INDIAN OCEAN FISHERY AND DEVELOPMENT PROGRAMME
PELAGIC FISH ASSESSMENT SURVEY NORTH ARABIAN SEA

Sub-contractor: Institute of Marine Research, Bergen

REPORT ON CRUISE No 4 OF
R/V »DR. FRIDTJOF NANSEN»

Bergen, April 1976.

INTRODUCTION

This report covers the fourth cruise of R/V "Dr. Fridtjof Nansen" to the North Arabian Sea. The cruise represents the third complete coverage of the survey area from Mogadisco to the border between India and Pakistan.

Departure:	Mombasa, 11 January 1976
Arrival:	Karachi, 1 April 1976
Ports of call:	Mogadisco, 16-17 January
	Aden, 1-3 February
	Djibouti, 12-14 February
	Muscat, 1-2 March
	Dubai, 9-13 March
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INSTRUMENTS AND METHODS

The instruments used and the methods applied were described in Report on cruise no. 1 and 2 of R/V "Dr. Fridtjof Nansen".

Survey grid, fishing stations and hydrographical stations are shown in Fig. 1 and 2. The density of the survey grid was varied according to the experiences from the previous cruises, so that those areas in which important resources had been located were best covered.

SURVEY RESULTS

The distribution of total integrated echo intensities is shown in Fig. 3, and Table 1 gives details of the fishing stations. The echo recordings were attributed to four categories of scatterers: small pelagic fish (Fig. 4), mesopelagic fish (Fig. 5), plankton and 0-group fish (Fig. 6) and demersal fish (Fig. 7).

Small pelagic fish

At the eastern coast of Somalia porcupine fish (Diodon) constituted the major part of the echo scatterers, with cardinal fish (Synagrops) ranging next. Between 2° and 5° N these species were abundant. White sardinella (Sardinella albella) and round herring (Etrumeus teres) were observed in small quantities south of El Arar, while other species of sardines and of horse mackerels (Carangidae) were only taken as single specimens. Length distributions of the white sardinella and of round herring are given in Fig. 8 and 9.

The integrated echo intensities were higher than on the previous cruises in the southern part of the area, and similar in the northern part. But recordings of sardines and horse mackerels were lower than on the previous cruises.

At the northern coast of Somalia pelagic fish contributed little to the recorded echo intensities. The most important species in the area were horse mackerels. Near Mait Island young bigeye shad (Selar crumenophthalmus) was recorded. A pelagic trawl station gave a catch rate of 120 kg/hour of this species. The length distribution in the catch is shown in Fig. 10. Other trawl stations yielded little pelagic fish.

A few schools of larger horse mackerels were observed at the surface near Ras Alula (Fig. 11).

The integrated echo intensities attributed to pelagic fish at the northern coast of Somalia were lower than those of cruise no 1, but slightly higher than those of cruise no 3.

Along the coast of Yemen the recordings of pelagic fish were generally better than off northern Somalia. The area between Ras al Ara and Aden was covered twice with 3-4 days interval (Fig. 12). During the first coverage good recordings of white sardinella (S. albella) were obtained. Most of the fish were ripening or nearly ripe, and a few were spawning. Length distribution is

shown in Fig. 8. During the second coverage of the area only small quantities of fish were found.

The integrated echo intensities in the area were similar to those of cruise no 1 but higher than those recorded on cruise no 3.

Between Ras al Kalb and Ras Fartak Indian oil-sardinella (Sardinella longiceps) were observed in a narrow zone close to the shore (Fig. 13, 14). The best recordings were made in waters shallower than 20-30 m. Near Zaghtal schools were counted in an area about 30 square nautical miles using the sonar. Approximately 300 schools were found to be present. Most of the schools were estimated to be less than 2 tons.

In the Mukkalla area the purse seiner "Dhab Dhab" operated, and got fairly good catches of Sardinella. Samples of some of these catches placed at our disposal by Mr. Willy Ellingsen contained only Indian oil-sardinella (S. longiceps). Both our catches and those of the purse seiner mainly consisted of immature and early maturing fish. Length distributions for some of the catches are shown in Fig. 15.

Both the first and the third cruise showed higher integrated echo intensities in this area than we found. But it should be noted that the surveys with "Dr. Fridtjof Nansen" do not cover the very shallow waters where the sardines sometimes prevail.

Between Ras Fartak and the Yemen-Oman border, there were locally good recordings and catches of crevalle (Alepes djeddaba). The length distribution of this species is shown in Fig. 16.

Other horse mackerel species (e.g. Trachurus sp., Decapterus spp. and Selar crumenophthalmus) were caught in smaller numbers along most of the Yemen coast. Anchovies were caught as single specimens only.

At the Oman coast good recordings of pelagic fish were obtained in the Gulf of Masira (Fig. 17). In this shallow water area schools of Indian oil-sardinella (S. longiceps), white sardinella (S. albella), and round herring (Etrumeus teres) were abundant. The size of the schools were up to 20 tons. The Indian oil sardinella were immature, while the white sardinella and the round herring were ripening or nearly ripe. The length distributions from the area are shown in Fig. 8, 9 and 15. Several species of horse mackerels and Spanish mackerel (Scomberomorus sp.) were also caught. Counting of schools by the sonar was impossible due to rough bottom.

The integrated echo intensities from this area were similar to those obtained during cruise no 3, and significantly higher than those of cruise no 2.

At the south coast of Iran, little pelagic fish were recorded although some species of horse mackerels were taken at fishing stations. Integrated echo intensities from this area were low also on the previous cruises.

At the coast of Pakistan relatively good recordings of pelagic fish were made, especially in Sonmiani Bay and at Kori Great Bank (Fig. 18). The most important species were rainbow sardine (Dussumieria acuta), orangemouth thryssa (Thryssa vitrirostris), and buccaneer anchovy (Stolophorus buccaneeri). Some sardinella species (Sardinella spp.), scad (Decapterus dayi), and djeddaba crevalle (Alepes djeddaba) were also caught in fairly large numbers. Various scombroid species were caught in small quantities.

The horse mackerels and the buccaneer anchovy were immature, while the other species were in various stages of ripening. Length distributions are shown in Fig. 16, 19, 20 and 21.

Most of the fish were recorded in shallow waters (10-30 m), where they formed schools estimated to contain up to 20 tons.

The integrated echo intensities from the area were slightly lower than on cruise no 2, but higher than those of cruise no 3.

Mesopelagic fish

In the whole area, off the shelf, one or more deep scattering layers (DSL) were observed (Fig. 5). Off Somalia a single layer was found, and there was no school formation. In the Gulf of Aden and the Gulf of Oman there were diffuse layers at 250-350 m depth, and a denser layer, often with schools, between 150 and 200 m. Off the coast of Pakistan the lower layer was fairly constant, while the shallow layer occurred more sporadically.

At night the layers migrated towards the surface.

Catches from the DSL usually contained lanternfish (Myctophidae), and in most of the area Benthosema pterotum was the dominating species. Gonostomiatidae, Sternoptychidae, Astronesthidae and Chauliodus spp. were often fairly abundant in the deepest DSL. In a small area near the Kuria Muria Islands Champsodon sp. was the most abundant mesopelagic fish. Length distribution of some important species are shown in Fig. 22.

The best concentrations of mesopelagic fish were often found in a narrow zone along the continental slopes, and in such concentrations catch rates up to 10 tons/hour were obtained. This could probably be much higher if a more suitable trawl were available.

In the Gulf of Oman and off the coast of Pakistan special studies of diurnal vertical migration and its influence on echo intensity were carried out. The results indicated that the variation in integrated echo intensity was small, although parts of the fish may rise above the transducer level at night especially at new moon. Off the Pakistan coast all deck lights were put on for 4 hours during night. This experiment, which was carried out twice, showed that lanternfish (Benthosema pterotum) and krill were accumulated in the light zone.

At the eastern coast of Somalia integrated echo intensities were similar to those of cruise no 3 and slightly lower than on cruise no 1. In the

Gulf of Aden the echo intensities were lower, and in the Gulf of Oman much lower than on cruise no 1 and 2. Compared to cruise no 3 the values from Gulf of Aden were similar and those from the Gulf of Oman were higher. At the Pakistan coast the echo intensities were lower than those of cruise no 2 and much higher than those of cruise no 3.

Demersal fish

Fig. 7 shows the distribution of echo intensities attributed to demersal fish. The relation between echo abundance attributed to demersal fish and quantity of such fish taken in bottom trawl was poor, and the figure will therefore probably give an inadequate picture of the fish distribution.

At the coast of Somalia the best bottom trawl hauls gave catch rates between 800 and 1 000 kg/hour. The most important food fishes in the area were snappers (Lutjanus spp.), scavengers (Lethrinus spp) and goatfishes (mainly Parupeneus spp.).

At the coast of Yemen two bottom trawl hauls in deep water (250-350m) gave catch rates about 3 tons/hour. The dominating species in the catches was Psenes sp. Near Mukkalla catch rate 4 tons/hour was obtained, with goatfish (Upeneus sulphureus) and ponyfish (Leiognathus bindus) as the most important species. Sweetlips (Plectorhynchus spp.), scavengers (Lethrinus spp.) and groupers (Aethaloperca sp.) were taken in small quantities.

In the Gulf of Masira demersal fish were rather abundant. The highest catch rate from the area was 20 tons/hour. Dominating species were catfish (Arius sp.) and large rays. The mean size of the catfish was 0.7 kg.

In the Gulf of Oman demersal fish were sparce.

At the coast of Pakistan demersal fish were more abundant, and catch rates up to 7 ton/hour were obtained. Important species were grunts (Pomadasys spp.), croakers (Sciaenidae), threadfin breams (Nemipterus spp.), and largehead hairtail (Trichiurus lepturus). Mean sizes for these groups were 1.7 kg, 0.1 kg, 0.06 kg and 0.2 kg respectively.

In most of the survey area small sharks were rather abundant, and at all longline fishing stations these formed the dominant part of the catch.

Plankton and 0-group fish

The highest echo intensities attributed to plankton were recorded off the east coast of Somalia (Fig. 6). The most important target in the area was swimming crab (Charybdis edwardsi), which also dominated in several trawl catches (Table 1). In the Gulf of Aden echo intensities from plankton were generally lower. Mantis prawn (Oratosquilla investigatoris) was the most important scatterer.

At the coasts of Oman, Iran and Pakistan the plankton consentrations were relatively low, and it consisted mainly of organisms too small to be caught in the trawl.

Except for 0-group horse mackerels (size approximately 4-8 cm) which were common at the coast of Pakistan, 0-group fish were seldom caught, and they probably contributed little to the echo recordings.

Off the coast of Somalia south of Ras Hafun the integrated echo intensities were generally higher than on the previous cruises. At the coast of Pakistan they were lower than on cruise no 2, but higher than those of cruise no 3. In the remaining area the echo intensities were mostly lower than on the previous cruises.

Surface observations

Fig. 11 shows the surface observations made. During most of the cruise the wind made the observing difficult, and the map may, therefore, not give an adequate picture of the distribution of the organisms involved.

Dolphins were frequently observed, often in schools with 10-100 specimens or more. Larger whales were seldom observed, and turtles only once.

Fish schools, usually consisting of horse mackerels or sardines, were observed several times in the Gulf of Aden, in the Gulf of Masira, and at the coast of Pakistan.

Sea snakes were observed in the Gulf of Oman and at the coast of Pakistan. All observations were from the area near the shore.

Hydrography

Fig. 23, 24 and 25 show the horizontal distribution of temperature, salinity and oxygen at 10 m depth. The lowest temperatures and the highest salinities were found in the Gulf of Oman. In the remaining area the variations were small. Fig. 26-30 show how the same parameters vary with depth. In most of the area the water masses were homogenous in the upper 75 m. The temperatures, salinities and oxygen contents in these masses were 22-26° C, 35.5-36.8 °/oo, and 4.5-5.5 ml/l. The parameters decreased with depth except in the Gulf of Aden and in the Gulf of Oman where intermediate maxima were observed in 200-500 m and in 100-250 m respectively. These maxima were due to outflow from the Red Sea and the Persian Gulf. At depths below 200 m the oxygen contents was below 1 ml/l and in large areas even below 0.5 ml/l.

Fig. 28 indicates tendencies of upwelling off Ras Fartak. It seems to be more pronounced than observed on cruise no 1, but much less than on cruise no 3.

Generally the hydrographical conditions were comparable to those observed during cruise no 1 and 2, and except for the effects of upwelling, also to those found during cruise no 3.

Table 1. R/V "Dr. Fridtjof Nansen". Record of fishing operations. BTR: bottom trawl, LPT: large pelagic trawl, SPT: small pelagic trawl, DTR: bottom trawl towed pelagic, PSE: purse seine, FDN: floating driftnet, BLL: bottom long line, FLL: floating long line. Fish names: FAO Species Identification Sheets for Fishery Purposes.

