O. mediterranea											(1)	1
Candacia spp.		2			1		1	3		1		
Haloptilus spp.								1	(1)			
Copilia spp.							3					(1)
Corycaeus spp.	9 (4)	2 (1)	4 (2)		(5)	4	1	2	2	4	1 (3)	3 (2)
Sapphirina spp.		(1)		1			1	1	14			(1)
Oithona spp.	10 (7)	19 (1)	4 (3)	6	18 (16)	19 (12)	11	16	(11)	17 (29)	5 (14)	6 (17)
Labidocera spp.											(1)	
Thalia democratica	4	2 (2)		3								
Evadne tergestina	4	22 (18)	9 (2)	3								
Penilia schmackeri	10	(2)	1									

TABLE 6

THE STANDING STOCK OF PLANKTON IN EACH AREA
(mg/M^3)

	Coastal		Offshore				
	A	G	B	C	D	E	F
	43	46	18	67	17	20	28
	87		26	23	46		
	70						
	72						
Mean	68	46	22	45	32	20	28

TABLE 7

SEASONAL CHANGES IN THE ZOOPLANKTON OF COASTAL AREA A

	5.2.59	23.2.59	9.5.59	5.6.59
Biomass	43	87	70	72
Density/ organisms	191	199	207	207
Copepod density	90	102	150	162
Dominant spp.	Temora turbinata	T. turbinata	Acartia danae	Oithona spp.
	Clausocalanus arcuicornis	Oithona spp.	Oncaea venusta	A. danae
		C. arcuicornis	Oithona spp.	O. venust
	Oithona spp.	E. tergestina	Nannocalanus minor	Mecynoce clausi
	Evadne tergestina			
	Penilia schmackeri			
Temora turbinata	18	15	0	0
Acartia danae	0	3	31	20
Evadne tergestina	7	20	0	0
Penilia schmackeri	8	1	0	0

LEGENDS FOR FIGURES

Cruise DH8/59

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

Fig. 2.- Section 1. Distribution of temperature (°C), surface to 1500 m.

Fig. 3.- Section 2. Temperature.

Fig. 4.- Section 1. Distribution of density (σ_t), surface to 1500 m.

Fig. 5.- Section 2. σ_t.

Fig. 6.- Section 1. Distribution of salinity (‰), surface to 1500 m.

Fig. 7.- Section 2. Salinity.

Fig. 8.- Section 1. Distribution of percentage oxygen saturation, surface to 1500 m.

Fig. 9.- Section 2. Percentage oxygen saturation.

Fig.10.- Section 1. Distribution of total phosphorus (μg at./l.), surface to 1500 m.

Fig.11.- Section 2. Total phosphorus.

Fig.12.- Temperature distribution at the surface. Boundaries of regional water masses are indicated.

Fig.13.- Distribution at the surface of total phosphorus. Boundaries of regional water masses are indicated.

Fig.14.- Surface temperature-salinity diagram showing regional water masses.

Fig.15.- Contours of dynamic heights in dynamic centimetres (1000 decibars).

Fig.16.- Rate of CO_2 uptake at Station DH8/73/59.

Fig.17.- Rate of CO_2 uptake at Station DH8/76/59.

Fig.18.- Vertical profiles for pigments.

Fig.19.- Positions of stations at which plankton collections were made on Cruises DH1/59, 2/59, 6/59, and 8/59.

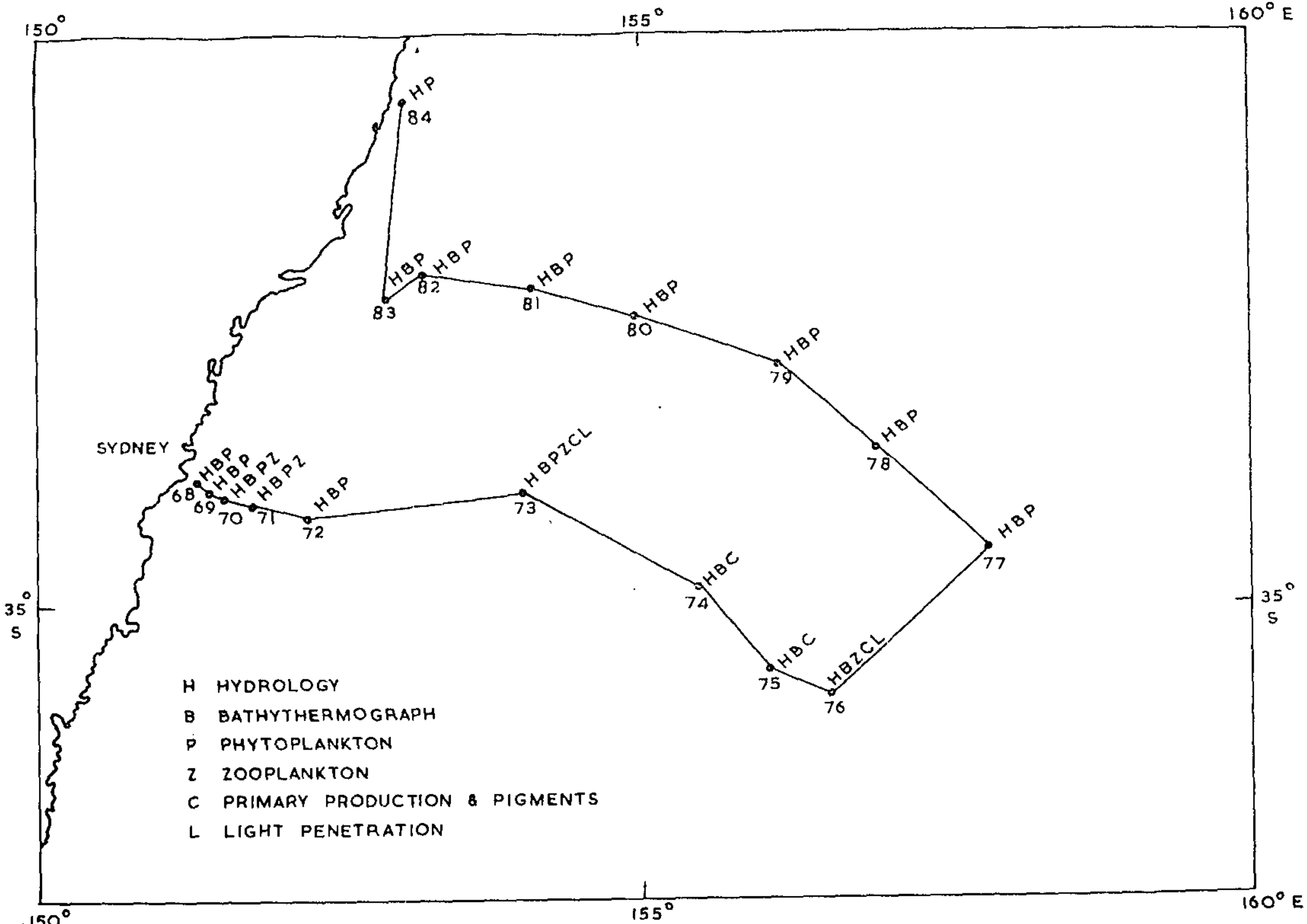
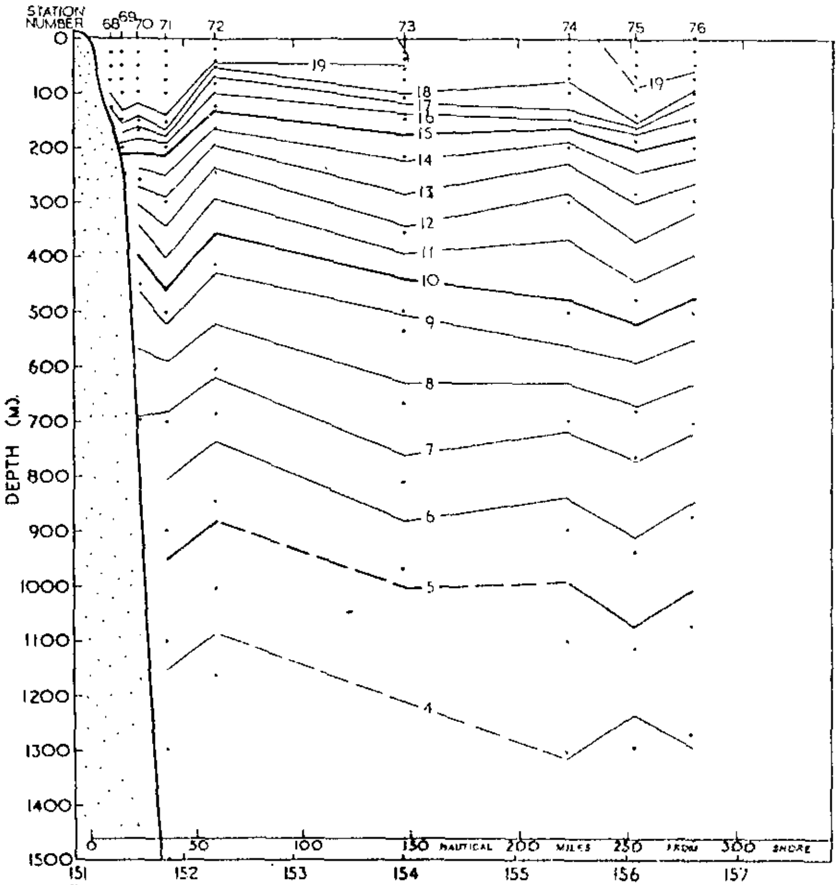

150°
155°
160° E
35° S
35° S
150°
155°
160° E
SYDNEY
HP 84
HBP 83
HBP 82
HBP 81
HBP 80
HBP 79
HBP 78
HBP 77
HBZCL 76
HBC 75
HBC 74
HBPZCL 73
HBP 72
HBPZ 71
HBPZ 70
HBP 69
HBP 68
H HYDROLOGY
B BATHYTHERMOGRAPH
P PHYTOPLANKTON
Z ZOOPLANKTON
C PRIMARY PRODUCTION & PIGMENTS
L LIGHT PENETRATION

Fig. 1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68 69 70 71 72 73 74 75 76
DEPTH (M.)
NAUTICAL MILES FROM SHORE
151 152 153 154 155 156 157

