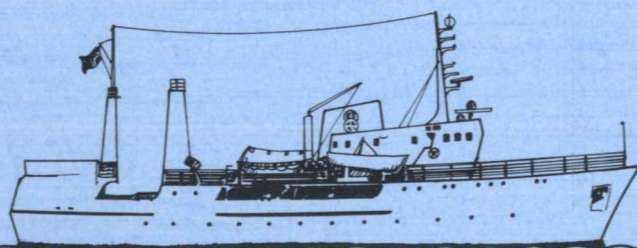


**JOINT NORAD/MOÇAMBIQUE/FAO PROJECT
TO INVESTIGATE THE FISH RESOURCES
OFF THE COAST OF MOÇAMBIQUE**

**cruise report no.1 of
R/V«DR. FRIDTJOF NANSEN»**



**Sub-contractor: Institute of Marine Research
Bergen-Norway**

INTRODUCTION

According to the agreement between the People's Republic of Mozambique and the Norwegian Agency for Development (NORAD) a project is carried out to survey the fish resources and fishing possibilities in the waters adjacent to Mozambique. The project is executed by a team of Norwegian scientists together with Mozambican specialists onboard the R/V "Dr. Fridtjof Nansen". It started in August 1977 and the present report is a preliminary review on the work done by R/V "Dr. Fridtjof Nansen" during her first cruise off the coast of Mozambique.

The main objectives of the project are as follows:

1. To map the distribution area of the commercially important fish stocks with special emphasis on the pelagic species.
2. To carry out biological studies of the commercially important species.
3. To carry out physical and chemical oceanographic studies within the distribution area.
4. To estimate the abundance of the important stocks.
5. To evaluate the efficiency of different fishing gears.
6. To introduce the Mozambican participants in the methods of acoustic fish stock assessment.

NARRATIVE

Departure: Maputo, 24 August 1977

Arrival: Maputo, 4 October 1977

Ports of call: Pemba, 29 - 31 August
Beira, 11 - 16 September

Captain: G. Haugland

Scientific staff: R. Sætre, C.J. Rørvik, R. Silva
(To 16 September), K. Strømsnes,
C. Achane (To 16 September),
B.J. Litleskare, E. Molvær,

M. Sousa (From 16 September),
F. Simões (From 16 September,
L. Mendonça (From 16 September).

Two Mozambican fishermen joined the crew in Maputo to be trained in modern fishing methods.

INSTRUMENTS AND METHODS

Vessel and gear

R/V "Dr. Fridtjof Nansen" is a 150 feet combined stern trawler and purse seiner. The main engine of 1500 Hp gives a maximum speed of 13 knots. There are accommodations for 28 men. All winches are hydraulic. She carries two pelagic trawls, one bottom trawl and one purse seine, gillnets, long lines and hand lines. A satellite navigator allows very precise determination of position.

Acoustics

The acoustic equipment consists of three scientific sounders (120, 50 and 38 kHz), two echointegrators, one sonar (18 kHz) and one net-sonde (50 kHz). The two echointegrators were coupled to the 38 kHz sounder.

Echo integrator values were read for each nautical miles and averaged over five nautical miles. Continuous watch was kept on the acoustic instruments and fishing carried out whenever the echo recordings changed its characteristics. The acoustic data were scrutinized once every day. Integrator contributions from false bottom, wakes etc. were deleted and the integrator readings were splitted in four categories: small pelagic fish, demersal fish, plankton and fish larvae, and mesopelagic fish. The values within each group were plotted on charts and finally all readings within each half degree square were averaged.

Fish biology

For identification of the species the following literature were used: J. L. B. Smith, 1949. The Sea Fishes of Southern Africa and the FAO Species Identification Sheets for Fishery Purpose. In case of discrepancy between these two manuals the latter was given priority.

For the biological observations the following guidelines were followed:

- A - Large fish: Length - Weight - Sex and Maturity stage for each specimen.
- B - Small fish: Length - Sex and Maturity stage for each specimen. Weight of entire sample.

The total length was used as the length measurement of fish. Small species were measured to the nearest 0.5 cm below the measurement and large species to the nearest 1 cm below. Also for lobster and shrimps the total length was used as measured from the tip of the rostrum to the posterior edge of the telson.

The criteria for the observation of maturity stages were as follows:

<u>Maturity stage</u>	<u>Stage no</u>
Immature	1
Mature unripe	2
Mature ripening	3
Mature nearly ripe	4
Mature ripe (Non spawning)	5
Mature ripe running	6
Mature spent	7

Plankton

Plankton samples were obtained at each hydrographic station by a vertical haul 100 - 0 m, with a 36 cm diameter Juday net of 500 μ mesh size. Wet displacement volume of the samples were measured on board. Due to bad weather conditions no plankton samples were obtained at SECTION VI.

Hydrography

At the hydrographic stations temperature and salinity were observed at the following standard depths: 0-10-20-30-50-75-100-125-150-200-250-300-400-500.

Samples for oxygen titration were taken from 0-10-20-30-50-75-100-150-200-300-500 m.

At SECTION V samples were taken at standard depths to the bottom.

The salinity and the oxygen samples were analyzed on board. Approximately each 30 nautical mile the vertical distribution of the temperature down to 250 m or bottom was observed by means of a bathy thermograph.

The surface current was mapped by observing the drift of the vessel.

Trawl bottom

The quality of the trawl bottom as judged from the echo recordings was characterized at depth shallower than 250 m according to the following scale:

Impossible to use bottom trawl	1
Possible with caution	2
Good trawl bottom	3

RESULTS

The cruise track, fishing stations and hydrographic stations are shown in Figs. 1a and 1b. Table 1 gives the details of the fishing stations and Table 2 gives the length distributions of the most important species.

Oceanography

The surface currents as observed by the drift of the vessel are shown in Figs. 2a and 2b. In the northern part off Cabo Delgado there is a northgoing current. This is a part of the seasonally changing moon-soon gyre in the Indian Ocean. The rest of the coast is dominated by the Mozambique current and the Agulhas current which are parts of the anticyclonic subtropical gyre.

Down to about 15°S the strongest current are found offshore, but further south the strongest current are usually observed above the continental edge. In the Sofala Bank area the currents were weak and variable. On the shelf north of Beira and in the Maputo Bay area a counter current were observed close to the shore. This countercurrent reached its highest velocities off the Island of Inhaca.

The maximum current velocities were 3 to 4 knots.

The horizontal temperature distribution in the surface is shown in Figs. 10a and 10b. The highest temperatures were observed in the northern part gradually decreasing southwards.

Figs. 11a and 11b show the horizontal salinity distribution in the surface. The influence of the fresh water outflow from the Zambezi River is clearly demonstrated.

The depth to the thermocline, D , was defined as $(t_0 - t_D) < 1^\circ\text{C}$ where t_0 is the temperature in the surface and t_D the temperature at the upper boundary of the thermocline. In Figs. 12a and 12b are drawn isolines of this depth. The thickness of the mixed and homogeneous layer is about 100 m in the northern area and decreases towards the shelf.

Figs. 3 - 9 show the vertical distribution of temperature, salinity and oxygen content in the six hydrographic sections along the coast. SECTION I is the northernmost section and SECTION VI the southernmost.

The temperature is decreasing from 23 - 25°C at the surface to 10 - 11°C in 500 m. A characteristic feature in all the sections is the salinity maximum at about 200 m depth. This water originates from the subtropical surface water of the southern subtropical gyre. There is a oxygen minimum within the thermocline slightly above the salinity maximum.

Trawl bottom

The configuration of the continental shelf off the northern part of Mozambique down to about 15°S is markedly different from the rest of the Mozambican shelf. Here the shelf is narrow, only a few hundred meters, and deeply scarred with submarine canyons. Only at a few localities it seems possible to use bottom trawl and then mainly at depths between 100 and 200 m. Neither the shallow Bank of St. Lazarus seems to be suited for bottom trawling due to rough bottom and corals.

South of 15°S, off Beira, is an area which seems unsuitable for bottom trawling due to the undulating character of the bottom (Fig. 2b). The depth is less than 50 m and the waves at the bottom is most likely sand waves generated by strong current. The wavelength is several hundred meters and the amplitude 10 - 15 m.

Occasionally bad trawl bottom was observed in other localities, but not as a coherent larger area.

Plankton

Figs. 13a and 13b show the average integrator deflection in mm per nautical mile due to plankton. These recordings include also a minor contribution from mesopelagic fishes during night. These fishes occur at the surface at night and then it is difficult to separate the contribution from mesopelagic fishes from that of plankton.

There is also a vertical migration of zooplankton. Off the shelf area krill was observed in the upper layer during nighttime only. During daytime the krill migrates to deeper layers and scatters. A vertical migration of plankton was noticeable, also in shallow waters.

The highest concentrations of plankton were usually found close to the continental edge. At the continental shelf north of Beira huge aggregates of phytoplankton were observed floating at the surface.

The wet displacement volume of plankton along the hydrographic sections, (Fig. 14), was usually below 5 ml except at SECTION I. An attempt was made to correlate the integrator contribution from plankton and the wet displacement volume. The correlation was rather poor. The main reason for this discrepancy is most likely that the echo integrator readings are caused by all plankton particles and that the Juday net with 500 μ mesh size is catching only the larger organisms.

Surface observations

Figs. 2a and 2b show the recorded sightings of tunas or tunalike fishes, turtles, whales and dolphins.

The schools of tuna or tunalike fishes were often discovered because of the birds which preyed on the same fishes in the surface as the tuna. In the northern area the efficiency of the visual observations for tunas was greatly reduced due to wind.

Dolphins were observed on five occasions when they approached the vessel and rided the bow wave. The largest group consisted of at least twenty animals, and were observed on the Admiralte Leite Bank. Dolphins are generally difficult to identify in the sea with certainty. It is likely, however, that most of the dolphins observed were bottlenose dolphins (Tursiops truncatus). This species is found worldwide in temperate and tropical waters.

Of the 12 larger whales observed 11 were humpbacks (Megaptera novaeangliae), all of which were observed in the shelf area. One large whale was observed outside the shelf at 2 500 meters depth. This was a Balaenoptera sp., probably a fin whale (B. physalus) or a sei whale (B. borealis). This unidentified whale seemed to have been scared by the vessel, possible because of the sonar. Approximately 1 nautical mile was the nearest we got to this fast swimming whale.

In the modern whaling off Mozambique in 1910 to 1915, humpbacks made up almost 100% of the catch. Most of the whaling boats had their base at Inhambane. The whaling season usually started in June when the humpbacks arrived from the feeding grounds in the Antarctic, and lasted to the beginning of November when most of the whales had migrated further south.

Pelagic fish

Except for a few visual observations of tunas or tunalike fishes very few recordings were made outside the continental shelf. The echo recordings of fish were mainly confined to the shelf area and to the St. Lazarus Bank (S 12°10', E 41°25').

The pelagic fish recorded at St. Lazarus Bank consisted mainly of banded barracuda (Sphyraena jello) of the length 50-60 cm and cardinal fish (Apogonidae sp.). Small schools of horse mackerel were observed visually from the vessel, but due to the shallow water it was impossible to get any samples of this species. The barracudas caught were all in maturity stage 3.

Good recordings were made at the bottom of about 180 m depth off Nacala. Due to rough bottom it was impossible to trawl at the best recordings. Snake mackerel (Thyrstitoides sp.) and round scad (Decapterus maruadsi) were caught at trawl station in the vicinity of these recordings. It is most likely, however, that the recordings consisted mainly of round scad because of the character of the echo recordings. Moreover, R/V "Prof. Mesaytsev" had a good catch of this species in the same area and depth. The length of the round scad was 22 - 35 cm, with an average length of 28.3 cm. Most of the fish was in maturity stage 3, but there was also some in stage 6 and 7.

Off the Zambezi River good pelagic recordings were obtained consisting mainly of species from the families Engraulidae and Clupeidae. The dominating species by weight were indian pellon (Pellona ditchela) and orangemouth thryssa (Thryssa vitirostris). Minor contribution

comes from rainbow sardine (Dussumeria acuta) and buccaneer anchovy (Stolephorus buccaneeri). Largehead hairtail (Trichiurus lepturus) was a dominant species at trawl station 206. The majority of the orangemouth thryssa was in maturity stage 2 and 3 with a length from 10 to 17 cm. For the indian pellona the maturity stage were mainly 3 and 4 and the length 13 - 17 cm.

Off Beira the pelagic recordings were completely dominated by buccaneer anchovy. The average length was 4 - 5 cm. This species occurred both as a continuous layer and as large schools. The largest catch rate during the cruise was obtained at trawl station 200 on buccaneer anchovy with 4.8 tons/trawl hour.

At the Sofala Bank area between 18° and 21° south fish larvae of different pelagic species as round scad, Sardinella sp., short-bodied mackerel (Rastrelliger brachysoma), indian mackerel (R. kanagurta) and obtuse barracuda (Sphyrena obtusata) were found.

