IOP/TECH/77/14

INDIAN OCEAN PROGRAMME

summary report on the cruise of the r/v shoyo maru in the north arabian sea

UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

Indian Ocean Programme IOP/TECH/77/14

Technical Reports No. 14

SUMMARY REPORT ON CRUISE OF THE R/V SHOYO MARU IN THE NORTH ARABIAN SEA

2 October 1976 - 13 January 1977

by

H. Yamanaka, M. Yukinawa and I. Nakamura*
Far Seas Fisheries Research Laboratory
Fishery Agency of Japan
Shimizu, Japan

*Ichthyological Laboratory, Department of Fisheries
Faculty of Agriculture, Kyoto University
Maizuru, Japan

(translated by S. Hayasi, Tokoku Regional Fisheries Research Laboratory)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS DEVELOPMENT PROGRAMME
Rome, November 1977

Yamanaka, H., M. Yukinawa & I. Nakamura (1977)
Tech.Rep.Indian Ocean Programme, (14):83 p.
Summary report on cruise of the R/V Shoyo Maru in the North Arabian Sea, 2 October 1976 - 13 January 1977

Cruises. Reports. Surveys. Exploratory fishing. Oceanographic data. ISW, Arabian Sea. ISW, Pakistan.

SUMMARY

At the Fifth Session of the IOFC Executive Committee held in Rome in April 1976, the Indian Ocean Programme reported its success in again bringing the R/V SHOYO MARU to the Arabian Sea and adjacent waters off India and Pakistan in November and December 1976. The present paper gives a brief description of the survey and its results, summarized from the original report in Japanese which will be published by the Fishery Agency of Japan sometime in 1977.

The activities covered oceanographic observation, conventional biological survey (sighting of pelagic shoals and collection of fishes) and acoustic survey. In spite of special attention, the squid Symplectoteuthis oualaniensis did not appear abundantly during the present cruise.

The equatorial undercurrent did not exist in the equatorial waters during the transitional period from the southwest monsoon to the northeast monsoon. Although the upwelling was recognized in the western part of the Second Area in the 1975 cruise, this was not encountered in the 1976 cruise. This might be attributed to the difference in the survey period; the first cruise in 1975 covered the late southwest monsoon season while the present cruise the early northeast monsoon season. The coastal upwelling on the continental slope was evidently less remarkable during the present cruise than during the previous one. The pelagic shoals again appeared rather scarce in the offshore waters throughout the survey period as was the previous cruise. There was a considerable number of important commercial fishes, almost the same species of the previous survey, on the Pakistani continental shelf, but none of them appeared to be large enough to attract a large-scale operation. In the present survey, the squids were not caught as often as in the previous survey. The index of echo abundance in the Second Area in 1976 was half of that in 1975. Since the duration of our cruise was very limited, it was difficult to find any reasoning for such year-to-year variation. However, it might be suggested that the squids moved toward the west coast of India or the southern Arabian Peninsula, or a deeper layer during the northeast monsoon season.

TABLE OF CONTENTS

		Page
1.	PURPOSE	1
2.	AREA	1
3.	PERIOD	1
4.	VESSEL	1
5.	STAFF	1
6.	ITEMS OF INVESTIGATION	1
7.	ITINERARY	1
8.	OCEANOGRAPHIC OBSERVATION	2
9.	CONVENTIONAL BIOLOGICAL SURVEY	7
10.	ACOUSTIC SURVEY	8
	REFERENCES	11
Table 1.	Number of fish schools, bird flocks and whales, etc., sighted in the whole survey area	13
Table 2.	Records on trolling in the whole survey area	20
Table 3.	Records on surface larvae net tows in the whole survey area	23
Table 4.	Larvae of Scombridae and Istiophoridae collected by surface larvae net tows	27
Table 5.	Records on midwater handline in the whole survey area	28
Table 6.	Records on bottom handline in southern coast of Pakistan	29
Table 7.	Records on catch by midwater trawl net in the whole survey area	30
Table 8.	Records on catch by bottom trawl net in the southern coast of Pakistan	31
Table 9.	Fish and squid species caught by bottom trawl net in the southern coast of Pakistan	32
Figure 1.	Track chart with survey areas by R/V SHOYO MARU, 2 October 1976 to 13 January 1977	36
Figure 2.	Wind characteristics in the survey areas, 4 November to 12 December 1976	37
Figure 3.	Track chart and oceanographic stations in the First Area, 4 to 21 November 1976	38
Figure 4.	Vertical profile of water temperature (°C) along the meridian of long. 64°E in the First Area	39
Figure 5.	Vertical profile of salinity (‰) along the meridian of long. 64°E in the First Area	40
Figure 6.	Vertical profile of content of dissolved oxygen (ml/L) along the meridian of long. 64°E in the First Area	41
Figure 7.	Vertical profile of content of Phosphate-P (ug-atom/L) along the meridian of 64°E in the First Area	42
Figure 8.	Vertical profile of content of Silicate-Si (ug-atom/L) along the meridian of 64°E in the First Area	43
Figure 9.	Track chart and oceanographic stations in the Second Area, 28 November to 8 December 1976	44
Figure 10.	Vertical profile of water temperature (°C) along the meridian of long. 62°05'E in the Second Area	45
Figure 11.	Vertical profiles of salinity (‰, left) and content of dissolved oxygen (ml/L, right) along the meridian of long. 62°05'E in the Second Area	46
Figure 12.	Vertical profiles of contents of Phosphate-P (ug-atom/L, left) and Silicate-Si (ug-atom/L, right) along the meridian of long. 62°05'E in the Second Area	47

TABLE OF CONTENTS (cont'd)

		Page
Figure 13.	Vertical profile of water temperature (°C) along the meridian of long. 63°10'E in the Second Area	48
Figure 14.	Vertical profile of salinity (‰) along the meridian of long. 63°10'E in the Second Area	49
Figure 15.	Vertical profile of water temperature (°C) along the meridian of long. 64°15'E in the Second Area	50
Figure 16.	Vertical profiles of salinity (‰, left) and content of dissolved oxygen (ml/L, right) along the meridian of long. 64°15'E in the Second Area	51
Figure 17.	Vertical profiles of contents of Phosphate-P (ug-atom/L, left) and Silicate-Si (ug-atom/L, right) along the meridian of long. 64°15'E in the Second Area	52
Figure 18.	Vertical profile of water temperature (°C) along the meridian of long. 65°60'E in the Second Area	53
Figure 19.	Vertical profiles of salinity (‰, left) and content of dissolved oxygen (ml/L, right) along the meridian of long. 65°50'E in the Second Area	54
Figure 20.	Vertical profile of water temperature (°C) along the meridian of long. 66°25'E in the Second Area	55
Figure 21.	Vertical profiles of contents of dissolved oxygen (ml/L, left) and Silicate-Si (ug-atom/L, right) along the meridian of long. 66°25'E in the Second Area	56
Figure 22.	Horizontal distribution of water temperature (°C) at 50 m layer in the Second Area	57
Figure 23.	Horizontal distribution of salinity (‰) at 50 m layer in the Second Area	58
Figure 24.	Horizontal distribution of content of dissolved oxygen (ml/L) at 50 m layer in the Second Area	59
Figure 25.	Horizontal distribution of content of Phosphate-P (ug-atom/L) at 50 m layer in the Second Area	60
Figure 26.	Horizontal distribution of content of Silicate-Si (ug-atom/L) at 50 m layerin the Second Area	61
Figure 27.	Horizontal distribution of depth of the mixed layer in the Second Area	62
Figure 28.	Horizontal distribution of depth of 1.0 ml/L content of dissolved oxygen in the Second Area	63
Figure 29.	Biological survey stations in the First Area	64
Figure 30.	Biological survey stations in the Second Area	65
Figure 31.	Distribution of oil balls collected by surface larvae net tows in the whole survey area	66
Figure 32.	Mantle length composition of Symplectoteuthis oualaniensis by sex (whole survey area)	67
Figure 33.	Body weight composition of Symplectoteuthis oualaniensis by sex (whole survey area)	68
Figure 34.	Length composition of Argyrops spinifer (BHL-3, 24°06'N, 66°51'E)	69
Figure 35.	Length composition of Argyrops spinifer (BHL-4, 24°05'N, 66°48'E)	70
Figure 36.	Length composition of Arius thalassinus (BHL-1, 23°28'N, 67°33'E)	71
Figure 37.	Mantle length composition of Loligo duvaucelii (BHL-1, 23°28'N, 67°33'E)	72
Figure 38.	Mantle length composition of Loligo duvaucelii (BHL-2, 24°04'N, 67°13'E)	72
Figure 39.	Mantle length composition of Loligo duvaucelii (BHL-6, near Karachi harbour	73
Figure 40.	Specification of midwater trawl net on board the R/V SHOYO MARU	74
Figure 41.	Schematic representation of diurnal changes of swimming layers estimated as squid	75

TABLE OF CONTENTS (cont'd)

		Page
Figure 42.	Diagrammatic representation of index of echo abundance per 30 nautical miles in the First Area in 1976	76
Figure 43.	Diagrammatic representation of index of echo abundance per 30 nautical miles in the offshore waters of Pakistan in 1976	77
Figure 44.	Diagrammatic representation of index of echo abundance per 5 nautical miles on echo survey line in the southern coast of Pakistan in 1976 .	78
Figure 45.	Revised diagrammatic representation of echo abundance per 30 nautical miles in the offshore waters of Pakistan in 1975	79
Plate I:	Record of squid indicating sinking movement at the dawn and rising at sunset (28 KHz)	80
Plate II:	Record of squid indicating shallow swimming layer in day-time (28 KHz)	81
Plate III:	Record of squid indicating deep swimming layer in day-time (50 KHz) . .	82

1. PURPOSE

The purpose of the present cruise was to obtain information on distribution of pelagic fish stocks in relation with the environmental factors in the Arabian Sea. Special attention was paid on distribution and behaviour of squid, Symplectoteuthis oualaniensis, which was observed over wide ranges during the last survey in 1975.

2. AREA

The survey covered two areas, the First or the central portion of the South Arabian Sea and the Second or the portion of the North Arabian Sea off Pakistan (Fig. 1). The initial plan envisaged coverage also of the area off India, but permission of the host country could not be obtained in time.

3. PERIOD

The vessel cruised for 104 days from 2 October 1976 to 13 January 1977 and surveyed the First Area in the southern Arabian Sea for 19 days from 3 to 21 November, and the Second Area in the North Arabian Sea for 17 days from 26 November to 12 December.

4. VESSEL

The vessel R/V SHOYO MARU (1 381.8 GT, 4 000 PS, Call Sign JDRD) belongs to the Ministry of Agriculture and Forestry, Government of Japan.

5. STAFF

The staff of the vessel was as follows:

Crew	Captain Kazuyuki Oomura and 40 other members		
Scientists	Hajima Yamanaka (Chief)	Oceanography & Acoustics	F.S.F.R.L.
	Mori Yukinawa	"	"
	Izumi Nakamura	Biology	Kyoto Univ.
Assistant Scientists	Singo Fujii	"	Kyushu Univ.
	Yoshihisa Kamihashi	Chemical Oceanography	Tokai Univ.
Part-time Scientists	Shamusuddin Qureshi	Assistant Biologist	Marine Fisheries Department, Pakistan
	Muhammad Arshad	"	"

6. ITEMS OF INVESTIGATION

(i) Oceanographic observation

(ii) Conventional biological survey

(iii) Acoustic survey

7. ITINERARY

Ports of Call	Arrival	Departure	Remarks
Tokyo		2.10.76	
Singapore	14.10.76	18.10.76	

Port of Call	Arrival	Departure	Remarks
Colombo[1/]	26.10.76	3.11.76	Discussion on the survey cruise with staffs of FAO (including IOP) and Japanese Fishery Agency for alteration of the survey cruise.
	3.11.76	21.11.76	Survey in the First Area.
Karachi	22.11.76	26.11.76	Arrangement of the survey schedule with the Pakistani officials.
	26.11.76	12.12.76	Survey in the Second Area
	13.12.76	17.12.76	Discussion on the survey results with the Pakistani officials.
Penang	27.12.76	31.12.76	
Tokyo	13.1.77		

8. OCEANOGRAPHIC OBSERVATION

In the whole survey area (Fig. 1) the following measurements were made:

(i) meteorological factors by ordinary instruments;

(ii) temperature and salinity in upper 750 m layers by STD;

(iii) temperature in upper 250 m layers by BT;

(iv) temperature in upper 450 m layers by XBT; and

(v) direction and velocity of surface currents by GEK.

Water samples were collected from upper 750 m layers in the Rosett Multi-Sampler. The thermosalinograph was continuously operated to locate siome or current-rips. The water samples were determined on board by:

(i) salinity by the auto-lab salinometer for the check to STD reading;

(ii) content of dissolved oxygen by Winkler's method; and

(iii) content of Silicate-Si and Phosphate-P by the auto-analyser and cross check by the colorimeter.

8.1 Meteorological Observation

The present surveys covered a period early November to mid-December of transition from the southwest monsoon to the northeast monsoon (Wooster et al., 1967). In November, the low pressure zone appears in the vicinity of lat. 11°N, and then moves southward with development of the high pressure zone in the north. The northeast monsoon season begins when the south-going low pressure zone reaches the equator. Other monsoon depression occurs in an area over lat. 5°N - 15°N, long. 70°E - 80°E, and moves toward west and west-northwest (Sadler and Gildley, 1973).

Figure 2 shows the wind observed in the whole survey period from 4 November to 12 December. The wind direction and velocity given in the figure are either daily average in the First Area south of lat. 21°N, or the average of measurement over the 15-day survey period in the Second Area.

1/ Originally the vessel was expected to call at Madras and Bombay before the cancelled survey off India. Due to lack of definite permission in time, the vessel called at Colombo instead of the above two ports.

It is noted that the wind has been mild, usually 4 or below in the Beaufort scale, in the First Area, especially in the southern part; SE - SSE in direction and 2 - 3 in the Beaufort scale in lat. 6°S - 2°S- SSW - NW and 3- 4 in 2°S - 10°N; and various velocity in 10°N - 15°N; and NE - E and 3 - 4 in the northern area. In the Second Area, northeast wind dominated, comprising 21%, and the velocity was found having often reached 5 in the Beaufort scale.

The mild and varying wind in the part of the surveyed area south of lat. 10°N indicates that the observations there were conducted during the transition period from the southwest monsoon to the northeast monsoon. Although the survey in the lat. 10°N - 15°N zone failed to indicate any definite trend due to disturbance caused by passage of depression and cyclone, the northeastern wind dominated in the part north of lat. 15°N. The northeast monsoon was found starting in the part north of lat. 18°N surveyed in late November, for the dominancy of the northeastern wind, fine weather and high atmospheric pressure.

8.2 Oceanographic Observation

The present survey was conducted during the transitional period when only limited surveys were ever conducted in spite of possible drastic changes of oceanographic conditions (Wyrtki et al., 1971). The data are now analysed in detail for better understanding of possible complicated procedures of seasonal change in the current system peculiar to the Indian Ocean. The present report covers merely a description of observations so far made during the present survey.

8.2.1 First Area

The first survey forms a line extending from lat. 6°S to 22°N along the meridian of long. 64°E, including grids in the part north of lat. 15°N. In total 68 observation stations were occupied as shown in Figure 3.

The vertical distribution of temperature along the meridian in Figure 4 indicates a westward current in the part south of lat. 2°30'S and an eastward current in the part between lat. 2°30'S - 3°N. The current systems in the northern part appear quite complicated, but a scrutiny of the data implies presence of a westward current in the part north of lat. 3°N, and of a vortex in the part between lat. 7°N and 9°30'N. Data from the waters around the equator failed to show clearly existence of the so-called thermocline spreading phenomenon.

The vertical profile of salinity is shown in Figure 5. A distinct halocline of a 50 - 100 m layer appeared in the part north of lat. 1°S. Above the discontinuity, the water mass of high salinity exceeding 36.0‰ of northern origin expanded toward lat. 3°N. The gradient in the deeper layer is mild. The core of midlayer high saline water was not found in the waters around the equator.

Figure 6 presents the vertical profile of content of dissolved oxygen. The isometric lines of 3 ml/L or above run above 100 m layer, in parallel with the sea surface in 100 m or shallower layers. The oxygen content shows distinct vertical change below 100 m layer in the waters north of lat. 5°N. In the layers below 100 m, the oxygen content decreases northward, below 1 ml/L at lat. 5°N, or north, and 0.5 ml/L in the northern waters of lat. 11 N.

As seen in Figure 7, the content of Phosphate-P does not change from south to north in the shallower layers above 100 m where the content does not reach 2.0 ug-atom/L. The high content of 2.0 ug-atom/L occurs in rather shallow waters of a little over 100 m in the northern part of lat. 5°N - 12°N, but sinks to about 400 m depth in the southern waters. The higher isometric contour of 2.5 ug-atom/L also shows similar vertical change, thus indicating richer distribution of the nutrient in the northern portion of the surveyed area.

The vertical profile of Silicate-Si also appears to show a higher content in the northern waters than in the southern waters at shallow layers above 500 m. In the deeper layer, the content of Silicate-Si rises in the waters south of lat. 3°S.

8.2.2 Second Area

Figure 9 shows cruise tracks and distribution of survey stations in the Second Area that was once covered by the previous research cruise in 1975. The survey period in the present cruise from 28 November to 8 December appears to have been in the northeast monsoon season. The following statement of vertical and horizontal distributions of temperature are based on observations made by bathythermographs and expendable bathythermographs, which were conducted at dense intervals.

1. Vertical profiles

(1) Line around long. 62°E.

Vertical profiles are shown for temperature (Fig. 10), salinity and content of dissolved oxygen (Fig. 11), and contents of Phosphate-P and Silicate-Si (Fig. 12). The isothermal contours appear to be shallowest at around lat. 23°N, and to deepen northward and southward. The profile of salinity shows a similar trend, except that a core of 36.3‰ or more exists at the layer of 200 m near lat. 22°N. The oxygen content is low, less than 1 ml/L below 60 m depth. The contours also deepen toward the north and south ends of the Area. Similar north-south change of depth of contours appears for contents of Phosphate-P and Silicate-Si.

(2) Line around long. 63°E

Figures 13 and 14 illustrate the vertical profiles of temperature and salinity respectively. The isothermal contours appear to be shallowest at around 24°N and deepen toward the northern and southern ends of the Area. A similar geographic change is observed in unshown vertical distributions of Phosphate-P and Silicate-Si. The salinity shows more complicated vertical profiles with a core of 35.8‰ or less at 180 m depth and another core of 36.1‰ or more at 300 m depth, both being the most conspicuous around lat. 23°N.

(3) Line around long. 64 E

The profiles are given on temperature (Fig. 15), salinity and content of dissolved oxygen (Fig. 16), contents of Phosphate-P and Silicate-Si (Fig. 17). The isothermal contours lie at the shallowest layers at around lat. 24°N, deepen toward lat. 22°30'N, and come to shallower layers southward. Similar geographic changes of depth of contours are observed for the other factors. The salinity has two cores at around lat. 23°N; a low saline core of 35.9‰ or less at 100 m depth and a high core of 36.3‰ or more at 300 m depth.

(4) Line around long. 66 E

Figure 18 shows the profile of temperature and Figure 19 that of salinity and content of dissolved oxygen. The contours along the line show less geographic change than those along the aforementioned three lines. The isothermal contours lie almost parallel to the sea surface. Such change appears in the oxygen content as well as contours of content of the two nutrient salts, although the figures are not shown.

(5) Line around long. 66°25'E

Profiles are given on temperature (Fig. 20) and contents of dissolved oxygen and Silicate-Si (Fig. 21). The contours of these three factors appear to have become shallower along the continental slope. This geographic change implies existence of a coastal upwelling which is not confirmed due to scarcity of data on the shelf area.

2. Horizontal distributions

The present description is based on the observations at the 50 m depth layer, selected due to relatively remarkable geographic change and to the convenience for comparison with the distribution patterns during the previous survey in 1975.

(1) Temperature (Fig. 22)

Observed temperature ranges between 22°C and 27°C, except small cold parts below 22°C at the western end (west of long. 63°E) and the central part (lat. 24°N, long. 64°E). Warm waters of 26°C or above are located in the waters south of lat. 23°N.

(2) Salinity (Fig. 23)

The low saline waters are observed at the parts of low temperature. However, this coincidence between temperature and salinity may not always occur at other depth layers due to the complicated vertical variation of salinity such as existence of low and high saline cores.

(3) Content of dissolved oxygen (Fig. 24)

The high content of oxygen occurs in the southeastern part and low content in the northeastern part. The low oxygen content intrudes toward long. 64°E along the parallel of lat. 24°N.

(4) Phosphate-P (Fig. 25)

Generally the content of Phosphate-P does not exceed 2.0 ug-atom/L, except two parts at around lat. 24°N, long. 64°E and at around lat. 22°N, west of long. 62°E.

(5) Silicate-Si (Fig. 26)

A high content of Silicate-Si exceeding 15 ug-atom/L appears at the high Phosphate-P concentration of lat. 24°N, long. 64°E. It is also noted that the contour of 10 ug-atom/L intrudes from the western waters south of lat. 23°N toward the highest concentration.

(6) Depth of mixed layer (Fig. 27)

Generally the mixed layer is located at shallow layers at the eastern and western ends and at deeper layers at the central part of the surveyed area. The north-south change of depth of the mixed layer is especially conspicuous along long. 64°E, above 40 m at lat. 24°N but below 80 m at the south. The mixed layer is found shallower in this cruise than in the previous cruise in 1975.

(7) Depth of low oxygen content of 1 ml/L (Fig. 28)

The low oxygen layer is found shallower in this cruise than in the previous cruise. The layer appears very shallow, above 30 m, at lat. 24°N, long. 64°E. From this point, a ridge of the low oxygen layer expands southwestward, reaching lat. 23°N, long. 62°E.

8.2.3 Consideration

1. First Area

The westward current observed in the waters of lat. 2°30'S and south appears to be the south equatorial current. The position thus found in the present survey is

far north compared to previous reports of the position of the current at lat. 7°S and south in January to May (Uda & Nakamura, 1973) and 5°S and south in the northern winter (Sharma, 1976).

There are two possibilities to identify the eastward current found in the waters of lat. 2°30'S - 3°N. It could be either the forming equatorial counter current or the equatorial jet which were found by Wyrtki (1973 a, b). According to him, the former is located between lat. 3°N and 5°S in November and December, and the latter appears during the transition period of the two monsoon seasons along the equator.

It is noted in the equatorial waters that the so-called thermocline spreading was not detected and that the core of high saline waters was not located during the surveys in the First Area. This indicates that the equatorial undercurrent (Swallow, 1967, Taft, 1967, Taft and Knaus, 1967) did not exist in this area during the period under discussion.

In the shallower layers, the high saline waters exceeding 36.0‰ expands from north to south. The high saline water masses in the northern part, north of lat. 5°N, and those in the southern part appear to be the water masses "D" originated in the central Arabian Sea, and the water masses "E" of the equatorial waters defined by Rochford (1964) respectively. The geographic distribution of dissolved oxygen and Phosphate-P, which are characterized by low concentration in the former and high concentration in the latter in the northern part, were already observed during the International Indian Ocean Expedition (Wyrtki et al., 1971). This indicates that the northern Arabian Sea water expands toward lat. 5°N - 10°N.

2. Second Area

A conspicuous thermal ridge is located at lat. 23°N, long. 62°E, lat. 24°N, long. 63°E, and lat. 24°N, long. 64°E. But there is no such ridge observed in the eastern part. The waters surrounding the above thermal ridges are mostly characterized by the shallow mixed layer, low temperature, low oxygen content and high contents of the nutrient salts. But the ridge around lat. 24°N, long. 64°E shows peculiar values of salinity at each layer and such isolated distributions as to temperature and phosphate at 50 m layer and temperature and silicate at 100 m layer, which differ from those in the western waters along the ridge.

An examination of charts prepared by Kavanova (1968) indicates eastward expansion of a highly productive zone of 1.45 gc/m^2/day from the Arabian Peninsula during the southwest monsoon season. Such characteristic was observed during the previous survey in 1975. This may have been attributed to long southwest monsoon season in 1975, which appeared to have remained even in late October. Lack of offshore upwelling that is featured by eastward expansion of high productive zone is encountered in the 1976 cruise. This is most likely reflected by the survey period in 1976 that started later by about ten days as well as the earlier turnover of monsoon during the 1976 survey period. The remnant of productive waters in the western part implies that once developed upwelling off the Arabian Peninsula during the southwest monsoon season and resultant expansion of highly nutritive waters were fading in the period of the present cruise after commencement of the northeast monsoon season, but the trace remained at the waters around lat. 24°N, long. 64°E.

The coastal upwelling on the continental slope was evidently less remarkable during the present cruise than during the previous one. The difference may also be due to the lags of termination of the southwest monsoon season and of the cruise between these two years.

9. CONVENTIONAL BIOLOGICAL SURVEY

Non-acoustic surveys for locating the fishery stocks during the present cruise comprises visual observations, egg and larvae sampling and test fishing with the use of trolling for large pelagic fishes, and handlines, longlines and small trawls for the demersal fishes and squids.

Larvae sampling and test fishing were conducted at the stations shown in Figs. 29 and 30.

9.1 Visual Observation and Trolling

During the day-time surface schools of fishes, flocks of birds, other large animals and drifts that may attract fishes were watched over the survey tracks in the First Area (8 to 20 November) and in the Second Area (28 November to 11 December). Table 1 summarizes their occurrence for each two-hour duration. Most fish schools might have been skipjack tuna of Euthynnus. Birds were not frequently found and most flocks were small. Trolling gears were operated for about one hour around sunrise and sunset on 8 to 20 November and 28 November to 7 December, and caught 16 specimens of skipjack tuna and dolphin fish (Table 2).

In general, tuna and related fishes did not appear abundant off Pakistan in the survey period. This coincides with the previous observation that the R/V DR. FRIDTJOF NANSEN did not find tuna schools in 1975 and 1976 (Institute of Marine Research, 1975, 1976 a, b), and that only a single school of frigate mackerel was observed in the previous survey by the R/V SHOYO MARU (Fishery Agency of Japan, 1976, Yamanaka et al., 1976).

9.2 Egg and Larvae Sampling

A larvae net with a mouth opening of 2 meters in diameter for the surface collection was towed at a speed of about 2.5 knots for 20 minutes, once in the morning and at night (Table 3). The fishes were classified by family. Among tuna and billfishes, the skipjack tuna dominated in number (Table 4). This differs from the result in the previous survey when only 12 larvae of frigate mackerel of Auxis were obtained (Fishery Agency of Japan, 1976, Yamanaka et al., 1976).

The surface larvae net tow indicates that oil balls were frequent off Pakistan (Fig. 31).

9.3 Midwater Handline

The gear of midwater handline was used at 33 stations scattered over the whole area, aiming mainly at squids of Symplectoteuthis oualaniensis which were abundantly taken during the previous survey. The test fishing captured about 130 specimens of the squids (Table 5), ranging from 12 to 36 cm in mantle length (Fig. 32) and 75 to 1 375 g in body weight (Fig. 33). The sexual dimorphism is quite evident, males are far smaller than females.

9.4 Bottom Handline

In order to capture demersal fishes, bottom handlines were operated at six stations located on the continental shelf off southern Pakistan (Table 6). Longspine seabream of Argyrops spinifer and giant catfish of Arius thalassinus dominated over about 20 species of fishes. The seabream taken at lat. 24°06'N, long. 66°51'E showed a monomodal length composition around 24 to 26 cm in total length (Fig. 34). The other sample of 92 specimens taken at lat. 24°05'N, long. 66°48'E showed two modes around 28 to 30 cm and 48 to 50 cm (Fig. 34). The catfish from lat. 23°28'N, long. 67°33'E were found with a mode of 38 to 40 cm in total length (Fig. 36). Specimens of these two species taken during the present survey resemble in range of total length those caught abundantly during the previous cruise (Fishery Agency of Japan, 1976, Yamanaka et al., 1976). Another dominating animal is the squid of Loligo duvaucelii. The size composition shows some variation, a monomodal composition around 14 to 16 cm in mantle length at lat. 23°28'N, long. 67°33'E (Fig. 37), another monomodal one around 8 to 10 cm at lat. 24°04'N, long. 67°13'E (Fig. 38), and a bimodal composition around 10 to 12 cm and 16 to 18 cm at another station near Karachi harbour (Fig. 39).

9.5 Bottom Longline

Once bottom longline was operated at lat. 23°28'N, long. 67°33'E, which was set in the evening of 8 December and hauled in the next morning. The hook rate was as high as 50%, and the catch comprised two specimens each of lined silver grunt of Pomadasys hasta and longspine seabream and 14 specimens of giant catfish. Rough sea conditions forbidden any additional operation for this year in the following survey period.

9.6 Midwater Trawl

The newly designed small sized midwater trawl has the dimension illustrated in Fig. 40. The gear was towed at a speed of 3 knots at a depth range of 40 to 300 m aiming at dense echo reflection. Major species in the catch taken at the 16 stations comprised swimming crab of Charybdis edwardsi, a kind of gender of Vinciguerria lucetia and a kind of lantern fish of Benthosema pterota (Table 7). However, none of the squid of Symplectoteuthis oualaniensis were caught by the gear.

9.7 Bottom Trawl

The same gear shown in Fig. 40 was also towed near bottom at eight stations on the continental shelf regardless of the echo reflection. The towing speed ranged between 3 and 4 knots (Table 8). A few hundred species of fishes, squids and shrimps were taken by the gear. Among them, sweet lips of Pomadasys spp., largehead hairtail of Trichiurus lepturus, several species of Theraponidae, lizardfish of Saurida spp., and threadfin breams of Nemipterus spp., may consist of economically important fishes in the survey area (Table 9). It is noted that longspine seabream and giant catfish were not numerous in catch by bottom trawl although they dominated over catch made by bottom longline.

9.8 Consideration

There are a considerable number of important commercial fishes on the Pakistani continental shelf, but none of them appear to be large enough to attract a large-scale operation. Based on the survey by the R/V AKADEMIK KNIPOVICH in the western continental shelf of India from January to March 1966, Shubnikov and Tokareva (1973) described almost the same opinion. In the present survey, the squid of Symplectoteuthis oualaniensis were not caught as often as in the previous survey. Further discussion on this year-to-year change on appearance of the squid is given in the following section on the acoustic survey.

10. ACOUSTIC SURVEY

The survey was conducted with the use of the 28 KHz echo sounder of the ultrasonic fish counting system, and the three-wave echo sounder for the navigation system. Of the latter sounder, only a wave of 50 KHz was used for the acoustic survey. The present survey was conducted as a rule from 06.00 to 20.00 h because it has been noted during the previous survey in 1975 that the fish schools were not always discriminated from dense deep scattering layer (DSL) which had frequently appeared at night. The recorders were usually fitted for the depth range from surface to 200 m for the 28 KHz sounder or to 400 m for the 50 KHz sounder. In the waters shallower than these designated depths, the recorders were switched for appropriately narrow ranges. The sensitivity was kept for ensuring the best records.

10.1 Swimming Layer of the Squid

Dense records frequently observed during the previous survey again appeared in the offshore waters of 200 m or deeper during the present survey. The experimental handlining indicated that these records consisted of the squid, Symplectoteuthis oualaniensis. Also diurnal change of these records was confirmed as a sinking movement at dawn and a rising movement at sunset (Plate 1).

Analysis of echo records obtained in the 1975 survey indicated that the squid mostly stayed at a depth of 120 to 200 m in day-time (Fishery Agency of Japan, 1976, Yamanaka et al., 1976). During the present survey the swimming layer of squid was observed not only at a rather shallow layer above 200 m (Plate 2), but also at a deeper layer (Plate 3). The records at the layer below 200 m are found resembling the unknown records discovered by Currie et al., (1973) off Somalia.

The observation implies two types of diurnal changes (shallow and deep) of swimming layers of squid as schematically illustrated in Fig. 41. There was no relation between dominancy of shallow or deep layers or between geographic position and oceanographic conditions. Due to the deficit of the 50 KHz sounder for the biological survey, the "index of echo abundance" of the squid was estimated only for schools that occurred in the layers above 200 m. The "index of echo abundance" was defined by Yokota (1953) as a product of length of the record (nautical miles) and height of the record (m) without any adjustment for intensity of the reflection.

10.2 Records in the First Area

Figure 42 shows distribution of the relative abundance of animals in 0 to 200 m layer for a distance of 30 nautical miles of survey track. Skipjack tuna might have been a major contributor to the records in the waters south of the equator. Schools assumed as squid were not frequent in the water from lat. 6 S to 13 N, but increased in abundance in the northern waters.

10.3 Records in the Second Area

(1) Waters west of Karachi

As shown in Fig. 43, the squid appeared very abundantly distributed in the coastal waters around long. 63 30'E. A smaller concentration was found in the offshore waters of lat. 22 N, long. 64 E.

(2) Waters south of Karachi

Figure 44 gives survey tracks in the coastal waters along southern Pakistan and the indices of echo abundance for a distance of 5 nautical miles. During the survey, the standing stocks appeared rather low except demersal stocks off Karachi and pelagic stocks off the Kemi river.

10.4 Consideration

The squids appear to be concentrated in particular areas although Okutani (1973) found that the geographic range expands widely over the Indian Ocean. In the First Area, the abundance was high in the waters north of lat. 13 N, where the oxygen content in the middle layers is rather low, between 0.2 to 0.5 ml/L, according to Wyrtki et al., (1971), and results of the present survey. This coincidence with the previous result (Fishery Agency of Japan, 1976, Yamanaka et al., 1976) again implies that the squids are distributed in the waters of low oxygen content. In the Second Area, the squid appear to have been distributed avoiding the waters with diminishing upwellings.

Recently some numerical correction was found necessary for the indices of echo abundance of squid in 1975. Figure 45 must replace the corresponding figures in the previous papers (Fig. 39 in the Fishery Agency of Japan, 1976, and Fig. 22 in Yamanaka et al., 1976). Such correction did not affect the major conclusion that the squids are distributed around the upwellings.

The squids were less abundant by half in the index of echo abundance and the ranges of distribution were different between these years. Since duration of our cruises are very limited, it is difficult to find out any reasoning for such year-to-year variation. However,

it could be noted that the survey covered the late southwest monsoon season in 1975 and the early northeast monsoon season in 1976; consequently the oceanographic conditions are different between the two surveys. This may suggest that the squids moved toward the west coast of India (Silas, 1969) or the southern Arabian Peninsula (Zylyev, G.V., 1971) or to a deeper layer as aforementioned during the northeast monsoon season.

Further surveys on the ecological study of the squid including migration and behaviour, etc., may be necessary to provide more information on availability and abundance of this important living resource in the Arabian Sea.