Fig. 2

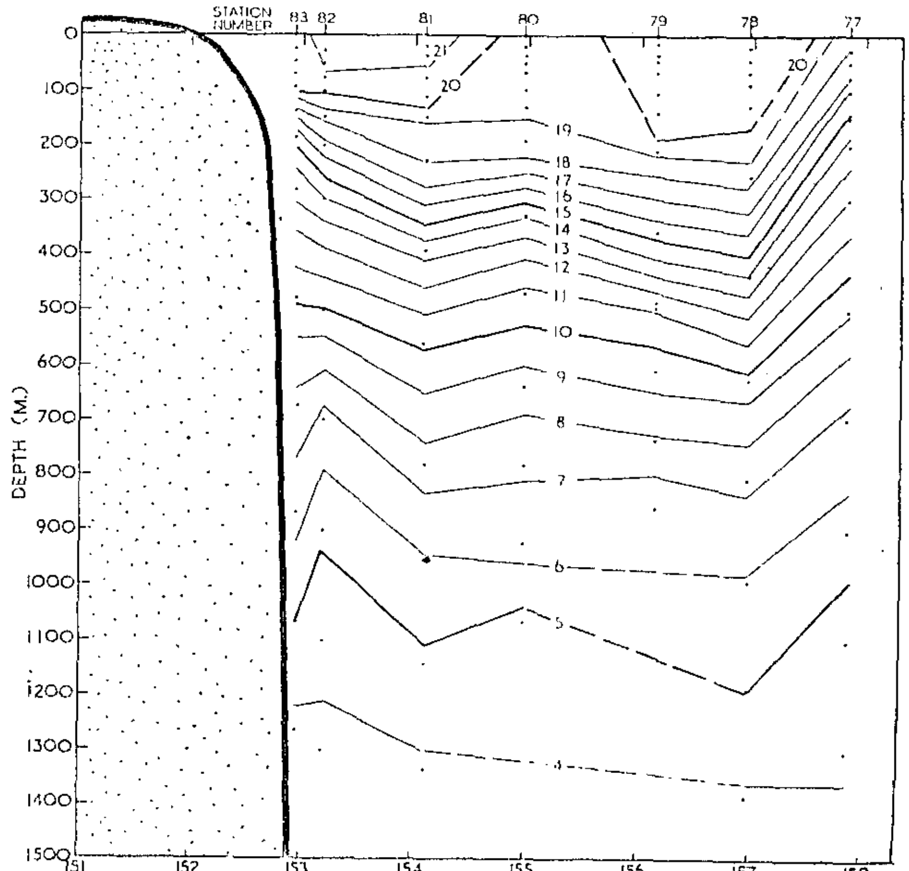
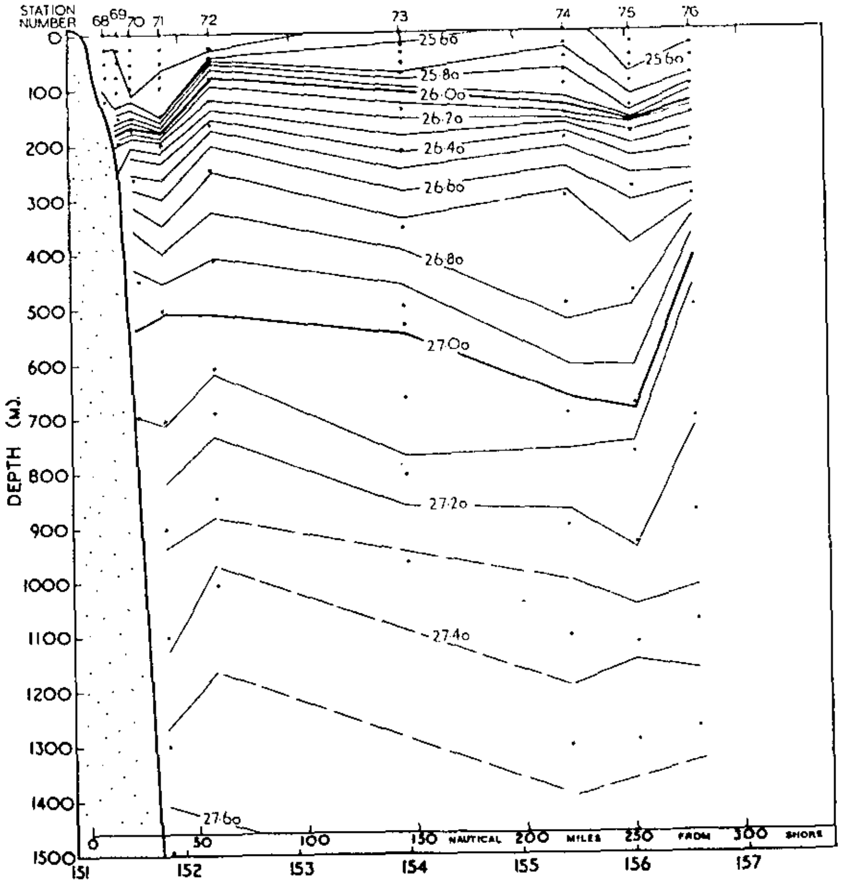
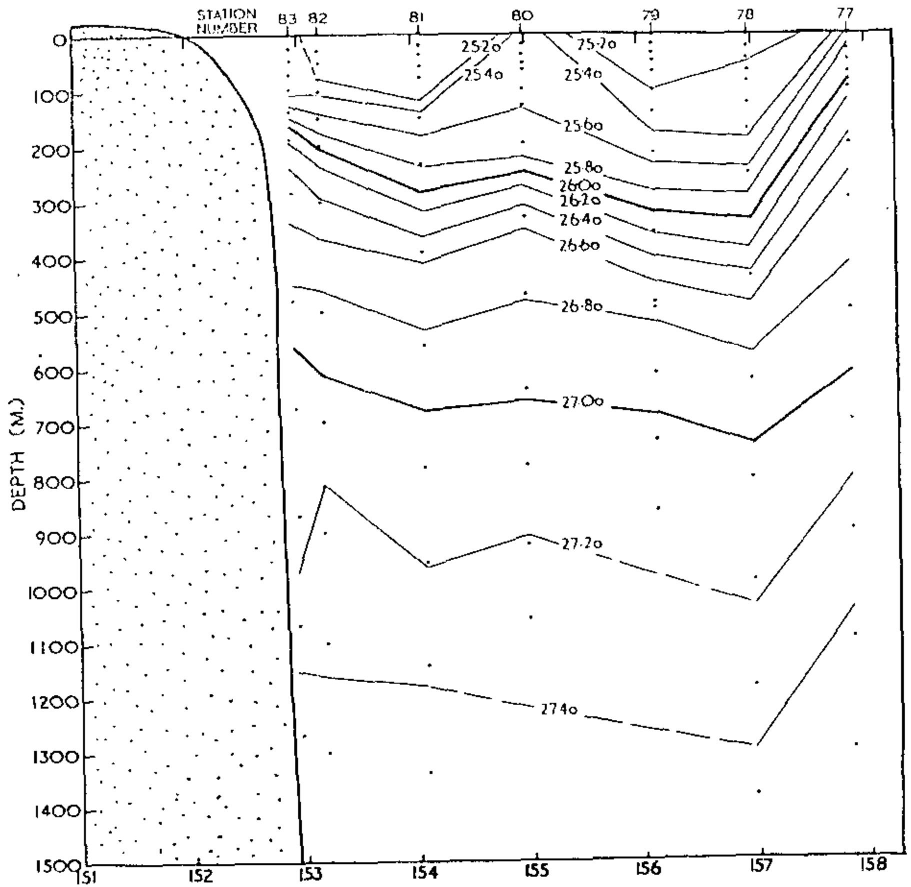

STATION NUMBER
83 82 81 80 79 78 77
DEPTH (M.)
151 152 153 154 155 156 157 158

Fig 3



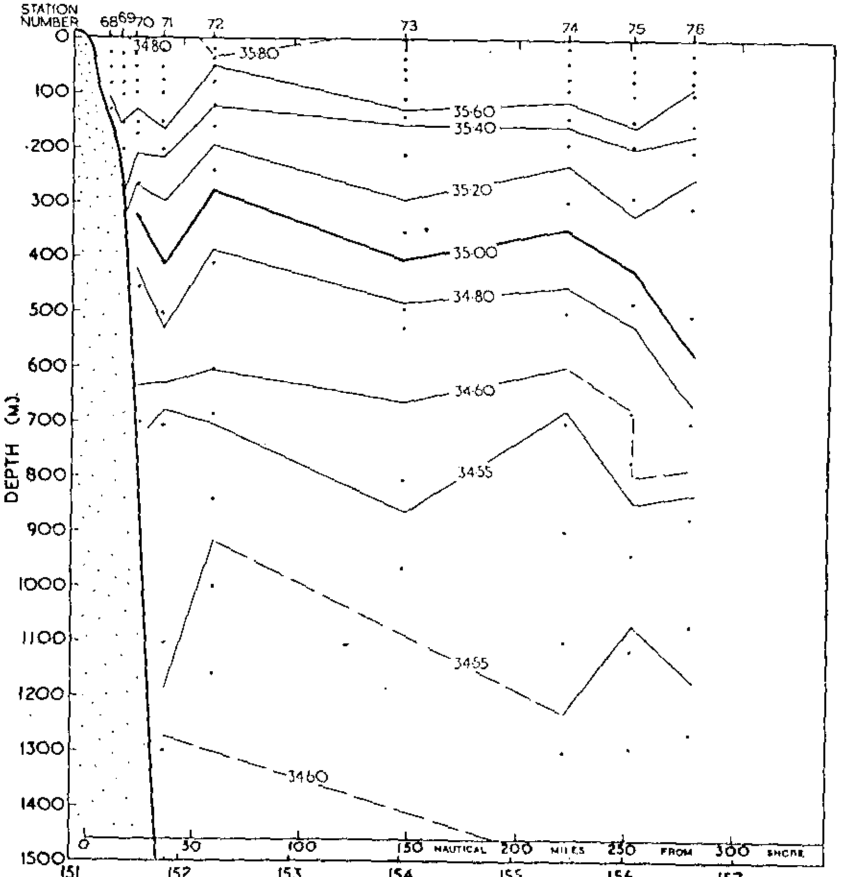
STATION NUMBER
68 69 70 71 72 73 74 75 76
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
25·60
25·80
26·00
26·20
26·40
26·60
26·80
27·00
27·20
27·40
27·60
0 50 100 150 NAUTICAL 200 MILES 250 FROM 300 SHORE
151 152 153 154 155 156 157

Fig. 4



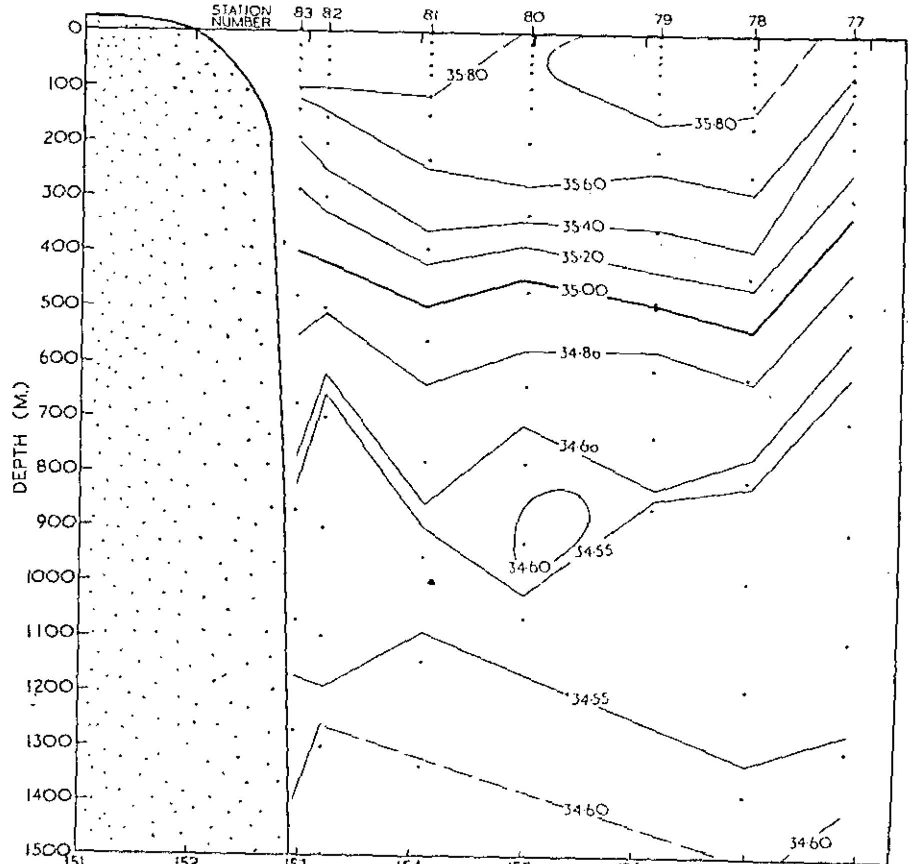
STATION NUMBER
83 82 81 80 79 78 77
DEPTH (M.)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
25·20
25·40
25·60
25·80
26·00
26·20
26·40
26·60
26·80
27·00
27·20
27·40
151 152 153 154 155 156 157 158

