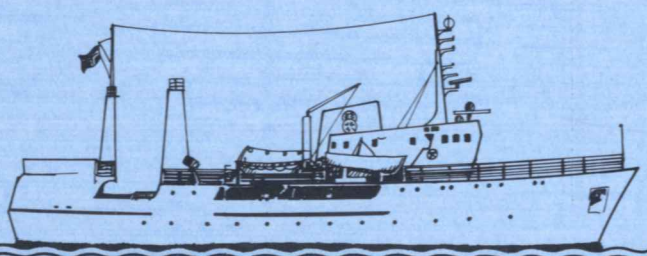
JOINT NORAD/MOÇAMBIQUE/FAO PROJECT TO INVESTIGATE THE FISH RESOURCES OFF THE COAST OF MOÇAMBIQUE

cruise report no.2 of R/V«DR. FRIDTJOF NANSEN»

OCTOBER – DECEMBER 1977



Sub-contractor: Institute of Marine Research
Bergen-Norway

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INTRODUCTION

This report covers the second cruise of R/V "Dr. Fridtjof Nansen" in the waters along the coast of Mozambique. The main objectives of the project have been already described in Cruise Report No. 1.

NARRATIVE

Departure:	Maputo, 12 October 1977
Arrival:	Maputo, 2 December 1977
Ports of call:	Durban, 13 - 23 October
	Beira, 26 - 28 October
	Pemba, 4 - 11 November
	Beira, 17 - 21 November
Captain:	T. Tangen
Scientific staff:	D. Danielssen, F. Rey, R. Silva, L. Sousa (from 21 November), M. Johannessen, M. Francisco (to 17 November), E. Molvær, R. Lund (from 4 November).

Two Mozambican fishermen and one engineer assistant joined the whole cruise.

Important repairs of instruments and other equipments onboard made the long portcalls at Durban and Pemba necessary. The loss of time in these ports made it necessary to reduce the coverage in some parts of the coast.

INSTRUMENTS AND METHODS

The instruments used and the methods applied were described in Cruise report no. 1 of R/V "Dr. Fridtjof Nansen".

On request from the Director of Fisheries in Mozambique, four hydrographic sections were taken outside the Zambezi River delta. At these sections, in addition to the standard sampling depths, temperature, salinity and oxygen were measured at 5 m depth.

At every station samples for oxygen were taken at all standard sampling depths.

At all sections samples were taken at standard depths only to 500 m.

Due to lack of time the SECTION VI was omitted.

At SECTION III, the temperature, salinity and oxygen values in the figure were omitted from 125 m and downwards at the two outer stations, due to large wireangle caused by bad weather conditions and strong current. Temperature values from bathy termograph were used down to 250 m.

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.

Hydrography

The horizontal distribution of temperature at the surface is shown in Figs. 2a and 2b. As in the first cruise the highest temperatures were observed in the northern part gradually decreasing southwards. However, along the whole coast temperatures were about 2 - 3^{o}C higher.

The horizontal distribution of salinity at the surface is shown in in Figs. 3a and 3b. In the southern part, the salinity was slightly higher than in the northern part. In the area between Beira and Quelimane the influence of the fresh water outflow from the Zambezi River is clearly demonstrated. As the cruise took place at the end of the dry season, the influence of the Zambezi River was smaller than in the first cruise. The salinity distributions at the four hydrographic sections outside the Zambezi River (Figs. 4 - 7) shows that the influence of the fresh water outflow goes down to the bottom (30 m depth) as far out as 20 - 30 nautical miles from the coast.

The depth to the thermocline, as defined in the first cruise report, is shown in Figs. 8a and 8b. The thickness of the mixed and homogenous layer is about 25 m along almost the whole coast, except in the northernmost part (off Pemba). The depth of the thermocline increases gradually offshore but in the whole area it is shallower than in the first cruise. The depth of the thermocline of about 25 m in the northernmost area is restricted to the St. Lazarus bank.

Figs. 9 - 13 show the vertical distribution of temperature, salinity and oxygen content in five hydrographic sections along the coast. SECTION I is the northernmost section and SECTION V the southernmost.

The temperature at the surface is 27 - 28°C, about 2 to 3°C higher than in the first cruise, and decrease to 10 - 11°C at 500 m depth. The warming up of the upper layers in the northern part reach greater depths than in the southern. At all sections a salinity maximum is observed at about 150 - 250 m depth. This water originates from the subtropical surface water of the southern subtropical gyre of the Indian Ocean. An oxygen minimum is found at about the same depth as the salinity maximum. Below the subtropical water an oxygen maximum is observed at about 400 - 500 m. This layer with higher oxygen content is originated in the transition area south of the subtropical convergence and spreads north by vertical convection.

Plankton and 0-group fish

The average integrator deflection in mm per nautical mile due to plankton and 0-group fish is shown in Figs. 14a and 14b. These recordings include also a minor contribution from mesopelagic fishes during the night as this is sometimes difficult to separate from plankton. The highest concentrations of plankton were found close to the continental edge from Quelimane to Maputo. As in the first cruise there were small concentrations in the northernmost part. Squids were supposed to make a significant contribution to plankton recordings, especially in the southern area, as they were commonly found in pelagic trawls.

The wet displacement volumes of plankton along the hydrographic sections is shown in Fig. 15 and Fig. 16. As in the first cruise the values were very small with no differences between day and night and were poorly correlated with integrator readings. This poor correlation is most likely due to the selective plankton sampling with the 500 u mesh size Juday net, especially as the larger zooplankton organisms as squids totally avoid the net.

Surface observations

Recorded sightings of tuna fishes, whales and dolphines are shown in Figs. 8a and 8b.

As the tuna or tuna-like fishes schools were feeding in the surface, they were not recorded on the sonar. From a long distance the schools were discovered because of the birds preying on the same fishes as the tuna, and afterwards they were identified by sight as the vessel approached the schools. In contrast to the first cruise very few tuna schools were observed and only in the area between Zambezi River delta and Nacala.