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Table 1. Number of fish schools, bird flocks and whales, etc., sighted in the whole survey area

Figures in parenthesis denote number of individuals

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
				(First Area)									
	06-08	05-29 S	64-35 E							1(40)			
	08-10	05-36 S	64-26 E										
Nov., 8	10-12	05-59 S	64-01 E										
	12-14	05-52 S	64-01 E										
	14-16	05-24 S	63-57 E										
	16-18	05-05 S	64-01 E										
	06-08	03-08 S	63-57 E										
	08-10	03-07 S	63-57 E										
	10-12	02-39 S	63-57 E						1	1(32)			
Nov., 9	12-14	02-30 S	63-58 E						1				
	14-16	02-01 S	63-59 E										
	16-18	01-57 S	63-59 E										
	06-08	00-07 N	64-05 E			1	2			1			
	08-10	00-18 N	64-04 E				1						
	10-12	00-40 N	64-03 E										
Nov., 10	12-14	00-55 N	64-09 E										
	14-16	00-59 N	64-11 E						1				
	16-18	01-21 N	64-08 E						1				
	06-08	02-38 N	63-55 E		1		1						
	08-10	02-54 N	63-51 E										
	10-12	03-08 N	63-50 E				1	1					
Nov., 11	12-14	03-18 N	63-54 E										
	14-16	03-58 N	64-00 E										
	16-18	03-58 N	64-00 E										

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	05-52 N	63-53 E										
	08-10	05-53 N	63-53 E										
	10-12	06-18 N	63-52 E										
Nov., 12	12-14	06-30 N	63-52 E										
	14-16	07-01 N	63-54 E										
	16-18	07-12 N	64-01 E										
	06-08	09-02 N	64-06 E						1				
	08-10	09-13 N	64-05 E										
	10-12	09-31 N	64-03 E						1				
Nov., 13	12-14	09-54 N	63-56 E										
	14-16	10-05 N	63-56 E										
	16-18	10-30 N	63-57 E						1				
	06-08	12-30 N	64-00 E				1				1(5)		
	08-10	12-45 N	64-00 E										
	10-12	13-07 N	63-56 E										
Nov., 14	12-14	13-31 N	63-55 E										
	14-16	13-30 N	63-54 E						1				
	16-18	13-40 N	63-56 E										
	06-08	15-09 N	63-05 E						1				
	08-10	15-09 N	62-56 E						2				
	10-12	15-08 N	62-45 E										
Nov., 15	12-14	15-04 N	62-58 E										
	14-16	15-05 N	62-42 E										
	16-18	15-01 N	61-26 E						1				

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	16-45 N	61-47 E										
	08-10	17-01 N	61-59 E						1				
	10-12	17-01 N	62-19 E						1				
Nov., 16	12-14	17-01 N	62-43 E										
	14-16	17-01 N	63-01 E						1				
	16-18	17-01 N	63-27 E										
	06-08	17-01 N	65-48 E										
	08-10	17-01 N	66-00 E										
	10-12	17-24 N	65-47 E						1				
Nov., 17	12-14	17-34 N	65-47 E										
	14-16	18-00 N	65-52 E										
	16-18	18-15 N	65-55 E										
	06-08	18-59 N	64-35 E						2				
	08-10	18-59 N	64-21 E										
	10-12	18-57 N	63-59 E										
Nov., 18	12-14	18-57 N	63-43 E										
	14-16	18-55 N	63-37 E						1				
	16-18	18-57 N	63-28 E										
	06-08	20-01 N	63-58 E						2				
	08-10	20-01 N	64-08 E						1				
	10-12	20-01 N	64-45 E						1				Turtle(1)
Nov., 19	12-14	20-01 N	64-44 E						1				
	14-16	20-10 N	65-02 E										
	16-18	20-30 N	65-03 E										

Table 1 (cont'd)

Date	Time (LMT)	Position Lat.	Position Long.	Fish schools Large	Fish schools Medium	Fish schools Small	Bird flocks Large	Bird flocks Medium	Bird flocks Small	Porpoises	Whales	Drifts	Others
	06-08	20-59 N	63-56 E						2			Wooden boad (1)	
	08-10	21-05 N	63-56 E					1					
	10-12	21-29 N	63-56 E						2				
Nov., 20	12-14	21-46 N	63-56 E										
	14-16	22-05 N	64-07 E										
	16-18	22-16 N	64-18 E										
				(Second Area)									
	06-08	21-00 N	62-05 E										
	08-10	21-01 N	62-05 E										
	10-12	21-20 N	62-05 E						1				
Nov., 28	12-14	21-36 N	62-13 E										
	14-16	21-48 N	62-07 E										
	16-18	22-06 N	62-03 E						2				
	06-08	23-50 N	62-04 E						2				
	08-10	24-03 N	62-04 E										Turtle(1)
	10-12	24-20 N	62-02 E										
Nov., 29	12-14	24-43 N	62-01 E										
	14-16	24-50 N	62-10 E										
	16-18	24-51 N	62-14 E										

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	23-14 N	62-36 E						1				
	08-10	22-58 N	62-36 E						2				
	10-12	22-34 N	62-35 E						1				
NOv., 30	12-14	22-24 N	62-34 E						1				
	14-16	22-00 N	62-36 E			1			1				
	16-18	21-44 N	62-39 E						2				
	06-08	21-23 N	63-10 E						3				
	08-10	21-33 N	63-10 E										Turtle(1)
	10-12	21-50 N	63-10 E						1				
Dec., 1	12-14	22-01 N	63-10 E										
	14-16	22-19 N	63-10 E						1				
	16-18	22-50 N	63-10 E									Drift board with fishes	
	06-08	24-32 N	63-14 E										
	08-10	24-40 N	63-13 E						1				
	10-12	24-48 N	63-08 E					1					
Dec., 2	12-14	24-49 N	63-21 E										
	14-16	24-39 N	63-38 E					1					
	16-18	24-50 N	63-42 E						1				
	06-08	23-41 N	64-14 E						1				
	08-10	23-33 N	64-14 E										
	10-12	22-44 N	64-16 E										
Dec., 3	12-14	22-50 N	64-19 E										
	14-16	22-33 N	64-17 E			1			1				
	16-18	22-20 N	64-17 E										

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	20-59 N	64-32 E						1				
	08-10	21-05 N	64-48 E										
	10-12	21-13 N	65-06 E									Sargassum (1)	
Dec., 4													
	12-14	21-22 N	65-17 E										
	14-16	21-29 N	65-18 E										
	16-18	21-46 N	65-19 E										
	06-08	23-33 N	65-20 E										
	08-10	23-50 N	65-20 E						1				
	10-12	24-20 N	65-20 E						1				
Dec., 5	12-14	24-19 N	65-19 E										
	14-16	24-46 N	65-21 E						1				
	16-18	24-50 N	65-21 E	1		2				2	2(100) (10)		
	06-08	23-28 N	65-53 E			1					1		
	08-10	23-28 N	65-53 E						2				
	10-12	22-50 N	65-53 E						1				
Dec., 6	12-14	22-48 N	65-52 E						1				
	14-16	22-19 N	65-51 E										
	16-18	22-00 N	65-51 E										
	06-08	23-18 N	66-22 E										
	08-10	23-30 N	66-23 E						1				
	10-12	23-50 N	66-26 E						1				
Dec., 7	12-14	23-56 N	66-25 E				1						
	14-16	24-18 N	66-24 E										
	16-18	24-50 N	66-25 E						3				Turtle(1) Sea snake(1)

Table 1 (cont'd)

Date	Time (IMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	22-51 N	66-56 E								1		
	08-10	22-52 N	66-57 E						1				
	10-12	23-02 N	67-12 E						1				
Dec., 8	12-14	23-03 N	67-12 E				1	1	2				
	14-16	23-15 N	67-25 E										
	16-18	23-28 N	67-33 E					1					
	06-08	23-28 N	67-33 E										
	08-10	23-32 N	67-29 E										
	10-12	23-35 N	67-32 E				1						
Dec., 9	12-14	23-39 N	67-20 E				1						Turtle(1)
	14-16	23-42 N	67-18 E										
	16-18	23-55 N	67-15 E										
	06-08	24-04 N	67-13 E										
	08-10	23-58 N	67-04 E					1					
	10-12	23-59 N	67-04 E										
Dec., 10	12-14	24-06 N	66-51 E										
	14-16	24-05 N	66-48 E										
	16-18	24-12 N	66-41 E										
	06-08	24-12 N	66-41 E					1					
	08-10	24-24 N	66-35 E										
	10-12	24-32 N	66-37 E										
Dec., 11	12-14	24-32 N	66-42 E										
	14-16	24-39 N	66-38 E										
	16-18	24-39 N	66-35 E										

Table 2. Records on trolling in the whole survey area

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Distance trolled	Species and total catch	Remarks
TR- 1	Nov., 8	17:33- 18:30	05-00 S 05-07 S	64-02 E 64-02 E	7.3 (miles)		
TR- 2	Nov., 9	05:30- 06:30	03-17 S 03-08 S	63-05 E 63-57 E	9.0		
TR- 3	Nov., 9	17:30- 18:30	01-45 S 01-38 S	64-03 E 64-03 E	7.3		
TR- 4	Nov.,10	05:43- 06:25	00-05 S 00-01 N	64-05 E 64-05 E	5.6		
TR- 5	Nov.,10	17:30- 18:25	01-36 N 01-42 N	64-06 E 64-04 E	7.0	Euthynnus pelamis (5)	Fork length 39.2-59.5 cm
TR- 6	Nov.,11	05:30- 06:23	02-32 N 02-38 N	63-58 E 63-55 E	7.1		
TR- 7	Nov.,11	17:30- 18:17	04-00 N 04-06 N	64-03 E 64-05 E	6.5		
TR- 8	Nov.,12	05:30- 06:26	05-38 N 05-45 N	63-52 E 63-52 E	7.6		
TR- 9	Nov.,12	17:25- 18:18	07-12 N 07-20 N	64-01 E 64-02 E	7.5		
TR-10	Nov.,13	17:20- 18:10	10-40 N 10-47 N	63-58 E 63-58 E	6.7		
TR-11	Nov.,14	05:40- 06:35	12-22 N 12-30 N	64-00 E 64-00 E	7.5		
TR-12	Nov.,14	17:00- 17:31	13-54 N 13-58 N	63-59 E 64-00 E	4.1		
TR-13	Nov.,15	05:50- 06:50	15-09 N 15-09 N	63-14 E 63-05 E	8.0	E. pelamis (3)	F.L. 38.6-40.5 cm

Table 2 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Distance trolled	Species and total catch	Remarks
TR-14	Nov., 15	17:20- 17:55	14-49 N 14-59 N	61-07 E 61-03 E	4.6 (miles)		
TR-15	Nov., 16	06:00- 06:36	16-45 N 16-49 N	61-47 E 61-49 E	5.0		
TR-16	Nov., 17	05:50- 06:45	16-57 N 16-57 N	65-29 E 65-37 E	7.4		
TR-17	Nov., 18	05:50- 06:47	18-59 N 18-59 N	64-44 E 64-35 E	7.6		
TR-18	Nov., 19	06:00- 06:55	20-01 N 20-01 N	63-42 E 63-51 E	7.6		
TR-19	Nov., 20	06:09- 06:58	20-52 N 20-59 N	63-56 E 63-56 E	6.4		
TR-20	Nov., 28	16:40- 17:44	22-14 N 22-23 N	62-03 E 62-03 E	8.8		
TR-21	Nov., 29	06:30- 07:30	23-50 N 23-58 N	62-04 E 62-04 E	8.1		
TR-22	Nov., 30	06:15- 07:15	23-14 N 23-06 N	62-36 E 62-36 E	7.9		
TR-23	Nov., 30	14:27- 15:02 (Fishes with a wood found)	22-00 N	62-36 E	3.8	Coryphaena hippurus (6) Carcharhinus sp. (1)	F.L. 44.7-72.7cm T.L. 105.3 cm
TR-24	Nov., 30	17:10- 18:00	21-44 N 21-38 N	62-39 E 62-39 E	6.7	Coryphaena equisetis (1)	F.L. 35.3 cm
TR-25	Dec., 1	06:30- 07:30	21-23 N 21-30 N	63-10 E 63-10 E	7.5		
TR-26	Dec., 2	06:15- 07:10	24-26 N 24-32 N	63-14 E 63-14 E	6.5		

Table 2 (cont'd)

St. No.	Date (LMT)	Time	Position Lat.	Position Long.	Distance trolled	Species and total catch	Remarks
TR-27	Dec., 3	06:20- 07:17	23-48 N 23-41 N	64-14 E 64-14 E	7.4(miles)		
TR-28	Dec., 3	17:00- 17:58	22-13 N 22-06 N	64-15 E 64-14 E	7.4		
TR-29	Dec., 4	06:00- 06:58	20-56 N 20-59 N	64-24 E 64-32 E	7.8		
TR-30	Dec., 5	06:10- 07:08	23-26 N 23-33 N	65-20 E 65-20 E	7.5		
TR-31	Dec., 5	16:54- 17:50	24-50 N 24-50 N	65-21 E 65-31 E	7.7		
TR-32	Dec., 6	06:00- 07:00	23-35 N 23-28 N	65-53 E 65-53 E	7.8		
TR-33	Dec., 7	17:00- 17:43	24-50 N 24-45 N	66-25 E 66-30 E	5.6		

Table 3. Records on surface larvae net tows in the whole survey area

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Fishes(family or order level) caught and number in parentheses
LN- 1	Nov., 8	20:00-20:20	04-40 S	64-02 E	Myctophidae (27), Hemirhamphidae (3), Exocoetidae (1), Carangidae (1)
LN- 2	Nov., 9	07:39-08:04	03-08 S	63-57 E	Hemirhamphidae (14), Clupeidae (10), Istiophoridae (1), Exocoetidae (1) Carangidae (1), Beryciformes (1)
LN- 3	Nov., 9	18:33-18:55	01-36 S	64-03 E	Myctophidae (48), Hemirhamphidae (23), Scombridae (7), Coryphaenidae (3), Bregmacerotidae (2)
LN- 4	Nov., 10	08:00-08:29	00-13 N	64-04 E	Hemirhamphidae (54), Beryciformes (31), Exocoetidae (14)
LN- 5	Nov., 10	20:00-20:20	01-58 N	63-58 E	Myctophidae (215), Scombridae (3), Coryphaenidae (3)
LN- 6	Nov., 11	08:00-08:20	02-54 N	63-51 E	Hemirhamphidae (6), Exocoetidae (3), Astronesthidae (1), Myctophidae (1) Echeneidae (1), Clupeidae (1), Unidentified fishes (30)
LN- 7	Nov., 11	20:00-20:20	04-23 N	64-05 E	Myctophidae (98), Clupeidae (8), Astronesthidae (7), Exocoetidae (3)
LN- 8	Nov., 12	08:00-08:20	05-52 N	63-53 E	Hemirhamphidae (18), Istiophoridae (6), Beryciformes (2), Coryphaenidae (1) Exocoetidae (1), Unidentified fishes (20)
LN- 9	Nov., 12	18:59-19:19	07-27 N	64-05 E	Myctophidae (93), Scombridae (25), Synodontidae (6), Coryphaenidae (6), Hemirhamphidae (3), Gempylidae (1), Beryciformes (1), Astronesthidae (1)
LN-10	Nov., 13	09:30-09:50	09-30 N	64-04 E	Hemirhamphidae (13), Exocoetidae (5)
LN-11	Nov., 13	19:20-19:43	11-00 N	63-58 E	Myctophidae (110), Gonostomatidae (2), Anguilliformes (2), Hemirhamphidae (2), Synodontidae (2), Clupeidae (1), Exocoetidae (1), Astronesthidae (1)
LN-12	Nov., 14	08:00-08:20	12-45 N	64-00 E	Hemirhamphidae (38), Exocoetidae (6), Beryciformes (4), Unidentified fishes (5)

Table 3 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Long.	Fishes(family or order level) caught and number in parenthesis
LN-13	Nov., 14	20:00-20:20	14-15 N	64-02 E	Myctophidae (72), Anguilliformes (36), Coryphaenidae (2), Beryciformes (2), Bregmacerotidae (1)
LN-14	Nov., 15	06:50-07:10	15-09 N	63-05 E	Coryphaenidae (6), Beryciformes (3), Hemirhamphidae (1), Unidentified fishes (29)
LN-15	Nov., 15	20:00 20:20	15-12 N	61-06 E	Myctophidae (161), Anguilliformes (5), Carangidae (2), Exocoetidae (1), Coryphaenidae (1)
LN-16	Nov., 16	07:37-08:00	16-58 N	61-54 E	Coryphaenidae (1), Anguilliformes (1), Unidentified fishes (20)
LN-17	Nov., 16	20:20-20:40	16-58 N	63-49 E	Myctophidae (99), Anguilliformes (30), Beryciformes (1), Coryphaenidae (1)
LN-18	Nov., 17	07:50-08:10	16-57 N	65-48 E	Hemirhamphidae (6), Exocoetidae (3); Unidentified fishes (7)
LN-19	Nov., 17	20:00-20:20	18-31 N	65-56 E	Clupeidae (253), Coryphaenidae (12), Myctophidae (10), Exocoetidae (5)
LN-20	Nov., 18	08:00-08:20	18-59 N	64-21 E	Clupeidae (8)
LN-21	Nov., 18	19:40-20:00	19-00 N	62-57 E	Myctophidae (113), Exocoetidae (29), Anguilliformes (14), Clupeidae (3), Coryphaenidae (5)
LN-22	Nov., 19	08:00-08:20	20-01 N	64-01 E	Beryciformes (1), Coryphaenidae (1), Exocoetidae (1)
Ln-23	Nov., 19	20:07-20:37	20-30 N	65-03 E	Myctophidae (29), Balistidae (12), Clupeidae (10), Coryphaenidae (2)
LN-24	Nov., 20	08:00-08:20	21-09 N	63-56 E	Clupeidae (3), Beryciformes (1)
LN-25	Nov., 28	08:02-08:22	21-01 N	62-05 E	Coryphaenidae (16), Carangidae (11), Exocoetidae (9), Tetraodontidae (7), Blennidae (7), Beryciformes (5), Pleuronectidae (3), Hemirhamphidae (3), Sphyraenidae (1), Clupeidae (1), Unidentified fishes (12)

Table 3 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Long.	Fishes(family or order level) caught and number in parenthesis
LN-26	Nov., 28	20:00-20:20	22-41 N	62-04 E	Myctophidae (88), Mugilidae (5), Exocoetidae (5), Coryphaenidae (2), Synodontidae (1), Hemirhamphidae (1), Unidentified fishes (9)
LN-27	Nov., 29	08:00-08:21	24-03 N	62-04 E	Bothidae (3), Clupeidae (2), Carangidae (1), Unidentified fishes (18)
LN-28	Nov., 29	20:00-20:20	24-50 N	62-34 E	Myctophidae (147), Pleuronectidae (33), Coryphaenidae (11), Stromateidae (9), Synodontidae (8), Mugilidae (3), Exocoetidae (1), Dactylopteridae (2), Unidentified fishes (2)
LN-29	Nov., 30	08:00-08:20	22-58 N	62-36 E	Pleuronectidae (11), Carangidae (3), Hemirhamphidae (2), Beryciformes (2), Atherinidae (2), Synodontidae (2), Exocoetidae (2)
LN-30	Nov., 30	19:59-20:19	21-25 N	62-38 E	Atherinidae (8), Myctophidae (6), Synodontidae (5), Coryphaenidae (5), Clupeidae (4), Exocoetidae (2), Beryciformes (1), Diodontidae (1), Carangidae (1), Unidentified fish (1)
LN-31	Dec., 1	08:00-08:20	21-33 N	63-10 E	———
LN-32	Dec., 1	20:00-20:20	23-02 N	63-11 E	Clupeidae (66), Myctophidae (31), Exocoetidae (6), Atherinidae (5), Coryphaenidae (4), Aluteridae (2), Unidentified fishes (28)
LN-33	Dec., 2	08:00-08:22	24-40 N	63-13 E	Coryphaenidae (4), Atherinidae (2), Clupeidae (2), Unidentified fishes (57)
LN-34	Dec., 2	20:00-20:20	24-48 N	63-58 E	Atherinidae (82), Stromateidae (11), Gonostomatidae (10), Myctophidae (6), Scombridae (1), Coryphaenidae (1), Synodontidae (1), Unidentified fishes (2)
LN-35	Dec., 3	07:58-08:19	23-33 N	64-14 E	Hemirhamphidae (2), Atherinidae (1)
LN-36	Dec., 3	20:00-20:20	21-51 N	64-14 E	Myctophidae (19), Exocoetidae (8), Coryphaenidae (3), Beryciformes (1), Atherinidae (1), Unidentified fishes (3)

Table 3 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Long.	Fishes(family or order level) caught and number in parenthesis
LN-37	Dec., 4	08:00-08:20	21-03 N	64-43 E	Exocoetidae (14), Mugilidae (3), Coryphaenidae (2), Hemirhamphidae (2), Unidentified fishes (10)
LN-38	Dec., 4	20:00-20:19	21-44 N	65-10 E	Myctophidae (483), Exocoetidae (26), Coryphaenidae (18), Atherinidae (9), Hemirhamphidae (5), Beryciformes (3), Balistidae (1), Unidentified fish (1)
LN-39	Dec., 5	08:00-08:20	23-33 N	65-20 E	Atherinidae (49), Hemirhamphidae (6), Coryphaenidae (5), Carangidae (1), Exocoetidae (1)
LN-40	Dec., 5	20:00-20:20	24-50 N	65-50 E	Atherinidae (12), Coryphaenidae (5), Stromateidae (3), Synodontidae (2), Clupeidae (1), Myctophidae (1), Unidentified fish (1)
LN-41	Dec., 6	08:00-08:19	23-18 N	65-53 E	Coryphaenidae (3), Exocoetidae (2), Hemirhamphidae (2), Carangidae (1), Atherinidae (1), Unidentified fish (1)
LN-42	Dec., 6	20:00-20:18	21-54 N	65-54 E	Myctophidae (35), Clupeidae (7), Atherinidae (6), Coryphaenidae (1), Unidentified fishes (2)
LN-43	Dec., 7	07:30-07:50	23-18 N	66-22 E	Sphyraenidae (26), Stromateidae (9), Clupeidae (6), Hemirhamphidae(2), Unidentified fish (1)
LN-44	Dec., 7	20:00-20:19	24-26 N	66-45 E	Myctophidae (72), Scorpaenidae (61), Carangidae (49), Stromateidae (41), Clupeidae (37), Atherinidae (26), Synodontidae (14), Sphyraenidae (9), Bregmacerotidae (7), Exocoetidae (6), Coryphaenidae (4), Blennidae (2), Trichiuridae (2), Uranoscopidae (1), Unidentified fishes (13)
LN-45	Dec., 8	08:08-08:26	22-51 N	66-56 E	Clupeidae (4), Coryphaenidae (1), Unidentified fishes (2)

Table 4. Larvae of Scombridae and Istiophoridae collected by surface larvae net tows

St. No.	Species	Number collected	Size range (T.L. mm)
LN- 2	Makaira mazara	1	15.0
LN- 3	Euthynnus pelamis	4	6.1 - 7.5
	Thunnus obesus	2	7.3, 7.3
	Scombridae	1	10.0
LN- 5	Euthynnus pelamis	2	5.0, 5.1
	Thunnus albacares	1	6.7
LN- 8	Makaira mazara	6	8.5 - 11.5
LN- 9	Euthynnus pelamis	25	4.6 - 8.0
LN-34	Auxis sp.	1	12.5

Table 5. Records on midwater handline in the whole survey area

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Number of gears used	Species and number caught
MWHL- 1	Nov., 5	23:49 - 01:18	04-02 S	63-54 E	3 - 4	Symplectoteuthis oualaniensis (2)
MWHL- 2	Nov., 9	22:06 - 23:00	01-02 S	64-04 E	3 - 4	S. oualaniensis (2)
MWHL- 3	Nov., 10	04:24 - 05:35	00-05 S	64-05 E	3 - 4	S. oualaniensis (2)
MWHL- 4	Nov., 10	20:20 - 21:29	01-59 N	63-58 E	3 - 4	S. oualaniensis (5)
MWHL- 5	Nov., 12	22:20 - 23:20	04-57 N	63-58 E	3 - 4	S. oualaniensis (1)
MWHL- 6	Nov., 13	19:47 - 20:47	11-01 N	63-58 E	3 - 4	S. oualaniensis (1)
MWHL- 7	Nov., 19	16:55 - 21:50	20-30 N	65-03 E	7 - 15	S. oualaniensis (30), Euthynnus pelamis (1), Auxis thazard (3), Coryphaena equiselis (3), Carcharhinus sp. (2)
MWHL- 8	Nov., 20	17:20 - 18:45	22-25 N	64-28 E	20	---
MWHL- 9	Nov., 28	04:00 - 06:15	21-00 N	62-05 E	9	S. oualaniensis (3)
MWHL-10	Nov., 28	17:45 - 18:10	22-23 N	62-03 E	14	S. oualaniensis (1)
MWHL-11	Nov., 28	21:40 - 23:30	22-50 N	62-06 E	5 - 10	S. oualaniensis (36)
MWHL-12	Nov., 29	05:30 - 06:30	23-50 N	62-04 E	8	S. oualaniensis(4), A. thazard(3), C. equiselis(2)
MWHL-13	Nov., 30	18:05 - 18:45	21-38 N	62-39 E	11	S. oualaniensis (3)
MWHL-14	Dec., 1	03:10 - 03:45	20-49 N	63-09 E	5	S. oualaniensis (9)
MWHL-15	Dec., 1	06:01 - 06:30	21-23 N	63-10 E	10	---
MWHL-16	Dec., 1	17:50 - 18:45	22-50 N	63-12 E	12 - 13	S. oualaniensis (13)
MWHL-17	Dec., 2	00:45 - 01:45	23-45 N	63-13 E	1 - 3	S. oualaniensis (4)
MWHL-18	Dec., 2	06:00 - 06:15	24-26 N	63-14 E	7	---
MWHL-19	Dec., 2	18:07 - 18:45	24-47 N	63-45 E	12 - 13	S. oualaniensis (3)
MWHL-20	Dec., 2	22:10 - 23:00	24-50 N	64-14 E	3	---
MWHL-21	Dec., 3	04:50 - 05:50	23-52 N	64-14 E	4	---
MWHL-22	Dec., 3	18:00 - 18:30	22-06 N	64-14 E	12	S. oualaniensis (5), E. pelamis (1)
MWHL-23	Dec., 3	20:25 - 21:05	21-51 N	64-14 E	5	---
MWHL-24	Dec., 4	03:15 - 04:00	20-48 N	64-09 E	4	---
MWHL-25	Dec., 4	19:00 - 19:30	21-50 N	65-20 E	12 - 15	S. oualaniensis (4), A. thazard (1)
MWHL-26	Dec., 5	17:55 - 18:25	24-50 N	65-31 E	14	---
MWHL-27	Dec., 5	20:30 - 21:10	24-56 N	65-50 E	5	---
MWHL-28	Dec., 6	00:45 - 01:10	24-20 N	65-53 E	4	---
MWHL-29	Dec., 6	04:10 - 04:45	23-46 N	65-53 E	4	---
MWHL-30	Dec., 6	18:40 - 19:30	21-52 N	65-51 E	7	S. oualaniensis (1)
MWHL-31	Dec., 7	02:40 - 03:30	22-49 N	66-22 E	3	---
MWHL-32	Dec., 8	00:00 - 00:45	23-28 N	67-33 E	2	---
MWHL-33	Dec., 8	03:30 - 04:00	23-28 N	67-33 E	1	---

Table 6. Records on bottom handline in southern coast of Pakistan

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Number of gears used	Main species and number caught
BHL- 1	Dec., 8	17:15 - 20:30	23-28 N	67-33 E	10 - 15	Loligo duvaucelii (150), Argyrops spinifer (11), Acanthopagrus datnia (5)
BHL- 2	Dec., 9 Dec., 10	16:49 - 07:53	24-04 N	67-13 E	20 - 25	L. duvaucelii (120), Arius thalassinus (102), Therapon jarbua (7), Pomadasys maculatus(3)
BHL- 3	Dec., 10	12:14 - 12:58	24-06 N	66-51 E	10 - 15	A. spinifer (30), Epinephelus diacanthus (13), Epinephelus chrolostigma (4) Saurida undosquamis (6)
BHL- 4	Dec., 10	13:36 - 15:35	24-05 N	66-48 E	10 - 15	E. diacanthus (121), E. chrolostigma (18), A. spinifer (117), Trichiurus lepturus (23), Sarda orientalis (6)
BHL- 5	Dec., 11 Dec., 12	18:08 - 07:00	24-33 N	66-21 E	20 - 25	E. diacanthus (29), E. chrolostigma (14), A. spinifer (13), T. jarbua (6)
BHL- 6	Dec., 12	18:08 - 23:30	Off Karachi		20 - 25	L. duvaucelii (500), Rastrelliger kanagurta (50), Decapterus sp. (35)

Table 7. Records on catch by midwater trawl net in the whole survey area

After MWTR-9, cod end was covered by fine meshed net

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Trawled maximum depth(m)	Total catch(Kg)	Species caught
MWTR- 1	Nov., 14	13:30 - 14:00	13-30 N	63-54 E	123	4.4	Charybdis edwardsi
MWTR- 2	Nov., 16	17:25 - 17:55	16-59 N	63-29 E	110	1.75	C. edwardsi , Vinciguerria lucetia
MWTR- 3	Nov., 17	17:10 - 17:42	18-23 N	65-57 E	107	0.1	C. edwardsi, V. lucetia
MWTR- 4	Nov., 18	14:10 - 14:50	18-55 N	63-37 E	220	0.03	C. edwardsi, V. lucetia
MWTR- 5	Nov., 18	17:09 - 17:40	18-59 N	63-19 E	130	20.0	C. edwardsi
MWTR- 6	Nov., 29	- -	24-50 N	62-10 E	-	-	(Not succeeded)
MWTR- 7	Nov., 29	16:48 - 17:20	24-51 N	62-10 E	93	0.3	V. lucetia, Myctophidae, Squid larvae, C. edwardsi, Anguilliform larvae
MWTR- 8	Nov., 29	17:50 - 18:25	24-51 N	62-13 E	40	0.6	Myctophidae, V. lucetia, Squid larvae, Anguilliform larvae
MWTR- 9	Dec., 2	- -	24-48 N	63-20 E	-	-	(Not succeeded)
MWTR-10	Dec., 2	13:05 - 13:35	24-48 N	63-26 E	110	12.8	Benthosema pterota, Abralia sp.
MWTR-11	Dec., 2	17:12 - 17:45	24-49 N	63-45 E	100	4.31	B. pterota, Squid larvae
MWTR-12	Dec., 4	13:25 - 13:55	21-22 N	65-17 E	300	0.23	V. lucetia, B. pterota, Squid larvae, Anguilliform larvae
MWTR-13	Dec., 4	17:12 - 17:45	21-45 N	65-19 E	125	0.24	V. lucetia, B. pterota, Anguilliform larvae
MWTR-14	Dec., 4	18:16 - 18:50	21-42 N	65-20 E	40	1.38	Myctophidae(B. pterota ,etc.), V. lucetia, Cubiceps sp., Bregmaceros sp, Anguilliform larvae
MWTR-15	Dec., 5	14:54 - 15:30	24-46 N	65-21 E	330	0.32	Harpodon nehereus, Champsodon capensis, V. lucetia, Synagrops japonicus, Myctophidae, Shrimps, Anguilliform larvae
MWTR-16	Dec., 6	16:58 - 17:35	22-00 N	65-51 E	150	0.205	V. lucetia, Anguilliform larvae

Table 8. Records on catch by bottom trawl net in the southern coast of Pakistan

Cod end was covered by fine meshed net

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Maximum depth(m)	Bottom Temp.(°c)	Total catch(Kg)	Main species caught
BTR- 1	Dec., 8	10:29 - 11:00	23-04 N	67-14 E	105	22.0	81.4	Thrissocles malabaricus Trichiurus lepturus Nemipterus spp.
BTR- 2	Dec., 8	14:28 - 15:00	23-15 N	67-25 E	25	24.5	39.7	Sepia pharaonis Argyrops spinifer
BTR- 3	Dec., 9	10:02 - 10:35	23-37 N	67-35 E	30	25.1	77.0	Pomadasys maculatus Loligo duvaucelii Scomberomorus commerson Eggs of Sepiidae
BTR- 4	Dec., 9	13:26 - 14:32	23-46 N	67-22 E	22	23.5	169.9	Himantura uarnak Pomadasys maculatus Loligo duvaucelii Sepia brevimana
BTR- 5	Dec., 10	09:40 - 10:15	23-58 N	67-04 E	23	24.0	238.7	Saurida tumbil Acanthopagrus datnia Loligo duvaucelii
BTR- 6	Dec., 11	08:55 - 09:15	24-39 N	66-38 E	70	24.7	94.3	Trichiurus lepturus Nemipterus sp. Pomadasys hasta Loligo duvaucelii Sepia trygonia
BTR- 7	Dec., 11	12:22 - 12:55	24-32 N	66-42 E	63	23.3	49.4	Nemipterus spp. Pomadasys maculata Rhonciscus stridens Loligo duvaucelii
BTR- 8	Dec., 11	15:02 - 15:35	24-39 N	66-38 E	47	23.7	47.9	Pomadasys hasta Grammoplites scaber Sepia spp.

Table 9. Fish and squid species caught by bottom trawl net in the southern coast of Pakistan

Numerals denote number of individuals caught

Species	Station number							
	1	2	3	4	5	6	7	8
(Pisces)								
Carcharhinidae								
Carcharhinus spp.	6					2		2
Rhinobatidae								
Rhinobatos annandalei Norman	1							
Dasyatidae								
Dasyatis sp.					2			
Gymnura micrura (Bloch et Schneider)	2						1	
Gymnura poecilura (Shaw)				1				
Himantura bleekeri (Blyth)								1
Himantura uarnak (Forskål)				38	2			
Muraenesocidae								
Muraenosox cinereus (Forskål)	1			1				1
Congridae								
Rhynchocymba nystromi Jordan et Snyder	1							
Clupeidae								
Dussumieria hasseltii (Bleeker)							1	
Sardinella fimbriata (Valenciennes)				1				
Engraulidae								
Thryssa vitrirostris (Gilchrist et Thompson)	100							
Synodontidae								
Saurida tumbil (Bloch)			13	106	108	1		17
Saurida undosquamis (Richardson)	30	50	9	11	2	6	11	4
Ariidae								
Arius thalassinus (Rüppell)								1
Bregmacerotidae								
Bregmaceros nectabanus Whitley						3	1	3
Fistulariidae								
Fistularia petimba Lacepède		5		5	12	1		2
Triglidae								
Lepidotrigla sp.	4	3	1	18	13			
Synanceidae								
Minous monodactylus (Bloch et Schneider)	1				2			1
Platycephalidae								
Grammoplites scaber (Linnaeus)	30	10	3	57	75	20	23	100
Thysanophrys crocodilus (Tilesius)					25	1	1	

Table 9 (cont'd)

Species	Station number							
	1	2	3	4	5	6	7	8
Serranidae								
Epinephelus diacanthus (Valenciennes)	100							
Theraponidae								
Rhonciscus stridens (Forskål)							250	1
Apogonidae								
Apogon quadrifasciatus Cuvier				10				
Acropomidae								
Acropoma sp.	1006	1				2		
Lactariidae								
Lactarius lactarius (Bloch et Schneider)						30		1
Rachycentridae								
Rachycentron canadum (Linnaeus)		1		1				
Echeneidae								
Echeneis naucrates (Linnaeus)				1				
Carangidae								
Alectis cilialis (Bloch)					2			
Carangoides malabaricus (Bloch et Schneider)			8	6	9	10	9	
Carangoides chrysophrys Valenciennes						1		
Carangoides sp.			1					
Decapterus muroadsi (Temminck et Schlegel)		41						
Decapterus sp.			150	550	10000	2	6	2
Formio niger (Bloch)		4						
Scomberoides commersonianus Lacepède			1					
Selar crumenophthalmus (Bloch)		1						
Seriolina intermedia (Temminck et Schlegel)		1		1				
Trachinotus blochii (Lacepède)			1					
Uraspis helvolus (Forster)						5		1
Leiognathidae								
Leiognathus elongatus (Günther)		10		1				
Leiognathus brevirostris (Valenciennes)			5			1		
Leiognathus equulus (Forskål)								3
Leiognathus smithursti (Ramsay et Ogilby)				5				
Nemipteridae								
Nemipterus bathybus (Snyder)	60		4	150	500	300	100	50
Nemipterus spp.	100	50		150	500	500	4	14
Pomadasyidae								
Pomadasys hasta (Bloch)						3		7
Pomadasys maculatus (Bloch)			3	3			1000	1

Table 9 (cont'd)

Species	Station number							
	1	2	3	4	5	6	7	8
Sparidae								
Acanthopagrus datnia Buchanan-Hamilton					14			
Argyrops spinifer (Forskål)		7	3	10			2	16
Sciaenidae								
Otolithes ruber (Schneider)	16							
Argyrosomus spp.	6					1		1
Ephippidae(Drepanidae)								
Drepane longimana (Bloch et Schneider)				3	1			2
Drepane punctata (Linnaeus)				1				
Mullidae								
Upeneus vittatus (Forskål)							21	7
Uranoscopidae								
Zalescopus tosae Jordan et Hubbs		1		6	2			1
Champsodontidae								
Champsodon capensis Regan	60			9	1	5	3	
Sphyraenidae								
Sphyraena jello Cuvier			1				2	1
Sphyraena obtusata Cuvier	2			1		4		
Polynemidae								
Polynemus sextarius Bloch et Schneider	50							
Callionymidae								
Callionymus kaianus Günther	7							
Callionymus sp.		13		500	30	10		
Stromateidae								
Peneus indicus (Day)						2	2	
Trichiuridae								
Trichiurus lepturus Linnaeus	40					500	3	4
Scombridae								
Rastrelliger kanagurta (Cuvier)			9	3				
Scomberomorus commerson (Lacepède)			3	1				
Psettoidae								
Psettodes erumei (Bloch et Schneider)		1	3	3	2			1
Bothidae								
Arnoglossus microphthalmus (Von Bonde)		50		3	30			
Pleuronectidae								
Pseudorhombs arsius (Hamilton-Buchanan)			8	80	50			

Table 9 (cont'd)

Species	Station number							
	1	2	3	4	5	6	7	8
Soleidae								
Aseraggodes sp.	2							
Zebrias zebra (Bloch et Schneider)		1		2				
Cynoglossidae								
Cynoglossoides gilchristi (Regan)				6				
Cynoglossus lida (Bleeker)		1	1		6	3		
Cynoglossus lingua Hamilton-Buchanan					5			
Triacanthidae								
Pseudotriacanthus strigilifer (Cantor)			4	2				
Triacanthus biaculeatus (Bloch)				8	1			
Tetraodontidae								
Lagocephalus lunaris lunaris (Bloch et Schneider)		1	4	1	5	1		1
(Decapoda (Decembrachiata))								
Sepiidae								
Sepia pharaonis Ehrenberg		8	1	1				
Sepia spp.	15	1000	2000	13	10	8	10	500
Loligonidae								
Loligo duvaucelii d' Orbigny	10	1500	5000	1000	1000	4	50	500

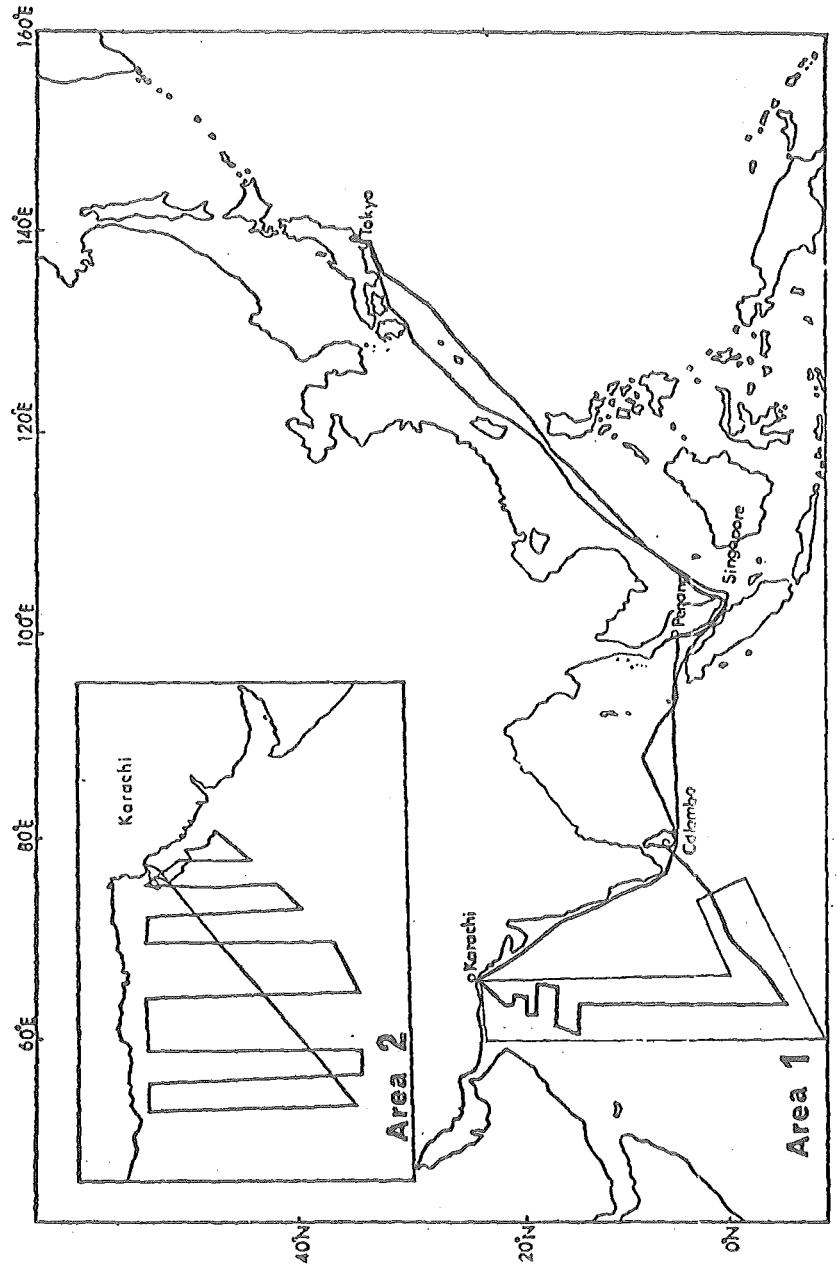


Figure 1. Track chart with survey areas by R/V SHOYO MARU, 2 October 1976 to 13 January 1977

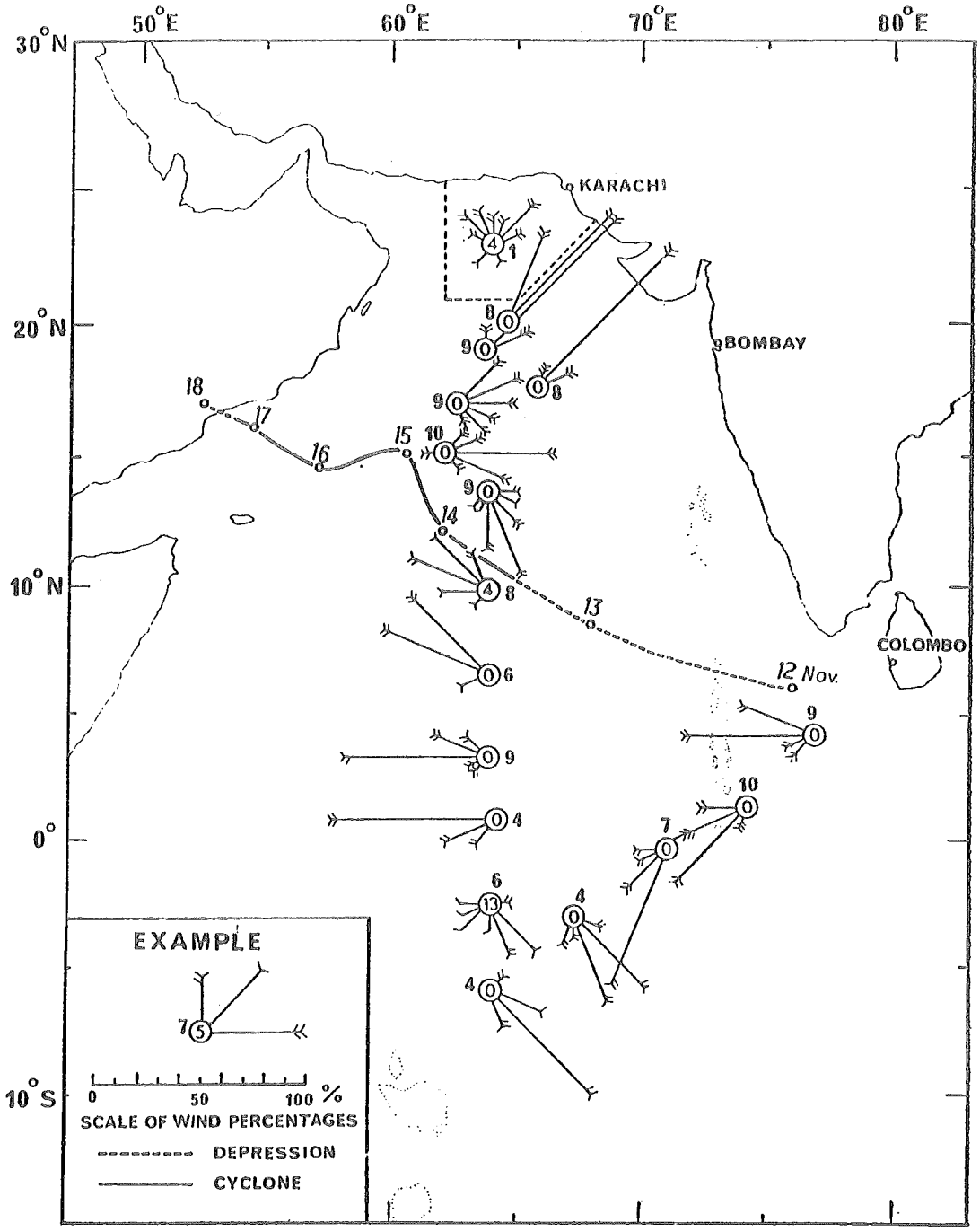


Figure 2. Wind characteristics in the survey areas, 4 November to 12 December 1976. Numerals in and out of the circles denote percentage of the calm and average cloud amount respectively. The example in the lower-left corner indicates that: east wind comprised 40% with the average velocity of 4 in the Beaufort scale; northeastern wind comprised 35% with the average velocity of 2; northern wind comprised 20% with the average velocity of 3; calm comprised 5%; and the average cloudiness was 7. Solid and dotted lines denote positions of depression and cyclone respectively.