Fig 5



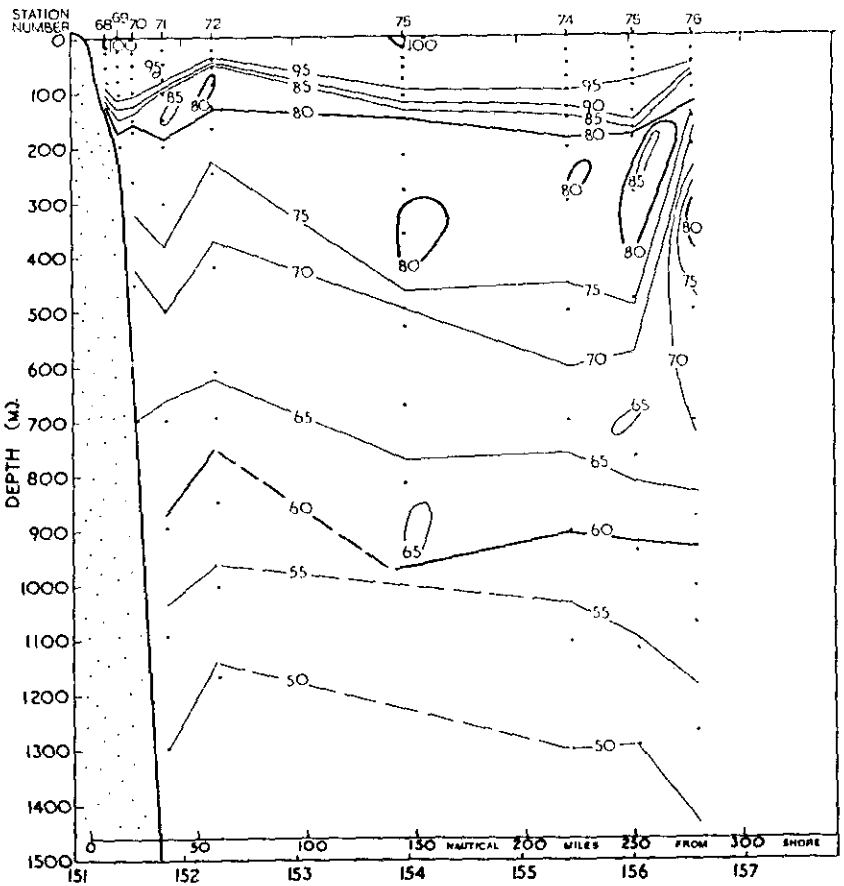
STATION NUMBER
68 69 70 71 72 73 74 75 76
34.80
35.80
35.60
35.40
35.20
35.00
34.80
34.60
34.55
34.55
34.60
DEPTH (M.)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
0 50 100 150 NAUTICAL 200 MILES 250 FROM 300 SHORE
151 152 153 154 155 156 157

Fig 6



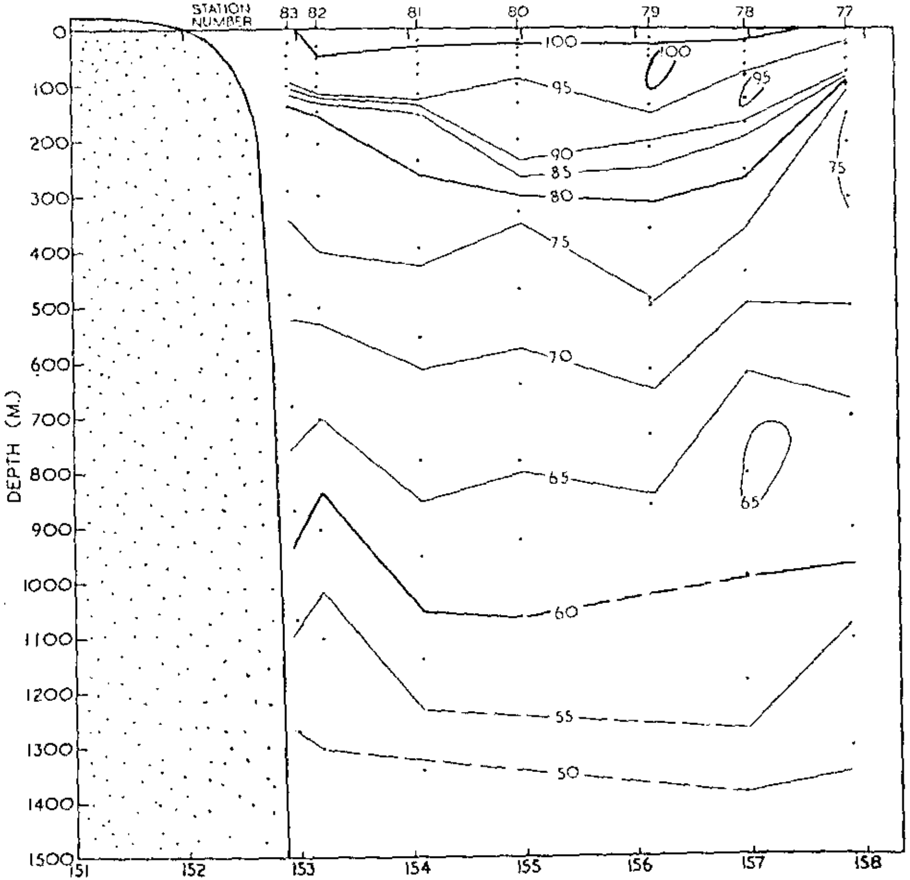
STATION NUMBER
83 82 81 80 79 78 77
35.80
35.80
35.60
35.40
35.20
35.00
34.80
34.60
34.60
34.55
34.55
34.60
34.60
DEPTH (M.)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
151 152 153 154 155 156 157 158

