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PHYSICAL AND BIOLOGICAL DESCRIPTION OF WARM-CORE EDDY J DURING SEPTEMBER - OCTOBER, 1979

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Abstract

Three cross sections of eddy J were examined during 20 September - 3 October 1979. During this time the eddy core extended from the surface to at least 360m near the eddy centre and was characterized by a narrow range of temperatures (18.5 - 18.7°C) and salinities (35.69 - 35.72‰). Surface currents up to 2 $m.s^{-1}$ circumscribed the eddy. Nutrient concentrations were generally low in all regions (2.0 µg-at N/ℓ, 1.0 µg-at Si/ℓ) but surface nitrate concentration was slightly higher inside the eddy than outside the eddy. Surface phytoplankton (maximized fluorescence), micronekton biomass (fish, crustaceans, and salps), and myctophid diversity (number of species of myctophids per trawl were greater outside the eddy than inside the eddy, particularly in the north-east and southern sections. Data suggest that the biological processes within the uniformly mixed regions of a warm-core eddy are quite distinct from those in surrounding water masses.

INTRODUCTION

A warm-core anticyclonic eddy or ring provides a good experimental site to study oceanic processes since an eddy forms a uniquely tractable body of water which can be revisited in time series. Eddies in the Tasman Sea are believed to form when a meander of the East Australian Current breaks off into a closed-ring structure (Hamon 1965, Andrews and Scully-Power 1976, Nilsson *et al.* 1977). These eddies are analogous to those produced by other major western boundary currents such as the Gulf Stream (Parker 1971, Fuglister 1972) and the Kurushio (Tomosada 1978). Eddies off the east coast of Australia are typically 200 - 300 km in diameter with isothermal cores extending to 300m depth or more (Andrews and Scully-Power 1976). Surface currents up to 1.5 $m.s^{-1}$ have been measured in eddies (Hamon 1965) and satellite tracking has shown that eddies can move at least 1.5×10^{-2} $m.s^{-1}$ (13 km in 24 hr) (Nilsson and Cresswell in press). More detailed descriptions of eddy structure can be found in Andrews and Scully-Power (1976), Nilsson *et al.* (1977) and Nilsson and Cresswell (in press).

In addition to the contrasts in physical characteristics between eddies and surrounding water masses, differences in nutrient cycling (Scott 1978) and phytoplankton productivity (Tranter *et al.* 1980) have also been observed. Little information is available on higher trophic levels although studies in other areas have shown that distributions of micronekton often correlate with particular water masses or frontal zones between water masses (Hutchins 1947, Robins 1952, Backus *et al.* 1969, McGowan 1971, Uda 1973, Jahn and Backus 1976, Robertson *et al.* 1979, Magnuson *et al.* in press, Brandt and Wadley in press, and many others). The mechanisms maintaining these associations are still largely unknown.

The work described here forms part of a one year program to study a particular eddy, eddy J, in time series. The objectives of this program are to examine the physical and biological interactions of warm-core eddies and to assess the impact of eddies on oceanic processes in surrounding water masses. This report is intended to provide a preliminary comparison of eddy J with surrounding water masses, to detail methodology for future reference and to provide a source of data in a reasonable amount of time that can be used by others interested in and responsible for research related to warm-core eddies.

MATERIALS AND METHODS

Sampling strategy

Eddy J was studied from 20 September to 3 October 1979 from the *R.V. Sprightly*. The basic sampling strategy was to examine three radii of eddy J at compass headings of approximately 45°, 165° and 285° from the eddy centre. For each of three 4-day periods the sampling scheme was to:

1. Map 1/3 of the eddy circumference from T_{250} (temperature at a depth of 250m) of 13.5 - 18.5°C by a zig-zag pattern.

2. Estimate the position of the eddy centre from thermal plots and ship's drift obtained during the mapping sequence.

3. Sample at the eddy centre for 24 hr.

4. Intensively (48 hr) study the radial section of the eddy opposite to the region mapped.

This sampling plan was followed closely throughout the cruise with only minor exceptions (due to weather), outlined below.

Mapping

The cruise track is given in Fig. 1. Initially (1300 hr, 20 September to 0900 hr, 21 September) we mapped the southwestern perimeter of the eddy (155° to 295° arc) and then worked along the 045° compass heading from the eddy centre. Then (0940 hr, 24 September to 0300 hr, 25 September) we mapped the north and northwest perimeter of the eddy (295° to 015° arc) followed by work on the 165° section. Finally (2000 hr, 27 September to 0400 hr, 29 September) we mapped the east and southeast edge of the eddy (060° to 155° arc) and completed work along the 285° section. Additionally, data from the 045° section (015° to 060° arc) were used to map eddy structure (1000 hr, 21 September to 1430 hr, 22 September).

Mapping transects were run at speeds of approximately 3-5 $m.s^{-1}$ (6-10 knots) on a zig-zag course. The lengths of the transects were determined by the gradient of the isotherms at the eddy edge. Turn-around points were defined as T_{250} = 13.5°C (outer edge) and T_{250} = 18.5°C (inner edge). Vertical temperature profiles were measured along the transect using expendable bathythermographs (Appendix 1) at intervals (0.3 -2.0 hr) dependent on the steepness of the thermal gradients (see Fig. 5).

Continuous measures of surface temperature and salinity (thermosalinograph), nutrients (autoanalyser), *in vivo* phytoplankton fluorescence, particle size distribution, and light intensity were made underway. Sea water was supplied to the deck laboratory through an intake about 2m below the surface. A portion of this continuous stream of water was fed to a particle size analyser (Hiac PC 320) which gave accumulated counts per hour. The coarse sensor was appropriate for particles with nominal diameters of less than 250 μm. A second portion of the stream was equally subdivided between a pair of Turner Designs 10-005 R fluorometers set up in parallel for *in vivo* chlorophyll *a* fluorometry. For one fluorometer, Diuron was introduced into the stream 10 seconds before entering the measuring cuvette in amounts to achieve a maximized fluorescence response (F_M). The other fluorometer recorded the variable fluorescence (F_V). The two signals were fed to a two-pen strip recorder and the ship's data logging system. Dosing was timed for 3 minutes of every 10 minutes by the ship's computer. Paired values of F_M and F_V are used to compute the "photochemical quantum efficiency", $\phi p = (F_M - F_V)/F_M$, a dimensionless number between 0 and 1 which estimates the portion of absorbed quanta (correlated with F_M) that are utilized in photochemistry. Calibration was frequently checked using substandards described by Parker and Vaudrey (1980). Temperature of the water entering the fluorometers was continuously recorded.

Photosynthetically useful irradiation incident to the sea surface was monitored using a Lambda LI 192S sensor. The signal was electronically integrated for each 10 min period prior to a fluoresence reading and a total value calculated for each day.

Hydrology

Twenty five hydrology stations were sampled (Fig. 2, Table 1). At each station water samples (reversing Niskin bottles) were taken at the surface, 10m, 25m, 50m, 75m, 100m, 150m, 200m, 250m, 300m, 350m, 400m, 450m and 500m and analysed for temperature, nitrate, silicate, and ^{14}C uptake. At some stations a second cast was made to collect samples at 25m intervals from 200m to 500m.

Vertical thermal profiles were taken at most hydrology stations using expendible bathythermographs. (Table 1).

Zooplankton were collected with a ¼ m^2, free fall plankton net and the sample was split into 2 aliquots. One aliquot was preserved with formalin for nitrogen analysis, and the other was processed for particle size analysis and then preserved with formalin for taxonomic reference.

Also at each station water samples were collected at discrete depths (to 100m) using a submersible pump. A spherical light sensor (Lambda LI 193S) and a depth transducer was fitted on the pump cage. At each depth the line was flushed for 3½ min before 2-3 min readings of *in vivo* fluorescence were taken. Samples were also processed with the particle size analyser. Water samples from the discharge of the F_V fluorometer were filtered using Whatman GF/C fibreglass filters. Duplicate aliquots of filtrate were fixed with Grasshof's buffer for dissolved NO_3 analyses. The particulate matter (with the filter) was frozen for storage.

Currents

Speed and direction of surface currents were estimated from ship's drift using satellite navigation.

Micronekton

The purpose of the midwater trawling program was to study the distributional ecology of the mesopelagic fishes, crustaceans, and squid in relation to the front between eddy J and surrounding water masses and to examine the vertical distribution of mesopelagic organisms as a function of the depth of the mixed layer. Five depth strata (20m, 50m, 100m, 200m, 300m) and six temperature strata (11.0 - 20.0°C at 1.5°C intervals) were selected for sampling.

Our strategy was to take relicate samples in each of the temperature-depth strata that existed. Additional trawls were taken as needed within the entire time-series program on eddy J.

Forty-five midwater samples were taken (Fig. 3, Table 2). All samples were collected at night using a RMT 8 net (Baker *et al.* 1973, Griffiths *et al.* 1980) towed at depth for 60 min (range 60 - 150 min) at a speed of about 1.5 $m.s^{-1}$. A bathysonde attached approximately 3m above the top of the net, provided a continuous graphic record of temperature and depth (Table 3). During the latter part of the cruise the thermistor module was flooded and trawl temperature was calculated using trawl depth range and thermal profiles taken at the beginning and end of each trawl. The RMT had a 4.5 mm mesh with the cod end bucket lined with 330 µm mesh netting. The net samples an area of 8 m^2 and is designed to open and close. The triggering mechanism for this net (Oceanic Instruments) starts a clock at a depth of 20m, opens the net after a pre-determined time interval and then closes the net 60 min later. The system malfunctioned after a few tows and all subsequent trawling was done with the net open during setting and retrieval. In an attempt to reduce the contamination we set and retrieved the net with the ship holding position.

Samples were sorted into categories of fish, crustaceans, molluscs (mainly squid) and other (mainly salps) weighed *en masse* using a lever scale (Iuchi Scale Co. Ltd, Tokoshima, Japan) and preserved in seawater formalin. Exceptionally large catches of salps were subsampled (1600 mℓ). Additionally, the entire trawl sample was photographed (35 mm Agfa colour slide film) at a distance of 1m.

Acoustics

Acoustic data were recorded graphically throughout the cruise. For each trawl sample acoustic data from the 12 kHz Precision Depth Recorder were quantitatively recorded on magnetic tape. These data will be analysed by computer to provide quantitative measures of relative biomass of scatterers using echo squared integration (Peterson *et al.* 1976).

The vertical migration of animals at dawn (approximately 0430-0520 hr) and dusk (approximately 1745-1830 hr) were monitored acoustically at stations inside and outside the eddy. During these times surface light intensity was measured continuously using a moonlight meter developed by CSIRO.

Aerial and satellite photographs

An aerial reconnaissance of ocean colour and frontal features was conducted over the southern and southeastern perimeter of eddy J on 13 September 1979 from an altitude of approximately 500m.

TIROS N infrared photographs (NASA) of the southeastern Australian region were obtained 5 days prior to and 5 days after the cruise.

RESULTS

Eddy structure

Eddy J was centred at approximately lat. 33°44.7'S., long. 153°25.3'E (Figs 4,5), about 60 km south of the eddy's position during 17 - 30 August (Tranter personal communication). The eddy appeared to be stationary throughout the present study and was basically circular in configuration as estimated by the isotherms at a depth of 250m. At 250m (T_{250} = 15.0°C), eddy J was approximately 150 km wide along the north-south axis and 180 km long along the east-west axis. Eddy diameter at 350m was 85 km. The temperature across the eddy edge (T_{250}) changed by about 6°C over a distance of about 40 km (Fig. 4).

Vertically, the eddy was lens-shaped with isotherms deepening from the eddy edge towards the centre (Fig. 6-12). The eddy core extended from the surface to a depth of at least 360m near the eddy centre and was characterized by a narrow range of temperatures (18.5 - 18.7°C) and salinities (35.69-35.72‰).

Surface temperatures (Fig. 13) were 18.5-18.7°C inside the eddy and ranged from approximately 17.0 to 20.6°C outside the eddy. A warm surface band of water circumscribed the northeast and northern edges of the eddy. Pockets of warm surface water were also observed near the edge of other sections of the eddy but did not appear continuous. The sharpness of the thermal gradients at the eddy edge and at the edge of the East Australian Current are illustrated in the infrared satellite photographs (Appendix 2,3).

Surface currents

Surface currents up to 2 $m.s^{-1}$ (4 knots) were calculated using ship's drift (Fig. 14). These currents circumscribed the eddy and flowed in a counter-clockwise direction. Currents were generally larger towards the outer edge of the eddy and diminished towards the centre. There appeared to be an intrusion of warm water into the northeast section of the eddy which extended across the northwest section of the eddy and perhaps beyond (Fig. 13).

Another surface manifestation at the eddy edge was a region of increased surface turbulence as seen from an aerial photograph (Fig. 15). The region inside the eddy also seemed to be generally calmer than that outside the eddy.

Nutrients

At any one station temperature was highly correlated with nitrate and silicate concentrations (Fig. 16-21). Nutrient levels were generally low (<2.0 μg-at N/ℓ, <1.0 μg-at Si/ℓ) in the well mixed eddy core. At any depth, nutrient levels below the mixed layer were generally higher towards the outside of the eddy. Surface nitrate concentration was low throughout the area but generally lower outside than inside the eddy (Figs 16-21).

Phytoplankton

The surface distribution of F_M corrected for the diel cycle (Parker unpublished) is given in Fig. 22. Phytoplankton within the eddy was relatively sparse, but increased toward the outer boundaries. Phytoplankton density increased rapidly at the eddy edge and reached maxima northeast and south of the eddy. ϕ_p was relatively high (0.50-0.55 when corrected for ambient light) throughout the area. An example of the measurements made and their treatment is given in Fig. 23. The vertical distribution of F_M is given in Table 4 and of ϕ_p in Table 5. Tabulated data are not corrected for either the F_M diel cycle or for light.

The noise level in underwater light intensity was high at shallow depths. An example of the recording is shown in Fig. 24. Mean values were estimated as the centre of the distribution. A secchi disc was improvised from a white PVC pail lid and secchi depths (Zs) were recorded at subsequent stations where practical. Results of the underwater irradiation measurements are given in Table 6. Plots of the PAR measurements are shown in Fig. 25. The attenuation lines show marked curvature toward the surface. Lines drawn between the 2m and 5m values were extrapolated to the surface and the 10% irradiation level calculated. These were taken as an estimate of the Zs and are shown in Fig. 25 to be about the same as secchi disc depths recorded for other stations within the eddy with low F_M values in the 2-25m water samples. The secchi disc depths of 16-19m obtained for stations outside the eddy (Table 6) reflect the higher fluorescence measurements.

The daily distribution and amounts of irradiation incident to the sea surface during this cruise are shown in Fig.26. The skies were generally cloudy with only intermittent periods of direct sunshine.

Micronekton

Catches of micronekton were generally small and ranged from 75g to 33 530g (Table 2). Most biomass was salps. Catches of fish (Fig. 27), crustaceans, and salps (Fig. 28) were much smaller inside the eddy than outside the eddy. Largest catches were made to the northeast and south of the eddy.

Myctophids were by far the most common fishes caught, thirty four species being found (Table 7). *Hygophum hygomii, Lampanyctus alatus, Benthosema suborbitale, Scopelopsis multipunctatus,* and *Diaphus meadi* were the most abundant species and represented 71% of the total myctophid catch. These species were also common during a study of eddy F during summer (November - December) 1978 and represented 64% of the total myctophid catch during that time (Brandt, unpublished). Myctophid diversity (number of species per trawl) was generally higher outside the eddy than inside the eddy, particularly in the northeastern and southern sections (Fig. 29). Some fishes such as Bothidae larvae (Fig. 30) and juvenile *Trachurus mccullochi* (Fig. 31) were more abundant outside the eddy than inside the eddy.

DISCUSSION

The physical and biological structure of eddy J during September-October was typical of other warm-core eddies in the Tasman Sea during winter (Tranter *et al.* 1980). Within the eddy, nutrients and phytoplankton were rather uniformly mixed from the surface to depths of at least 360m. Surface nutrient concentrations were only slightly higher inside the eddy than outside the eddy. Phytoplankton and micronekton were more abundant outside the eddy than inside the eddy, particularly at the north-eastern and southern sections.

The lower concentrations of phytoplankton and fish northwest of the eddy is difficult to explain. This region is nearest to the continental shelf and perhaps an eddy/shelf interaction may be responsible. An alternative explanation involves the historic movements of eddy J. Between August and September, eddy J had moved to the southeast. Thus, the region to the northwest of eddy J during September was in the wake of the eddy and perhaps reflects the movement of this 'depauperate' eddy through the area.

These preliminary data indicate that the physical and biological processes occurring within the eddy are largely distinct from those in surrounding water masses. Tranter *et al.* (1980) have documented a time lag of 1 - 2 months between the development of a phytoplankton bloom inside a warm-core eddy (eddy F) and in the surrounding water masses. They argue that, during winter, phytoplankton productivity inside the eddy is light limited because of the deep mixing to depths beyond the 'critical depth'. During summer, the situation is reversed. A warm cap forms over the eddy core and phytoplankton levels in the mixed layer are higher inside the eddy than outside the eddy. Differences in nutrient cycling and phytoplankton productivity may affect the distribution and abundance of species of higher trophic levels. The apparent advection of warm surface water into the northeast section of eddy J during the present study suggests that the eddies are not completely isolated from the surrounding water masses.

Our time-series analyses of eddy J should help answer such questions as: How isolated (physically and biologically) is the eddy from surrounding water masses? What originally establishes these distinct communities? How have they evolved through time? What are the mechanisms maintaining the biological contrasts? What is the impact of these eddies on to the pelagic community as a whole?

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Table 1: Station information for hydrology samples.

Station	Date	Time	Position Latitude °S	 Longitude °E	XBT
1	21.9.79	1010	33 49.7	153 33.9	42
2	22.9.79	0620	33 14.9	153 31.8	52
3	22.9.79	0920	33 23.5	153 26.6	53
4	22.9.79	1605	33 16.0	154 03.5	-
5	23.9.79	0630	32 58.8	154 18.6	69
6	23.9.79	1545	32 50.5	154 42.0	77
7	25.9.79	0620	33 43.7	153 19.2	103
8	25.9.79	1235	34 08.5	153 28.6	106
9	26.9.79	0750	34 22.5	153 36.5	114
10	26.9.79	1230	34 18.2	153 40.8	115
11	27.9.79	0655	34 30.8	153 43.8	-
12	27.9.79	1100	34 40.1	153 43.9	-
13	29.9.79	0650	33 12.0	154 31.5	182
14	29.9.79	1030	33 10.1	154 24.9	183
15	29.9.79	1540	33 06.6	154 37.7	184
16	30.9.79	1000	33 35.2	153 28.5	-
17	30.9.79	1505	33 28.2	153 09.3	192
18	1.10.79	0630	33 20.0	152 46.6	196
19	1.10.79	1130	33 20.8	152 28.8	197
20	2.10.79	0630	33 24.9	152 15.9	208
21	2.10.79	1035	33 25.5	152 10.0	209
22	3.10.79	0510	33 41.7	152 10.2	-
23	3.10.79	0710	33 43.2	152 03.3	-
24	3.10.79	0835	33 44.2	151 59.1	-
25	3.10.79	1005	33 43.3	151 48.2	-

Table 2: Station information for midwater trawl samples. A dash (-) indicates no data collected.

Station	Start					Duration	Finish			Acoustic	Total catch
	Date	Time	XBT no.	Position Latitude °S	Position Longitude °E	(mins)	XBT no.	Position Latitude °S	Position Longitude °E	tape no.	(grams)
01	21. 9.79	1843	46	33 18.4	153 58.1	90	47	33 15.7	153 57.1	2	475
02	21. 9.79	2110	47	33 11.9	153 55.3	70	48	33 09.4	153 54.3	3	425
03	21. 9.79	2230	48	33 08.0	153 52.0	70	49	33 08.0	153 47.0	4	745
04	22. 9.79	0030	49	33 07.3	153 43.4	60	50	33 06.3	153 38.8	5	500
05	22. 9.79	0155	50	33 05.9	153 36.3	70	-	33 05.3	153 29.8	6	1435
06	22. 9.79	1920	60	33 10.3	154 03.8	65	61	33 09.0	154 03.7	7	3130
07	22. 9.79	2055	61	33 08.6	154 03.5	75	-	33 07.1	154 03.2	8	1245
08	22. 9.79	2340	65	33 04.7	154 07.9	75	66	33 04.3	154 06.9	9	3040
09	23. 9.79	0125	66	33 03.7	154 07.2	65	-	33 03.0	154 07.3	9	2260
10	23. 9.79	0340	67	33 01.6	154 12.4	65	-	33 01.3	154 14.8	10	1700
11	23. 9.79	1835	-	32 50.9	154 41.4	60	78	32 50.2	154 41.8	11	1175
12	25. 9.79	0340	103	33 45.5	153 23.6	60	-	33 44.0	153 20.2	16	215
13	25. 9.79	1825	107	33 44.7	153 24.7	65	-	33 45.3	153 22.3	20	335
14	25. 9.79	1957	-	33 45.4	153 21.7	65	108	33 45.5	153 19.3	21	365
15	25. 9.79	2120	108	33 45.6	153 18.5	60	109	33 46.0	153 16.3	22	375
16	25. 9.79	2253	109	33 46.3	153 15.3	60	110	33 47.1	153 13.1	23	425
17	26. 9.79	0018	110	33 47.5	153 12.6	62	-	33 48.0	153 11.8	24	245
18	26. 9.79	0315	112	33 59.3	153 14.2	65	-	33 59.5	153 14.0	25	205
19	26. 9.79	1820	119	34 32.7	153 42.4	65	120	34 33.2	153 42.3	26	19210
20	26. 9.79	2000	120	34 33.4	153 42.3	65	121	34 33.8	153 42.2	27	17715
21	26. 9.79	2120	121	34 34.3	153 42.4	65	122	34 35.5	153 43.0	28	1370
22	26. 9.79	2300	122	34 36.0	153 43.2	65	123	34 37.5	153 42.8	29	7885
23	27. 9.79	0030	123	34 38.8	153 42.6	70	124	34 40.0	153 42.3	30	17690
24	27. 9.79	0330	127	34 29.5	153 44.3	65	128	34 30.6	153 45.0	31	8455
25	27. 9.79	1830	131	34 24.0	153 45.5	65	132	34 24.8	153 47.3	33	9220
26	29. 9.79	1855	185	33 09.5	154 34.0	115	-	33 12.5	154 32.3	35	33530
27	29. 9.79	2315	186	33 17.6	154 30.7	65	187	33 19.0	154 30.8	36	1260
28	30. 9.79	0150	188	33 21.8	154 25.0	70	-	33 23.0	154 24.8	37	6055
29	30. 9.79	1835	193	33 27.4	153 07.5	65	194	33 26.0	153 07.3	38	270
30	30. 9.79	2018	194	33 25.1	153 07.4	65	-	33 23.7	153 07.7	39	3205
31	30. 9.79	2140	-	33 22.8	153 07.8	150	-	33 19.2	153 05.3	40	105
32	1.10.79	0210	195	33 16.6	153 03.6	65	-	33 15.7	153 02.5	41	175
33	1.10.75	0340	-	33 15.2	153 01.9	65	-	33 13.0	153 00.1	42	075
34	1.10.79	1825	198	33 27.9	152 14.8	65	199	33 28.1	152 15.0	43	3235
35	1.10.79	1955	199	33 28.3	152 14.4	65	200	33 28.5	152 13.1	44	960
36	1.10.79	2115	200	33 28.5	152 12.9	60	201	33 29.0	152 11.4	45	1355
37	1.10.79	2353	203	33 29.9	152 22.7	63	204	33 30.4	152 21.4	46	430
38	2.10.79	0125	204	33 30.6	152 20.6	60	205	33 31.2	152 19.1	47	625
39	2.10.79	0320	206	33 31.2	152 21.3	60	207	33 30.8	152 21.3	48	355
40	2.10.79	1835	210	33 32.8	152 34.2	60	211	33 31.6	152 31.8	49	6360
41	2.10.79	2000	211	33 32.1	152 31.0	60	212	33 32.7	152 30.1	50	815
42	2.10.79	2220	213	33 31.8	152 18.0	60	214	33 33.4	152 12.2	51	9535
43	3.10.79	0017	215	33 34.5	152 07.0	60	216	33 34.8	152 03.0	52	2640
44	3.10.79	0137	216	33 34.8	152 03.5	60	217	33 35.6	152 04.5	53	1055
45	3.10.79	0300	217	33 35.9	152 05.0	60	-	33 36.5	152 02.5	54	1430

Table 3: Depths and temperatures of midwater trawls. Values were calculated from 1.8 - 3.6 min interval readings of a continuous chart. Some temperature values were estimated using thermal profiles taken at the beginning and end of the tow and the continuous record of trawl depth.