North of Inhambane some round scad were observed and further south small schools of layang scad (Decapterus macrosoma) and horse mackerel (Trachurus trachurus) were recorded. A large contribution to the pelagic recordings south of Inhambane, however, came from schools of porcupine fish (Diodon maculifer).

The most important distribution area for pelagic fish seems to be the Sofala Bank area off Beira and the shelf area off the Zambezi River. The dominant species recorded on this cruise were buccaneer anchovy and clupoides. Horse mackerels, especially the round scad which was observed along the whole coast, made also a significant contribution. Due to few trawl stations in the northern part of the coast the abundance of the round scad observed north of Nacala might be seriously underestimated. This might also relate to the snake mackerel occurring at the depth of 200-300 m where the numbers of trawl haul were rather few.

Demersal fish

At St. Lazarus Bank the use of bottom trawl was impossible due to rough bottom. This, together with a strong current also made it difficult to use long line or gill net. However, good catches were made by handlines. The catch consisted almost exclusively of the mangrove red snapper (Lutjanus argentimaculatus) at the depths between 20 and 30 m. The average weight of the fish was 2.8 kg and the maximum weight 7.7 kg.

In the shelf area between Pebane and the Sofala Bank the catches of demersal fish were rather poor. Dominating species were different croakers (Otholithes ruber, Johnius belangerii, J. dussumieri, J. coitor). In addition some goatfish (Upeneus sp.), lined silver grunt (Pomadasyss hasta) and blackspot threadfin (Polynemus sextarius) also occurred in the catches.

Farther south trawling usually took place at greater depths as given in Table 1. The dominant species were seabreams (Evynnis cardinalis, Chrysoplephus anglicus, C. puniceus, Pagellus natalensis). The best catches obtained were of englishman (Chrysoplephus anglicus) at trawl station 218 (237 kg/trawl hour) and of Polysteganus coeruleopunctatus (208 kg/trawl hour) at trawl station 214.

Mesopelagic fish

The general impression concerning mesopelagic fishes is that the abundance is low. Recordings of a deep scattering layer were rare. At a few localities single schools were observed during daytime at 200-300 m. The catches of mesopelagic fishes were mainly obtained in the surface layer during nighttime with lantern fish (Myctophidae sp.) and Cubiceps sp. as dominant species.

Along the continental slope south of Beira mesopelagic fishes were recorded close to the bottom. According to the trawl catches these recordings consisted of Myctophidae sp., Champsodon capensis, hatchet fish (Polyipnus spinosus), Psenes indicus and Neoscombrops annectens.

Crustacea

The crustacea caught during this cruise are mainly included in the following groups:

PENAEIDAE

CARIDAE

ASTACURA

PALINURA

The shrimps belonging to the family Penaeidae were caught at depths between 13 and 570 m. The species composition in shallow water, however, differs from that of deeper water. At depths down to about 40 m the following species were the most significant: Flower shrimp - Penaeus japonicus, White prawn - P. indicus, Jumbo tiger prawn - P. monodon, Brown shrimp - Metapenaeus monoceros and M. stebbingi. In general these species were more abundant in the trawl catches near the mouth of the rivers.

In deeper water the shrimp catches consisted of the following species: Hymenopenaeus triarthrus, Aristeomorpha foliacea, Penaeus marginatus or P. trisulcatus, Penaeopsis philifrii and Solenocera africannum.

Several species of shrimps belonging to the group Caridae were observed at all depths. The following species have been determined: Heterocarpus dorsalis, H. tricarinatus, Glyphocrangon dentatus and Oplophorus sp.

Between 400 and 570 m the following species of the family Astacidae (Lobster) were recorded: Nephrops andamanica and N. stewarti.

Between 200 and 570 m the following specimens from the group Palinura were caught: From the family Palinuridae - Spiny lobster - Palinurus delagoae, from the family Scyllaridae - Showel-nosed lobster - Ibacus incisus and from family Eryohidae - Polychetes granulatus. In addition specimens of the group Stomatopoda and crabs of the family Inachidae - Pleistacantha mosekyi were caught.

Lack of time and bibliography made it impossible to determine all the crustacea material. Data on catch rates are not presented as they are believed not to be representative due to unsuitable gear for crustacea.

Table 1. RECORD OF FISHING OPERATION

BT = Bottom trawl - PL = Pelagic trawl - GN = Gillnet

LL = Long line - HL = Handline

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
2.9	188	GN	30	0-10	12°12'	41°25'	33	-	Mangrove red snapper <u>Lutjanus argentimaculatus</u> Brown shark <u>Carcharhinus obscurus</u>
3.9	189	HL	30	30	12°12'	41°25'	53	-	Mangrove red snapper <u>Lutjanus argentimaculatus</u> Yellowfin jack <u>Caranx ignobilis</u>
3.9	190	PL	25-300	0-20	12°09'	41°26'	64	40	Cardinal fish <u>Apogonidae</u> sp. Banded barracuda <u>Sphyraena jello</u> Yellowfin jack <u>Caranx ignobilis</u>
3.9	191	HL	30	30	12°12'	41°25'	113	-	Mangrove red snapper <u>Lutjanus argentimaculatus</u>
4.9	192	LL	25	25	12°12'	41°25'	9	-	Mangrove red snapper <u>Lutjanus argentimaculatus</u>
5.9	193	BT	190	190	13°57'	40°39'	65	65	Round scad <u>Decapterus maruadsi</u> Snake mackerel <u>Thyrsitoides</u> sp. Sharks
6.9	194	BT	33	33	15°29'	40°39'	0	0	No catch
6.9	195	PT	2000	0-16	15°38'	41°46'	4	8	Lantern fish <u>Myctophidae</u> sp. <u>Cubiceps</u> sp.

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
7.9	196	PT	1700	10-26	16°22'	40°33'	4	8	Eel larvae Lantern fish <u>Myctophidae</u> sp. <u>Cubiceps</u> sp.
8.9	197	PT	530	0-16	16°54'	39°31'	21	42	Lantern fish <u>Myctophidea</u> sp. Krill
9.9	198	BT	13	13	17°09'	38°42'	94	95	Flower shrimp <u>Penaeus japonicus</u> Kelee shad <u>Hilsa Kelee</u> Catfish <u>Arius</u> sp.
9.9	199	BT	150	150	17°28'	38°32'	1	2	Lantern fish <u>Myctophidae</u> sp. Toby <u>Arothron immaculatus</u>
16.9	200	PT	27	0-16	19°48'	35°26'	2075	4300	Anchovy juv. <u>Stolephorus</u> sp. Round scad <u>Decapterus maruadsi</u>
17.9	201	BT	40	40	18°56'	36°52'	0	0	No catch
17.9	202	BT	33	33	18°44'	36°58'	35	70	Goatfish <u>Upeneus</u> sp. Round scad <u>Decapterus maruadsi</u> Narrow-barred Spanish mackerel <u>Scomberomorus commerson</u>
18.9	203	BT	20	20	18°24'	36°52'	4	8	Shortfin Lizardfish <u>Saurida micropectoralis</u> Indian mackerel <u>Rastrelliger kanagurta</u> Squids
19.9	204	PT	180	16-32	19°26'	36°49'	200	400	Indian driftfish <u>Ariomma indica</u> Sharks
19.9	205	PT	35	12-28	19°00'	36°35'	50	70	Buccaneer anchovy <u>Stolephorus buccaneeri</u>

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
19.9	206	BT	20	20	18°56'	36°36'	190	380	Indian pellona <u>Pellona</u> ditchela <u>Largehead hairtail</u> <u>Trichiurus lepturus</u> Lined silver grunt <u>Pomadasys</u> <u>hasta</u>
19.9	207	BT	20	20	19°00'	36°20'	610	1220	Indian pellona <u>Pellona</u> ditchela <u>Orangemouth</u> <u>thyssa</u> <u>Thryssa vitrirostris</u> Rainbow sardine <u>Dussumieria</u> <u>acuta</u>
19.9	208	BT	210	210	19°34'	36°41'	15	30	Lantern fish <u>Myctophidae</u> sp. <u>Neoscombrops</u> sp. <u>Languster</u> <u>Palinurus delagoae</u>
20.9	209	PT	35	0-16	19°51'	35°36'	20	30	Buccaneer anchovy <u>Stolephorus buccaneeri</u>
21.9	210	PT	840	50-66	20°39'	36°00'	10	20	Lantern fish <u>Myctophidae</u> sp. <u>Trachipteridae</u> sp.
21.9	211	PT	40	10-26	20°23'	35°42'	5	6	Cardinal fishes <u>Apogonidae</u> sp Shark sucker <u>Echeneis</u> naucrates <u>Indian mackerel</u> <u>Rastrelliger kanagaruta</u>
22.9	212	BT	570	570	21°23'	35°41'	23	23	Hatched fish <u>Polyipnus</u> <u>spinosus</u> <u>Shrimp</u> <u>Macropetasma</u> <u>africanum</u> <u>Shrimp</u> <u>Carida</u> sp.
22.9	213	BT	275	275	21°25'	35°35,5'	30	60	Lantern fish <u>Myctophidae</u> sp. Brushtooth <u>Lizardfish</u> <u>Saurida undosquamis</u> <u>Sharks</u>

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
23.9	214	BT	140	140	22°21'	35°37'	152	260	Blueskin <u>Polysteganus coeruleopunctatus</u> Seabream <u>Evynnis cardinalis</u>
24.9	215	PT	40	10-25	23°11'	35°34'	11	6	Round scad <u>Decapterus maruadsi</u>
25.9	216	BT	223	223	24°00'	35°39,5'	0	0	No catch
25.9	217	BT	205	205	24°03'	35°38'	44	88	Crocodile fish <u>Peristedion adeni</u> Brushtooth lizardfish <u>Saurida undosquamis</u> Sharks
28.9	218	BT	97	97	26°06'	33°03'	424	424	Englishman <u>Chrysoblephus anglicus</u> Slinger <u>C. puniceus</u> Red grunter <u>Pagellus natalensis</u>
28.9	219	BT	240	240	26°05'	33°04'	<1		
29.9	220	BT	285	285	25°23'	30°40,5'	194	288	Snake mackerel <u>Cempylidae</u> sp. <u>Neoscombrops annectens</u> <u>Champsodon capensis</u>
29.9	221	BT	400	400	25°25'	33°55'	18	18	Dolphinfish <u>Coelorhynchus</u> sp. Lobster <u>Nephrops andamanicus</u> <u>Chlorophthalmus agassizi</u>
30.9	222	BT	118	118	25°08'	34°40'	47	94	<u>Psenes indicus</u> Hammerhead shark <u>Sphyrna zygaena</u> Rock cod <u>Epinephelus</u> sp.

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
30.9	223	BT	215	215	25°21'	34°12'	321	642	<u>Champsodon capensis</u> Croaker <u>Sciaenidae</u> sp. Brushtooth lizard-fish <u>Saurida undosquamis</u>
30.9	224	PT	50	16-27	24°49'	34°59'	150	300	<u>Buccaneer anchovy</u> <u>Stolephorus buccaneeri</u> Horse hackerel <u>Decapterus macrosoma</u> Horse mackerel <u>Trachurus trachurus</u>
1.10	225	PT	150	115-125	24°32'	35°25'	7	14	Krill Squids Anchovy Larvae <u>Stolephorus</u> sp.
1.10	226	PT	120	25-40	24°26'	35°26'	210	420	Porcupine fish <u>Diodon</u> <u>Maculifer</u>

FIGURES

- Fig. 1a Survey grid and stations - northern part.
- Fig. 1b Survey grid and stations - southern part.
- Fig. 2a Surface and current observations - northern part
- Fig. 3 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION I, 0 - 500 m.
- Fig. 4 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION II, 0 - 500 m.
- Fig. 5 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION III, 0 - 500 m.
- Fig. 6 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION IV, 0 - 500 m.
- Fig. 7 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION V, 0 - 500 m.
- Fig. 8 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION V, 0 - bottom.
- Fig. 9 Vertical distribution of $t^{\circ}\text{C}$, S o/oo and O_2 ml/l in SECTION VI, 0 - 500 m.
- Fig. 10a Surface temperature and demersal fish recordings - northern part
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- Fig. 13b Plankton - Average integrator deflection in mm per nautical mile - southern part.
- Fig. 14 Wet displacement volume of plankton at the hydrographic sections I-V.