Fig. 7



STATION NUMBER
68 69 70 71 72 75 74 75 76
DEPTH (M.)
NAUTICAL MILES FROM SHORE
151 152 153 154 155 156 157

Fig. 8



STATION NUMBER
83 82 81 80 79 78 77
DEPTH (M.)
151 152 153 154 155 156 157 158

Fig. 9

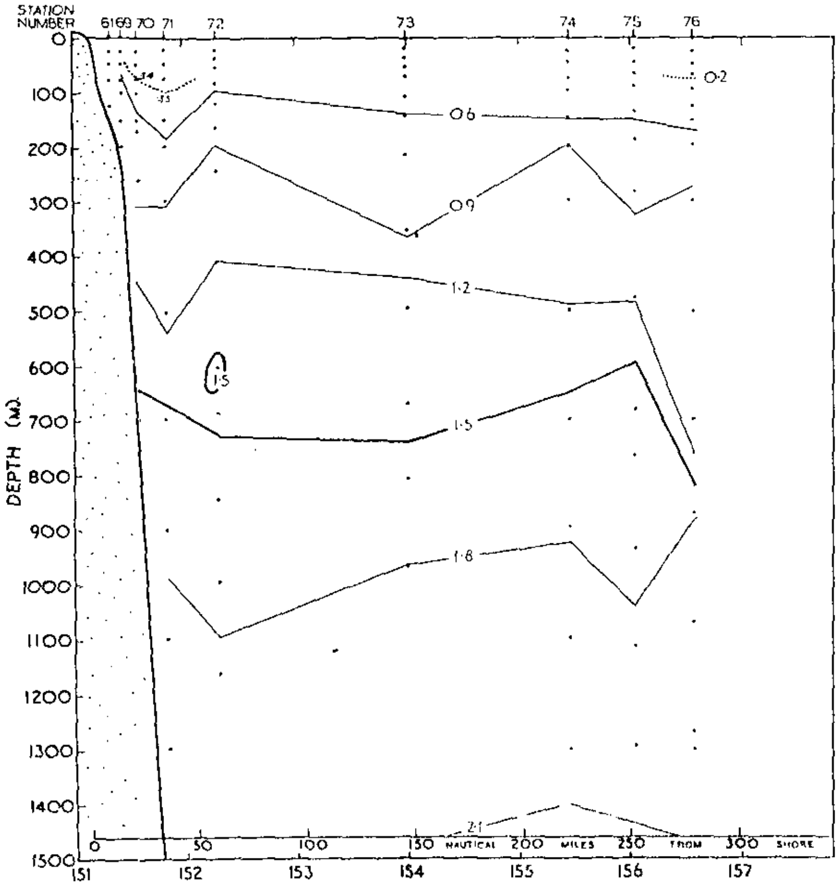

STATION NUMBER
DEPTH (M.)
NAUTICAL MILES FROM SHORE

Fig 10

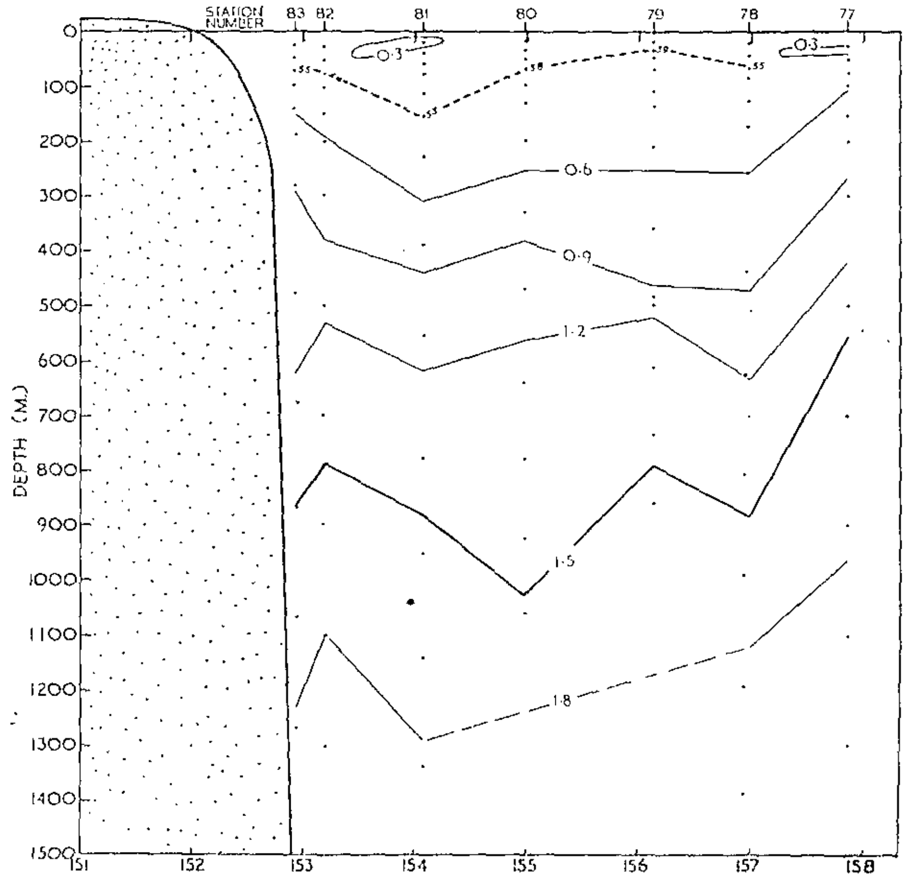
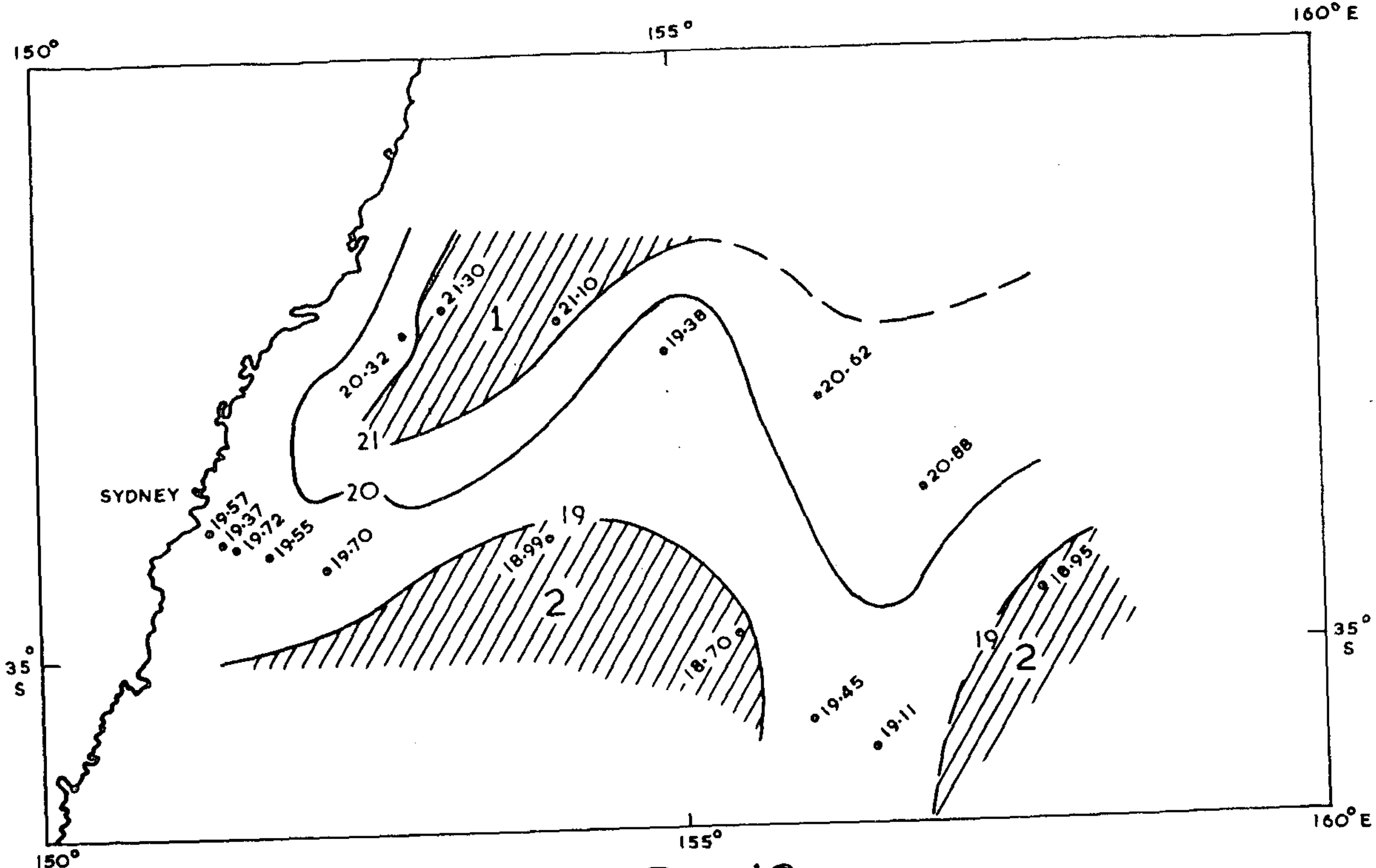
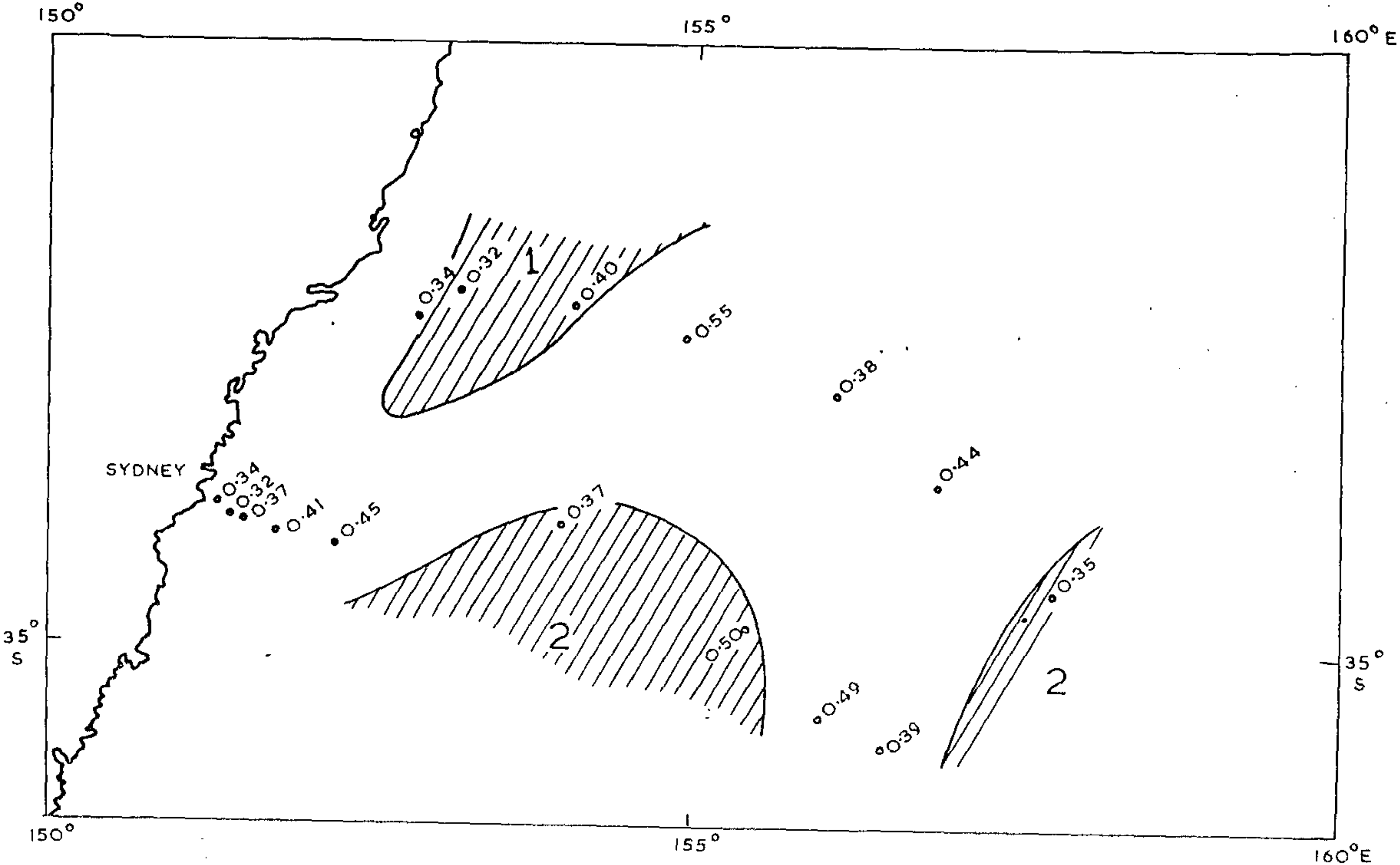

STATION NUMBER
DEPTH (M.)

Fig 11



150°
155°
160° E
SYDNEY
21·30
21·10
1
20·32
21
20
19·38
20·62
20·88
19·57
19·37
19·72
19·55
19·70
19
18·99
2
18·70
19·45
19·11
18·95
19
2
35°
S
150°
155°
160° E

Fig. 12



150°
155°
160° E
SYDNEY
0·34
0·32
0·40
1
0·55
0·38
0·44
0·34
0·32
0·37
0·41
0·45
0·37
2
0·50
0·49
0·39
0·35
2
35° S
35° S
150°
155°
160° E

Fig. 13

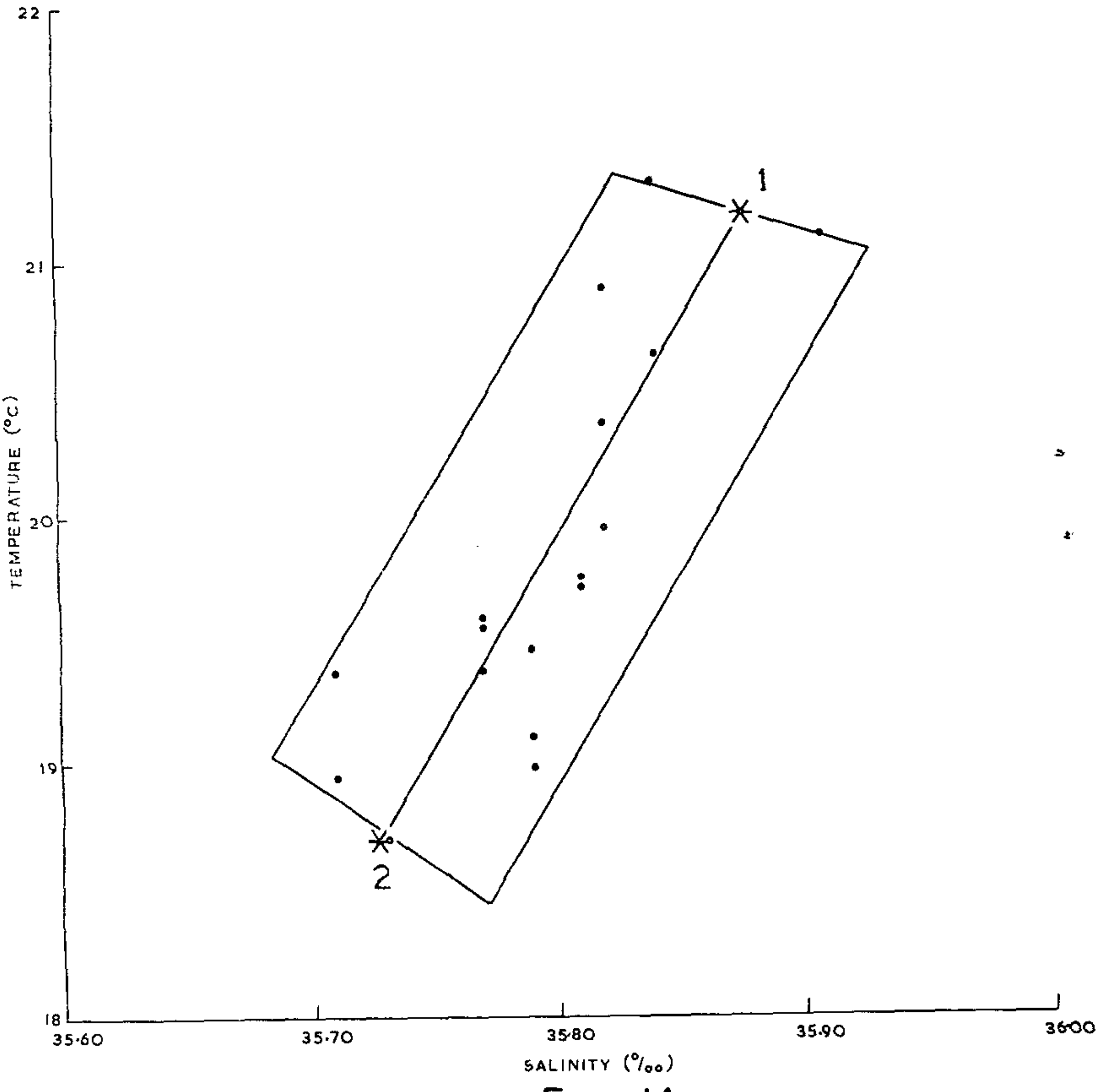

22
21
20
19
18
TEMPERATURE (°C)
1
2
35·60
35·70
35·80
35·90
36·00
SALINITY (°/oo)