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position South North	East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
						South:				
14/1	0200	257	SPT	2000	1000	01° 03'	42° 32'	11	11	Meso- and bathypelagic fish.
						North				
15/1	1613	258	SPT	200	15-110	00° 58'	43° 56'	44	88	Swimming crab Charybdis edwardsi (34)
18/1	0930	259	SPT	180	25	02° 06'	45° 40'	17	68	Swimming crab C. edwardsi (17)
18/1	1035	260	BTR	178	178	02° 07'	45° 41'	69	69	Porcupine fish Diodon sp (32) Swimming crab C. edwardsi (31)
18/1	2047	261	SPT	210	100-90	02° 40'	46° 25'	2500	5000	Cardinal fish Synagrops adeni (2500)
19/1	0940	262	SPT	120	100-75	03° 38'	47° 30'	0		
19/1	1715	263	BTR	33-36	33-36	04° 22'	47° 56'	17,5	35	White sardinella Sardinella albella (8), Round herring Etrumeus teres (3.6)
19/1	1945	264	BTR	136	136	04° 20'	48° 03'	0		
20/1	1352	265	SPT	2000	250	04° 19'	49° 00'	2	4	Lantern fish MYCTOPHIDAE (1)
21/1	0430	266	SPT	128	80	05° 57'	49° 04'	3,5	7	Swimming crab C. edwardsi
21/1	1715	267	BTR	45	45	07° 35'	49° 52'	480	960	Snappers Lutjanus spp. (88), Goatfish Parupeneus spp. (37), Scavengers Lethrinus spp. (21)
22/1	1910	268	SPT	220	35-45	09° 27'	51° 01'	1000	2000	Porcupine fish Diodon sp. (1000)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position South North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
23/1	0755	269	BTR	35	35	10° 39'	51° 18'	432	846	Red snapper Lutjanus gibus (22) Scavengers Lethrinus sp. (21) Reys (100)
23/1	1615	270	SPT	-	0-20	11° 21'	51° 36'	4,5	9	Porcupine fish Diodon sp. (4.5)
24/1	0225	271	SPT	435	70-27	11° 53'	51° 39'	12	24	Swimming crab C. edwardsi (9)
25/1	0535	272	BTR	61-66	61-66	11° 33'	51° 22'	8,7	17	Blacksaddle goatfish Parupeneus fraterculus (3.5), Groupers Epinephelus sp. (4)
25/1	2030	273	SPT	450	80	12° 04'	50° 47'	25	50	Lantern fish MYCTOPHIDAE (10), Swimming crab C. edwardsi (7)
26/1	1350	274	SPT	527	240-260	11° 25'	48° 35'	10	20	Meso- and bathypelagic fish
26/1	1640	275	SPT	500	10-15	11° 18'	48° 10'	71,5	143	Bigeye scad Selar crumenophthalmus (61)
27/1	0150	276	SPT	2000	370	11° 17'	47° 09'	27	54	Squids (11)
27/1	1820	277	Gillnet	35	35	10° 52'	45° 54'	0	-	
28/1	0608	278	BTR	40-35	40-35	10° 55'	45° 52'	337	595	Groupers Epinephelus spp. (67), Surgeonfish Acanthurus sp. (43), Snappers Lutjanus spp. (30), Scavengers Lethrinus spp. (27)
28/1	1410	279	SPT	800	125-115	10° 34'	45° 00'	18,3	36	Lantern fish Benthosema pterotum (17)
29/1	1718	280	SPT	267	80-100	12° 28'	43° 32'	7	14	Lantern fish B. pterotum (7)
30/1	1820	281	SPT	35	12-30	12° 40'	44° 47'	300	720	Sardinella spp. (250)
31/1	0200	282	SPT	170	85	12° 24'	44° 18'	410	820	Lantern fish B. pterotum (405)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position South North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
4/2	1400	283	PSE	33		12° 57'	45° 18'	1600	-	White sardinella Sardinella albella (1500)
5/2	0505	284	SPT	360-210	30-40	13° 23'	46° 56'	8,5	17	Mantis prawn Oratosquilla investigatoris (5,2)
5/2	0808	285	BTR	50-56	50-56	13° 28'	47° 15'	0	-	
5/2	1055	286	BTR	51-58	51-58	13° 35'	47° 28'	26,3	36	Longface emperor Lethrinus miniatus (9.8), Grouper Epinephelus sp. (6.4)
5/2	1750	287	SPT	240-175	10-20	13° 50'	47° 57'	400	800	Mantis prawn O. investigatoris (386)
7/2	0815	288	SPT	2050	300	13° 41'	50° 02'	15	20	Lanternfish Diaphus spp. (5)
8/2	1411	289	BTR	313-338	313-338	14° 25'	49° 12'	1500	1500	Psenes sp. (1400)
8/2	1905	290	BTR	17	17	14° 40'	49° 30'	770	1540	Indian oil sardin Sardinella longiceps (171), Orangefin ponyfish Leiognathus bindus (414)
9/2	1108	291	BTR	32-29	32-29	14° 00'	48° 02'	13	26	Indian oil sardin S. longiceps (4.5)
9/2	1640	292	Traps	30	30	14° 03'	48° 44'	0		
10/2	0710	293	BTR	263-268	263-268	14° 05'	48° 50'	1400	2800	Psenes sp. (1009), Greeneye Chlorophthalmus sp. (117)
10/2	1230	294	BTR	489-515	489-515	13° 50'	48° 35'	250	1000	Atractophorus armatus (?) (148), Sting ray Dasyatis sp. (40)
10/2	1650	295	SPT	320	20	13° 48'	47° 59'	50	100	Lanternfish Benthosema pterotum (26)
15/2	0700	296	SPT	2000	175-200	11° 41'	46° 44'	45	90	Lanternfish B. pterotum (45)
17/2	0127	297	SPT	1900	55	12° 53'	53° 19'	186	372	Lanternfish Diaphus spp.
18/2	1240	298	SPT	150-172	5-20	14° 56'	50° 59'	3.6	7	Swimming crab Charybdis edwardsi (2.8)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
18/2	1905	299	BTR	33-45	33-45	14° 57'	50° 22'	428	856	Painted sweetlip Plectorhynchus pictus (100), Emperor Lethrinus nebulosus (100)
19/2	0002	300	BTR	17-14	17-14	14° 46'	49° 49'	452	452	Grouper Aethaloperca sp. (178),
19/2	0945	301	SPT	31-40	10	14° 44'	49° 38'	100	133	Mantis prawn Orathosquilla investigatoris (100)
19/2	1240	302	BTR	36-43	36-43	14° 45'	49° 43'	2000	4000	Yellow goatfish Upeneus sulphureus (800), Orangefin ponyfish Leiognathus bindus (550)
19/2	1750	303	BTR	130-114	130-114	14° 45'	50° 02'	0		
20/2	0534	304	SPT	125	85-100	15° 09'	51° 38'	104	208	Squids (100)
20/2	1530	305	BTR	17-15	17-15	16° 01'	52° 15'	250	500	Orangefin ponyfish Leiognathus bindus (133), Pugnose ponyfish Secutor insidiator (66)
20/2	1825	306	SPT	34	19	16° 10'	52° 20'	93	280	Djeddaba crevalle Alepes djeddaba (81)
21/2	0815	307	SPT	600-700	270	16° 46'	54° 01'	45	60	Champsodon sp. (45)
21/2	1125	308	BTR	28	28	16° 54'	54° 07'	50	100	Emperor Lethrinus nebulosus (20), Triggerfishes Sufflamen spp. (13)
21/2	1545	309	longline traps	23	23	16° 54'	54° 07'	19	-	Carcharhinus altimus (?) (11)
22/2	1025	310	SPT	400-700	270-290	16° 56'	54° 32'	2000	6000	Lanternfish Benthosema fibulatum (2000)
24/2	1533	311	SPT	500-300	30-40	17° 37'	56° 37'	50	100	Champsodon sp. (31), Squids (15)
25/2	0103	312	BTR	65-67	65-67	17° 48'	56° 37'	35,5	71	Shrimps (9), Sharks (4.5), Pagellus natalensis (7.4)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
25/2	2322	313	SPT	1500	50	18° 51'	57° 59'	180	360	Lanternfish MYCTOPHIDAE 4 spp. (165)
26/2	0725	314	SPT	740	250-300	19° 26'	58° 21'	250	500	Lanternfish Benthosema pterotum (230)
26/2	1500	315	BTR	18-14	18-14	19° 43'	57° 50'	10 000	20 000	Catfish Arius sp. (9520), Rays (1000), Tiger-toothed croaker Otolithus ruber (190)
26/2	1820	316	SPT	25	10-20	19° 54'	58° 00'	6500	13 000	White sardinella Sardinella albella (6192), Indian oil sardin Sardinella longiceps (200)
27/2	1018	317	SPT	34	20-30	19° 33'	57° 47'	746	748	Round herring Etrumeus teres (282), Rays 2 spp. (290), Narrow-barred spanish mackerel Scomberomorus commerson (50)
27/2	1645	318	SPT	30	15	19° 52'	58° 08'	400	1600	White sardinella Sardinella albella (255), Round herring Etrumeus teres (72)
28/2	0120	319	SPT	1200	15-35	20° 14'	58° 55'	900	1800	Lanternfish Benthosema pterotum (793)
29/2	0000	320	SPT	700-175	15-20	21° 37'	59° 37'	1500	3000	Lanternfish B. pterotum (1500)
29/2	0700	321	SPT	2200	150	22° 11'	59° 57'	2	8	Squids (1.8)
3/3	0625	322	SPT	2000	80-100	24° 38'	58° 50'	120	240	Lanternfish B. pterotum (120)
4/3	0535	323	SPT	175	135-155	25° 40'	57° 17'	4500	9000	Lanternfish B. pterotum (4500)
5/3	0740	324	SPT	820	265	24° 36'	57° 11'	60	120	Lanternfish B. pterotum (51)
5/3	0945	325	SPT	810	130-150	24° 36'	57° 11'	800	1600	Lanternfish B. pterotum (780)
5/3	1530	326	SPT	340	20	24° 37'	57° 11'	450	900	Lanternfish B. pterotum (438)
5/3	1740	327	SPT	340	90-110	24° 37'	57° 11'	450	900	Lanternfish B. pterotum (426)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
5/3	2100	328	SPT	800	15	24° 38'	57° 12'	150	300	Lanternfish B. pterotum (137)
6/3	0020	329	SPT	700	15-20	24° 37'	57° 11'	5000	10 000	Lanternfish B. pterotum (4979)
6/3	0455	330	SPT	300	120-140	24° 37'	57° 11'	650	1300	Lanternfish B. pterotum (650)
6/3	0710	331	SPT	300	250	24° 37'	57° 11'	150	300	Lanternfish B. pterotum (148)
7/3	0715	332	BTR	36	36	24° 28'	57° 46'	38	76	Great barracuda, Sphyraena barracuda (8), Ponyfish, Leiognathus leuciscus (8)
7/3	0945	333	BTR	270	270	24° 43'	56° 50'	135	270	Croaker, Artrobucca sp. (98), Sharks (17)
7/3	1245	334	long line	20	20	24° 45'	56° 31'	21	-	Sharks (18)
15/3	0805	335	SPT	300	1000	25° 00'	60° 17'	16.5	33	Lanternfish, B. pterotum (13)
15/3	1430	336	gillnet longline	-	-	25° 14'	60° 29'	38	-	Sharks (21)
16/3	0820	337	BTR	58-84	58-84	25° 09'	60° 52'	184	368	Longspine seabream Argyrops spinifer (38), Slender lizardfish Saurida elongata (31), Malabar cavalla Carangoides malabaricus (25)
18/3	0935	338	SPT	2900	450	22° 09'	61° 46'	2	4	Lanternfish, MYCTOPHIDAE 5 spp. (1)
19/3	0925	339	SPT	3500	425	22° 06'	63° 46'	0,5	1	Lanternfish, Benthosema pterotum
19/3	0420	340	SPT	3500	170-180	23° 07'	63° 47'	5,5	11	Lanternfish, B. pterotum
20/3	0400	341	BTR	80	80	25° 00'	64° 04'	157	314	Cownose ray Rhinoptera sp. (57) John's snapper Lutjanus johni (15) Black pomfret Formio niger (14)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
20/3	1155	342	SPT	2000	800	24° 32'	63° 16'	3	6	Lanternfish MYCTOPHIDAE 9 spp.
21/3	0855	343	SPT	2300	300	24° 15'	62° 14'	9	18	Lanternfish MYCTOPHIDAE 6 spp.
22/3	1013	344	BTR	24-28	24-28	25° 03'	62° 51'	544	1088	Sting rays Dasyatis spp. (186) Grunt Pomadasys sp. (103), Long-spine seabream Argyrops spinifer (72)
22/3	1420	345	Gillnet	-	-	25° 07'	63° 09'	38,5	-	Sharks Rhizoprionodon sp. (20), Djeddaba crevalle Alepes djeddaba (6)
22/3	1320	346	BTR	85	85	24° 57'	63° 48'	0		
23/3	1420	347	BTR	78	78	24° 57'	63° 48'	185	370	Japanese threadfin bream Nemipterus japonicus (27), Larghead hairtail Trichiurus lepturus (18), Black pomfret Formio niger (16)
24/3	0445	348	BTR	106	106	25° 02'	66° 03'	717	1434	Larghead hairtail Trichiurus lepturus (500), Croaker Megalonibea fusca (66), Orangemouth thryssa Thryssa vitrirostris (21)
24/3	0810	349	BTR	24-27	24-27	25° 15'	66° 23'	3500	3500	Catfish Arius sp. (2180), False trevally Lactarius lactarius (433) Japanese treadfin bream Nemipterus japonicus (428)
24/3	1115	350	SPT	17	17	25° 06'	66° 35'	3500	7000	Grunt Pomadasys sp. (1257) Sardinella Sardinella spp. (1657)
25/3	0830	351	SPT	1200	350	23° 38'	65° 45'	9,4	19	Lanternfish MYCTOPHIDAE 6 spp. (9.3)
26/3	0900	352	SPT	105	80-95	23° 07'	67° 12'	300	600	Lanternfish Benthosema pterotum (196), Shark Rhizoprionodon sp. (21)

(Table 1. Continued)

Date	Time start GMT	St. no.	Gear type	Bottom depth m	Gear depth m	Position North	Position East	Total catch kg	Catch per hour kg	Dominant species (total catch, kg)
26/3	1825	353	SPT	430	15	23° 18'	67° 16'	75	150	Lanternfish B. pterotum (50)
27/3	0815	354	BTR	68	68	23° 41'	67° 10'	5	10	Spanish mackerel Scomberomorus spp. (5)
27/3	0925	355	BTR	68	68	23° 41'	67° 10'	1000	2000	Larghead hairtail Trichiurus lepturus (346), Ponyfish Leiognathus sp. (170), Japanese threadfin bream Nemipterus japonicus (80)
27/3	1400	356	Traps	25	25	23° 49'	67° 25'	0	-	
28/3	1340	357	SPT	214	130-150	23° 41'	66° 20'	100	240	Lanternfish Benthosema pterotum (100)
28/3	1800	358	SPT	89	20	24° 02'	66° 27'	200	400	Jellyfish (195), Frigate mackerel Auxis thazard (5)
29/3	0015	359	BTR	25	25	24° 17'	67° 01'	55	110	Japanese threadfin bream Nemipterus japonicus (14), John's snapper Lutjanus johni (11), Grunt Pomadasys sp. (11)
29/3	0155	360	SPT	25	5	24° 18'	67° 01'	350	480	Shad Decapterus dayi (129) Anchovy Stolophoons buccaneeri (77), Frigate mackerel Auxis thazard (57)
29/3	1100	361	SPT	20	0-15	24° 40'	66° 53'	40	120	Rainbow sardine Dussumieria acuta (22)
29/3	1555	362	SPT	76	20-40	24° 32'	65° 42'	28	56	Jellyfish (22), Largehead hairtail Trichiurus lepturus (6)
30/3	0100	363	SPT	750	20	24° 44'	66° 02'	30	60	Jellyfish (30)
30/3	0555	364	SPT	400-800	260-310	24° 25'	65° 48'	24	48	Bombay-duck Harpodon sp. (15)
31/3	1755	365	SPT	230	20-40	24° 03'	65° 56'	20	40	Krill (12) Lanternfish Benthosema pterotum (5)

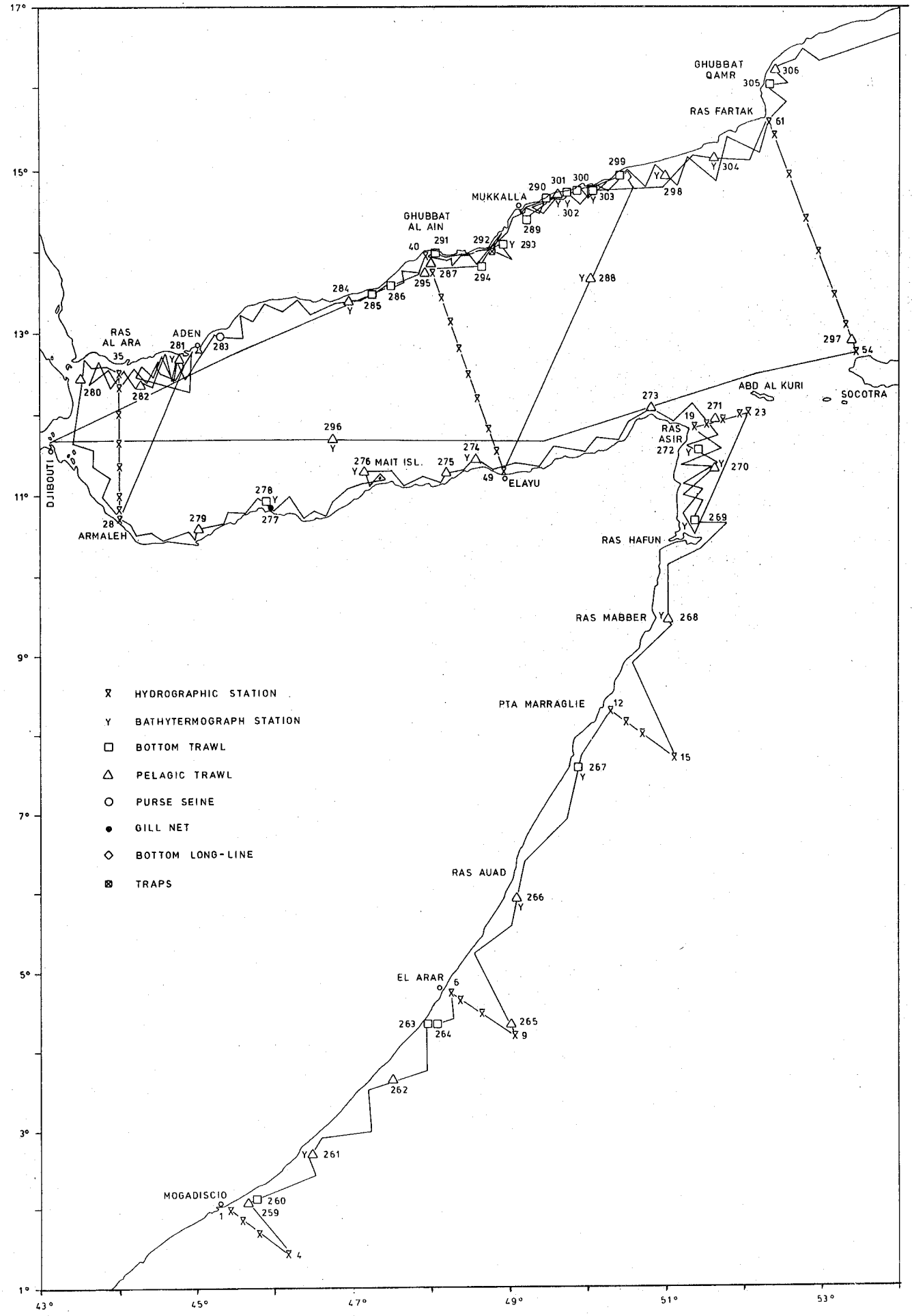


Fig. 1. Survey grid and stations, Somali east coast - Gulf of Aden.