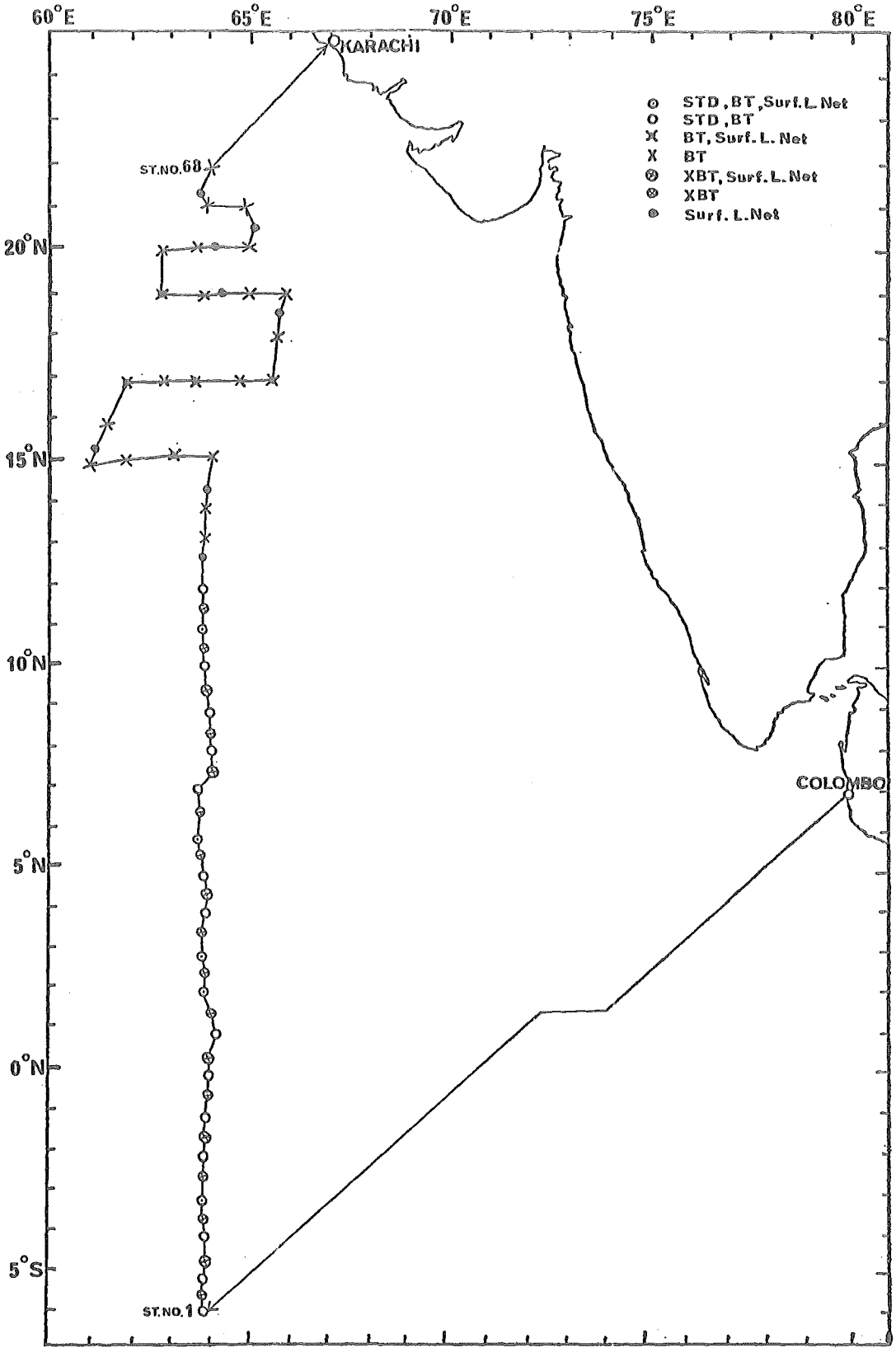


Figure 3. Track chart and oceanographic stations in the First Area, 4 to 21 November 1976

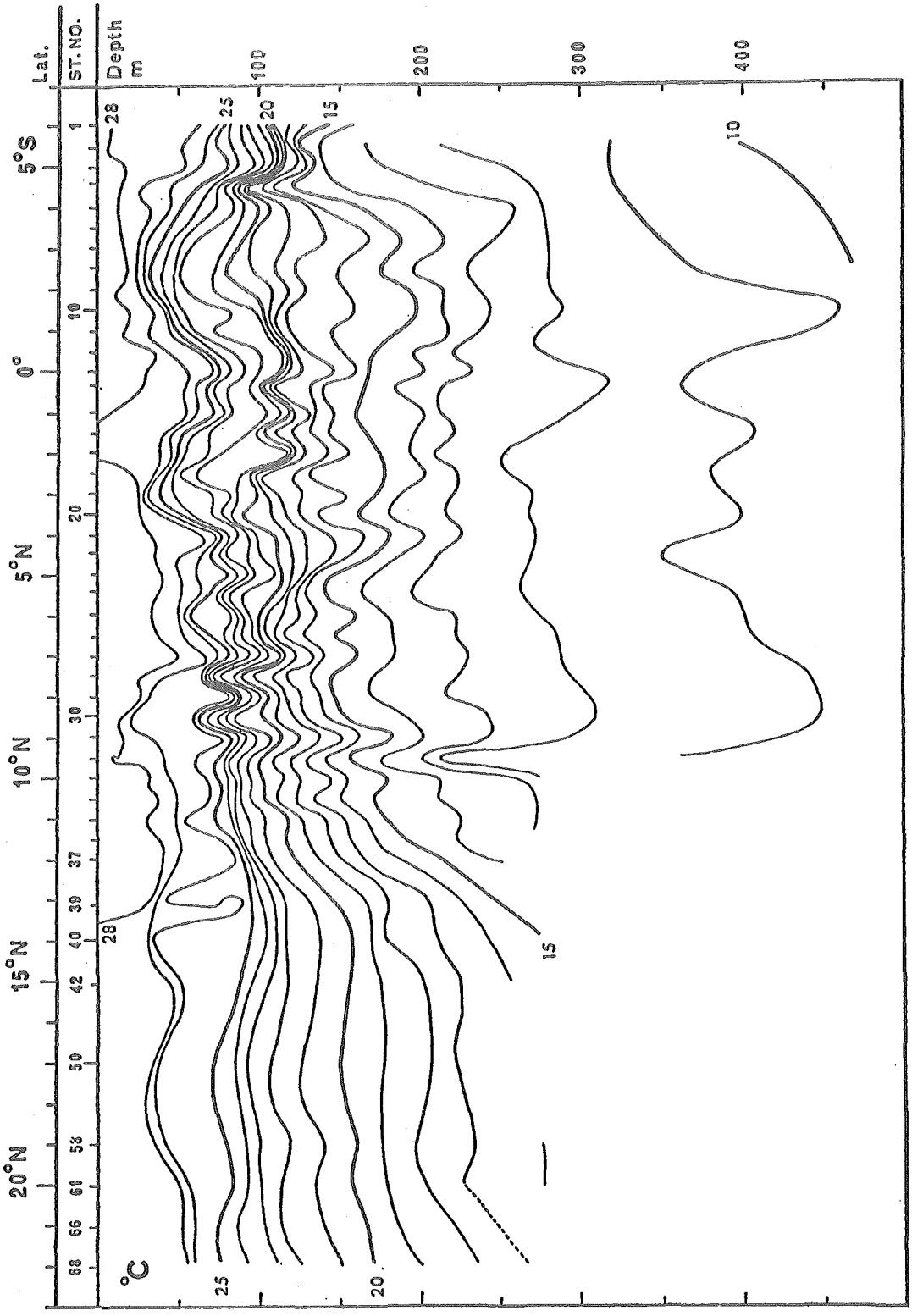


Figure 4. Vertical profile of water temperature (°C) along the meridian of long. 64°E in the First Area

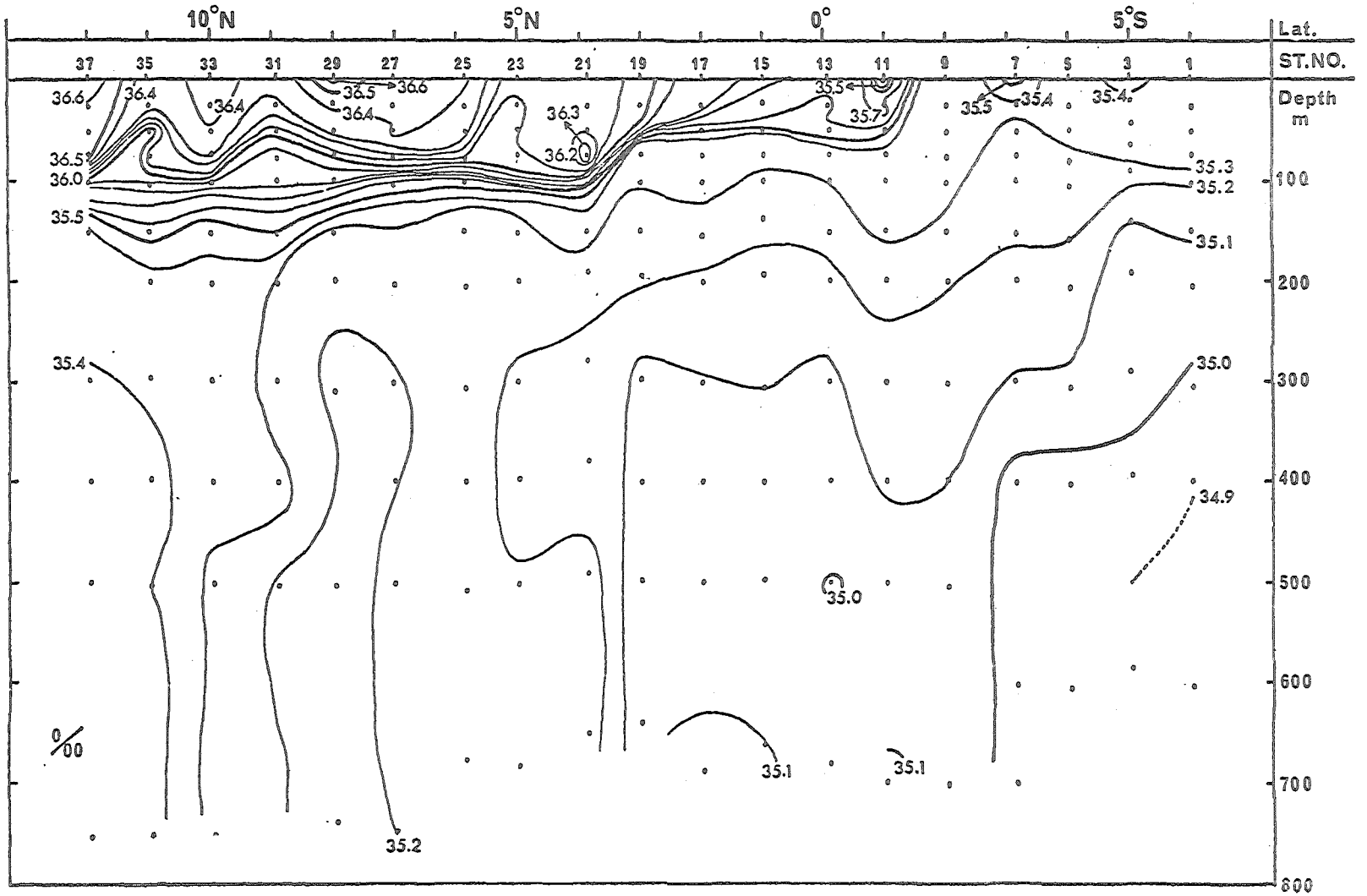


Figure 5. Vertical profile of salinity (‰) along the meridian of long. 64°E in the First Area

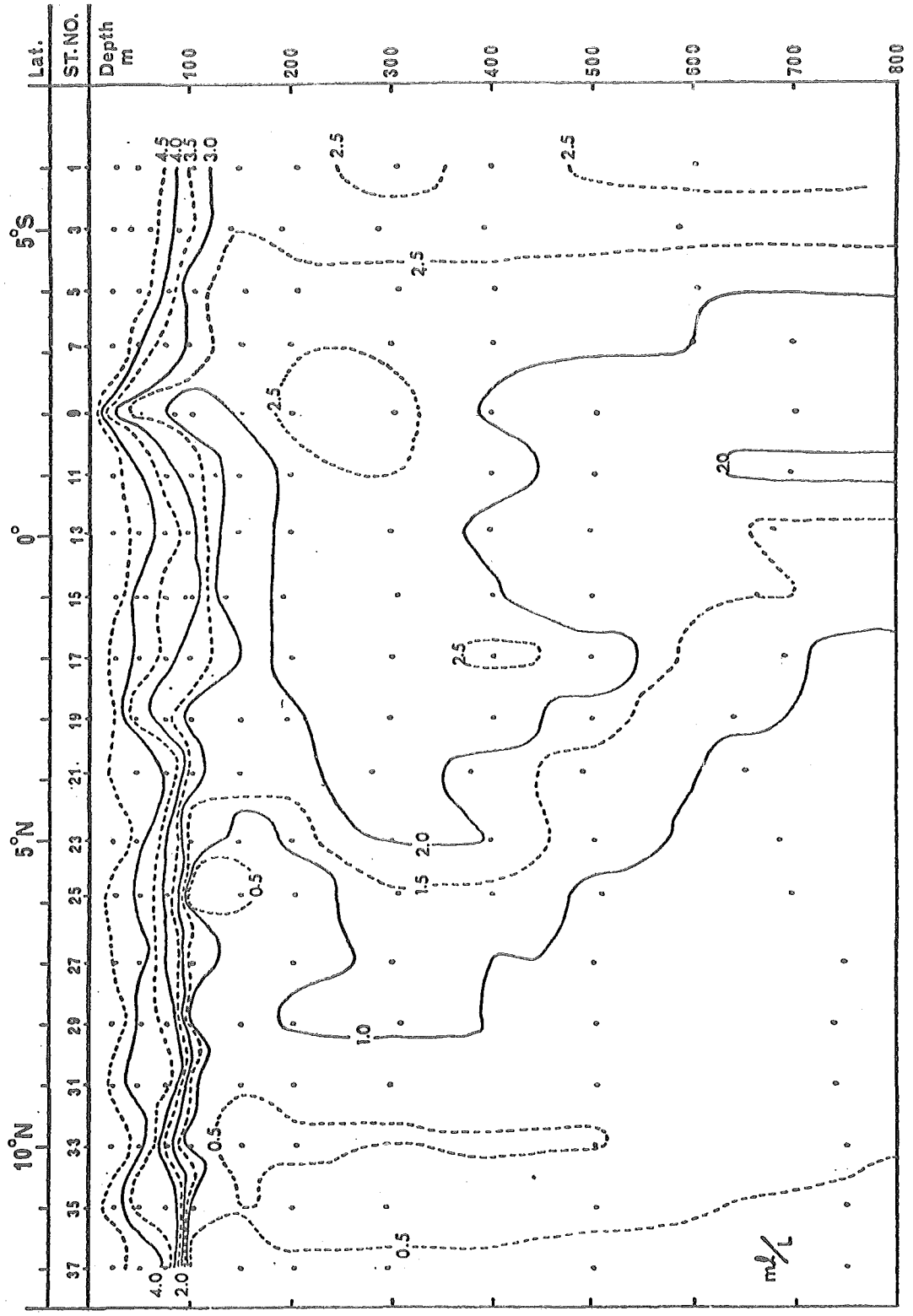


Figure 6. Vertical profile of content of dissolved oxygen (ml/l) along the meridian of long. 64°E in the First Area

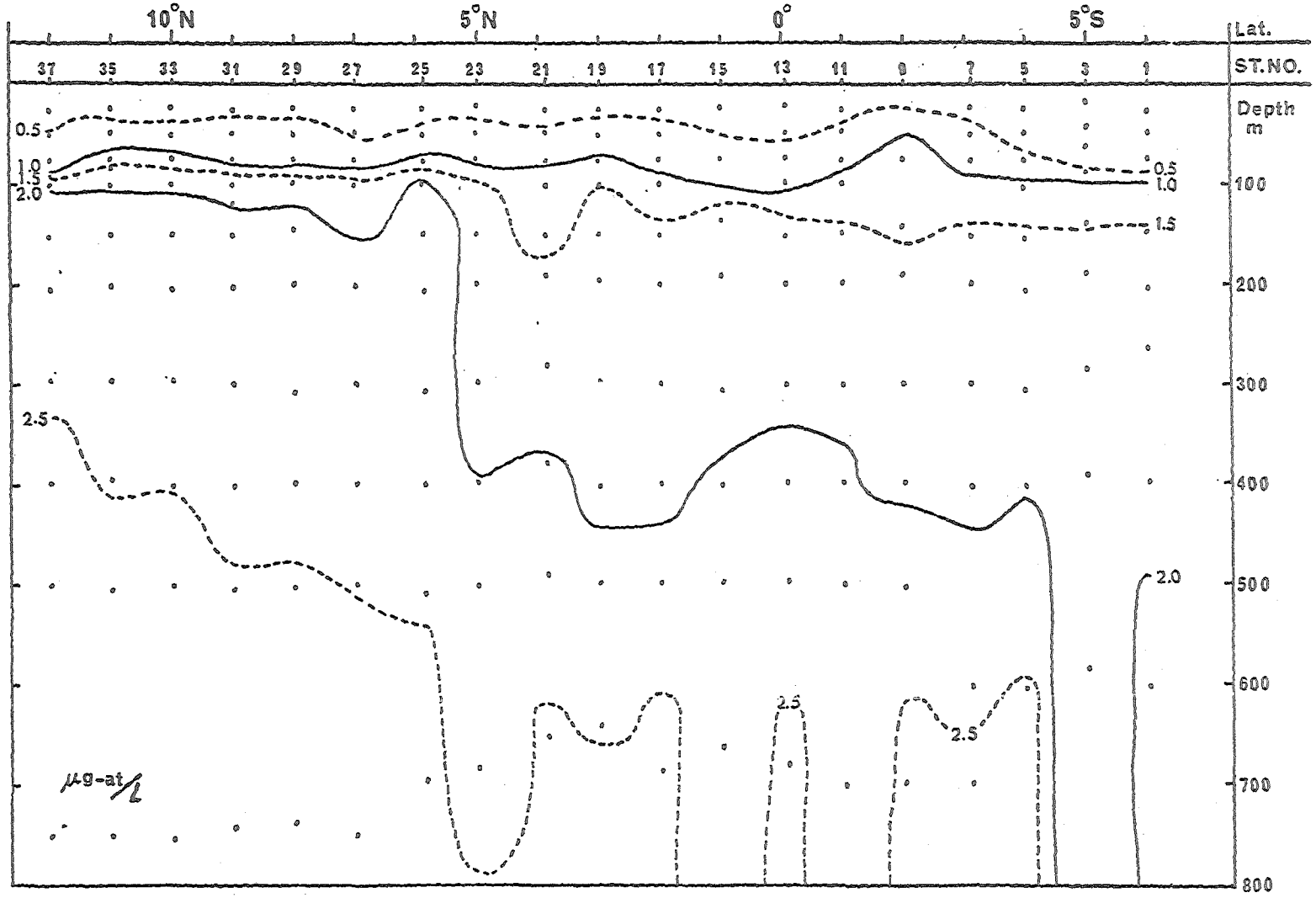


Figure 7. Vertical profile of content of Phosphate-P (ug-atom/L) along the meridian of 64°E in the First Area

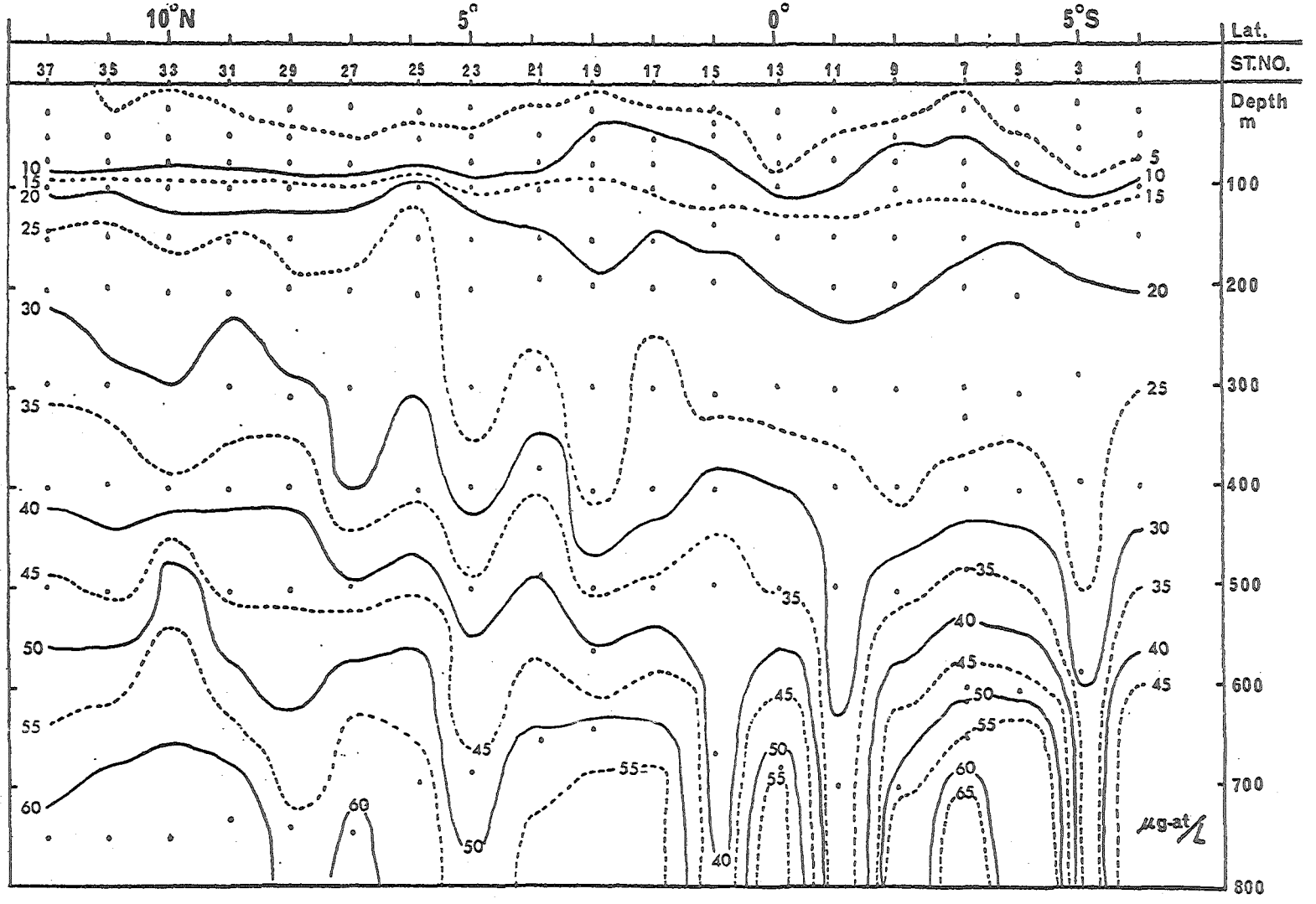


Figure 8. Vertical profile of content of Silicate-Si (ug-atom/L) along the meridian of 64°E in the First Area

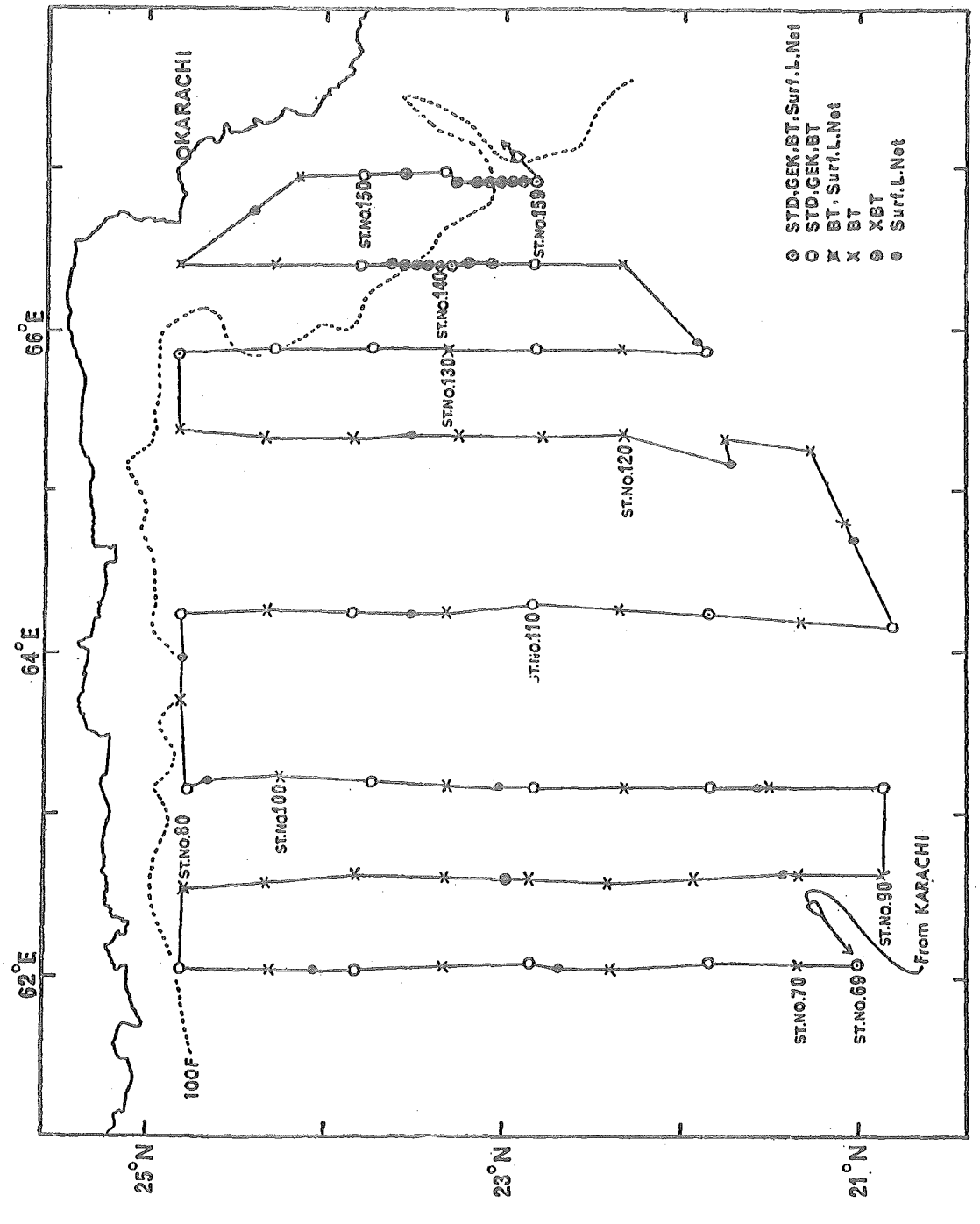


Figure 9. Track chart and oceanographic stations in the Second Area, 28 November to 8 December 1976

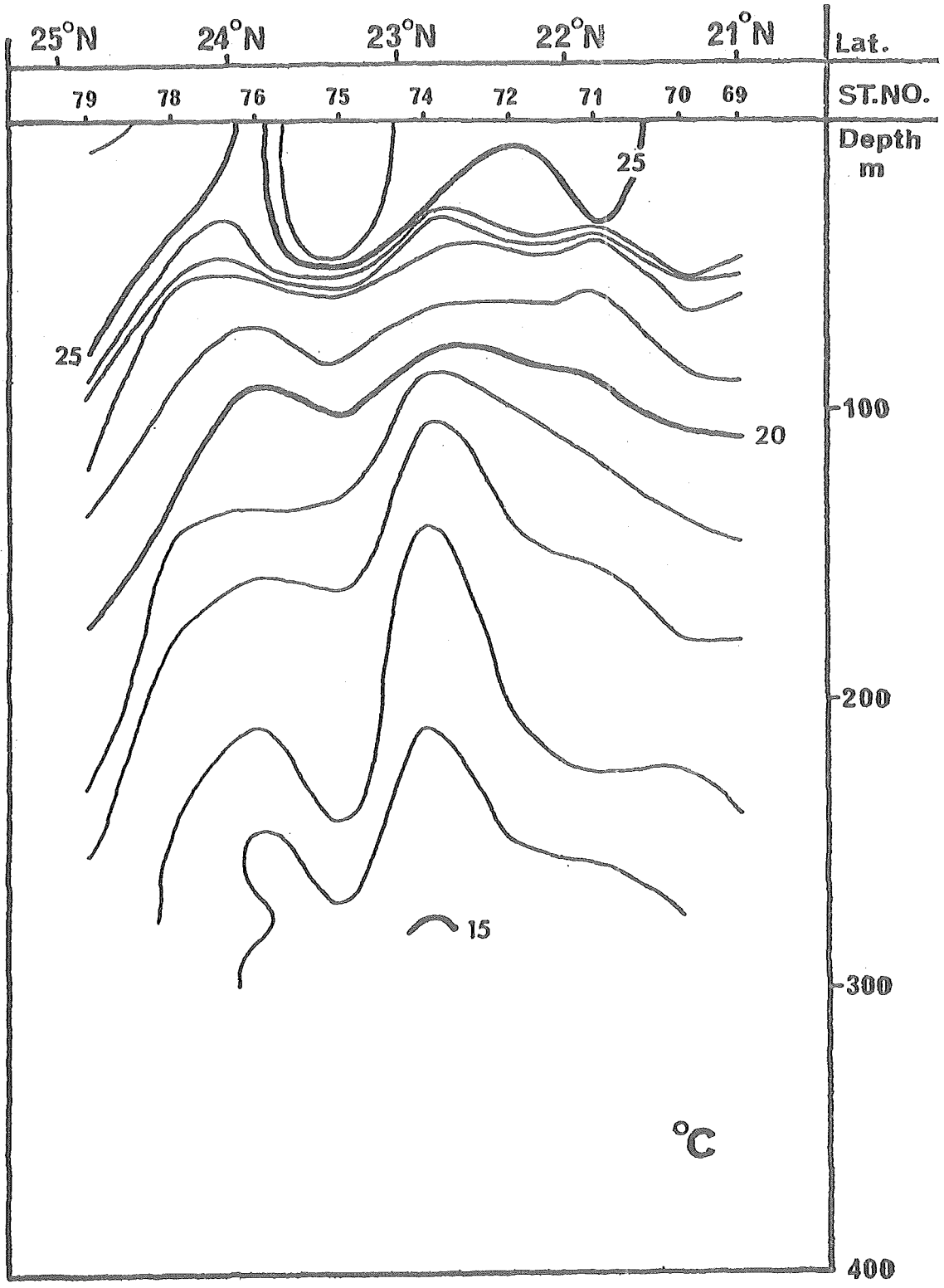


Figure 10. Vertical profile of water temperature (°C) along the meridian of long. 62°05'E in the Second Area

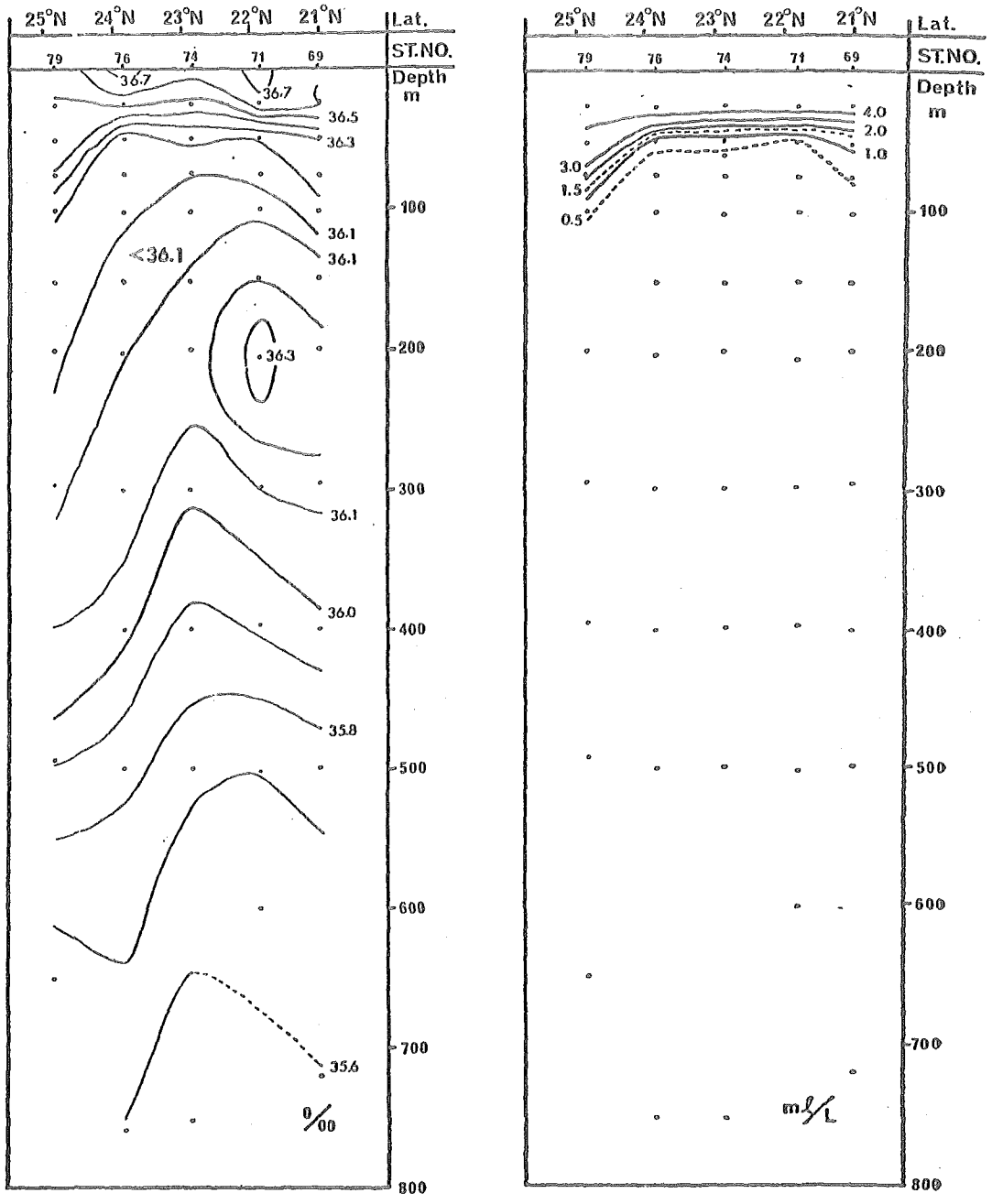


Figure 11. Vertical profiles of salinity (‰, left) and content of dissolved oxygen (ml/L, right) along the meridian of long. 62°05'E in the Second Area