Dolphines (most likely Tursiops truncatus) were observed only off Quelimane and between Inhambane and Maputo.

The only one observation of large whales (five unidentified) was off Quelimane. At this time of the year most of the whales have migrated southwards from the Mozambique coast.

Different species of sharks were observed at the surface along more or less the whole coast, especially on the Sofala Bank. Attacks on the trawl cod-end and Nansen bottles were registered. No special attempts to catch them were made, but they were occasionally obtained in the trawl.

On the continental shelf off Beira large concentrations of yellow material floating on the surface were observed. This material was identified as originating from terrestrial plants, most likely supposed to be pollen.

Pelagic fish

The echo-recordings from pelagic fishes were almost exclusively confined to the continental shelf and to the area between Angoche and Beira (Figs. 3a and 3b).

The largest trawl catch on the whole cruise was obtained east of Pebane and consisted mainly (78%, about 1.5 ton pr. trawl/hour) of large head hairtail (Trichiurius lepturus) ranging from 57 - 77 cm length with an average of 69.8 cm. In addition to this, small amounts of round scad (Decapterus maruadsi) were obtained ranging from 30 to 37 cm length.

South of Pebane good pelagic recordings were obtained consisting of anchovies (Anchoviella sp.) and silky shark (Carcharinus falciformis). By weight anchovies were about 23% (length range was from 4 - 8 cm) and the eight specimens of silky shark (77% by weight) ranged from 130 - 180 cm with a total weight of 149 kg.

The trawl catches demonstrated that the recordings south of Quelimane were mainly 0-group fishes, among them the families Gempylidae, Carangidae and Synodontidae.

On the shallow waters off the Zambezi River, typical pelagic fishes as orangemouth thryssa (Thryssa vitrirostris) and Indian

pellona (Pellona ditchella) were obtained in bottom trawls. Towards deeper waters (about 80 m depth) layang scad (Decapterus macrosoma) was also found in bottom trawl. This specie was in maturity stage 3 - 4 and had a mean length of 17.5 cm.

South of Zambezi River the recordings were dominated by 0-groups fishes, especially of the family Carangidae.

At about 300 m depth position 21°10'5 S 35°39'E, silver smelt (Argentina sphyraena) and snake mackerel (Thyrsitoides marleyi) were dominating near the bottom. Silver smelt had a mean length of 16,2 cm and most of them were in maturity stage 3 and 4. Concerning the snake mackerel the mean length was 16.9 cm and the majority were in maturity stage 1 and 2.

The pelagic recordings south of Inhambane were exclusively from schools of porcupine fish (Diodon maculifer), but in bottom trawl (about 400 m depth) a good catch of large head hairtail (Trichiurus lepturus) was obtained.

In contrast with the first cruise the pelagic recordings were scarce overall. The most dominating species were large head hair tail. (Trichiurus lepturus) together with organgemouth thryssa (Thryssa vitrirostris), Indian pellona (Pellona ditchella) and horse mackerels, although the three latter species were in significantly lower abundancy than on the first cruise. As in the previous cruise the most important distribution area for pelagic fish seems to be that from Pebane to Beira.

Demersal fish.

In the northernmost part demersal fishes were only recorded on the St. Lazarus Bank (Fig. 2a). With the experience obtained on the first cruise, the fishing effort was concentrated on handlines and longline. Due to difficulties in manuevring the vessel in the presence of the strong current the longline broke down during hauling. The handline showed again to be the most suitable

gear on this bank. Apart from on specimen of green jobfish (Aprion virescens), the entire catch consisted of the mangrove red snapper (Lutjanus argentimaculatus). The average size of the fish was significantly larger than on the first cruise, with a mean weight of 6.6 kg and a mean length of 64.2 cm. Nearly all the fishes were in maturity stage 3.

In the shelf area between Pebane and Quelimane (Figs. 2a and 2b) the most common species were different croakers (Johnius belangerii, J. dussumieri, Otolithes ruber), blotched grunt (Pomadasys maculatus) and yellow striped goatfish (Upeneus vittatus). In addition, pelagic fishes as organge-mouth thryssa (Thryssa vitrirostris), Indian pellona (Pellona ditchela) and largehead hairtail (Trichiurus lepturus) were also usually obtained in bottom trawls in this shallow area. Indistincly of the species almost all the fishes were in maturity stage 2 and 3.

In the area between Quelimane and Beira, north of Zambezi River the dominant specie was brush-tooth lizard fish (Saurida undosquamis), most of them in maturity stage 3.

Outside Beira at a depth of 50 m humpback red snapper (Lutjanus gibbus) and greasy grouper (Epinephelus taurina) dominated almost completely by weight. The humpback red snapper ranged from 30 to 76 cm length. The small specimens were in maturity stage 1 - 2 and the large ones in maturity stage 7 - 3. Brush-tooth lizard fish (Saurida undosquamis) was also found in this area.

Outside Inhambane demersal fishes were scarce and only crocodile fish (Peristedion sp.), Chlorophtalmus agassizi and brush tooth lizard fish (Saurida undosquamis) occurred in small amounts.

South of Inhambane the most dominating species were brush tooth lizard fish, spiny dog fish (Squalus acanthias), and large head hairtail (Trichiurus lepturus) that in this occasion behaved entirely as demersal fish.

Off Boa Paz (at about 25°20'S) tiger toothed croacker (Otolithes ruber) and Neoscombrops annectens were the most important species. Snake mackerel (Thyrsitoides marleyi) appeared in schools close to the bottom and was captured in the bottom trawl.

Mesopelagic fish.

As in the first cruise the abundance of mesopelagic fish was low, and deep scattering layers were rare (Figs. 8a and 8b). When recorded outside the continental slope, the catches consisted entirely of lantern fish (Myctophidae). In more shallow waters (deeper than about 30 meters), especially south of Beira, the mesopelagic fishes were usually found close to the bottom. Here, the main component was also lantern fish (Myctophidae, Daphus elucens, Myctophum sp.) mixed with other species as Champsodon capensis, Neoscombrops annectens, Psenes indicus, Cubiceps natalensis.