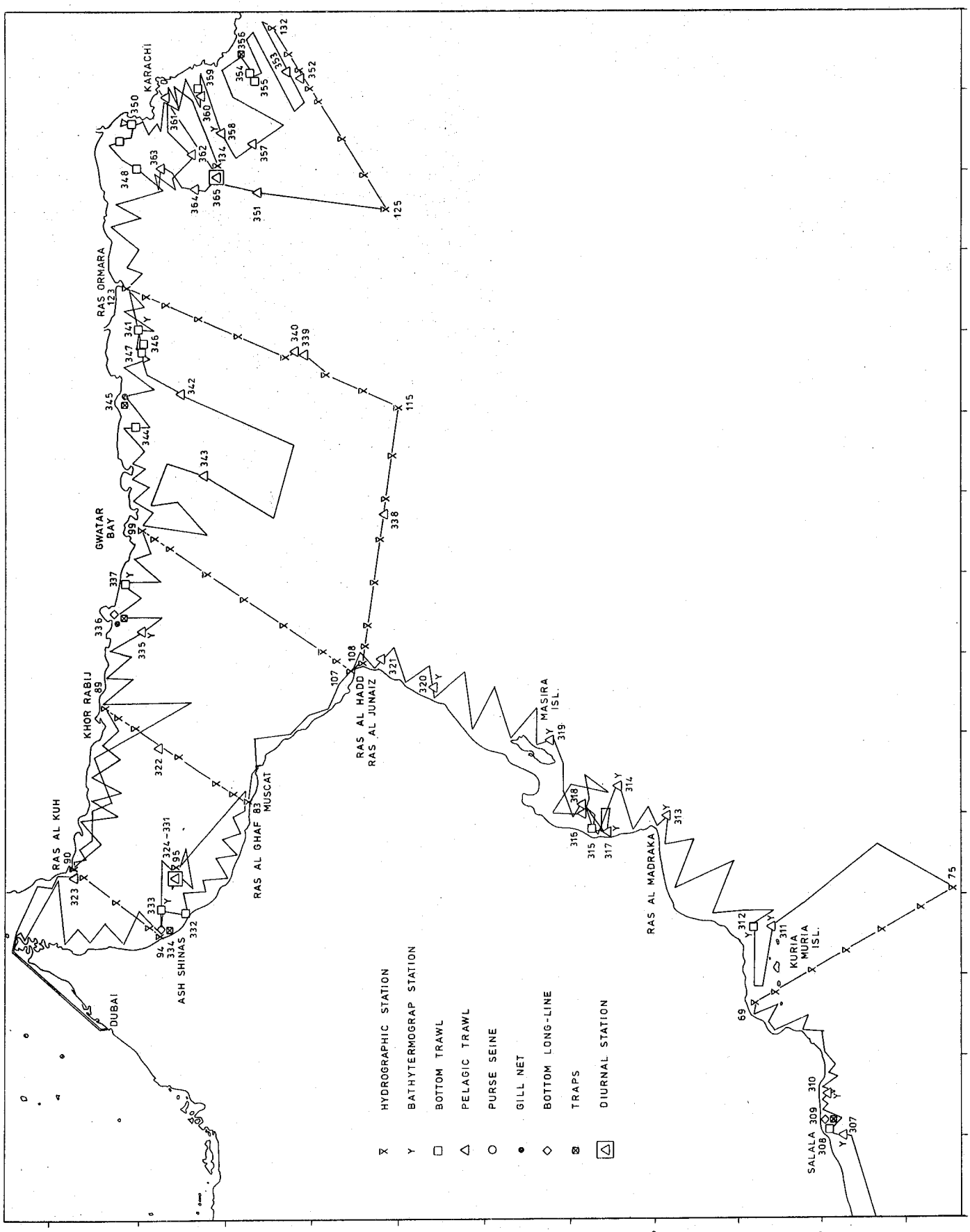


Fig. 2. Survey grid and stations, Oman coast - Gulf of Oman - Pakistan coast.

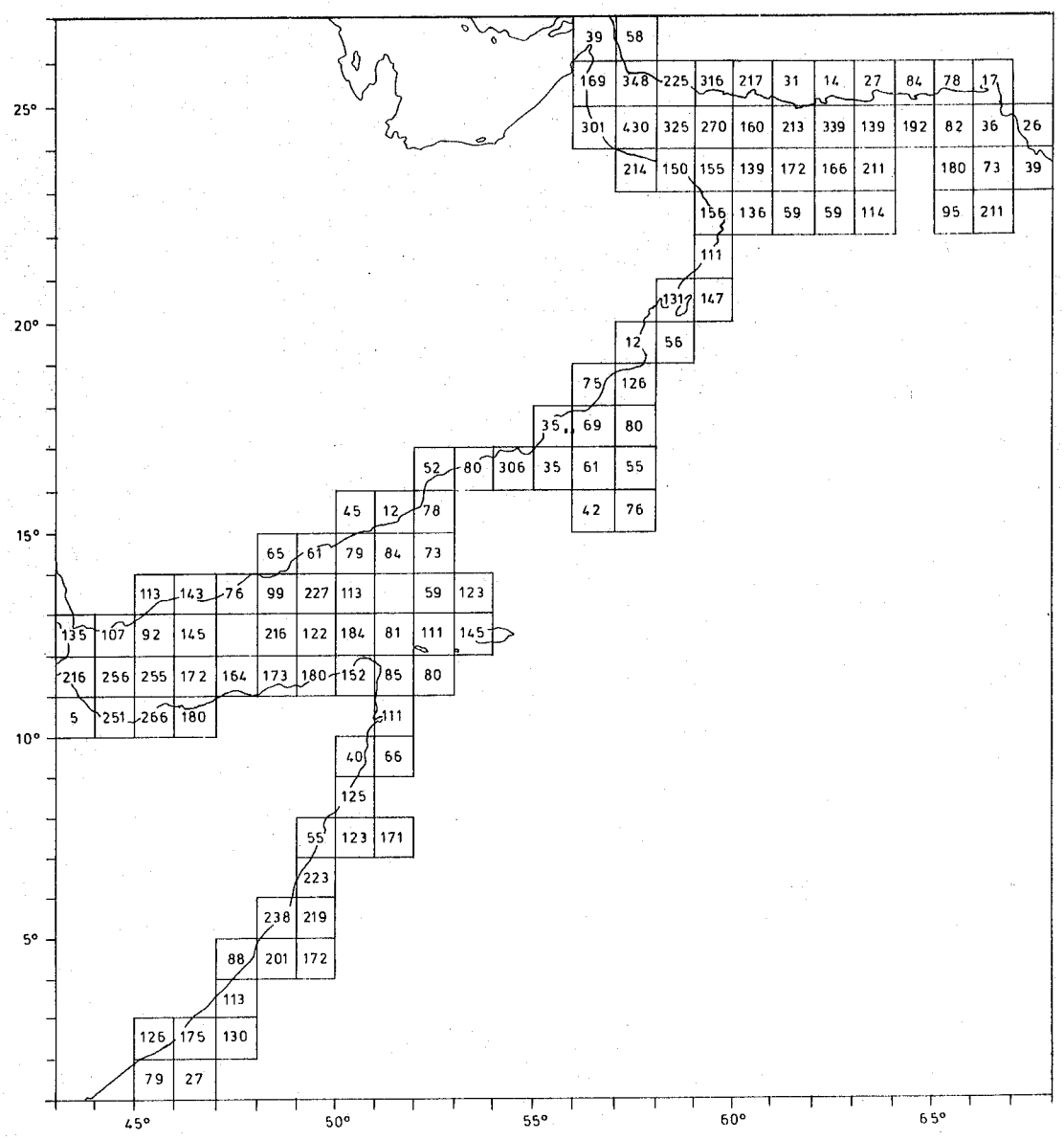


Fig. 3. Total echo recordings, average integrator deflection in mm per nautical mile.

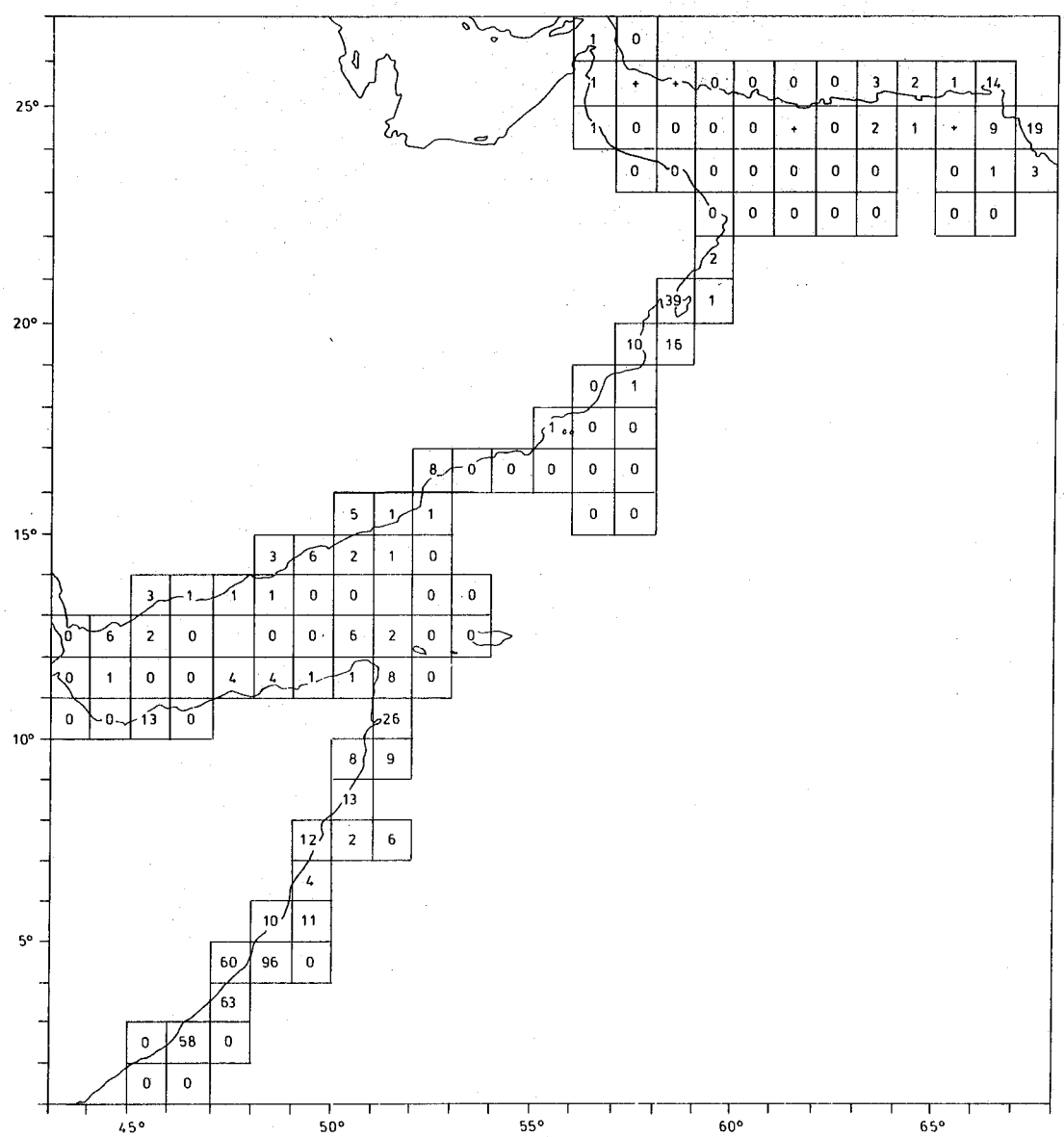


Fig. 4. Small pelagic fish, average integrator deflection in mm per nautical mile.

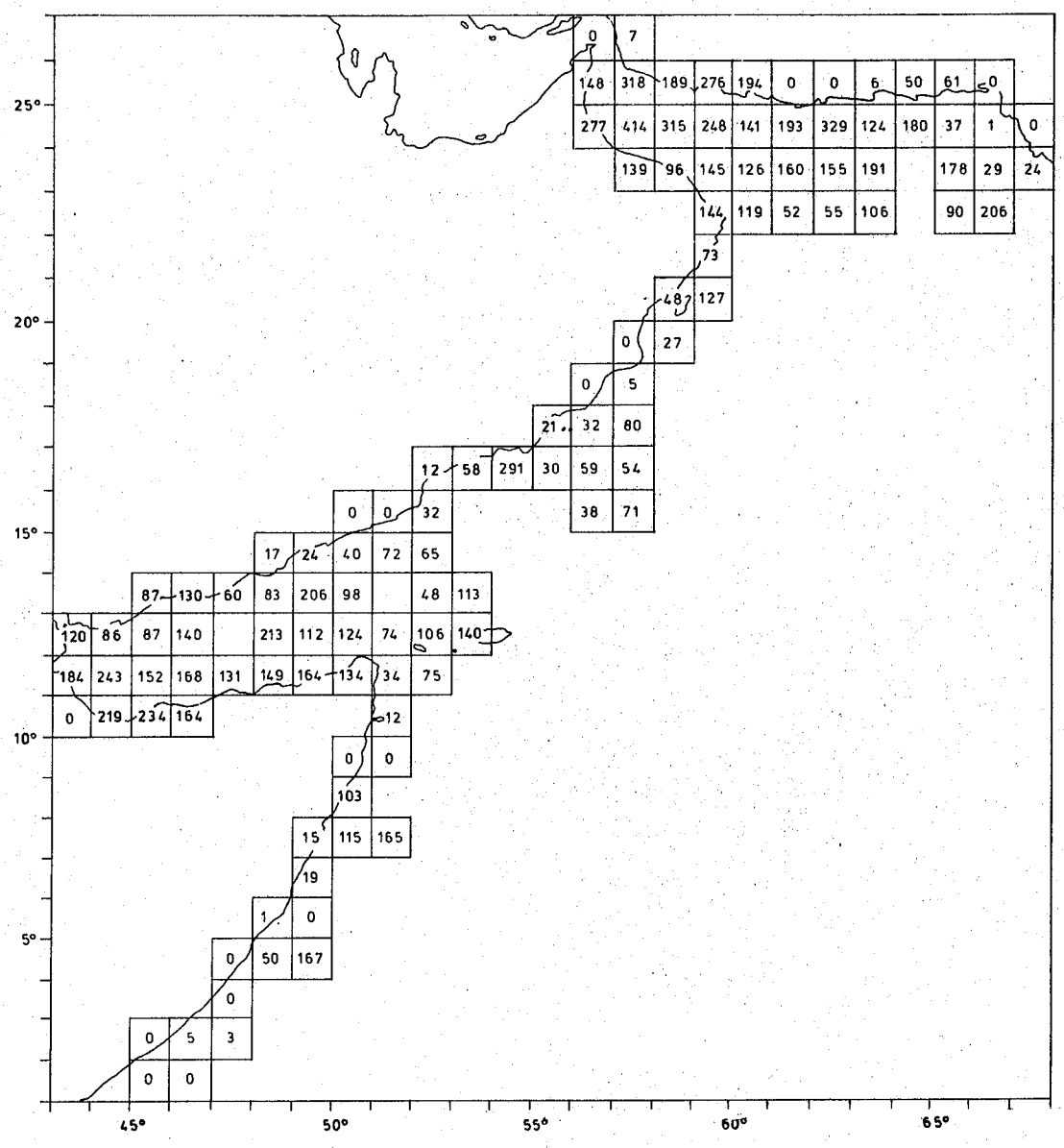


Fig. 5. Mesopelagic fish, average integrator deflection in mm per nautical mile.