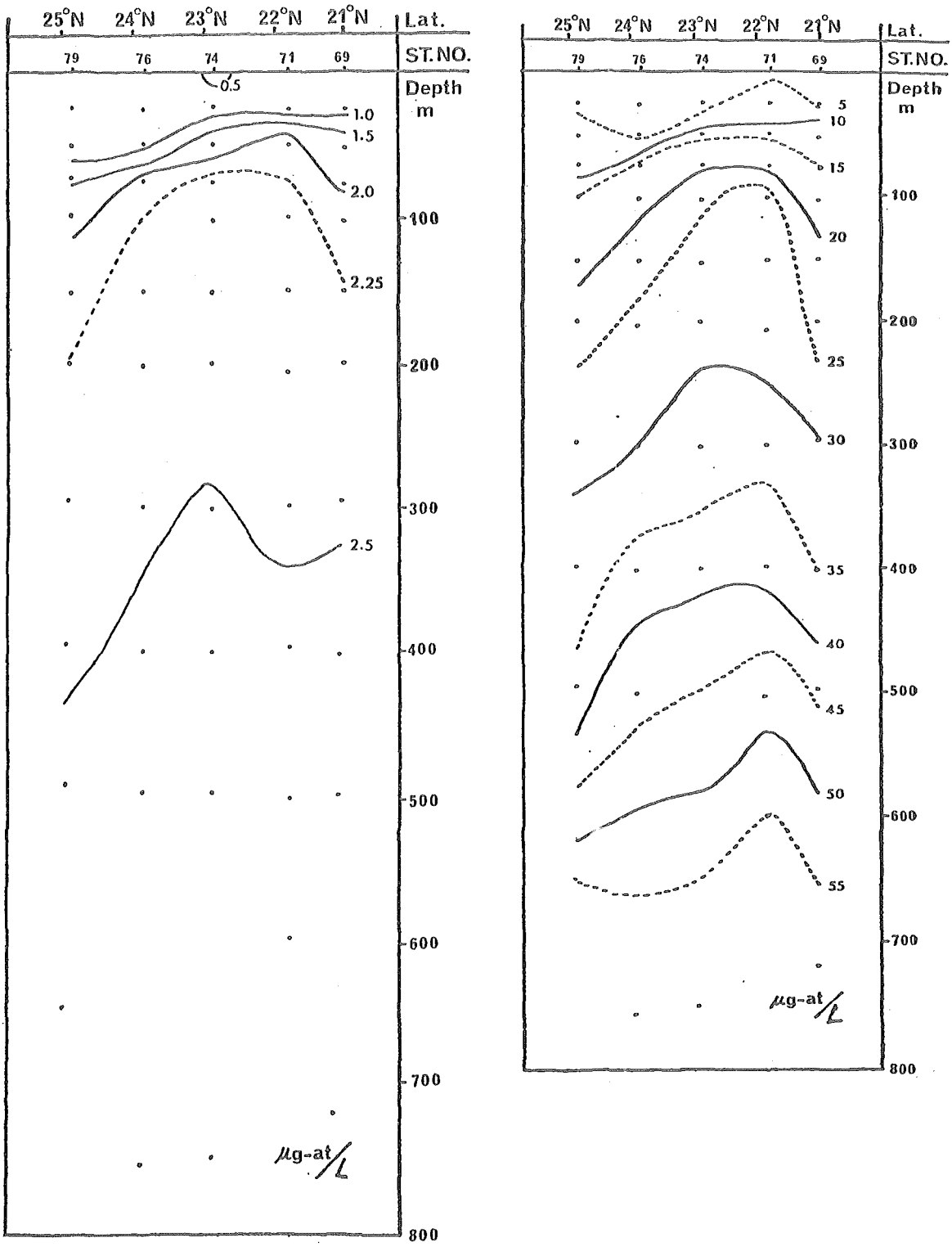


Figure 12. Vertical profiles of contents of Phosphate-P (ug-atom/L, left) and Silicate-Si (ug-atom/L, right) along the meridian of long. 62°05'E in the Second Area

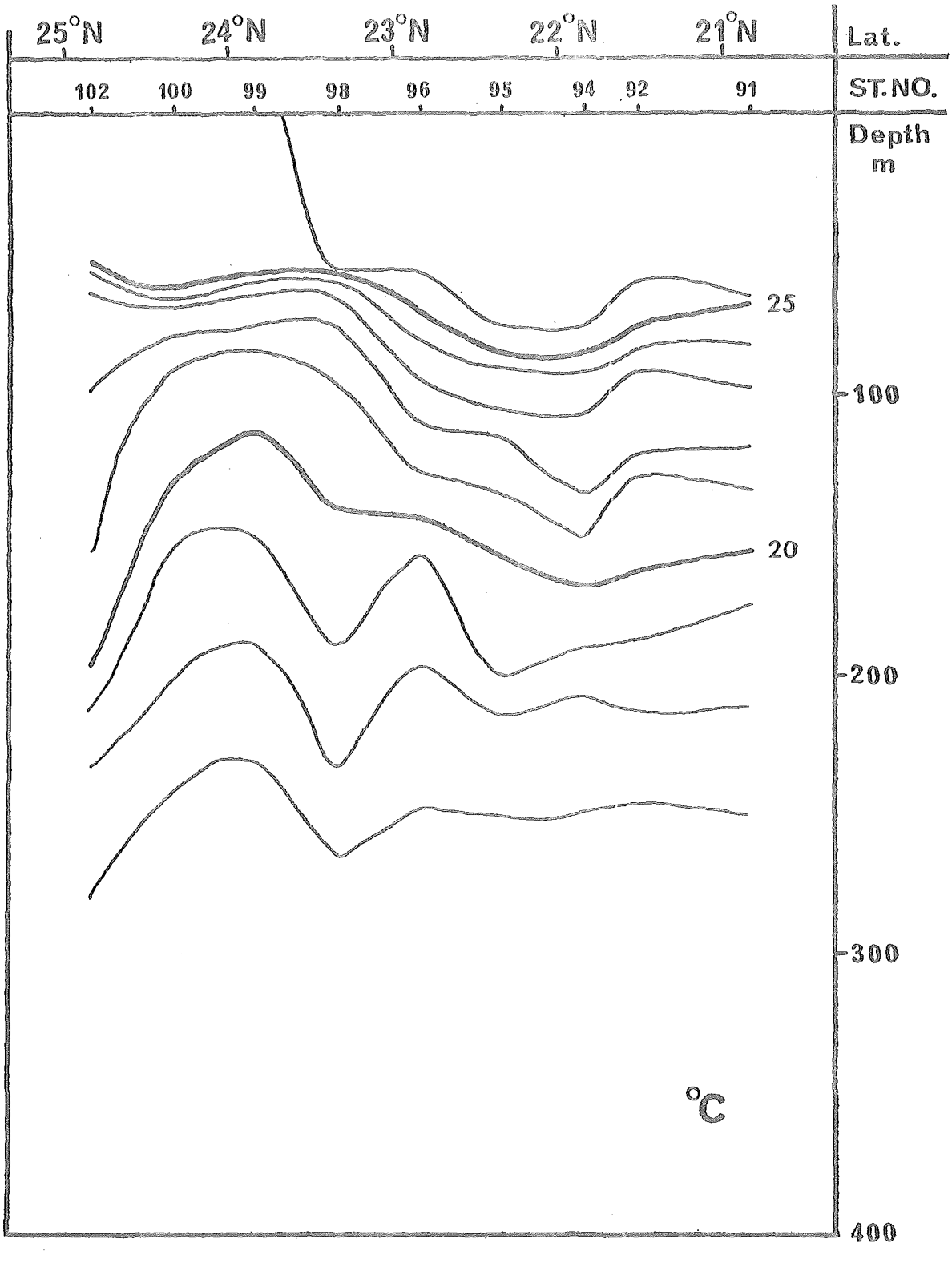


Figure 13. Vertical profile of water temperature (°C) along the meridian of long. 63°10'E in the Second Area

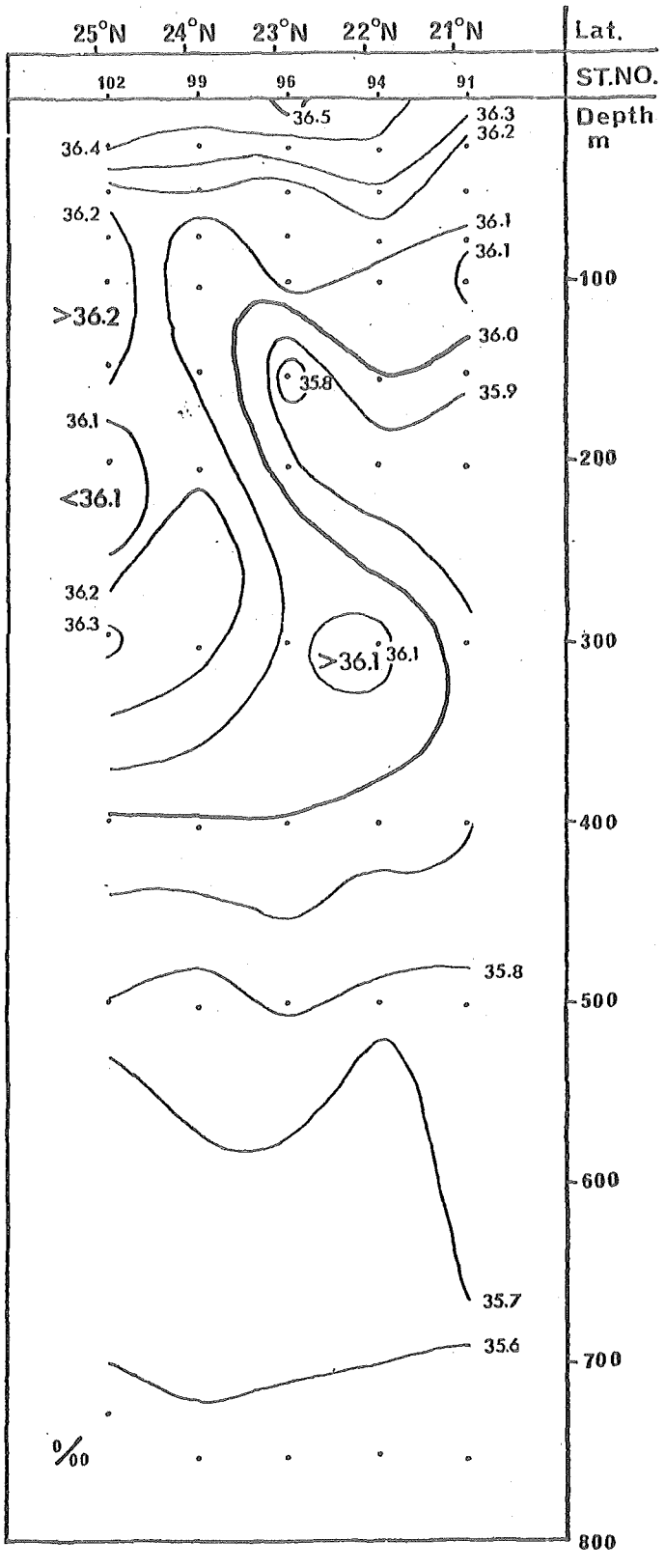


Figure 14. Vertical profile of salinity (‰) along the meridian of long. 63°10'E in the Second Area

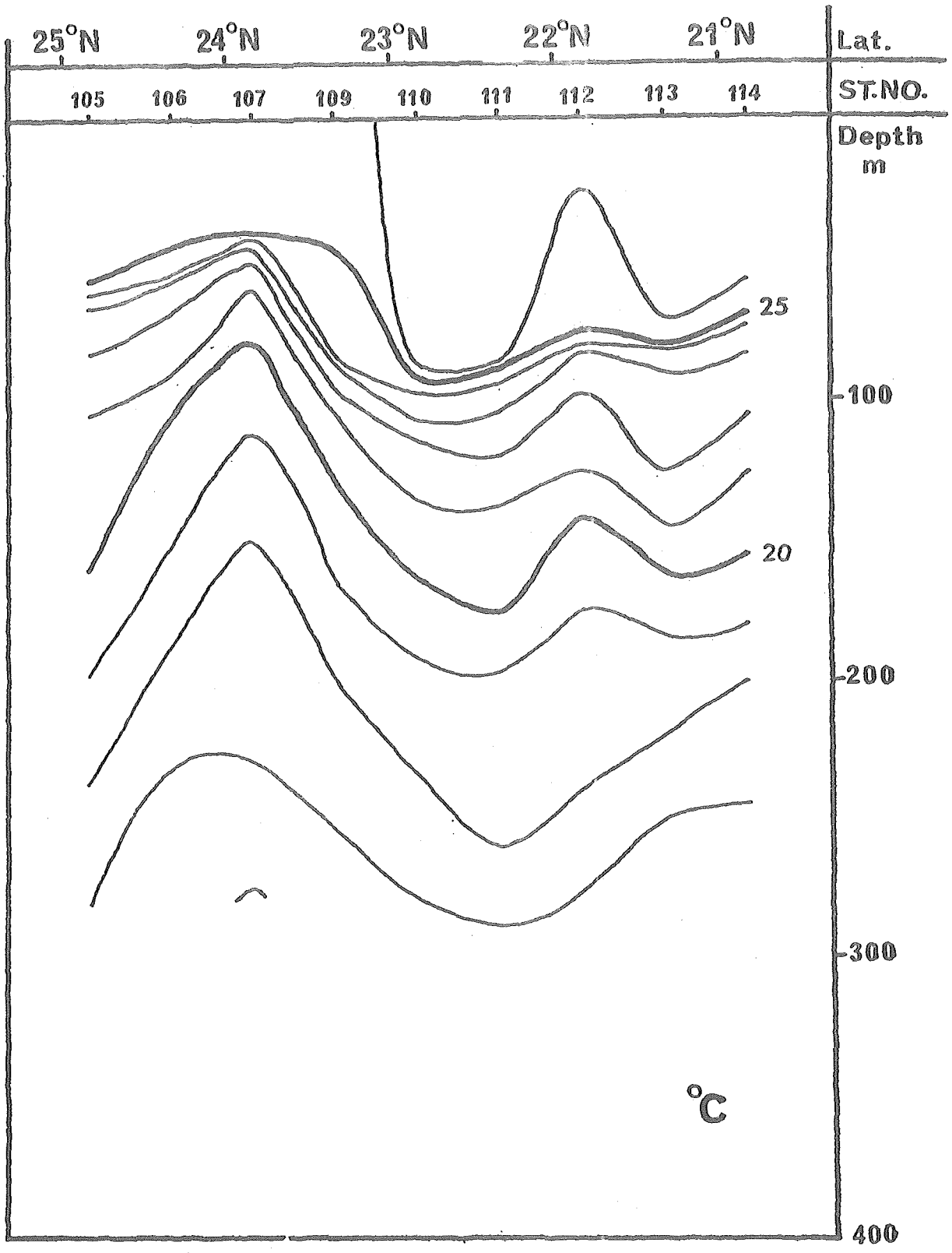


Figure 15. Vertical profile of water temperature (°C) along the meridian of long. 64°15'E in the Second Area

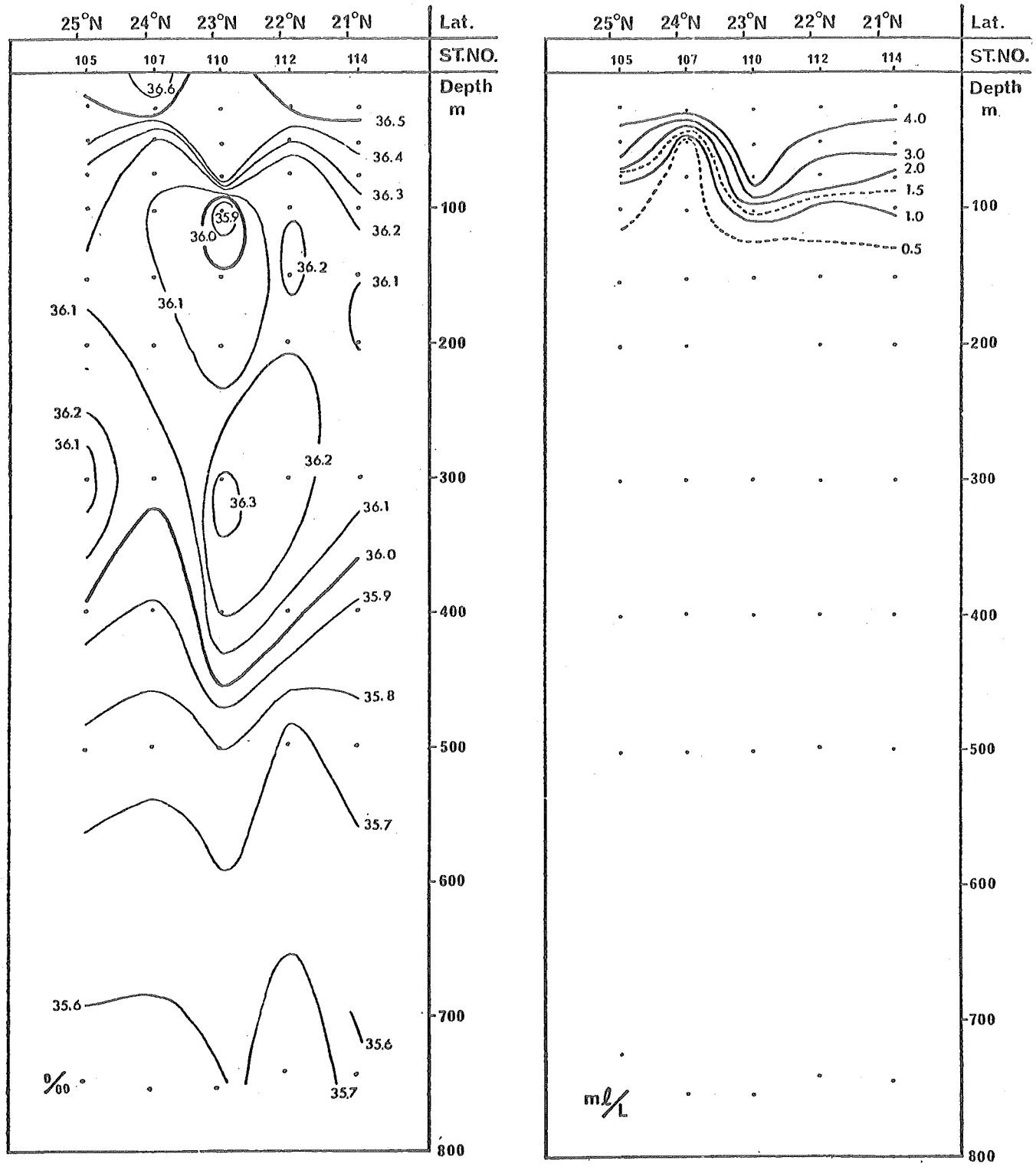


Figure 16. Vertical profiles of salinity (‰, left) and content of dissolved oxygen (ml/L, right) along the meridian of long. 64°15'E in the Second Area

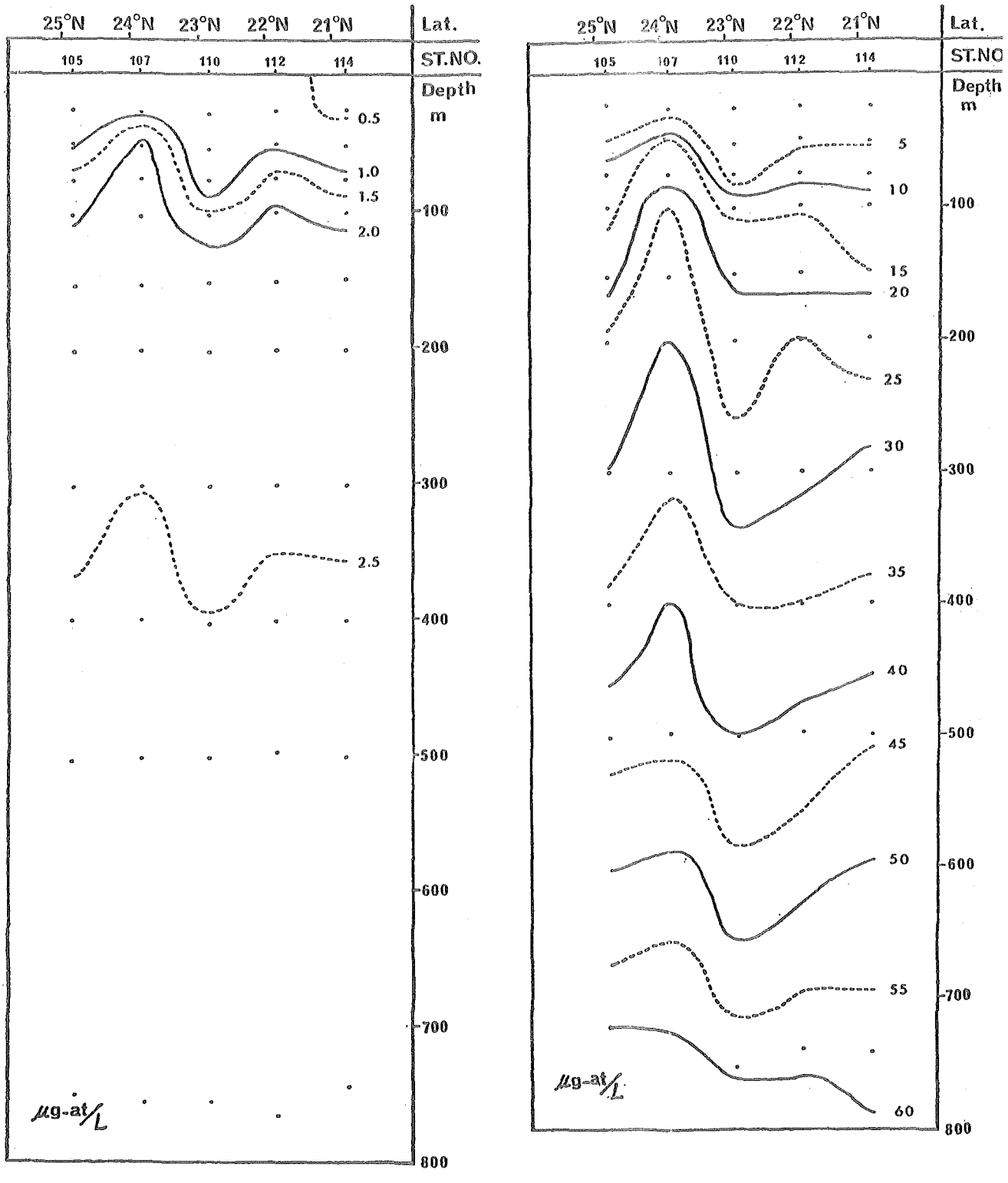


Figure 17. Vertical profiles of contents of Phosphate-P (ug-atom/L, left) and Silicate-Si (ug-atom/L, right) along the meridian of long. 64°15'E in the Second Area

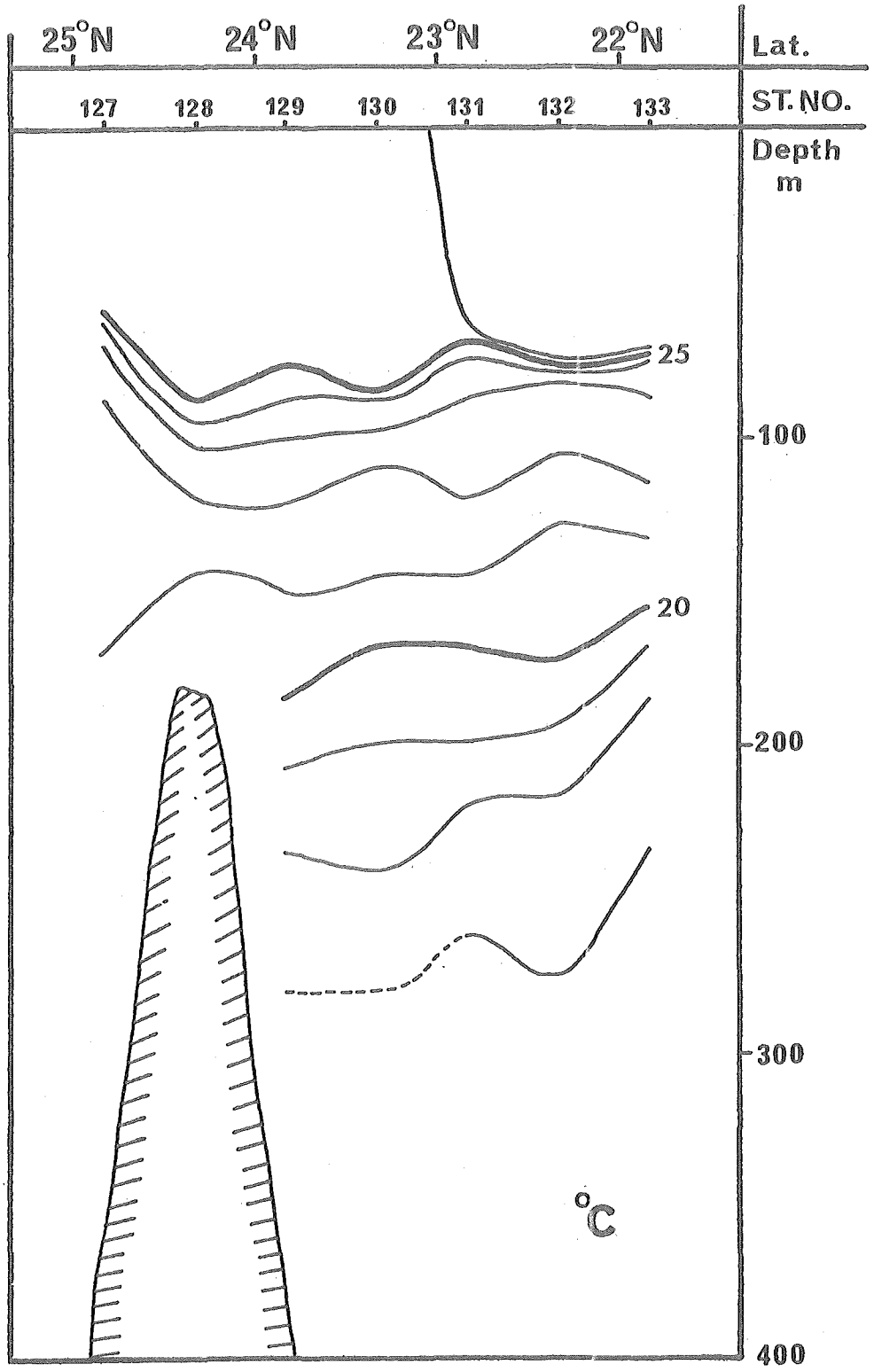


Figure 18. Vertical profile of water temperature (°C) along the meridian of long. 65°60'E in the Second Area

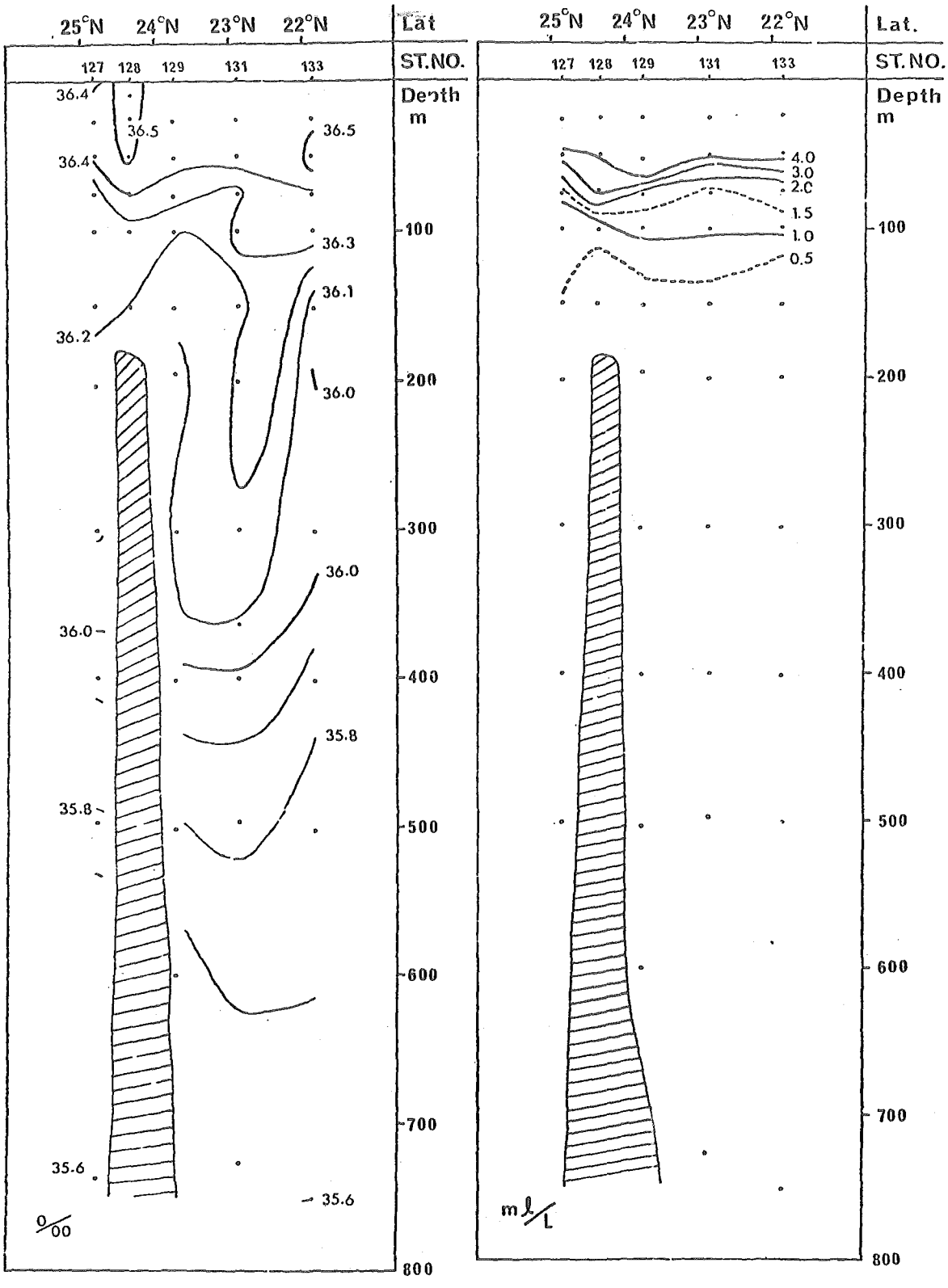


Figure 19. Vertical profiles of salinity (‰, left) and content of dissolved oxygen (ml/L, right) along the meridian of long. 65°50'E in the Second Area

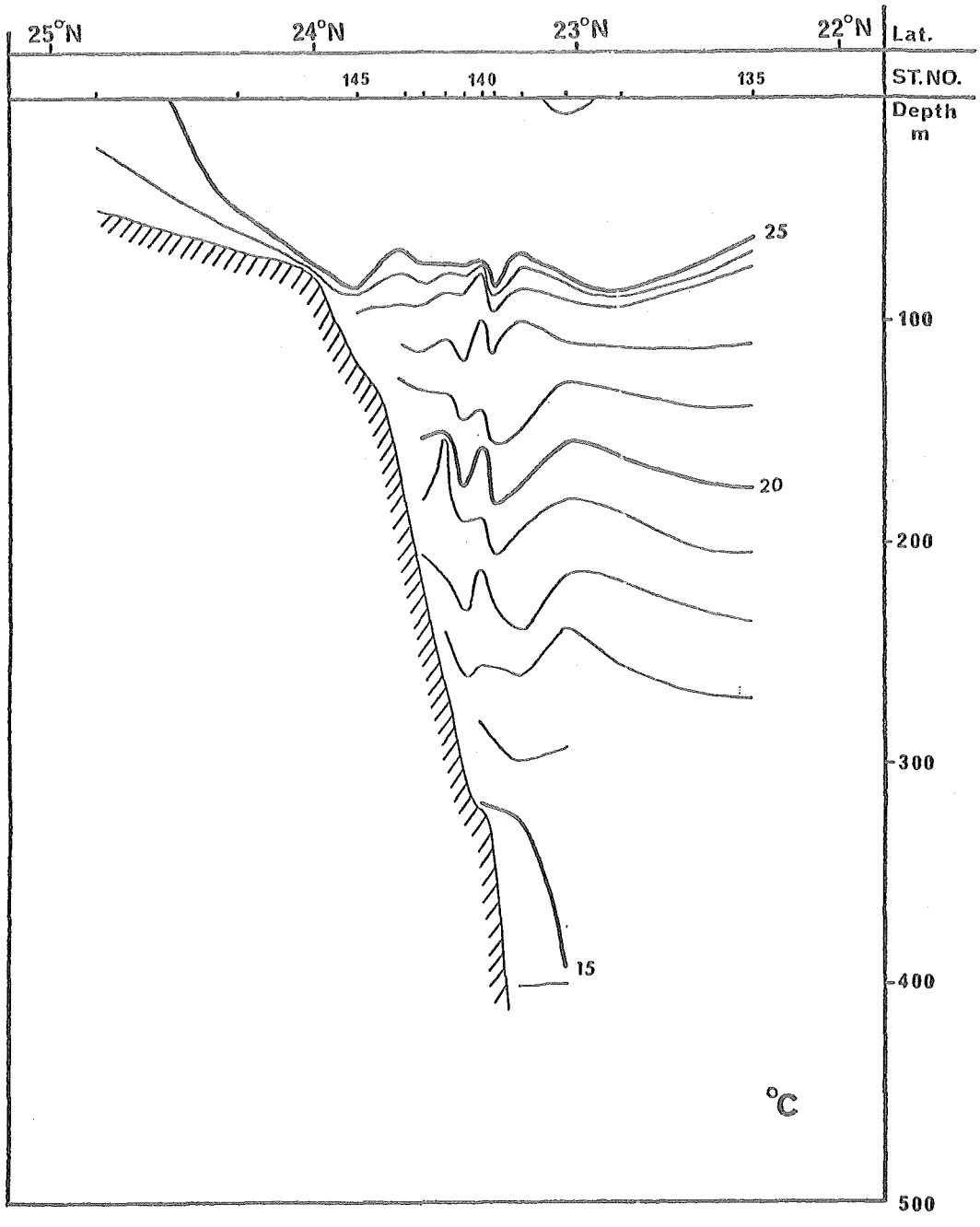


Figure 20. Vertical profile of water temperature (°C) along the meridian of long. 66°25'E in the Second Area

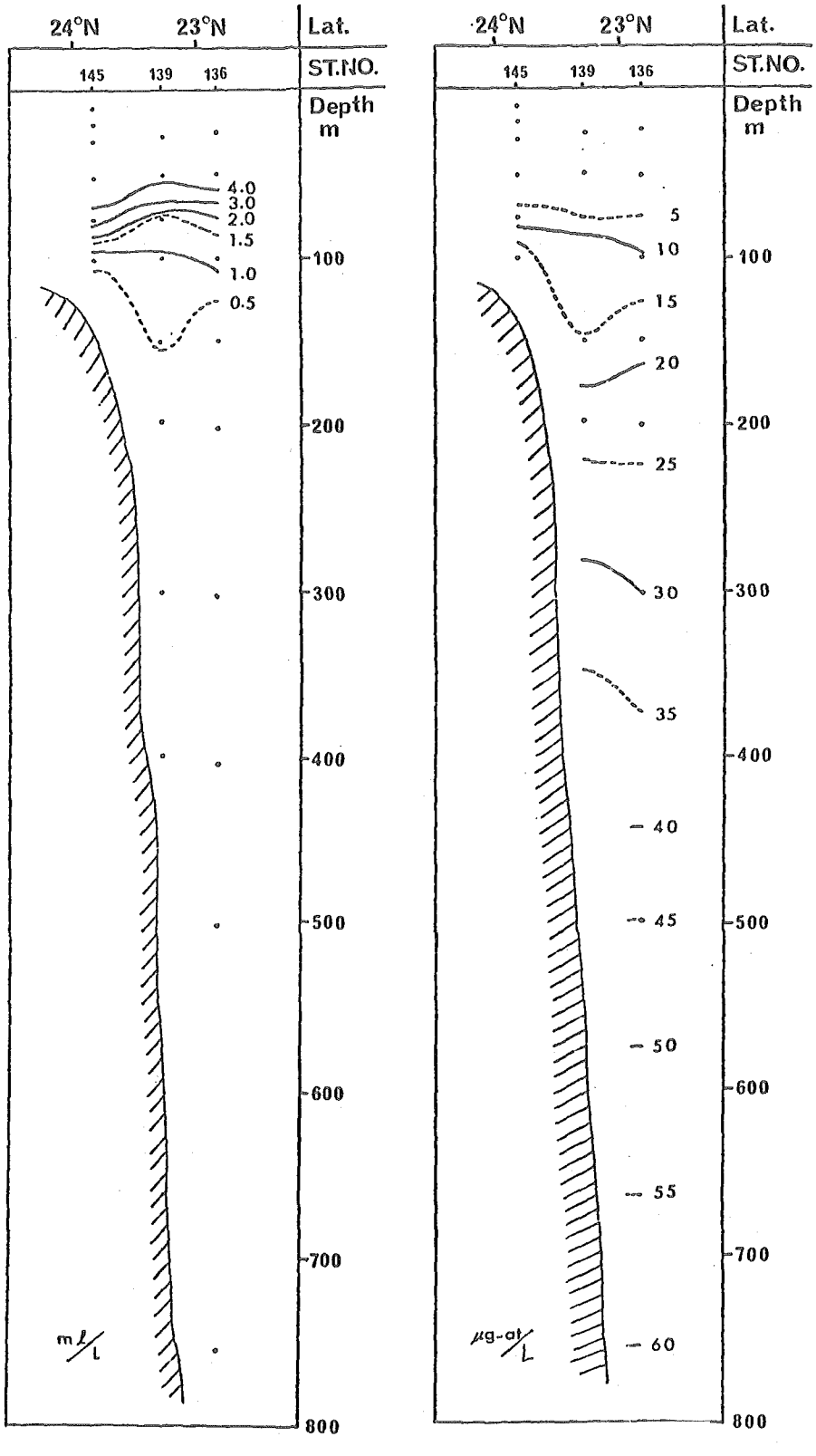


Figure 21. Vertical profiles of contents of dissolved oxygen (ml/L, left) and Silicate-Si (ug-atom/L, right) along the meridian of long. 66°25'E in the Second Area