Station	Depth			Temperature		
	mean	minimum	maximum	mean	minimum	maximum
1	49	35	52	19.5	19.4	19.7
2	98	82	107	18.6	18.6	18.8
3	189	182	200	16.9	16.0	17.3
4	14	10	18	18.5	18.5	18.5
5	266	225	324	14.2	13.0	15.7
6	192	178	216	15.6	15.0	15.7
7	57	37	60	17.9	17.8	17.9
8	88	80	106	17.8	17.5	17.8
9	200[a]	-	-	15.4	-	-
10	101[a]	-	-	17.8	-	-
11	47	42	52	18.8	18.8	18.8
12	101	93	112	18.6	18.6	18.6
13	214	199	223	18.6	18.6	18.6
14	56	53	59	18.6	18.6	18.6
15	338	318	358	17.6	16.4	18.6
16	30	28	31	18.6	18.5	18.6
17	276	259	297	18.6	18.6	18.6
18	215	198	232	18.5	18.5	18.5
19	236	232	241	12.3	12.1	12.5
20	51	49	54	17.0	16.7	17.2
21	300	296	311	11.6	11.5	11.7
22	11	10	13	17.2	17.2	17.3
23	86	79	110	15.6	15.2	15.7
24	206	194	236	13.8	12.7	14.0
25	110[a]	-	-	16.8	-	-
26	19[a]	-	-	17.7	-	-
27	216	198	233	14.7	13.7	15.2
28	304[a]	-	-	12.3	-	-
29	270	256	278	18.7	18.7	18.7
30	18	16	22	18.7	18.7	18.7
31	101	90	112	18.7	18.7	18.7
32	222	186	242	18.7	18.7	18.7
33	50	46	60	18.7	18.7	18.7
34	368	360	376	10.9	10.7	11.3
35	104	101	109	17.4	17.2	17.7
36	208	200	220	14.1	13.5	14.4
37	306	292	376	14.2	12.4	14.8
38	209	201	214	15.4	15.0	15.5
39	184	176	231	16.5	15.3	16.9
40	271	250	312	15.5	14.0	16.2
41	215	209	219	17.0	16.7	17.7
42	16	15	19	19.0	18.7	19.3
43	60	57	62	18.0	17.9	18.1
44	93	90	99	17.7	17.6	17.8
45	19	19	20	18.2	18.2	18.2

(a) Depth estimated from wire angle. No minimum or maximum values for depth or temperature are available.

Table 4: Maximized *in vivo* chlorophyll *a* fluorescence (F_M) profiles at hydrology stations. Values are uncorrected for diel cycles, SCAF units.

	Depth (m)						
Station	2	5	10	25	50	75	100
1	63	62	66	72	71	68	67
2	64	67	78	89	94	98	92
3	51	47	64	89	111	107	104
4	101	104	111	114	133	117	95
5	202	209	199	114	54	48	42
6	152	152	149	149	330	43	27
7	42	36	39	49	66	68	64
8	50	53	68	104	133	139	123
9	84	88	91	107	107	107	114
10	51	59	55	117	130	117	120
11	215	221	243	320	280	82	149
12	186	199	240	629	265	55	55
13	218	221	212	284	205	199	55
14	161	164	174	174	174	136	95
15	355	355	355	350	294	145	213
16	37	38	39	55	63	79	80
17	91	90	98	126	136	118	92
18	74	81	74	73	32	33	32
19	85	86	107	171	205	228	209
20	202	221	218	234	81	72	48
21	136	205	340	430	355	380	131

Table 5: Photochemical quantum efficiency (Φp) from *in vivo* fluorescence profiles at hydrology stations. Values are uncorrected for light.

	Depth (m)						
Station	2	5	10	25	50	75	100
1	.27	.26	.32	.38	.51	.53	.51
2	.28	.33	.38	.44	.51	.56	.58
3	.22	.26	.27	.38	.49	.52	.55
4	.44	.50	.48	.53	.57	.56	.56
5	.38	.36	.40	.48	.52	.50	.60
6	.52	.52	.53	.51	.52	.44	.44
7	.33	.28	.33	.40	.53	.57	.59
8	.22	.23	.28	.40	.49	.54	.58
9	.30	.32	.34	.41	.54	.52	.58
10	.20	.22	.22	.38	.49	.56	.56
11	.44	.43	.44	.53	.55	.37	.56
12	.41	.42	.46	.42	.59	-	-
13	.51	.50	.51	.53	.54	.51	.44
14	.39	.40	.47	.51	.53	.62	.61
15	.50	.51	.53	.53	.53	.51	.46
16	.16	.21	.21	.32	.37	.53	.46
17	.26	.28	.32	.43	.58	.56	.59
18	.31	.36	.27	.26	.50	.56	.55
19	.18	.16	.24	.39	.51	.58	.55
20	.38	.41	.42	.51	.52	.48	.46
21	.18	.29	.40	.51	.55	.51	.50

Table 6: Photosynthetically useful radiation (μ Einsteins $m^{-2}s^{-1}$) or Secchi disc depth (Zs) at hydrology stations.

Station	Depth (m)							
	Air	2	5	10	25	50	75	100
1 (1st)	273	186	91	58	33	13	5.4	
1 (2nd)	-	132	-	46	-	8.9	4.1	1.9
2		373	236	166	79	26	9.1	3.5
3		845	472	-	186	66	24	8.7

Station	Secchi disc depth (m)
8	30
9	34
10	32
11	18
12	17
13	17
14	16
20	19
21	19

Table 7: Total catch of species of the family Myctophidae.

Species	Catch
Electrona risso	9
Hygophum hygomii	366
Hygophum reinhardtii	15
Benthosema suborbitale	291
Myctophum asperum	5
Myctophum phengodes	5
Symbolophorus barnardi	6
Lobianchia gemellarii	4
Lobianchia dofleini	13
Diaphus meadi	180
Diaphus mollis	23
Diaphus danae	25
Diaphus termophilus	68
Diaphus metopoclampus	6
Diaphus parri	9
Diaphus fragilis	4
Diaphus anderseni	2
Diaphus brachycephalus	6
Diaphus perspicillatus	1
Lampichthys procerus	1
Lampanyctodes hectoris	4
Lampanyctus lepidolychnus	16
Lampanyctus australis	30
Lampanyctus alatus	311
Lampanyctus festivus	16
Lampanyctus ater	34
Lampanyctus pusillus	37
Bolinichthys nikolayi	11
Centrobranchus nigroocellatus	8
Notolynchus valdiviae	68
Diogenichthys atlanticus	39
Ceratoscopelus warmingii	42
Notoscopelus resplendens	32
Scopelopsis multipunctatus	186
Total	1,873

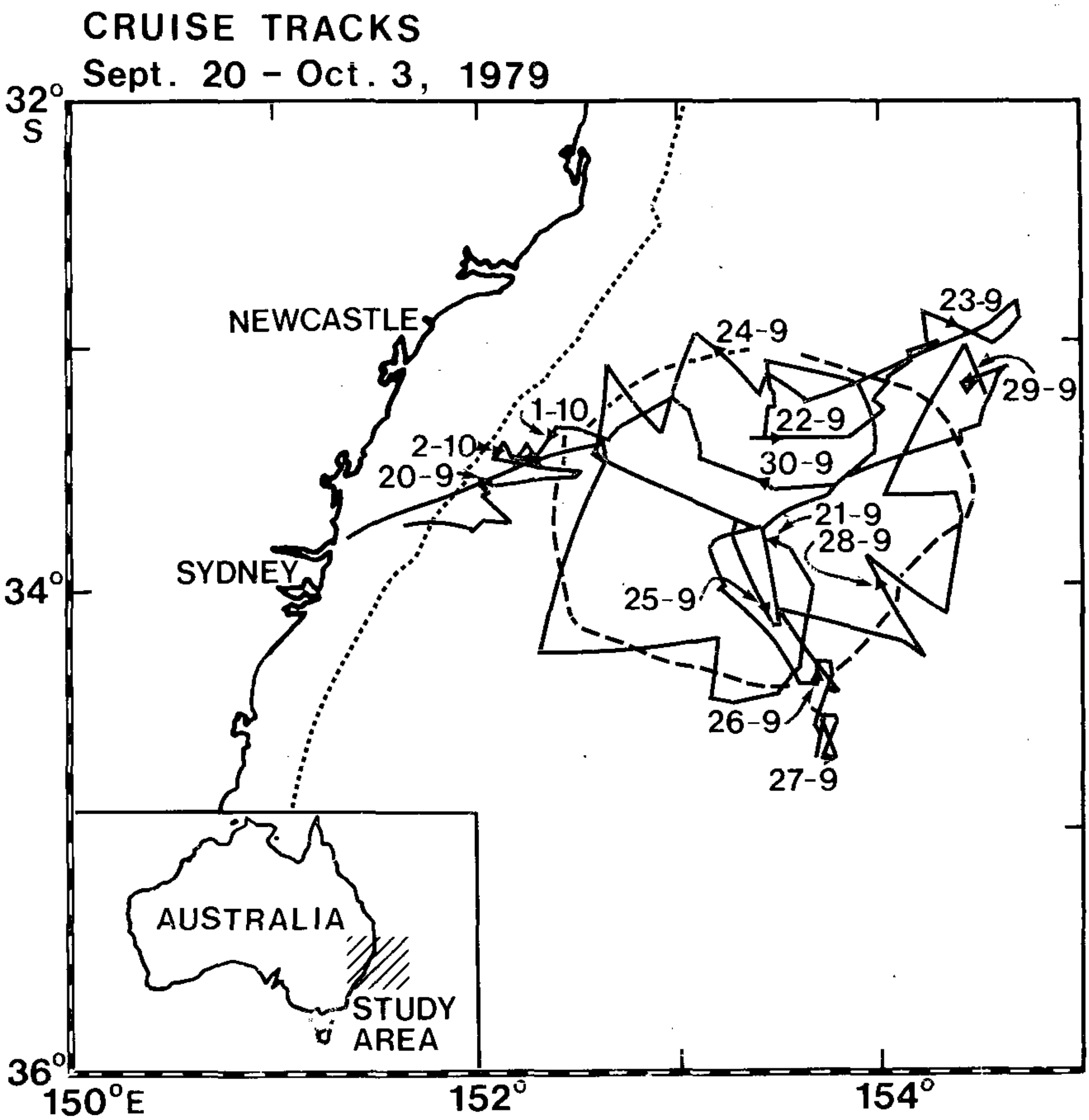


Fig. 1. Cruise track for *Sprightly* SP10/79 from 20 September to 3 October 1979. The arrow associated with each date denotes the 1200 hr position. The dotted line marks the position of the 15°C isotherm at a depth of 250m.

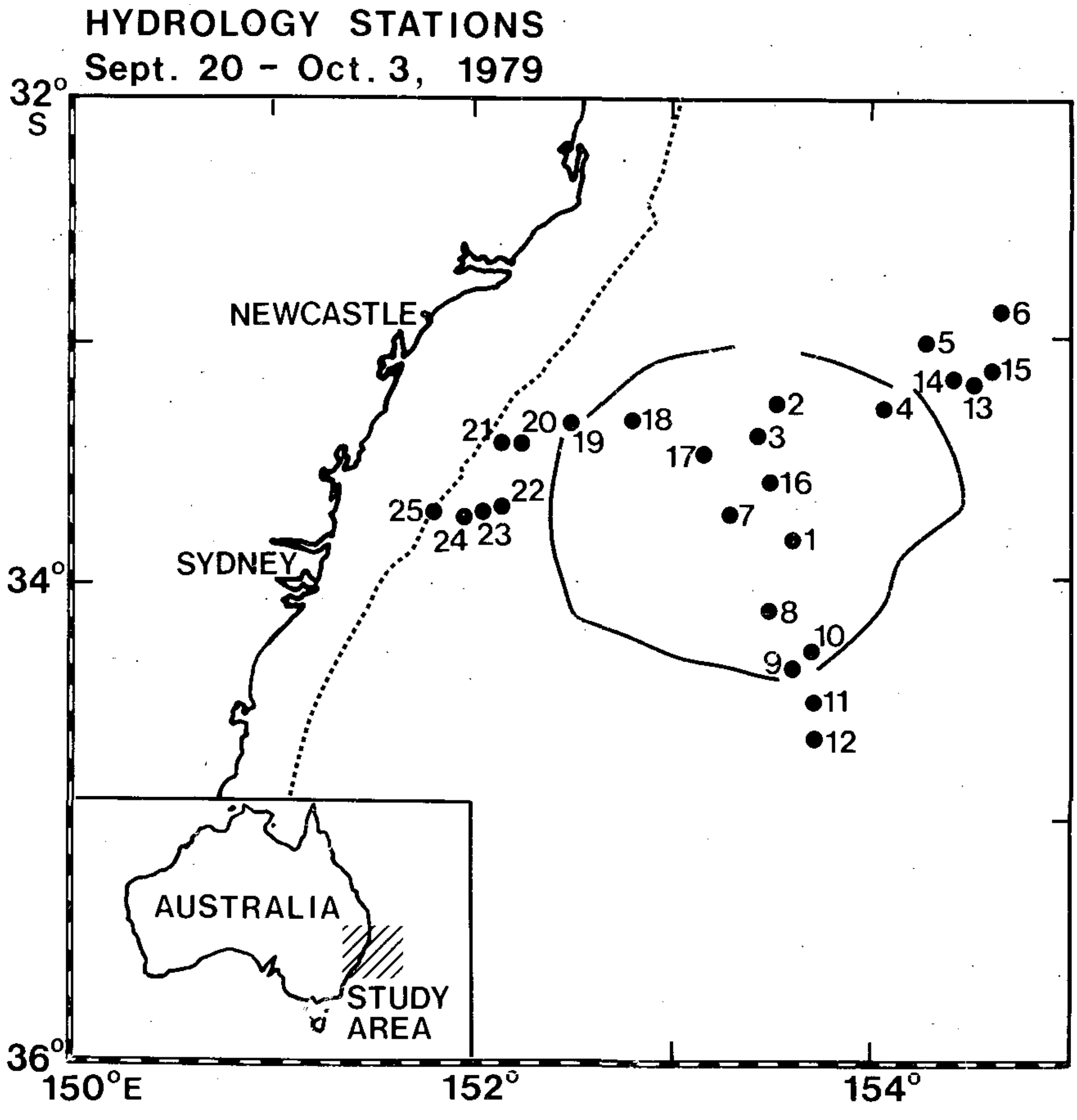


Fig. 2. Location of hydrology stations sampled during 20 September to 3 October 1979 in relation to the position of the 15.0°C isotherm at 250m (solid line).

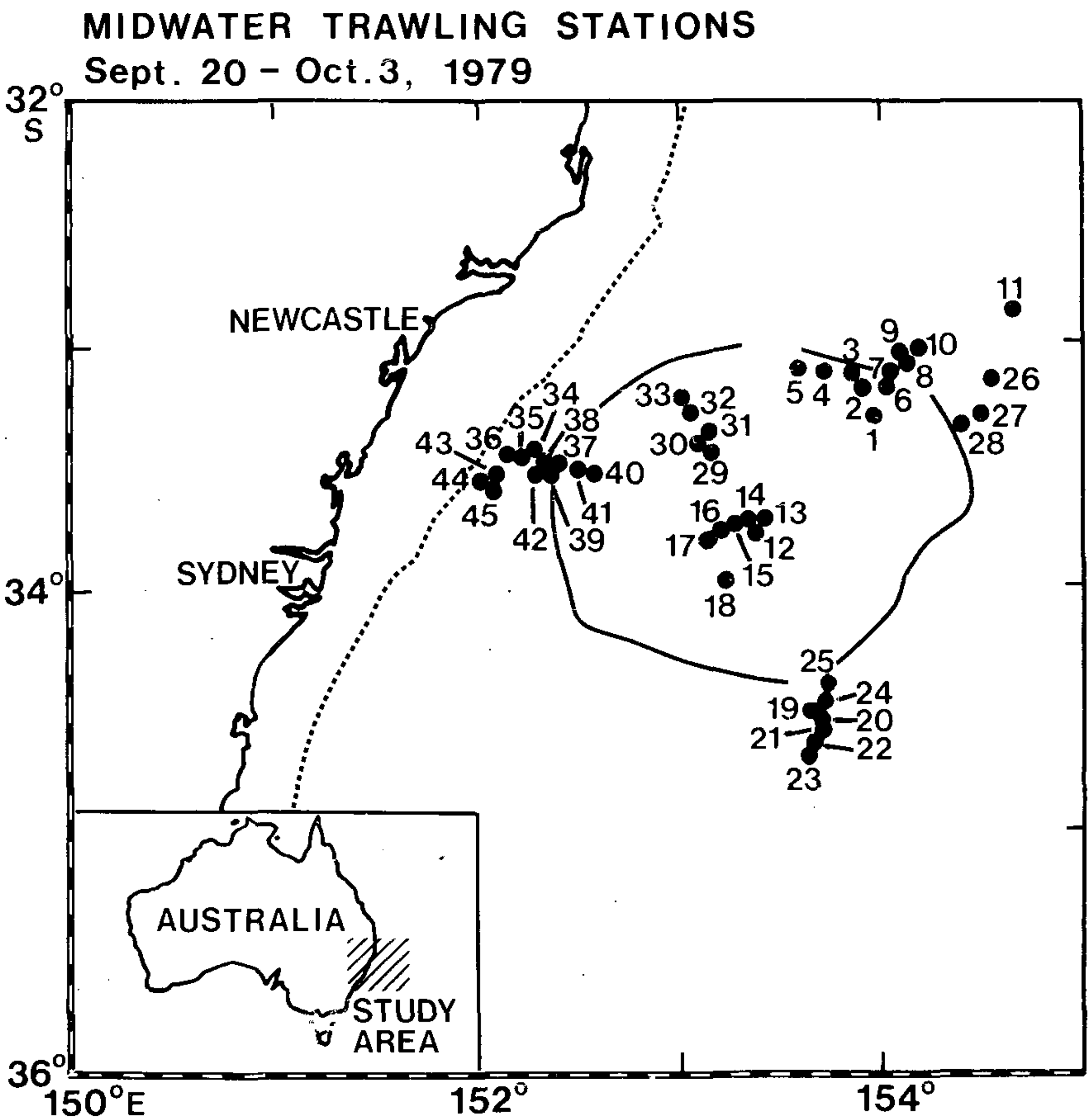


Fig. 3. Location of midwater trawl stations sampled during 20 September to 3 October 1979 in relation to the position of the 15.0°C isotherm at 250m (solid line).

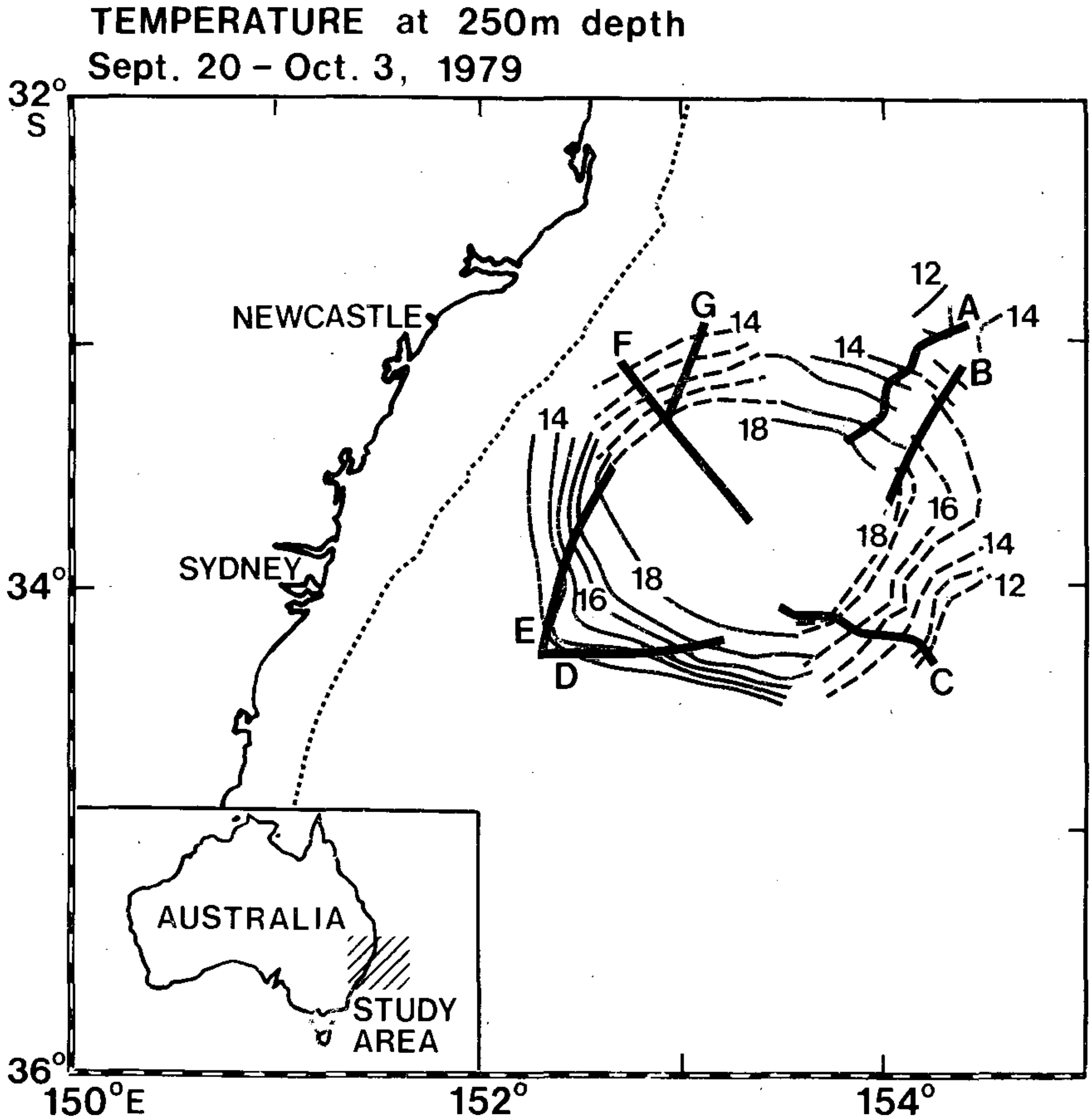


Fig. 4. Temperature at 250m during 20 September to 3 October 1979. The alternating solid and dashed lines represent four mapping sequences (see text for details). Location of XBTs are given in Fig. 5. Heavy lines (A - G) show locations of thermal cross-sections of Figs 6-12.