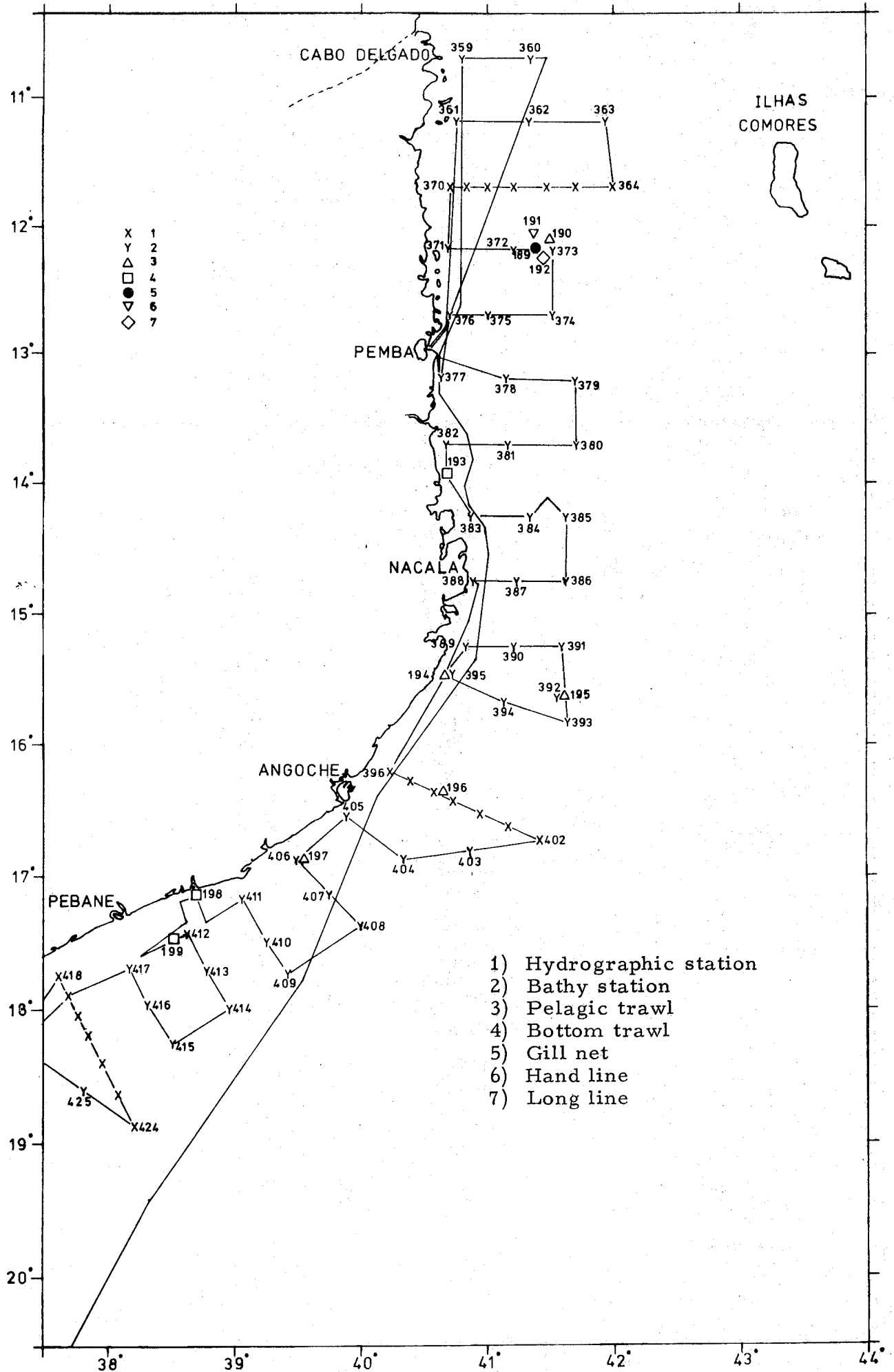


Fig. 1a. Survey grid and stations - northern part.

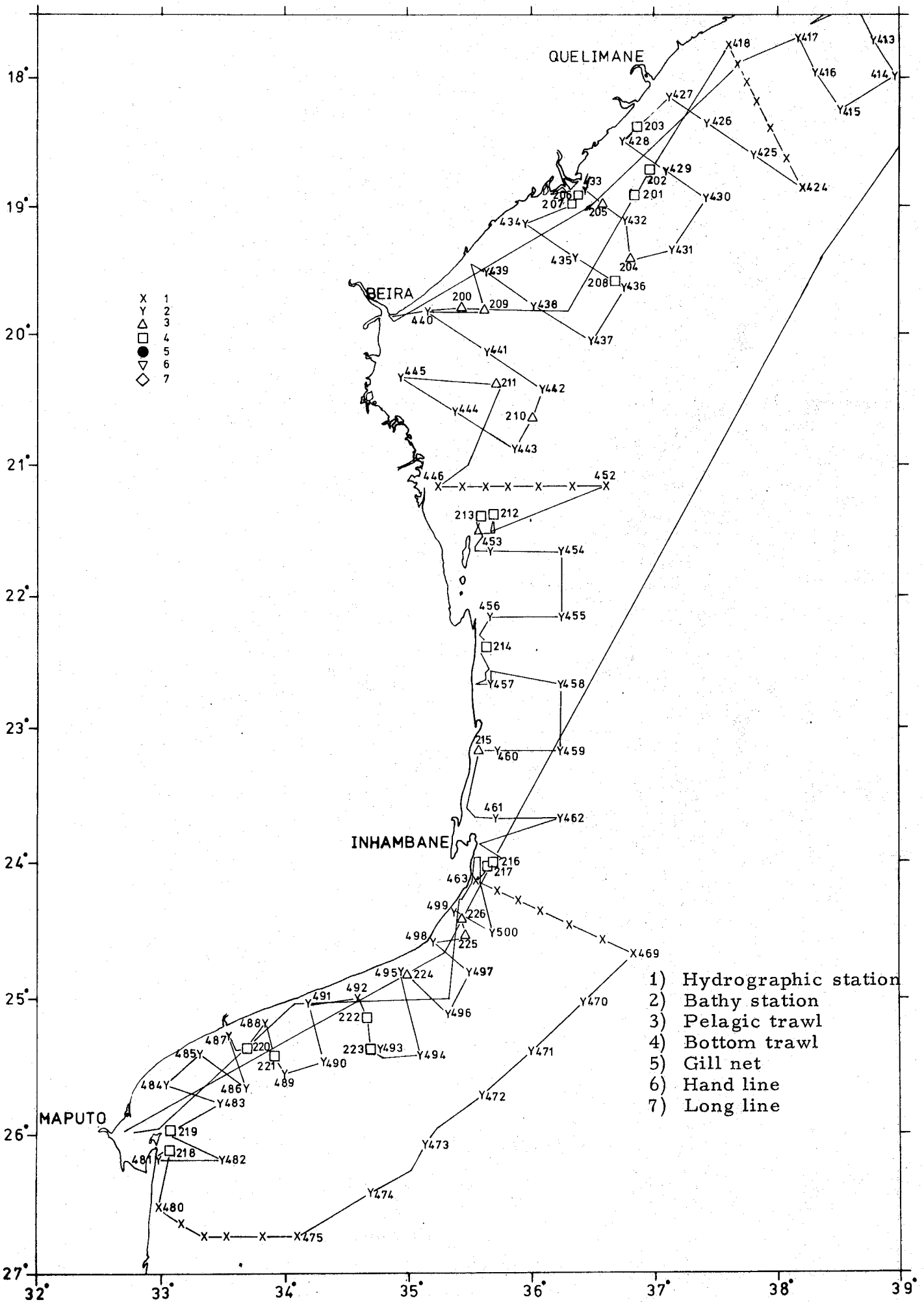


Fig. 1b. Survey grid and station - southern part.

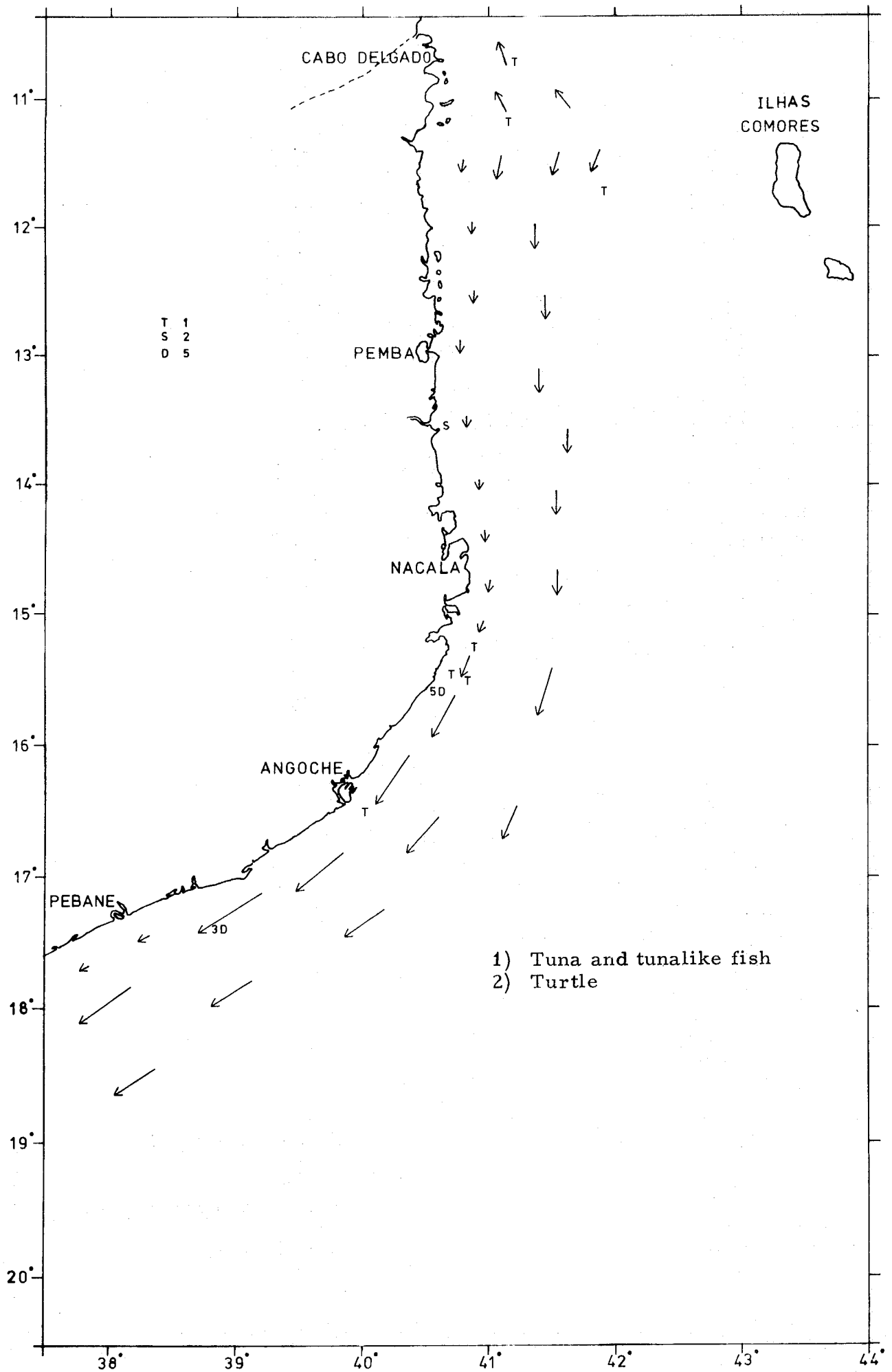


Fig. 2a. Surface and current observations - northern part.