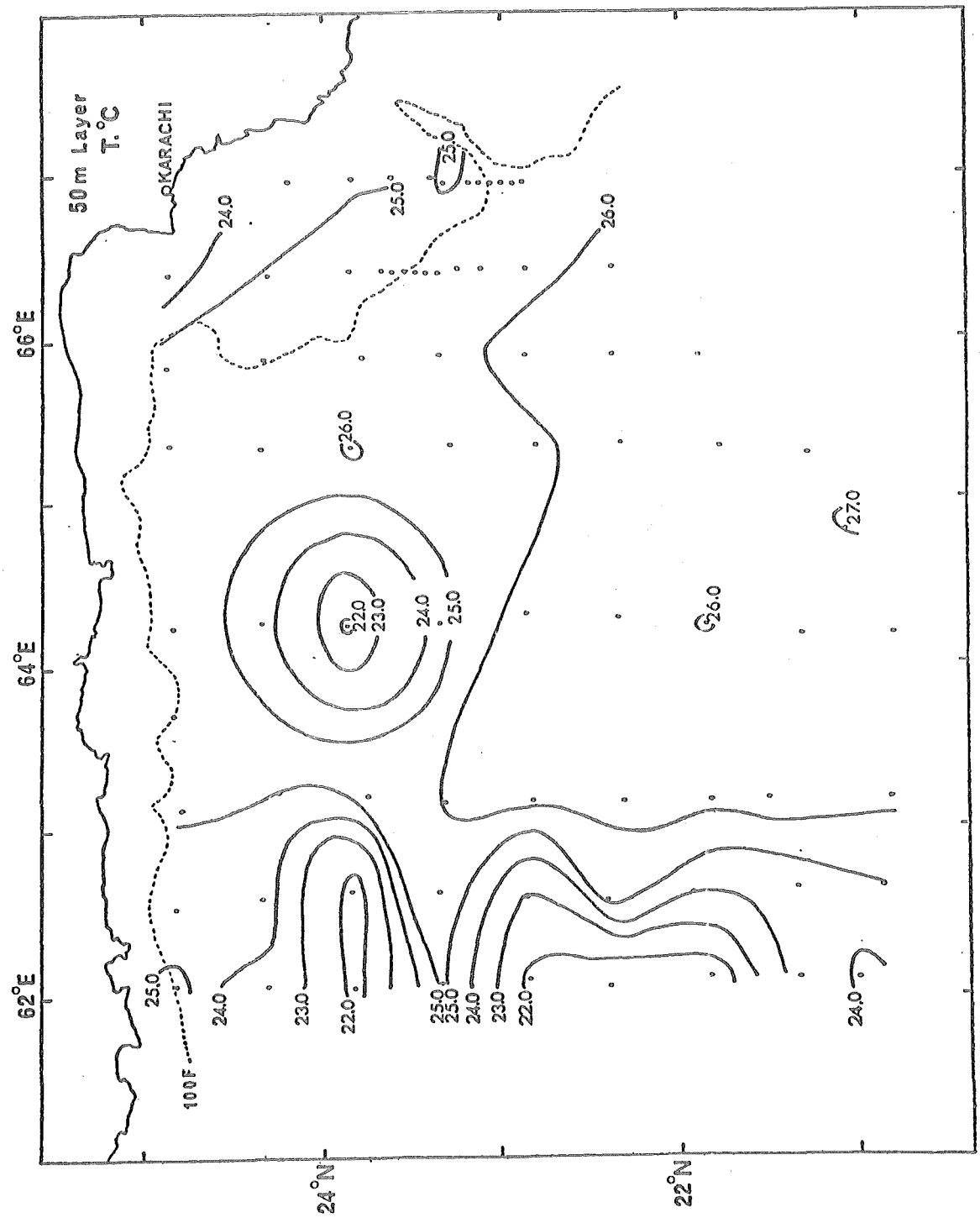


Figure 22. Horizontal distribution of water temperature (oC) at 50 m layer in the Second Area

Table 1. Number of fish schools, bird flocks and whales, etc., sighted in the whole survey area

Figures in parenthesis denote number of individuals

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
				(First Area)									
	06-08	05-29 S	64-35 E							1(40)			
	08-10	05-36 S	64-26 E										
Nov., 8	10-12	05-59 S	64-01 E										
	12-14	05-52 S	64-01 E										
	14-16	05-24 S	63-57 E										
	16-18	05-05 S	64-01 E										
	06-08	03-08 S	63-57 E										
	08-10	03-07 S	63-57 E										
	10-12	02-39 S	63-57 E						1	1(32)			
Nov., 9	12-14	02-30 S	63-58 E						1				
	14-16	02-01 S	63-59 E										
	16-18	01-57 S	63-59 E										
	06-08	00-07 N	64-05 E			1	2			1			
	08-10	00-18 N	64-04 E				1						
	10-12	00-40 N	64-03 E										
Nov., 10	12-14	00-55 N	64-09 E										
	14-16	00-59 N	64-11 E						1				
	16-18	01-21 N	64-08 E						1				
	06-08	02-38 N	63-55 E		1		1						
	08-10	02-54 N	63-51 E										
	10-12	03-08 N	63-50 E				1	1					
Nov., 11	12-14	03-18 N	63-54 E										
	14-16	03-58 N	64-00 E										
	16-18	03-58 N	64-00 E										

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	05-52 N	63-53 E										
	08-10	05-53 N	63-53 E										
	10-12	06-18 N	63-52 E										
Nov., 12	12-14	06-30 N	63-52 E										
	14-16	07-01 N	63-54 E										
	16-18	07-12 N	64-01 E										
	06-08	09-02 N	64-06 E						1				
	08-10	09-13 N	64-05 E										
	10-12	09-31 N	64-03 E						1				
Nov., 13	12-14	09-54 N	63-56 E										
	14-16	10-05 N	63-56 E										
	16-18	10-30 N	63-57 E						1				
	06-08	12-30 N	64-00 E				1				1(5)		
	08-10	12-45 N	64-00 E										
	10-12	13-07 N	63-56 E										
Nov., 14	12-14	13-31 N	63-55 E										
	14-16	13-30 N	63-54 E						1				
	16-18	13-40 N	63-56 E										
	06-08	15-09 N	63-05 E						1				
	08-10	15-09 N	62-56 E						2				
	10-12	15-08 N	62-45 E										
Nov., 15	12-14	15-04 N	62-58 E										
	14-16	15-05 N	62-42 E										
	16-18	15-01 N	61-26 E						1				

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	16-45 N	61-47 E										
	08-10	17-01 N	61-59 E						1				
	10-12	17-01 N	62-19 E						1				
Nov., 16	12-14	17-01 N	62-43 E										
	14-16	17-01 N	63-01 E						1				
	16-18	17-01 N	63-27 E										
	06-08	17-01 N	65-48 E										
	08-10	17-01 N	66-00 E										
	10-12	17-24 N	65-47 E						1				
Nov., 17	12-14	17-34 N	65-47 E										
	14-16	18-00 N	65-52 E										
	16-18	18-15 N	65-55 E										
	06-08	18-59 N	64-35 E						2				
	08-10	18-59 N	64-21 E										
	10-12	18-57 N	63-59 E										
Nov., 18	12-14	18-57 N	63-43 E										
	14-16	18-55 N	63-37 E						1				
	16-18	18-57 N	63-28 E										
	06-08	20-01 N	63-58 E						2				
	08-10	20-01 N	64-08 E						1				
	10-12	20-01 N	64-45 E						1				Turtle(1)
Nov., 19	12-14	20-01 N	64-44 E						1				
	14-16	20-10 N	65-02 E										
	16-18	20-30 N	65-03 E										

Table 1 (cont'd)

Date	Time (LMT)	Position Lat.	Position Long.	Fish schools Large	Fish schools Medium	Fish schools Small	Bird flocks Large	Bird flocks Medium	Bird flocks Small	Porpoises	Whales	Drifts	Others
	06-08	20-59 N	63-56 E						2			Wooden boad (1)	
	08-10	21-05 N	63-56 E					1					
	10-12	21-29 N	63-56 E						2				
Nov., 20	12-14	21-46 N	63-56 E										
	14-16	22-05 N	64-07 E										
	16-18	22-16 N	64-18 E										
				(Second Area)									
	06-08	21-00 N	62-05 E										
	08-10	21-01 N	62-05 E										
	10-12	21-20 N	62-05 E						1				
Nov., 28	12-14	21-36 N	62-13 E										
	14-16	21-48 N	62-07 E										
	16-18	22-06 N	62-03 E						2				
	06-08	23-50 N	62-04 E						2				
	08-10	24-03 N	62-04 E										Turtle(1)
	10-12	24-20 N	62-02 E										
Nov., 29	12-14	24-43 N	62-01 E										
	14-16	24-50 N	62-10 E										
	16-18	24-51 N	62-14 E										

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	23-14 N	62-36 E						1				
	08-10	22-58 N	62-36 E						2				
	10-12	22-34 N	62-35 E						1				
NOv., 30	12-14	22-24 N	62-34 E						1				
	14-16	22-00 N	62-36 E			1			1				
	16-18	21-44 N	62-39 E						2				
	06-08	21-23 N	63-10 E						3				
	08-10	21-33 N	63-10 E										Turtle(1)
	10-12	21-50 N	63-10 E						1				
Dec., 1	12-14	22-01 N	63-10 E										
	14-16	22-19 N	63-10 E						1				
	16-18	22-50 N	63-10 E									Drift board with fishes	
	06-08	24-32 N	63-14 E										
	08-10	24-40 N	63-13 E						1				
	10-12	24-48 N	63-08 E					1					
Dec., 2	12-14	24-49 N	63-21 E										
	14-16	24-39 N	63-38 E					1					
	16-18	24-50 N	63-42 E						1				
	06-08	23-41 N	64-14 E						1				
	08-10	23-33 N	64-14 E										
	10-12	22-44 N	64-16 E										
Dec., 3	12-14	22-50 N	64-19 E										
	14-16	22-33 N	64-17 E			1			1				
	16-18	22-20 N	64-17 E										

Table 1 (cont'd)

Date	Time (LMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	20-59 N	64-32 E						1				
	08-10	21-05 N	64-48 E										
	10-12	21-13 N	65-06 E									Sargassum (1)	
Dec., 4													
	12-14	21-22 N	65-17 E										
	14-16	21-29 N	65-18 E										
	16-18	21-46 N	65-19 E										
	06-08	23-33 N	65-20 E										
	08-10	23-50 N	65-20 E						1				
	10-12	24-20 N	65-20 E						1				
Dec., 5	12-14	24-19 N	65-19 E										
	14-16	24-46 N	65-21 E						1				
	16-18	24-50 N	65-21 E	1		2				2	2(100) (10)		
	06-08	23-28 N	65-53 E			1					1		
	08-10	23-28 N	65-53 E						2				
	10-12	22-50 N	65-53 E						1				
Dec., 6	12-14	22-48 N	65-52 E						1				
	14-16	22-19 N	65-51 E										
	16-18	22-00 N	65-51 E										
	06-08	23-18 N	66-22 E										
	08-10	23-30 N	66-23 E						1				
	10-12	23-50 N	66-26 E						1				
Dec., 7	12-14	23-56 N	66-25 E				1						
	14-16	24-18 N	66-24 E										
	16-18	24-50 N	66-25 E						3				Turtle(1) Sea snake(1)

Table 1 (cont'd)

Date	Time (IMT)	Position		Fish schools			Bird flocks			Porpoises	Whales	Drifts	Others
		Lat.	Long.	Large	Medium	Small	Large	Medium	Small				
	06-08	22-51 N	66-56 E								1		
	08-10	22-52 N	66-57 E						1				
	10-12	23-02 N	67-12 E						1				
Dec., 8	12-14	23-03 N	67-12 E				1	1	2				
	14-16	23-15 N	67-25 E										
	16-18	23-28 N	67-33 E					1					
	06-08	23-28 N	67-33 E										
	08-10	23-32 N	67-29 E										
	10-12	23-35 N	67-32 E				1						
Dec., 9	12-14	23-39 N	67-20 E				1						Turtle(1)
	14-16	23-42 N	67-18 E										
	16-18	23-55 N	67-15 E										
	06-08	24-04 N	67-13 E										
	08-10	23-58 N	67-04 E					1					
	10-12	23-59 N	67-04 E										
Dec., 10	12-14	24-06 N	66-51 E										
	14-16	24-05 N	66-48 E										
	16-18	24-12 N	66-41 E										
	06-08	24-12 N	66-41 E					1					
	08-10	24-24 N	66-35 E										
	10-12	24-32 N	66-37 E										
Dec., 11	12-14	24-32 N	66-42 E										
	14-16	24-39 N	66-38 E										
	16-18	24-39 N	66-35 E										

Table 2. Records on trolling in the whole survey area

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Distance trolled	Species and total catch	Remarks
TR- 1	Nov., 8	17:33- 18:30	05-00 S 05-07 S	64-02 E 64-02 E	7.3 (miles)		
TR- 2	Nov., 9	05:30- 06:30	03-17 S 03-08 S	63-05 E 63-57 E	9.0		
TR- 3	Nov., 9	17:30- 18:30	01-45 S 01-38 S	64-03 E 64-03 E	7.3		
TR- 4	Nov.,10	05:43- 06:25	00-05 S 00-01 N	64-05 E 64-05 E	5.6		
TR- 5	Nov.,10	17:30- 18:25	01-36 N 01-42 N	64-06 E 64-04 E	7.0	Euthynnus pelamis (5)	Fork length 39.2-59.5 cm
TR- 6	Nov.,11	05:30- 06:23	02-32 N 02-38 N	63-58 E 63-55 E	7.1		
TR- 7	Nov.,11	17:30- 18:17	04-00 N 04-06 N	64-03 E 64-05 E	6.5		
TR- 8	Nov.,12	05:30- 06:26	05-38 N 05-45 N	63-52 E 63-52 E	7.6		
TR- 9	Nov.,12	17:25- 18:18	07-12 N 07-20 N	64-01 E 64-02 E	7.5		
TR-10	Nov.,13	17:20- 18:10	10-40 N 10-47 N	63-58 E 63-58 E	6.7		
TR-11	Nov.,14	05:40- 06:35	12-22 N 12-30 N	64-00 E 64-00 E	7.5		
TR-12	Nov.,14	17:00- 17:31	13-54 N 13-58 N	63-59 E 64-00 E	4.1		
TR-13	Nov.,15	05:50- 06:50	15-09 N 15-09 N	63-14 E 63-05 E	8.0	E. pelamis (3)	F.L. 38.6-40.5 cm

Table 2 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Distance trolled	Species and total catch	Remarks
TR-14	Nov., 15	17:20- 17:55	14-49 N 14-59 N	61-07 E 61-03 E	4.6 (miles)		
TR-15	Nov., 16	06:00- 06:36	16-45 N 16-49 N	61-47 E 61-49 E	5.0		
TR-16	Nov., 17	05:50- 06:45	16-57 N 16-57 N	65-29 E 65-37 E	7.4		
TR-17	Nov., 18	05:50- 06:47	18-59 N 18-59 N	64-44 E 64-35 E	7.6		
TR-18	Nov., 19	06:00- 06:55	20-01 N 20-01 N	63-42 E 63-51 E	7.6		
TR-19	Nov., 20	06:09- 06:58	20-52 N 20-59 N	63-56 E 63-56 E	6.4		
TR-20	Nov., 28	16:40- 17:44	22-14 N 22-23 N	62-03 E 62-03 E	8.8		
TR-21	Nov., 29	06:30- 07:30	23-50 N 23-58 N	62-04 E 62-04 E	8.1		
TR-22	Nov., 30	06:15- 07:15	23-14 N 23-06 N	62-36 E 62-36 E	7.9		
TR-23	Nov., 30	14:27- 15:02 (Fishes with a wood found)	22-00 N	62-36 E	3.8	Coryphaena hippurus (6) Carcharhinus sp. (1)	F.L. 44.7-72.7cm T.L. 105.3 cm
TR-24	Nov., 30	17:10- 18:00	21-44 N 21-38 N	62-39 E 62-39 E	6.7	Coryphaena equisetis (1)	F.L. 35.3 cm
TR-25	Dec., 1	06:30- 07:30	21-23 N 21-30 N	63-10 E 63-10 E	7.5		
TR-26	Dec., 2	06:15- 07:10	24-26 N 24-32 N	63-14 E 63-14 E	6.5		

Table 2 (cont'd)

St. No.	Date (LMT)	Time	Position Lat.	Position Long.	Distance trolled	Species and total catch	Remarks
TR-27	Dec., 3	06:20- 07:17	23-48 N 23-41 N	64-14 E 64-14 E	7.4(miles)		
TR-28	Dec., 3	17:00- 17:58	22-13 N 22-06 N	64-15 E 64-14 E	7.4		
TR-29	Dec., 4	06:00- 06:58	20-56 N 20-59 N	64-24 E 64-32 E	7.8		
TR-30	Dec., 5	06:10- 07:08	23-26 N 23-33 N	65-20 E 65-20 E	7.5		
TR-31	Dec., 5	16:54- 17:50	24-50 N 24-50 N	65-21 E 65-31 E	7.7		
TR-32	Dec., 6	06:00- 07:00	23-35 N 23-28 N	65-53 E 65-53 E	7.8		
TR-33	Dec., 7	17:00- 17:43	24-50 N 24-45 N	66-25 E 66-30 E	5.6		

Table 3. Records on surface larvae net tows in the whole survey area

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Fishes(family or order level) caught and number in parentheses
LN- 1	Nov., 8	20:00-20:20	04-40 S	64-02 E	Myctophidae (27), Hemirhamphidae (3), Exocoetidae (1), Carangidae (1)
LN- 2	Nov., 9	07:39-08:04	03-08 S	63-57 E	Hemirhamphidae (14), Clupeidae (10), Istiophoridae (1), Exocoetidae (1) Carangidae (1), Beryciformes (1)
LN- 3	Nov., 9	18:33-18:55	01-36 S	64-03 E	Myctophidae (48), Hemirhamphidae (23), Scombridae (7), Coryphaenidae (3), Bregmacerotidae (2)
LN- 4	Nov., 10	08:00-08:29	00-13 N	64-04 E	Hemirhamphidae (54), Beryciformes (31), Exocoetidae (14)
LN- 5	Nov., 10	20:00-20:20	01-58 N	63-58 E	Myctophidae (215), Scombridae (3), Coryphaenidae (3)
LN- 6	Nov., 11	08:00-08:20	02-54 N	63-51 E	Hemirhamphidae (6), Exocoetidae (3), Astronesthidae (1), Myctophidae (1) Echeneidae (1), Clupeidae (1), Unidentified fishes (30)
LN- 7	Nov., 11	20:00-20:20	04-23 N	64-05 E	Myctophidae (98), Clupeidae (8), Astronesthidae (7), Exocoetidae (3)
LN- 8	Nov., 12	08:00-08:20	05-52 N	63-53 E	Hemirhamphidae (18), Istiophoridae (6), Beryciformes (2), Coryphaenidae (1) Exocoetidae (1), Unidentified fishes (20)
LN- 9	Nov., 12	18:59-19:19	07-27 N	64-05 E	Myctophidae (93), Scombridae (25), Synodontidae (6), Coryphaenidae (6), Hemirhamphidae (3), Gempylidae (1), Beryciformes (1), Astronesthidae (1)
LN-10	Nov., 13	09:30-09:50	09-30 N	64-04 E	Hemirhamphidae (13), Exocoetidae (5)
LN-11	Nov., 13	19:20-19:43	11-00 N	63-58 E	Myctophidae (110), Gonostomatidae (2), Anguilliformes (2), Hemirhamphidae (2), Synodontidae (2), Clupeidae (1), Exocoetidae (1), Astronesthidae (1)
LN-12	Nov., 14	08:00-08:20	12-45 N	64-00 E	Hemirhamphidae (38), Exocoetidae (6), Beryciformes (4), Unidentified fishes (5)

Table 3 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Long.	Fishes(family or order level) caught and number in parenthesis
LN-13	Nov., 14	20:00-20:20	14-15 N	64-02 E	Myctophidae (72), Anguilliformes (36), Coryphaenidae (2), Beryciformes (2), Bregmacerotidae (1)
LN-14	Nov., 15	06:50-07:10	15-09 N	63-05 E	Coryphaenidae (6), Beryciformes (3), Hemirhamphidae (1), Unidentified fishes (29)
LN-15	Nov., 15	20:00 20:20	15-12 N	61-06 E	Myctophidae (161), Anguilliformes (5), Carangidae (2), Exocoetidae (1), Coryphaenidae (1)
LN-16	Nov., 16	07:37-08:00	16-58 N	61-54 E	Coryphaenidae (1), Anguilliformes (1), Unidentified fishes (20)
LN-17	Nov., 16	20:20-20:40	16-58 N	63-49 E	Myctophidae (99), Anguilliformes (30), Beryciformes (1), Coryphaenidae (1)
LN-18	Nov., 17	07:50-08:10	16-57 N	65-48 E	Hemirhamphidae (6), Exocoetidae (3); Unidentified fishes (7)
LN-19	Nov., 17	20:00-20:20	18-31 N	65-56 E	Clupeidae (253), Coryphaenidae (12), Myctophidae (10), Exocoetidae (5)
LN-20	Nov., 18	08:00-08:20	18-59 N	64-21 E	Clupeidae (8)
LN-21	Nov., 18	19:40-20:00	19-00 N	62-57 E	Myctophidae (113), Exocoetidae (29), Anguilliformes (14), Clupeidae (3), Coryphaenidae (5)
LN-22	Nov., 19	08:00-08:20	20-01 N	64-01 E	Beryciformes (1), Coryphaenidae (1), Exocoetidae (1)
Ln-23	Nov., 19	20:07-20:37	20-30 N	65-03 E	Myctophidae (29), Balistidae (12), Clupeidae (10), Coryphaenidae (2)
LN-24	Nov., 20	08:00-08:20	21-09 N	63-56 E	Clupeidae (3), Beryciformes (1)
LN-25	Nov., 28	08:02-08:22	21-01 N	62-05 E	Coryphaenidae (16), Carangidae (11), Exocoetidae (9), Tetraodontidae (7), Blennidae (7), Beryciformes (5), Pleuronectidae (3), Hemirhamphidae (3), Sphyraenidae (1), Clupeidae (1), Unidentified fishes (12)

Table 3 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Long.	Fishes(family or order level) caught and number in parenthesis
LN-26	Nov., 28	20:00-20:20	22-41 N	62-04 E	Myctophidae (88), Mugilidae (5), Exocoetidae (5), Coryphaenidae (2), Synodontidae (1), Hemirhamphidae (1), Unidentified fishes (9)
LN-27	Nov., 29	08:00-08:21	24-03 N	62-04 E	Bothidae (3), Clupeidae (2), Carangidae (1), Unidentified fishes (18)
LN-28	Nov., 29	20:00-20:20	24-50 N	62-34 E	Myctophidae (147), Pleuronectidae (33), Coryphaenidae (11), Stromateidae (9), Synodontidae (8), Mugilidae (3), Exocoetidae (1), Dactylopteridae (2), Unidentified fishes (2)
LN-29	Nov., 30	08:00-08:20	22-58 N	62-36 E	Pleuronectidae (11), Carangidae (3), Hemirhamphidae (2), Beryciformes (2), Atherinidae (2), Synodontidae (2), Exocoetidae (2)
LN-30	Nov., 30	19:59-20:19	21-25 N	62-38 E	Atherinidae (8), Myctophidae (6), Synodontidae (5), Coryphaenidae (5), Clupeidae (4), Exocoetidae (2), Beryciformes (1), Diodontidae (1), Carangidae (1), Unidentified fish (1)
LN-31	Dec., 1	08:00-08:20	21-33 N	63-10 E	———
LN-32	Dec., 1	20:00-20:20	23-02 N	63-11 E	Clupeidae (66), Myctophidae (31), Exocoetidae (6), Atherinidae (5), Coryphaenidae (4), Aluteridae (2), Unidentified fishes (28)
LN-33	Dec., 2	08:00-08:22	24-40 N	63-13 E	Coryphaenidae (4), Atherinidae (2), Clupeidae (2), Unidentified fishes (57)
LN-34	Dec., 2	20:00-20:20	24-48 N	63-58 E	Atherinidae (82), Stromateidae (11), Gonostomatidae (10), Myctophidae (6), Scombridae (1), Coryphaenidae (1), Synodontidae (1), Unidentified fishes (2)
LN-35	Dec., 3	07:58-08:19	23-33 N	64-14 E	Hemirhamphidae (2), Atherinidae (1)
LN-36	Dec., 3	20:00-20:20	21-51 N	64-14 E	Myctophidae (19), Exocoetidae (8), Coryphaenidae (3), Beryciformes (1), Atherinidae (1), Unidentified fishes (3)

Table 3 (cont'd)

St. No.	Date	Time (LMT)	Position Lat.	Long.	Fishes(family or order level) caught and number in parenthesis
LN-37	Dec., 4	08:00-08:20	21-03 N	64-43 E	Exocoetidae (14), Mugilidae (3), Coryphaenidae (2), Hemirhamphidae (2), Unidentified fishes (10)
LN-38	Dec., 4	20:00-20:19	21-44 N	65-10 E	Myctophidae (483), Exocoetidae (26), Coryphaenidae (18), Atherinidae (9), Hemirhamphidae (5), Beryciformes (3), Balistidae (1), Unidentified fish (1)
LN-39	Dec., 5	08:00-08:20	23-33 N	65-20 E	Atherinidae (49), Hemirhamphidae (6), Coryphaenidae (5), Carangidae (1), Exocoetidae (1)
LN-40	Dec., 5	20:00-20:20	24-50 N	65-50 E	Atherinidae (12), Coryphaenidae (5), Stromateidae (3), Synodontidae (2), Clupeidae (1), Myctophidae (1), Unidentified fish (1)
LN-41	Dec., 6	08:00-08:19	23-18 N	65-53 E	Coryphaenidae (3), Exocoetidae (2), Hemirhamphidae (2), Carangidae (1), Atherinidae (1), Unidentified fish (1)
LN-42	Dec., 6	20:00-20:18	21-54 N	65-54 E	Myctophidae (35), Clupeidae (7), Atherinidae (6), Coryphaenidae (1), Unidentified fishes (2)
LN-43	Dec., 7	07:30-07:50	23-18 N	66-22 E	Sphyraenidae (26), Stromateidae (9), Clupeidae (6), Hemirhamphidae(2), Unidentified fish (1)
LN-44	Dec., 7	20:00-20:19	24-26 N	66-45 E	Myctophidae (72), Scorpaenidae (61), Carangidae (49), Stromateidae (41), Clupeidae (37), Atherinidae (26), Synodontidae (14), Sphyraenidae (9), Bregmacerotidae (7), Exocoetidae (6), Coryphaenidae (4), Blennidae (2), Trichiuridae (2), Uranoscopidae (1), Unidentified fishes (13)
LN-45	Dec., 8	08:08-08:26	22-51 N	66-56 E	Clupeidae (4), Coryphaenidae (1), Unidentified fishes (2)

Table 5. Records on midwater handline in the whole survey area

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Number of gears used	Species and number caught
MWHL- 1	Nov., 5	23:49 - 01:18	04-02 S	63-54 E	3 - 4	Symplectoteuthis oualaniensis (2)
MWHL- 2	Nov., 9	22:06 - 23:00	01-02 S	64-04 E	3 - 4	S. oualaniensis (2)
MWHL- 3	Nov., 10	04:24 - 05:35	00-05 S	64-05 E	3 - 4	S. oualaniensis (2)
MWHL- 4	Nov., 10	20:20 - 21:29	01-59 N	63-58 E	3 - 4	S. oualaniensis (5)
MWHL- 5	Nov., 12	22:20 - 23:20	04-57 N	63-58 E	3 - 4	S. oualaniensis (1)
MWHL- 6	Nov., 13	19:47 - 20:47	11-01 N	63-58 E	3 - 4	S. oualaniensis (1)
MWHL- 7	Nov., 19	16:55 - 21:50	20-30 N	65-03 E	7 - 15	S. oualaniensis (30), Euthynnus pelamis (1), Auxis thazard (3), Coryphaena equiselis (3), Carcharhinus sp. (2)
MWHL- 8	Nov., 20	17:20 - 18:45	22-25 N	64-28 E	20	---
MWHL- 9	Nov., 28	04:00 - 06:15	21-00 N	62-05 E	9	S. oualaniensis (3)
MWHL-10	Nov., 28	17:45 - 18:10	22-23 N	62-03 E	14	S. oualaniensis (1)
MWHL-11	Nov., 28	21:40 - 23:30	22-50 N	62-06 E	5 - 10	S. oualaniensis (36)
MWHL-12	Nov., 29	05:30 - 06:30	23-50 N	62-04 E	8	S. oualaniensis(4), A. thazard(3), C. equiselis(2)
MWHL-13	Nov., 30	18:05 - 18:45	21-38 N	62-39 E	11	S. oualaniensis (3)
MWHL-14	Dec., 1	03:10 - 03:45	20-49 N	63-09 E	5	S. oualaniensis (9)
MWHL-15	Dec., 1	06:01 - 06:30	21-23 N	63-10 E	10	---
MWHL-16	Dec., 1	17:50 - 18:45	22-50 N	63-12 E	12 - 13	S. oualaniensis (13)
MWHL-17	Dec., 2	00:45 - 01:45	23-45 N	63-13 E	1 - 3	S. oualaniensis (4)
MWHL-18	Dec., 2	06:00 - 06:15	24-26 N	63-14 E	7	---
MWHL-19	Dec., 2	18:07 - 18:45	24-47 N	63-45 E	12 - 13	S. oualaniensis (3)
MWHL-20	Dec., 2	22:10 - 23:00	24-50 N	64-14 E	3	---
MWHL-21	Dec., 3	04:50 - 05:50	23-52 N	64-14 E	4	---
MWHL-22	Dec., 3	18:00 - 18:30	22-06 N	64-14 E	12	S. oualaniensis (5), E. pelamis (1)
MWHL-23	Dec., 3	20:25 - 21:05	21-51 N	64-14 E	5	---
MWHL-24	Dec., 4	03:15 - 04:00	20-48 N	64-09 E	4	---
MWHL-25	Dec., 4	19:00 - 19:30	21-50 N	65-20 E	12 - 15	S. oualaniensis (4), A. thazard (1)
MWHL-26	Dec., 5	17:55 - 18:25	24-50 N	65-31 E	14	---
MWHL-27	Dec., 5	20:30 - 21:10	24-56 N	65-50 E	5	---
MWHL-28	Dec., 6	00:45 - 01:10	24-20 N	65-53 E	4	---
MWHL-29	Dec., 6	04:10 - 04:45	23-46 N	65-53 E	4	---
MWHL-30	Dec., 6	18:40 - 19:30	21-52 N	65-51 E	7	S. oualaniensis (1)
MWHL-31	Dec., 7	02:40 - 03:30	22-49 N	66-22 E	3	---
MWHL-32	Dec., 8	00:00 - 00:45	23-28 N	67-33 E	2	---
MWHL-33	Dec., 8	03:30 - 04:00	23-28 N	67-33 E	1	---

Table 6. Records on bottom handline in southern coast of Pakistan

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Number of gears used	Main species and number caught
BHL- 1	Dec., 8	17:15 - 20:30	23-28 N	67-33 E	10 - 15	Loligo duvaucelii (150), Argyrops spinifer (11), Acanthopagrus datnia (5)
BHL- 2	Dec., 9 Dec., 10	16:49 - 07:53	24-04 N	67-13 E	20 - 25	L. duvaucelii (120), Arius thalassinus (102), Therapon jarbua (7), Pomadasys maculatus(3)
BHL- 3	Dec., 10	12:14 - 12:58	24-06 N	66-51 E	10 - 15	A. spinifer (30), Epinephelus diacanthus (13), Epinephelus chrolostigma (4) Saurida undosquamis (6)
BHL- 4	Dec., 10	13:36 - 15:35	24-05 N	66-48 E	10 - 15	E. diacanthus (121), E. chrolostigma (18), A. spinifer (117), Trichiurus lepturus (23), Sarda orientalis (6)
BHL- 5	Dec., 11 Dec., 12	18:08 - 07:00	24-33 N	66-21 E	20 - 25	E. diacanthus (29), E. chrolostigma (14), A. spinifer (13), T. jarbua (6)
BHL- 6	Dec., 12	18:08 - 23:30	Off Karachi		20 - 25	L. duvaucelii (500), Rastrelliger kanagurta (50), Decapterus sp. (35)

Table 7. Records on catch by midwater trawl net in the whole survey area

After MWTR-9, cod end was covered by fine meshed net

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Trawled maximum depth(m)	Total catch(Kg)	Species caught
MWTR- 1	Nov., 14	13:30 - 14:00	13-30 N	63-54 E	123	4.4	Charybdis edwardsi
MWTR- 2	Nov., 16	17:25 - 17:55	16-59 N	63-29 E	110	1.75	C. edwardsi , Vinciguerria lucetia
MWTR- 3	Nov., 17	17:10 - 17:42	18-23 N	65-57 E	107	0.1	C. edwardsi, V. lucetia
MWTR- 4	Nov., 18	14:10 - 14:50	18-55 N	63-37 E	220	0.03	C. edwardsi, V. lucetia
MWTR- 5	Nov., 18	17:09 - 17:40	18-59 N	63-19 E	130	20.0	C. edwardsi
MWTR- 6	Nov., 29	- -	24-50 N	62-10 E	-	-	(Not succeeded)
MWTR- 7	Nov., 29	16:48 - 17:20	24-51 N	62-10 E	93	0.3	V. lucetia, Myctophidae, Squid larvae, C. edwardsi, Anguilliform larvae
MWTR- 8	Nov., 29	17:50 - 18:25	24-51 N	62-13 E	40	0.6	Myctophidae, V. lucetia, Squid larvae, Anguilliform larvae
MWTR- 9	Dec., 2	- -	24-48 N	63-20 E	-	-	(Not succeeded)
MWTR-10	Dec., 2	13:05 - 13:35	24-48 N	63-26 E	110	12.8	Benthosema pterota, Abralia sp.
MWTR-11	Dec., 2	17:12 - 17:45	24-49 N	63-45 E	100	4.31	B. pterota, Squid larvae
MWTR-12	Dec., 4	13:25 - 13:55	21-22 N	65-17 E	300	0.23	V. lucetia, B. pterota, Squid larvae, Anguilliform larvae
MWTR-13	Dec., 4	17:12 - 17:45	21-45 N	65-19 E	125	0.24	V. lucetia, B. pterota, Anguilliform larvae
MWTR-14	Dec., 4	18:16 - 18:50	21-42 N	65-20 E	40	1.38	Myctophidae(B. pterota ,etc.), V. lucetia, Cubiceps sp., Bregmaceros sp, Anguilliform larvae
MWTR-15	Dec., 5	14:54 - 15:30	24-46 N	65-21 E	330	0.32	Harpodon nehereus, Champsodon capensis, V. lucetia, Synagrops japonicus, Myctophidae, Shrimps, Anguilliform larvae
MWTR-16	Dec., 6	16:58 - 17:35	22-00 N	65-51 E	150	0.205	V. lucetia, Anguilliform larvae

Table 8. Records on catch by bottom trawl net in the southern coast of Pakistan

Cod end was covered by fine meshed net

St. No.	Date	Time (LMT)	Position Lat.	Position Long.	Maximum depth(m)	Bottom Temp.(°c)	Total catch(Kg)	Main species caught
BTR- 1	Dec., 8	10:29 - 11:00	23-04 N	67-14 E	105	22.0	81.4	Thrissocles malabaricus Trichiurus lepturus Nemipterus spp.
BTR- 2	Dec., 8	14:28 - 15:00	23-15 N	67-25 E	25	24.5	39.7	Sepia pharaonis Argyrops spinifer
BTR- 3	Dec., 9	10:02 - 10:35	23-37 N	67-35 E	30	25.1	77.0	Pomadasys maculatus Loligo duvaucelii Scomberomorus commerson Eggs of Sepiidae
BTR- 4	Dec., 9	13:26 - 14:32	23-46 N	67-22 E	22	23.5	169.9	Himantura uarnak Pomadasys maculatus Loligo duvaucelii Sepia brevimana
BTR- 5	Dec., 10	09:40 - 10:15	23-58 N	67-04 E	23	24.0	238.7	Saurida tumbil Acanthopagrus datnia Loligo duvaucelii
BTR- 6	Dec., 11	08:55 - 09:15	24-39 N	66-38 E	70	24.7	94.3	Trichiurus lepturus Nemipterus sp. Pomadasys hasta Loligo duvaucelii Sepia trygonia
BTR- 7	Dec., 11	12:22 - 12:55	24-32 N	66-42 E	63	23.3	49.4	Nemipterus spp. Pomadasys maculata Rhonciscus stridens Loligo duvaucelii
BTR- 8	Dec., 11	15:02 - 15:35	24-39 N	66-38 E	47	23.7	47.9	Pomadasys hasta Grammoplites scaber Sepia spp.