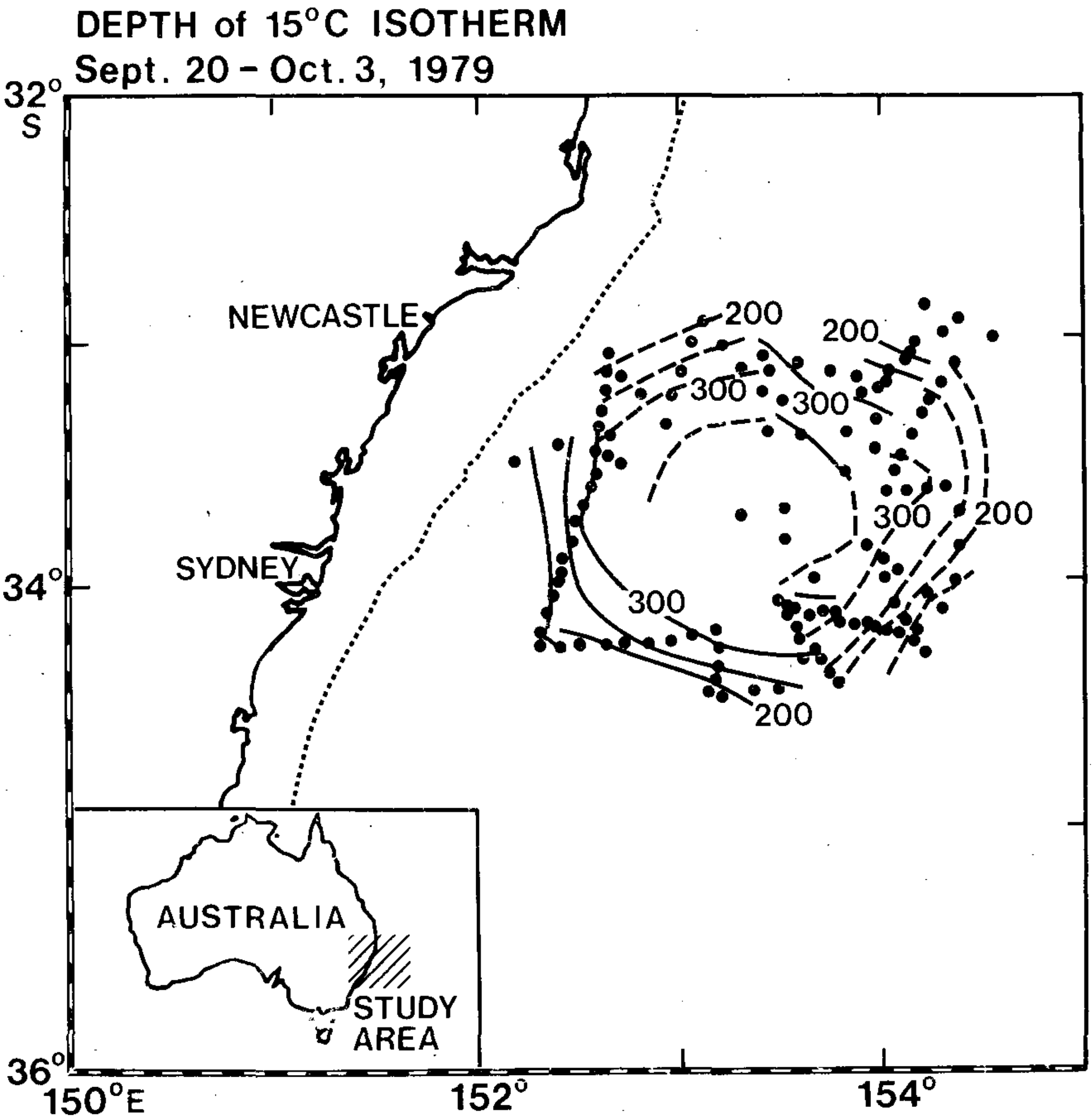


Fig. 5. Depth (m) of 15.0°C isotherm during 20 September to 3 October 1979. The alternating solid and dashed lines represent 4 mapping sequences separated in time (see text for details). Dots represent XBT locations during mapping.

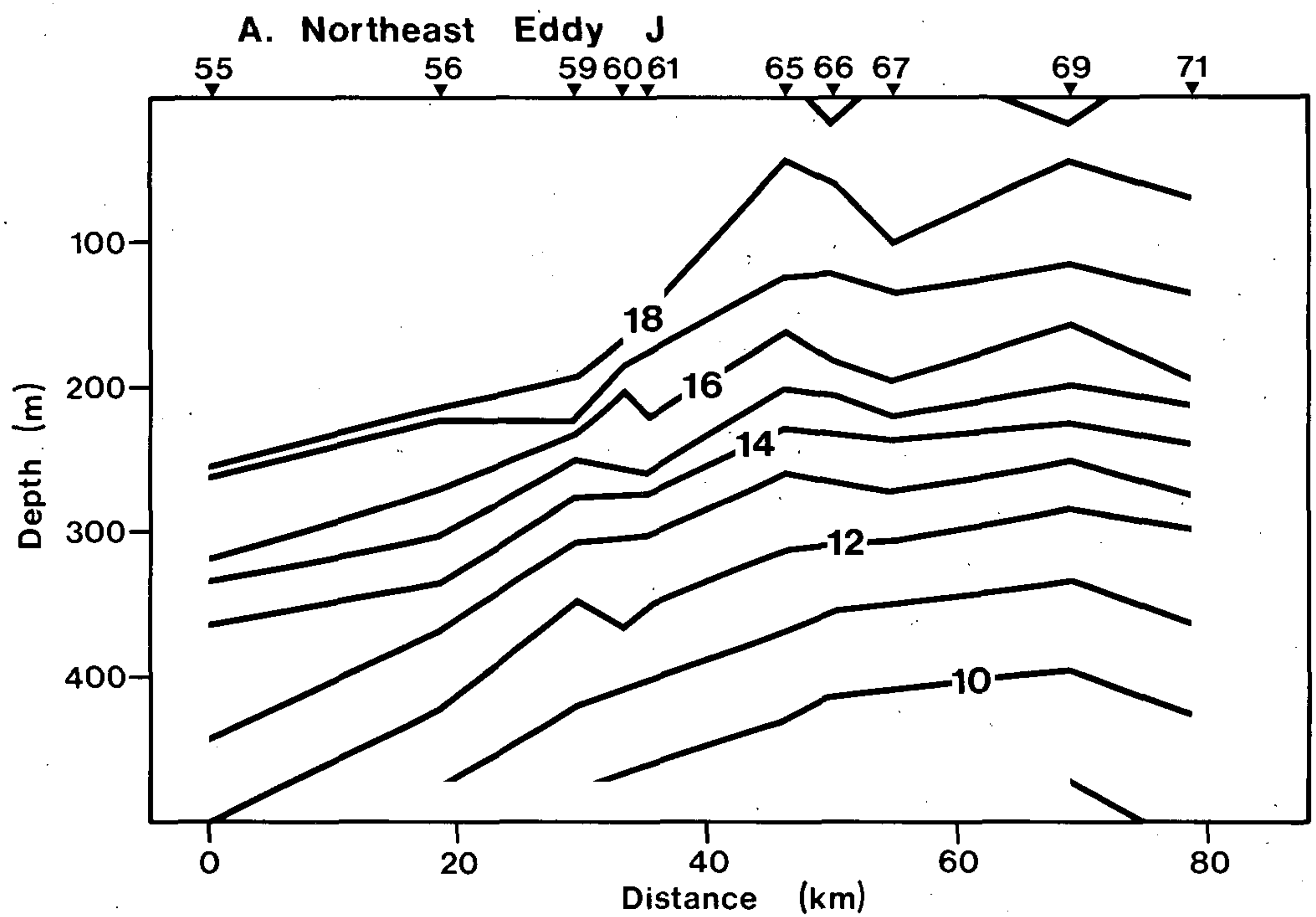


Fig. 6. Thermal cross section (A of Fig. 4) of eddy J. Station numbers are shown at the top.

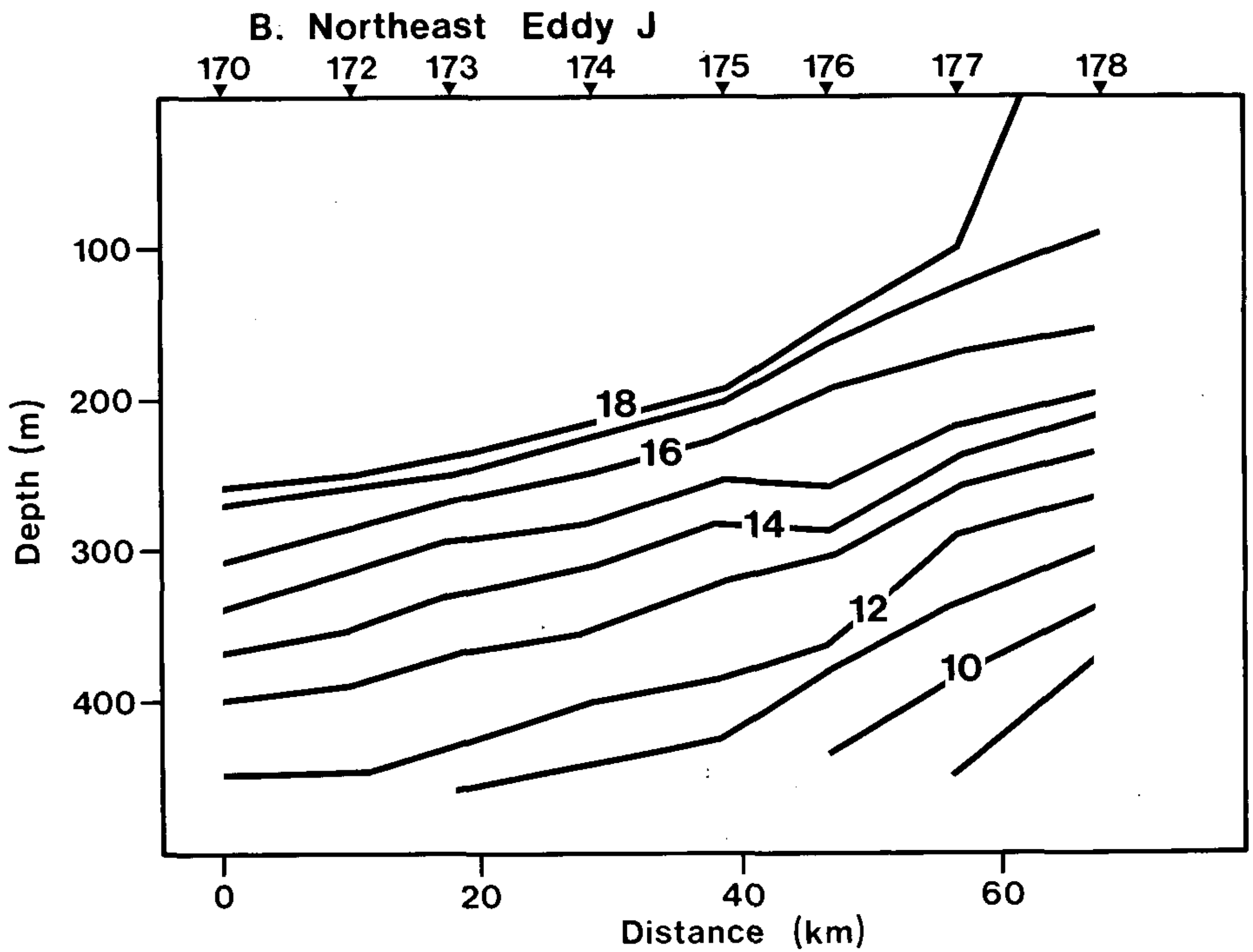


Fig. 7. Thermal cross section (B of Fig. 4) of eddy J. Station numbers are shown at the top.

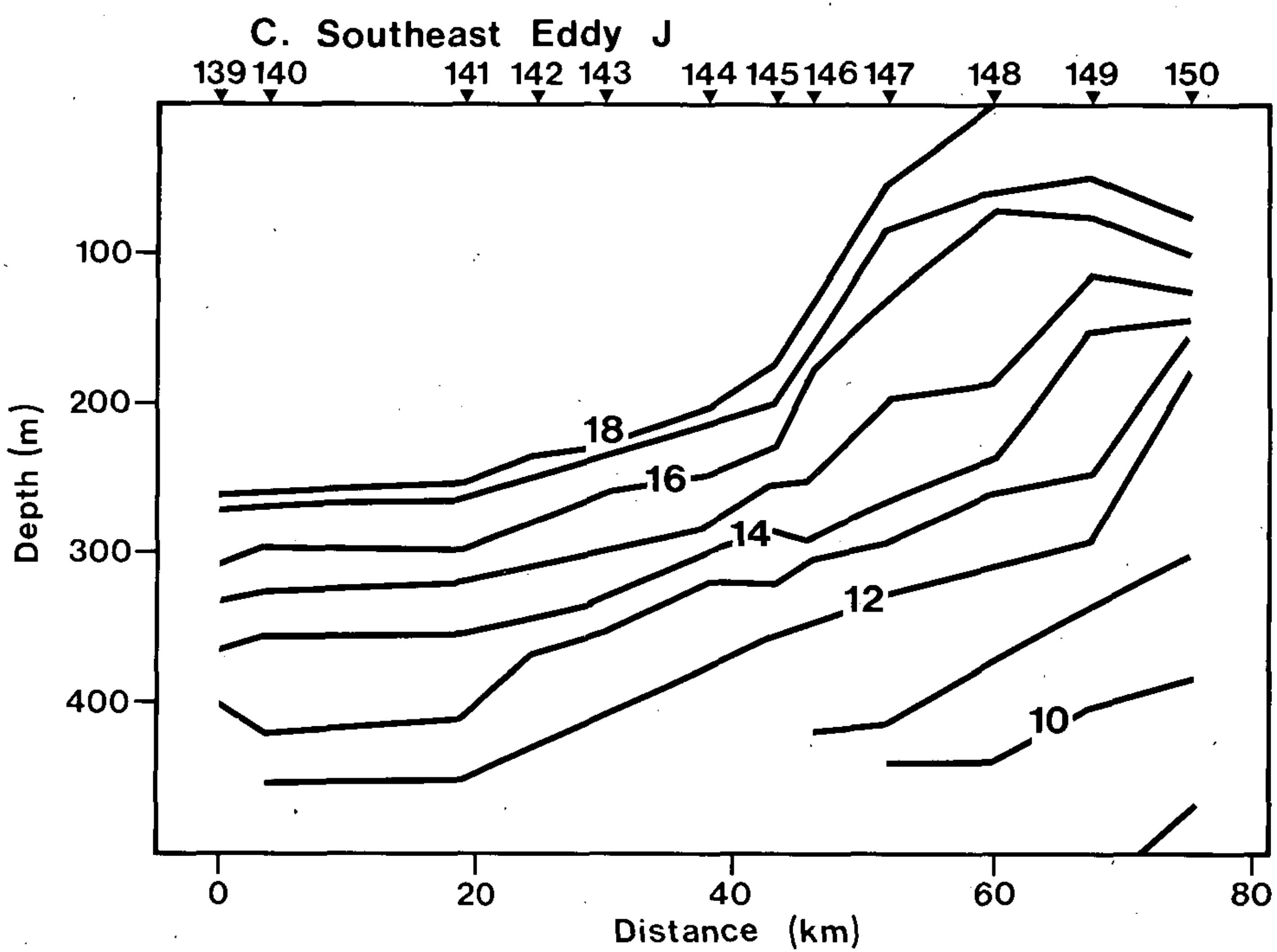


Fig. 8. Thermal cross section (C of Fig. 4) of eddy J. Station numbers are shown at the top.

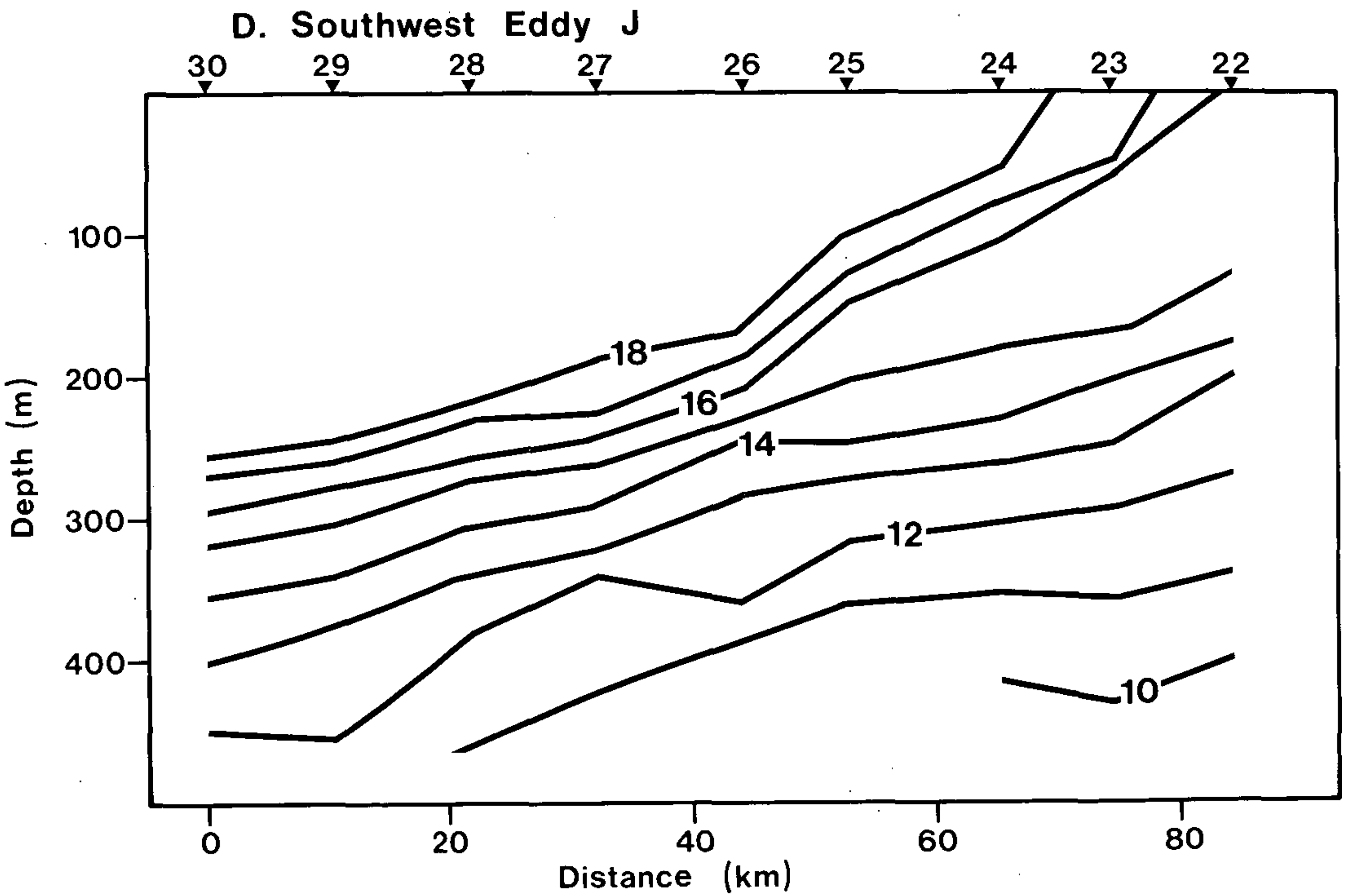


Fig. 9. Thermal cross section (D of Fig. 4) of eddy J. Station numbers are shown at the top.

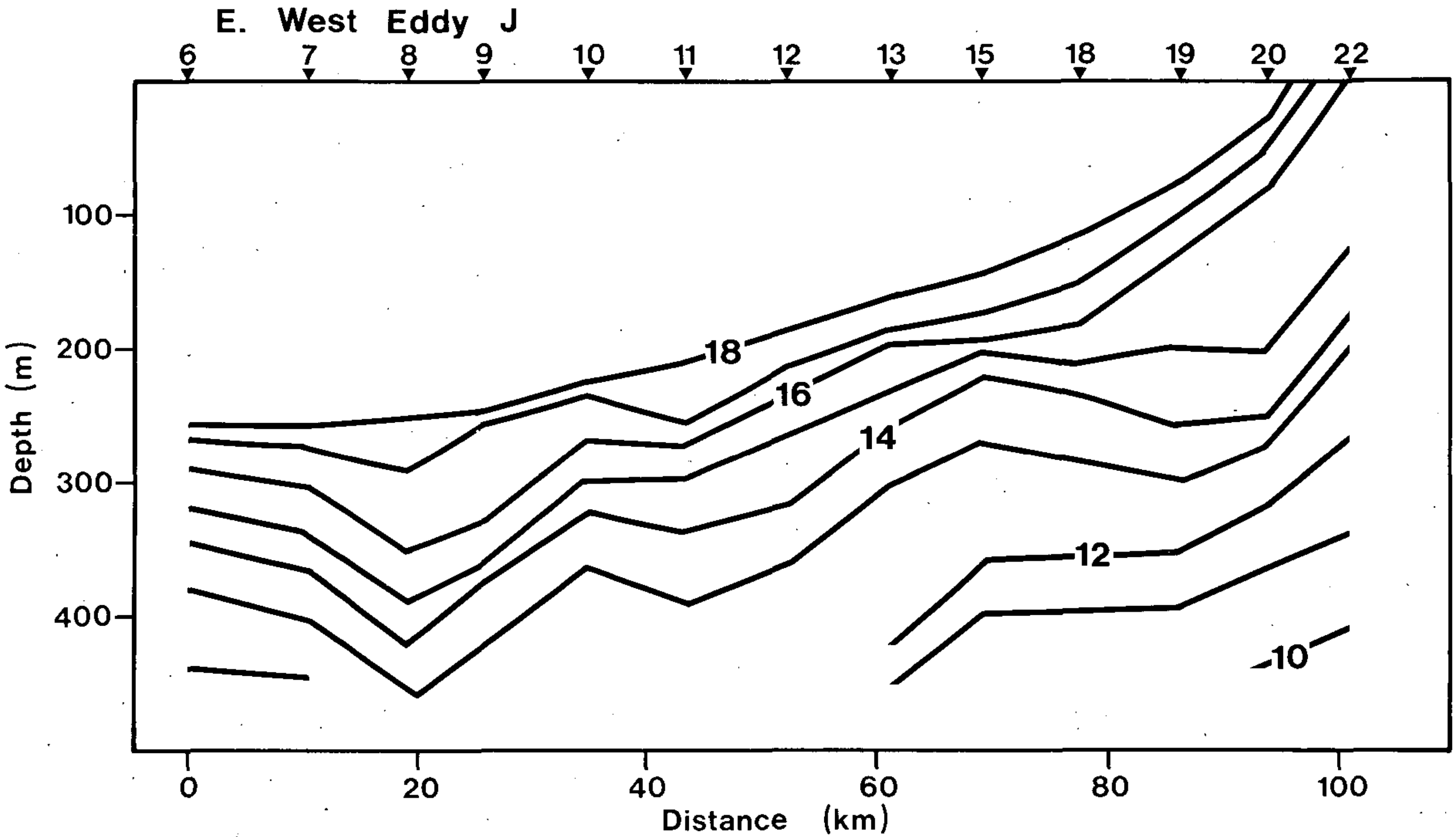


Fig. 10. Thermal cross section (E of Fig. 4) of eddy J. Station numbers are shown at the top.