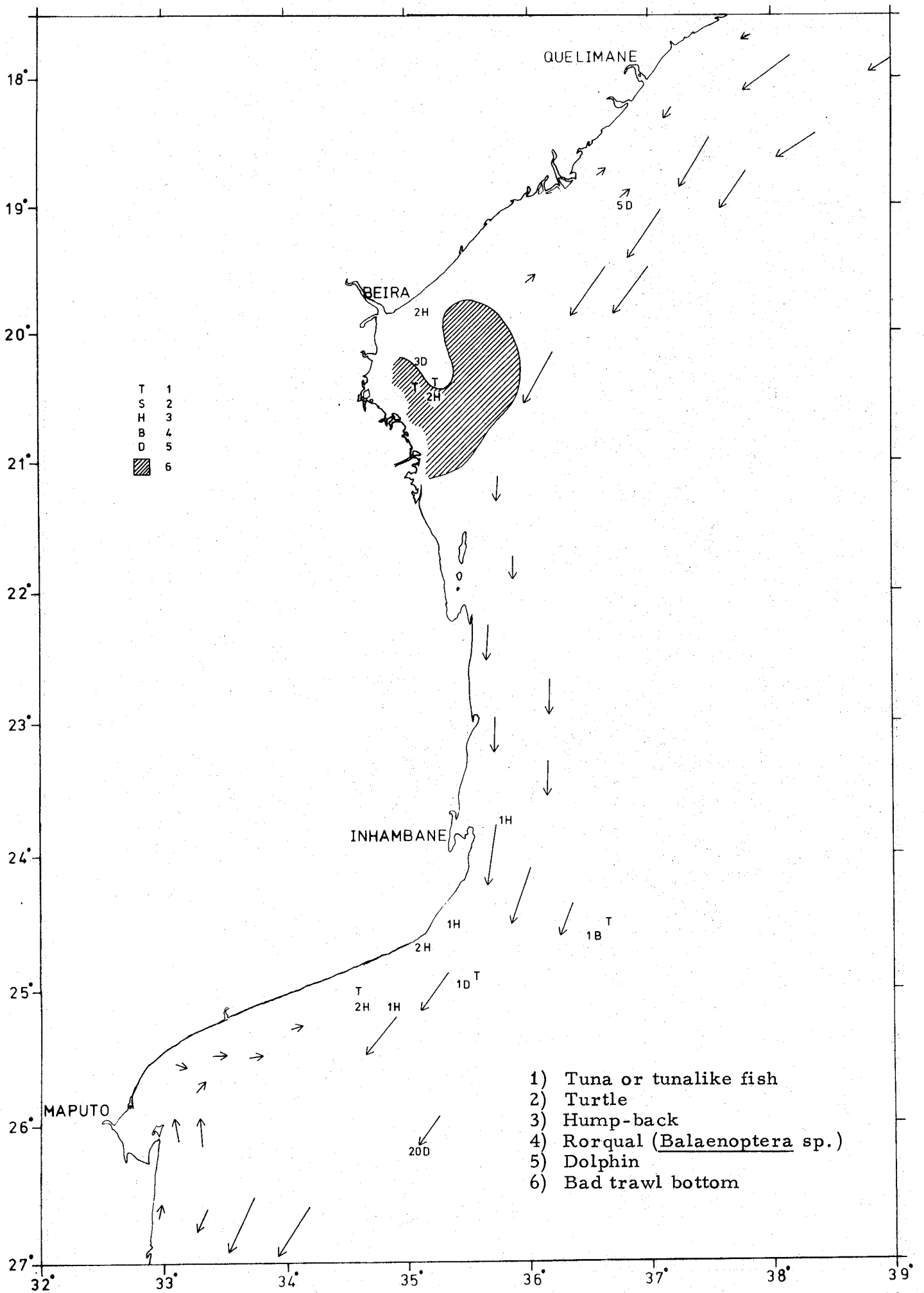


Fig. 2b. Surface and current observations - southern part.

SECTION I 1-2 SEPTEMBER 1977

STATIONS

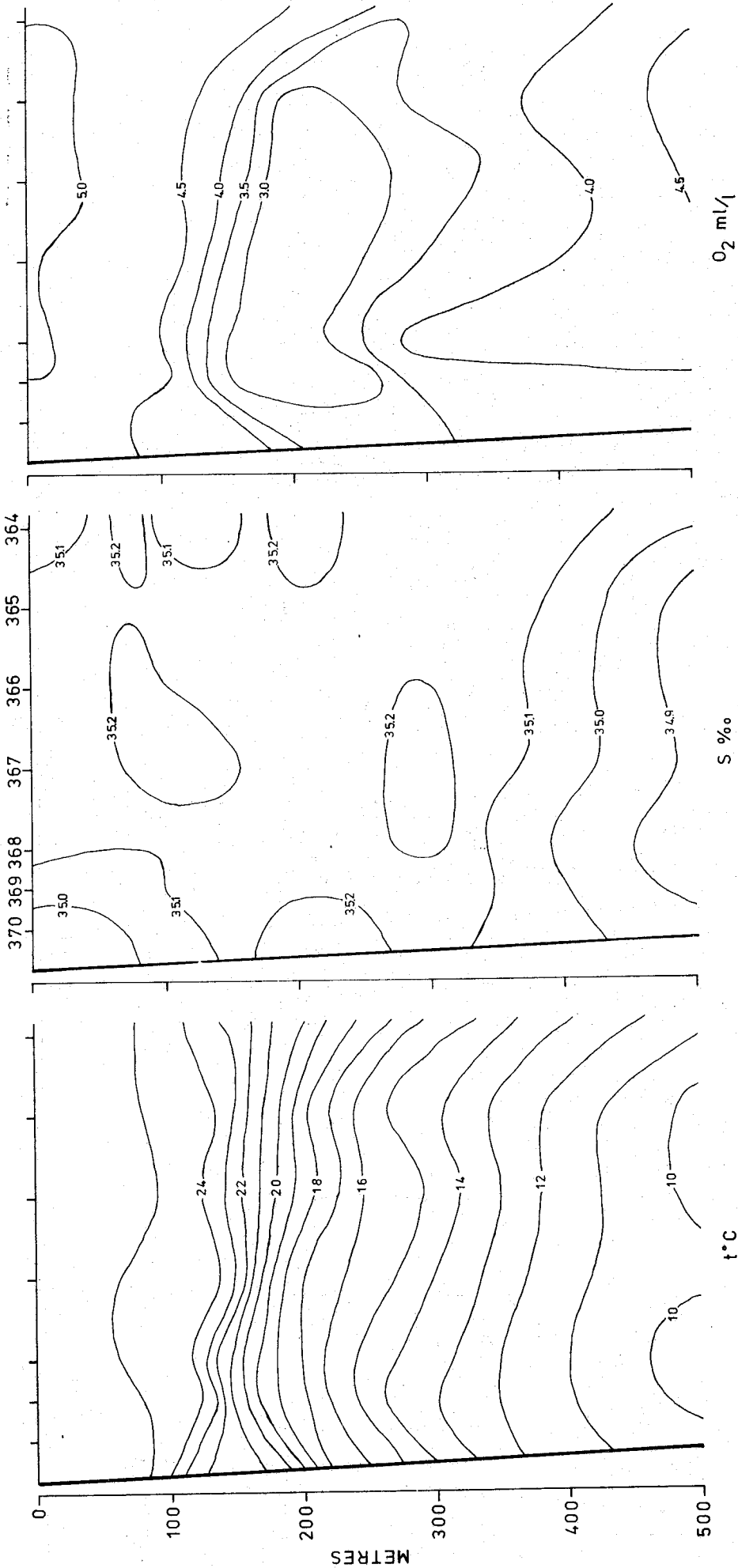


Fig. 3. Vertical distribution of $t^{\circ}\text{C}$, $S\text{‰}$ and $\text{O}_2 \text{ ml/l}$ in SECTION I, 0-500 m.

SECTION II 7-8 SEPTEMBER 1977

STATIONS

396 397 398 399 400 401 402

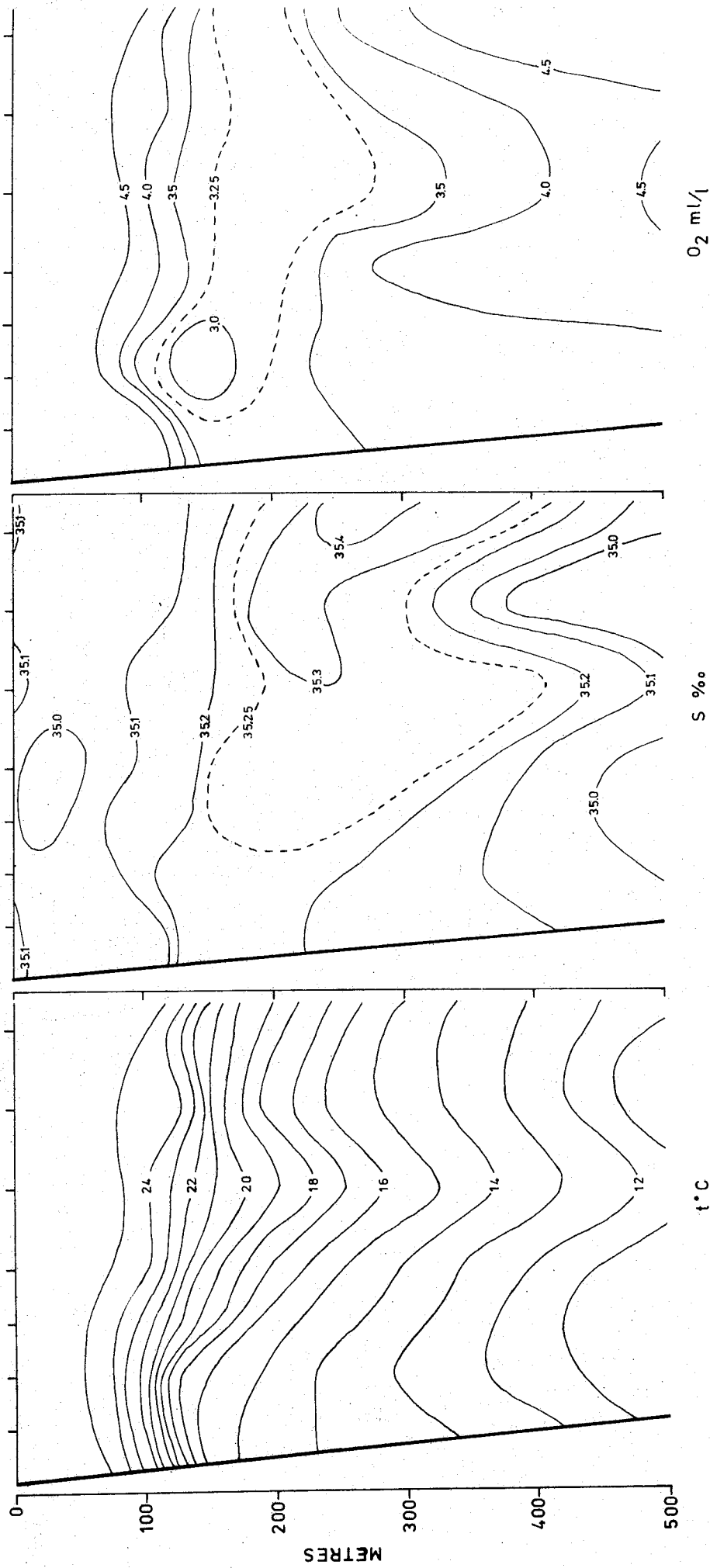


Fig. 4. Vertical distribution of t°C, S‰ and O₂ ml/l in SECTION II, 0-500 m.

SECTION III 17-18 SEPTEMBER 1977

STATIONS

418 419 420 421 422 423 424

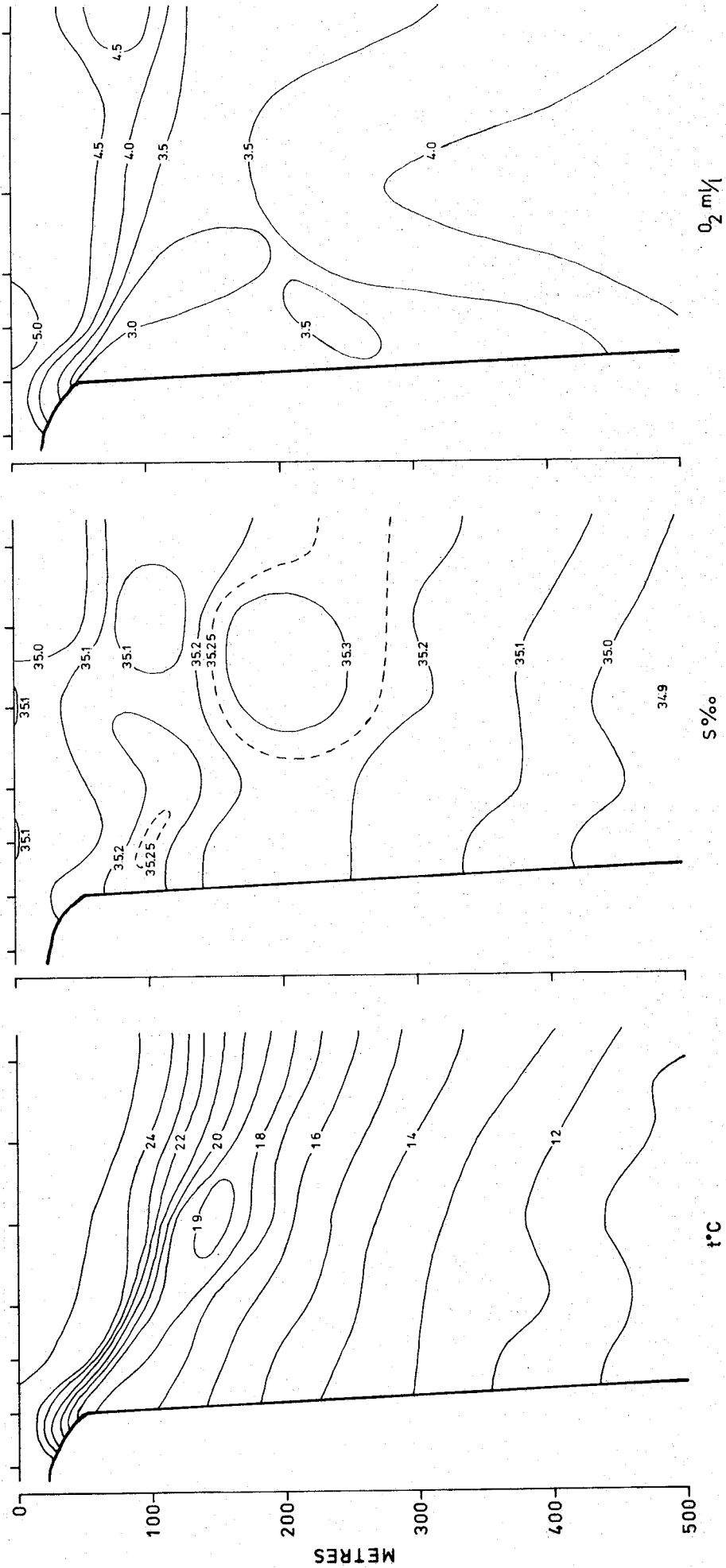


Fig. 5. Vertical distribution of t°C, S‰ and O₂ ml/l in SECTION III, 0-500 m.