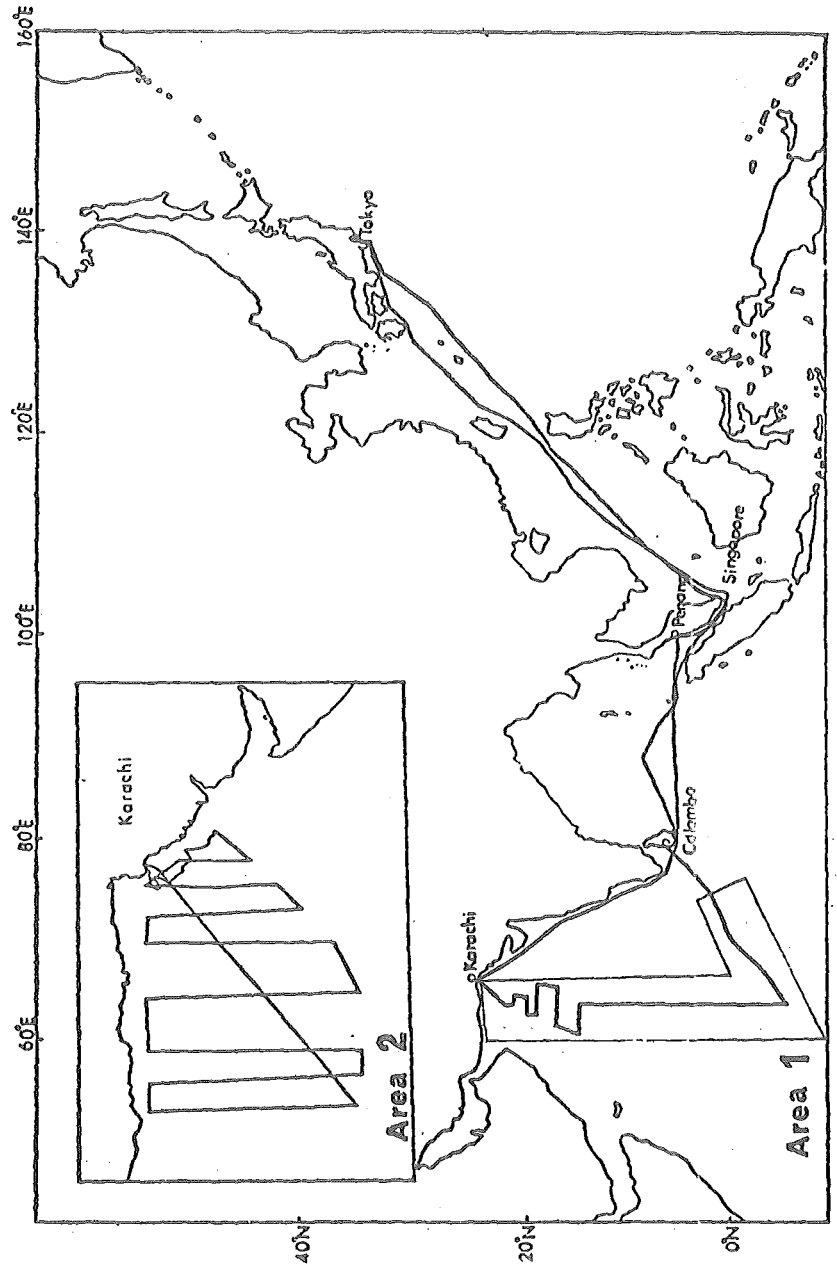


Figure 1. Track chart with survey areas by R/V SHOYO MARU, 2 October 1976 to 13 January 1977

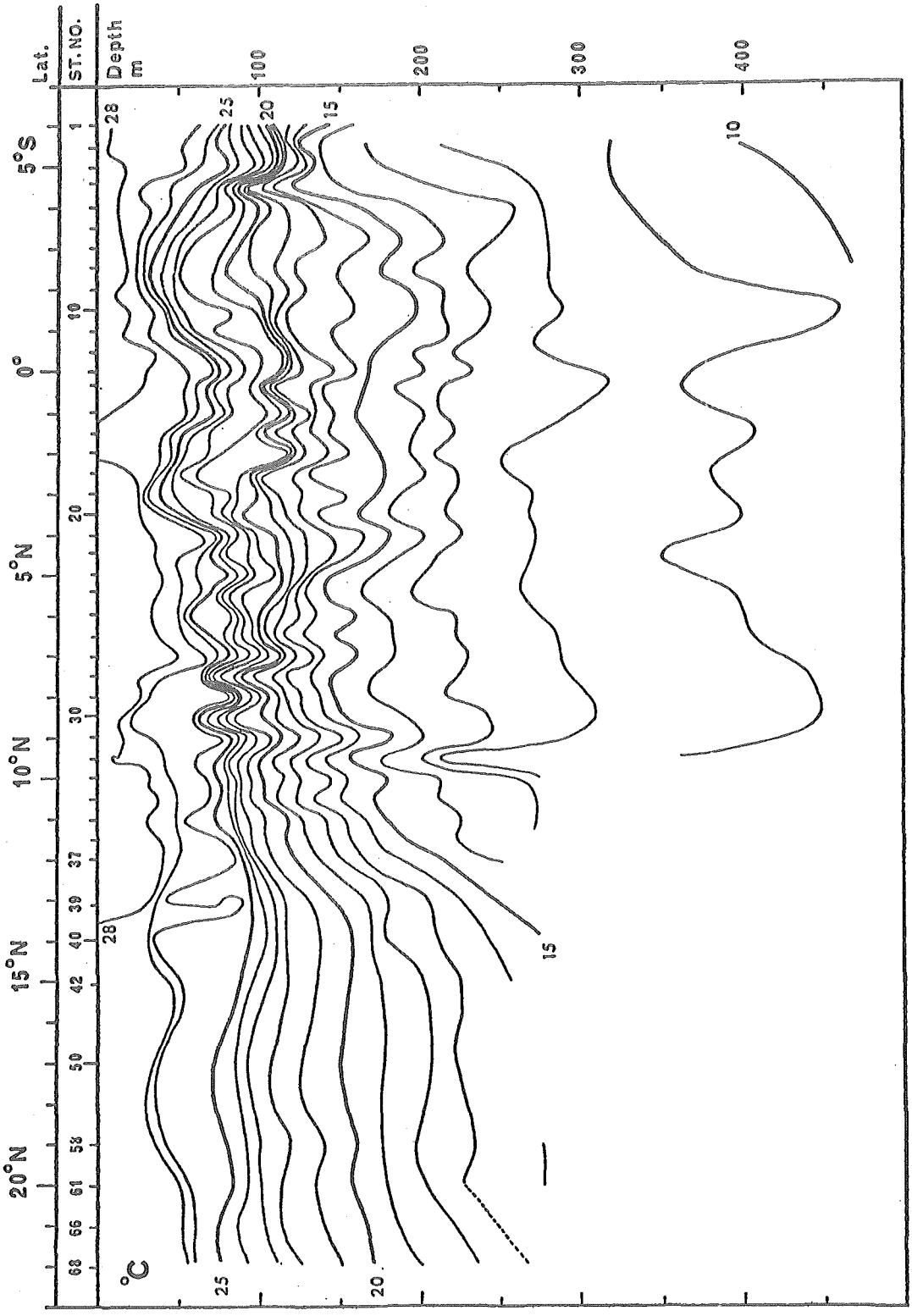


Figure 4. Vertical profile of water temperature (°C) along the meridian of long. 64°E in the First Area

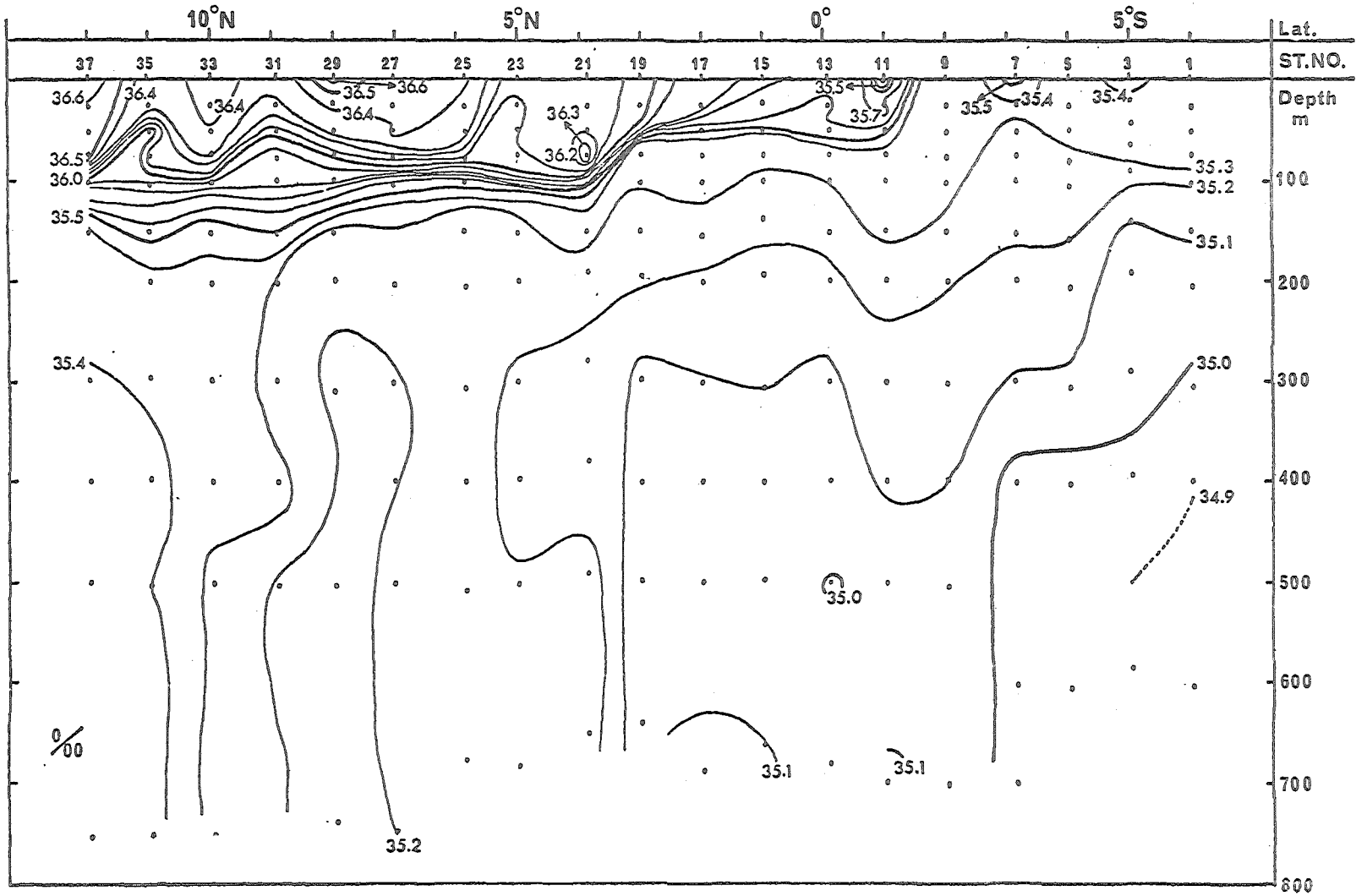


Figure 5. Vertical profile of salinity (‰) along the meridian of long. 64°E in the First Area

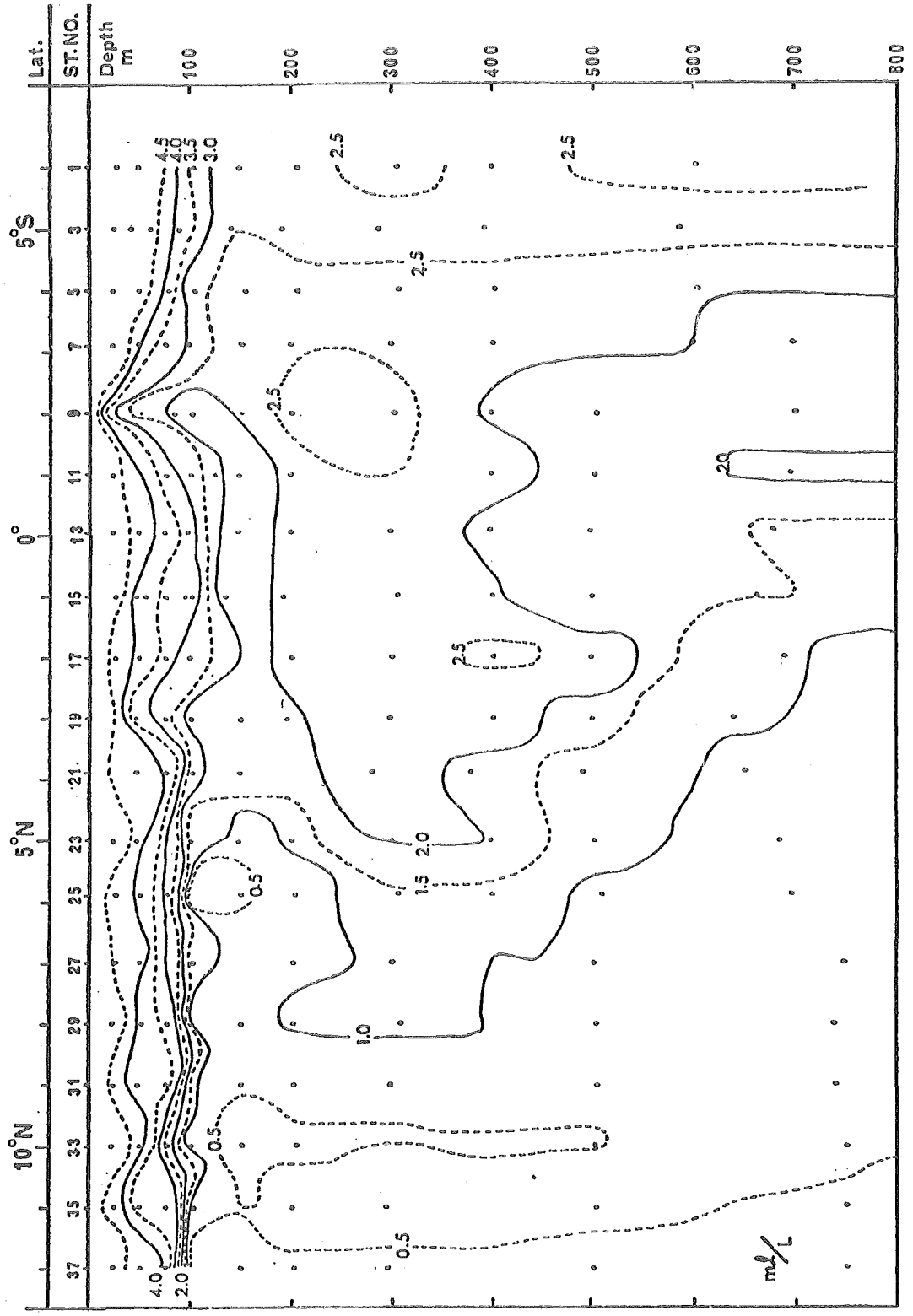


Figure 6. Vertical profile of content of dissolved oxygen (ml/l) along the meridian of long. 64°E in the First Area

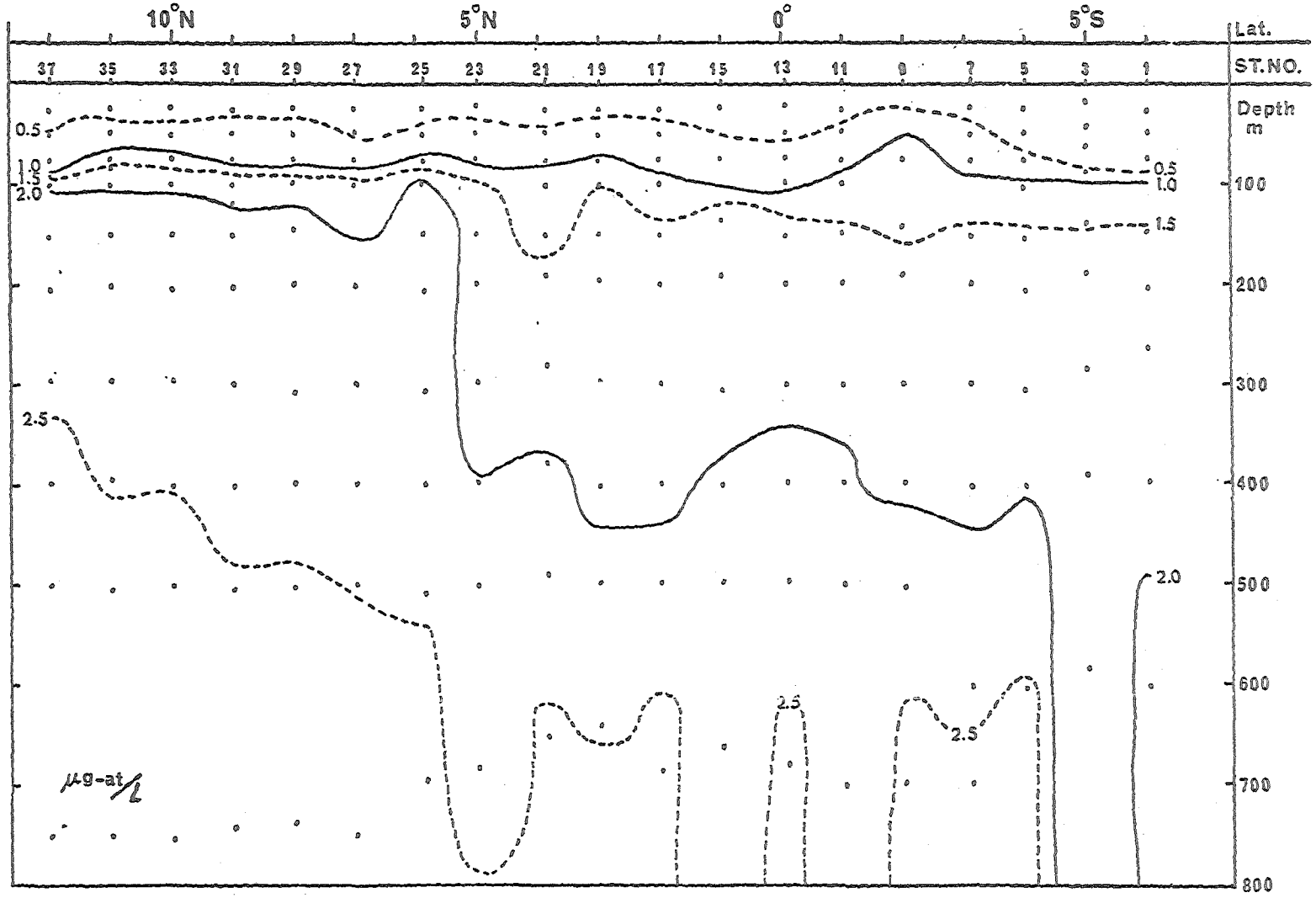


Figure 7. Vertical profile of content of Phosphate-P (ug-atom/L) along the meridian of 64°E in the First Area

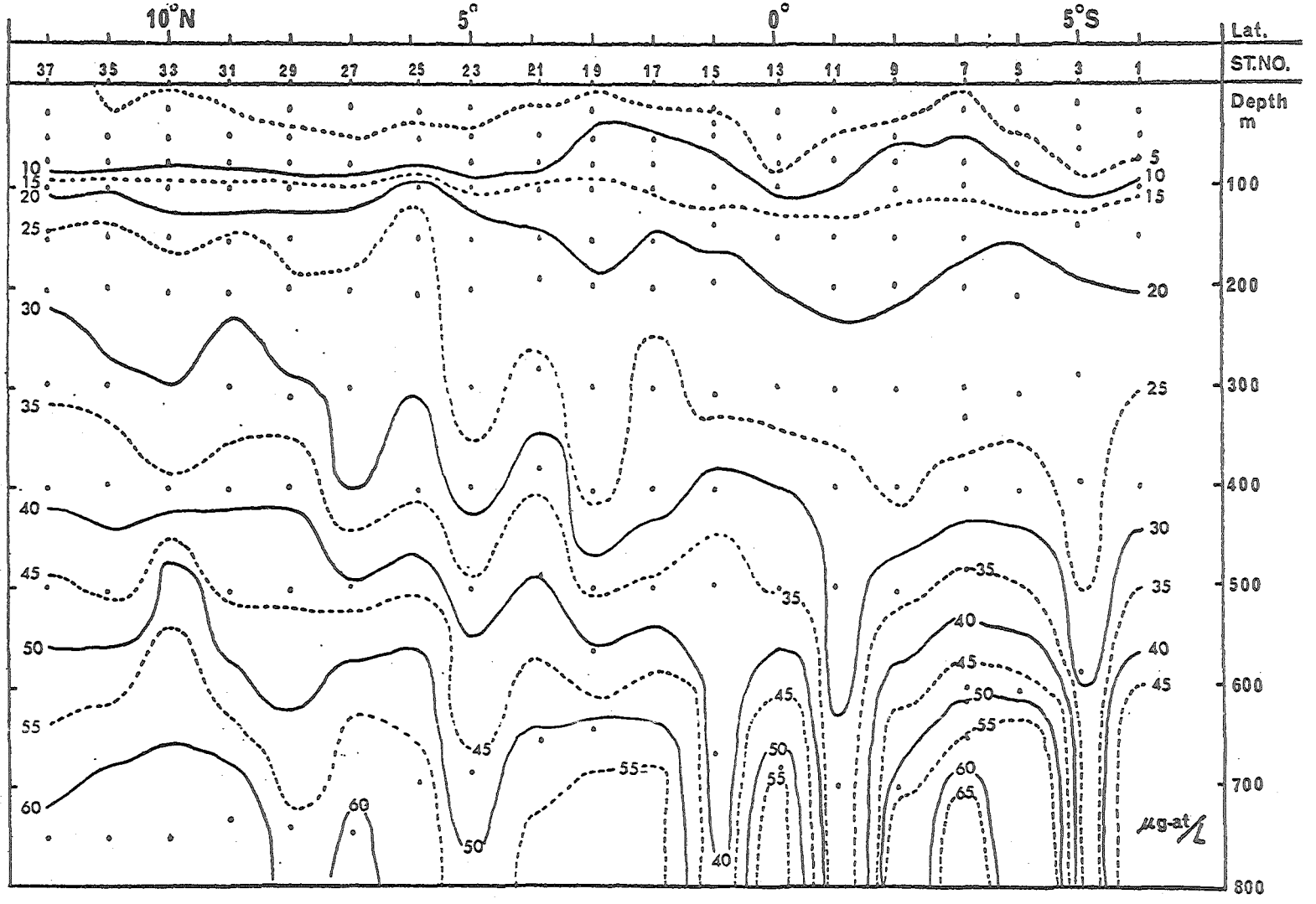


Figure 8. Vertical profile of content of Silicate-Si (ug-atom/L) along the meridian of 64°E in the First Area

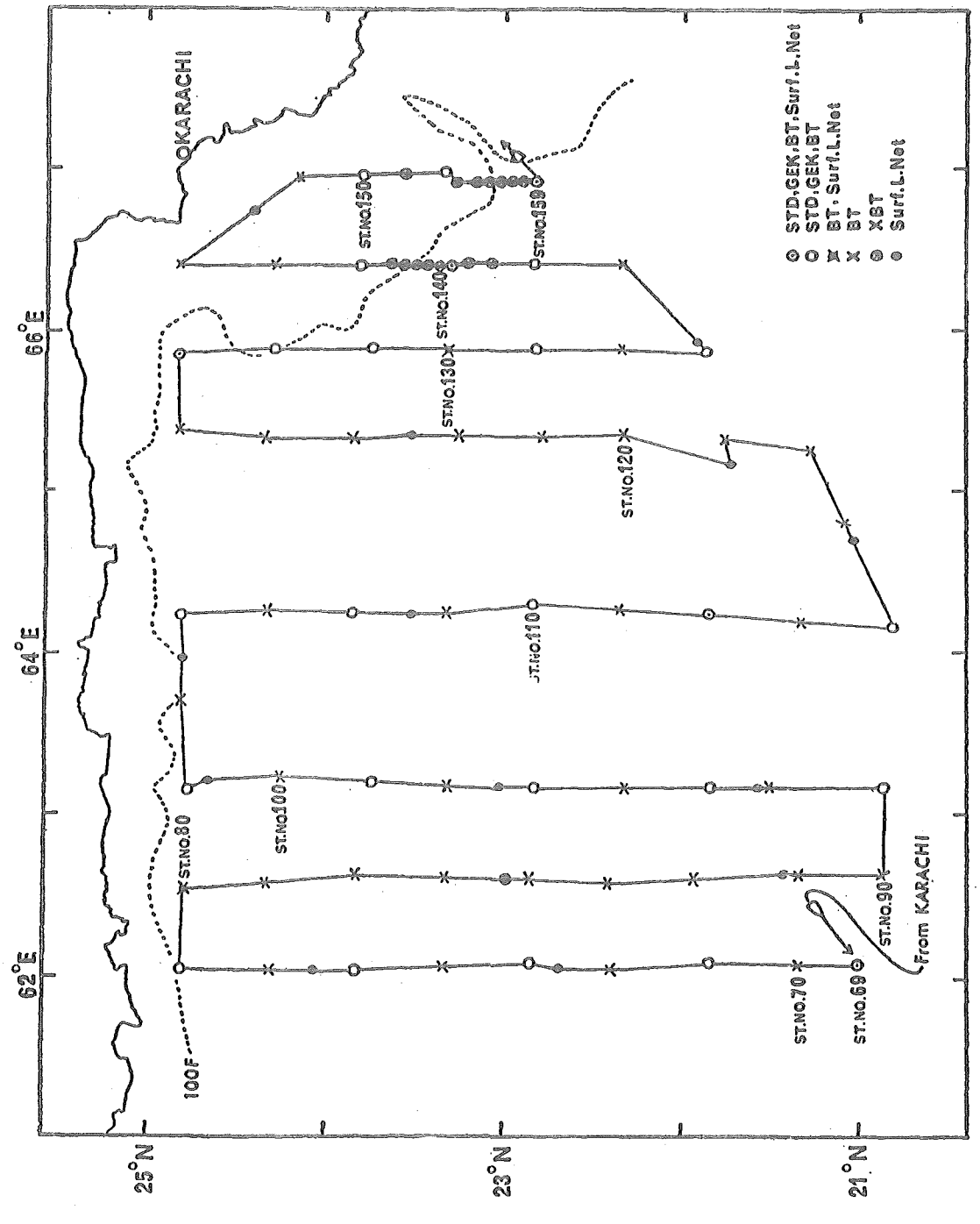


Figure 9. Track chart and oceanographic stations in the Second Area, 28 November to 8 December 1976

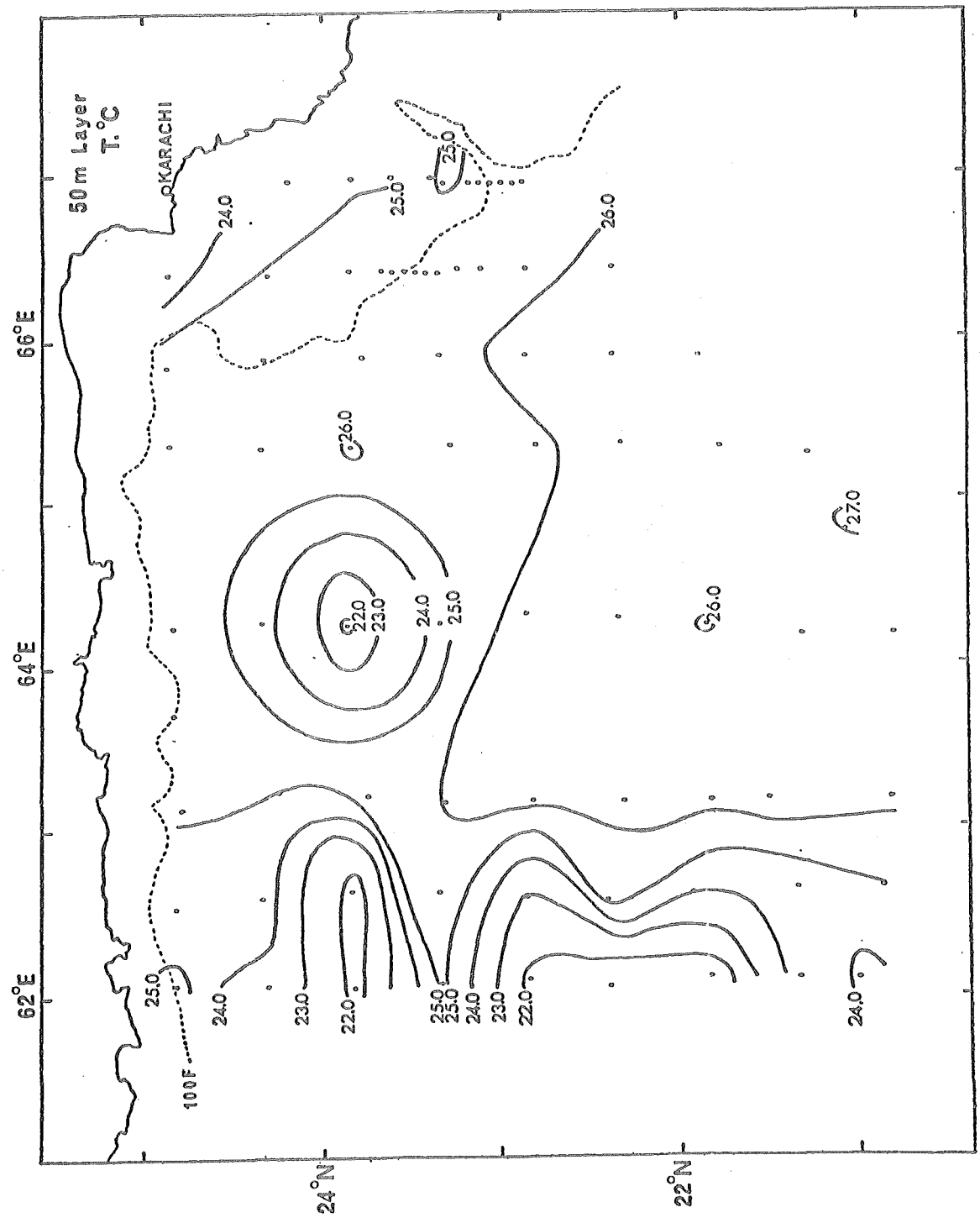


Figure 22. Horizontal distribution of water temperature (oC) at 50 m layer in the Second Area

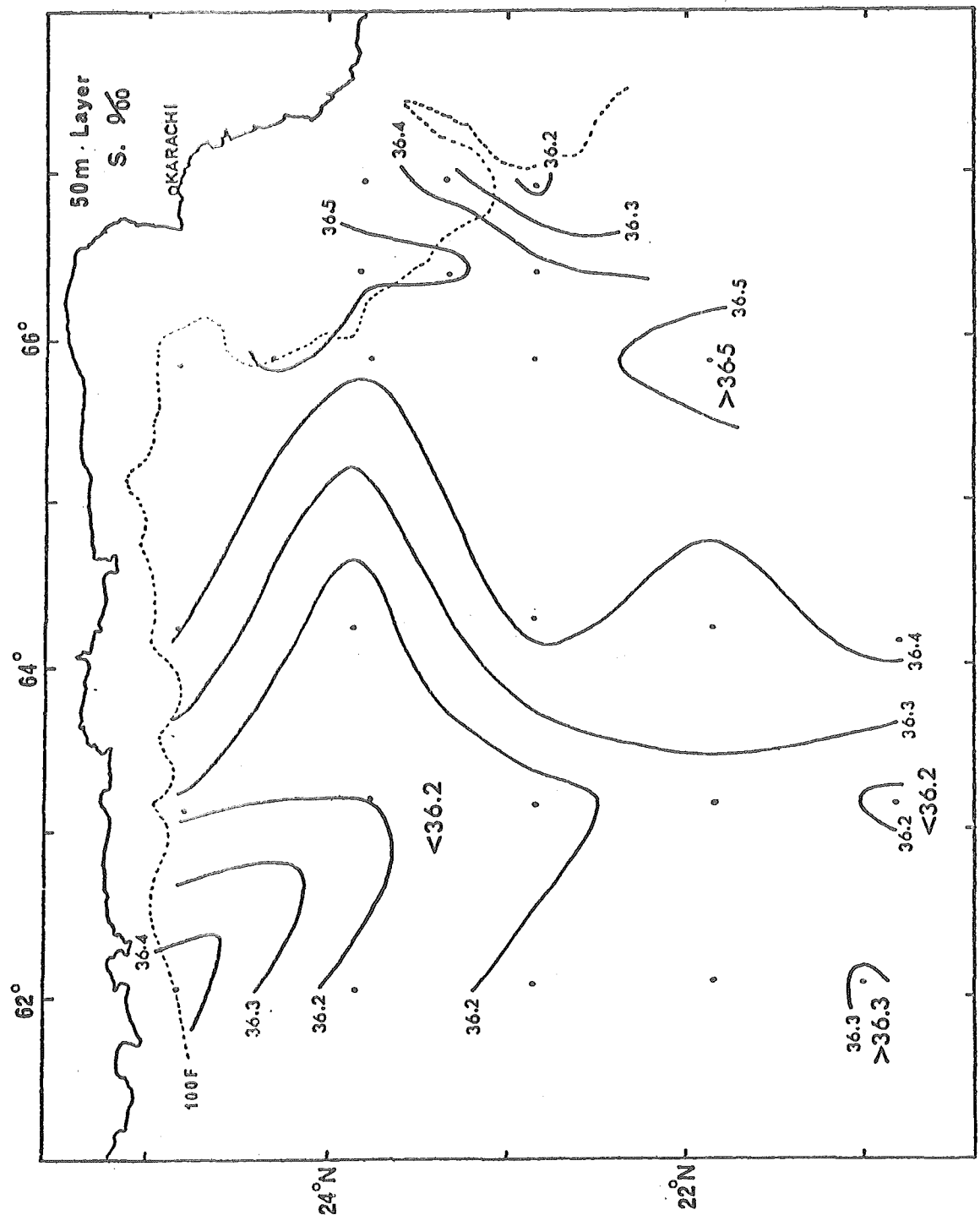


Figure 23. Horizontal distribution of salinity (‰) at 50 m layer in the Second Area

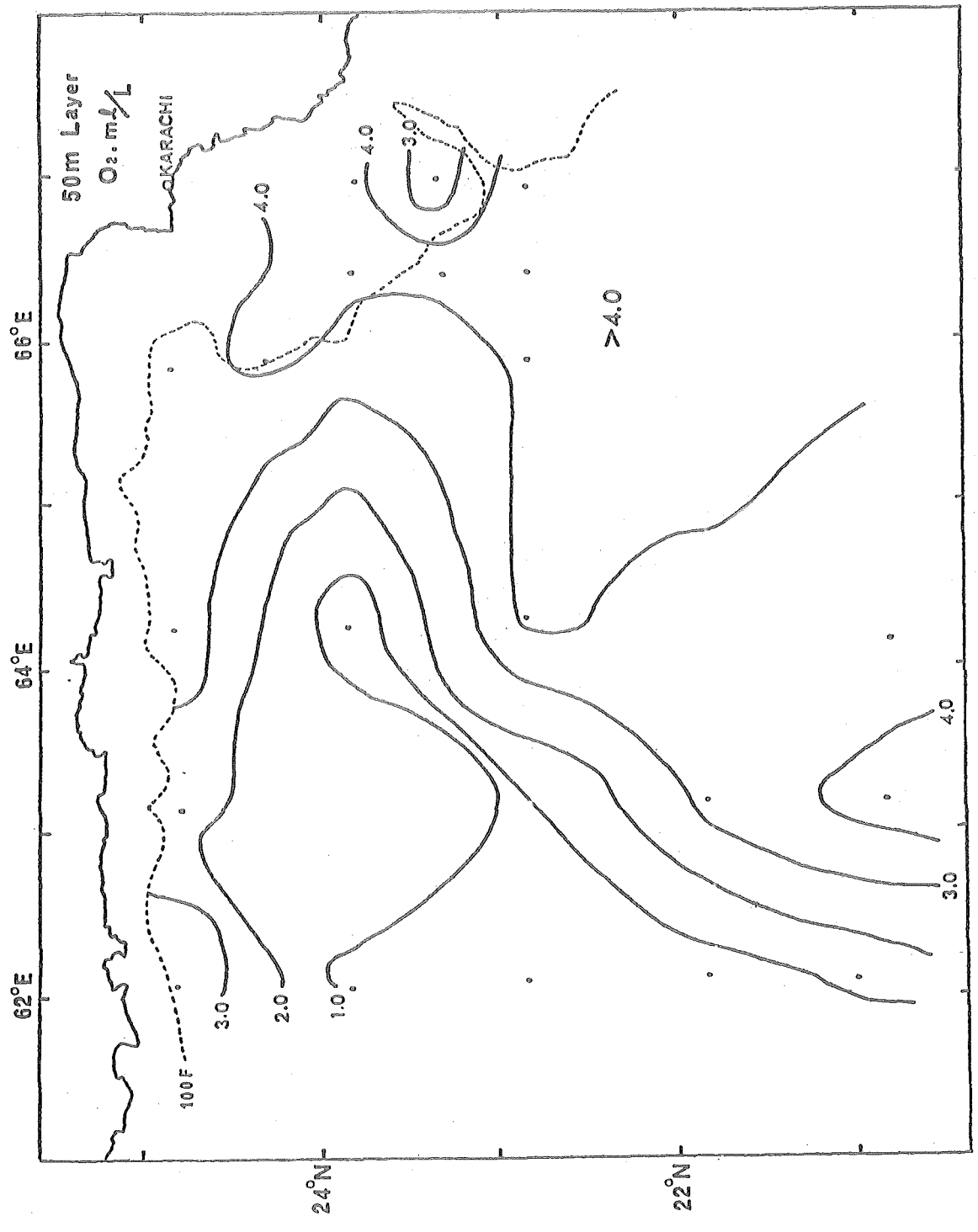


Figure 24. Horizontal distribution of content of dissolved oxygen (ml/L) at 50 m layer in the Second Area