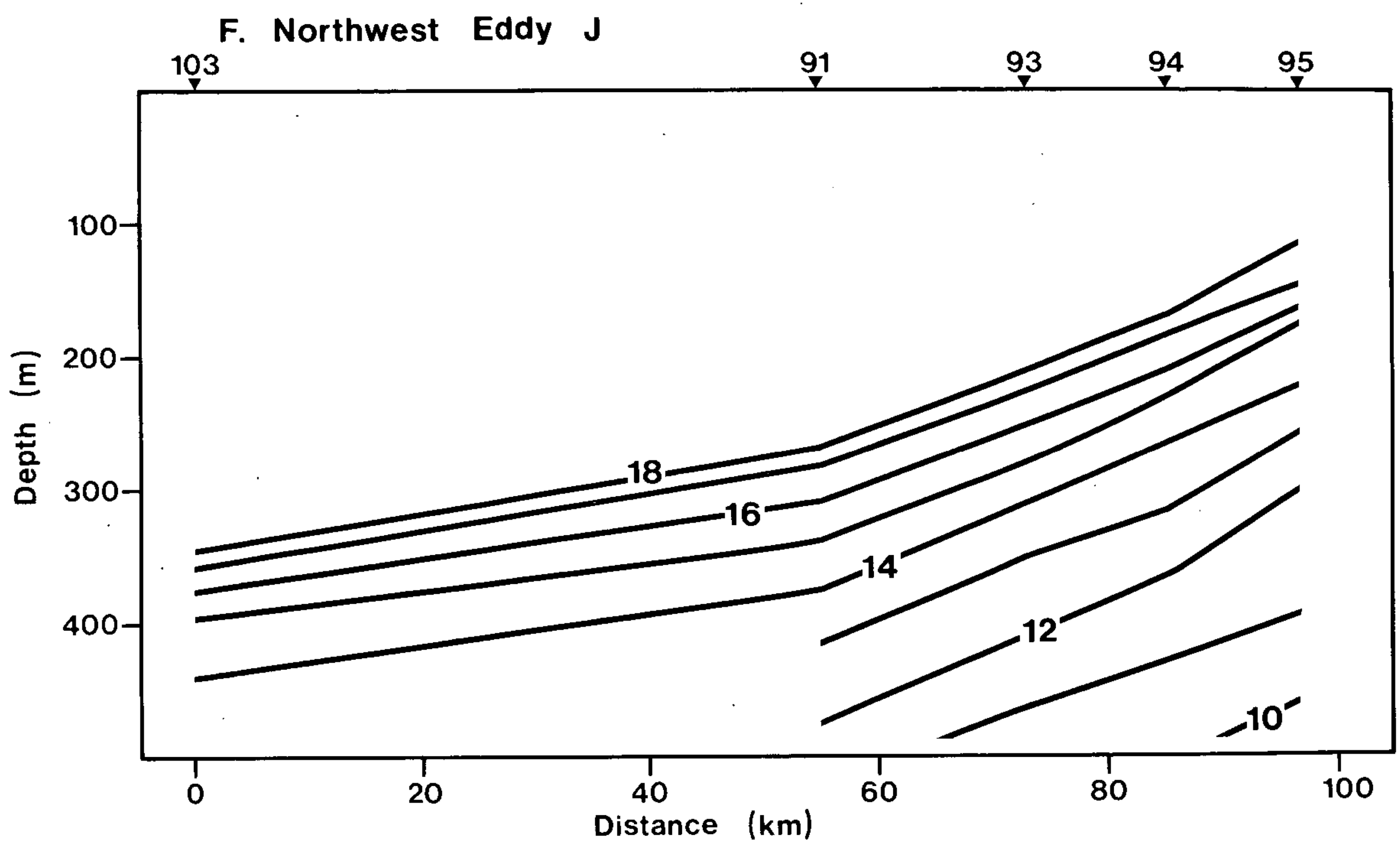


Fig. 11. Thermal cross section (F of Fig. 4) of eddy J. Station numbers are shown at the top.

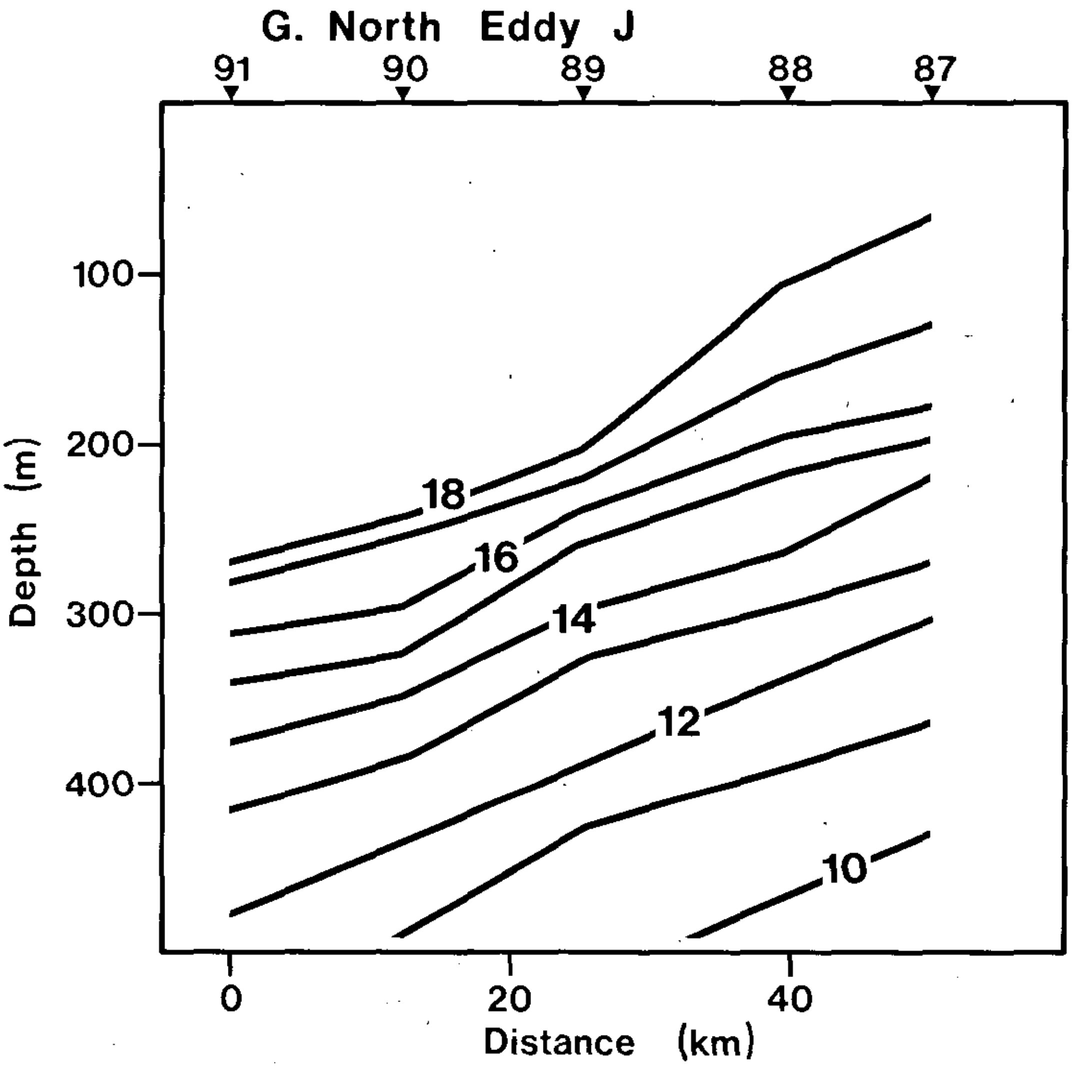


Fig. 12. Thermal cross section (G of Fig. 4) of eddy J. Station numbers are shown at the top.

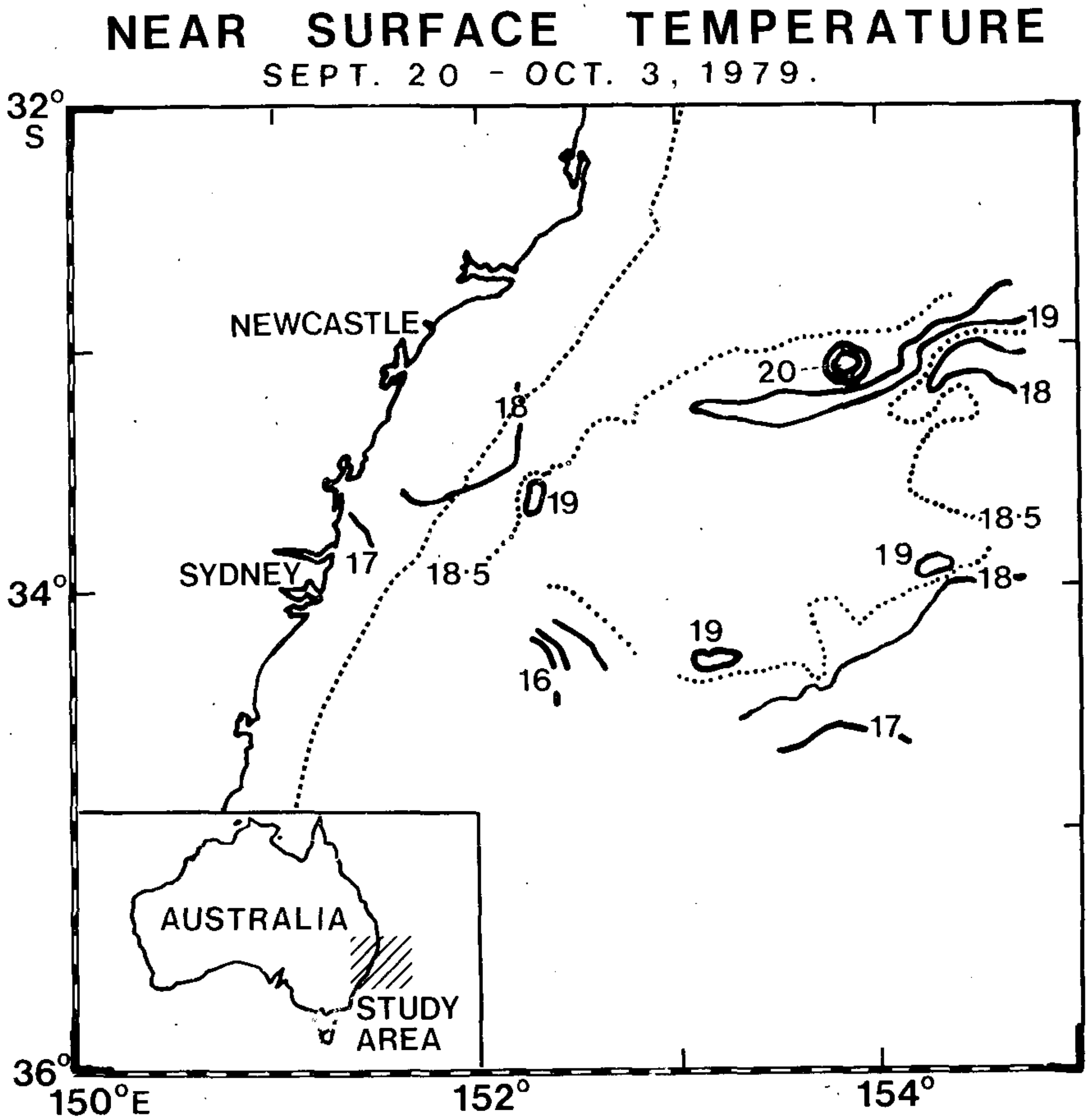


Fig. 13. Temperature at a depth of 5m. Data are taken from XBT measurements.

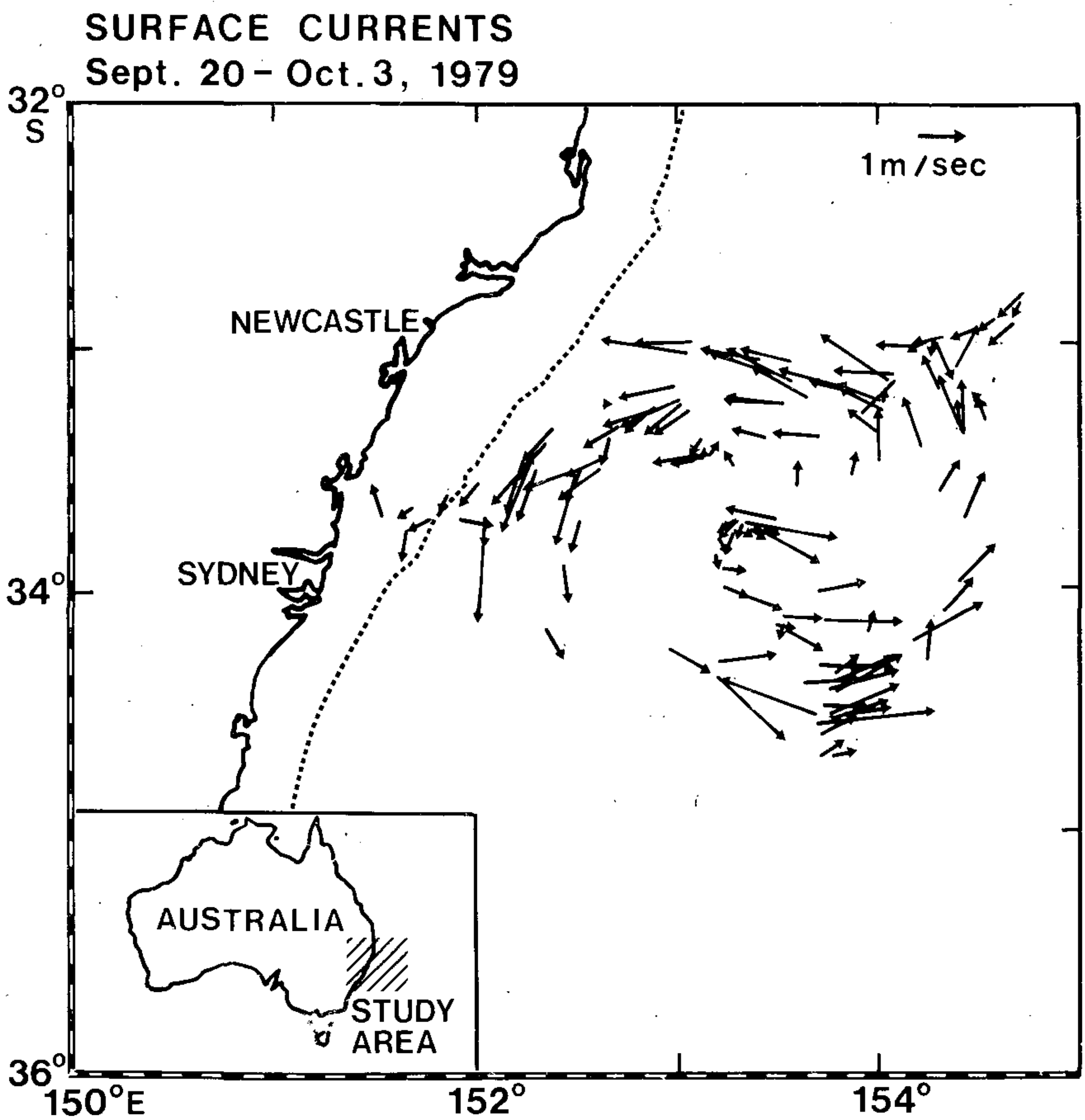


Fig. 14. Speed and direction of surface currents estimated from ship's drift using satellite navigation.

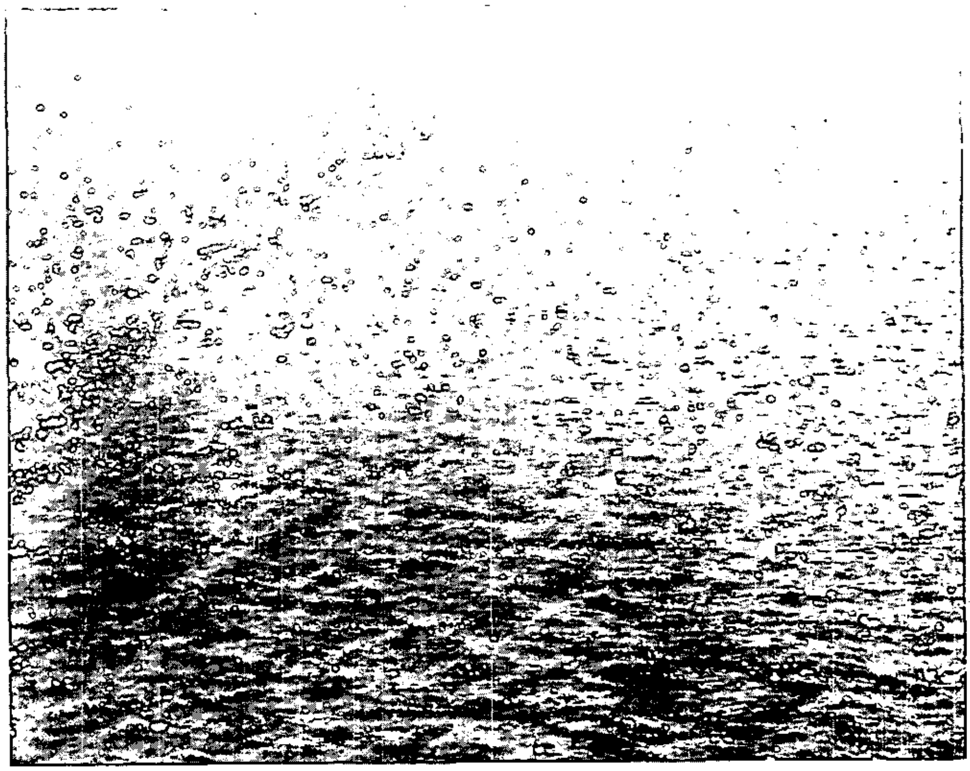


Fig. 15. Photograph taken of the surface front on the south-southeastern edge of eddy J on 13 September 1979 from an altitude of approximately 500m.