SECTION IV 21-22 SEPTEMBER 1977

STATIONS

446 447 448 449 450 451 452

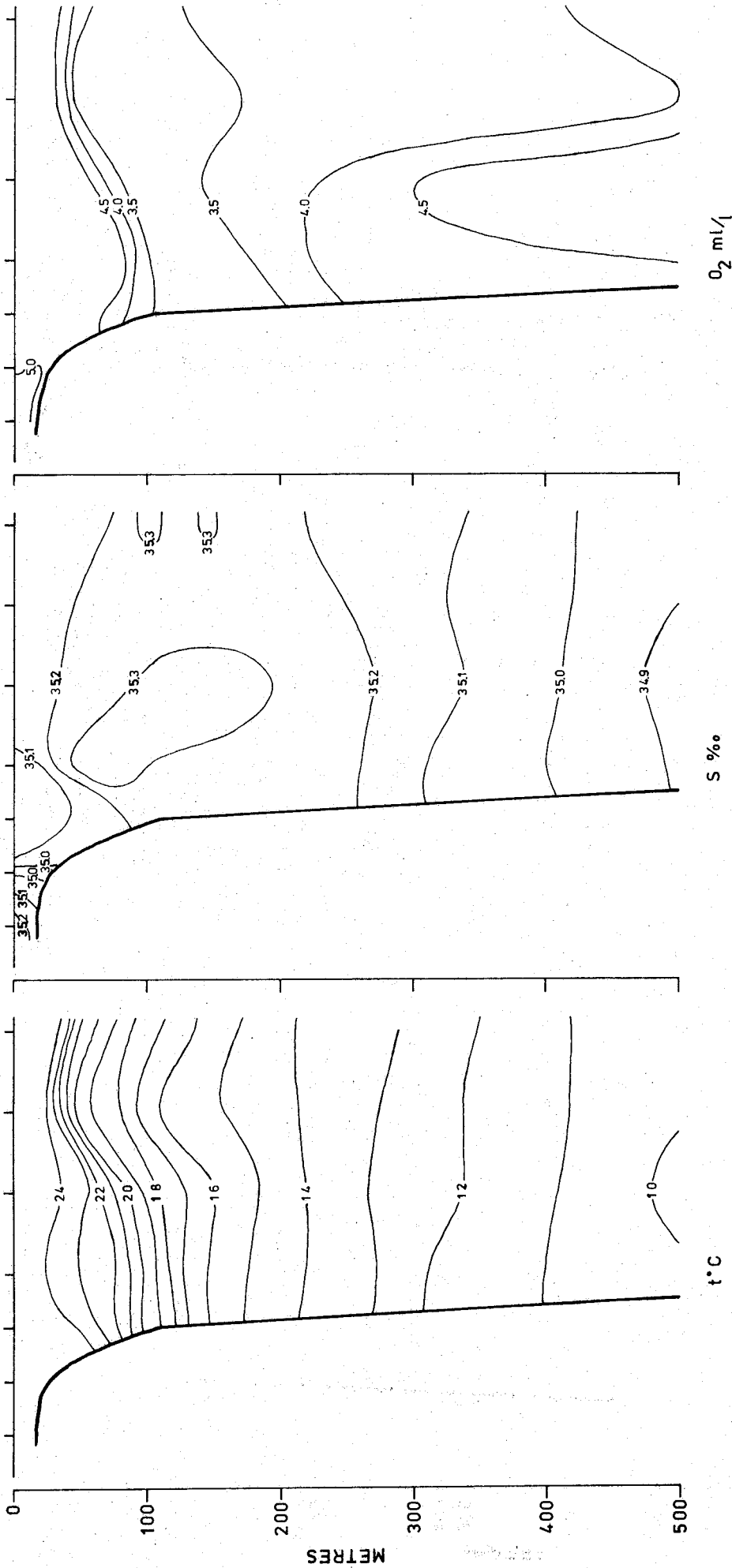


Fig. 6. Vertical distribution of $t^{\circ}\text{C}$, $S\text{‰}$ and $\text{O}_2\text{ ml/l}$ in SECTION IV, 0-500 m.

SECTION V 25-26 SEPTEMBER 1977

STATIONS

463 464 465 466 467 468 469

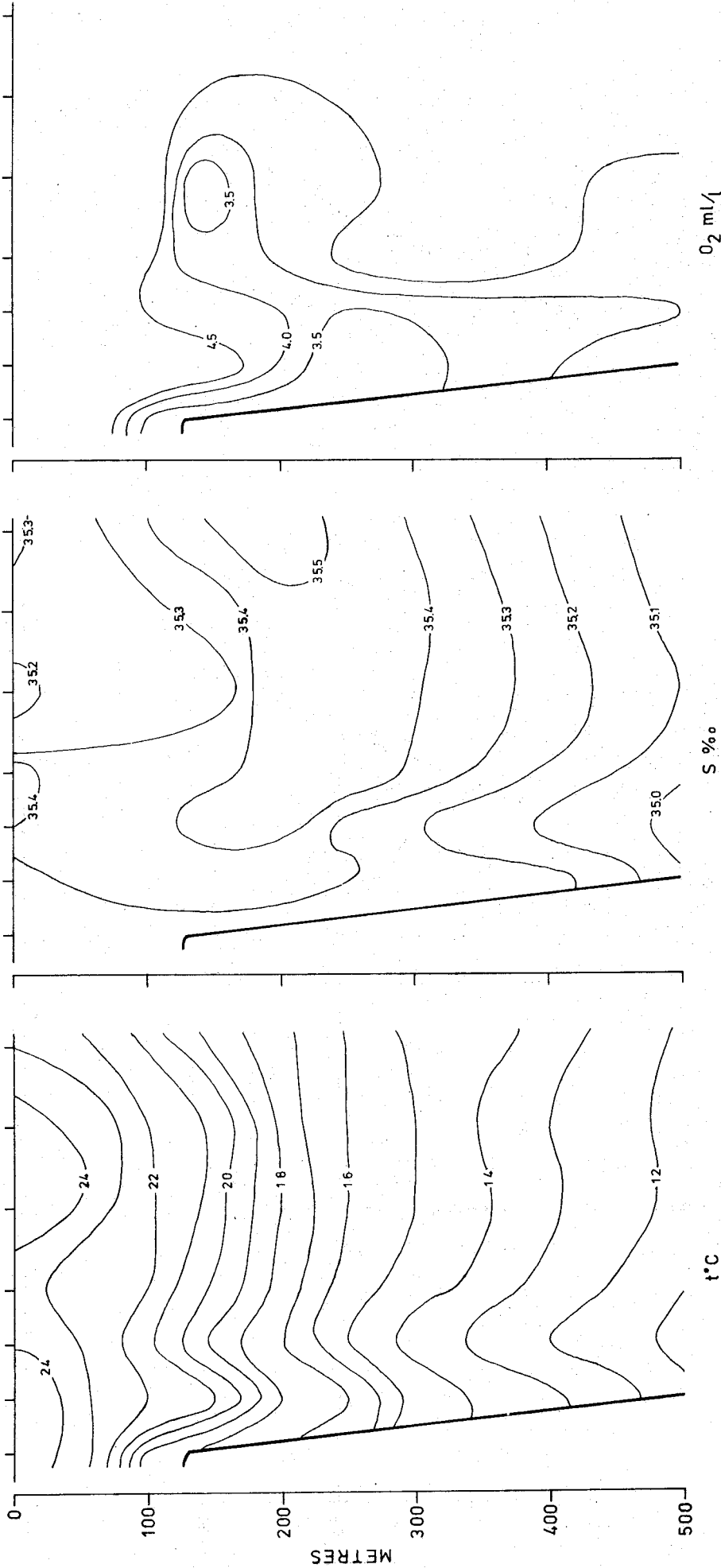


Fig. 7. Vertical distribution of $t^{\circ}\text{C}$, $S\text{‰}$ and $\text{O}_2 \text{ ml/l}$ in SECTION V, 0-500 m.

SECTION V 25-26 SEPTEMBER 1977

STATIONS

463 464 465 466 467 468 469

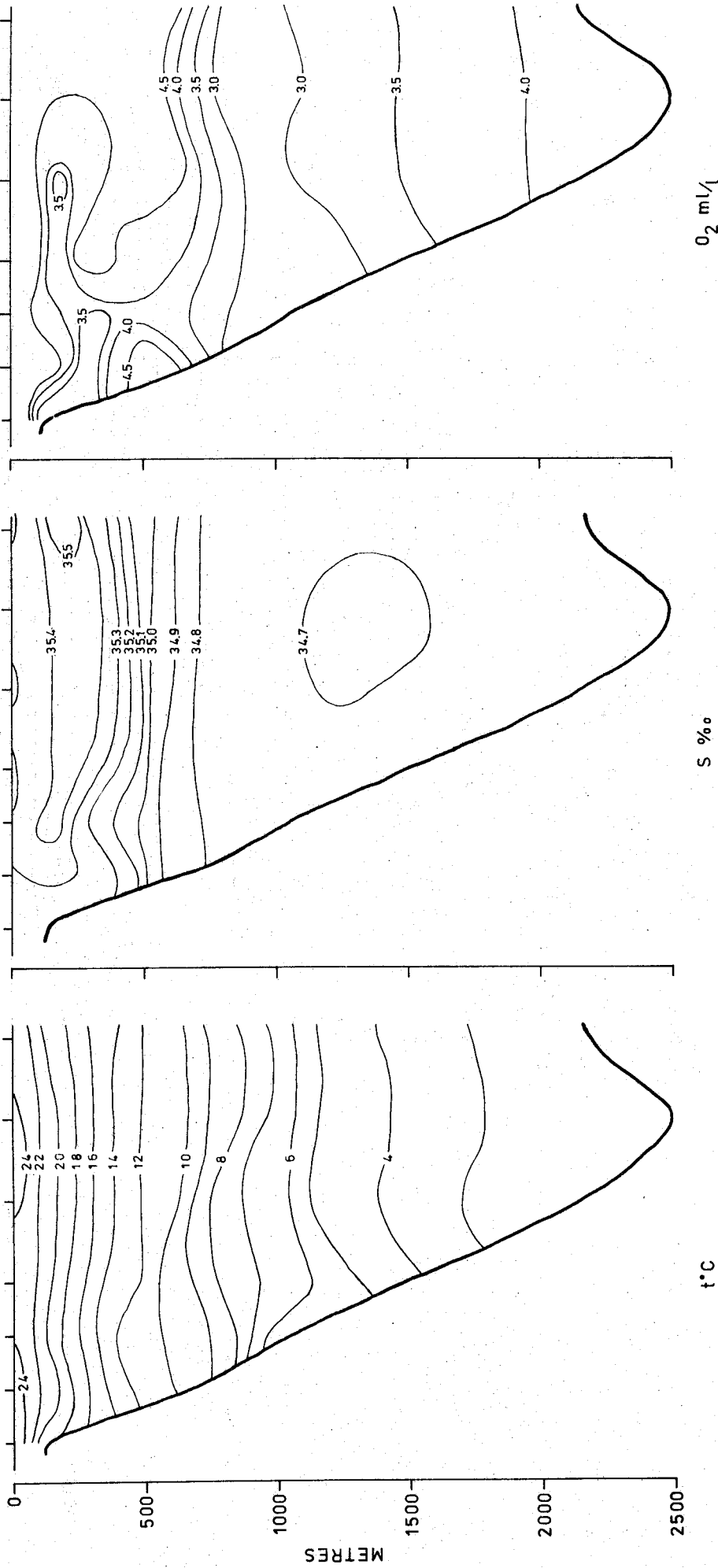


Fig. 8. Vertical distribution of $t^{\circ}\text{C}$, $S \text{‰}$ and $\text{O}_2 \text{ ml/l}$ in SECTION V, 0-bottom.