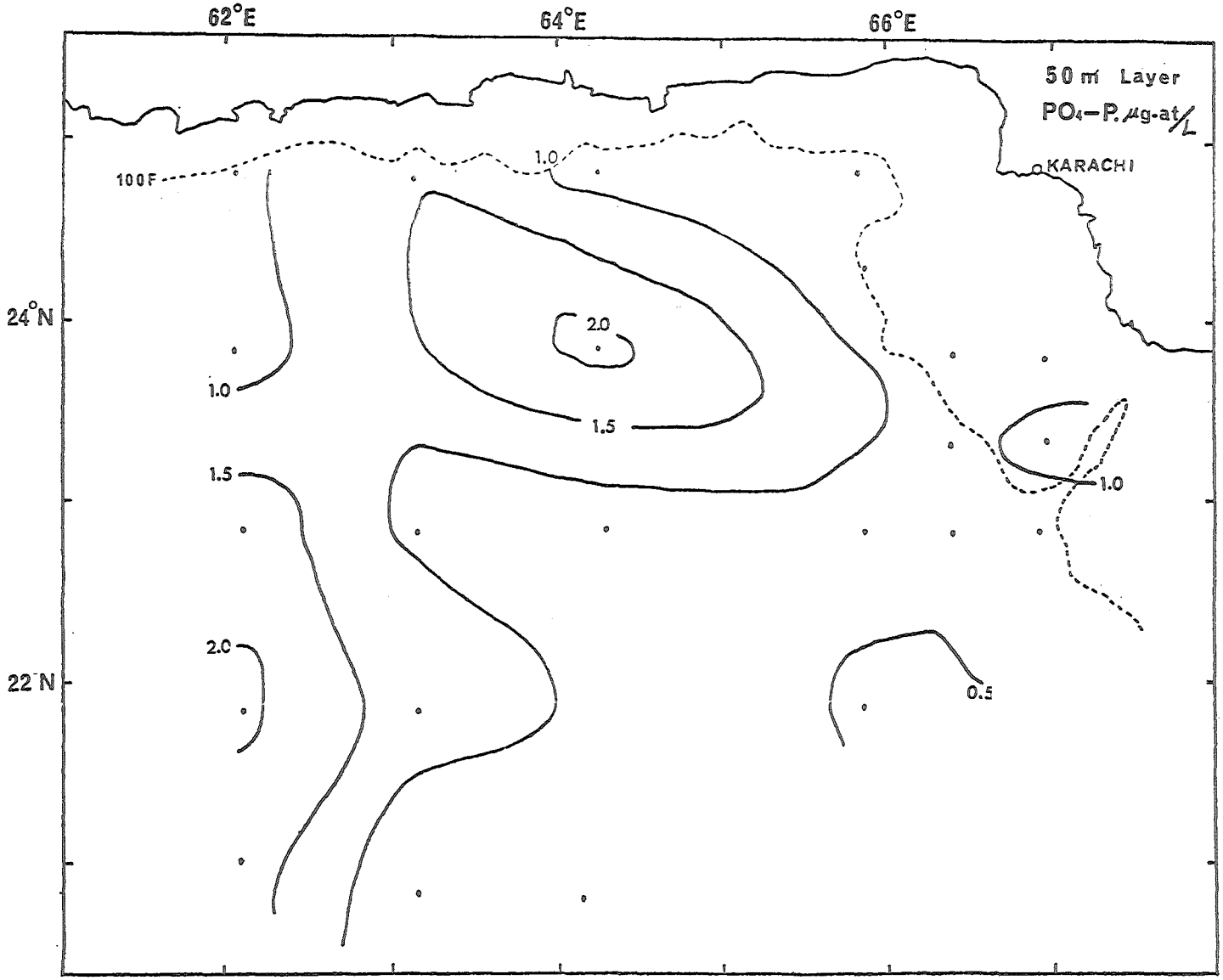


Figure 25. Horizontal distribution of content of Phosphate-P (ug-atom/L) at 50 m layer in the Second Area

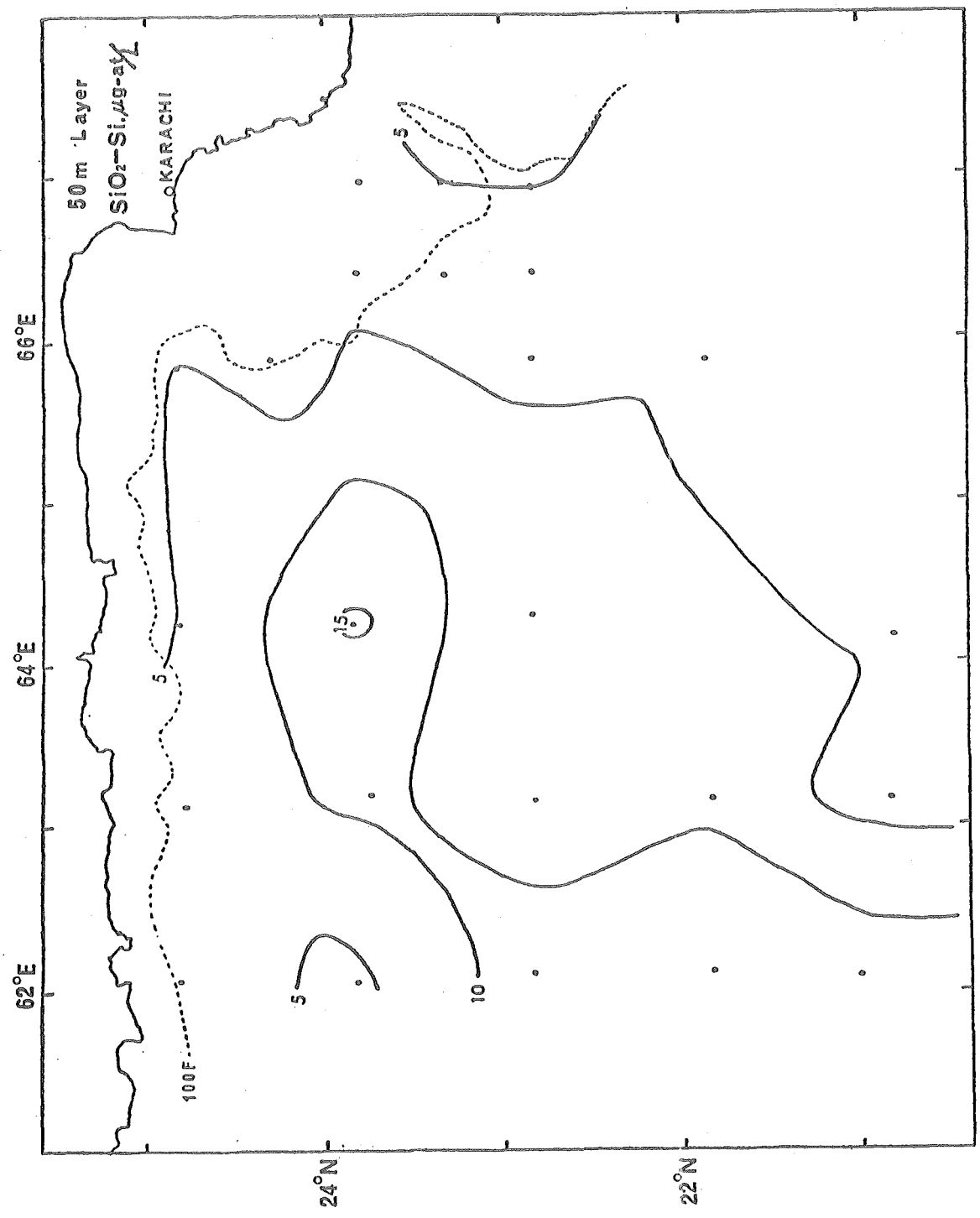


Figure 26. Horizontal distribution of content of Silicate-Si (µg-atom/L) at 50 m layer in the Second Area

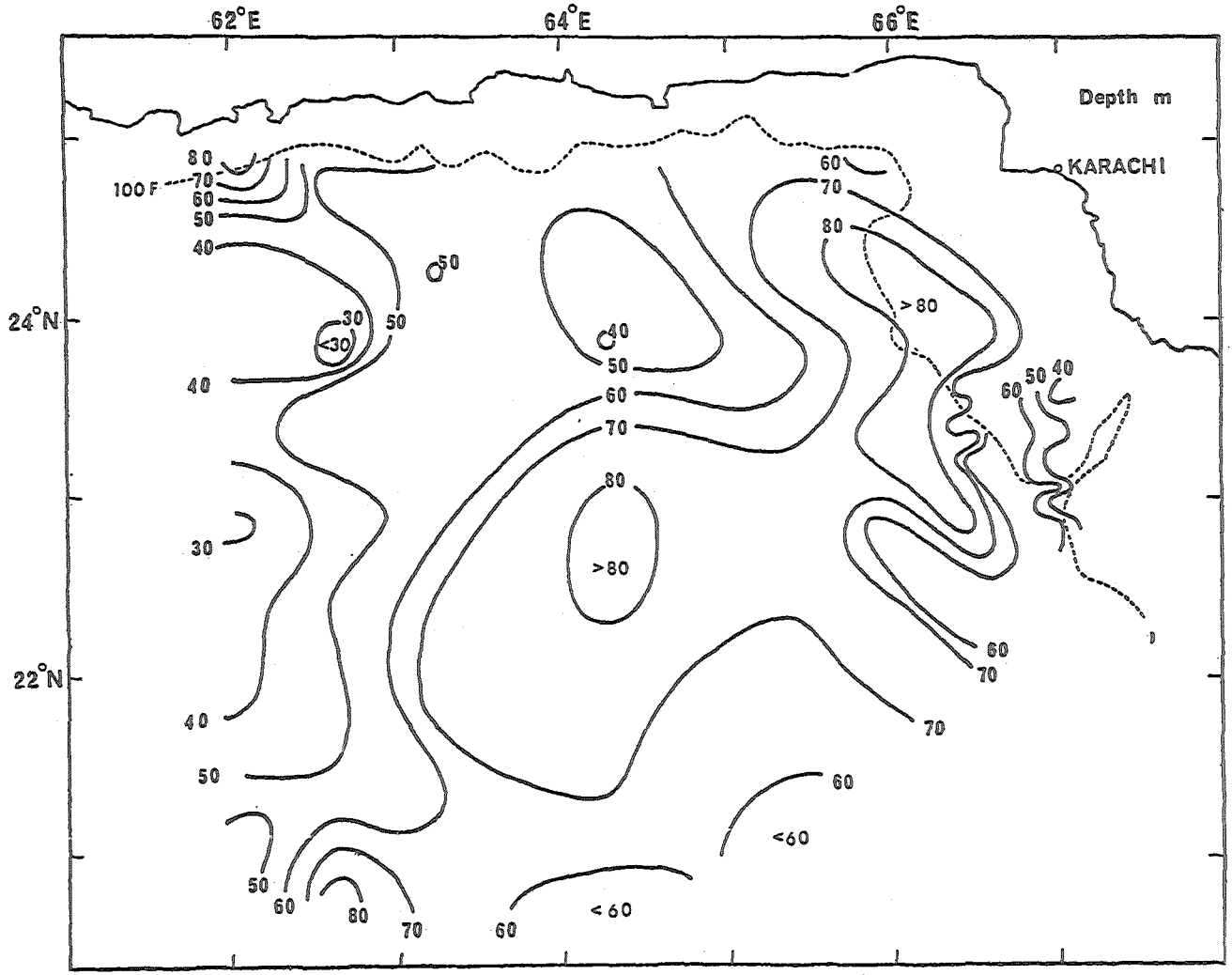


Figure 27. Horizontal distribution of depth of the mixed layer in the Second Area

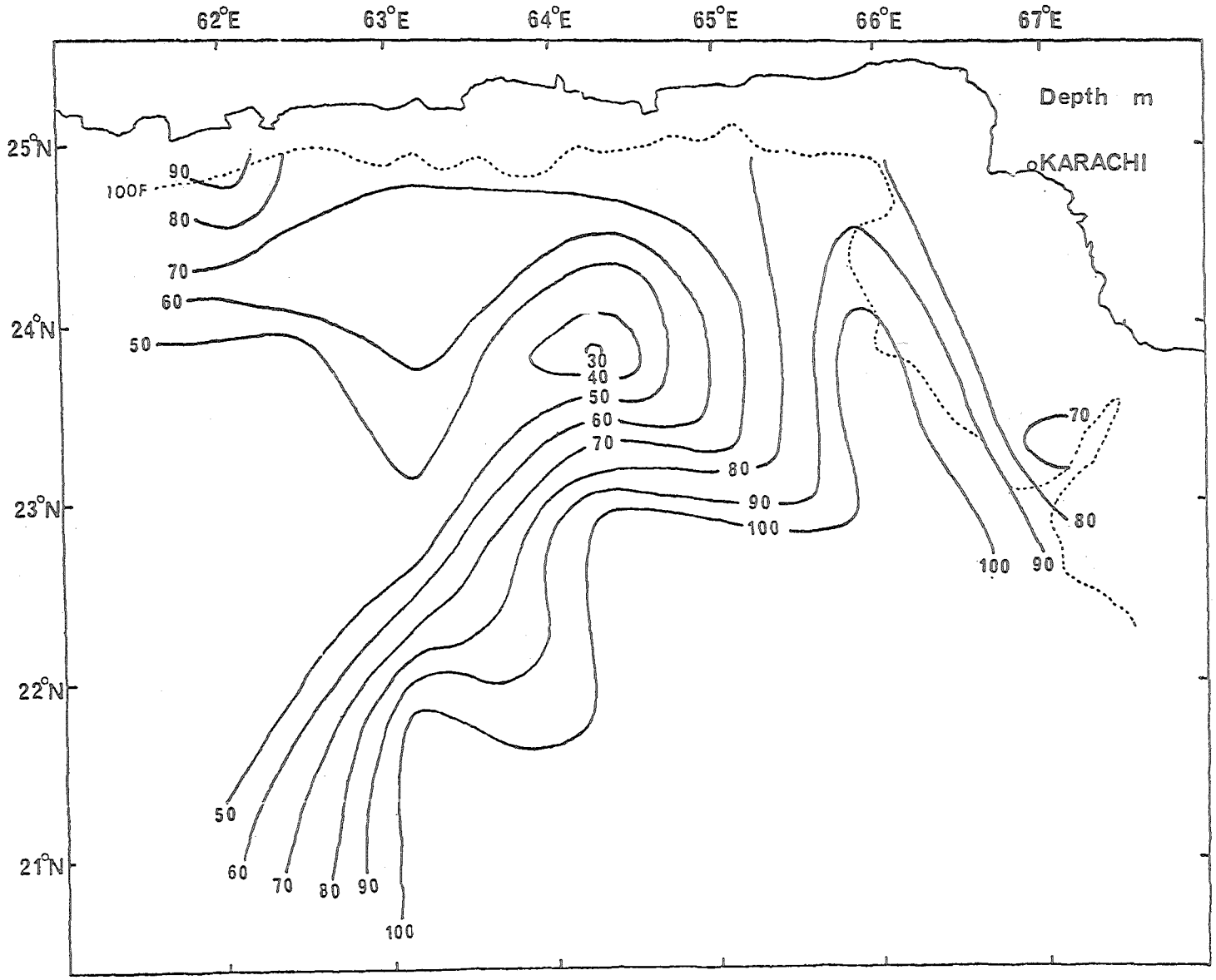


Figure 28. Horizontal distribution of depth of 1.0 ml/L content of dissolved oxygen in the Second Area

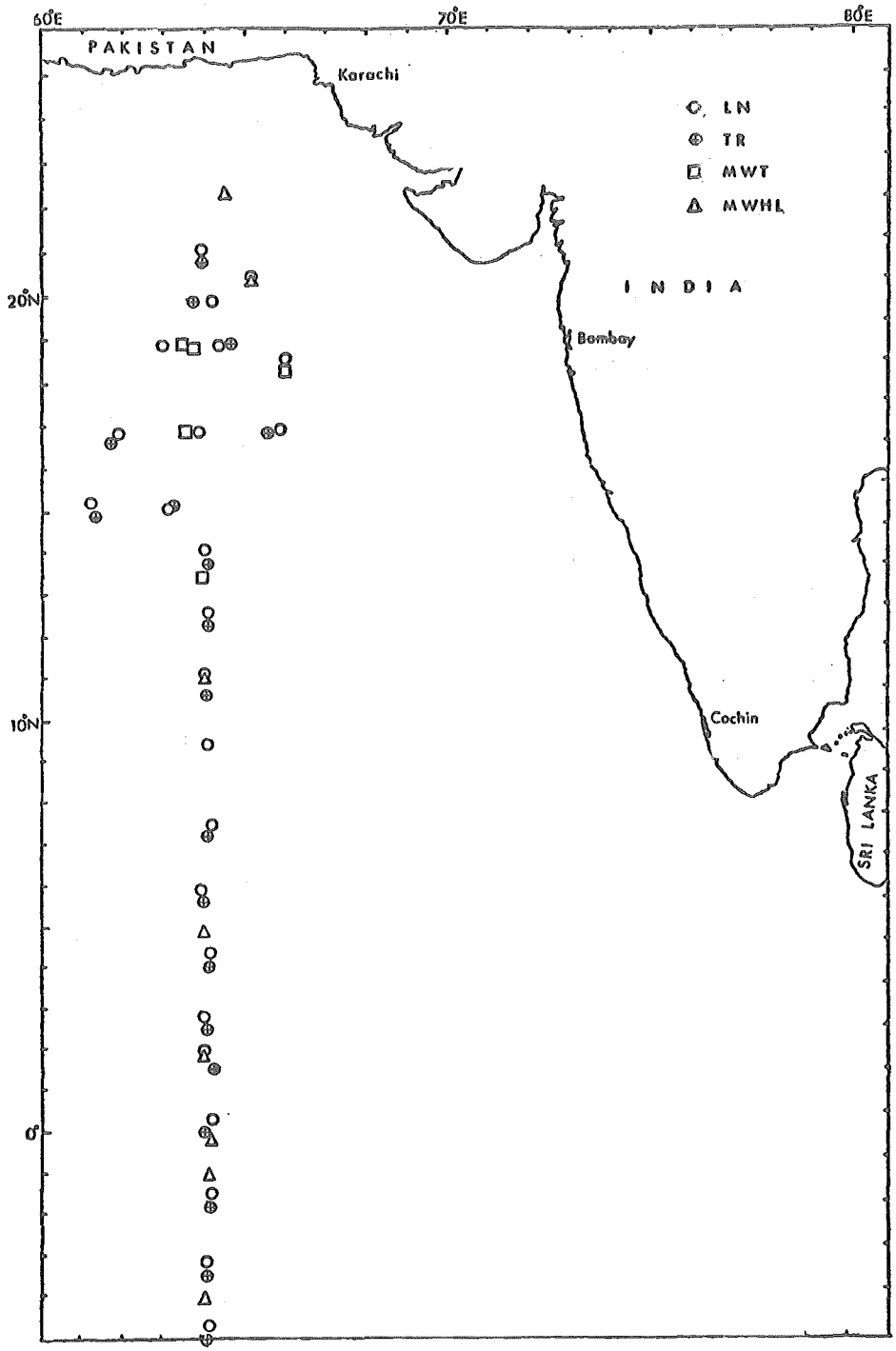


Figure 29. Biological survey stations in the First Area
LN: Larvae net; TR: Trolling; MWT: Midwater trawl; MWHL: Midwater handline

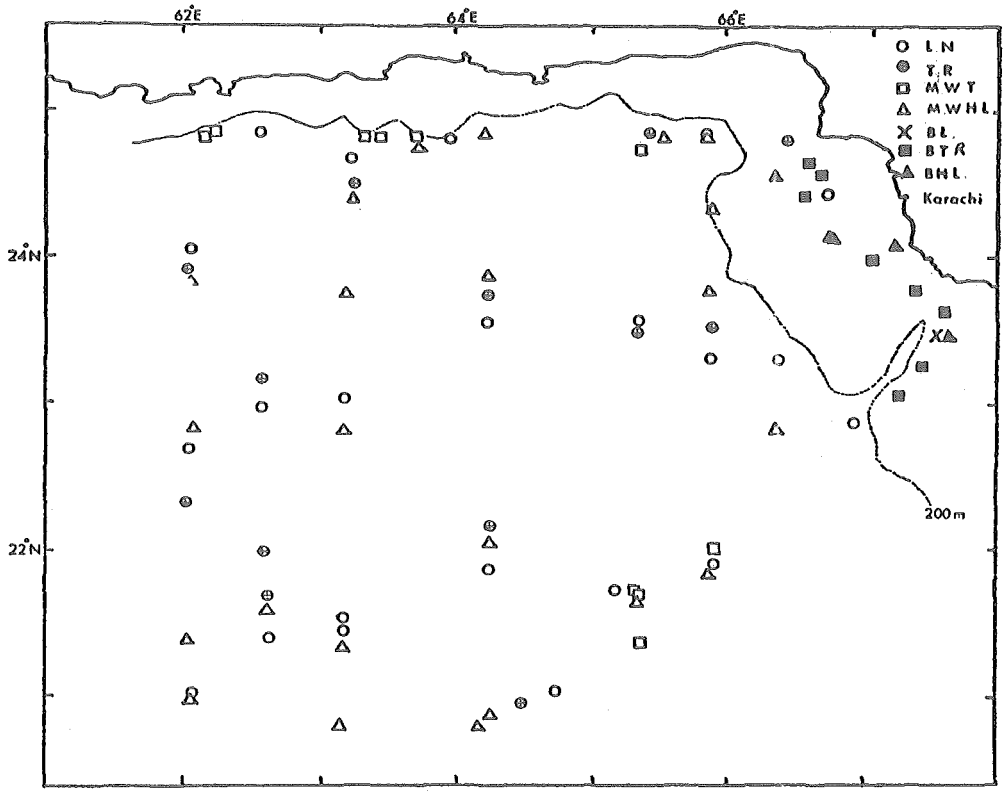


Figure 30. Biological survey stations in the Second Area
LN: Larva net; TR: trolling; MWT: Midwater trawl; MWHL: Midwater handline; BL: Bottom longline; BTR: Bottom trawl; BHL: Bottom handline

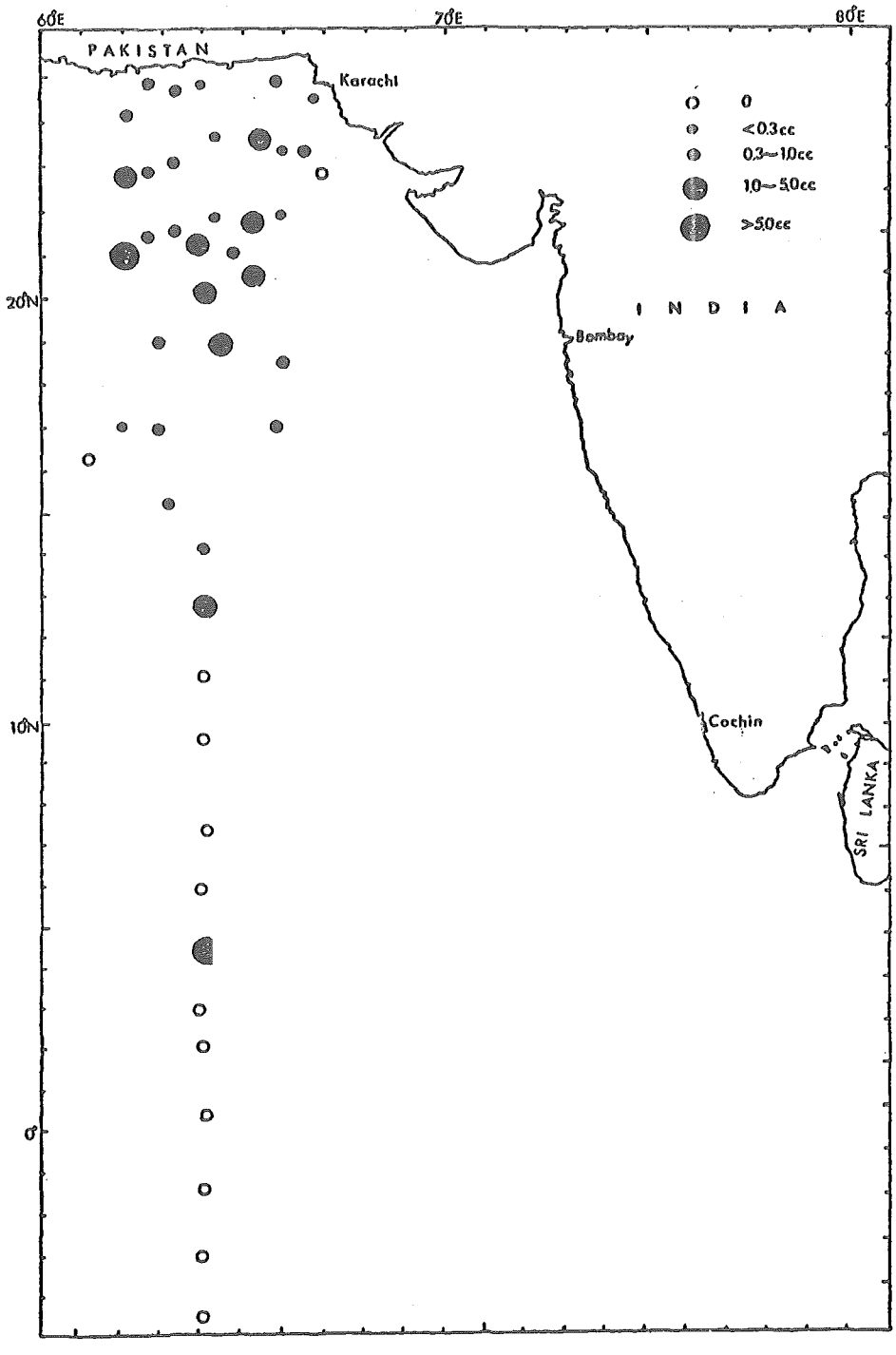


Figure 31. Distribution of oil balls collected by surface larvae net tows in the whole survey area

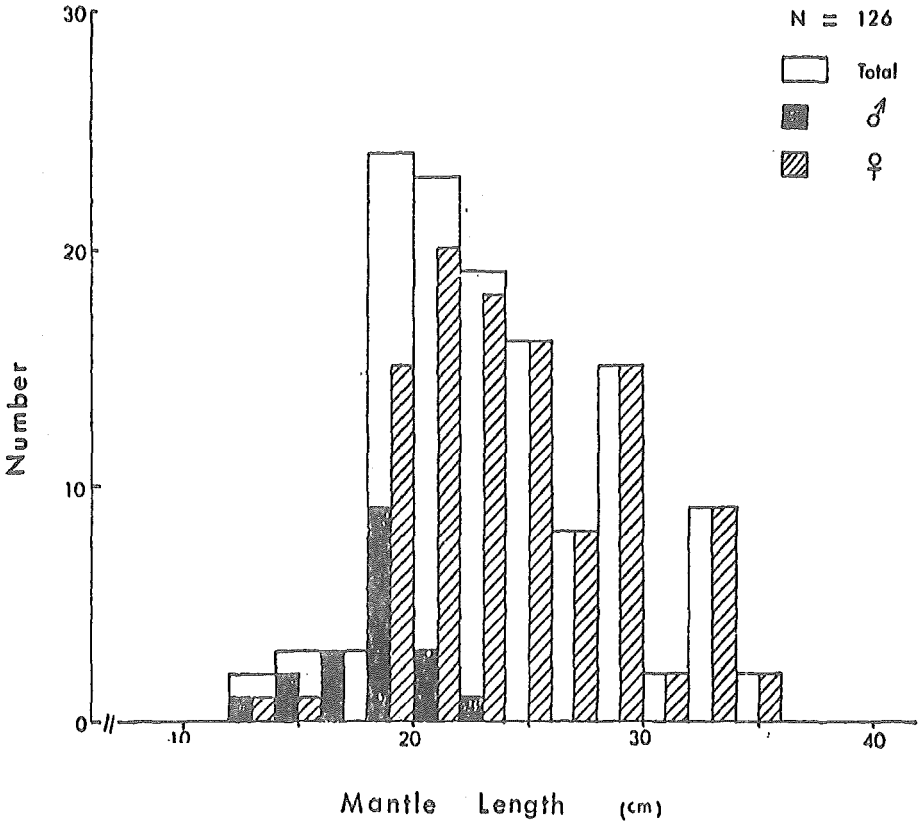


Figure 32. Mantle length composition of Symplectoteuthis oualaniensis by sex (whole survey area)

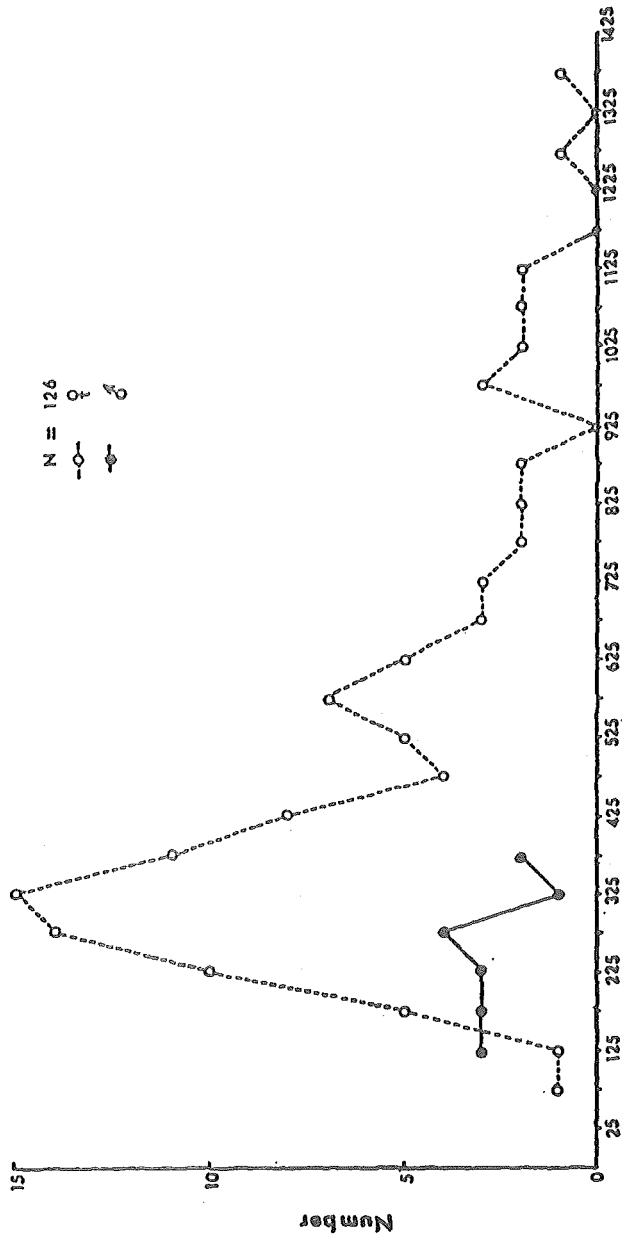


Figure 33. Body weight composition of Symplectoteuthis oualaniensis by sex (whole survey area)

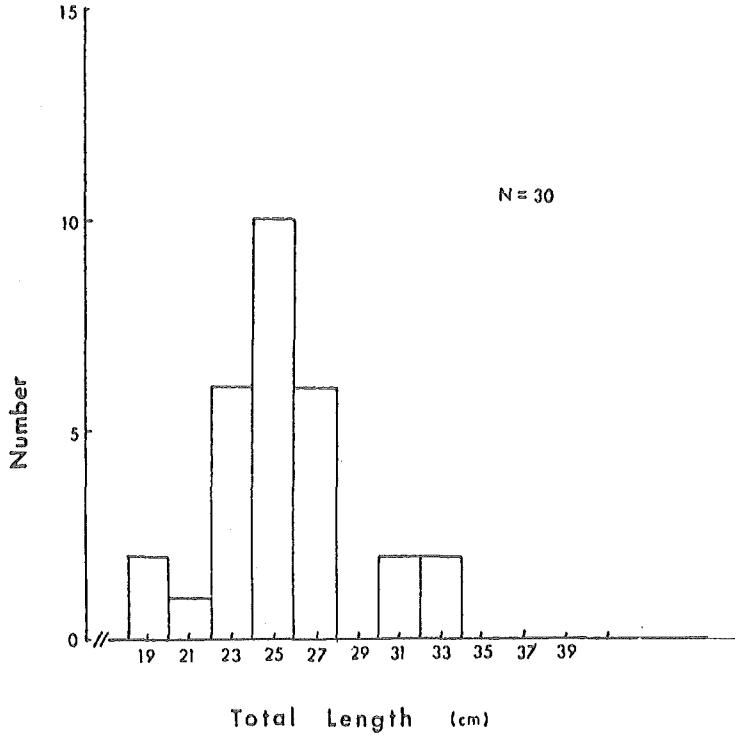


Figure 34. Length composition of Argyrops spinifer (BHL-3, 24°06'N, 66°51'E)

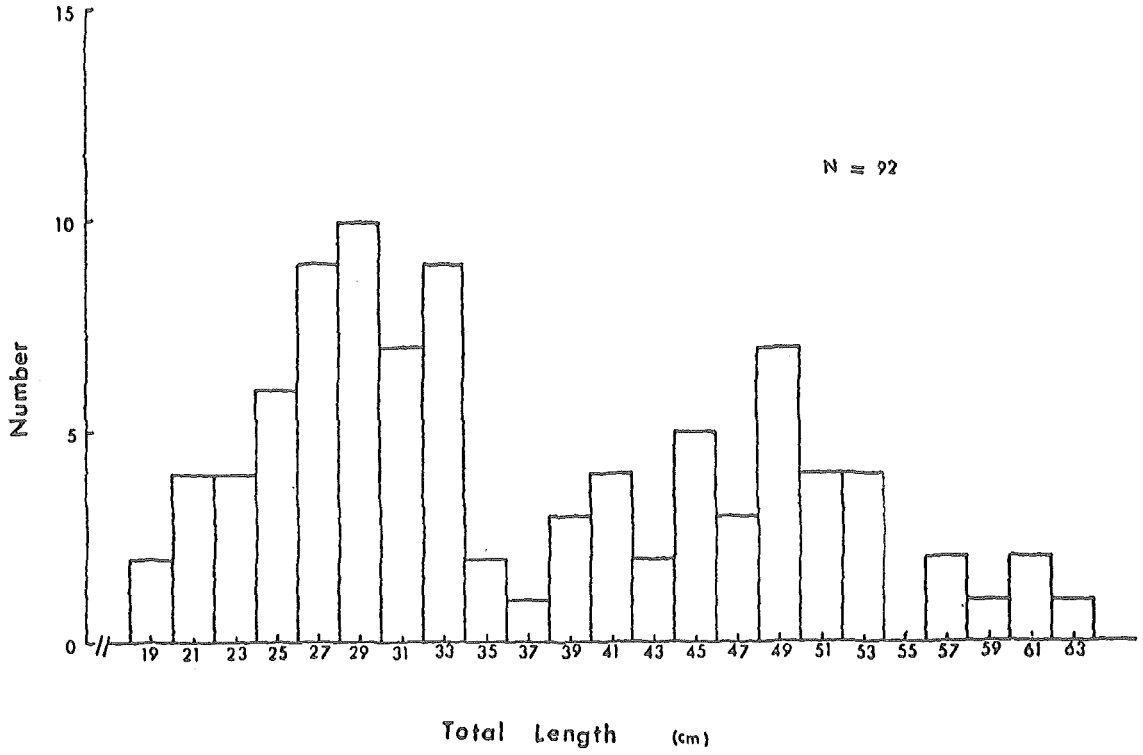


Figure 35. Length composition of Argyrops spinifer (BHL-4, 24°05'N, 66°48'E)

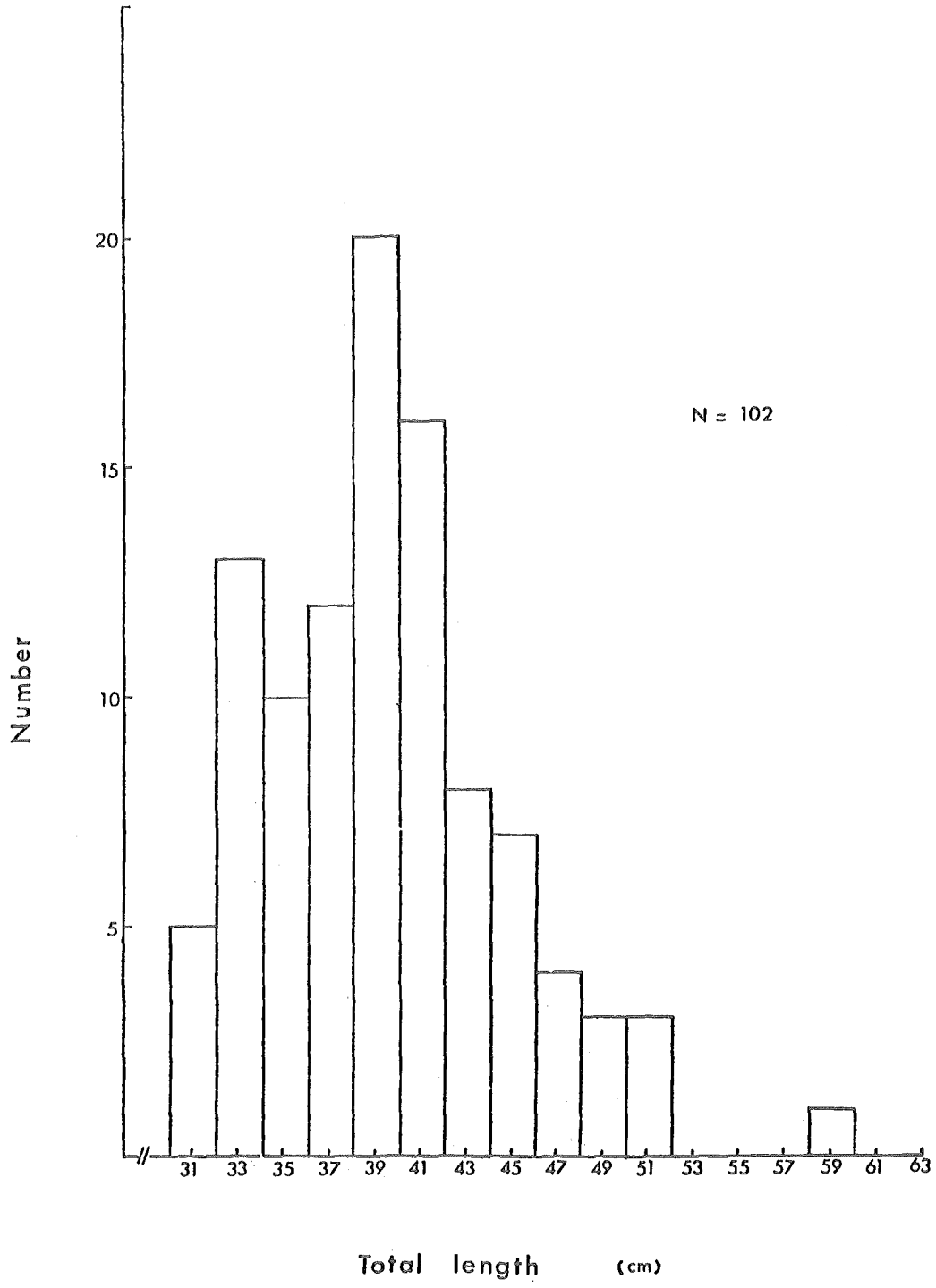


Figure 36. Length composition of Arius thalassinus (BHL-1, 23°28'N, 67°33'E)