Fig. 14

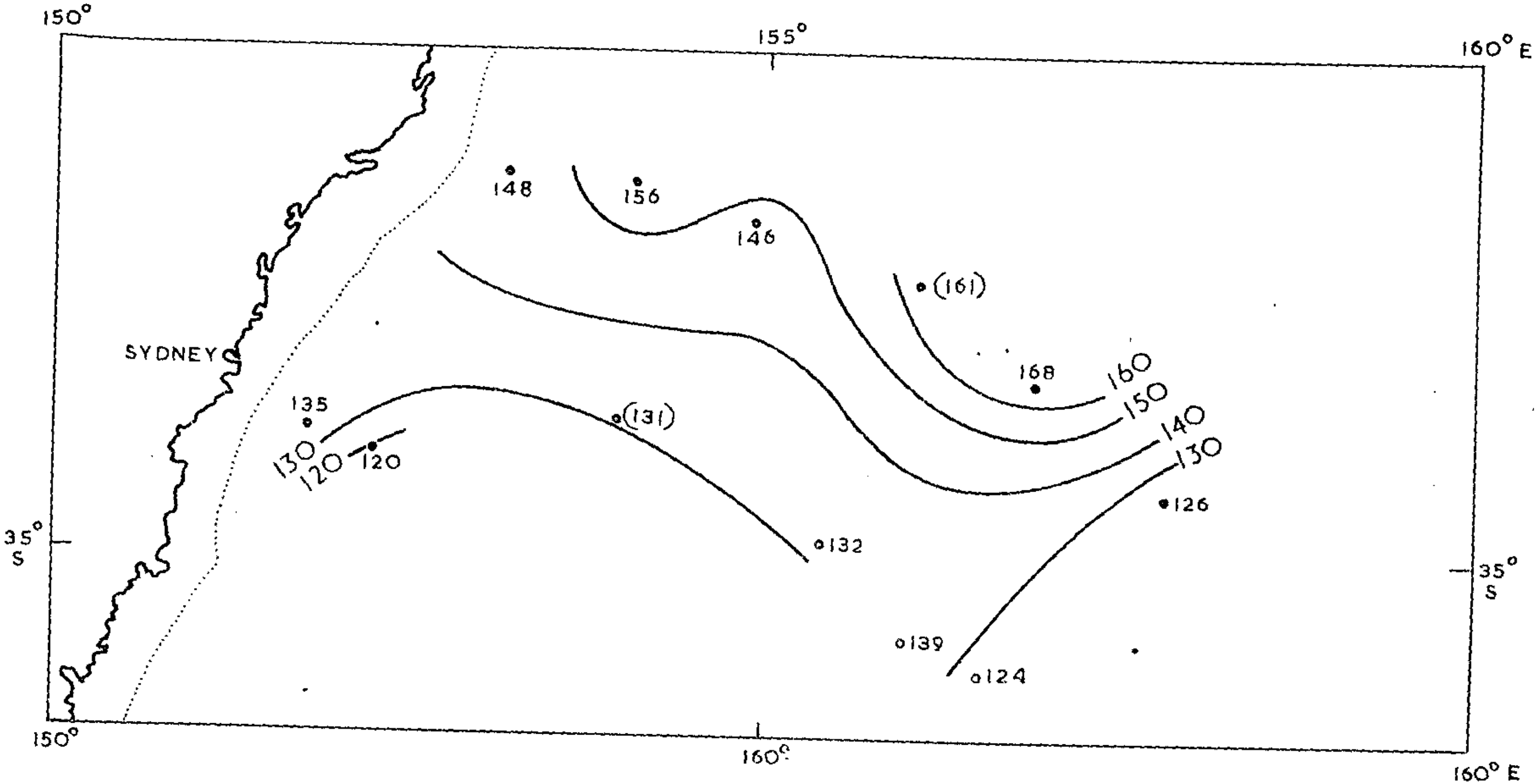
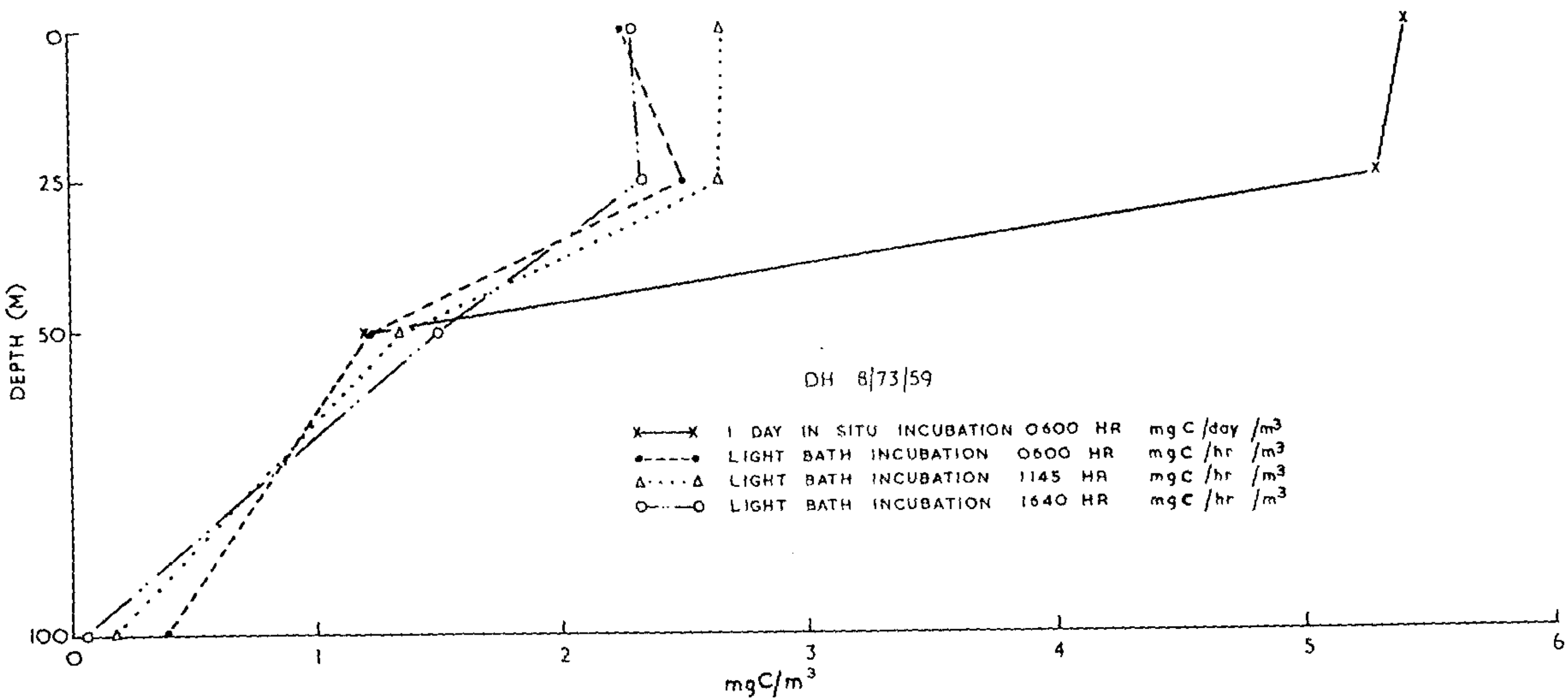
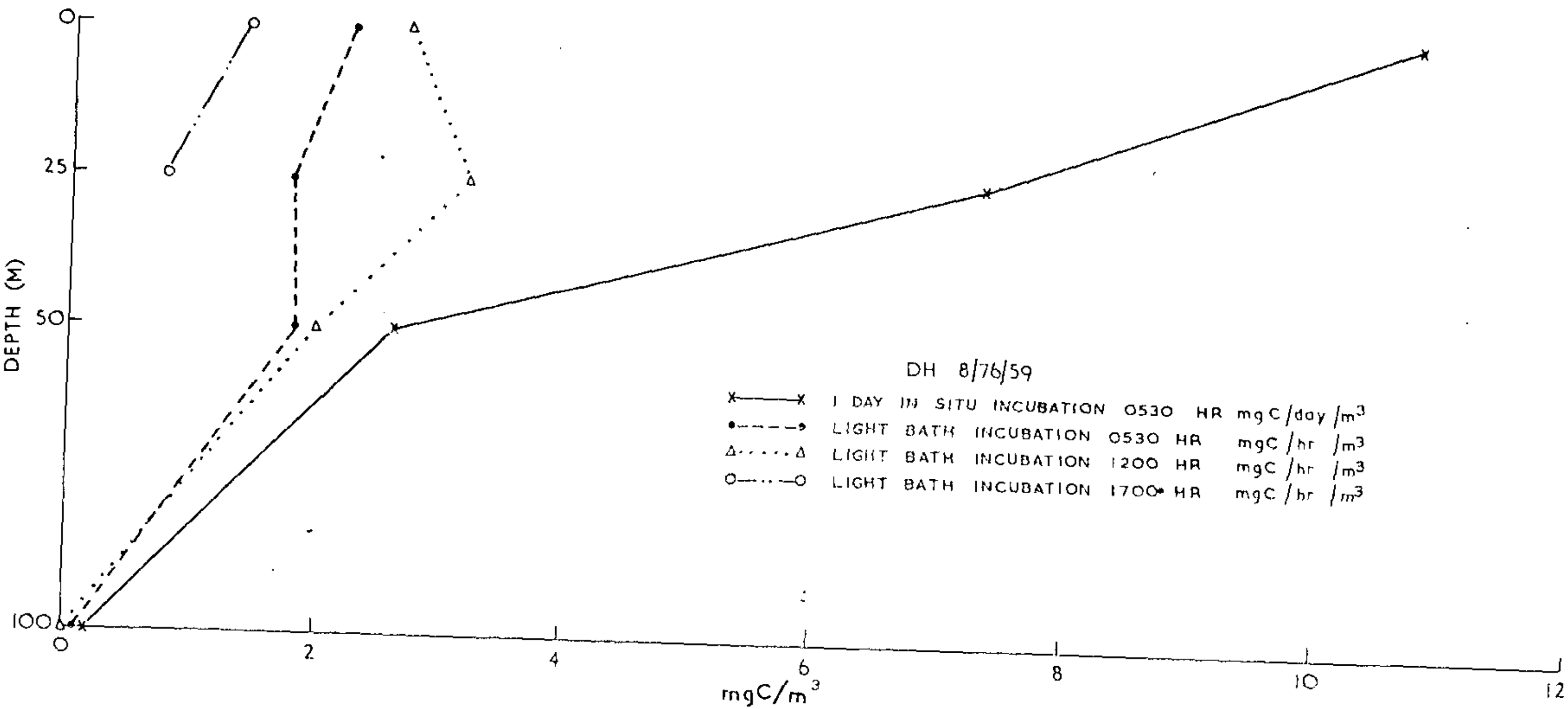

150°
155°
160° E
SYDNEY
148
156
146
(161)
168
160
150
140
130
135
(131)
130
120
120
126
132
35° S
35° S
139
124
150°
160°
160° E

Fig. 15



DEPTH (M)
0
25
50
100
0
1
2
3
4
5
6
mgC/m³
DH 8/73/59
I DAY IN SITU INCUBATION 0600 HR mg C /day /m³
LIGHT BATH INCUBATION 0600 HR mg C /hr /m³
LIGHT BATH INCUBATION 1145 HR mg C /hr /m³
LIGHT BATH INCUBATION 1640 HR mg C /hr /m³

Fig. 16



DH 8/76/59
I DAY IN SITU INCUBATION 0530 HR mgC/day/m3
LIGHT BATH INCUBATION 0530 HR mgC/hr/m3
LIGHT BATH INCUBATION 1200 HR mgC/hr/m3
LIGHT BATH INCUBATION 1700 HR mgC/hr/m3
DEPTH (M)
0
25
50
100
0
2
4
6
8
10
12
mgC/m3