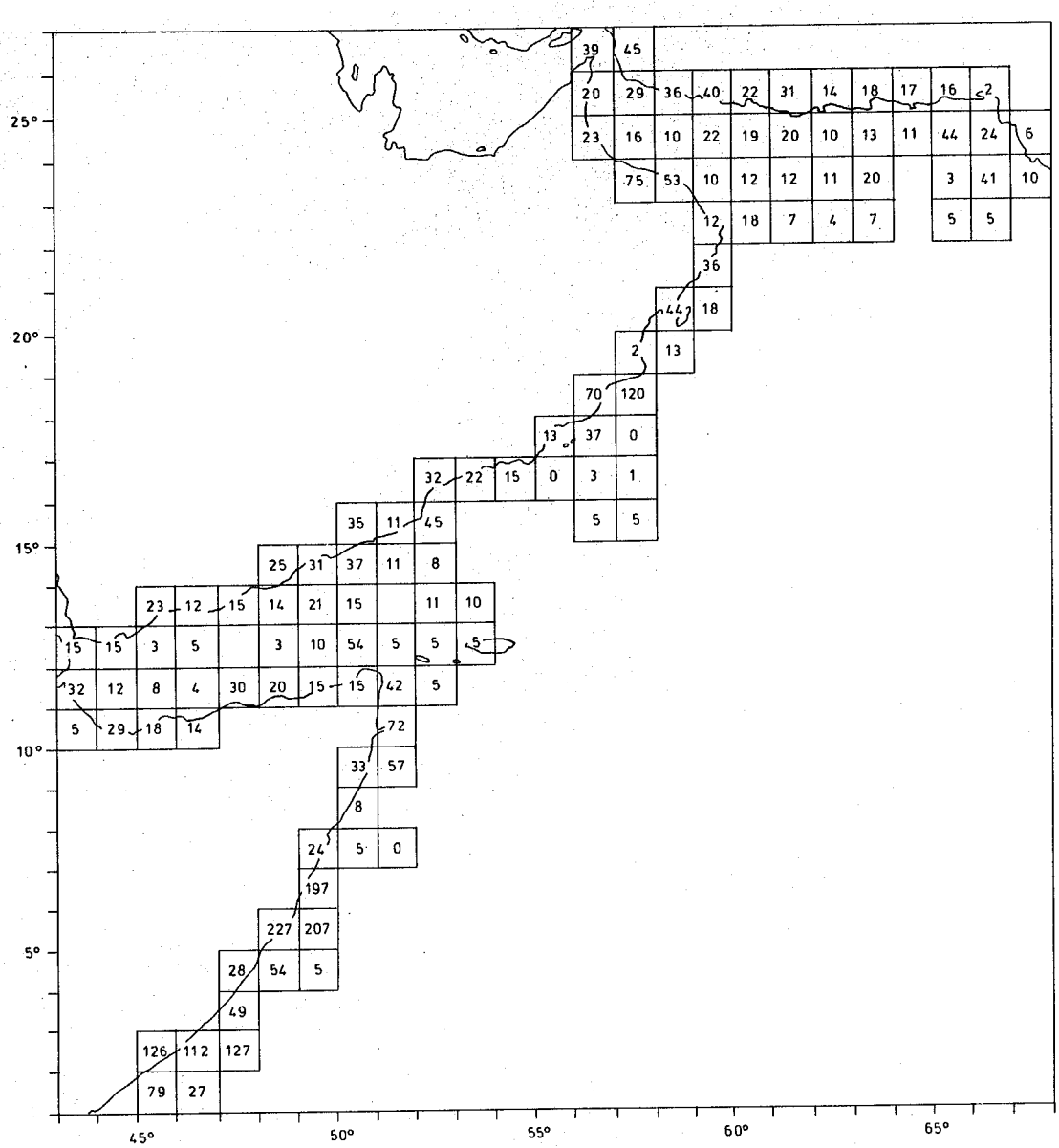


Fig. 6. Plankton and 0-group fish, average integrator deflection in mm per nautical mile.

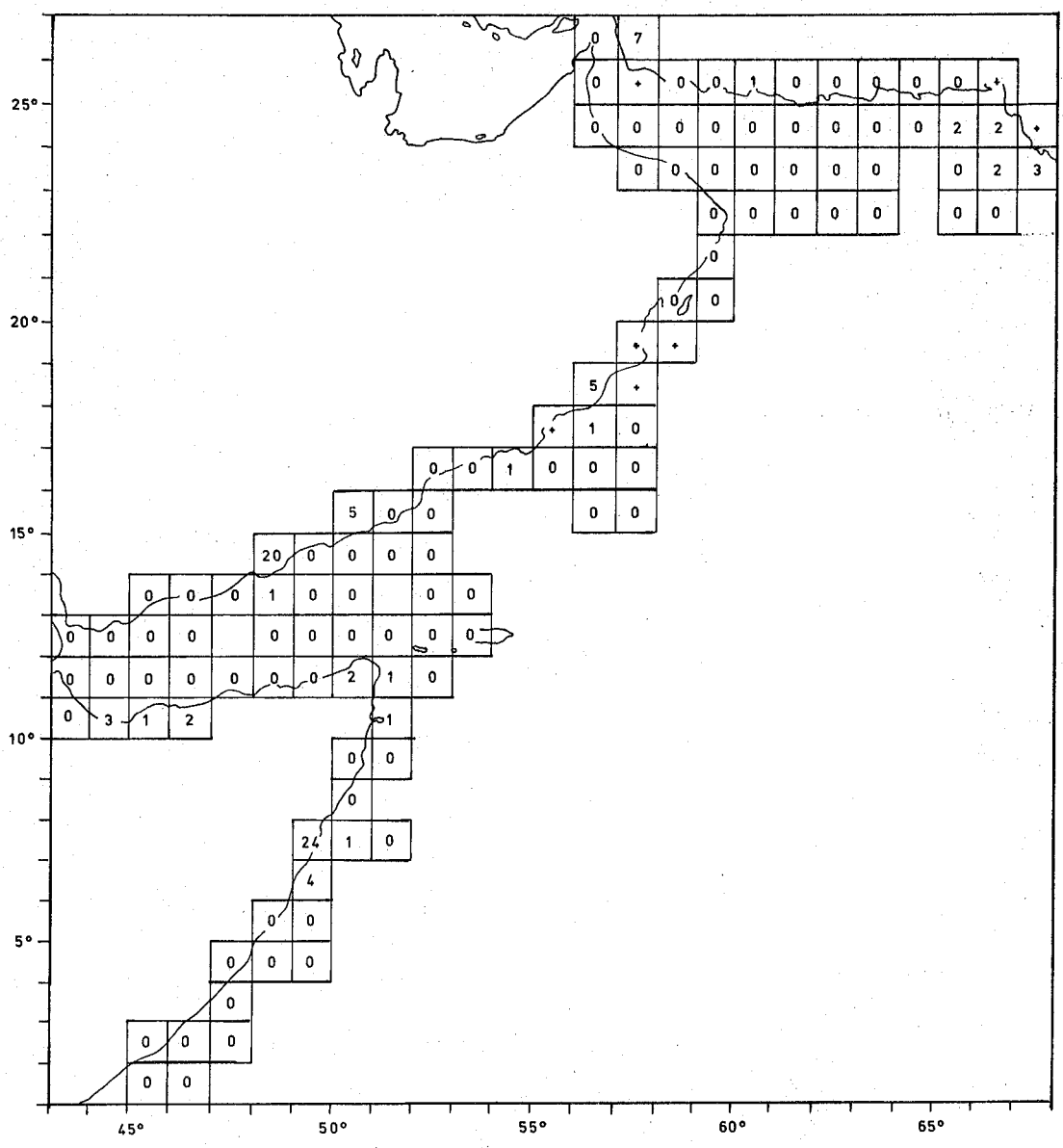


Fig. 7. Demersal fish, average integrator deflection in mm per nautical mile.

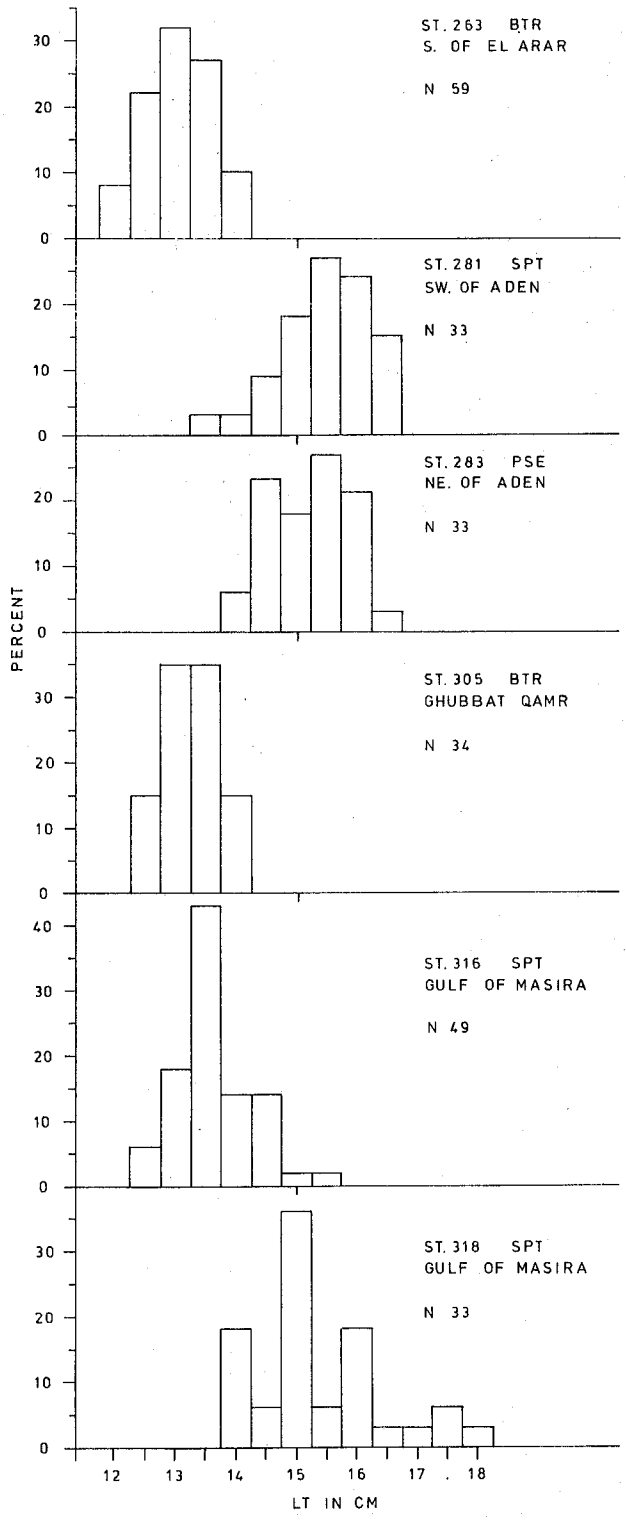


Fig. 8. Length distribution of Sardinella albella.

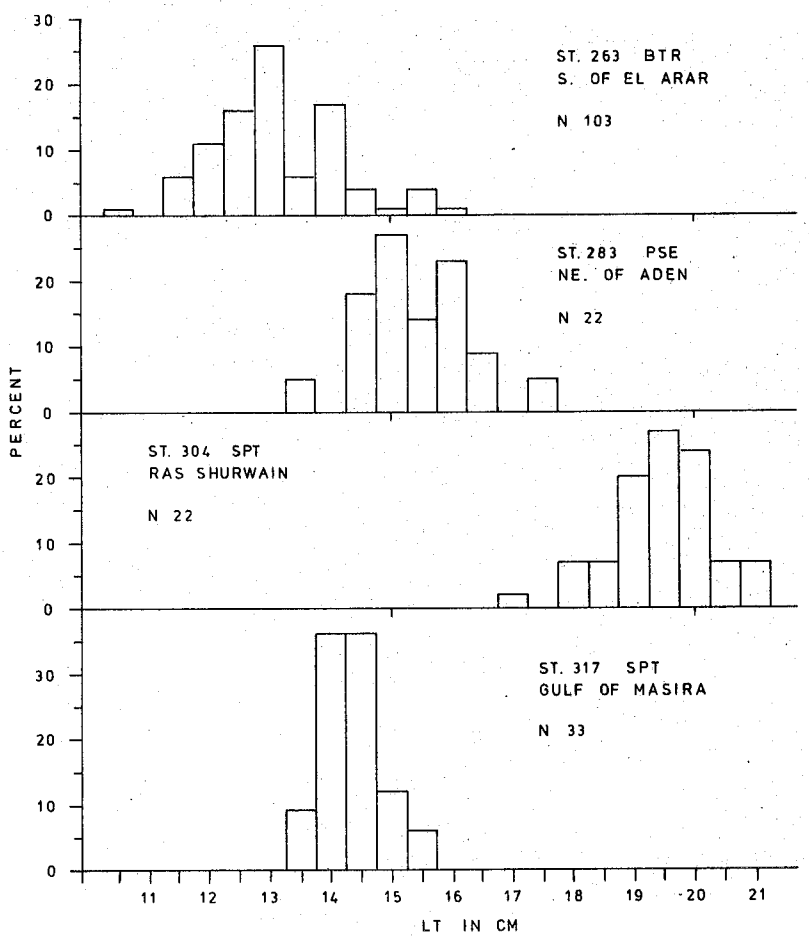


Fig. 9. Length distribution of Etrumeus teres.

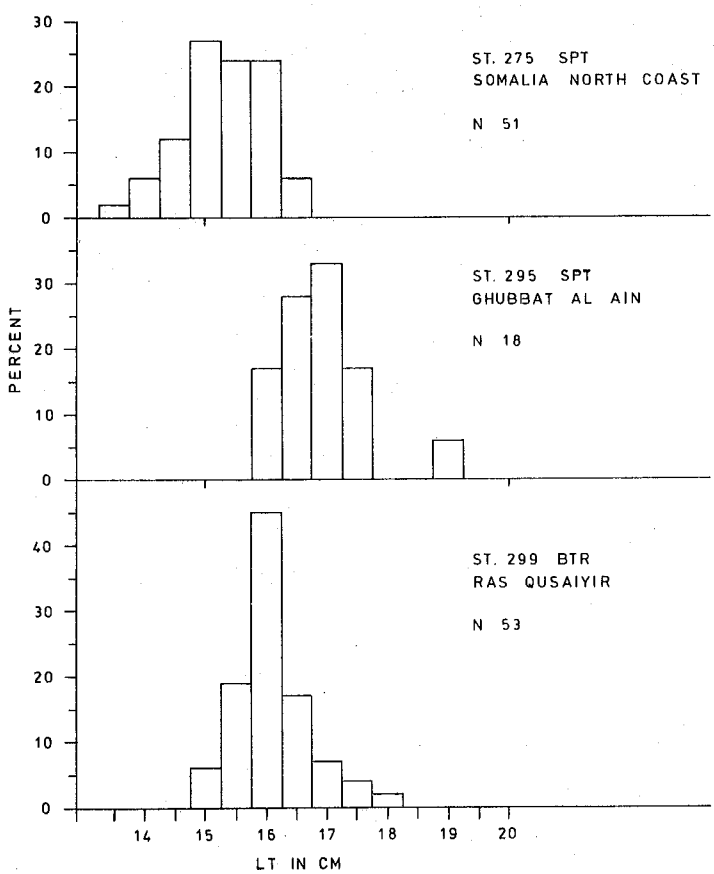


Fig. 10. Length distribution of Selar crumenophthalmus.