Crustacea.

Concerning the Crustacea, the catches can be divided in shallow and deep ones.

Catches in shallow waters (20 - 50 m) consisted mainly of shrimps of the family Penaeidae with the following species: white prawn (Penaeus indicus), brown shrimp (Metapenaeus monoceros), flower shrimp (Penaeus japonicus) jumbo tiger prawn (Penaeus monodon) and Metapenaeus stebbingi. Other registered crustacea were small unidentified species of the families Penaeidae and Caridae, together with small lobsters Palinurus sp.

Crustacea in deeper waters (250 to 400 m) consisted of: 1) deep water shrimps as Penaeopsis salsii, Heterocarpus dorsalis, Solenocera sp., and specimens from the family Caridae. 2) lobsters as spiny lobsters (Palinurus delagoae), Nephrops andamanica, and individuals of the family Scyllaridae.

Table 3 shows the percentage of crustacea catches in relation to the total catch in bottom trawls. As the trawl is not specially designed for shrimp fishing, the data must be considered with precaution.

However, they show that on most stations the percentage of shrimps and/or lobster catches were low, except at two of the deep trawl stations, where the percentages were about 25 to 30%.

Table 1. RECORD OF FISHING OPERATION

BT Bottom trawl - PL Pelagic trawl - IK Isaacs kid midwater trawl

GN Gill net - PS Purse seine - LL Long line - HL Hand line

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION SOUTH	POSITION EAST	TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
1.11.77	227	IK	1100	c.100	11°43'	40°43'	0	0	
2.11.	228	HL			12°11'	41°26'	261		Mangrove red snapper Lutjanus argentimaculatus
2.-3.11	229	LL			12°12'	41°25	34		Mangrove red snapper L. argentimaculatus
14.11.	230	PL	180	95-100	17°18'	38°53'	1024	2048	Large head hairtail Trichiurus lepturus Round scad Decapterus maruadsi
14.11	231	BT	18	12- 18	17°12'	38°43'	77.5	155	Orange mouth thryssa Thryssa vitrirostris Belanger's croacker Johnius belangerii

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
15.11.	232	BT	18	12-18	17°22'	38°15'	105	210	Orange mouth thryssa Thryssa vitrirostris, Indian pellona Pellona ditchela
15.11.	233	PL	30-42	0-20	17°46'	37°51	195	390	Silky shark Carcharhinus falciformes, Anchoviella sp.
23.11	234	PL	38-46	10-26	18°44'	37°05'	8	11	0 group of fish
24.11	235	BT	22	16-22	18°05'	37°12'	53	106	Longnose cavalla Carangoides chrysophrys, Malabar cavalla Carangoides malabaricus
24.11	236	BT	20	20	17°53'	37°21'	322	644	Belanger's croacker Johnius belangerii tiger toothed croacker Otolithes ruber, largehead heartail Trichiurus lepfurus orange-mouth thryssa Thryssa vitrirostris, Indian pellona Pellona ditchela

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
24-25.11.	237	BT	19-20	19	18°33'	36°44'	88	176	Yellow striped goatfish Upeneus riftatus, deep pugnose ponyfish Secutor ruconius brushtooth lizard fish Saurida undosquamis
25.11.	238	BT	78	78	19°03'	36°53'	36	54	Layang scad Decapterus macrosoma
25.11.	239	BT	26-22	26-22	19°09'	36°13'	14	28	Brushtooth lizard fish Saurida undosquamis
25.11.	240	PL	83	0	19°42'	36°25'	2	4	Squids
26.11.	241	PL	27	0	19°42'	35°42'	15	30	Squids
26.11.	242	PL	45	0	19°53'	35°49'	3	4	0 group of fish
26.11.	243	BT	52	52	20°02'	35°55'	250	375	Humpback red snapper Lutjanus gibbus, greasy grouper Epinephelus taurina
27.11.	244	PL	1280	110-100	21°08'	35°43'	9.7	19	Lantern fish Myctophidae

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION SOUTH	POSITION EAST	TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
27.11.	245	PL	340	325-335	21°08'	35°43'	87.5	175	Lantern fish Myctophidae
27.11.	246	BT	303	300	21°18'	35°39'	25	25	Lantern fish Myctophidae Silver smelt Argentina sphyraena Snake mackerel Thyrsitoides marleyi
28.11.	247	BT	100		22°50'	35°38'	24	48	Areolated grouper Epinephelus areolatus Longspine seabream Argyrops filamentosus Blueskin seabream Lolysteganus coeruleopunctatus
28.11.	248	BT	205-213	205-213	23°51'	35°41'	3.8	3.8	Brushtooth lizard fish Saurida undosquamis
28.11.	249	BT	410	400-410	23°55'	35°45'	130	130	Lantern fish Myctophidae Crocodile fish Peristedion adeni Deepwater shrimps
29.11.	250	BT	240	230-240	24°20'	35°35'	257.5	515	Brush tooth lizardfish Saurida undosquamis Spiny dog shark Squalus achantias Spiny lobster Palinurus delagoae

DATE	ST NO	GEAR TYPE	BOTTOM DEPTH	GEAR DEPTH	POSITION		TOTAL CATCH	CATCH PER HOUR	DOMINANT SPECIES
					SOUTH	EAST			
29.11.	251	PL	74	50	24°36'	35°20.5'	3	12	Squids, 0 group fo fish
30.11.	252	BT	410	400	24°39'	35°31'	256	512	Largehead hairtail Trichiurus lepturus Lantern fish Myctophidae
30.11.	253	BT	30	30	24°48'	34°55'	ca. 20		1 Raia sp.
30.11.	254	PL	79	25	25°03'	35°03'	37	74	Porcupine fish Diodon hystrix
1.12.	255	BT	336	330	25°27'	34°30'	32	78	Spiny lobster Palinurus delagoae Snake mackerel Epinnula orientalis
1.12.	256	BT	255	255	25°14'	33°57'	350	700	Snake mackerel Thyrsitoides marleyi Tiger toothed croacker Otholithes ruber Neoscombrops annectens

Table 2. Length distribution of the most important species. Ordinary scale 1-50 cm. x Scale from 51-100.