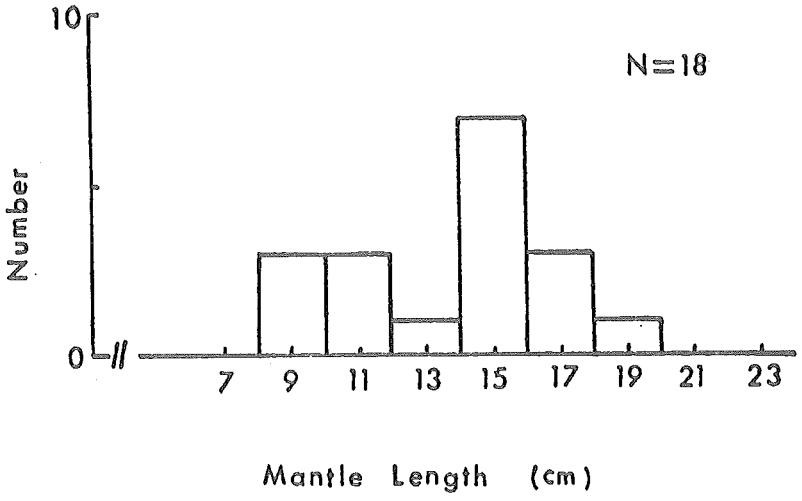


Figure 37. Mantle length composition of Loligo duvaucelii (BHL-1, 23°28'N, 67°33'E)

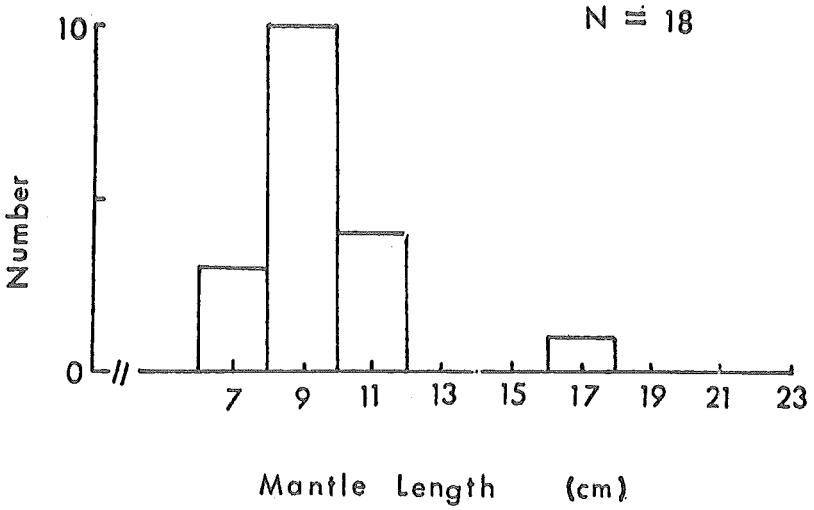


Figure 38. Mantle length composition of Loligo duvaucelii (BHL-2, 24°04'N, 67°13'E)

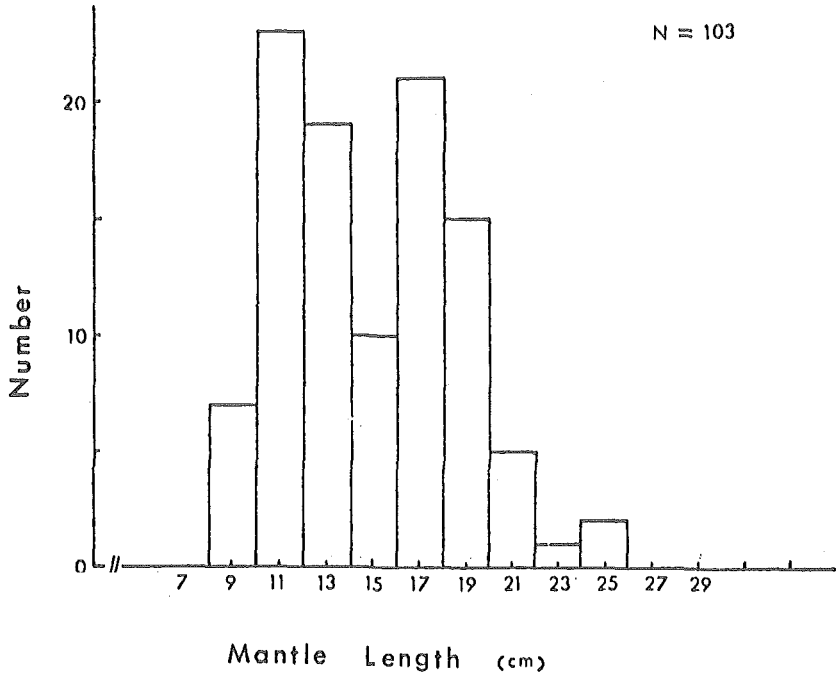


Figure 39. Mantle length composition of Loligo duvaucelii (BHL-6, near Karachi harbour)

H.R	14 φ	S.W.R
G.R	18 φ	C.P.R
L.L	18 φ	C.P.R
M.R	18 φ	C.P.R
W.L	18 φ	C.P.R

500 Mesh Mid-Water Trawl Net

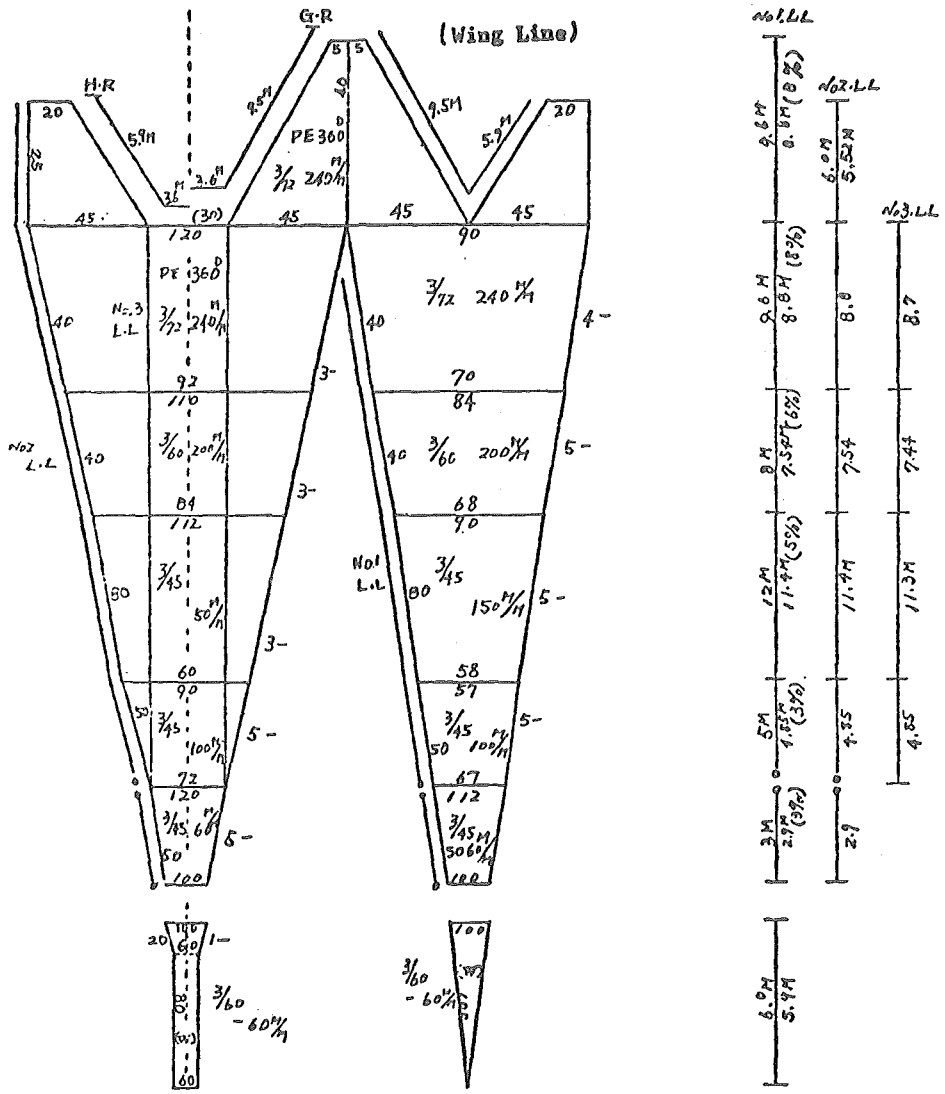


Figure 40. Specification of midwater trawl net onboard the R/V SHOYO MARU

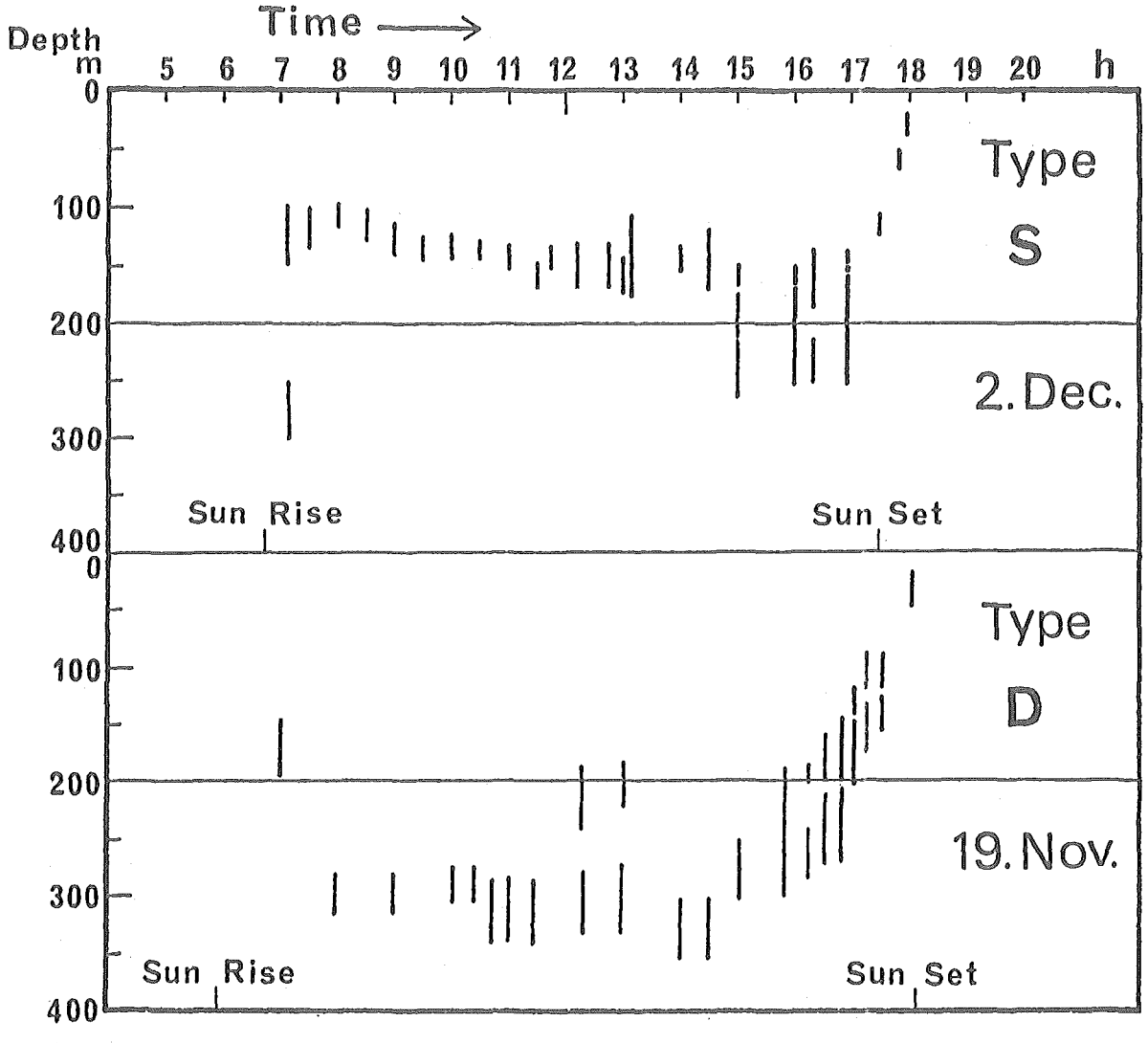


Figure 41. Schematic representation of diurnal changes of swimming layers estimated as squid

Type S .... Swimming layer in day-time is shallower than 200 m
Type D .... Swimming layer in day-time is deeper than 200 m

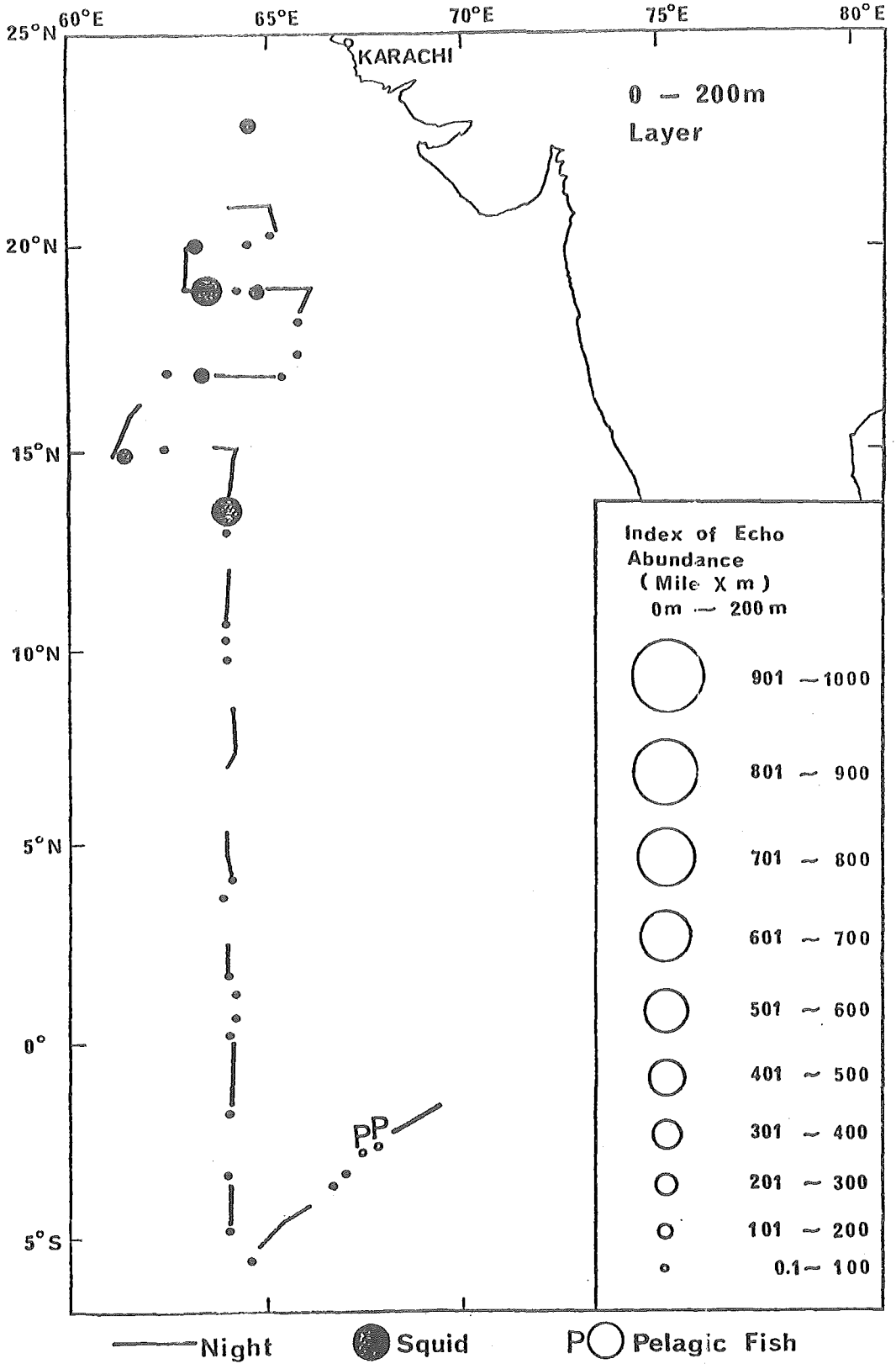


Figure 42. Diagrammatic representation of index of echo abundance per 30 nautical miles in the First Area in 1976.

Index of echo abundance was estimated only for schools that occurred above 200 m by 28 KHZ (the same for Figs. 43-45).

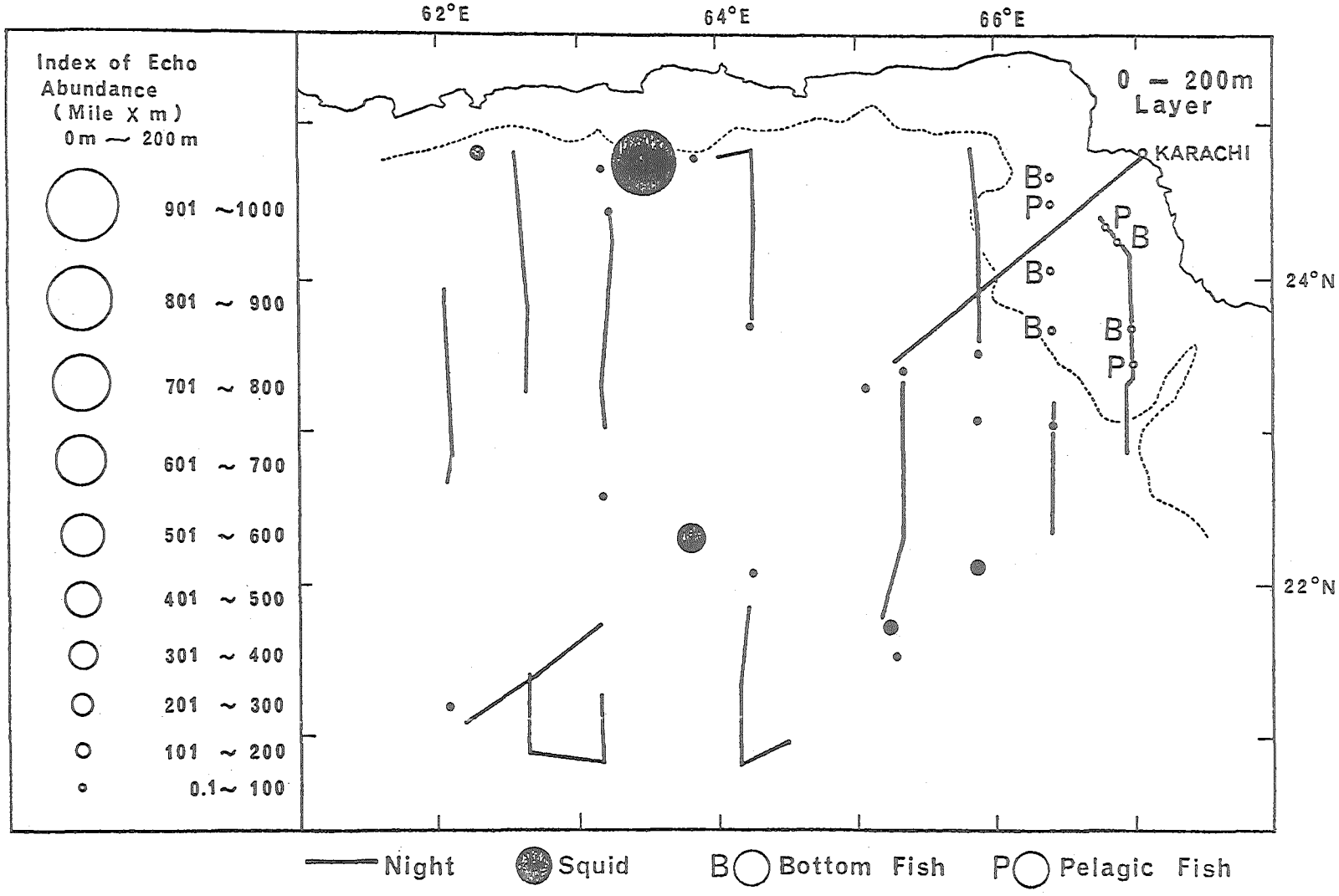


Figure 43. Diagrammatic representation of index of echo abundance per 30 nautical miles in the offshore waters of Pakistan in 1976

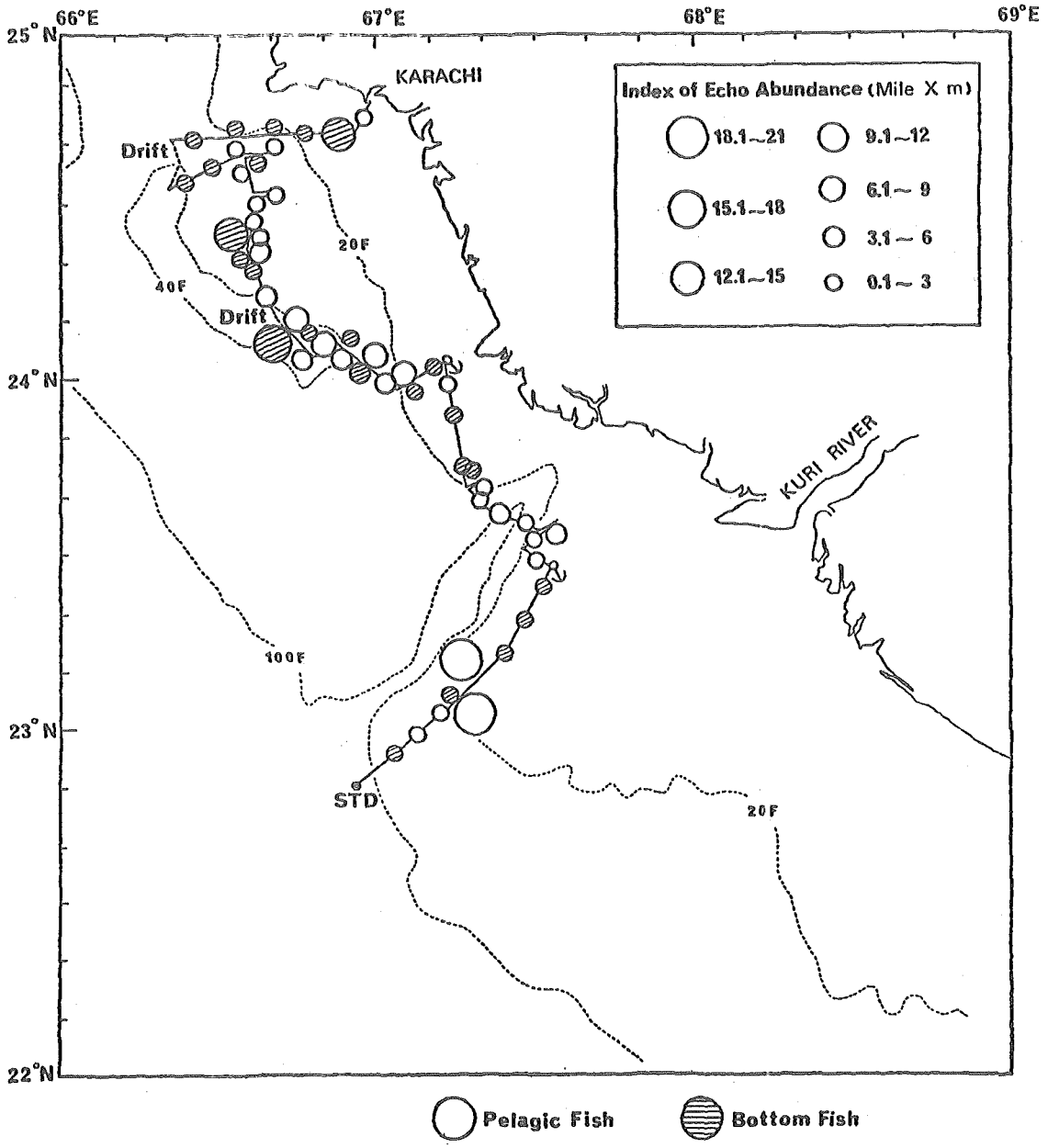


Figure 44. Diagrammatic representation of index of echo abundance per 5 nautical miles on echo survey line in the southern

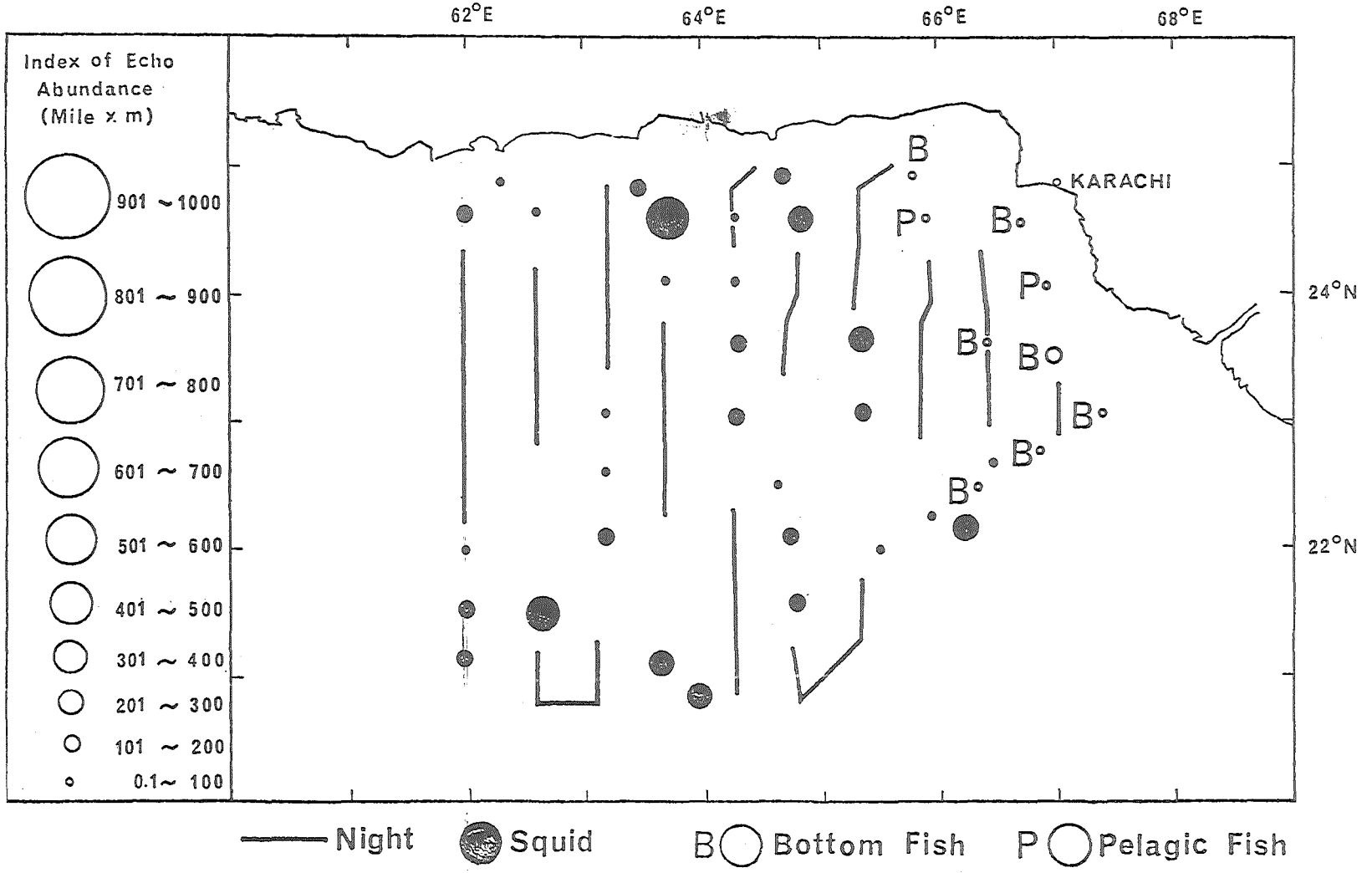
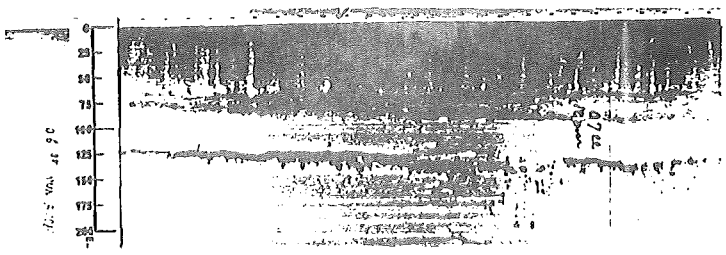
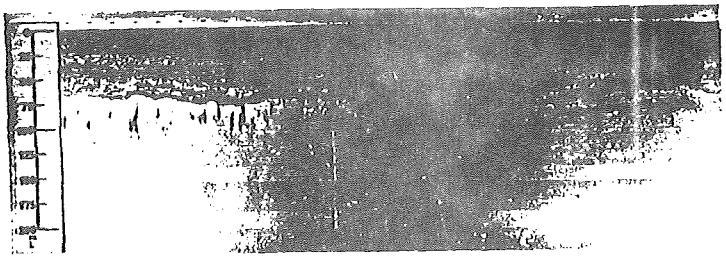


Figure 45. Revised diagrammatic representation of echo abundance per 30 nautical miles in the offshore waters of Pakistan in 1975

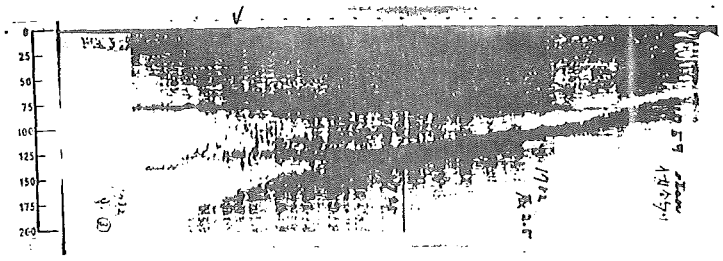
Plate I. Record of squid indicating sinking movement at the dawn and rising at sunset (28 KHz)



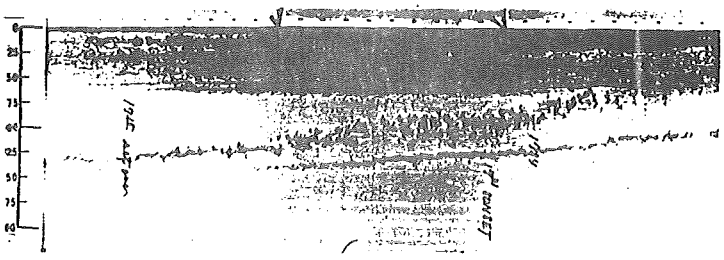
20°01'N, 63°56'E 07.30 (LMT), 19 November 1976



18°23'N, 65°57'E 18.30 (LMT), 17 November 1976

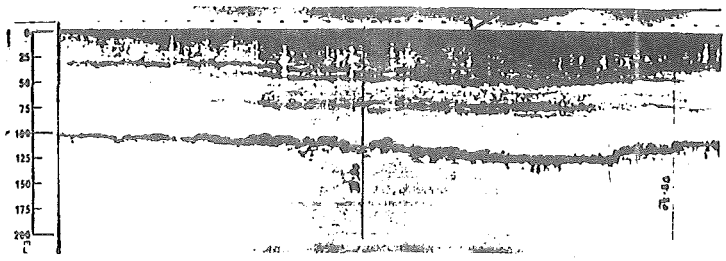


22°06'N, 64°14'E 17.45 (LMT), 3 December 1976

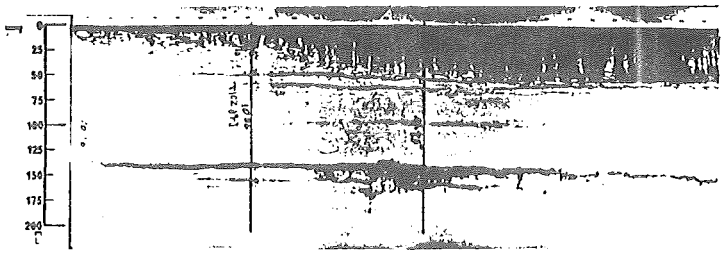


21 45'N, 65 19'E 17.35 (LMT), 4 December 1976

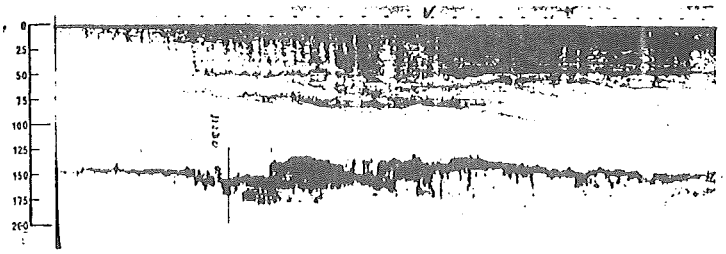
Plate II. Record of squid indicating shallow swimming layer in day-time, (28 KHz)



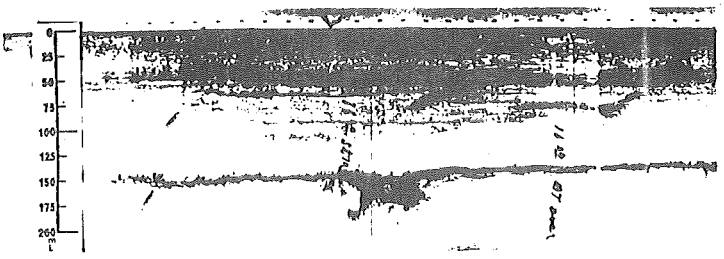
24°40'N, 63°13'E 08.15 (LMT), 2 December 1976



24°48'N, 63°26'E 10.45 (LMT), 2 December 1976

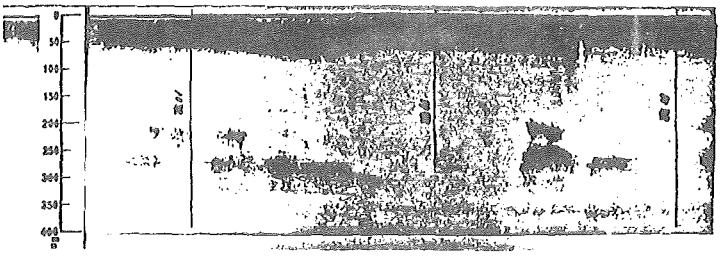


24°48'N, 63°08'E 11.45 (LMT), 2 December 1976

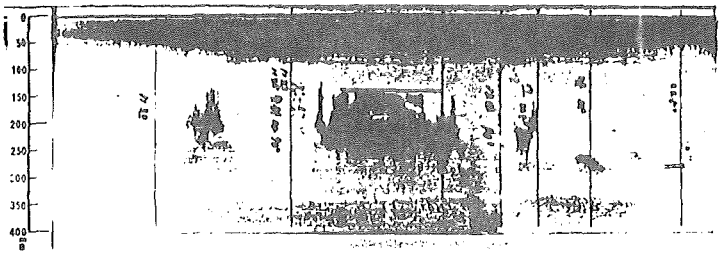


24°50'N, 63°42'E 16.30 (LMT), 2 December 1976

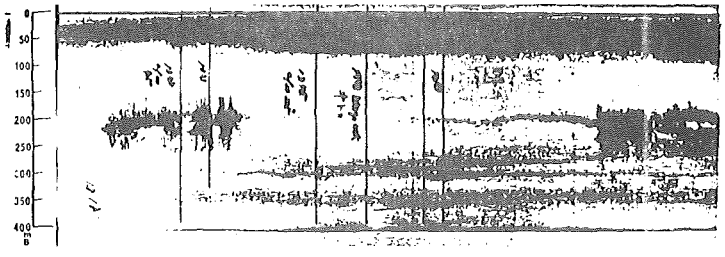
Plate III. Record of squid indicating deep swimming layer in day-time (50 KHz)



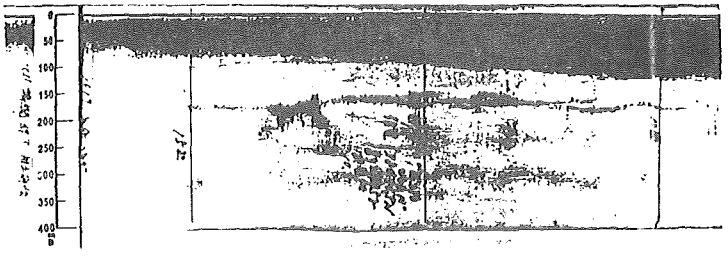
18°57'N, 63°59'E 11.00 (LMT), 18 November 1976



18°57'N, 63°43'E 12.17 (LMT), 18 November 1976



18°55'N, 63°37'E 14.00 (LMT), 18 November 1976



18°55'N, 63°36'E 15.00 (LMT), 18 November 1976

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3. Fisheries Development Possibilities in the Republic of Kenya. Labon, A., IOP/TECH/75/3.

4. A Report on the Building Up of a Statistical System for the Collection of Marine Fisheries Statistics in the United Arab Emirates. Banerji, S.K., IOP/TECH/75/4.

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6. Some developments in the Tuna Fisheries in the Indian Ocean. Kearney, R.E., IOP/TECH/75/6.

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12. The Sultanate of Oman Five Year Fisheries Development Plan. Labon, A., IOP/TECH/77/12 (not published).

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