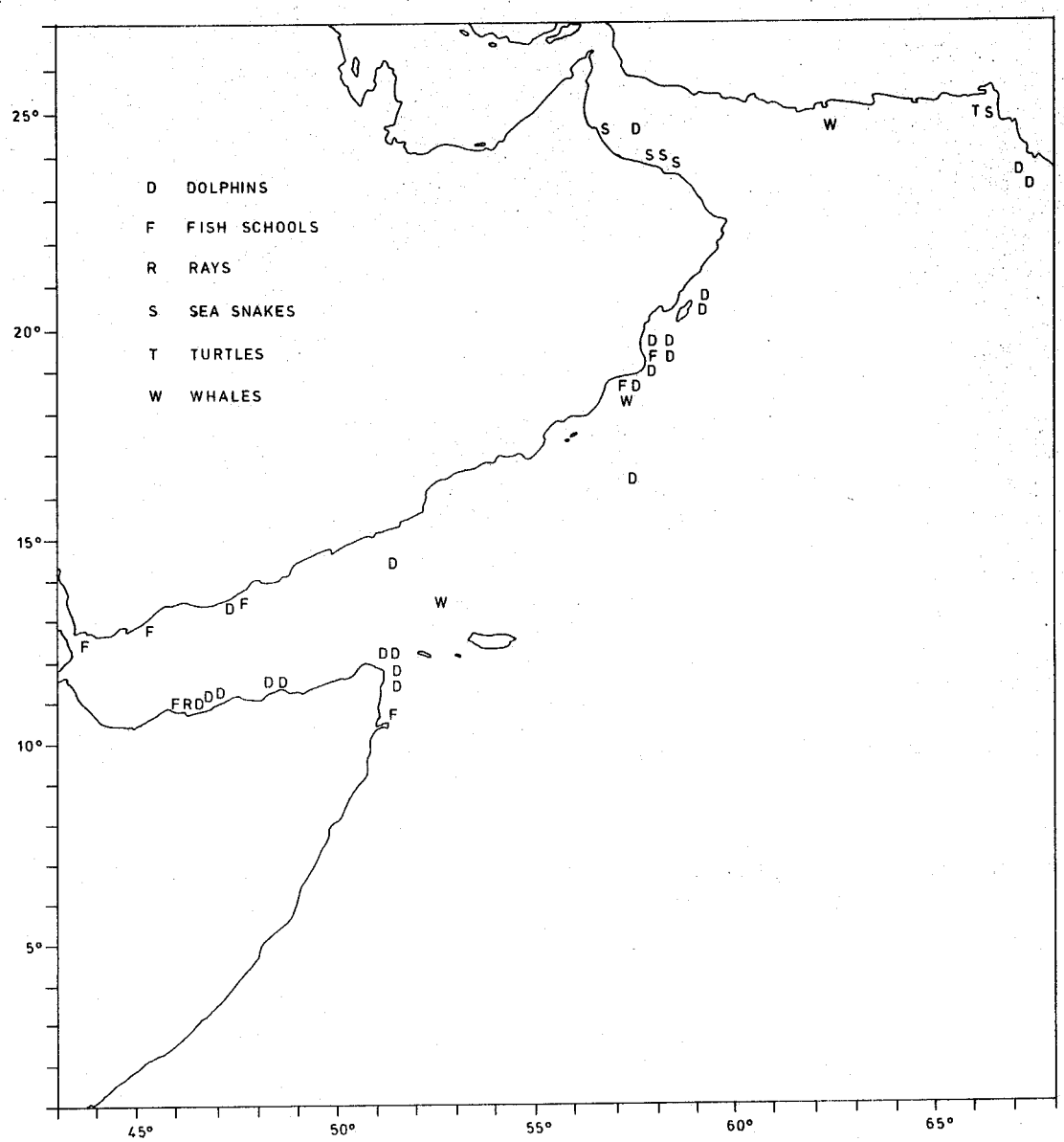


Fig. 11. Surface observations.

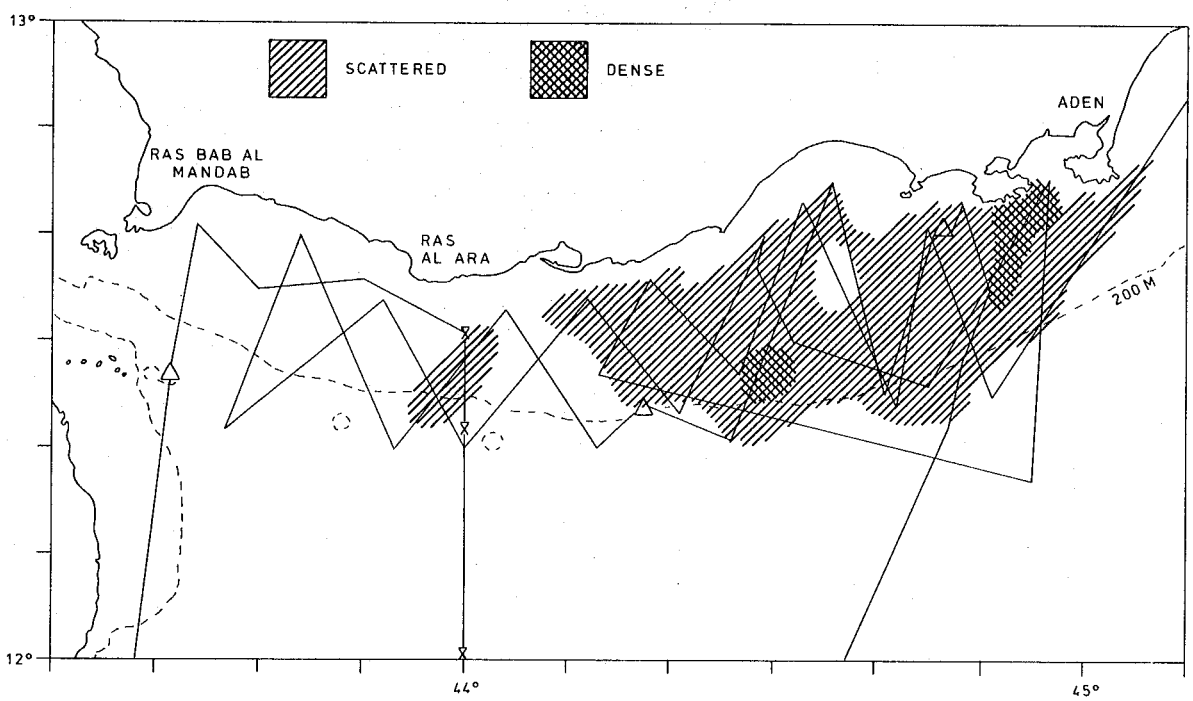


Fig. 12. Distribution of small pelagic fish between Ras al Ara and Aden, 29 January - 4 February.

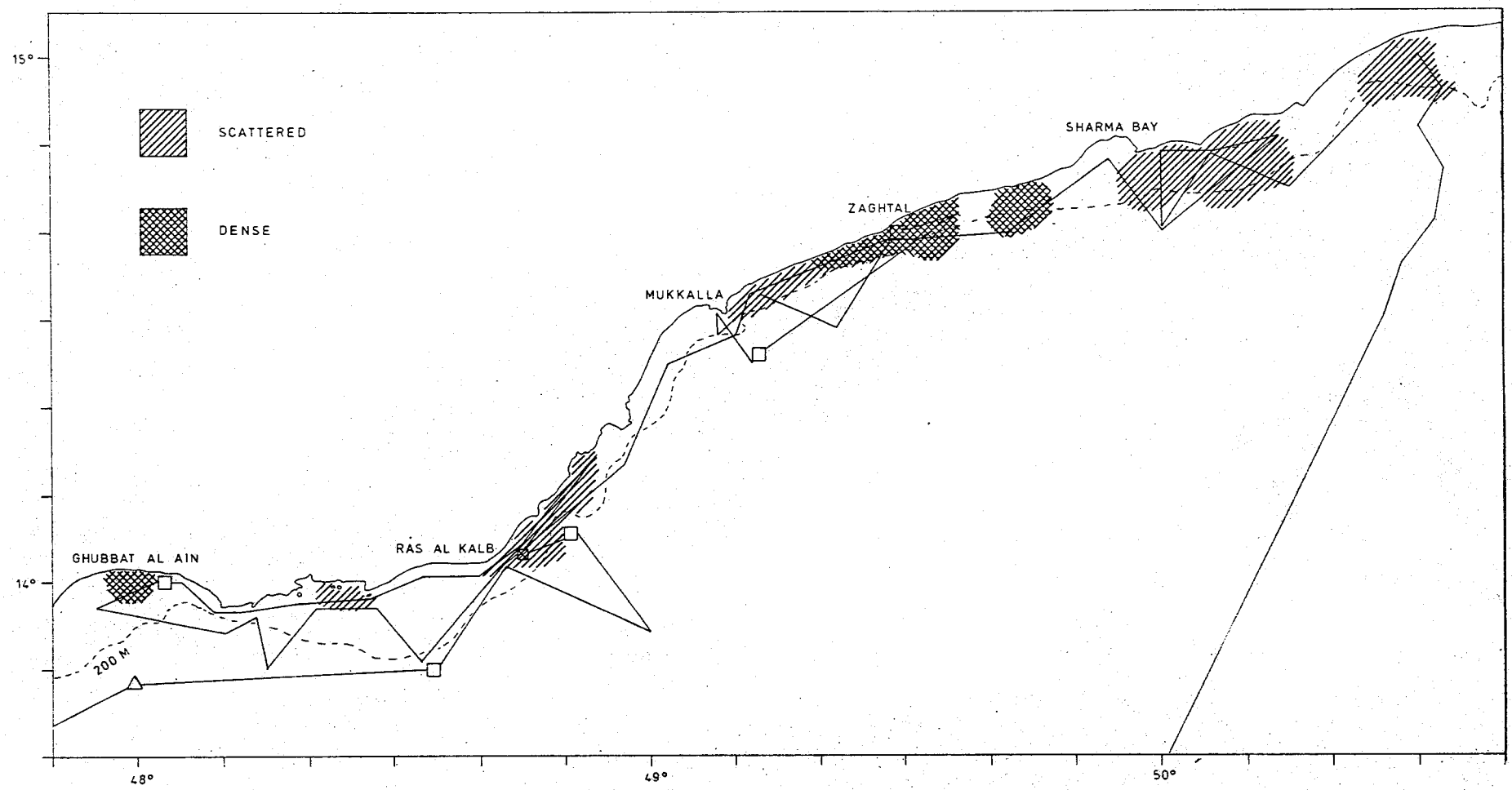


Fig. 13. Distribution of small pelagic fish in the Mukkalla area, 7 - 10 February.

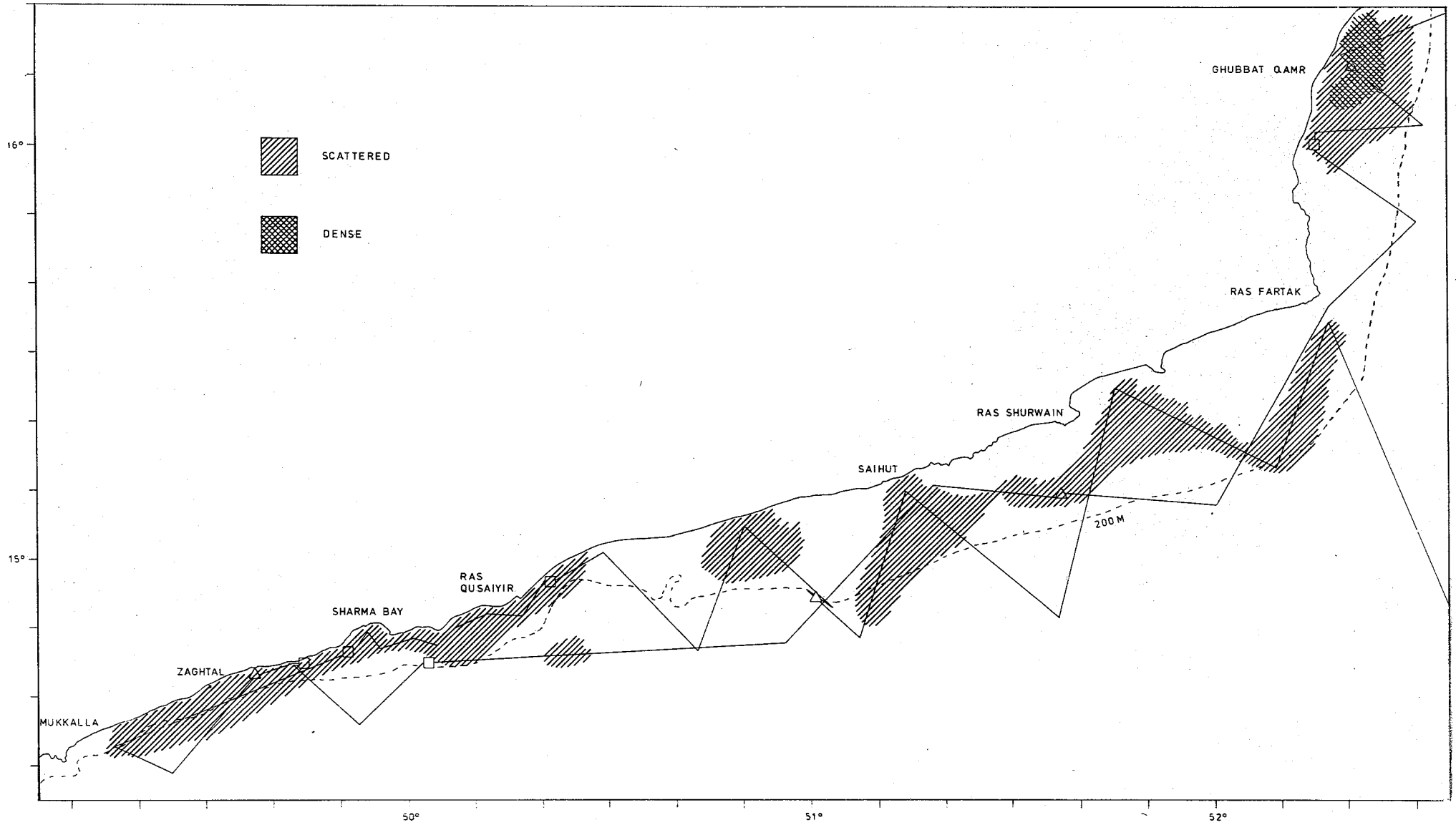


Fig. 14. Distribution of small pelagic fish between Mukkalla and Ghubbat Qamr, 17 - 21 February.

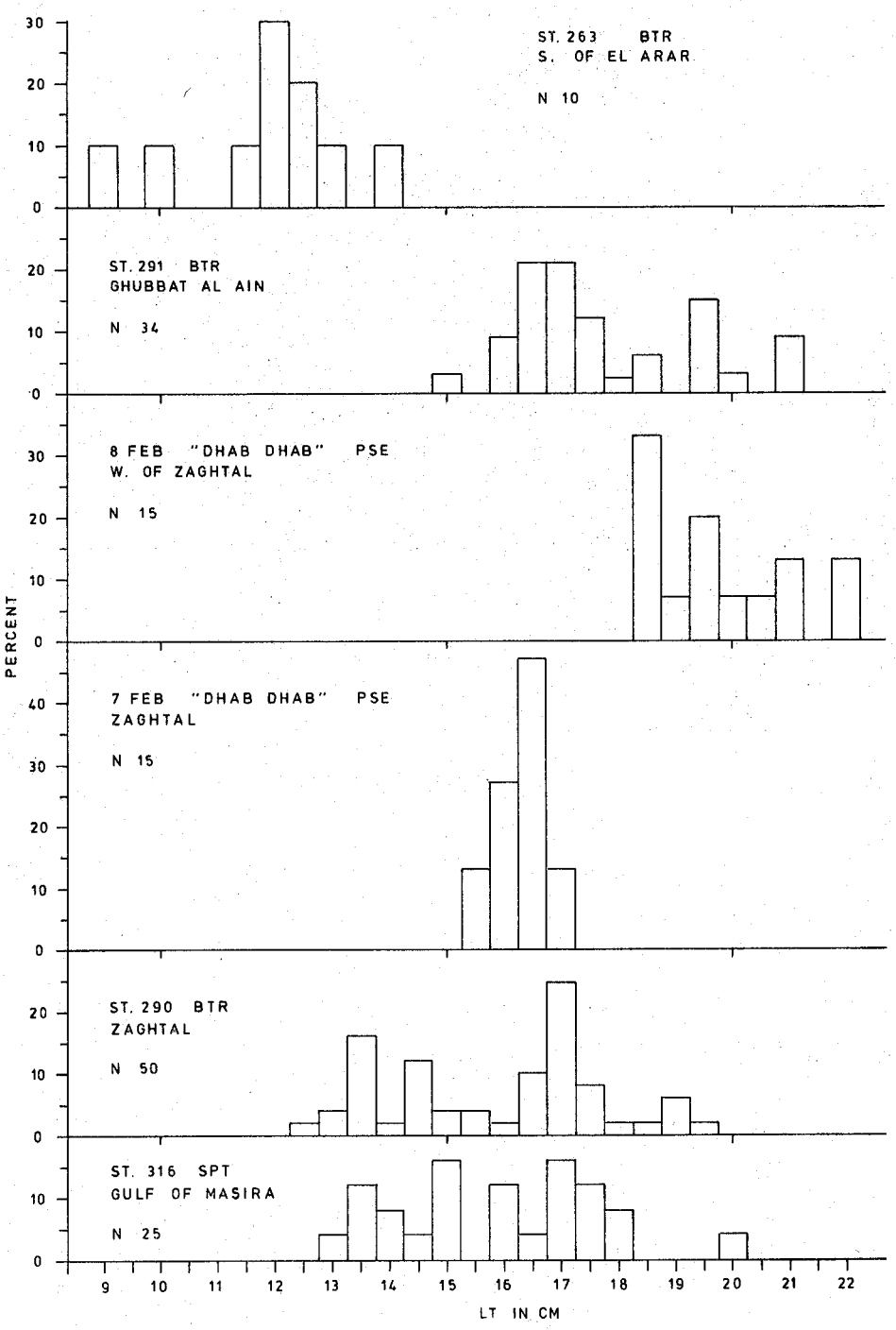


Fig. 15. Length distribution of Sardinella longiceps.