Fig. 17

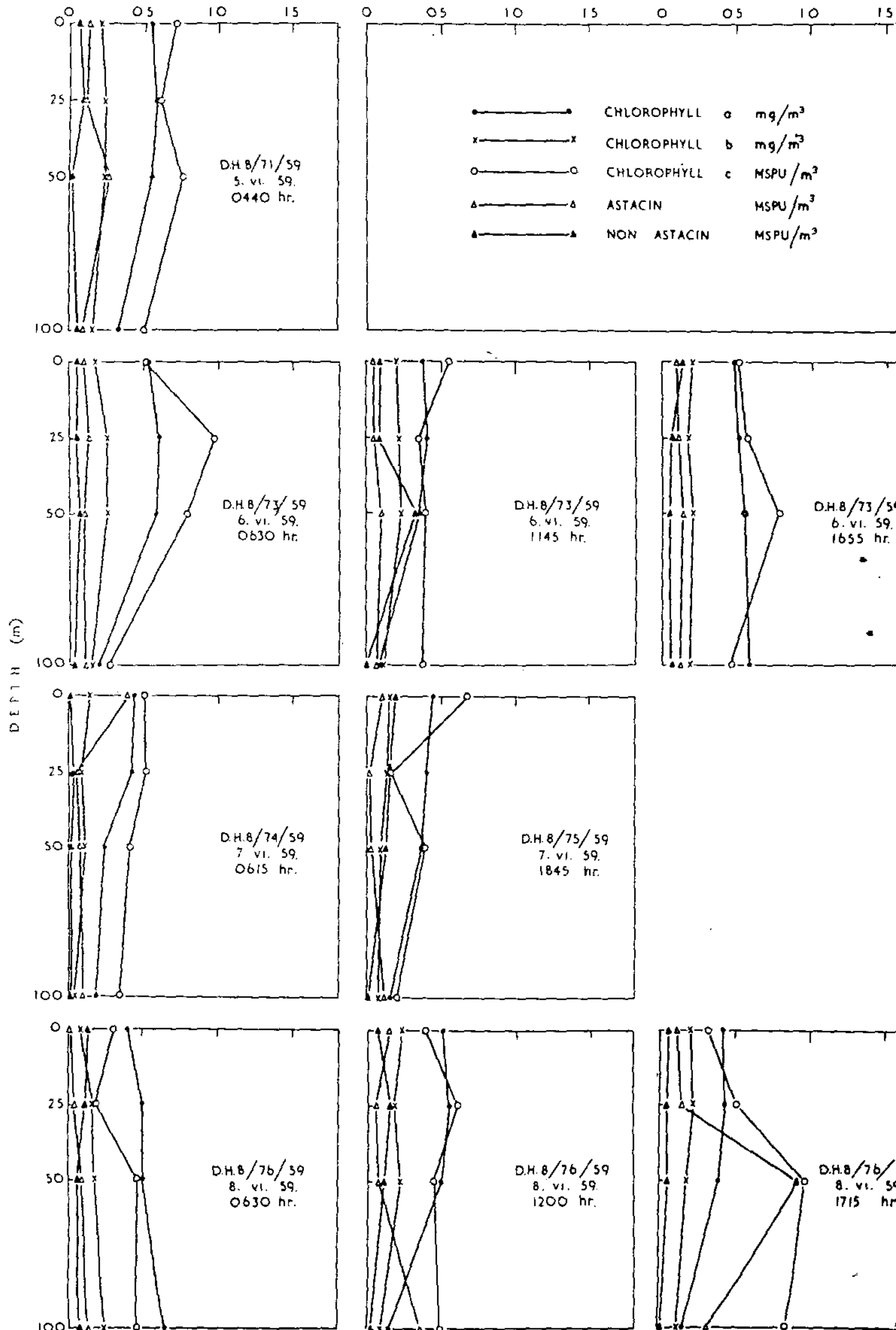

CHLOROPHYLL a mg/m³
CHLOROPHYLL b mg/m³
CHLOROPHYLL c MSPU/m³
ASTACIN MSPU/m³
NON ASTACIN MSPU/m³
D.H.8/71/59 5. vi. 59. 0440 hr.
D.H.8/73/59 6. vi. 59. 0630 hr.
D.H.8/73/59 6. vi. 59. 1145 hr.
D.H.8/73/59 6. vi. 59. 1655 hr.
D.H.8/74/59 7. vi. 59. 0615 hr.
D.H.8/75/59 7. vi. 59. 1845 hr.
D.H.8/76/59 8. vi. 59. 0630 hr.
D.H.8/76/59 8. vi. 59. 1200 hr.
DEPTH (m)

Fig. 18

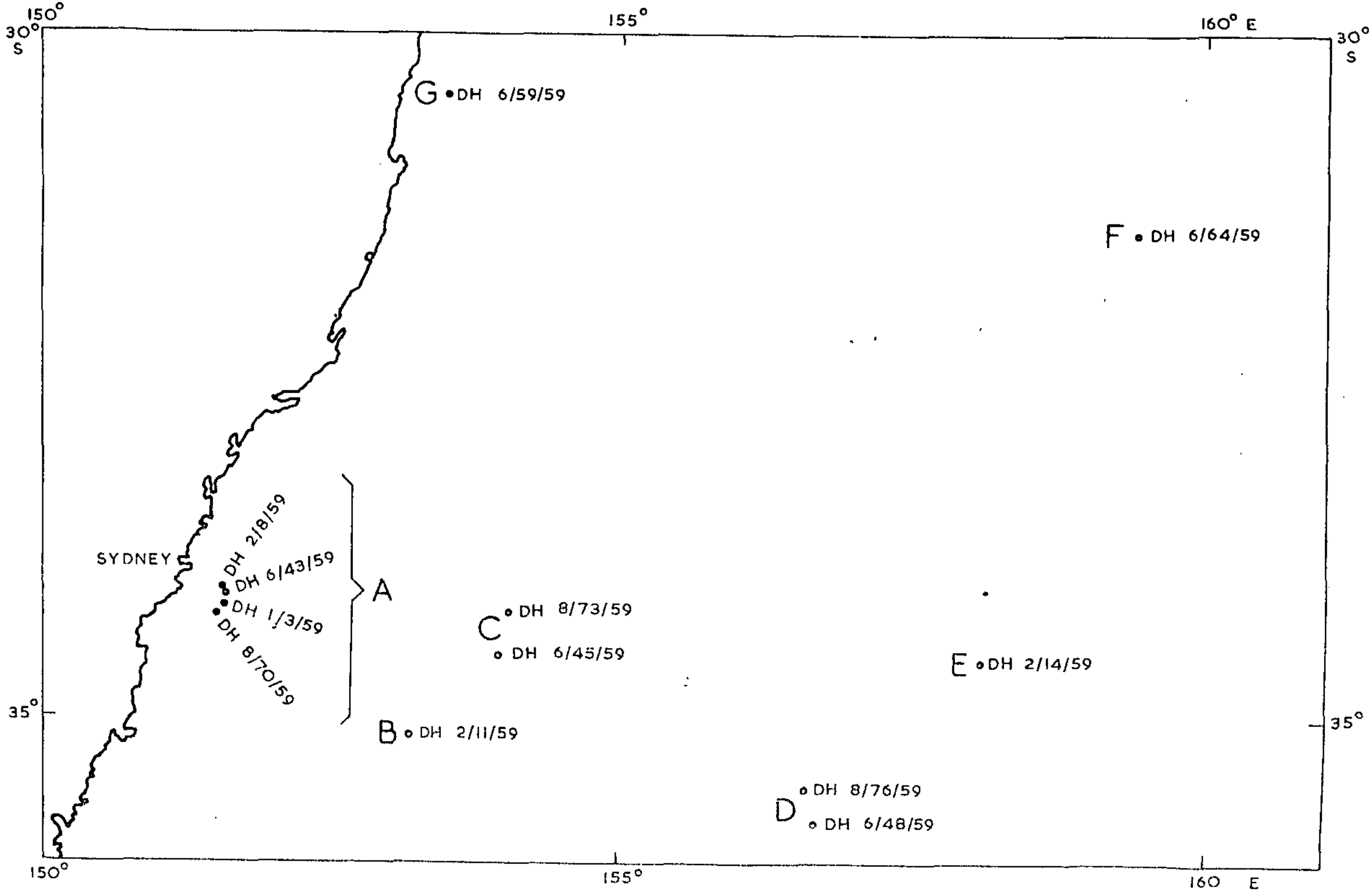

150°
155°
160° E
30° S
30° S
G DH 6/59/59
F DH 6/64/59
SYDNEY
DH 2/8/59
DH 6/43/59
DH 1/3/59
DH 8/70/59
A
C DH 8/73/59
DH 6/45/59
E DH 2/14/59
35°
35°
B DH 2/11/59
D DH 8/76/59
DH 6/48/59
150°
155°
160 E

Fig. 19

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH9/59

July 7-9, 14-16, 1959

SCIENTIFIC PERSONNEL

D.J. Tranter (in charge)
R. Desrosieres (F.A.O. Student from Institut Francais d'Oceanie, New Caledonia)
A.G.W. Hammick

ZOOPLANKTON - D.J. TRANTER and R. DESROSIERES

The purpose of the cruise was to study the vertical distribution of zooplankton and to observe any changes in this distributional pattern during a 48-hour period.

The station occupied was off Port Hacking (34°08'S. 151°28'E.). Collections were made with closing type Clarke-Bumpus samplers, and were carried out in the following manner:

Haul 1 :	horizontal	: 0, 18, 36, 54 m
Haul 2 :	"	: 72, 90, 108, 126 m
Haul 3 :	oblique	: 128-0, 64-0 (in duplicate).

The depths given are calculated values: in the horizontal hauls, for instance, the samplers were spaced 25 m apart and the wire angle was approximately 45°.

Seventeen such series of three hauls were taken between 1551 hours on July 14 and 1500 hours on July 16. In all, about 200 useful samples were returned to the laboratory for examination. No temperatures or salinities were taken in conjunction with the hauls, but those for the Port Hacking 100 m station on July 17, 1959, are given in Table 1.

TABLE 1

TEMPERATURE AND SALINITY AT PORT HACKING
100 m STATION - 14/7/59

Depth (m)	Temperature (°C)	Salinity ‰
0	17.52	35.75
10	17.60	35.73
20	17.50	35.71
30	17.60	35.71
40	17.30	35.73
50	17.20	35.70
75	17.12	35.68
100	16.60	35.57

The samples were weighed and tenthed, where necessary, to facilitate counting. Counts were made of certain groups and expressed in terms of frequency per cubic metre, the quantity of water filtered being known.

RESULTS

COPEPODS: Considered as a whole copepods showed a fairly regular vertical distribution in most of the hauls. There was, however, an avoidance of the surface layer during the day, and a concentration in the upper layers during the night - especially the first night. When individual species and genera were considered, three types of distributional pattern emerged.

(a) Indifferent distribution throughout the water column:
This is well illustrated by Oithona which tended to occur at all depths at all times, and at approximately the same density, except below 100 m where numbers began to decrease (Fig. 1). Such a pattern of distribution was encountered in several genera.

(b) Permanent concentration in the upper layers:
An example of this type of distribution is given by Oncaea venusta (Fig. 2) which was usually far more common above 50 m than below. There was no convincing evidence of migration.

(c) Distribution showing a pattern of migration:

A diurnal migratory sequence is evident in the distribution of the "small Calanid group", which comprises species of the families Paracalanidae and Pseudocalanidae whose size is typically very small (from 1 - 1.4 mm). By far the commonest species were Clausocalanus arcuicornis and Ctenocalanus vanus. The sequence is as shown in Figure 3: at dusk, a rise from deep water reaching the surface about midnight; during the early morning, a descent reaching 100 m by sunrise; and during the daytime, dispersal about the 100 m level. The rare exceptions to this pattern are probably the result of patchiness.

The distribution of other copepods was examined. The following conclusions were reached:

Mecynocera clausi: a fairly even distribution at all times and depths; thus there was little evidence of migration. Densities were often heaviest at sub-surface levels (18-36 m).

Nannocalanus minor: an upper water species, found usually above 75 m; absent from the surface during the middle of the day, but no suggestion otherwise of migration.

Acartia danae: great majority found above 50 m at all times, except for a few which appeared to make a slight descent in the early morning; an avoidance of the surface during the middle of the day.