SPECIES	St. No.	LENGTH DISTRIBUTION (in cm) 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0
ARGENTINIDAE Argentina sphyraena	246	8 45 19
CARANGIDAE Decapterus macrosoma (Layang scad)	238	7 34 21 17 20 6 1
Decapterus maruadsi (Round scad)	230	7 23 34 6 4 1 2
Selar crumenophtalmus (Bigeye scad)	230	2 1 4 6 4 1 2 2 1
CLUPEIDAE Pellona ditchela Indian Pelona)	231	3 2 5 5 1
	232	2 21 9 9 9
	236	4 5 22 16 2 1
CYNOGLOSSIDAE Cynoglossus cynoglossus (Bengal tonguesde)	231	1 1 5 2 6 5 1
ENGRAULIDAE Anchoviella sp.	233	10 46 31 5 8
Thryssa vitrirostris (orangemouth thryssa)	231	2 16 9 3 13 49 38 17 5 2 1
	232	1 1 4 2 13 19 4 4 1 1
	236	2 2 2 2 6 15 8 7 4 0 2
	237	1 10 11 16 15 8 1 2 1

SPECIES	St. no.	LENGTH DISTRIBUTION (in cm) 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0
GEMPYLIDAE Epinnula orientalis	255	1 1 2 2 1 1 3 12 7 3 4
Thyrsythoides marleyi (snake mackerel)	246	3 4 12 3 9 5 4 4 1 3
	256	1 3 4 12 21 21 13 9 10 3 1 1
LEIOGNATHIDAE Secutor ruconius	232	6 6 7 3
	237	1 11 4 22 15 36 12
LUTJANIDAE Lutjanus argentimacu	228x	1 2 1 4 2 4 2 2 4 3 5 1 3 4 3 2 1 2 1
latres (mangrove red snapper)	229x	1 1 1 2 1
Lutjanus gibbus (humpback red snapper)	243	1 1 1 2 3 2 1 1 2 1 1 1
	x	2 3 5 1 2 3 4 2 2 1 3 1 4 3 2 2 2
MULLIDAE Upeneus vittatus (Yellow striped goatfish)	231	4 14 17 8
	232	1 6 6 3
	237	2 18 50 10 8 1
MYCTOPHIDAE Diaphus elucens	250	2 9 9 8 48 22 4 1
	252	1 4 2 13 33 32 18 11 3 1
Myctophum sp.	252	1 9 31 10

SPECIES	St. no.	LENGTH DISTRIBUTION 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0
POLYNEMIDAE Polynemus sextarius	231	4 3 2 2 2 2
POMADASYIDAE Pomadasys hasta (Lined silvergrunt)	236	1 1 3 2 2 2 2
Pomadasys maculatus (Blotched grunt)	231	1 1 1 1 4 1 1 2 2
SCIAENIDAE		
Johnius belangerii (Belanger's croaker)	231	3 7 9 4 4 11 6 3 4 4 1 4 1 1
	232	2 21 9 9 9
	236	5 4 4 3 2 11 12 6 2 0 1
Johnius dussumieri	236	1 3 3 2 2 6 8 6 2 5 2 2
Otolithes ruber (Tiger toothed croaker)	231	2 2 1 1 2 2 6 8 6 3 1
	236	1 1 1 6 7 5 3 7 6 2 4 1 2 2 1 1
	256	1 1 1 2
SCOMBROPIDAE Neoscombrops amectens	250	2 12 12 15 6 4 2
	256	1 1 4 15 14 8 4 1 1 2 2 1 3 1

SPECIES	St. no.	LENGTH DISTRIBUTION 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
SYNODONTIDAE Saurida undosquamis (Brushtooth lizardfish)	239	2 3 3 1 3 8 7 9 8 1 3 2
	243	1 1 2 5 5 5 5 5 6 1 1 1 3 3 1
	250	1 1 4 14 19 17 23 10 5 4 3 1 1
SERRANIDAE Epinephelus taurina (Greasy grouper)	243x	1 1 1 1 1 1 1
TRICHIURIDAE Trichiurus lepturus (largehead hairtail)	230x	1 1 1 1 3 11 21 9 14 12 8 9 8 4 1 2
	232	2 2 1 2 1 2 2 2 4 3 3 5 6 11 4 4 5 5 1 2 1
	236	2 1 1 4 4 7 6 5 4 4 6 5 1 4 2 1 4 2 1 3
	x	2 2 1 2 1 2 1 1
	252	2 3 6 1 4 12 7 17
	x	15 23 17 14 9 3 3 1 1 2

Table 3. SHRIMPS (S), AND LOBSTER (L) CATCHES AS PERCENTAGE OF TOTAL CATCH AT BOTTOM TRAWL STATIONS

ST NO	TOTAL CATCH PER HOUR (KG)	SHRIMPS AND LOBSTER CATCH/HOUR (KG)	%	DEPTH (M)
256	700	4 (S)	0.6	255
255	78	23.6 (L)	30.3	336
252	512	9.0 (S)	1.8	410
250	515	29.0 (L)	5.6	240
249	130	33,3 (S)	25.5	410
237	176	10.8 (S)	6.1	20
236	644	22.8 (S)	3.5	20
		3.0 (L)	0.5	
231	155	12.6 (S)	8.1	18