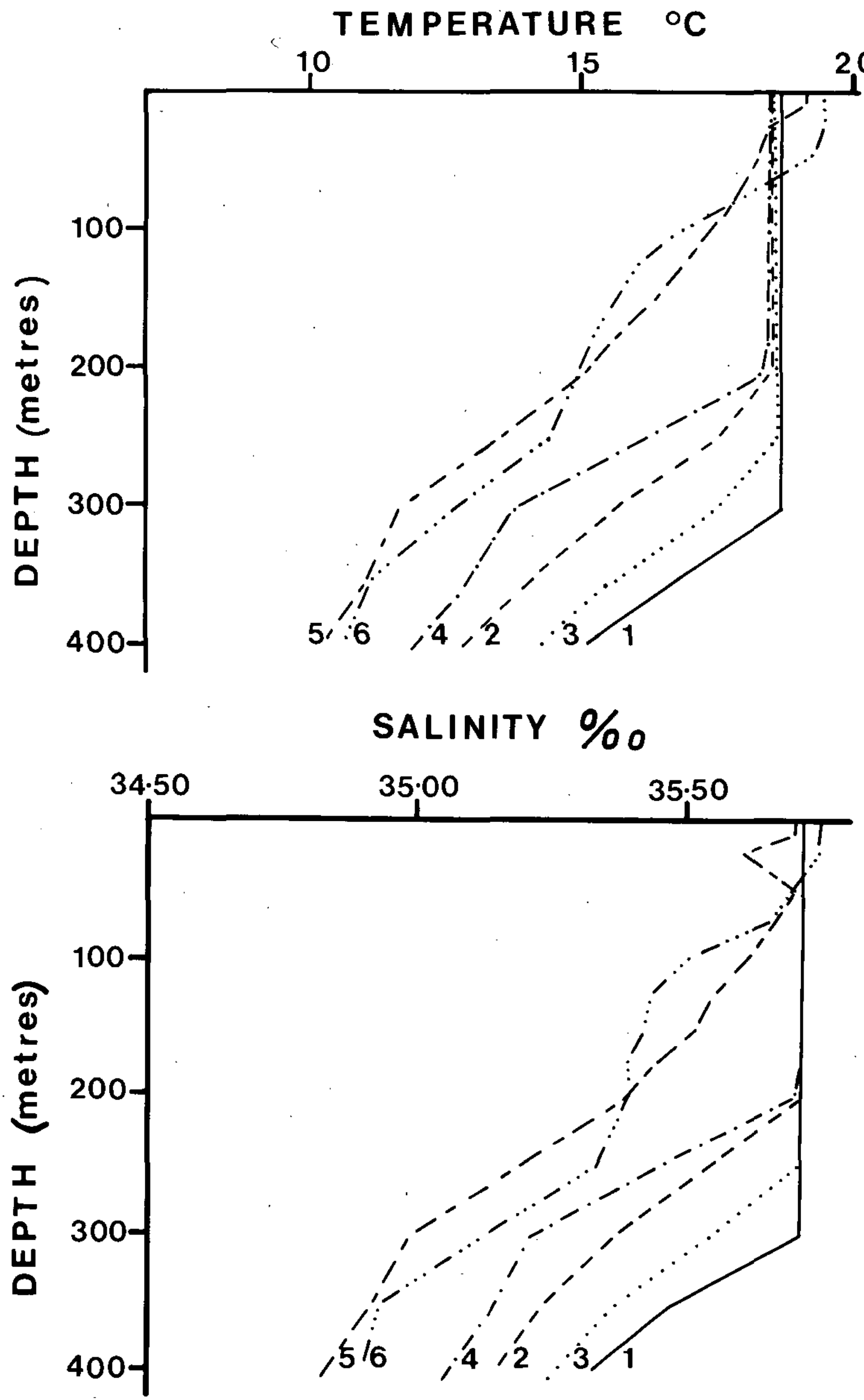
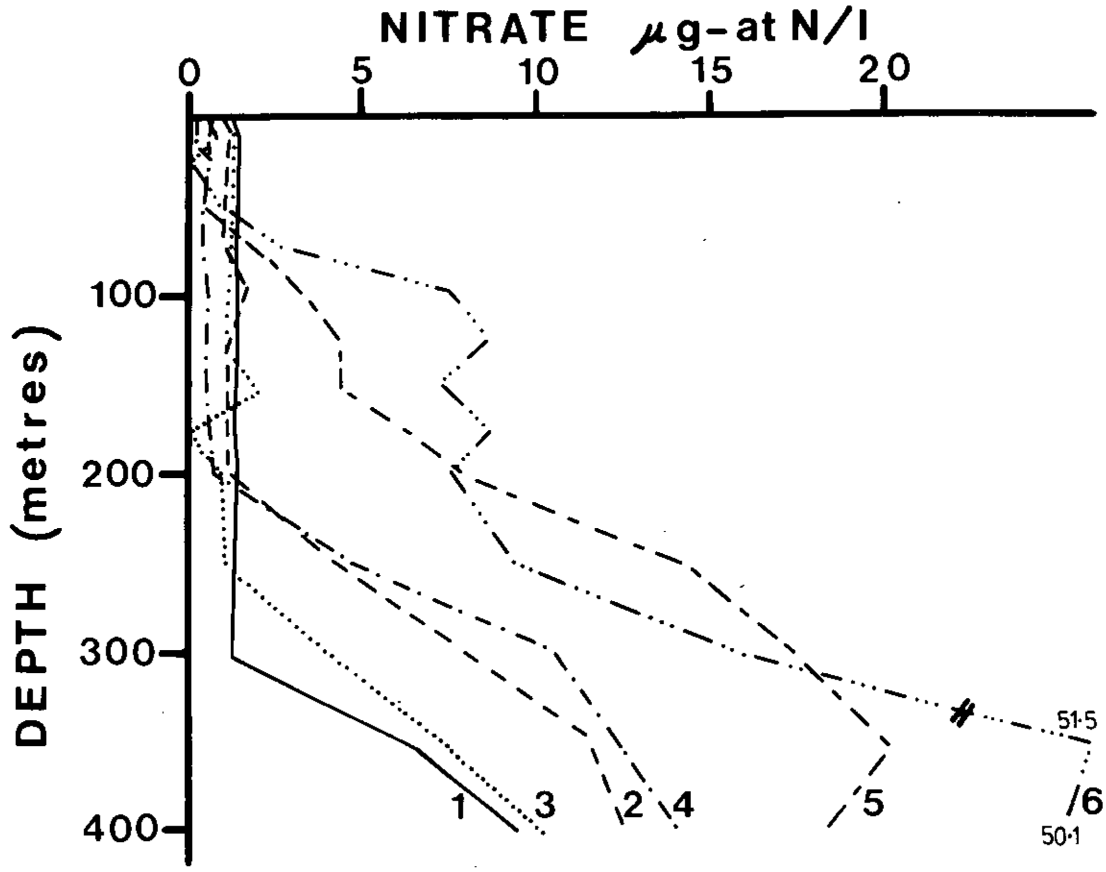


Fig. 16. Temperature and salinity profiles for hydrology stations 1-6 on the northeast section of eddy J.



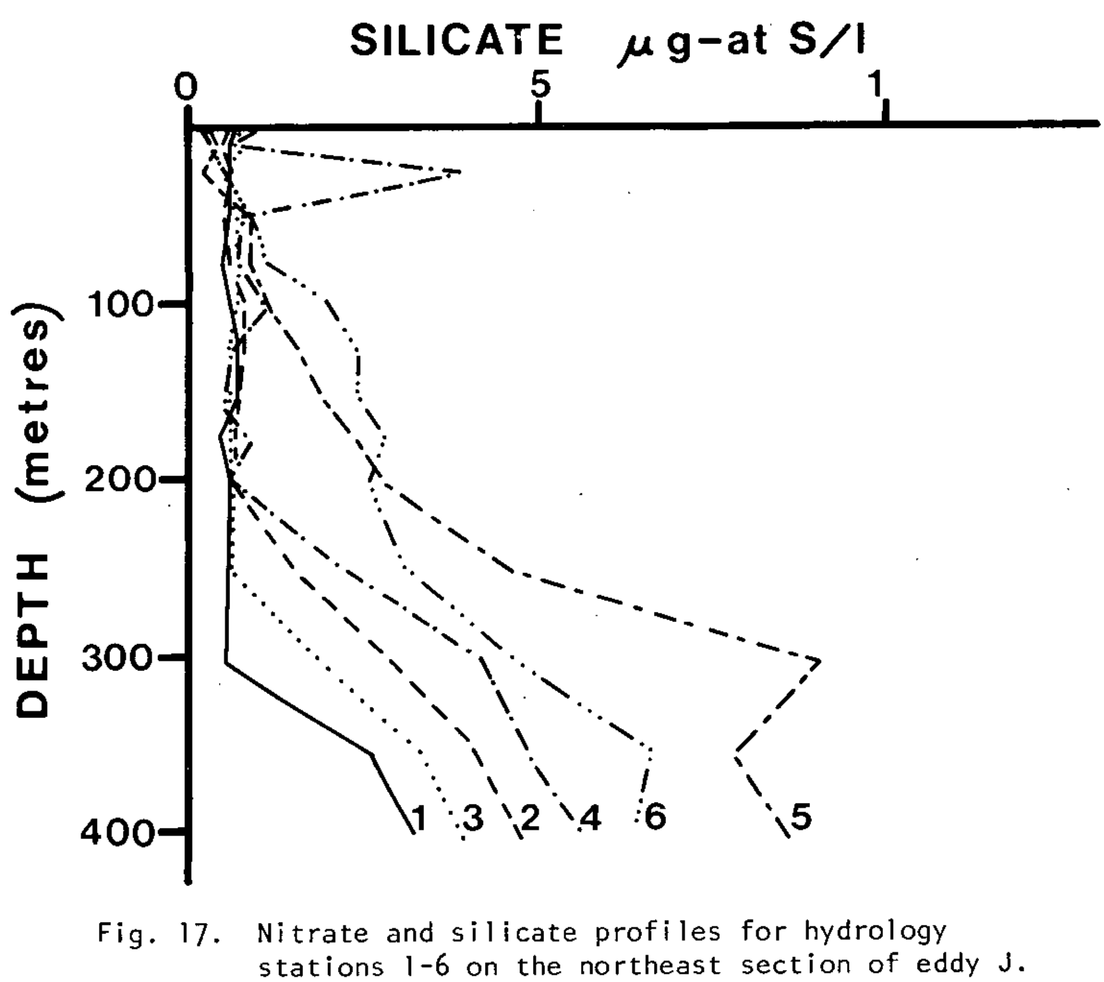


Fig. 17. Nitrate and silicate profiles for hydrology stations 1-6 on the northeast section of eddy J.

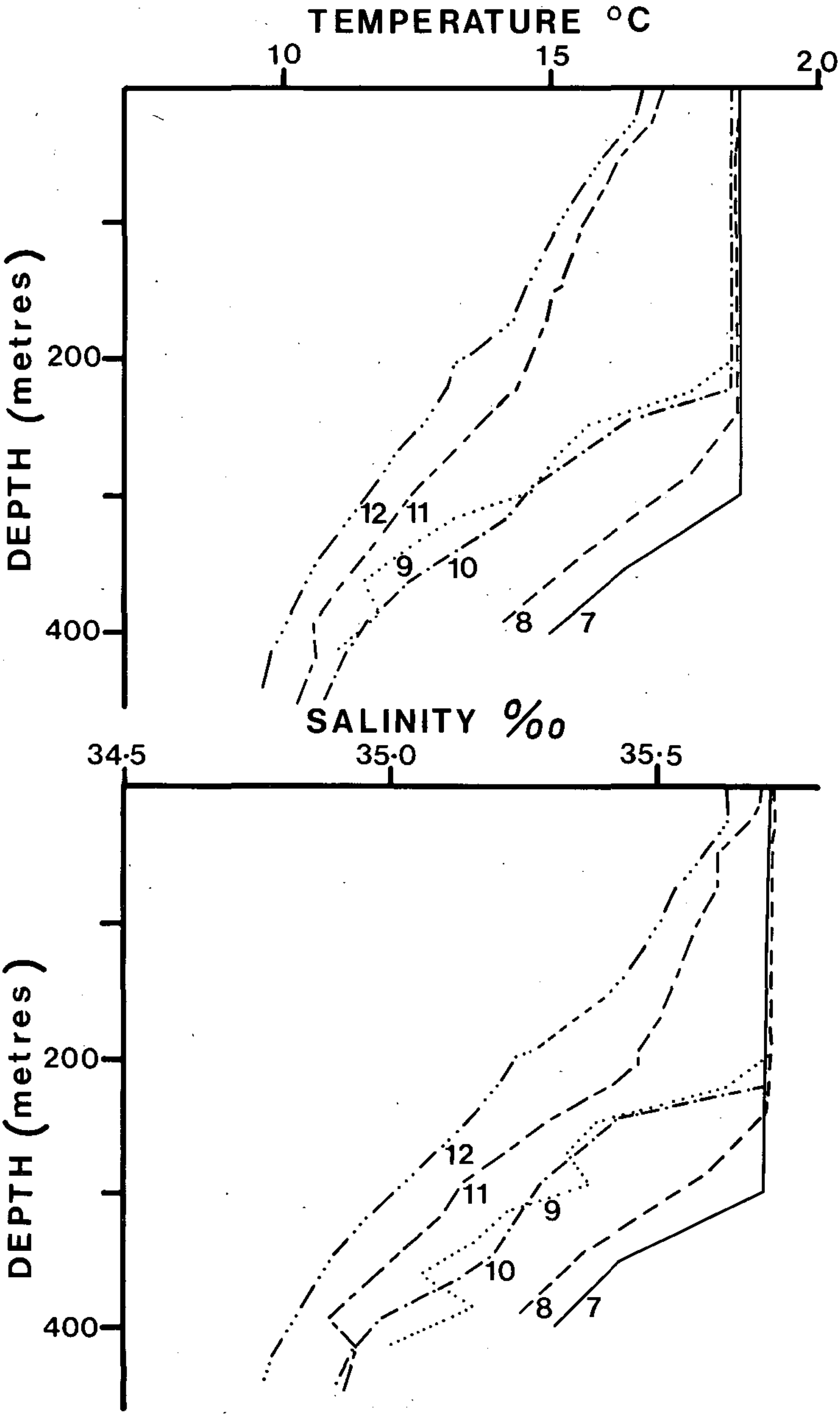


Fig. 18. Temperature and salinity profiles for hydrology stations 7-12 on the southern section of eddy J.

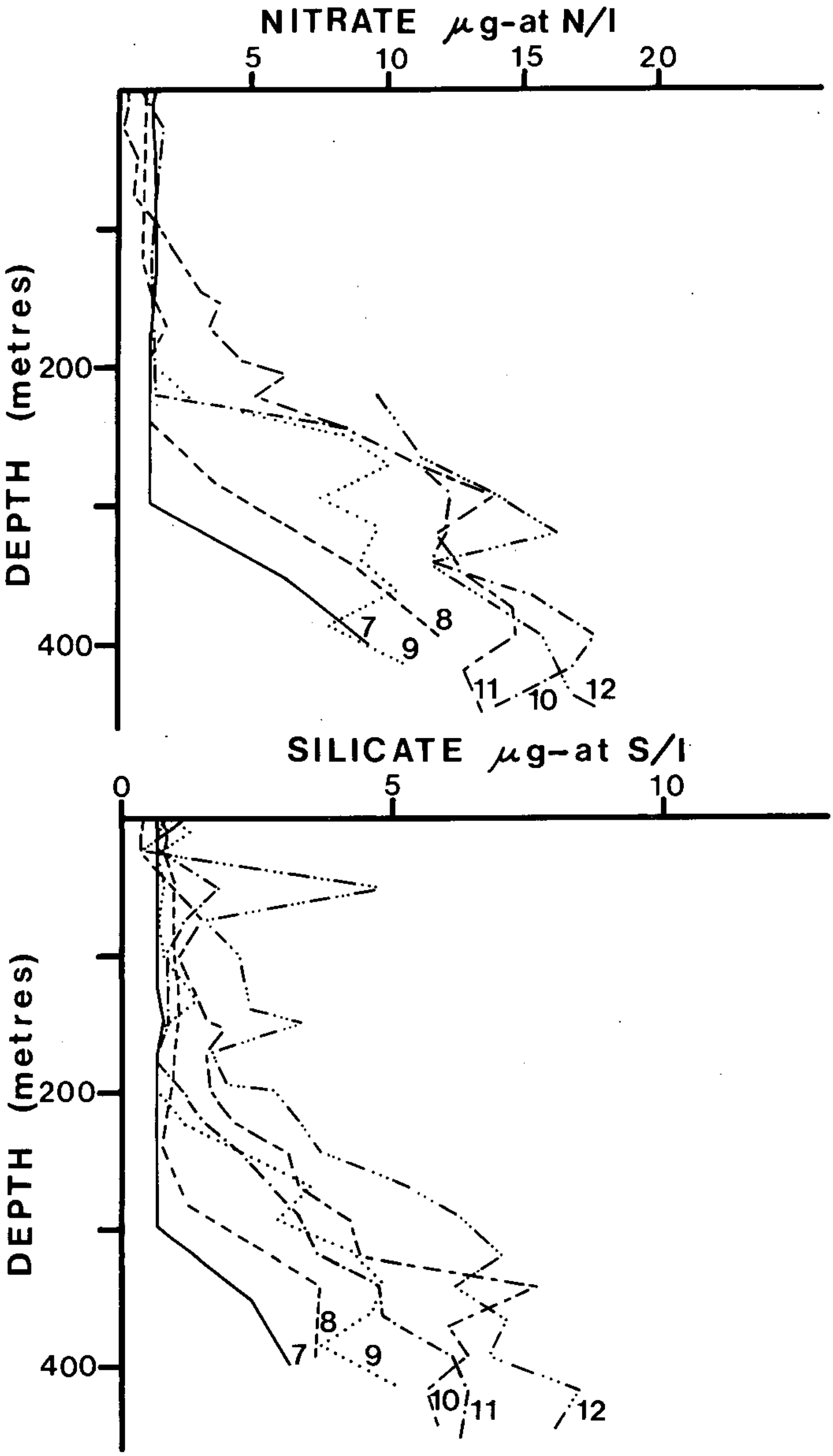


Fig. 19. Nitrate and silicate profiles for hydrology stations 7-12 on the southern section of eddy J. Nitrates from above 200m at stations 12 were contaminated.

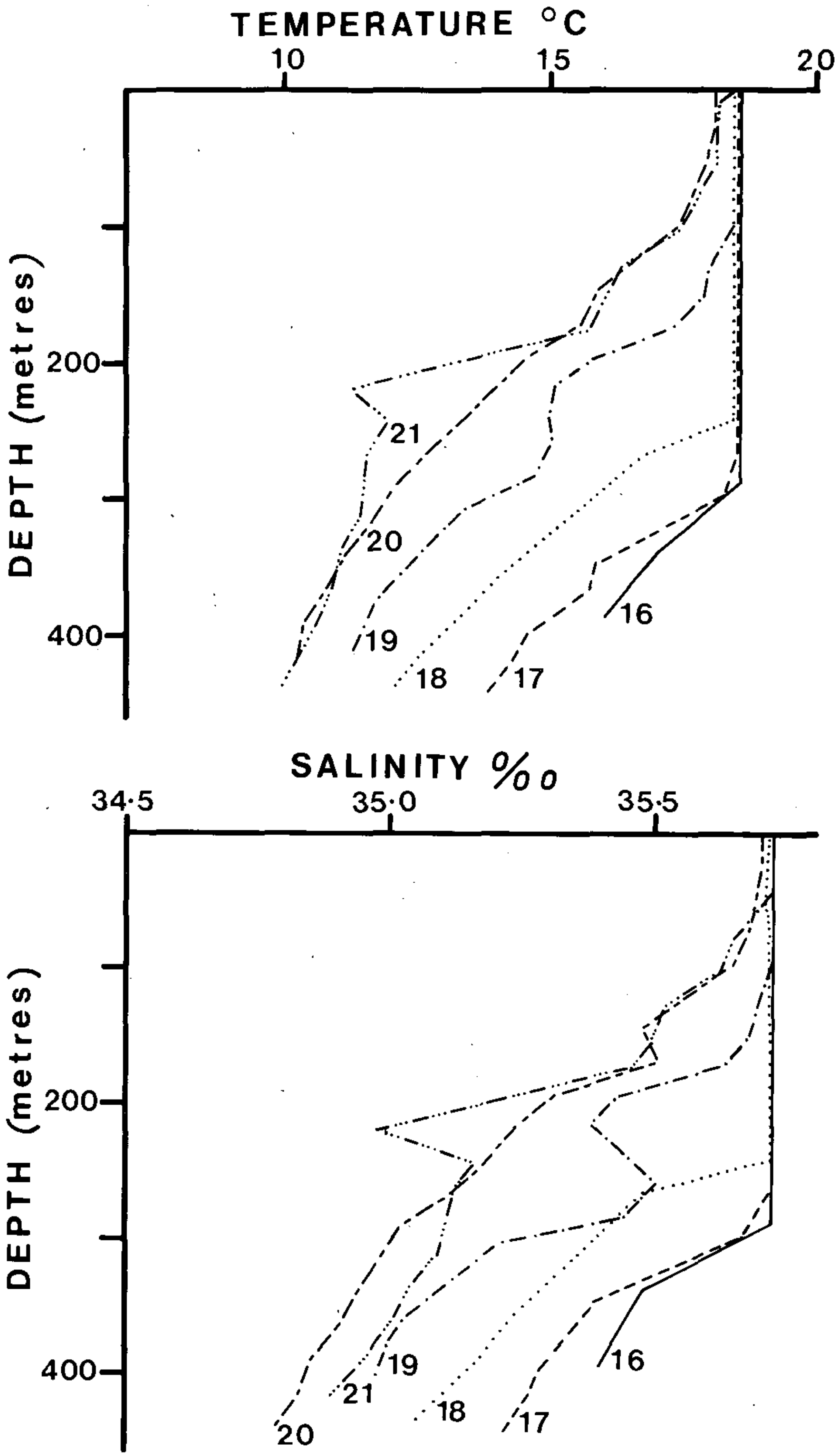


Fig. 20. Temperature and salinity profiles for hydrology stations 16-21 on the northwest section of eddy J.

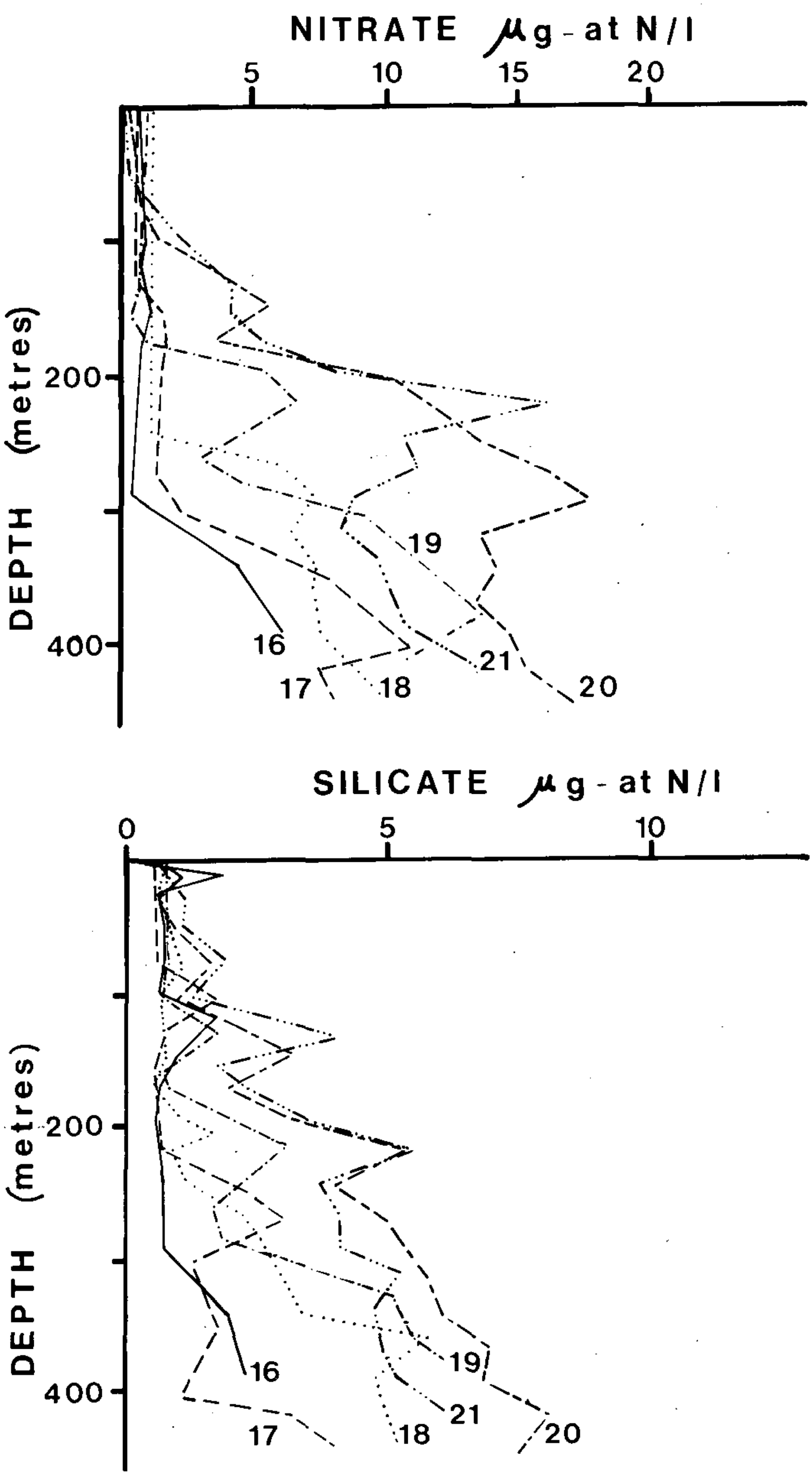


Fig. 21. Nitrate and silicate profiles for hydrology stations 16-21 on the northwest section of eddy J.