SECTION VI 27 SEPTEMBER 1977
STATIONS

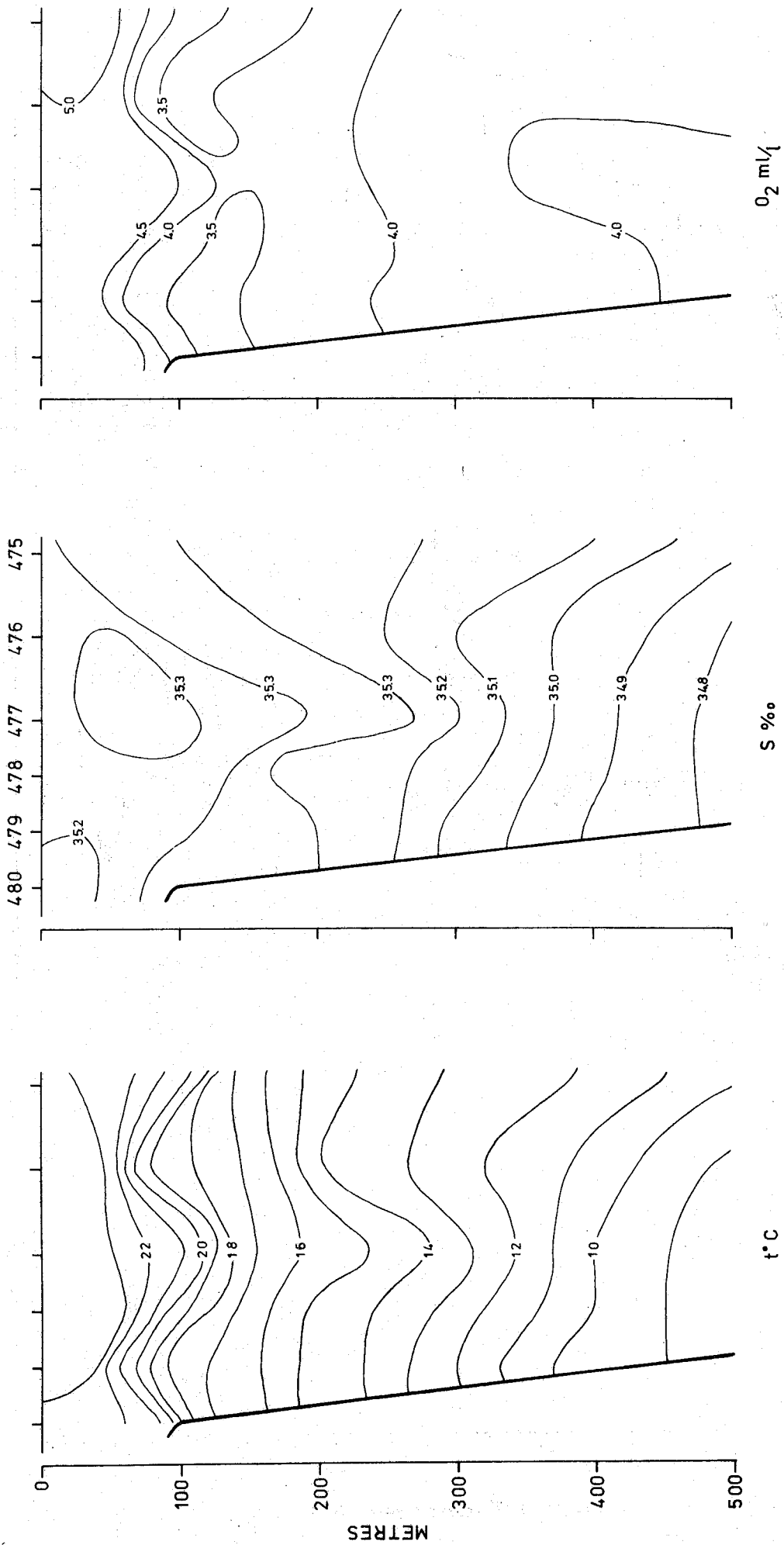


Fig. 9. Vertical distribution of t°C, S‰ and O₂ ml/l in SECTION VI, 0-500 m.

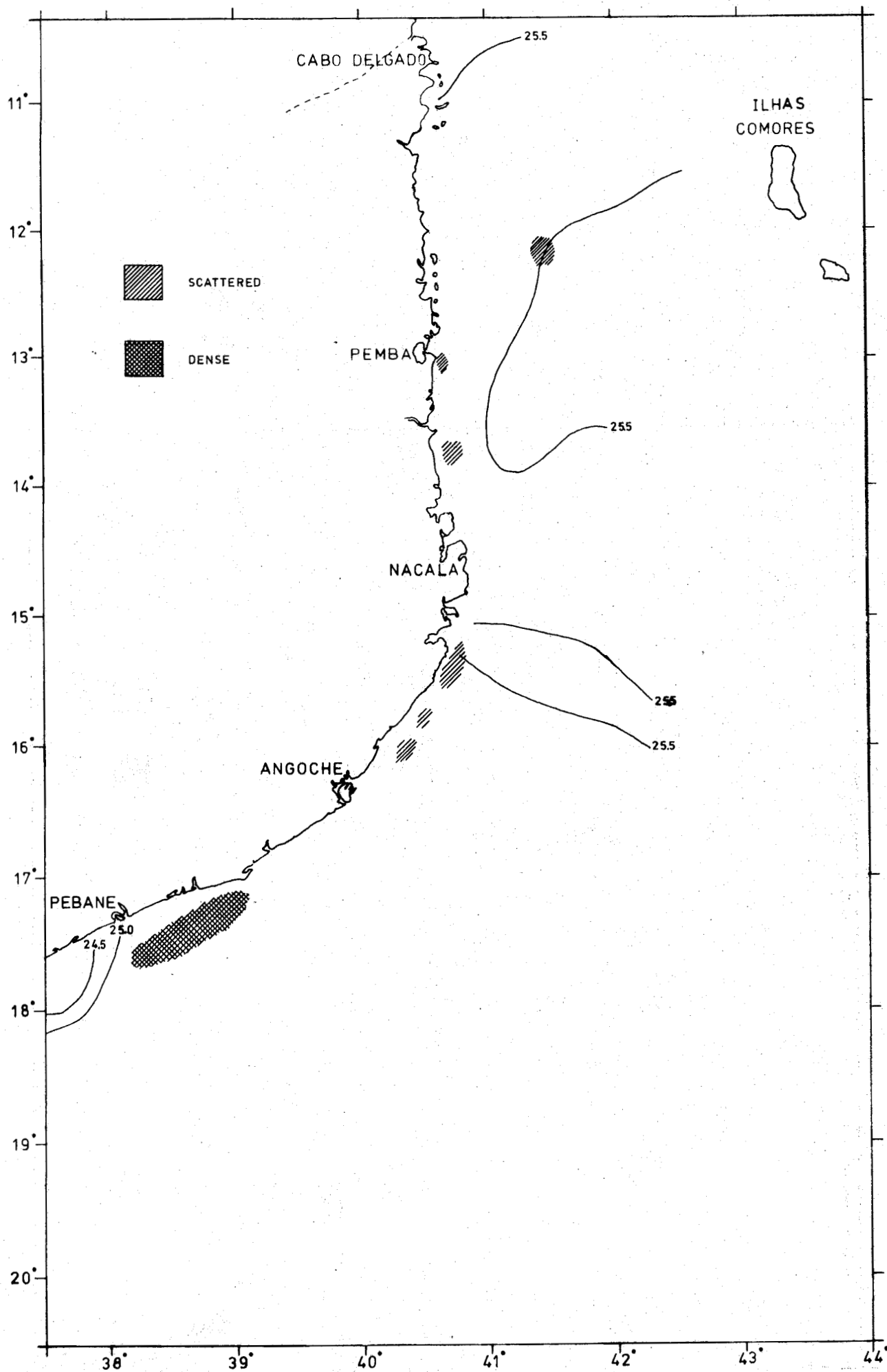


Fig. 10a. Surface temperature and demersal fish recordings - northern part.

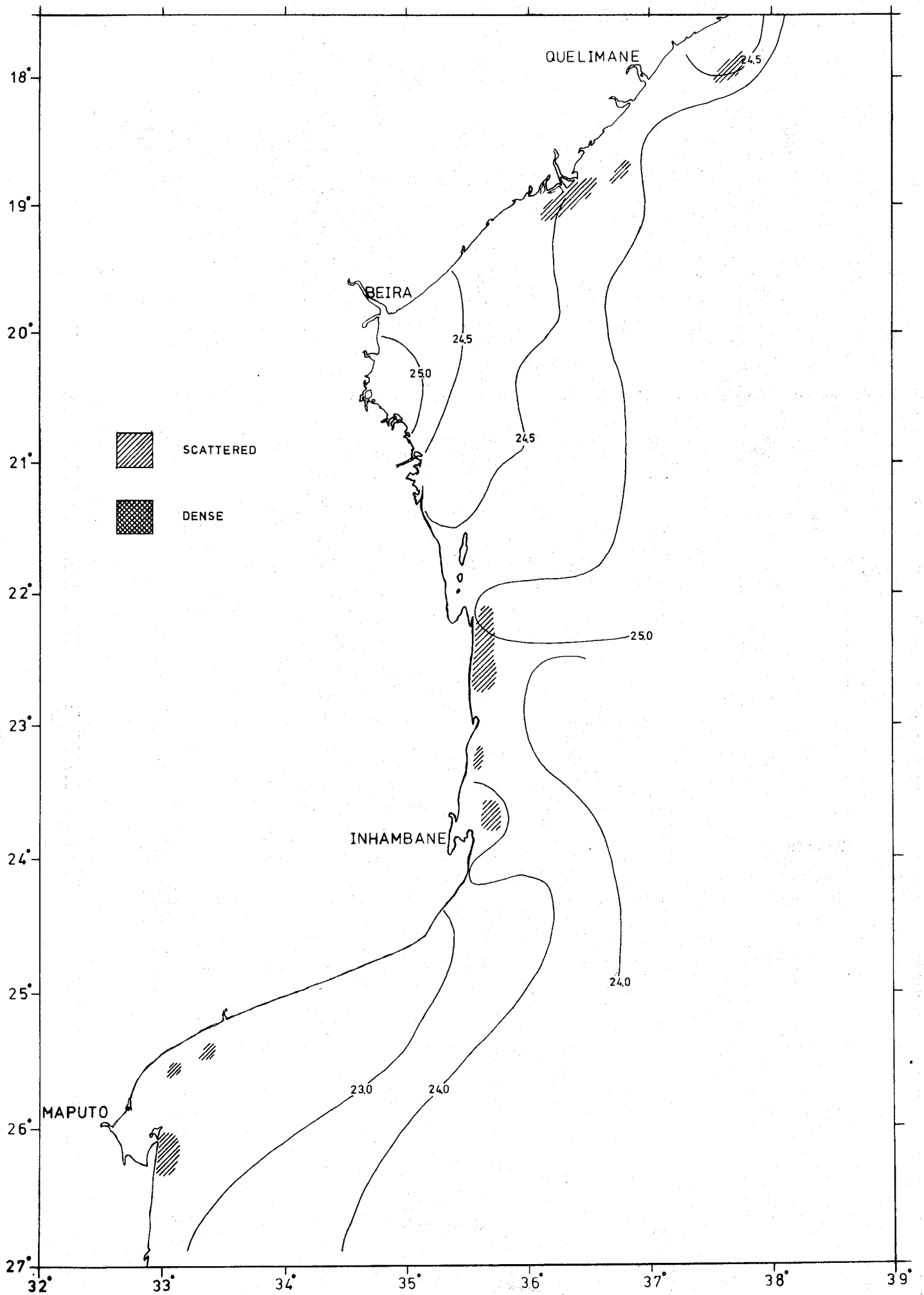


Fig. 10b. Surface temperature and demersal fish recordings - southern part.