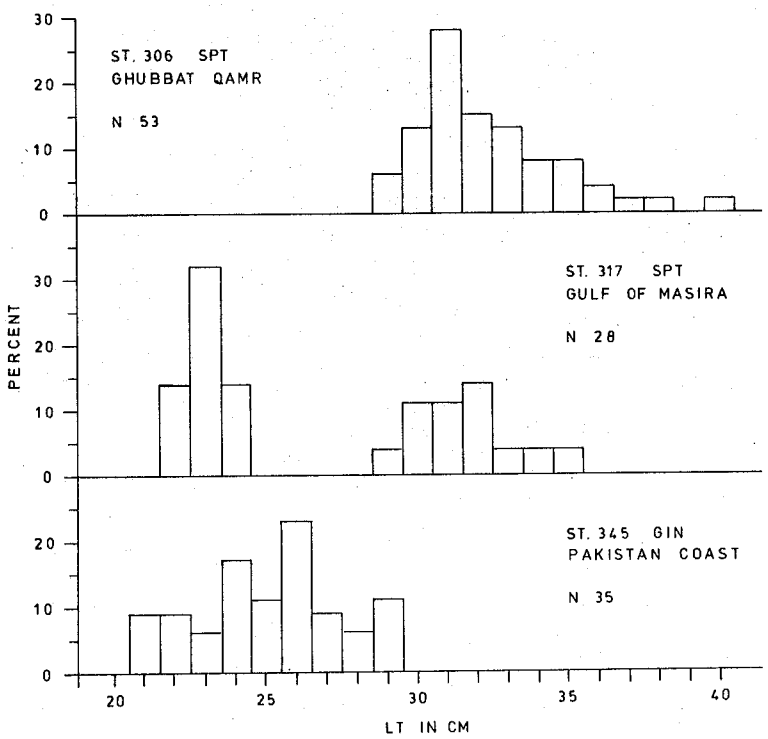


Fig. 16. Length distribution of Alepes djeddaba.

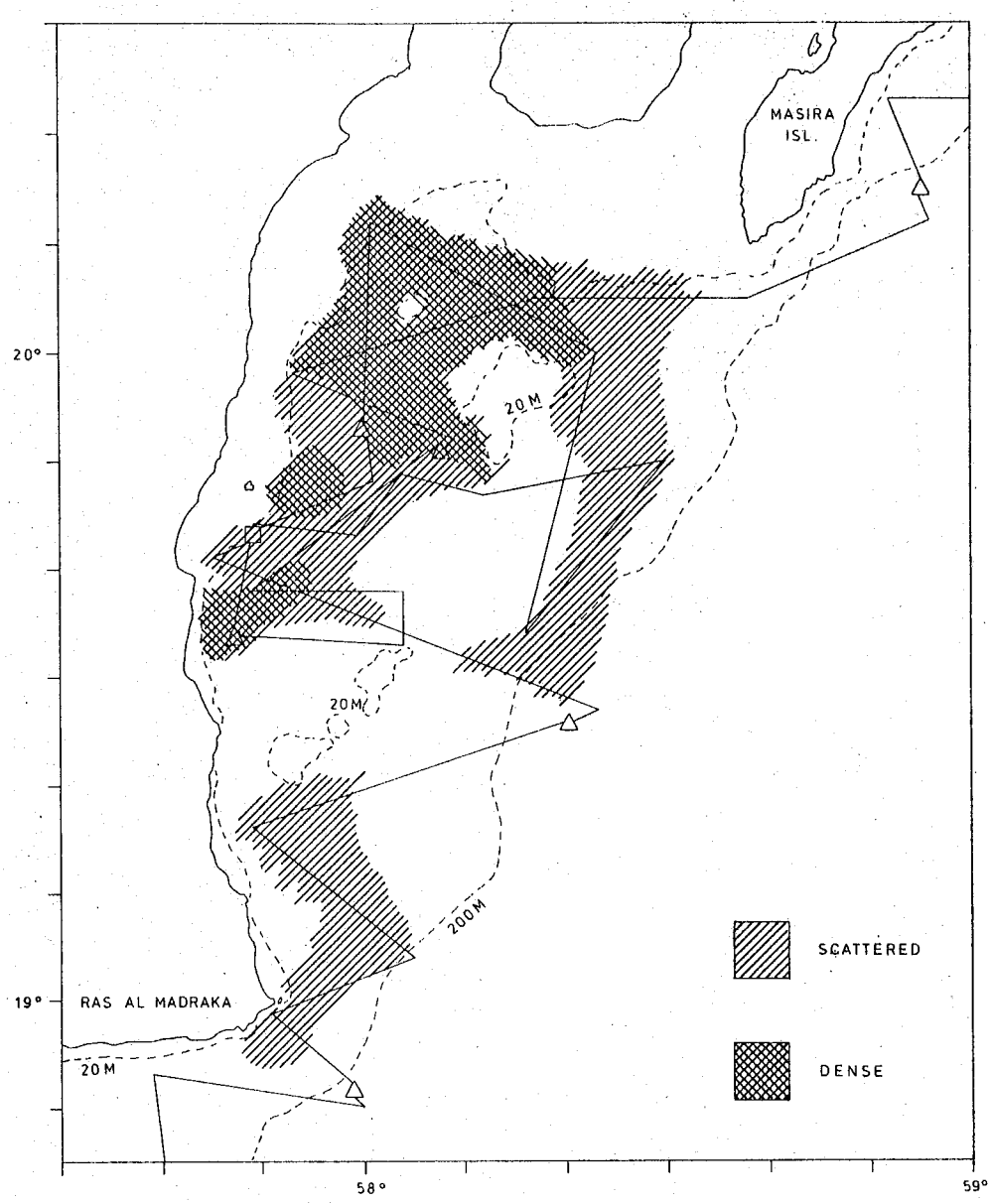


Fig. 17. Distribution of small pelagic fish in the Gulf of Masira, 25 - 28 February.

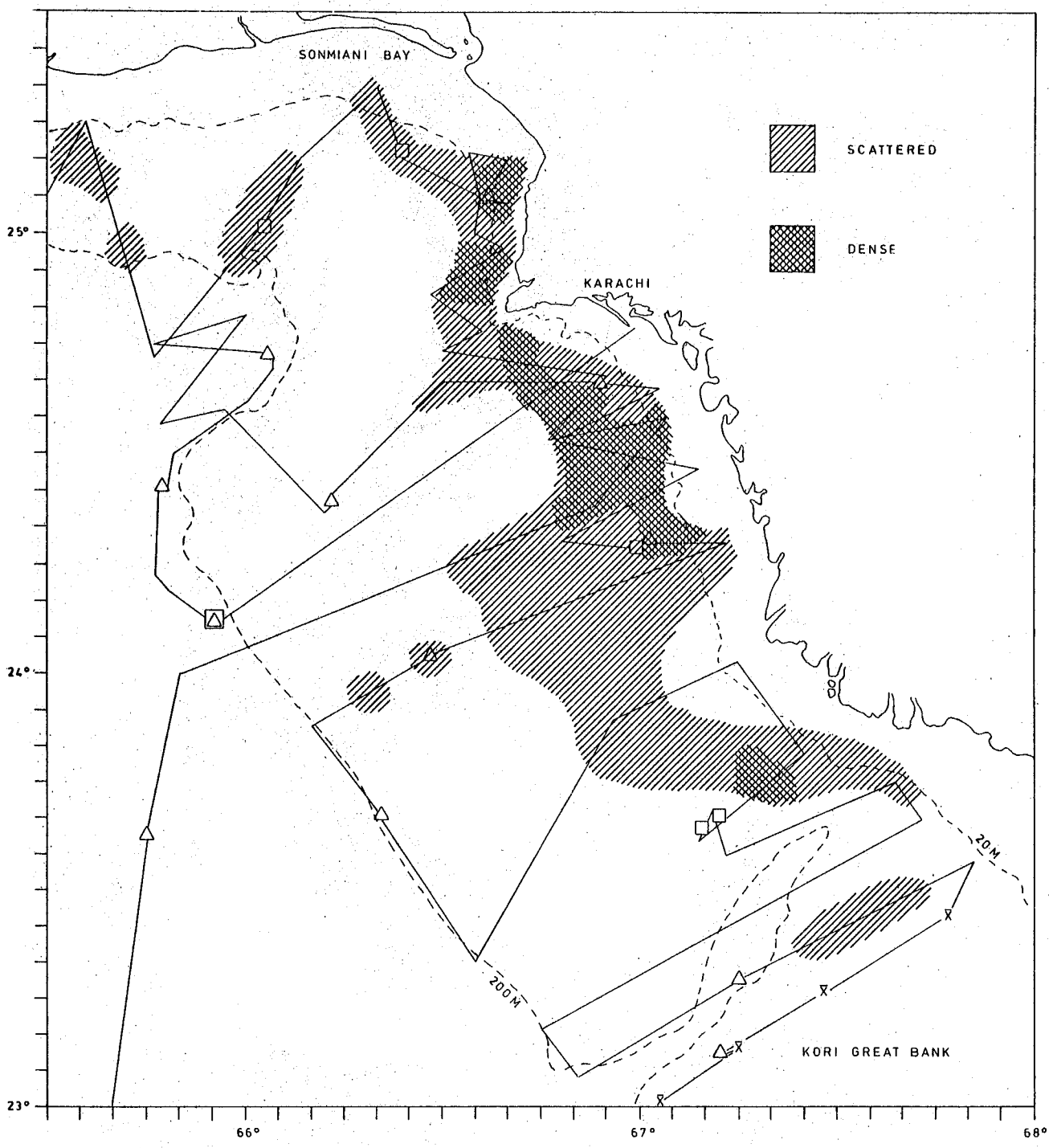


Fig. 18. Distribution of small pelagic fish off the Pakistani coast.

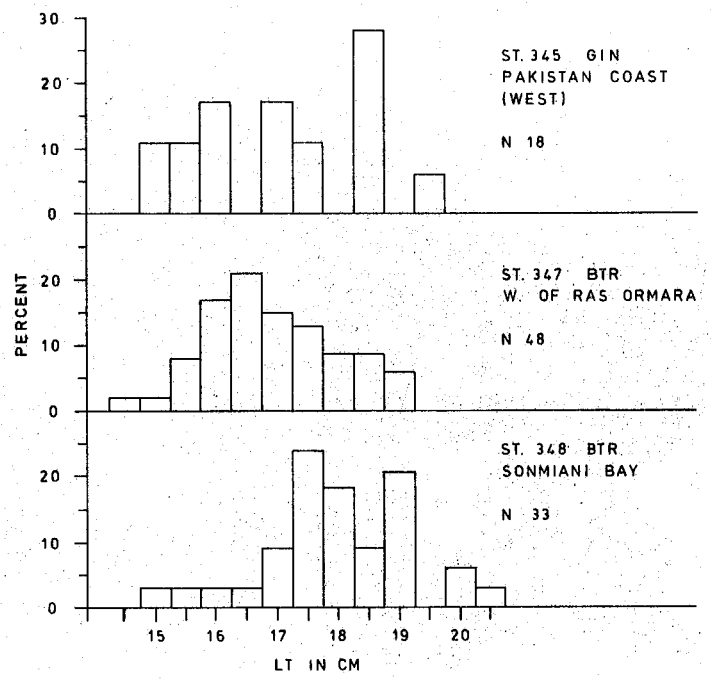


Fig. 19.

Length distribution of Thryssa vitrirostris.

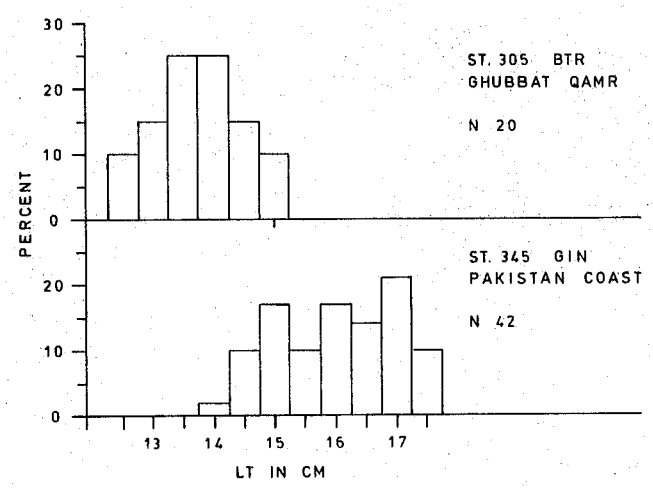


Fig. 20.

Length distribution of Sardinella gibbosa.

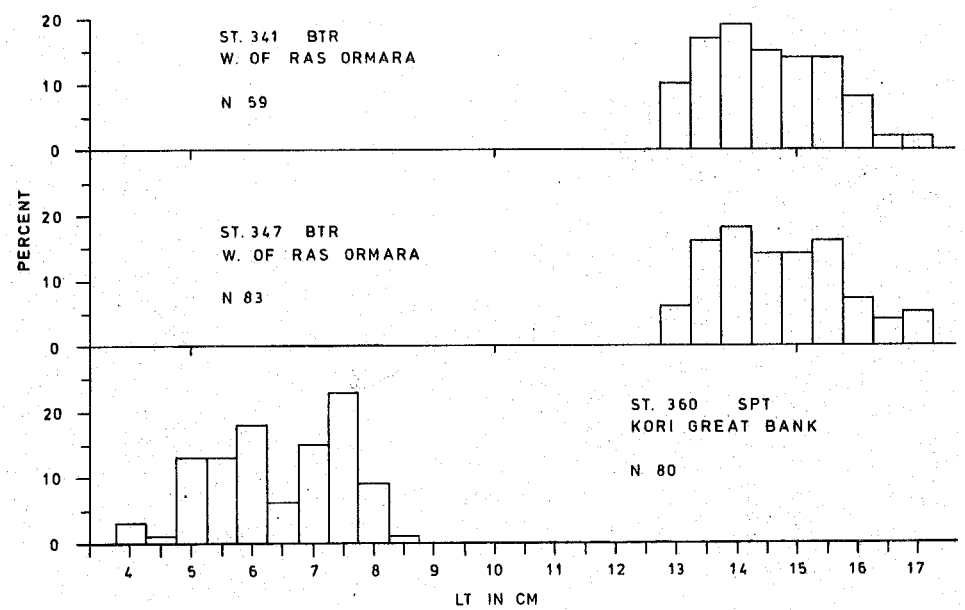


Fig. 21. Length distribution of Decapterus dayi.

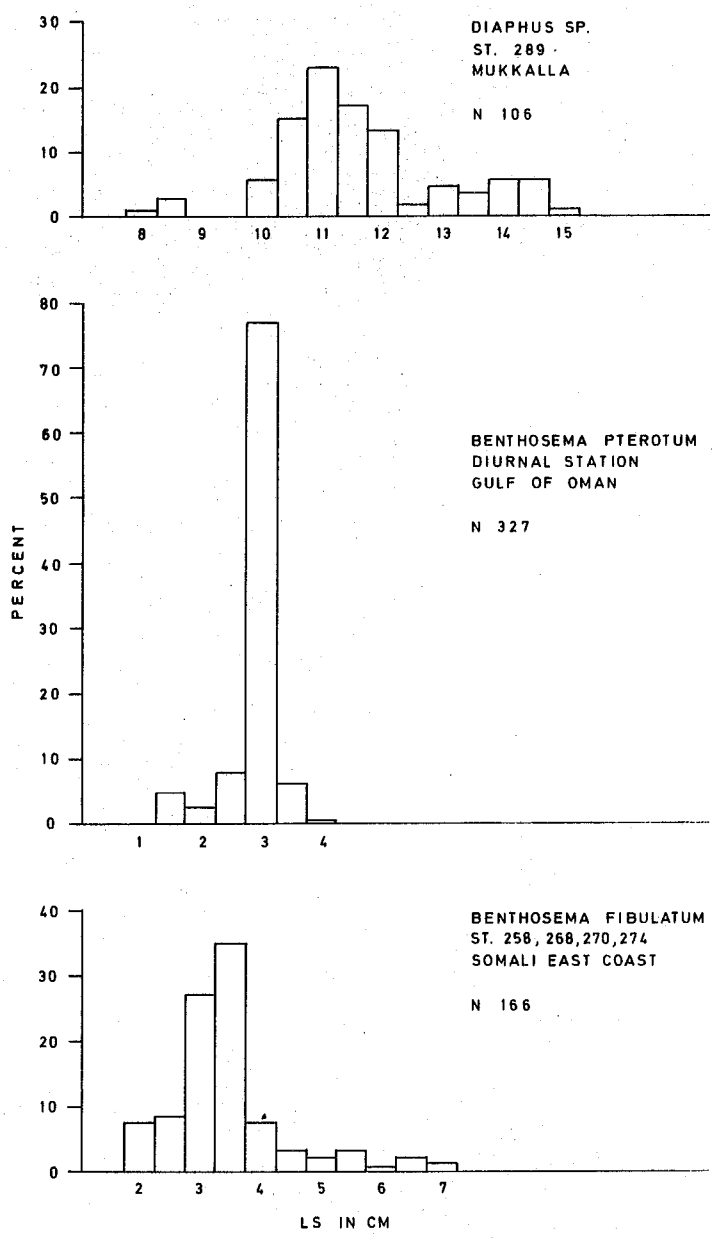


Fig. 22. Length distribution of Lanternfishes.