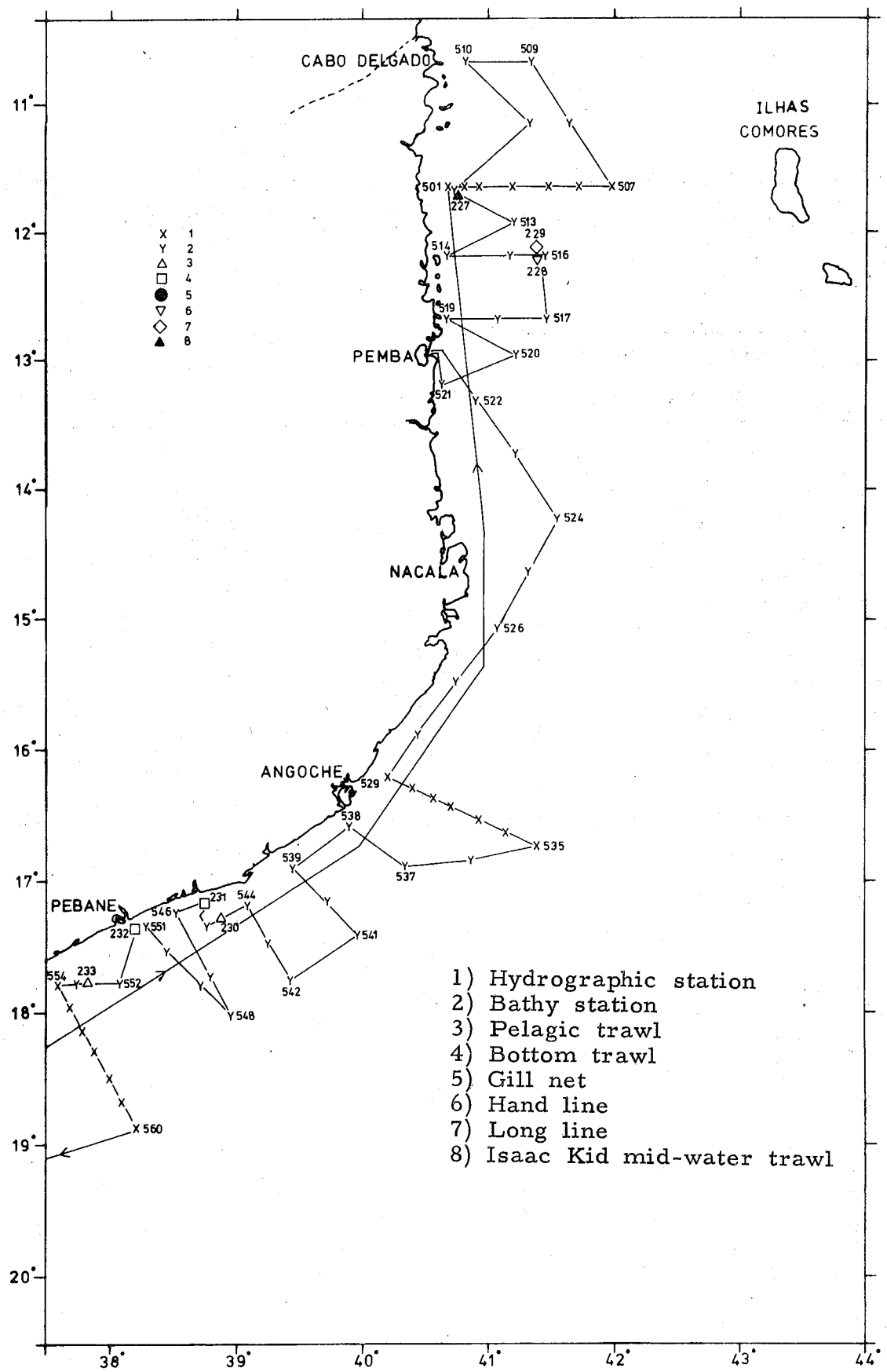

Fig. 1a. Survey grid and stations - northern part.