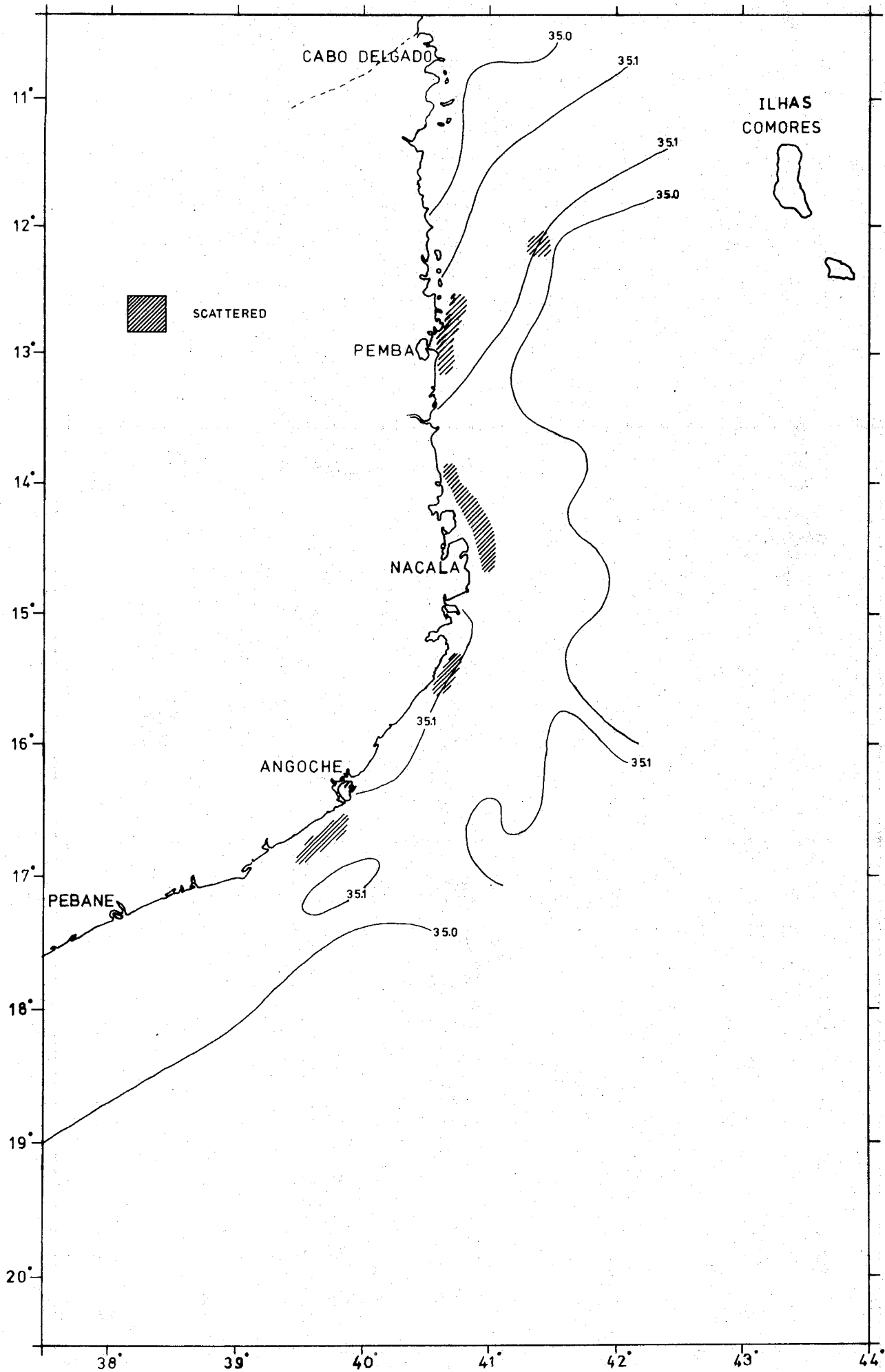


Fig. 11a. Surface salinity and pelagic fish recordings - northern part.

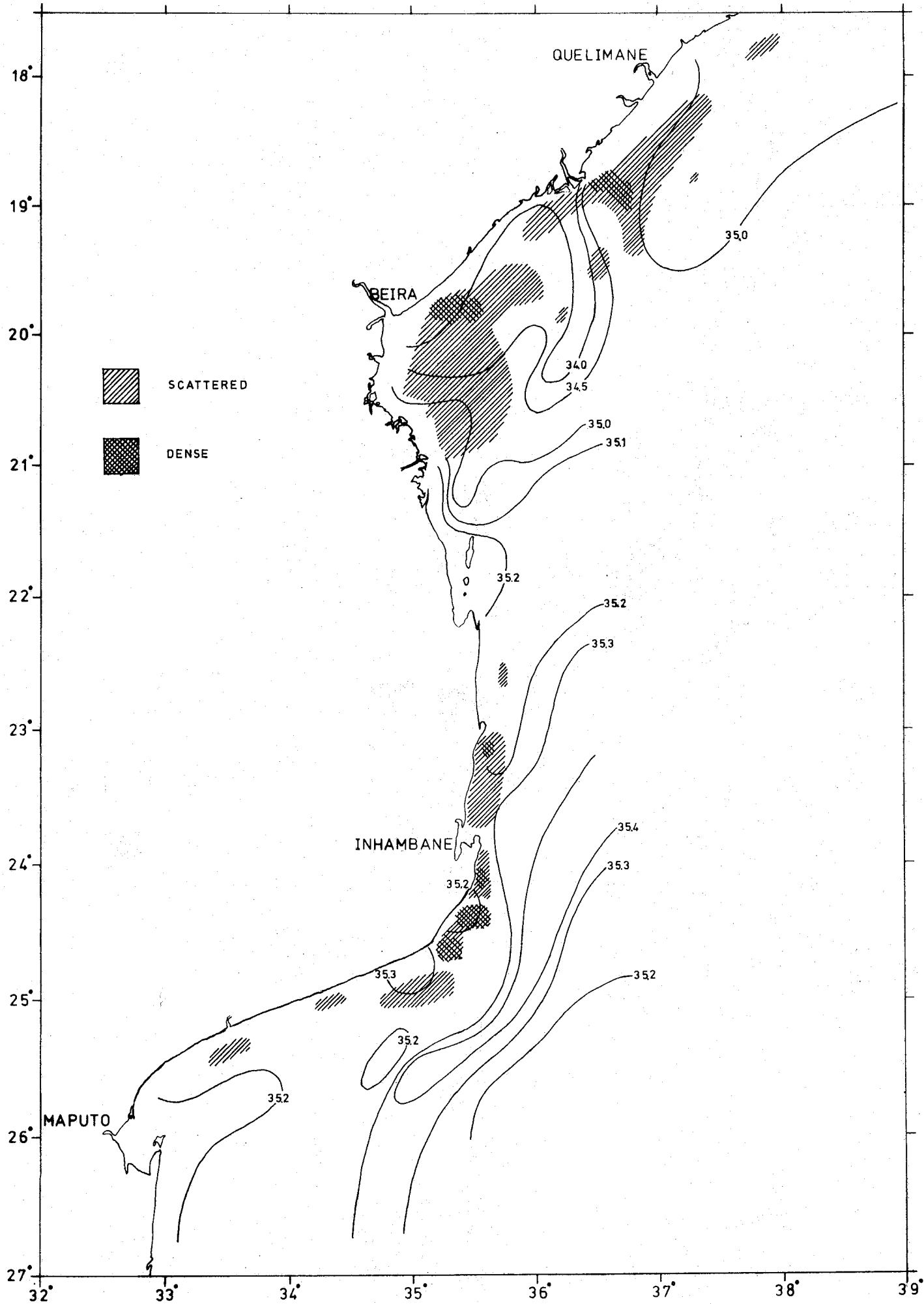


Fig. 11b. Surface salinity and pelagic fish recordings - southern part.

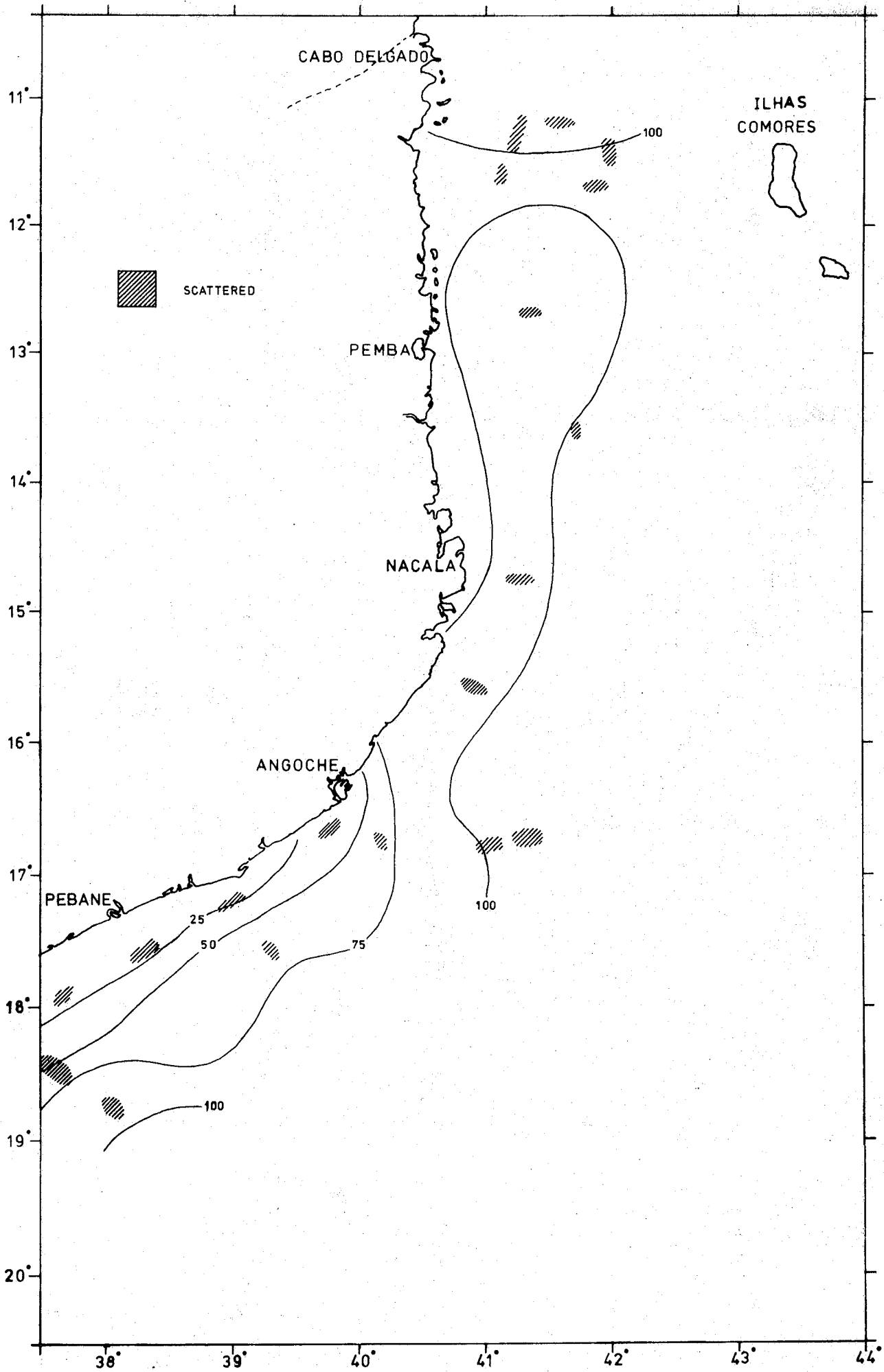


Fig. 12a. Depth to the thermocline and mesopelagic fish recordings - northern part.

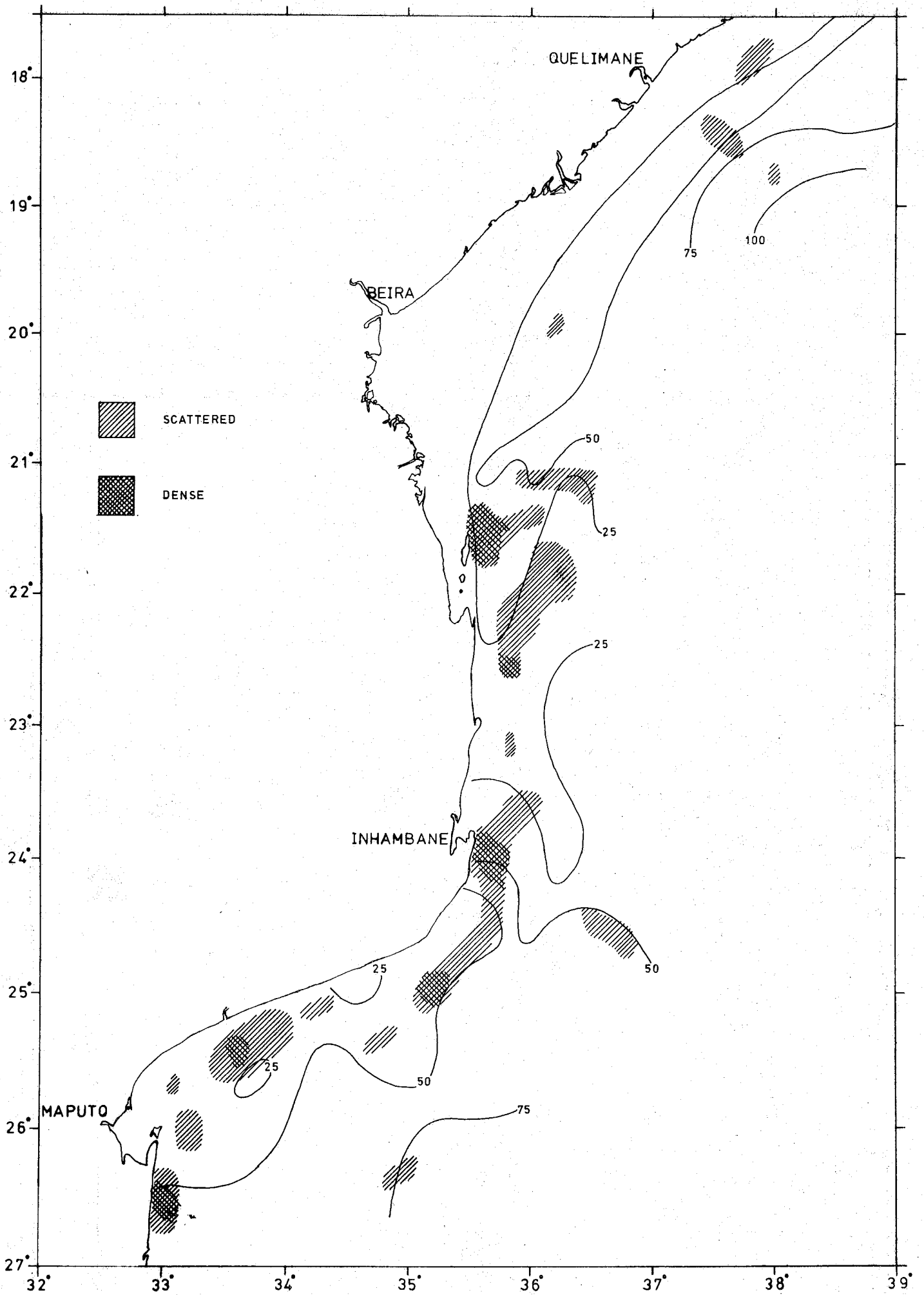


Fig. 12b. Depth to the thermocline and mesopelagic fish recordings - southern part.