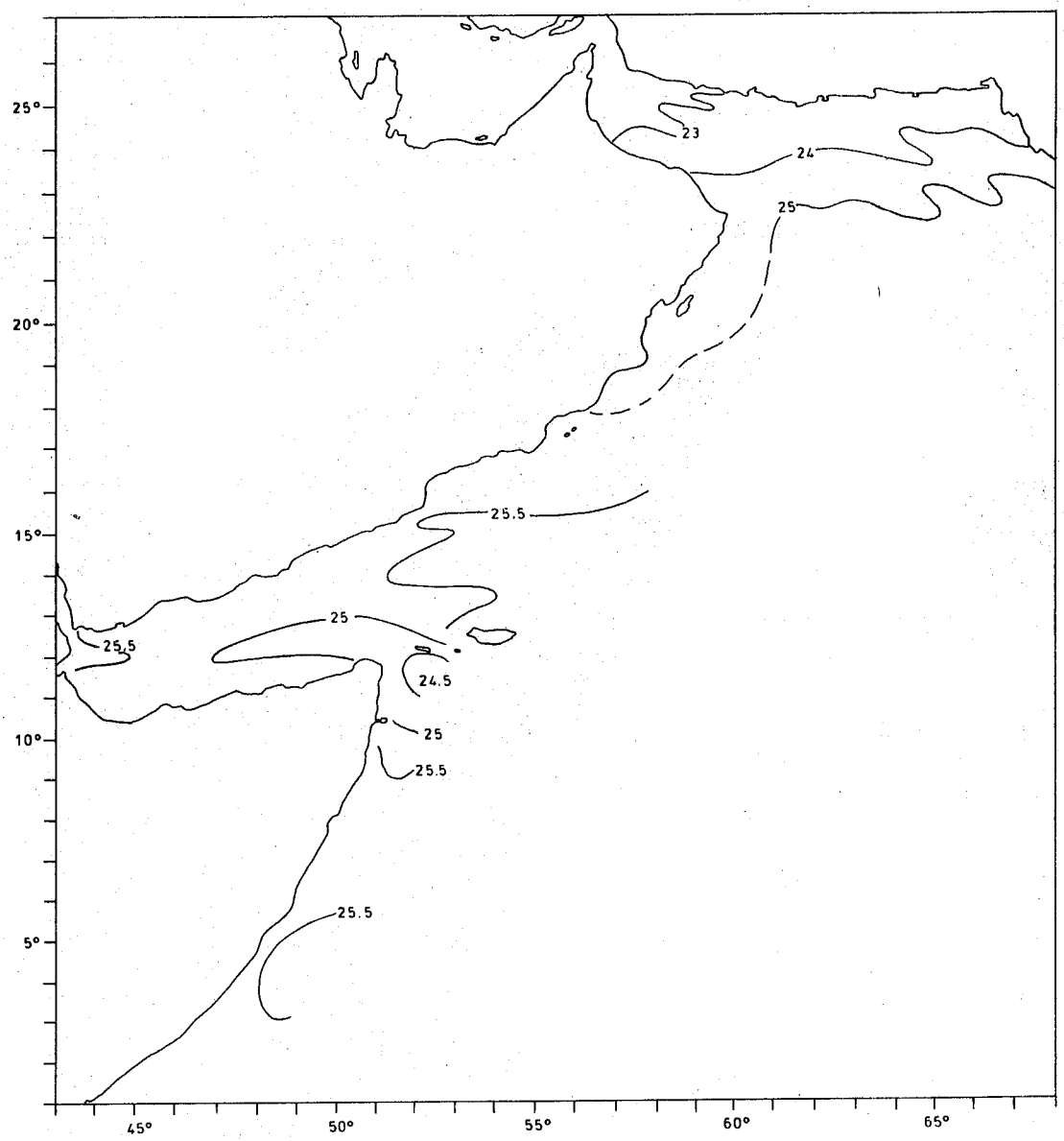


Fig. 23. Temperature, t°C, at 10 m depth.

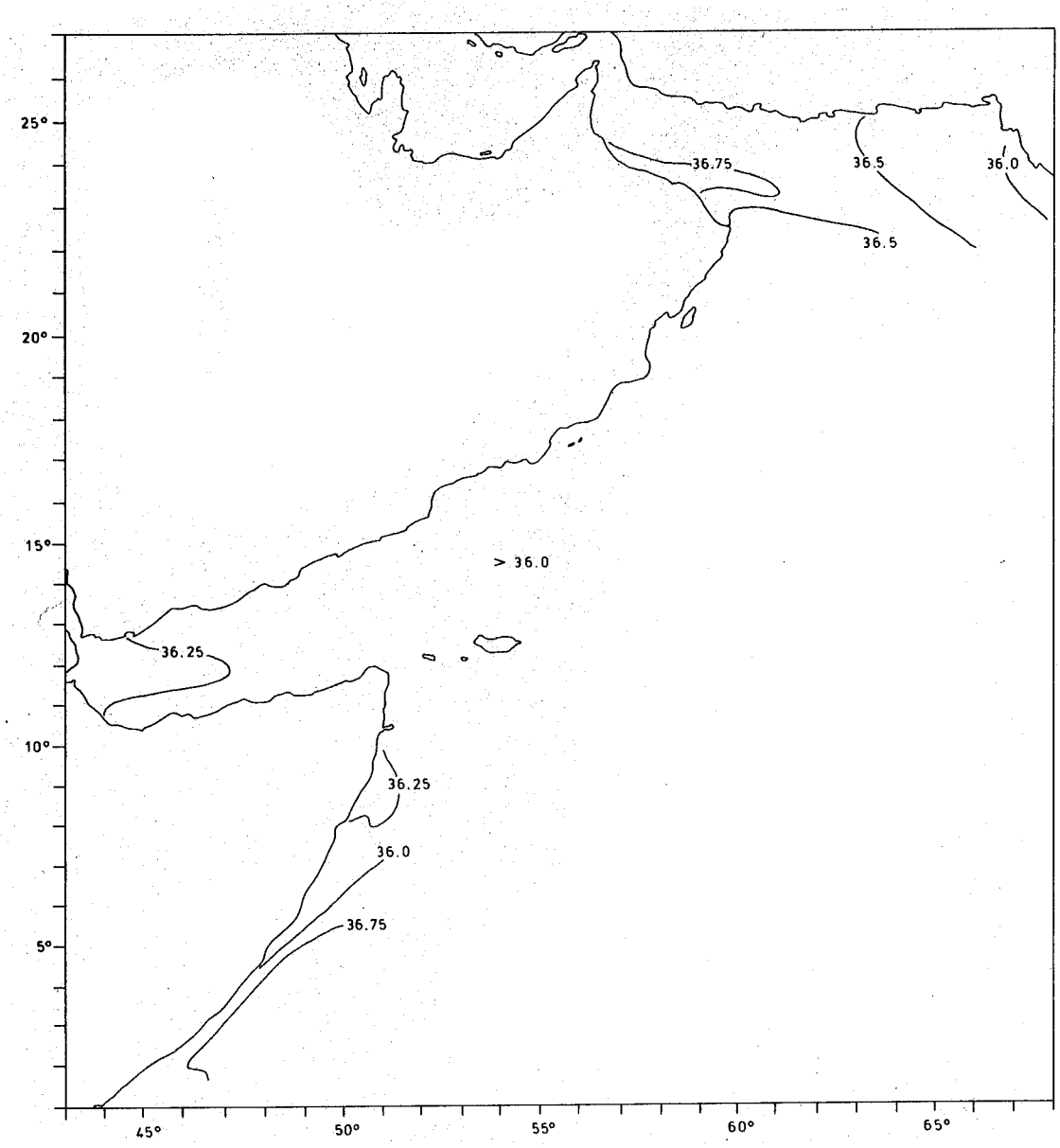


Fig. 24. Salinity, per mille, at 10 m depth.

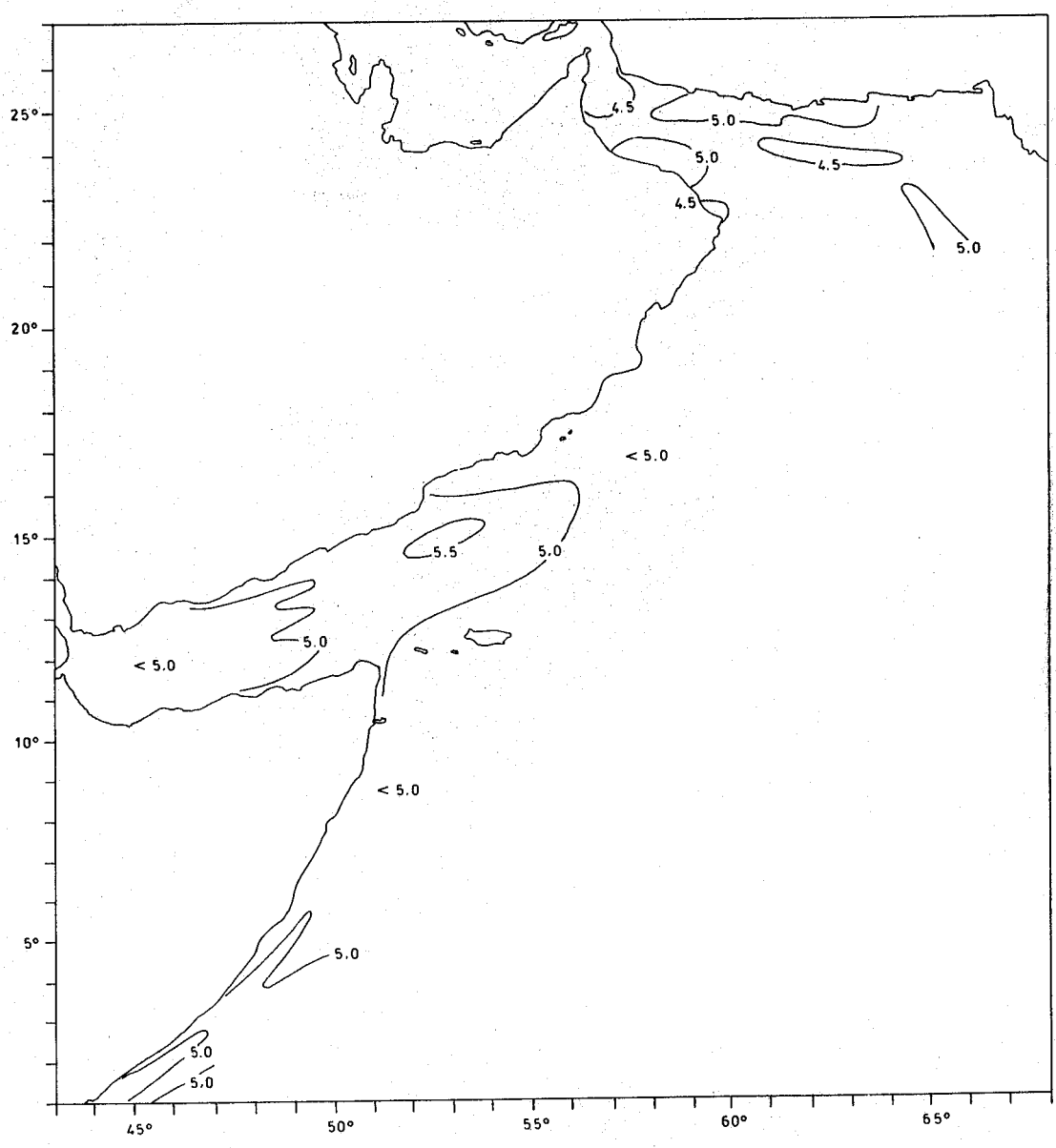


Fig. 25. Oxygen, ml/l, at 10 m depth.

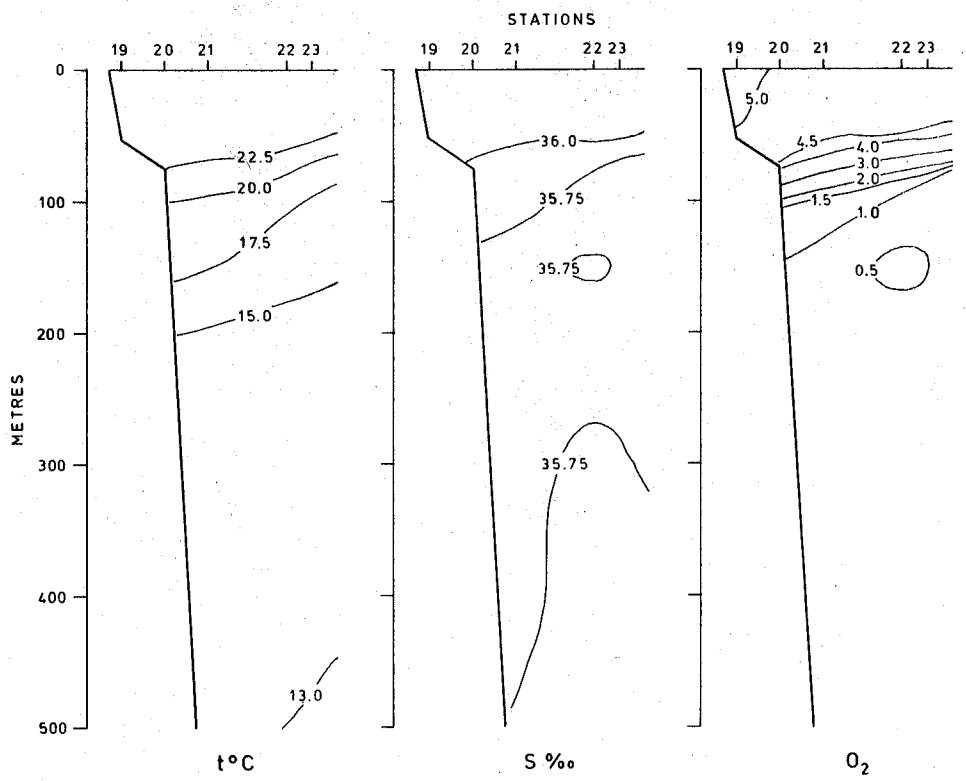


Fig. 26. Temperature, salinity and oxygen in the section Ras Asir - Abd al Kuri.