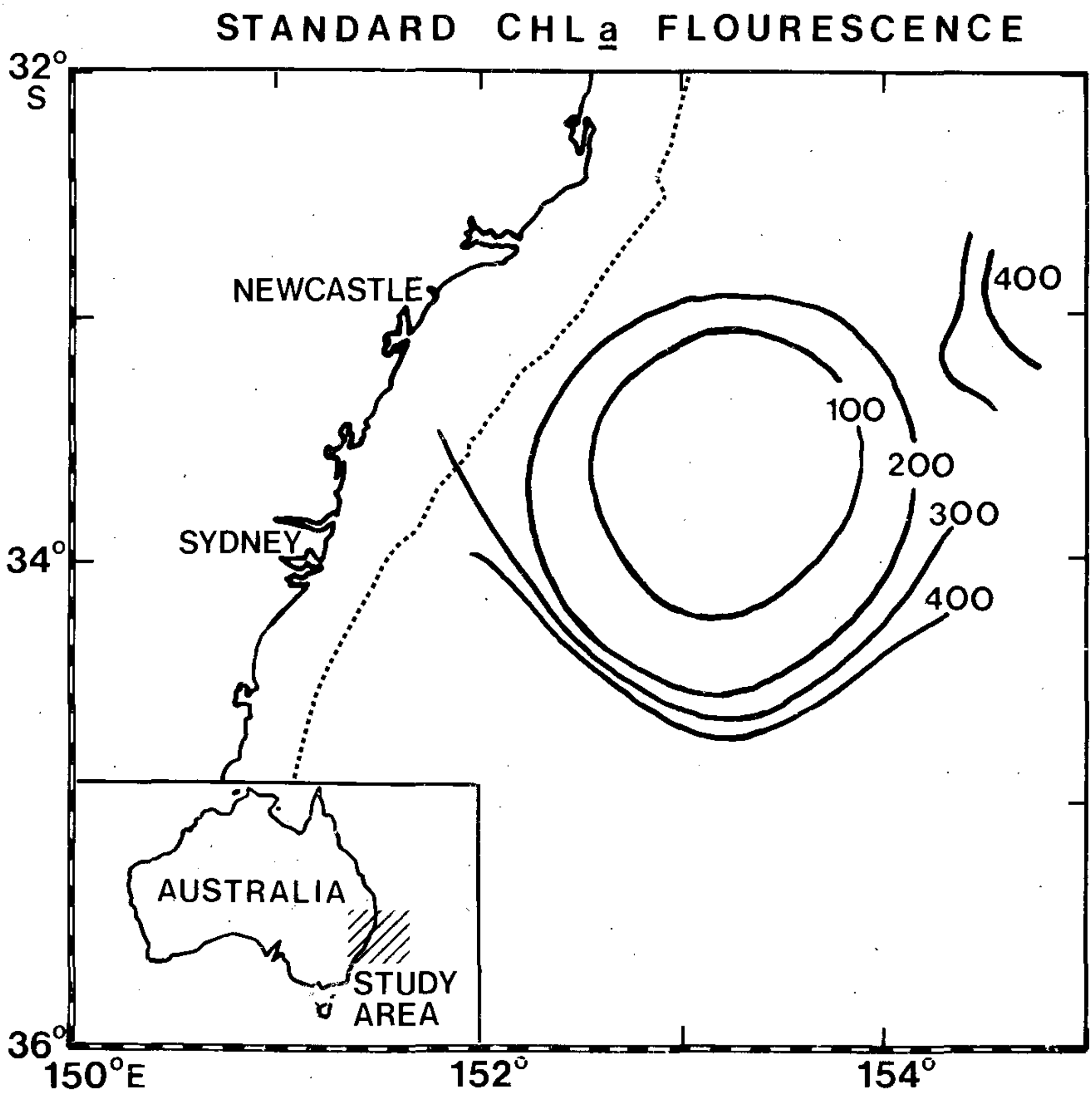


Fig. 22. Surface isopleths of standard chlorophyll *a* fluorescence (SCAF units) corrected for the diel cycle.

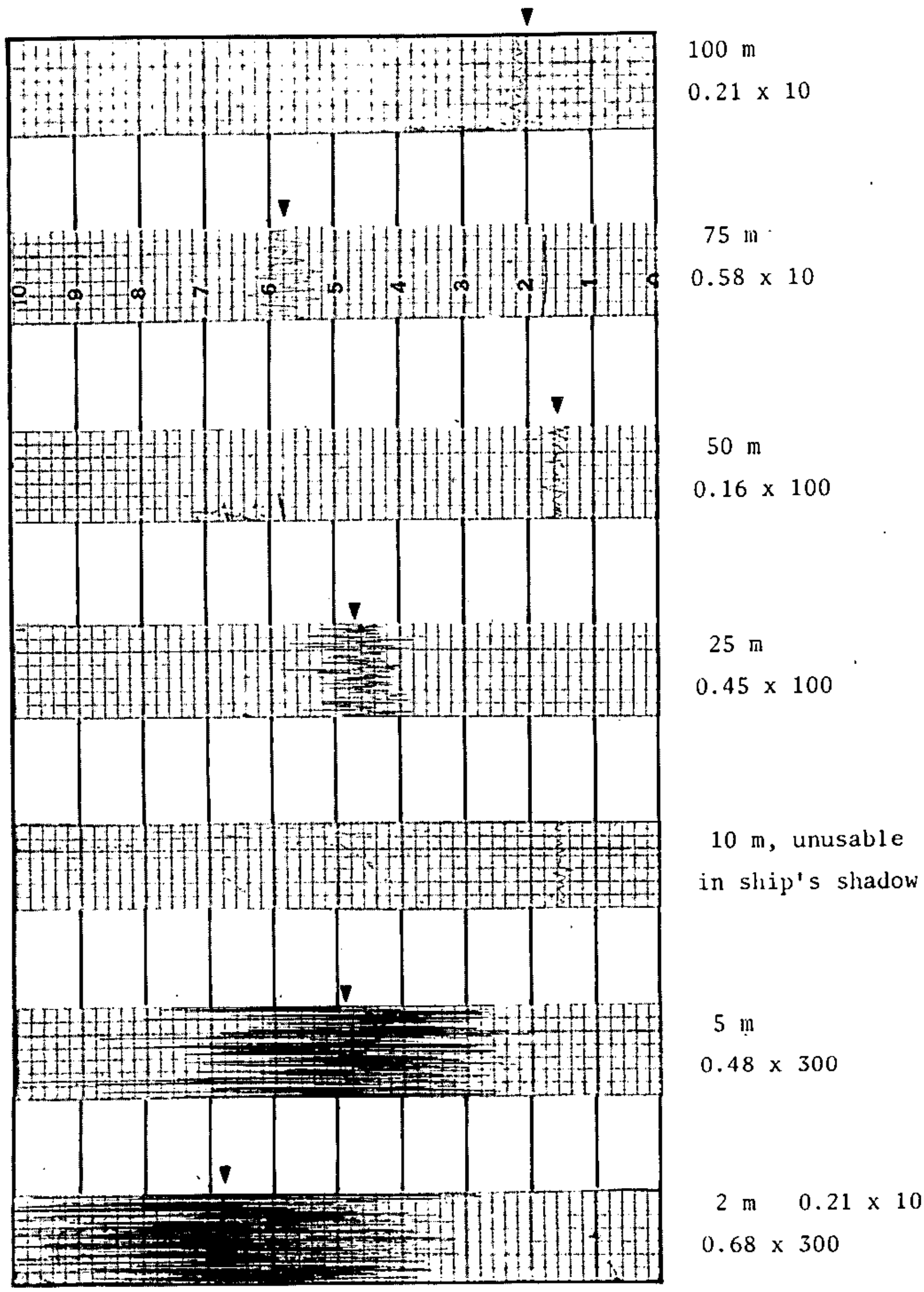


Fig. 23. Copy of a section of strip chart recording the fluorescence signals from a stream of water pumped at discrete depths, station 13, 29 September 1979. With the pump at "surface" (actual depth of intake ~2m) and Diuron pump off, the F_A fluormeter was set to coincide with the F_M fluorometer. The Diuron injection pump was then turned on, providing enough dose (~6µM) at the upstream end of a 10s mixing coil to achieve a maximum response in the fluorometer chamber. These traces were continued 2 or more minutes while a 5.75ℓ sample was drawn from the F_A fluorometer waste and a parallel stream was analysed in the particle size analyser. After sampling, the Diuron pump was turned off and the submersible pump lowered to the next sampling level. The system was then flushed for 3-4 min. Transit time in the umbilicus was about 2 min.

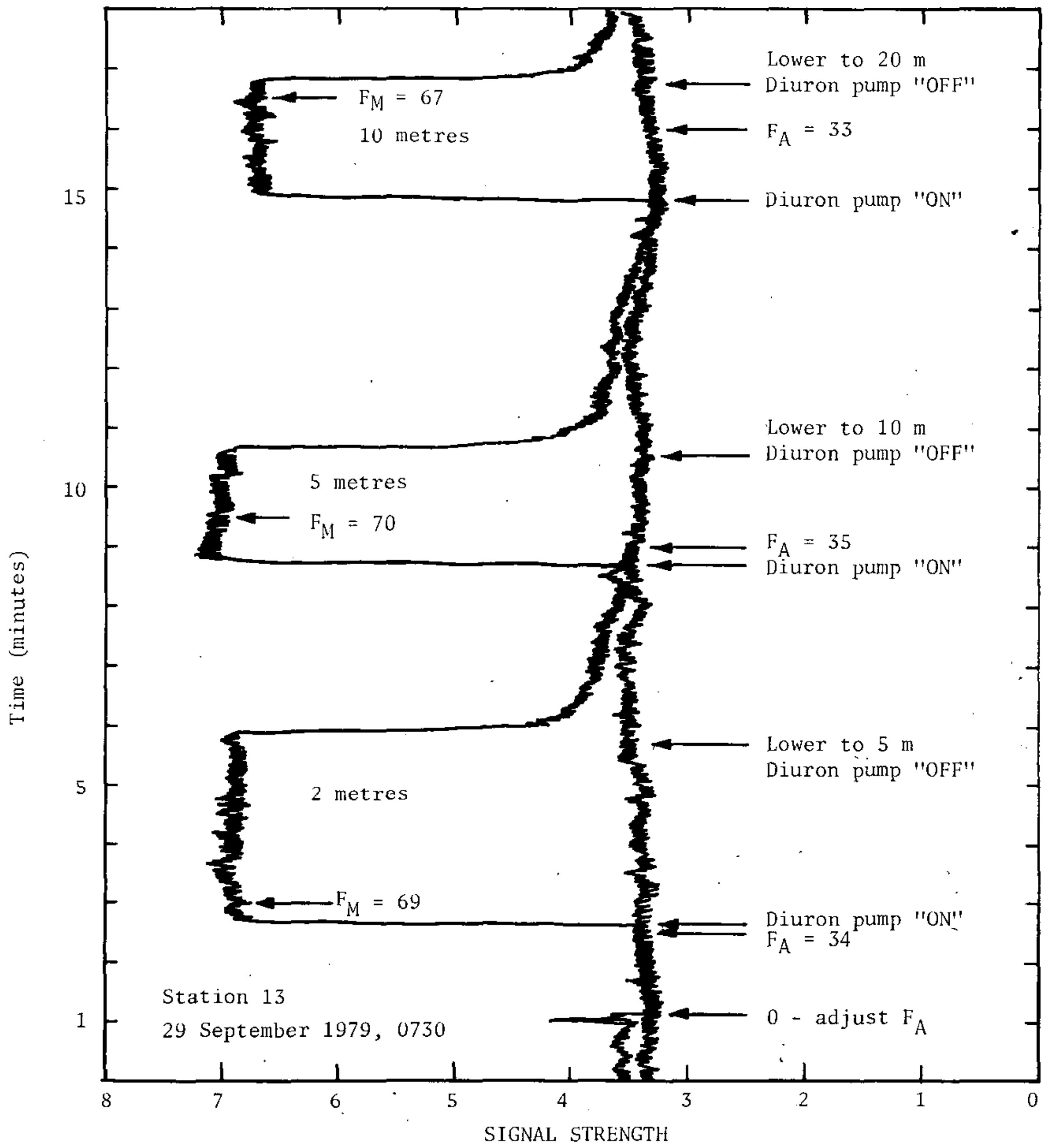


Fig. 24. Sections of traces from underwater light recordings at station 3, 22 September 1979, 0915hr. With the calibration factor 4.14 the estimated mean values for 2, 5, 50, 75 and 100m are 845, 472, 186, 66, 24 and 8.7 μEinsteins m^{-2} sec^{-1}, respectively.

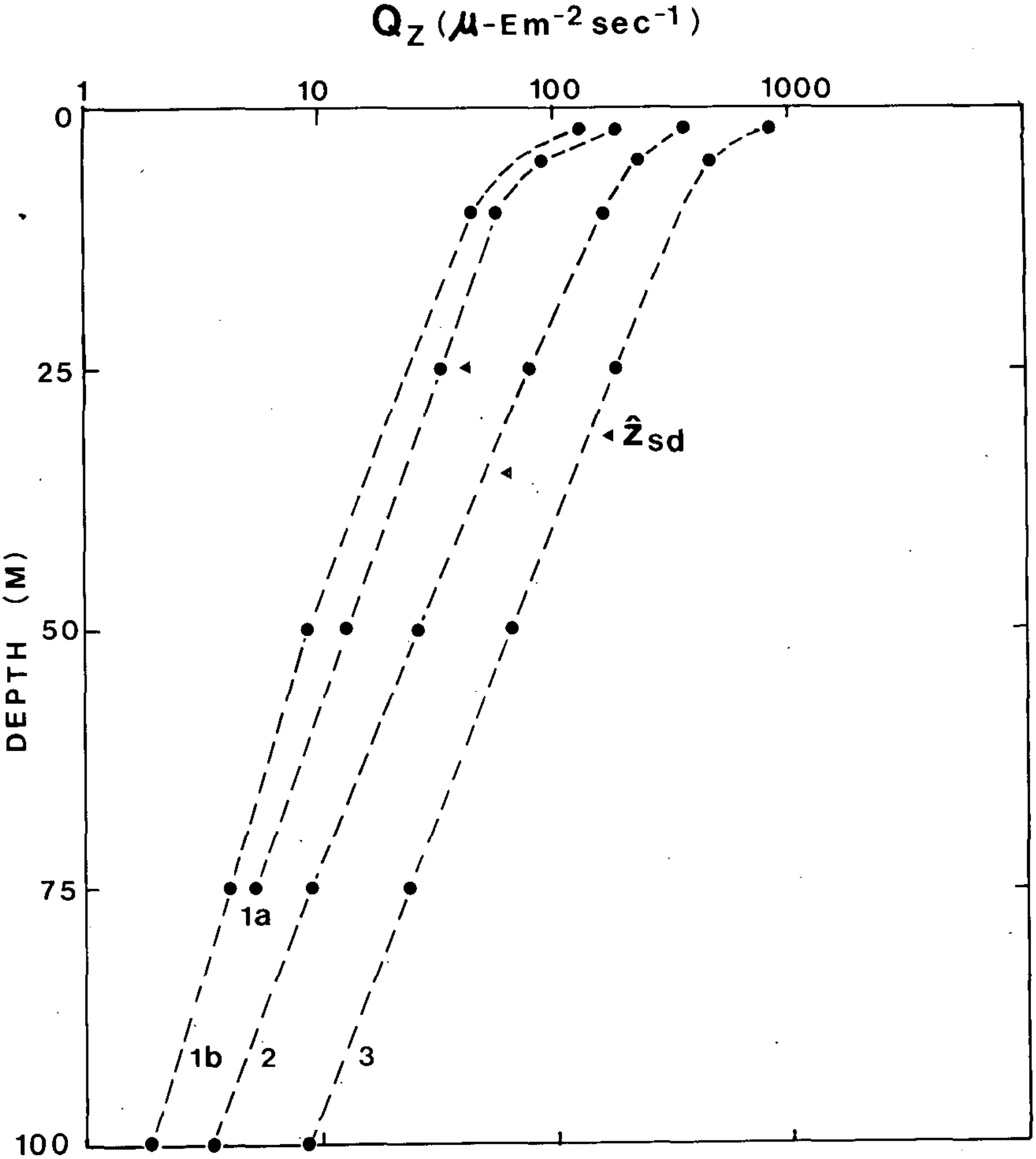


Fig. 25. Underwater radiation measurements for hydrology stations 1-3. Curves 1(a) and 1(b) are replicate pump profiles. $\hat{Z}_{sd}$ is an estimate of the Secchi disc depth (see text for explanation).

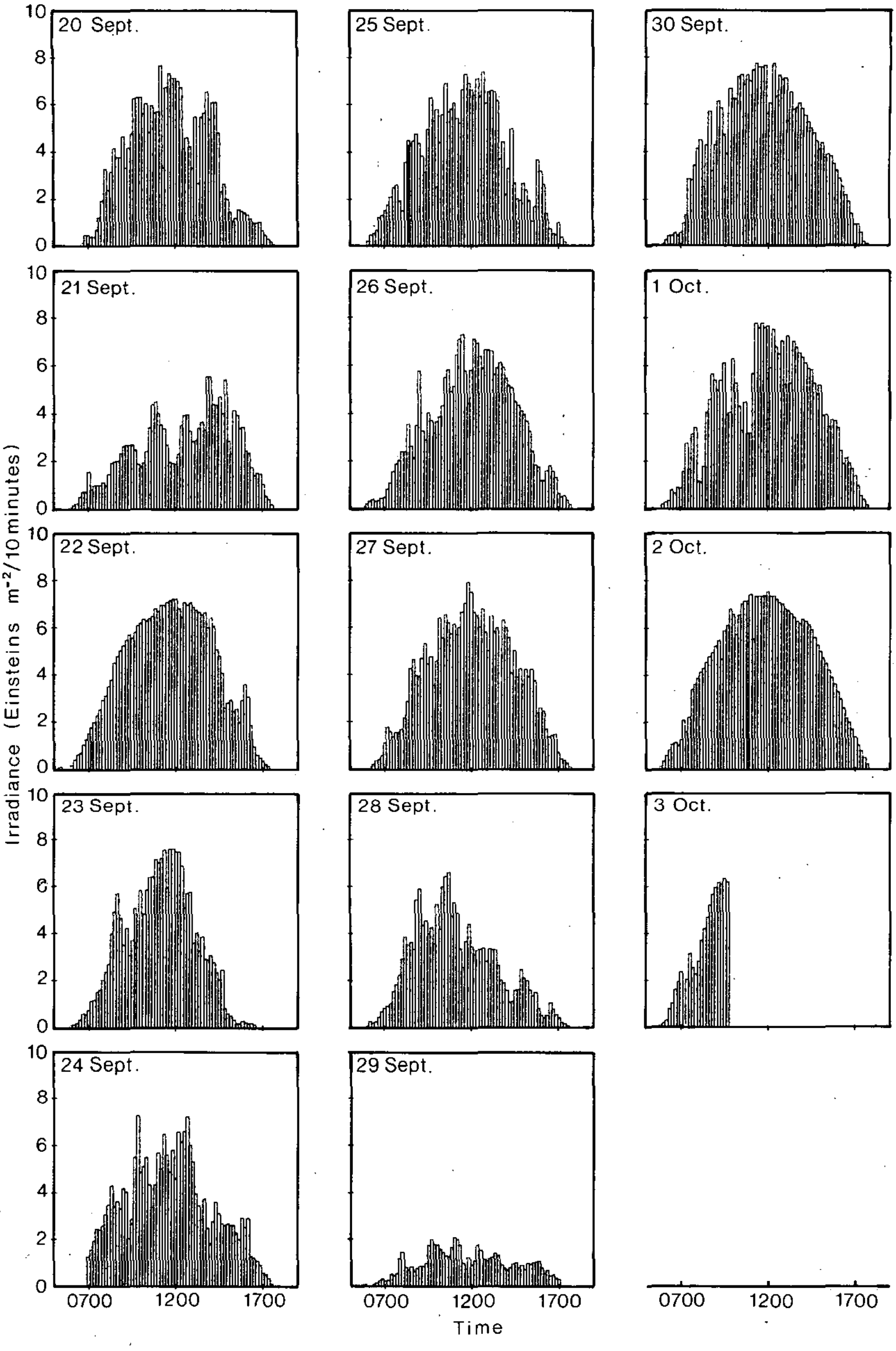


Fig. 26. Daily distribution and amounts of light incident to the sea surface during 20 September to 3 October 1979.

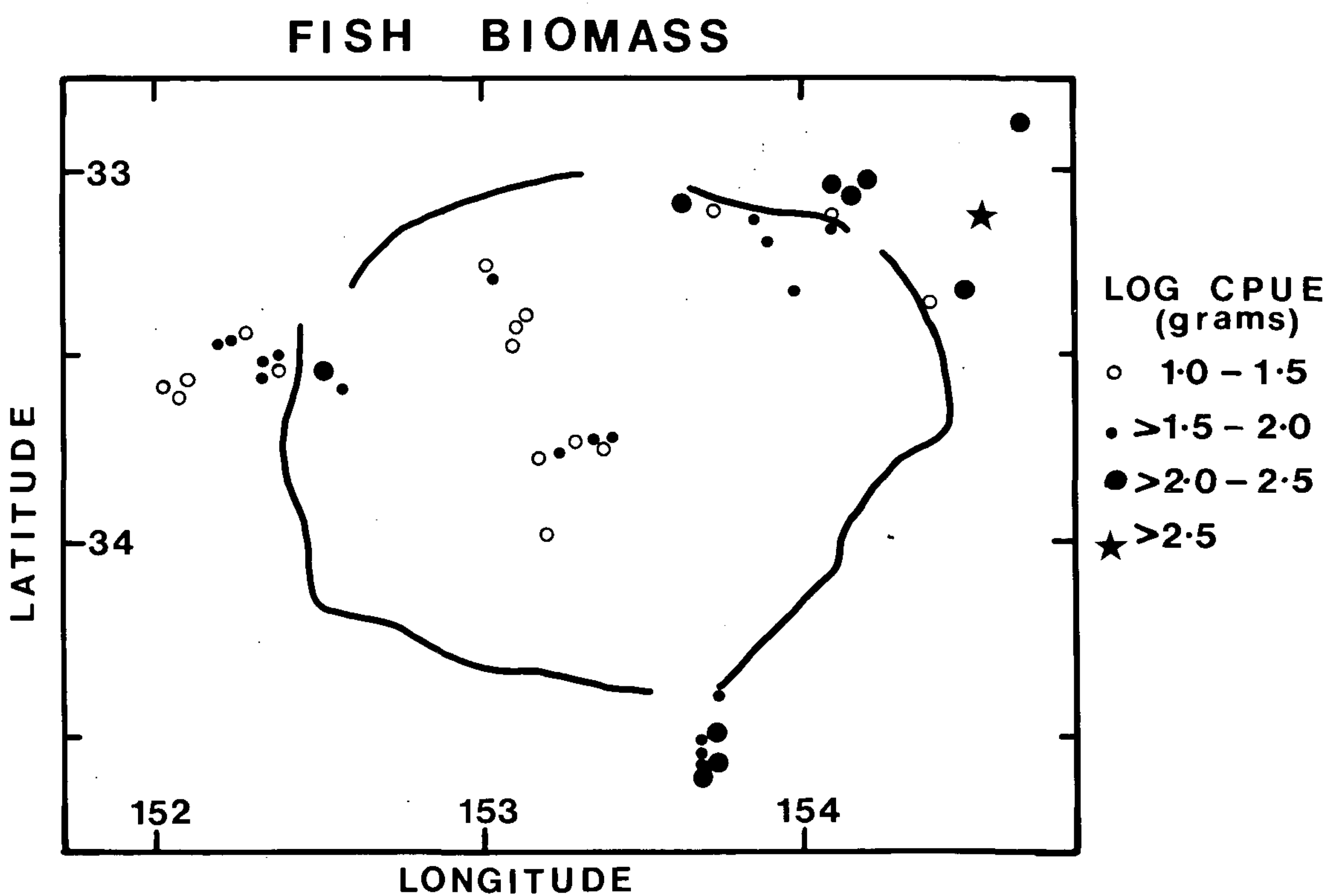


Fig. 27. Log fish biomass catch per trawl (CPUE). The solid line indicates the position of the 15.0°C isotherm at a depth of 250m.