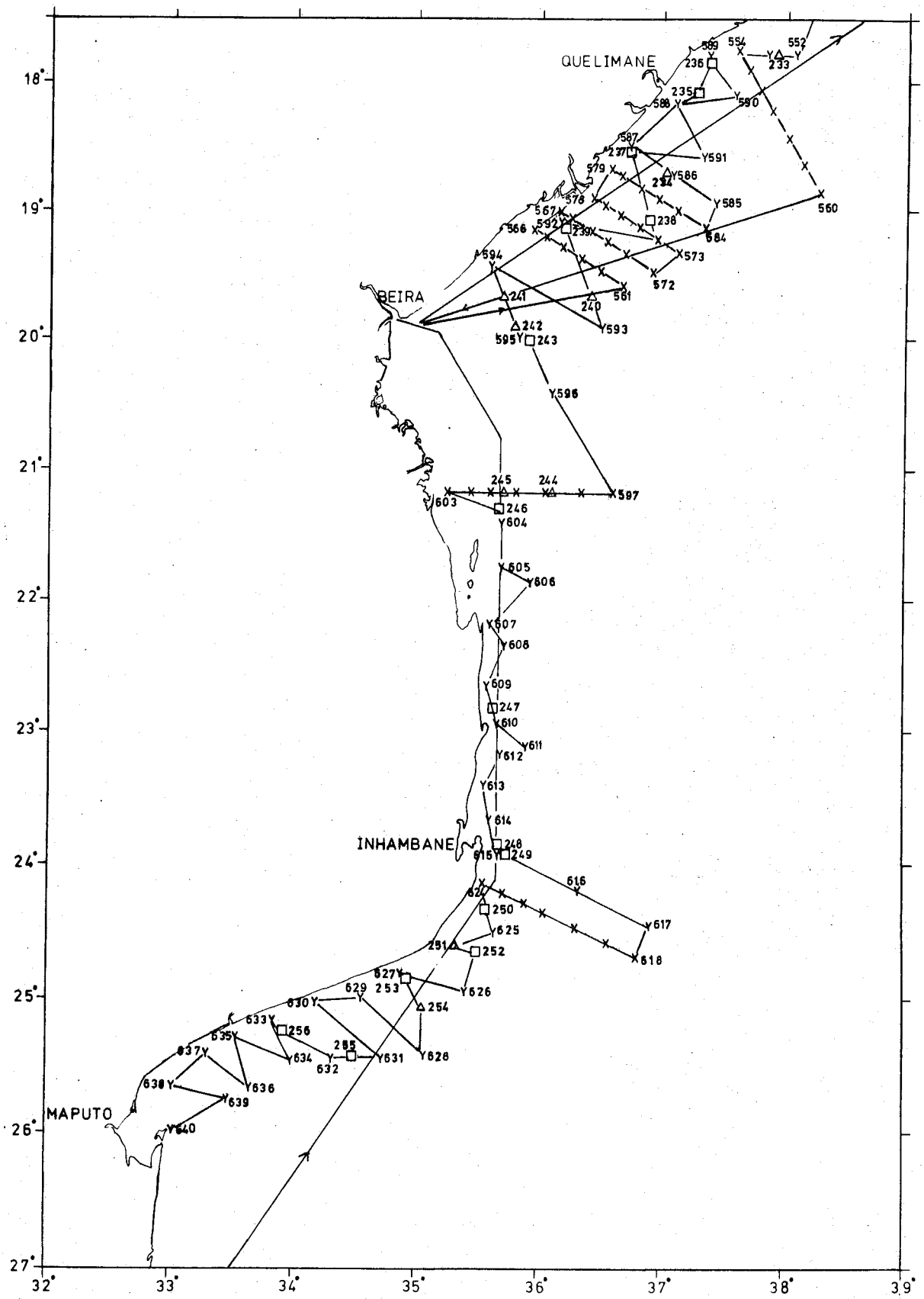

Fig. 1b. Survey grid and stations - southern part.

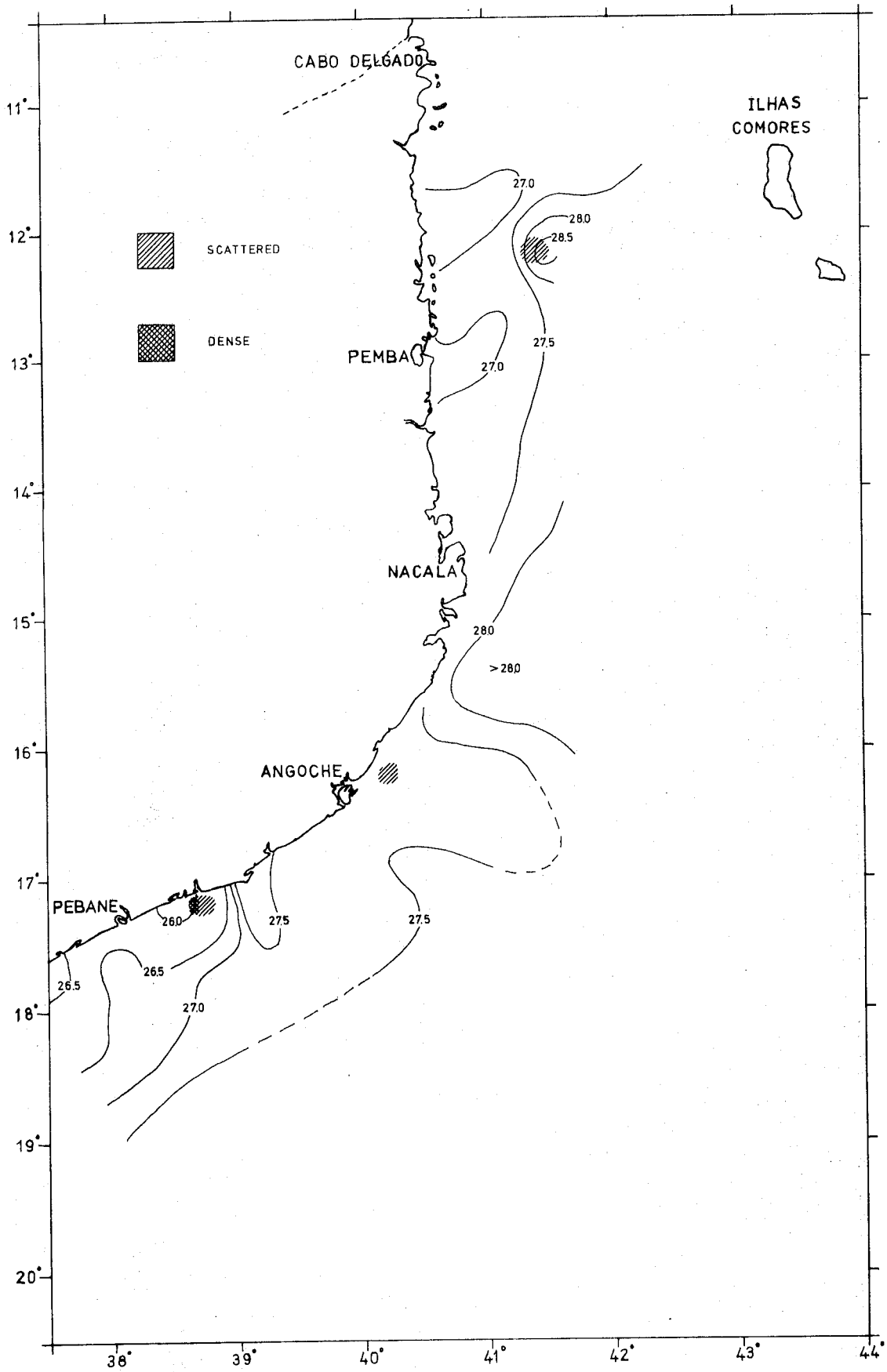

Fig. 2a. Surface temperature and demersal fish recordings - northern part.