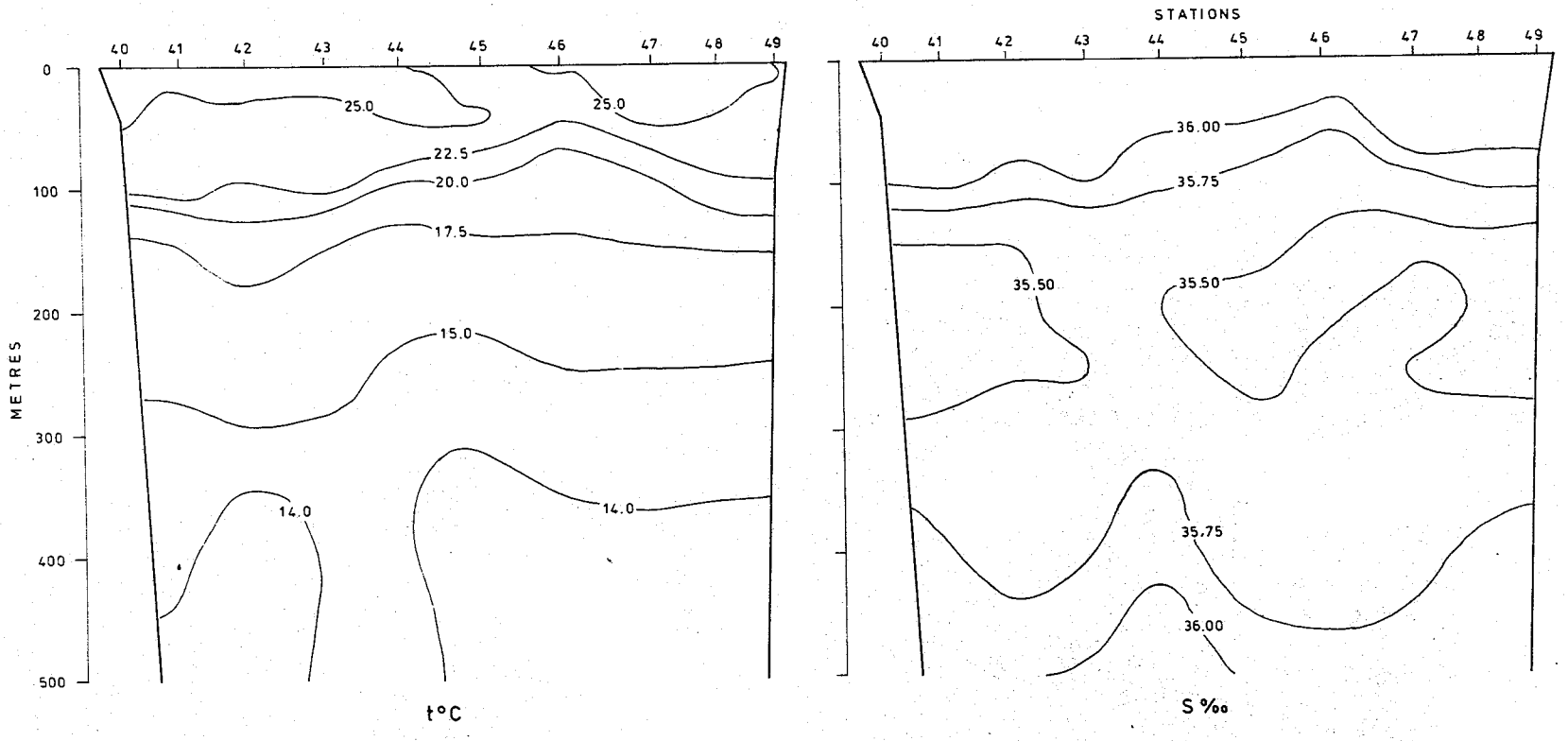
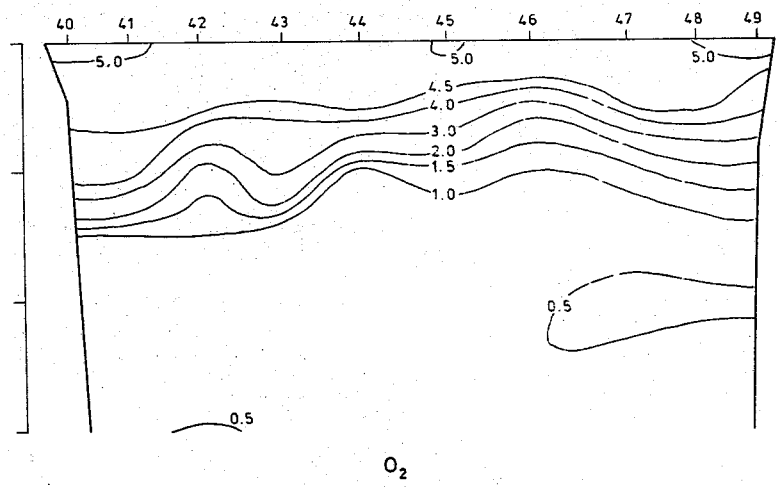
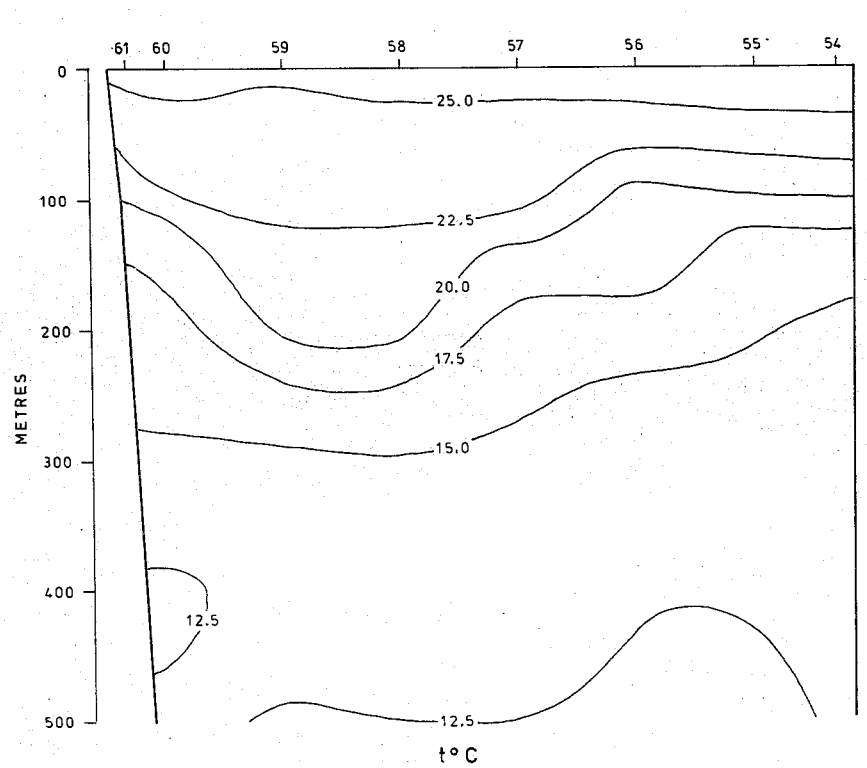


Fig. 27. Temperature, salinity and oxygen in the section Ghubbat al Ain - Elayu, Gulf of Aden.





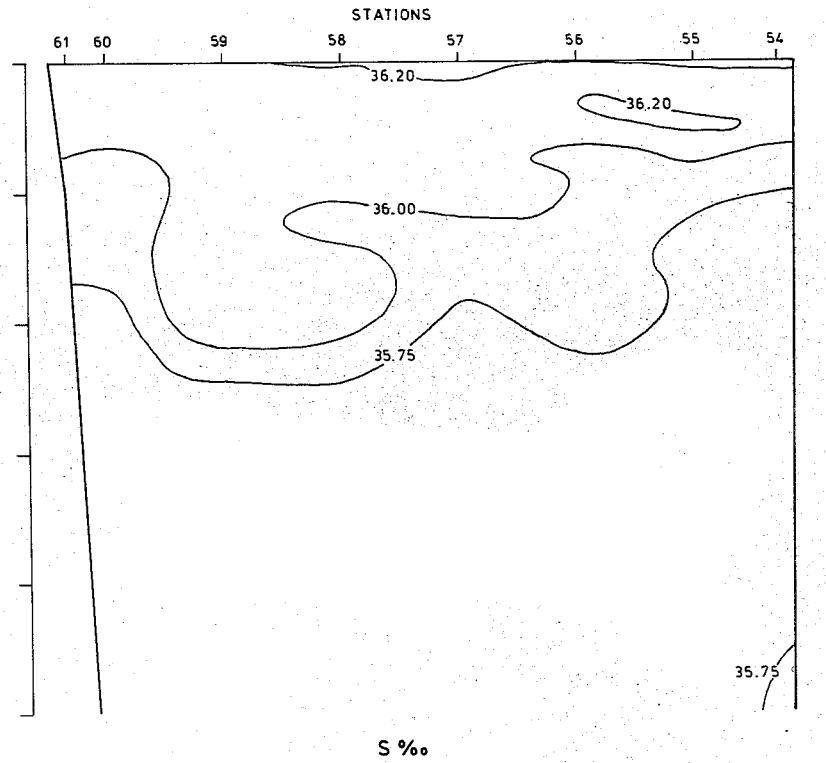
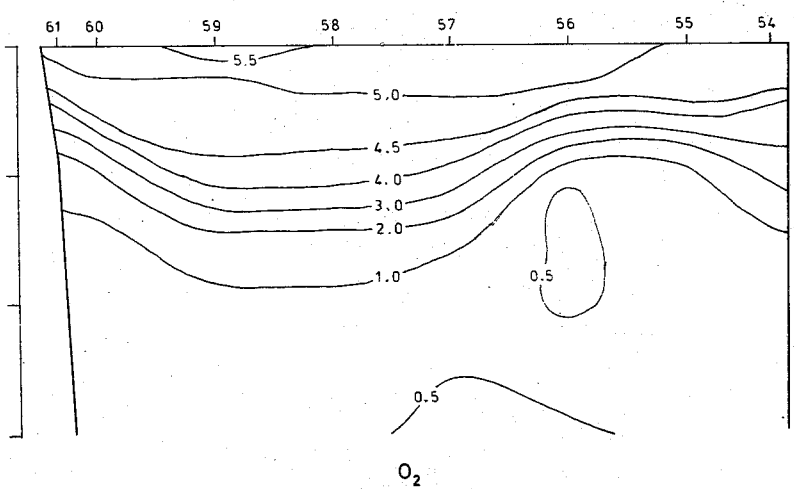


Fig. 28. Temperature, salinity and oxygen in the section Ras Fartak - Socotra.



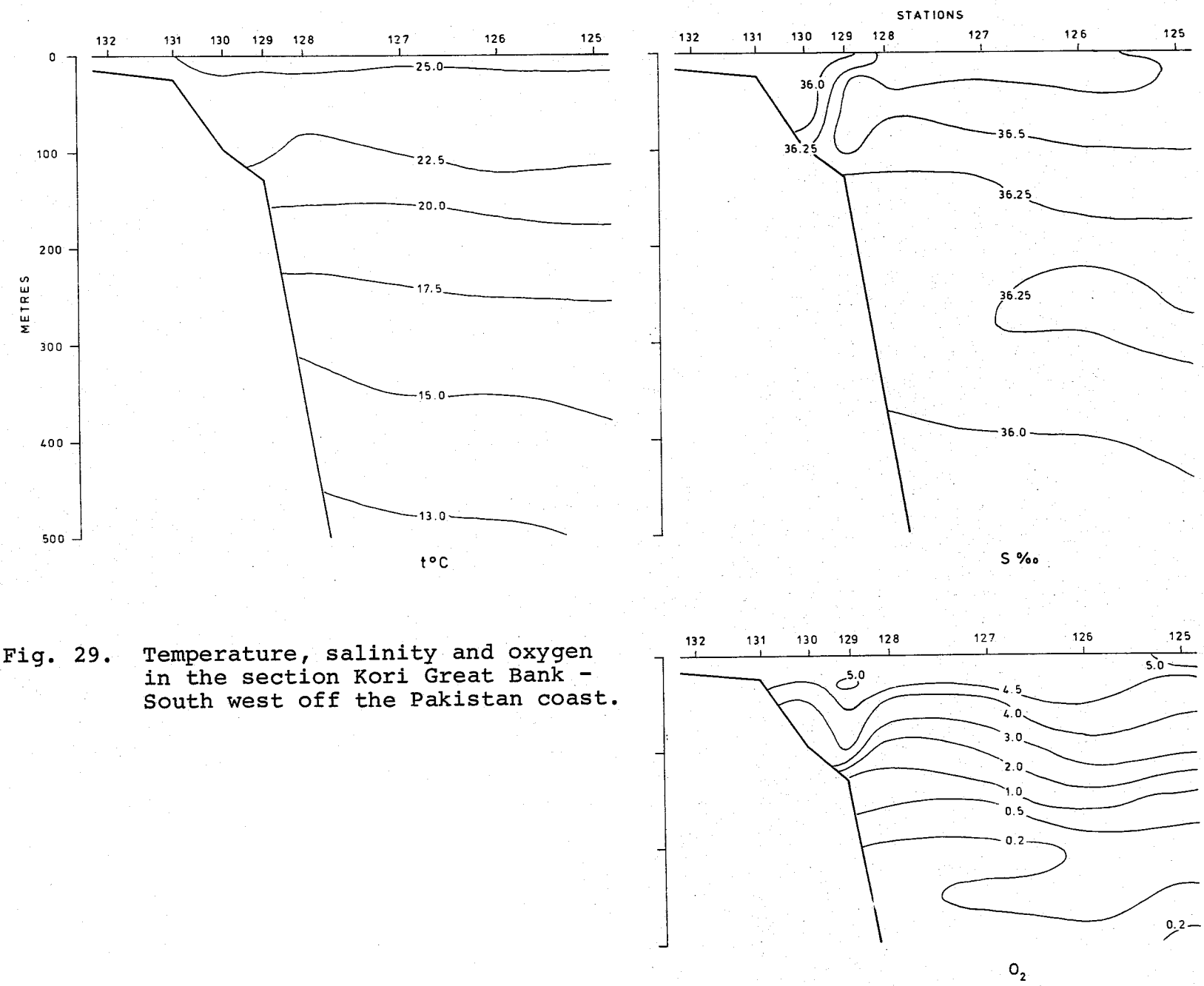


Fig. 29. Temperature, salinity and oxygen in the section Kori Great Bank - South west off the Pakistan coast.

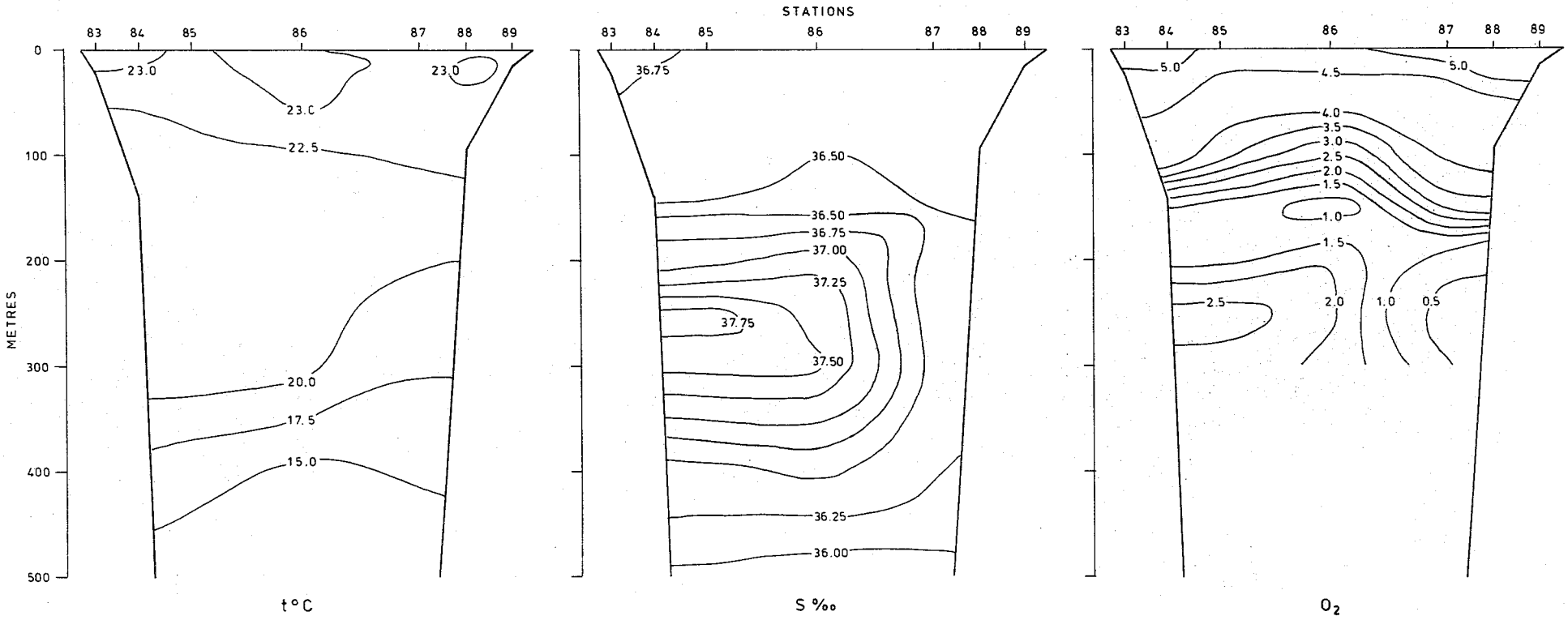


Fig. 30. Temperature, salinity and oxygen in the section Ras al Ghaf - Khor Rabij in the Gulf of Oman.