Calanus tenuicornis: diurnal migration apparent, with a dusk to midnight rise, a post-midnight descent, and a deep water aggregation by day - similar to small Calanid group; an unusual concentration at 18 m in the early afternoon of the first day.

Pleuromamma spp.: the two species (P. gracilis and P. abdominalis) were counted together owing to the difficulty of distinguishing between the juveniles; pattern of diurnal migration clearly evident; descent at dawn; daytime in deep water; ascent at dusk; 0-50 m distribution by night. The rarity of discordant counts suggests a lack of patchiness.

Lucicutia flavicornis: changed its vertical distribution but not in a regular cycle: avoided the daylight, accumulating in deeper water by day; regularly distributed by night.

EUPHAUSIID LARVAE: found throughout the water column; concentrations occurred in the upper layers during both night and day; distribution often patchy; on one occasion a migration from deeper water after dawn to the surface in the late evening.

CHAETOGNATHS: slight tendency to migrate upwards in the evening and downwards at dawn; otherwise fairly regular distribution.

TUNICATES: no evidence of migration of Oikopleura; often very patchy; capable of staying near the surface during the day.

PTEROPODS: shallow distribution, rarely in deep water; patchy.

The general absence of a migration pattern was probably the result of grouping many species together. There was a lack of continuity, sometimes in the series of densities at a given depth, at other times in the series of densities throughout the water column at a given time. These irregularities were caused by patchiness of distribution.

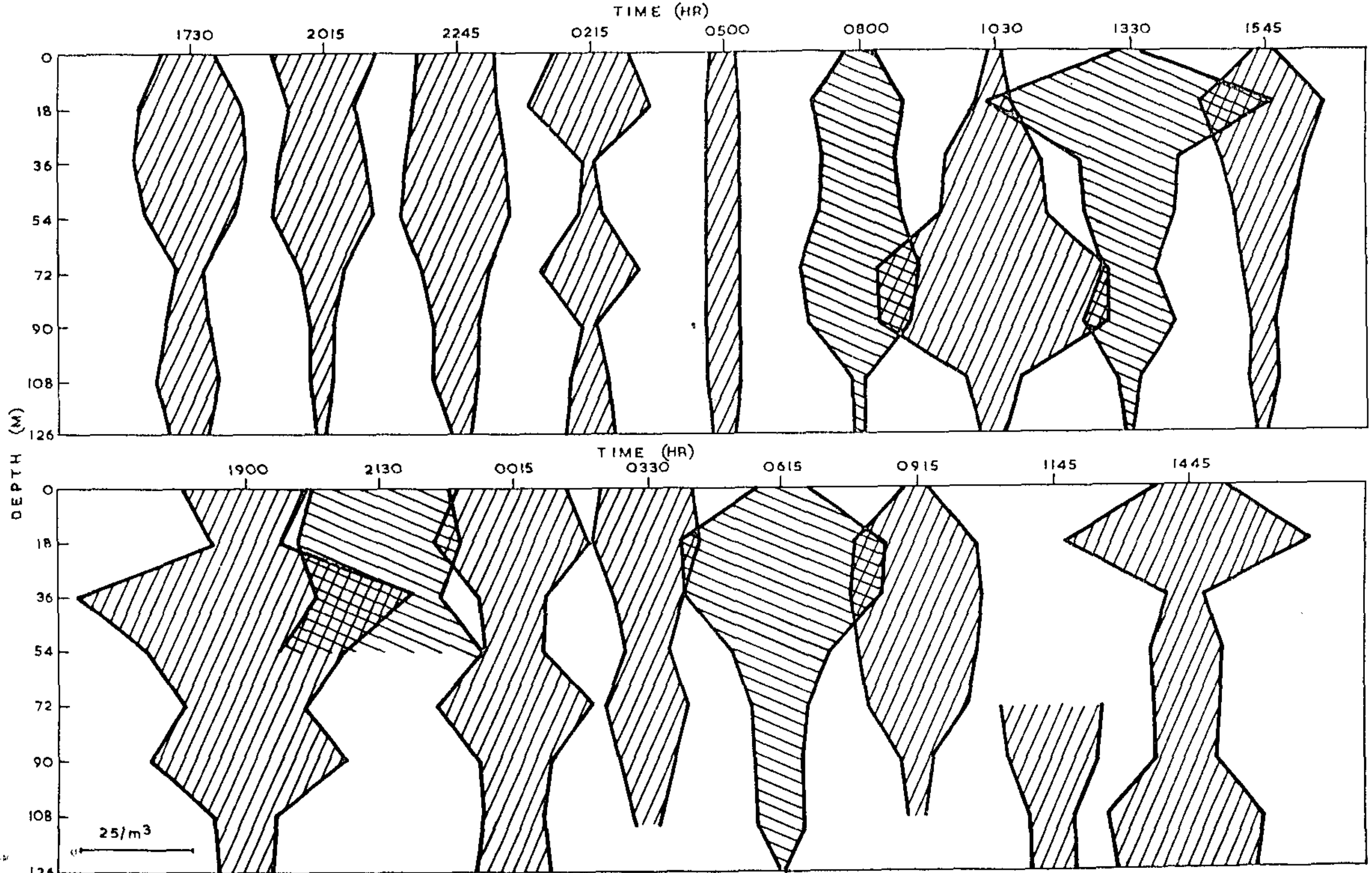
This was also responsible for several strange records in the oblique hauls. Very high densities were sometimes recorded for the upper layers, simultaneous with low densities for the whole water column (even less than 50 %, Fig. 4). Furthermore, two samplers only two metres apart during the haul sometimes collected significantly different samples; misleading values can be found either for single species or for the whole catch.

Discussion of Results of Cruises DH4/59 and DH9/59

When the results of the two cruises are compared it becomes obvious that there is a striking difference in the vertical distribution of a number of species. The following were found at a lower level during Cruise DH4/59 (April) than DH9/59 (July): Acartia danae, Nannocalanus minor, Oithona spp., Calanus tenuicornis, and Pleuromamma spp.

Although Cruise DH4/59 was further to the south, the water temperatures were much higher than during DH9/59. It is possible that the above species prefer cooler water and that they were to some extent restricted from the upper layers at Eden by the higher temperatures prevailing there.

If this is so, then one must conclude that Oncaea venusta and Mecynocera clausi are relatively tolerant species since their distribution was much the same during both cruises, and the consistent upper water distribution of the former may then have some other explanation than temperature preference.


TIME (HR)
1730
2015
2245
0215
0500
0800
1030
1330
1545
0
18
36
54
72
90
108
126
DEPTH (M)
TIME (HR)
1900
2130
0015
0330
0615
0915
1145
1445
0
18
36
54
72
90
108
126
25/m3

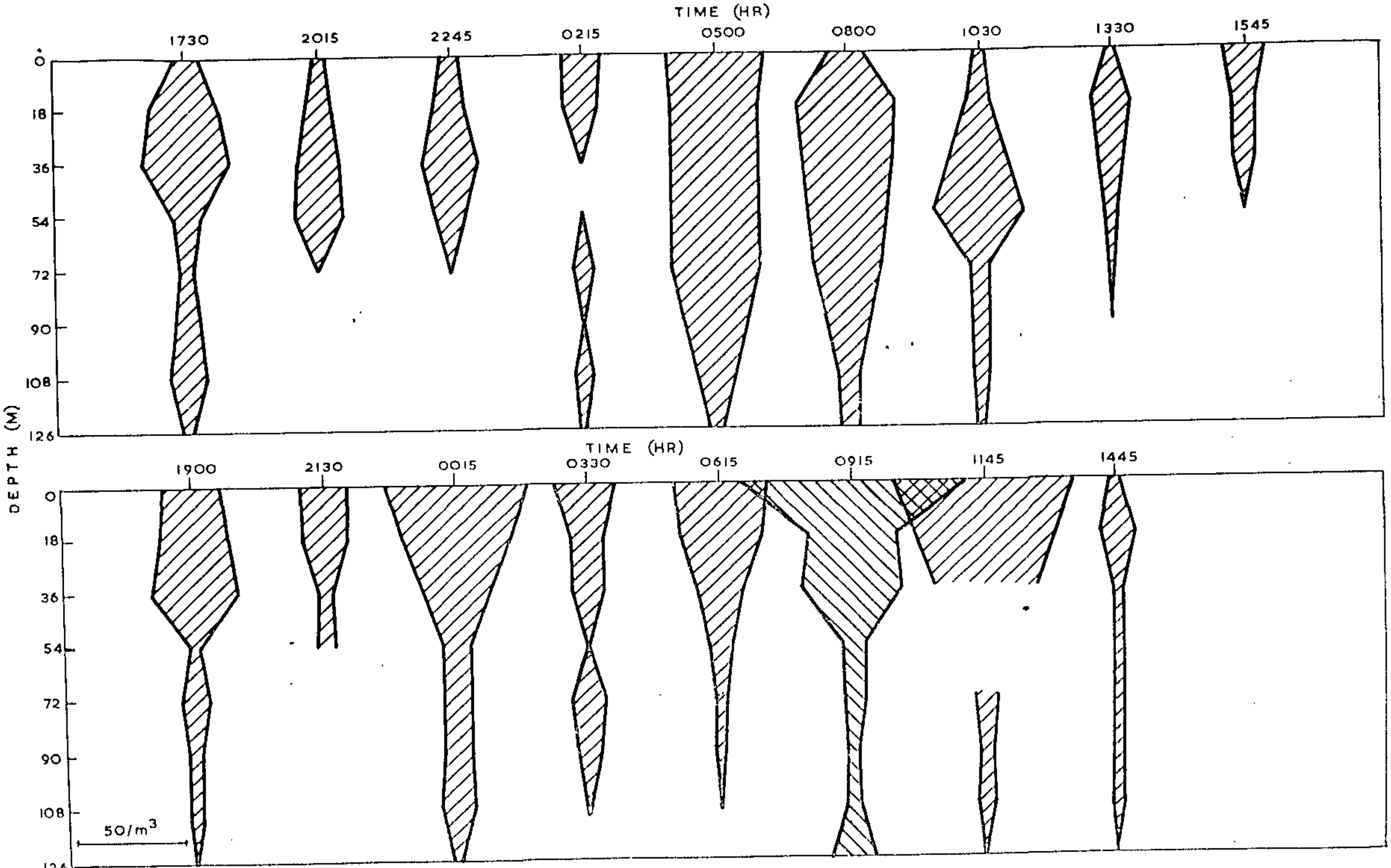

TIME (HR)
1730
2015
2245
0215
0500
0800
1030
1330
1545
0
18
36
54
72
90
108
126
DEPTH (M)
TIME (HR)
1900
2130
0015
0330
0615
0915
1145
1445
0
18
36
54
72
90
108
126
50/m3