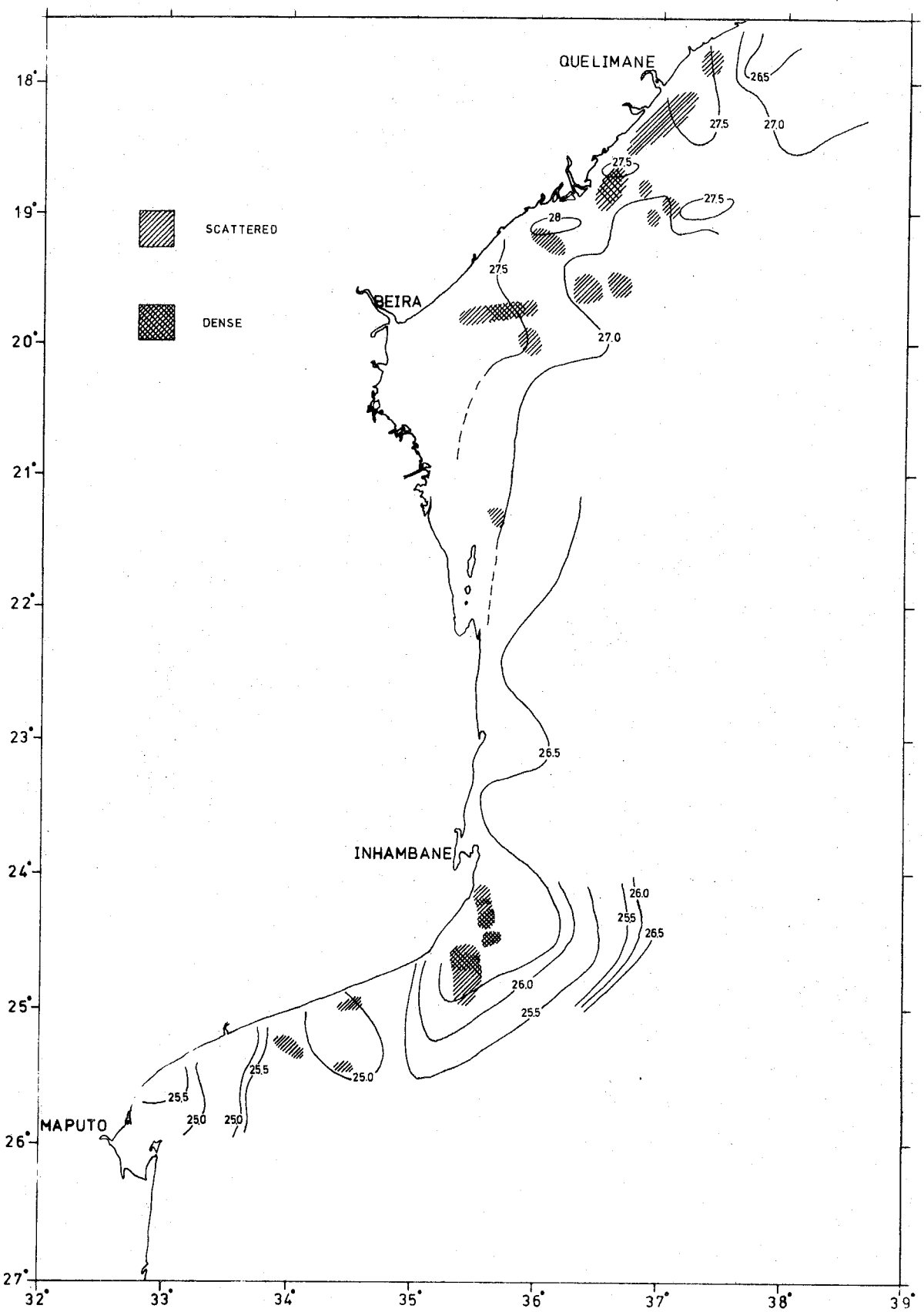

Fig. 2b. Surface temperature and demersal fish recordings- southern part.