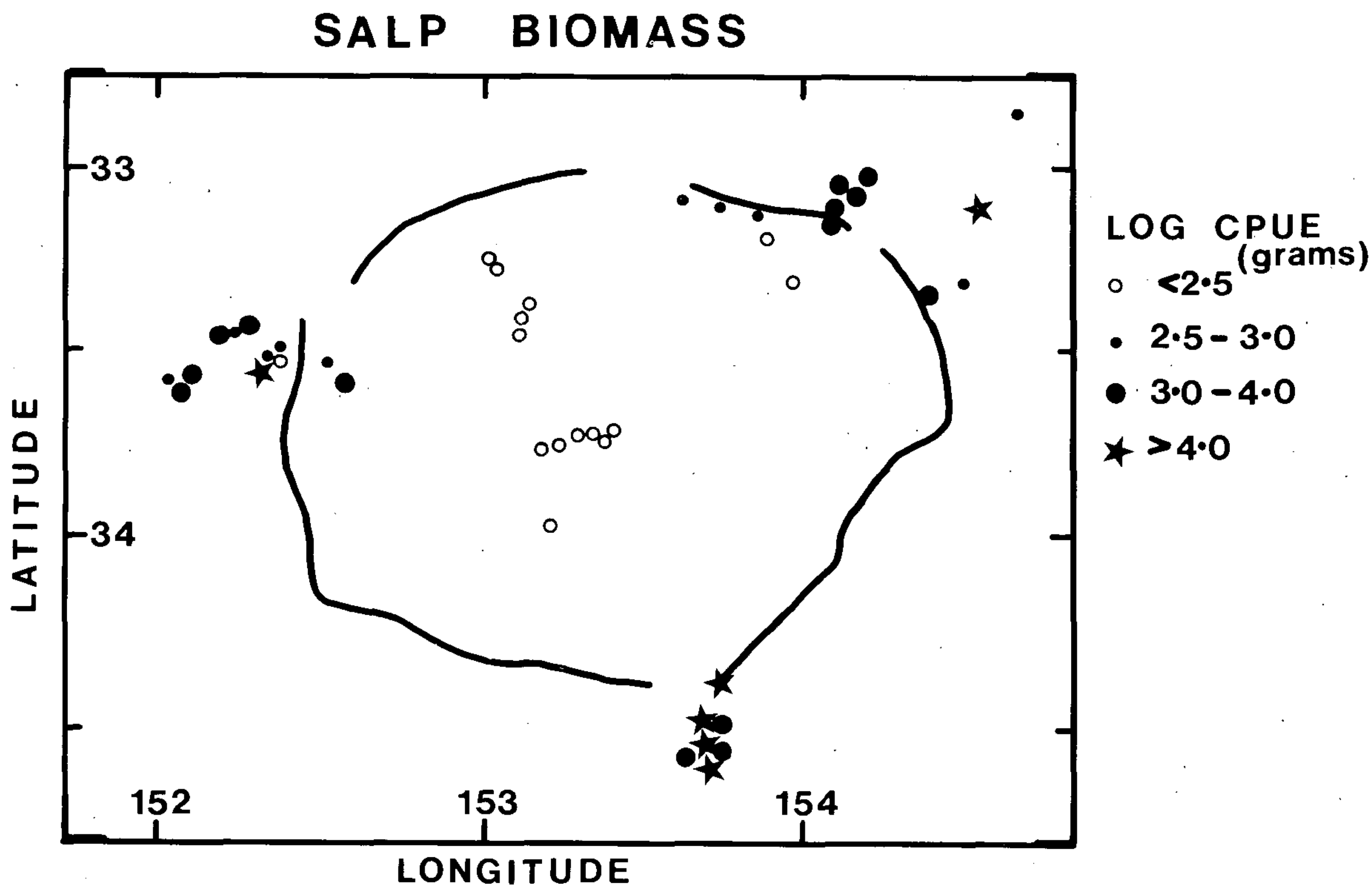


Fig. 28. Log of salp biomass catch per trawl (CPUE). The solid line indicates the position of the 15.0°C isotherm at a depth of 250m.

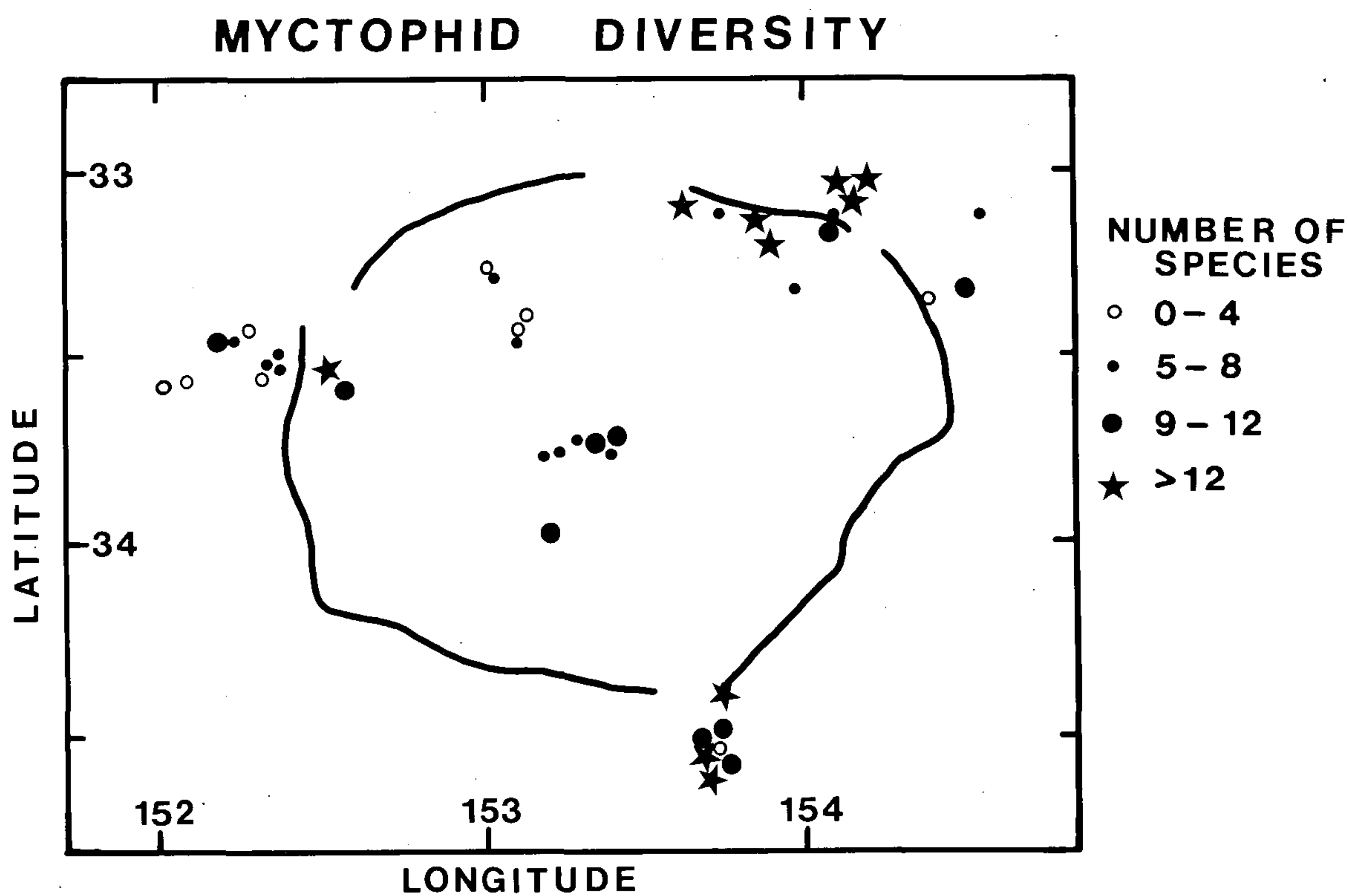


Fig. 29. Myctophid diversity (number of species per trawl). The solid line indicates the position of the 15.0°C isotherm at a depth of 250m.

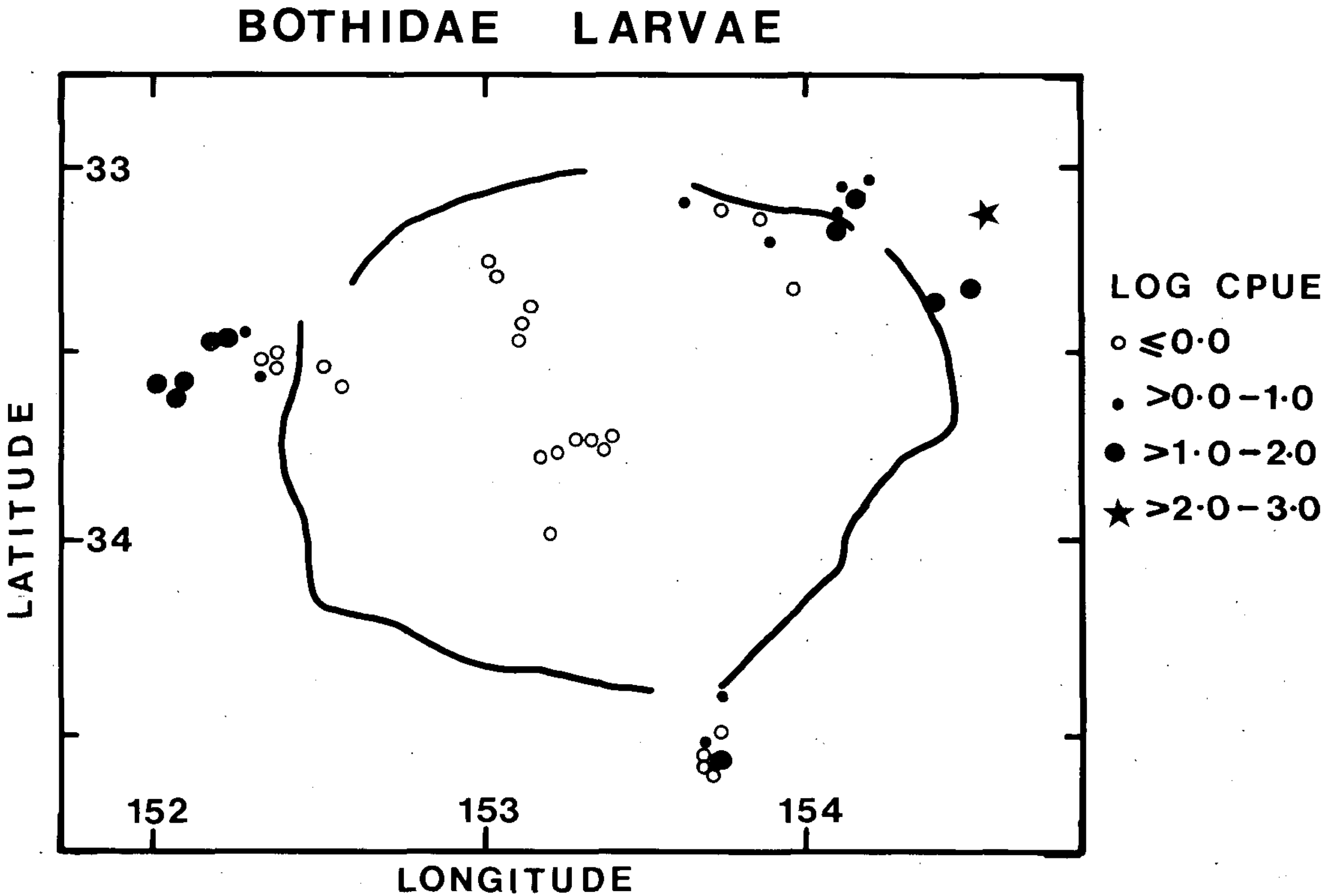


Fig. 30. Log catch (numbers) per trawl (CPUE) of Bothidae larvae. The solid line indicates the position of the 15.0°C isotherm at a depth of 250m.

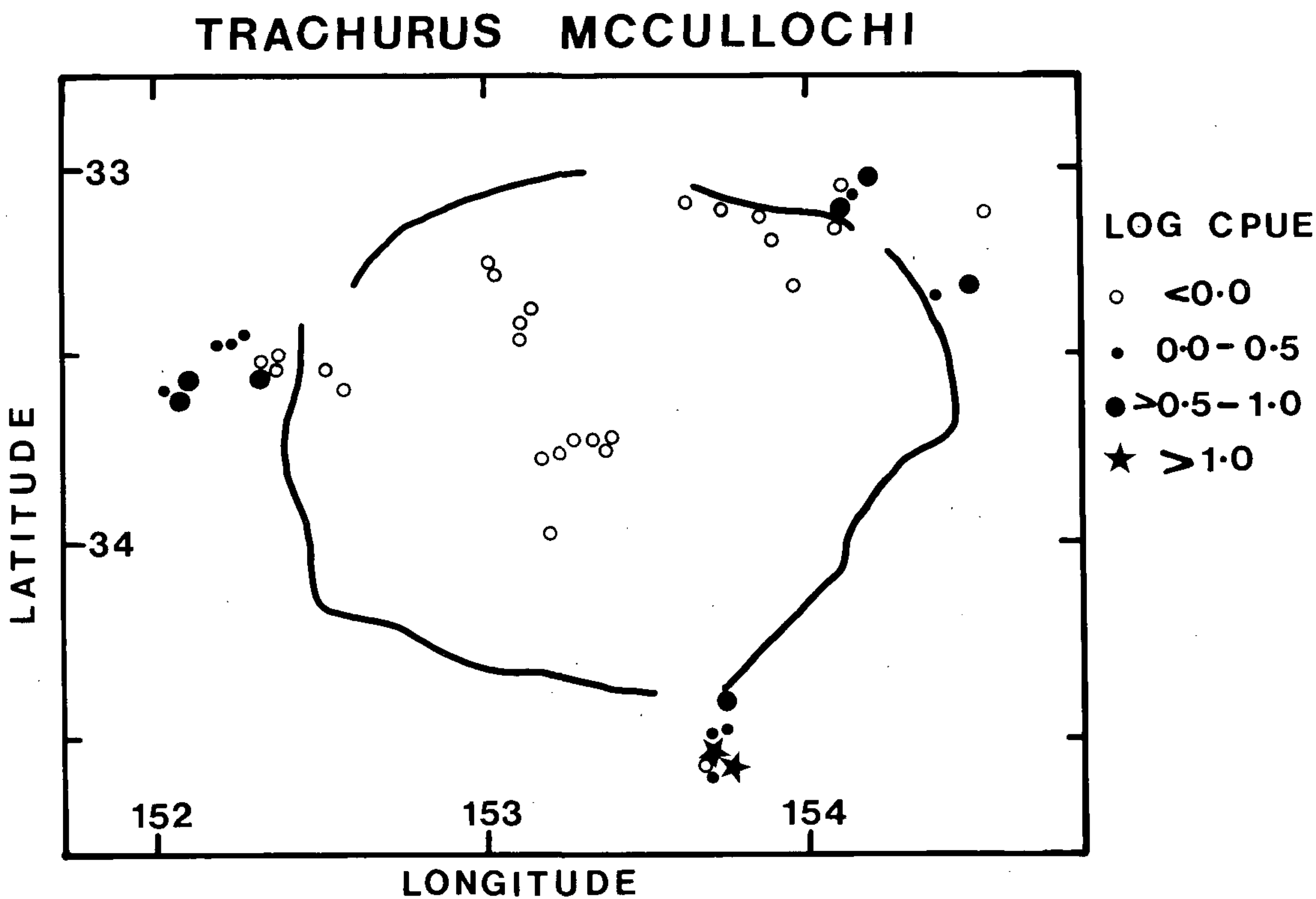


Fig. 31. Log catch (numbers) per trawl (CPUE) of juvenile *Trachurus mccullochi*. The solid line indicates the position of the 15.0°C isotherm at a depth of 250m.

Appendix 1: Station information for thermal profile using expendible bathythermographs (XBT). Temperatures at depths of 5m, 50m, 100m, 250m and 450m are given. Questionable XBTs are deleted. A dash (-) indicated no data.

XBT no.	Date	Time	Latitude °S	Longitude °E	Temperature 5m	50m	100m	250m	450m
1	20. 9.79	0803	33 47.7	151 24.2	16.7	13.9	-	-	-
2	20. 9.79	1000	33 40.0	151 43.9	18.0	16.9	14.4	-	-
3	20. 9.79	1130	33 35.9	151 57.9	17.7	18.8	15.8	14.6	-
4	20. 9.79	1300	33 30.9	152 12.0	18.0	17.9	17.6	12.7	10.0
5	20. 9.79	1430	33 26.9	152 25.2	18.5	18.5	18.4	14.4	10.6
6	20. 9.79	1602	33 23.8	152 40.3	18.6	18.6	18.6	18.5	11.9
7	20. 9.79	1704	33 28.6	152 39.6	18.7	18.7	18.7	18.7	11.9
8	20. 9.79	1731	33 32.5	152 37.1	18.8	18.8	18.8	18.4	13.4
9	20. 9.79	1801	33 36.9	152 34.9	18.6	19.6	19.2	17.4	-
10	20. 9.79	1830	33 41.2	152 32.7	18.7	18.7	18.7	16.6	12.4
11	20. 9.79	1900	33 45.7	152 30.5	18.8	19.2	19.2	17.1	12.6
12	20. 9.79	1929	33 50.0	152 28.8	18.6	18.6	18.7	16.1	12.6
13	20. 9.79	2000	33 54.6	152 22.0	18.9	18.9	18.8	15.6	12.1
14	20. 9.79	2031	33 58.9	152 25.4	18.6	18.5	18.5	-	-
15	20. 9.79	2035	33 59.6	152 25.2	18.5	18.5	18.3	13.7	10.7
18	20. 9.79	2106	34 03.9	152 23.7	18.3	18.5	18.4	15.8	-
19	20. 9.79	2131	34 07.4	152 22.5	18.5	18.4	17.3	14.4	10.2
20	20. 9.79	2202	34 11.7	152 21.7	18.2	17.1	15.7	14.1	9.9
22	20. 9.79	2235	34 16.2	152 20.4	15.9	15.9	15.6	12.4	9.5
23	20. 9.79	2301	34 15.9	152 26.0	17.7	17.0	15.7	13.0	9.7
24	20. 9.79	2330	34 15.5	152 32.4	18.3	18.2	16.5	13.4	9.6
25	21. 9.79	0001	34 15.1	152 39.0	18.5	18.5	18.1	14.1	10.1
26	21. 9.79	0029	34 14.9	152 45.3	18.6	18.6	18.5	13.7	11.2
27	21. 9.79	0100	34 14.6	152 52.1	18.7	18.6	18.7	15.2	10.3
28	21. 9.79	0128	34 14.2	152 58.7	18.7	18.7	18.7	16.1	11.1
29	21. 9.79	0200	34 13.2	153 05.8	18.8	19.0	18.9	17.3	12.0
30	21. 9.79	0229	34 12.3	153 12.6	18.7	18.6	18.7	17.9	12.1
31	21. 9.79	0258	34 15.4	153 13.1	18.7	18.7	18.7	17.0	11.7
33	21. 9.79	0335	34 21.3	153 12.3	19.2	19.3	19.3	16.3	10.6
34	21. 9.79	0358	34 24.0	153 11.8	18.6	18.6	18.5	12.9	10.4
35	21. 9.79	0427	34 27.4	153 10.9	18.3	18.3	17.5	13.0	9.6
36	21. 9.79	0457	34 27.6	153 15.9	18.3	18.3	17.7	12.1	10.0
37	21. 9.79	0527	34 26.6	153 22.8	18.6	18.5	18.5	12.1	10.0
38	21. 9.79	0558	34 25.6	153 29.9	18.5	18.5	18.5	14.4	9.7
39	21. 9.79	0701	34 18.7	153 37.5	18.7	18.7	18.7	16.5	11.7
40	21. 9.79	0803	34 08.2	153 39.9	18.7	18.7	18.7	18.7	12.2
41	21. 9.79	0859	33 59.0	153 41.2	18.7	18.7	18.7	18.8	12.8
42	21. 9.79	1001	33 49.7	153 33.9	18.8	18.8	18.7	18.8	13.7
43	21. 9.79	1430	33 42.0	153 31.8	18.7	18.7	18.7	18.8	13.6
44	21. 9.79	1530	33 33.8	153 50.9	18.7	18.7	18.7	18.6	12.8
45	21. 9.79	1631	33 25.9	153 57.8	18.6	18.7	18.7	17.2	12.3
46	21. 9.79	1816	33 19.6	153 59.7	18.6	18.7	18.7	16.3	11.9
47	21. 9.79	2057	33 12.6	153 55.8	19.1	18.9	18.8	16.2	11.1
48	21. 9.79	2226	33 09.1	153 53.6	18.6	18.6	18.6	15.7	10.8
49	22. 9.79	0001	33 07.6	153 46.2	18.6	18.6	18.6	15.5	10.3
50	22. 9.79	0150	33 06.0	153 36.5	20.6	20.0	19.2	16.0	11.1
51	22. 9.79	0410	33 04.4	153 26.3	18.5	18.5	18.5	16.0	10.9
52	22. 9.79	0614	33 14.9	153 31.8	19.1	18.7	18.7	16.9	12.6
53	22. 9.79	0915	33 23.4	153 26.6	18.9	18.7	18.7	18.6	12.9
54	22. 9.79	1259	33 23.5	153 36.9	18.7	18.7	18.7	18.7	12.8
55	22. 9.79	1431	33 22.6	153 51.3	18.6	18.5	18.5	17.9	12.8
56	22. 9.79	1535	33 18.9	154 00.2	18.8	18.5	18.5	16.5	11.7
59	22. 9.79	1835	33 11.6	154 01.2	18.6	18.5	18.5	14.8	10.4
60	22. 9.79	1901	33 09.9	154 03.2	18.6	18.5	18.4	15.0	10.4
61	22. 9.79	2041	33 09.0	154 03.3	18.4	18.3	18.3	15.3	10.2