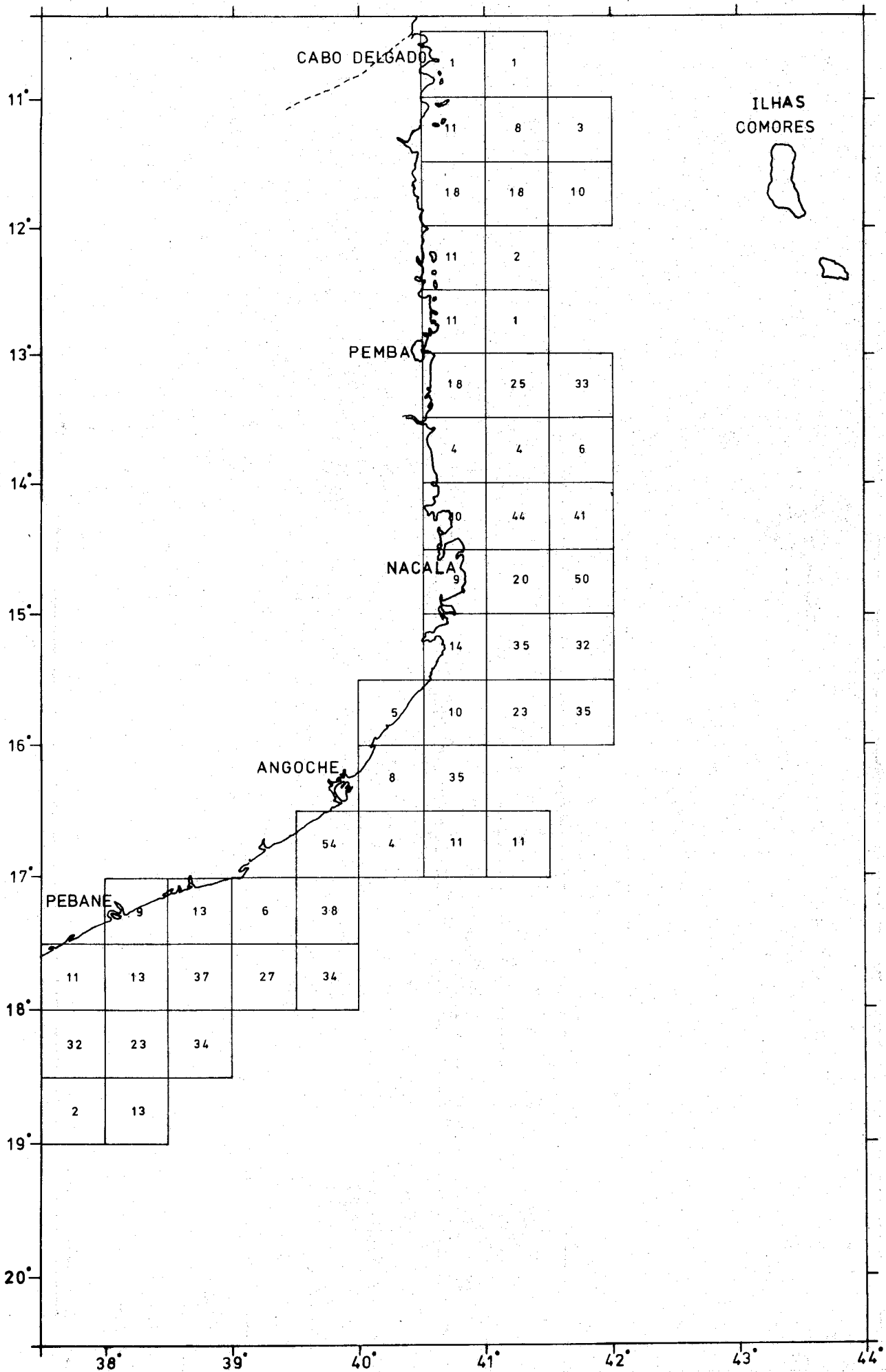


Fig. 13a. Plankton - Average integrator deflection in mm per nautical mile - northern part.

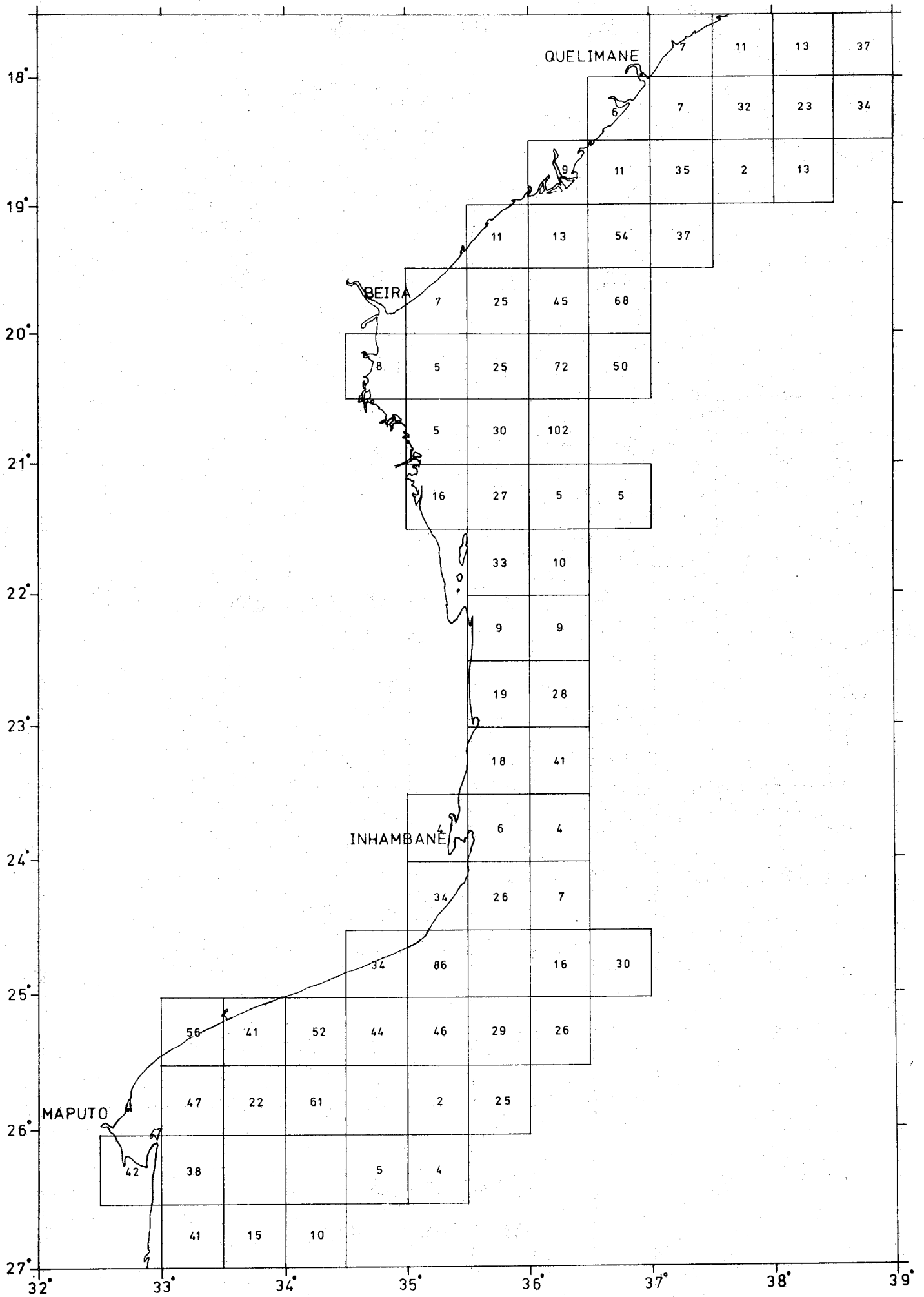


Fig. 13b. Plankton - Average integrator deflection in mm per nautical mile - southern part.

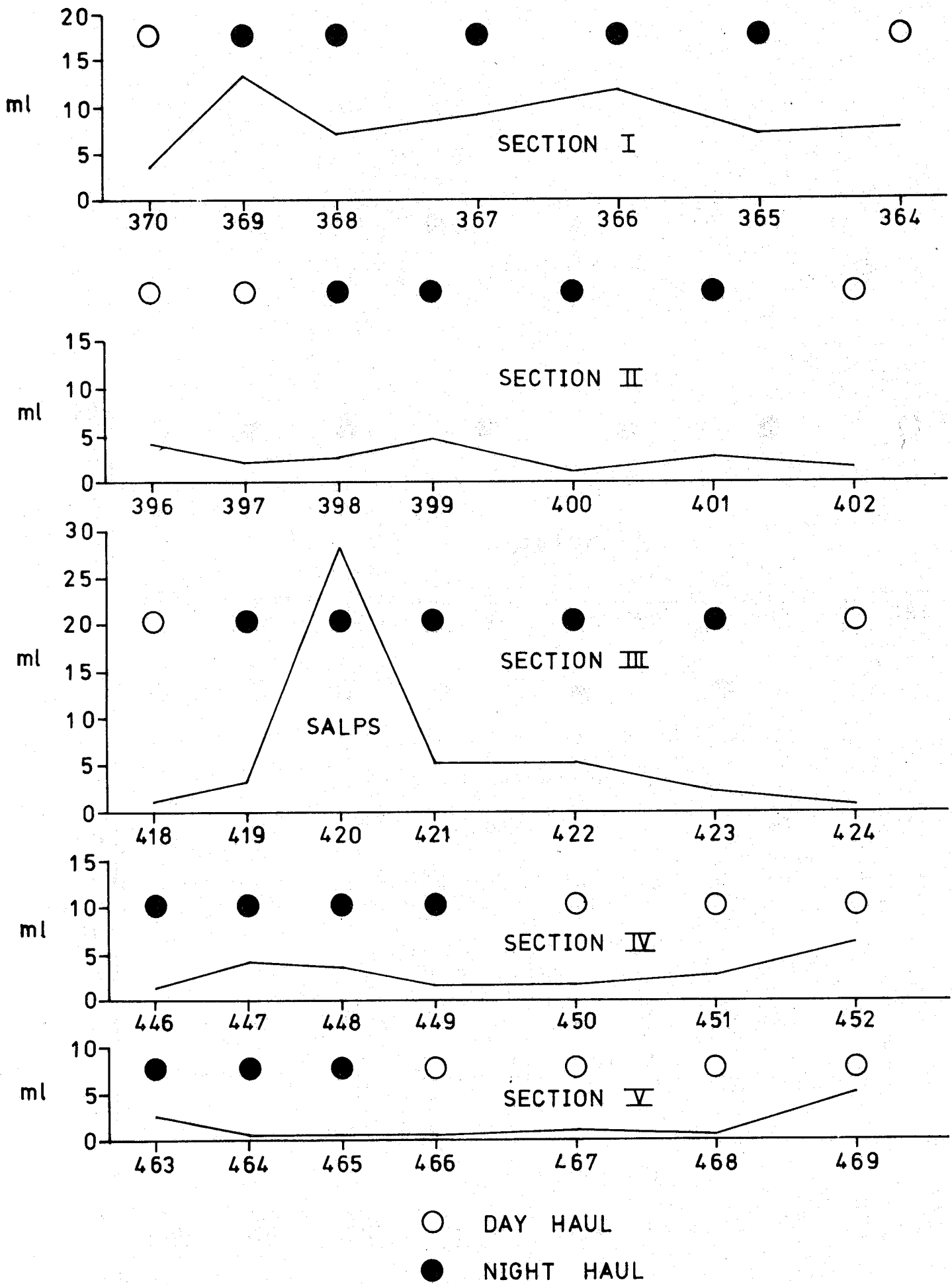


Fig. 14. Wet displacement volume of plankton at the hydrographic sections I - V.