Fig. 2

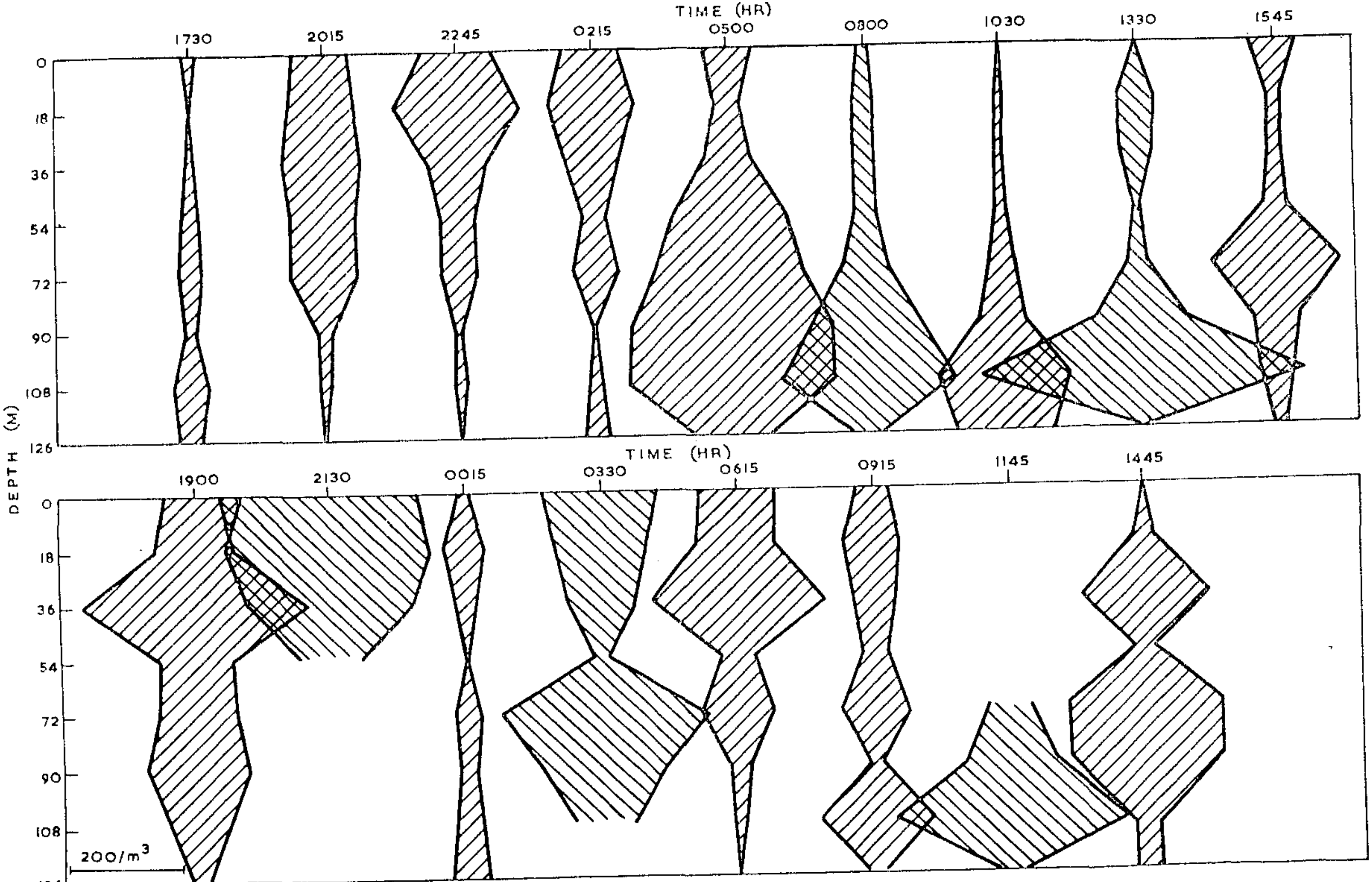
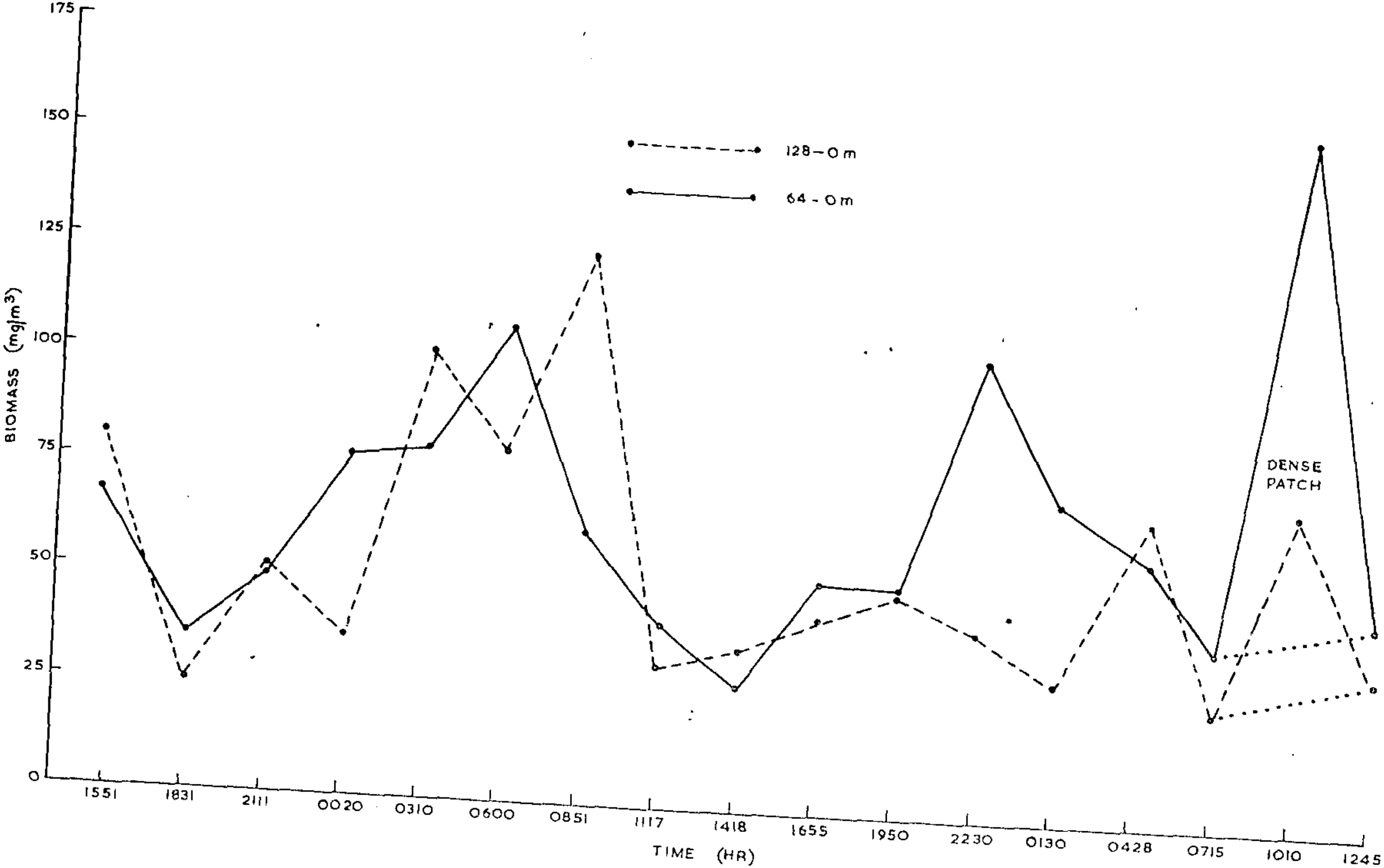

TIME (HR)
1730
2015
2245
0215
0500
0800
1030
1330
1545
DEPTH (M)
0
18
36
54
72
90
108
126
TIME (HR)
1900
2130
0015
0330
0615
0915
1145
1445
200/m3

Fig. 3



128–0 m
64 - 0 m
BIOMASS (mg/m³)
175
150
125
100
75
50
25
0
DENSE PATCH
1551
1831
2111
0020
0310
0600
0851
1117
1418
1655
1950
2230
0130
0428
0715
1010
1245
TIME (HR)

Fig. 4

Euchaeta marina and Undinula darwinii occurred with greater frequency during DH4/59 and were concentrated in the upper layers. Such a distribution would have an explanation in a preference for warmer water.

Bearing in mind the above difference of distribution, the migration behaviour of the copepod species was consistent during the two cruises. The most conspicuous difference was the much more definite diurnal cycle of the small Calanid group during DH9/59.

Euphausiids, tunicates, and chaetognaths showed a similar pattern of distribution and behaviour on both cruises.

LEGENDS FOR FIGURES

Fig. 1.- Depth distribution of *Oithona* spp.

Fig. 2.- Depth distribution of *Oncaea venusta*.

Fig. 3.- Depth distribution of small Calanid group.

Fig. 4.- Depth distribution of biomass during 24-hour period.

F.R.V. "DERWENT HUNTER"

SCIENTIFIC REPORT OF CRUISE DH10/59

July 24-30, 1959

SCIENTIFIC PERSONNEL

N. Dyson (in charge)

ITINERARY

This cruise was designed to determine sampling and experimental error in CO_2 uptake and pigment measurements. It was intended to work one station five miles off Port Hacking and one 50 miles off Newcastle. Bad weather prevented this.

SCIENTIFIC REPORTS

Primary Production and Biochemistry

Two fifteen gallon samples, one taken at 0500 and one at 1530 hours, were collected from the surface at Station DH10/89/59. This was divided into portions for 12 pigment and 12 ^{14}C samples.

At Station DH10/90/59, replicate ^{14}C and pigment samples were collected from the surface at 0500 hours. At 1230 replicate samples were collected at 25 m. Bad weather prevented sampling at 50 and 100 m.

The results of this cruise appear in C.S.I.R.O. Aust. (1961) and they are being discussed in a paper appearing elsewhere.

DIVISION OF FISHERIES AND OCEANOGRAPHY

REPORTS

1. Thomson, J.M. (1956).- Fluctuations in catch of yellow-eye mullet Aldrichetta forsteri (Cuvier and Valenciennes) (Mugilidae).

2. Nicholls, A.G. (1957).- The Tasmanian trout fishery. I. Sources of information and treatment of data. (For limited circulation: not available for exchange).

3. Nicholls, A.G. (1957).- The Tasmanian trout fishery. II. The fishery of the north west rivers. (For limited circulation: not available for exchange).

4. Chittleborough, R.G. (1957).- An analysis of recent catches of humpback whales from the stocks in Groups IV and V. Prepared for the International Commission on Whaling.

5. F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH3/56, DH4/56, DH5/56.

6. Cowper, T.R., and Downie, R.J. (1957).- A line fishing survey of the fishes of the south-eastern Australian continental slope.

7. Davis, P.S. (1957).- A method for the determination of chlorophyll in sea-water.

8. Jitts, H.R. (1957).- The ^{14}C method for measuring CO_2 uptake in marine productivity studies.

9. Hamon, B.V. (1957).- Mean sea level variations on the east Australian coast.

10. Nicholls, A.G. (1957).- The Tasmanian trout fishery. III. Rivers of the north and east. (For limited circulation: not available for exchange).

11. Nicholls, A.G. (1957).- The population of a trout stream and the survival of released fish. (For limited circulation: not available for exchange).

12. F.R.V. "Derwent Hunter" Scientific Report of Cruise DH6/56.

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

Kott, Patricia (1957).- Zooplankton of east Australian waters 1945-54.

F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH1/57 - DH4/57.

Rochford, D.J. (1958).- The seasonal circulation of the surface water masses of the Tasman and Coral Seas.

Chittleborough, R.G. (1958).- Australian catches of humpback whales 1957. Prepared for the International Commission on Whaling.

Australian documents prepared for the Unesco Conference on the Oceanography of the Tasman and Coral Seas, held at Cronulla, August 9-14, 1958.

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

F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH9/57, DH10/57, DH11/57, DH12/57.

F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH13/57, DH14/57, DH15/57, DH16/57.

Robins, J.P. (1959).- F.R.V. "Marelda" Scientific Report of Cruises July 1957 - May 1958.

Chittleborough, R.G. (1959).- Australian catches of humpback whales, 1958. Prepared for the International Commission on Whaling.

H.M.A. Ships "Queenborough" and "Quickmatch". Scientific Reports of Cruises in 1958.

H.M.A.S. "Warrego". Scientific Reports of Cruises 1957-58.

Thomson, J.M. (1959).- Summary review of a scientific survey of Lake Macquarie by C.S.I.R.O. Division of Fisheries and Oceanography.

F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH1/58 - DH9/58.

Chittleborough, R.G. (1960).- Australian catches of humpback whales, 1959. Prepared for the International Commission on Whaling.

F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH10/58 - DH20/58.

Chittleborough, R.G. (1961).- Australian catches of humpback whales, 1960.

F.R.V. "Derwent Hunter" Scientific Reports of Cruises DH1/59 - DH10/59.