Appendix 1 (continued)

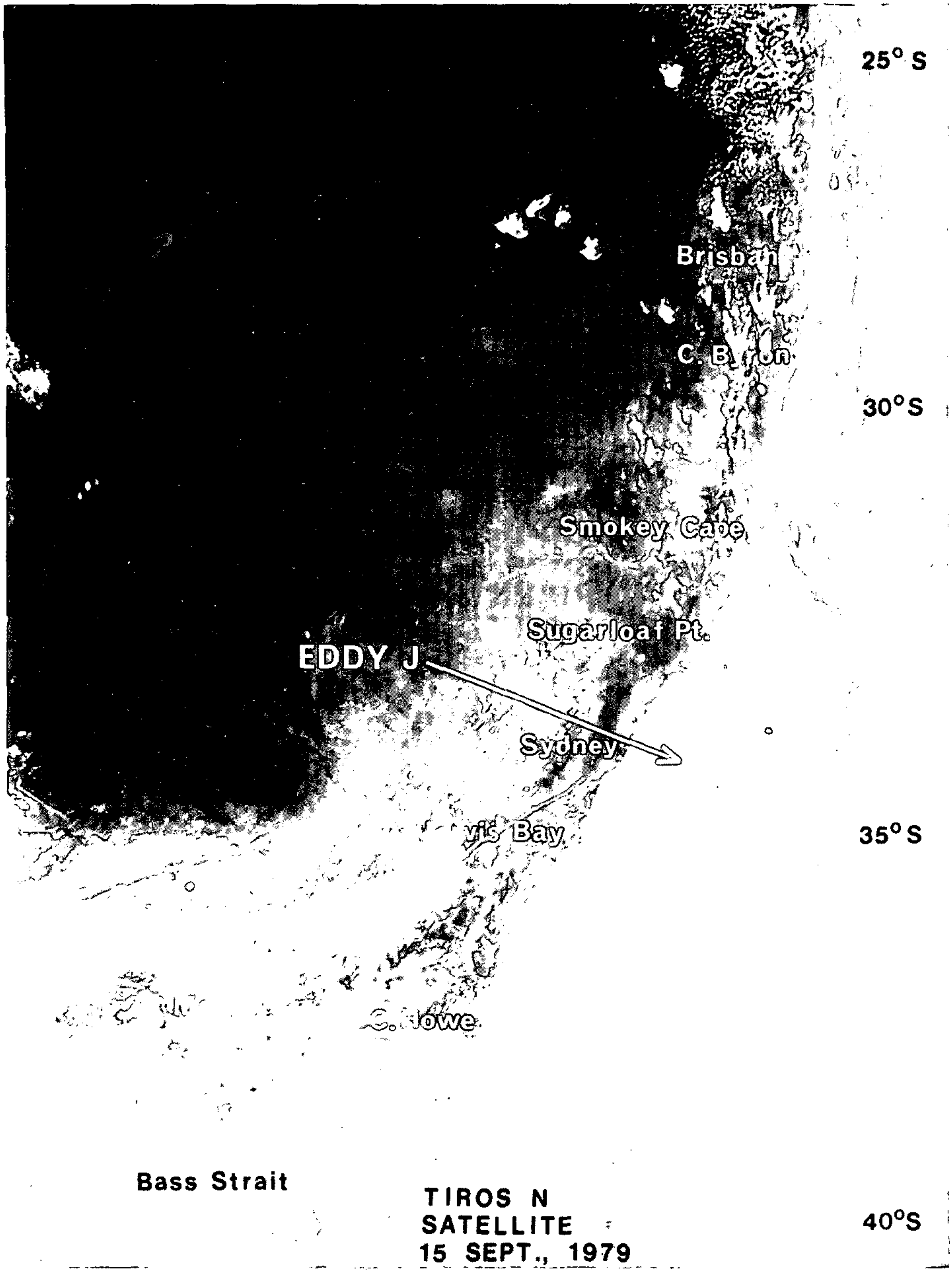
XBT no.	Date	Time	Latitude	Longitude	Temperature 5m	50m	100m	250m	450m
65	22. 9.79	2316	33 05.4	154 08.4	18.9	17.9	17.5	13.1	9.7
66	23. 9.79	0116	33 04.2	154 08.7	19.2	18.0	17.6	13.3	9.4
67	23. 9.79	0316	33 01.7	154 11.2	18.6	18.2	17.9	13.5	9.4
69	23. 9.79	0633	32 58.8	154 18.6	19.2	18.0	17.2	12.8	9.2
70	23. 9.79	1037	32 51.1	154 13.6	18.4	18.5	16.6	12.0	8.8
71	23. 9.79	1202	32 55.4	154 23.6	18.4	18.1	17.9	13.6	9.7
72	23. 9.79	1329	33 00.3	154 34.2	18.6	18.5	18.2	14.6	10.4
74	23. 9.79	1432	32 56.2	154 39.7	19.0	18.8	17.3	13.9	10.0
77	23. 9.79	1536	32 50.5	154 42.0	19.7	19.3	16.7	14.2	9.9
78	23. 9.79	1952	32 49.4	154 41.7	19.1	18.7	17.4	13.4	9.5
79	23. 9.79	2100	32 51.0	154 39.2	19.2	18.8	17.6	13.3	9.4
80	23. 9.79	2232	32 56.9	154 29.6	19.3	18.9	17.2	13.1	-
83	24. 9.79	0935	33 08.4	153 27.4	18.7	18.7	18.8	-	13.1
84	24. 9.79	1032	33 13.2	153 25.1	18.7	18.7	18.7	17.4	11.8
85	24. 9.79	1118	33 07.5	153 19.2	18.7	18.7	18.6	16.5	11.7
86	24. 9.79	1200	33 01.9	153 14.0	18.2	18.2	18.1	14.7	10.4
87	24. 9.79	1244	32 56.1	153 07.9	18.2	18.2	17.4	13.5	9.9
88	24. 9.79	1348	33 01.8	153 04.6	18.3	18.2	18.1	-	-
89	24. 9.79	1455	33 08.2	153 01.2	18.5	18.5	18.5	15.3	10.9
90	24. 9.79	1558	33 14.9	152 58.8	18.7	18.7	18.7	17.0	11.6
91	24. 9.79	1700	33 21.4	152 56.9	18.6	18.7	18.7	18.7	12.3
93	24. 9.79	1805	33 14.4	152 48.7	18.6	18.6	18.6	15.9	-
94	24. 9.79	1846	33 09.4	152 44.1	18.5	18.4	18.4	14.2	10.4
95	24. 9.79	1928	33 04.1	152 39.8	18.7	18.6	18.8	13.1	10.1
96	24. 9.79	1959	33 07.8	152 40.3	18.4	18.3	18.3	13.8	10.5
97	24. 9.79	2029	33 12.8	152 40.4	18.5	18.8	18.6	14.2	10.7
98	24. 9.79	2103	33 18.0	152 39.3	18.5	18.5	18.5	15.0	10.9
99	24. 9.79	2131	33 22.3	152 38.1	18.5	18.6	18.6	16.2	11.8
100	24. 9.79	2200	33 26.5	152 36.8	18.6	18.7	18.7	16.7	-
102	24. 9.79	2306	33 30.5	152 44.3	18.6	18.6	18.6	18.6	12.7
103	25. 9.79	0307	33 43.7	153 19.1	18.6	18.6	18.6	18.6	13.6
104	25. 9.79	1029	33 51.6	153 19.6	18.6	18.6	18.6	18.6	13.9
105	25. 9.79	1128	33 59.6	153 24.0	18.6	18.7	18.7	18.7	13.0
106	25. 9.79	1228	34 08.5	153 28.6	18.5	18.5	18.4	18.5	12.0
107	25. 9.79	1801	33 44.6	153 25.8	18.7	18.6	18.6	18.6	14.8
108	25. 9.79	2110	33 45.7	153 19.0	18.7	18.6	18.6	18.6	14.1
109	25. 9.79	2223	33 46.2	153 16.5	18.6	18.6	18.6	18.6	14.6
110	26. 9.79	0004	33 47.3	153 13.7	18.6	18.6	18.6	18.6	14.2
112	26. 9.79	0246	33 56.8	153 14.7	18.6	18.6	18.6	18.6	13.1
113	26. 9.79	0631	34 11.8	153 29.8	18.5	18.5	18.5	18.4	12.9
114	26. 9.79	0745	34 22.5	153 36.5	18.4	18.4	18.4	15.3	10.0
115	26. 9.79	1228	34 18.2	153 40.8	18.6	18.5	18.5	16.5	10.5
116	26. 9.79	1629	34 23.7	153 45.4	18.5	18.4	18.4	15.0	9.7
118	26. 9.79	1730	34 31.8	153 41.6	17.7	17.0	16.6	12.1	9.2
119	26. 9.79	1805	34 31.8	153 42.8	17.6	16.9	16.2	12.1	9.2
120	26. 9.79	1940	34 33.1	153 42.4	17.4	16.7	15.7	11.7	9.1
121	26. 9.79	2114	34 34.0	153 42.5	17.4	17.3	14.8	12.0	9.5
122	26. 9.79	2251	34 35.8	153 43.1	17.4	16.1	15.4	12.4	9.1
123	27. 9.79	0017	34 38.1	153 42.8	17.3	16.1	15.5	12.8	9.3
124	27. 9.79	0151	34 40.2	153 42.4	16.9	15.8	15.4	11.9	9.1
125	27. 9.79	0230	34 35.8	153 43.0	17.1	16.2	15.3	12.6	9.1
126	27. 9.79	0300	34 31.4	153 43.6	17.4	17.0	15.8	12.5	9.4
127	27. 9.79	0318	34 29.2	153 44.0	17.9	17.2	15.7	12.6	9.5
128	27. 9.79	0458	34 31.1	153 47.4	17.3	17.3	15.8	12.4	9.8
129	27. 9.79	1030	34 36.2	153 45.8	17.0	16.2	15.2	13.2	9.3

Appendix 1 (continued)

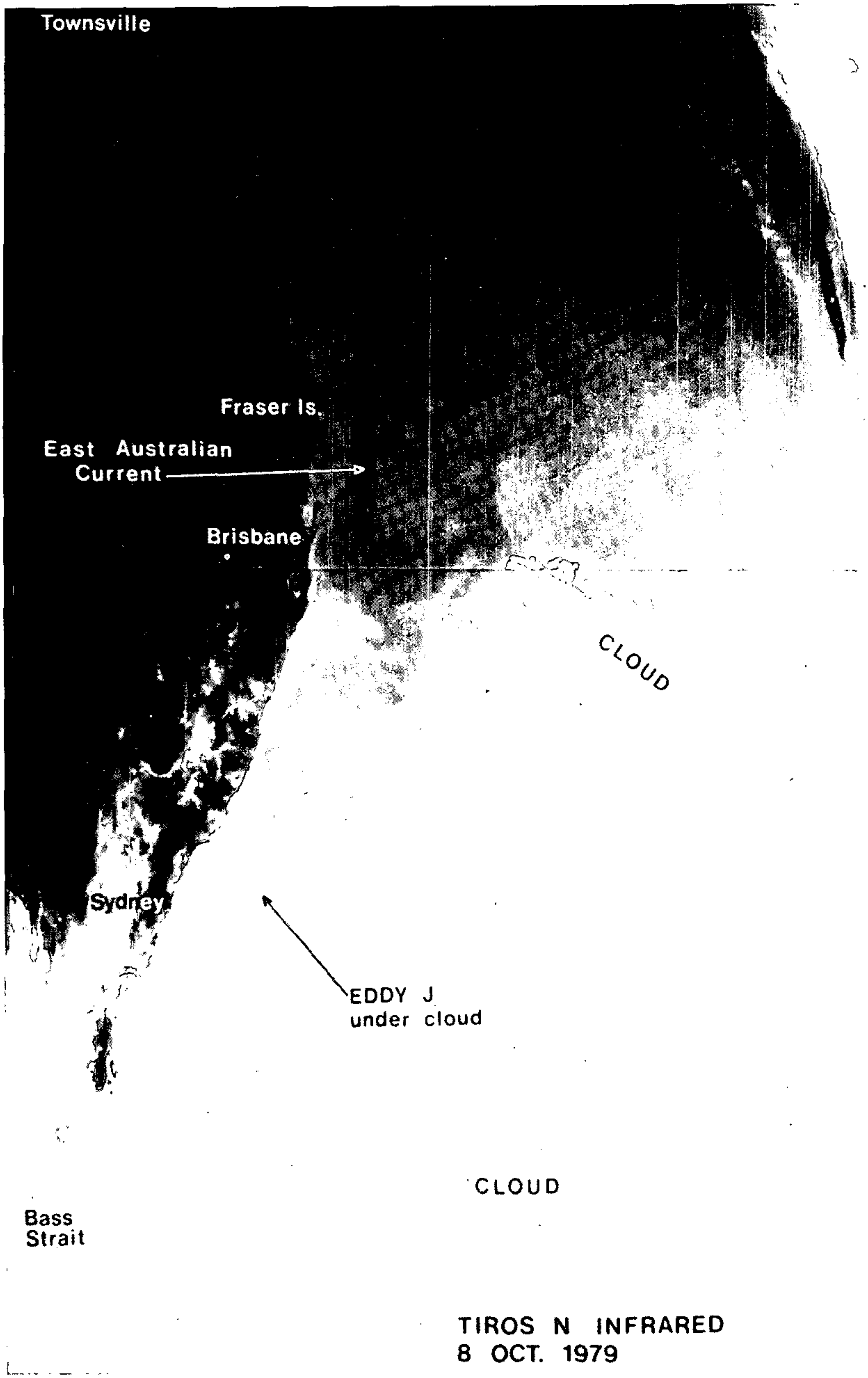
XBT no.	Date	Time	Latitude	Longitude	Temperature 5m	50m	100m	250m	450m
131	27. 9.79	1805	34 23.5	153 44.8	18.3	18.1	17.1	14.8	10.2
132	27. 9.79	1953	34 25.3	153 48.2	17.9	17.2	16.4	13.9	11.5
133	27. 9.79	2028	34 22.2	153 46.2	18.4	18.2	17.9	14.9	10.4
134	27. 9.79	2127	34 19.5	153 44.0	18.6	18.8	18.6	15.4	10.7
135	27. 9.79	2216	34 16.8	153 41.1	18.8	18.6	18.6	15.5	11.0
136	27. 9.79	2259	34 13.9	153 38.3	18.9	18.9	18.6	16.8	11.3
137	27. 9.79	2343	34 10.7	153 35.6	18.5	18.5	18.5	17.0	11.7
138	28. 9.79	0027	34 07.6	153 32.8	18.5	18.5	18.5	18.5	12.7
139	28. 9.79	0113	34 04.2	153 31.1	18.5	18.5	18.5	18.5	12.6
140	28. 9.79	0201	34 06.3	153 39.4	18.5	18.5	18.5	17.7	12.1
141	28. 9.79	0227	34 07.4	153 43.8	18.6	19.1	19.0	18.1	12.2
142	28. 9.79	0258	34 08.3	153 47.3	18.7	18.7	18.7	16.7	12.0
143	28. 9.79	0328	34 09.0	153 50.5	18.5	18.6	18.5	16.2	11.8
144	28. 9.79	0359	34 09.9	153 54.0	18.5	18.5	18.5	15.9	11.6
145	28. 9.79	0429	34 10.5	153 56.7	18.5	18.5	18.5	15.1	11.3
146	28. 9.79	0458	34 10.9	153 57.8	18.5	18.5	18.3	14.9	10.8
147	28. 9.79	0530	34 11.5	154 02.9	18.3	18.1	16.9	14.5	9.9
148	28. 9.79	0558	34 12.2	154 07.2	18.2	17.3	15.9	13.6	9.8
149	28. 9.79	0704	34 14.5	154 11.2	17.1	17.0	15.4	13.0	9.5
150	28. 9.79	0801	34 17.1	154 13.9	17.5	17.5	16.0	11.4	9.2
151	28. 9.79	0907	34 12.9	154 11.4	17.1	16.8	15.6	12.6	9.9
152	28. 9.79	0948	34 09.1	154 08.7	18.3	18.1	16.4	13.9	9.9
153	28. 9.79	1048	34 03.6	154 05.0	18.5	18.5	18.4	15.2	10.9
154	28. 9.79	1136	33 59.2	154 02.0	18.6	18.6	18.5	16.1	11.8
155	28. 9.79	1221	33 55.0	153 59.2	18.6	18.6	18.7	16.8	-
156	28. 9.79	1258	33 51.4	153 57.0	18.6	18.6	18.7	18.7	-
157	28. 9.79	1340	33 54.1	154 01.3	18.6	18.5	18.6	16.5	12.1
158	28. 9.79	1418	33 57.2	154 05.8	18.6	18.6	18.6	15.8	11.8
159	28. 9.79	1500	34 00.4	154 10.5	18.2	17.6	15.4	11.3	-
160	28. 9.79	1540	34 03.4	154 15.3	18.2	17.6	16.2	13.2	-
161	28. 9.79	1617	34 06.2	154 19.9	17.4	16.9	15.4	11.2	-
162	28. 9.79	1729	33 59.6	154 22.8	17.4	16.7	16.1	12.2	-
163	28. 9.79	1844	33 50.5	154 24.0	18.3	18.0	17.0	14.6	9.8
164	28. 9.79	1943	33 43.3	154 24.9	18.5	18.5	18.3	15.1	10.2
165	28. 9.79	2048	33 35.9	154 25.4	18.5	18.6	18.5	15.8	10.4
166	28. 9.79	2115	33 36.5	154 20.8	18.5	18.5	18.5	16.0	10.8
167	28. 9.79	2144	33 37.2	154 15.4	18.5	18.5	18.5	16.4	11.1
168	28. 9.79	2213	33 37.7	154 09.7	18.5	18.5	18.5	17.0	11.3
170	28. 9.79	2249	33 37.9	154 02.6	18.5	18.7	18.7	18.7	11.9
172	28. 9.79	2335	33 33.2	154 05.0	18.6	18.6	18.5	18.0	11.9
173	29. 9.79	0012	33 29.0	154 07.2	18.5	18.5	18.5	16.9	11.7
174	29. 9.79	0059	33 24.1	154 10.4	18.6	18.6	18.6	15.9	11.2
175	29. 9.79	0145	33 19.3	154 13.3	18.6	18.6	18.5	15.2	10.9
176	29. 9.79	0229	33 15.0	154 15.8	18.5	18.4	18.3	15.1	9.7
177	29. 9.79	0313	33 10.6	154 18.8	18.4	18.3	17.9	13.2	8.9
178	29. 9.79	0358	33 05.8	154 22.7	17.6	17.2	16.8	12.6	8.1
181	29. 9.79	0458	32 59.8	154 25.7	17.5	18.0	17.0	13.9	10.2
182	29. 9.79	0644	33 12.8	154 32.4	18.3	17.8	16.9	13.2	8.8
183	29. 9.79	1209	33 10.1	154 24.9	18.5	18.5	18.4	14.8	-
184	29. 9.79	1538	33 05.9	154 39.8	17.7	17.6	17.0	13.0	8.5
185	29. 9.79	1844	33 07.7	154 36.3	17.7	17.7	17.1	13.1	8.6
186	29. 9.79	2300	33 17.7	154 31.4	18.5	18.3	17.4	13.2	9.4
187	30. 9.79	0045	33 20.0	154 30.1	18.4	18.1	16.8	13.1	9.4
188	30. 9.79	0140	33 21.6	154 26.1	18.3	18.0	16.8	14.9	9.8
189	30. 9.79	0930	33 35.2	153 33.2	18.6	18.6	18.6	18.6	13.4

Appendix I (continued)

XBT no.	Date	Time	Latitude	Longitude	Temperature				
					5m	50m	100m	250m	450m
190	30. 9.79	1000	33 35.2	153 28.5	18.6	19.0	18.9	19.1	13.7
191	30. 9.79	1330	33 31.4	153 19.6	18.6	18.6	18.6	18.6	14.4
192	30. 9.79	1500	33 28.2	153 09.3	18.6	18.6	18.6	18.6	13.5
193	30. 9.79	1821	33 28.1	153 07.4	18.6	18.6	18.6	18.6	13.4
194	30. 9.79	2009	33 25.6	153 07.1	18.6	18.6	18.6	18.6	13.5
195	1.10.79	0158	33 16.5	153 03.9	19.0	18.6	18.6	18.6	12.4
196	1.10.79	0630	33 20.0	152 46.6	18.5	18.6	18.5	17.4	12.1
197	1.10.79	1127	33 19.7	152 26:7	18.5	18.5	18.5	15.5	10.8
198	1.10.79	1801	33 28.0	152 17.5	18.5	18.2	17.7	13.8	10.0
199	1.10.79	1950	33 28.4	152 14.5	18.2	18.1	17.6	13.1	9.7
200	1.10.79	2108	33 28.6	152 12.9	18.2	18.0	17.3	12.8	9.7
201	1.10.79	2231	33 29.0	152 10.8	18.3	18.2	17.4	12.4	9.8
202	1.10.79	2314	33 30.1	152 17.5	18.4	18.5	18.2	14.6	10.1
203	1.10.79	2342	33 30.9	152 21.8	18.7	18.6	18.5	15.2	10.5
204	2.10.79	0115	33 31.0	152 20.4	18.4	18.4	18.2	15.1	10.4
205	2.10.79	0237	33 31.2	152 19.1	18.4	18.4	18.4	15.0	10.4
206	2.10.79	0310	33 31.3	152 22.0	18.5	18.4	18.4	15.1	10.6
207	2.10.79	0434	33 30.3	152 20.8	18.4	18.4	18.4	15.1	10.3
208	2.10.79	0617	33 24.6	152 16.1	18.1	18.0	17.1	13.2	9.6
209	2.10.79	1035	33 23.4	152 9.1	18.2	18.2	17.4	11.8	9.4
210	2.10.79	1814	33 31.4	152 33.2	18.5	18.4	18.4	16.8	11.9
211	2.10.79	1953	33 31.9	152 31.2	18.7	18.5	18.5	16.0	11.4
212	2.10.79	2115	33 33.1	152 29.7	18.6	18.5	18.5	15.4	11.5
213	2.10.79	2210	33 32.8	152 19.2	18.8	18.5	18.3	18.5	9.9
214	2.10.79	2324	33 34.5	152 14.9	19.2	18.2	17.8	13.5	9.8
215	3.10.79	0006	33 34.3	152 6.8	18.2	18.0	17.5	11.8	9.1
216	3.10.79	0125	33 34.7	152 2.2	18.0	18.1	17.6	11.8	9.6
217	3.10.79	0253	33 35.8	152 5.3	18.2	18.2	17.5	12.3	10.4



Appendix 2. TIROS satellite photograph of eddy J taken 15 September 1979 (Courtesy NASA).



Appendix 3. TIROS satellite photograph of eddy J and the East Australian current taken 8 October 1979 (Courtesy NASA).

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