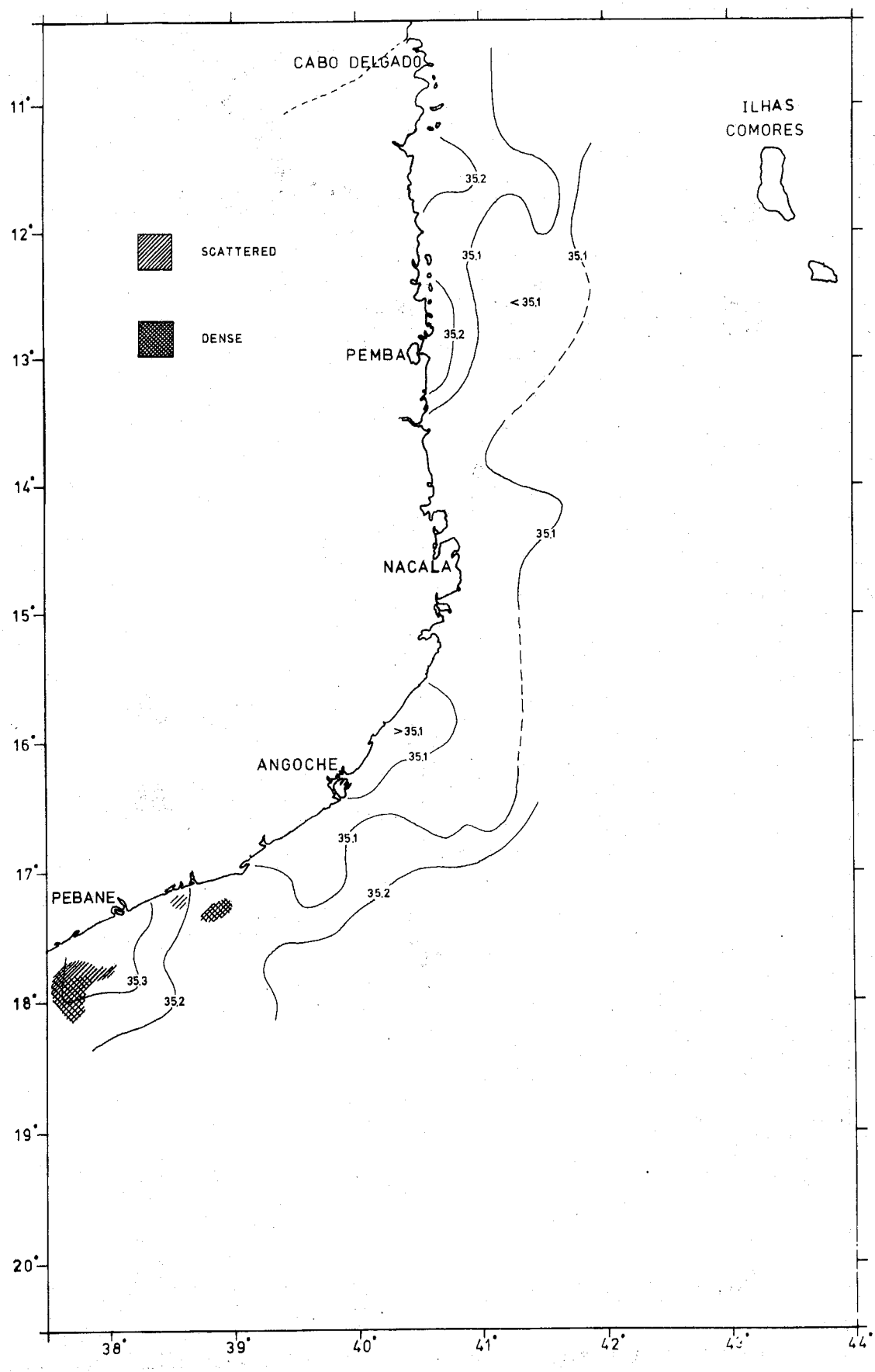

Fig. 3a. Surface salinity and pelagic fish recordings - northern part.

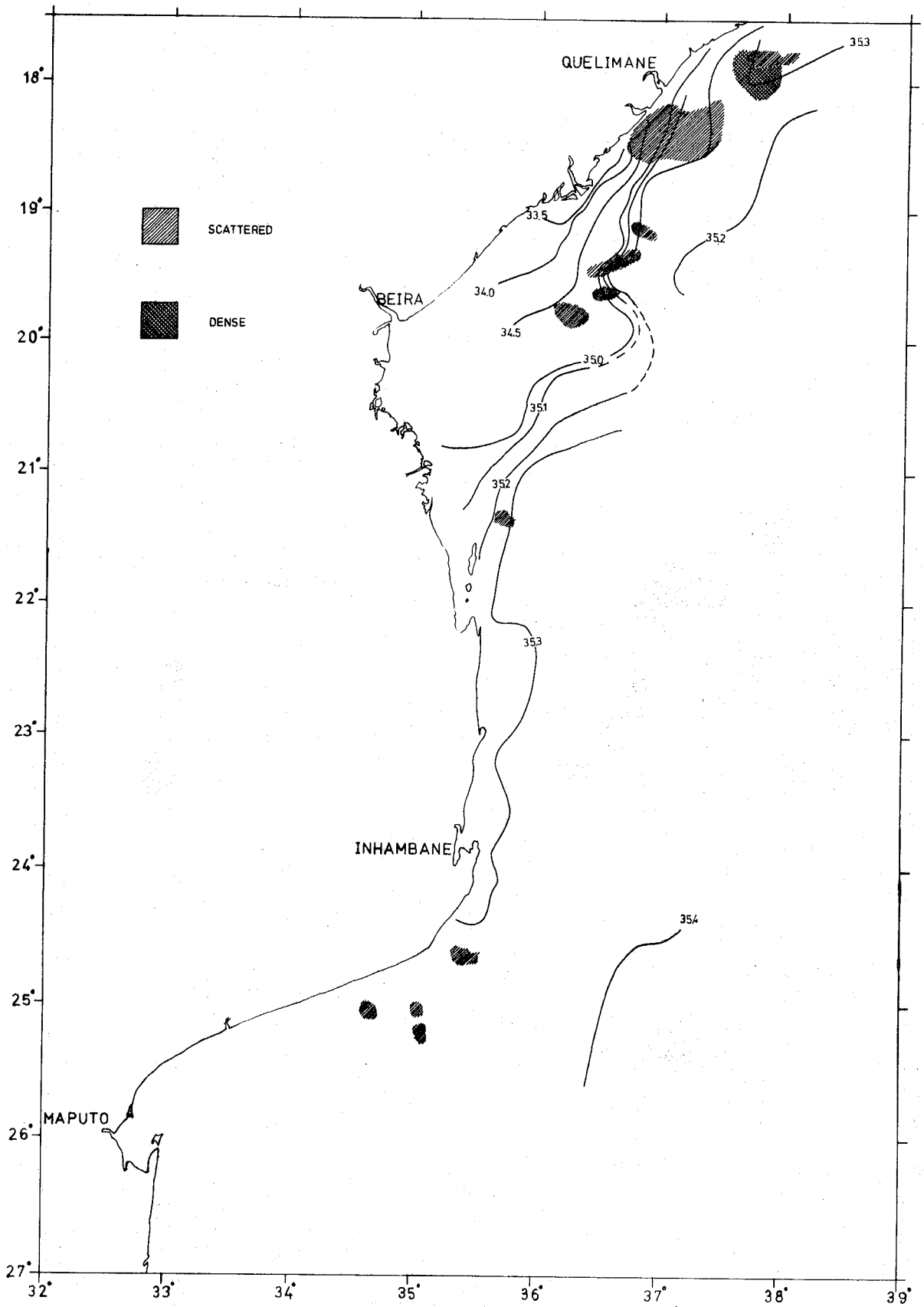

Fig. 3b. Surface salinity and pelagic fish recordings - southern part.

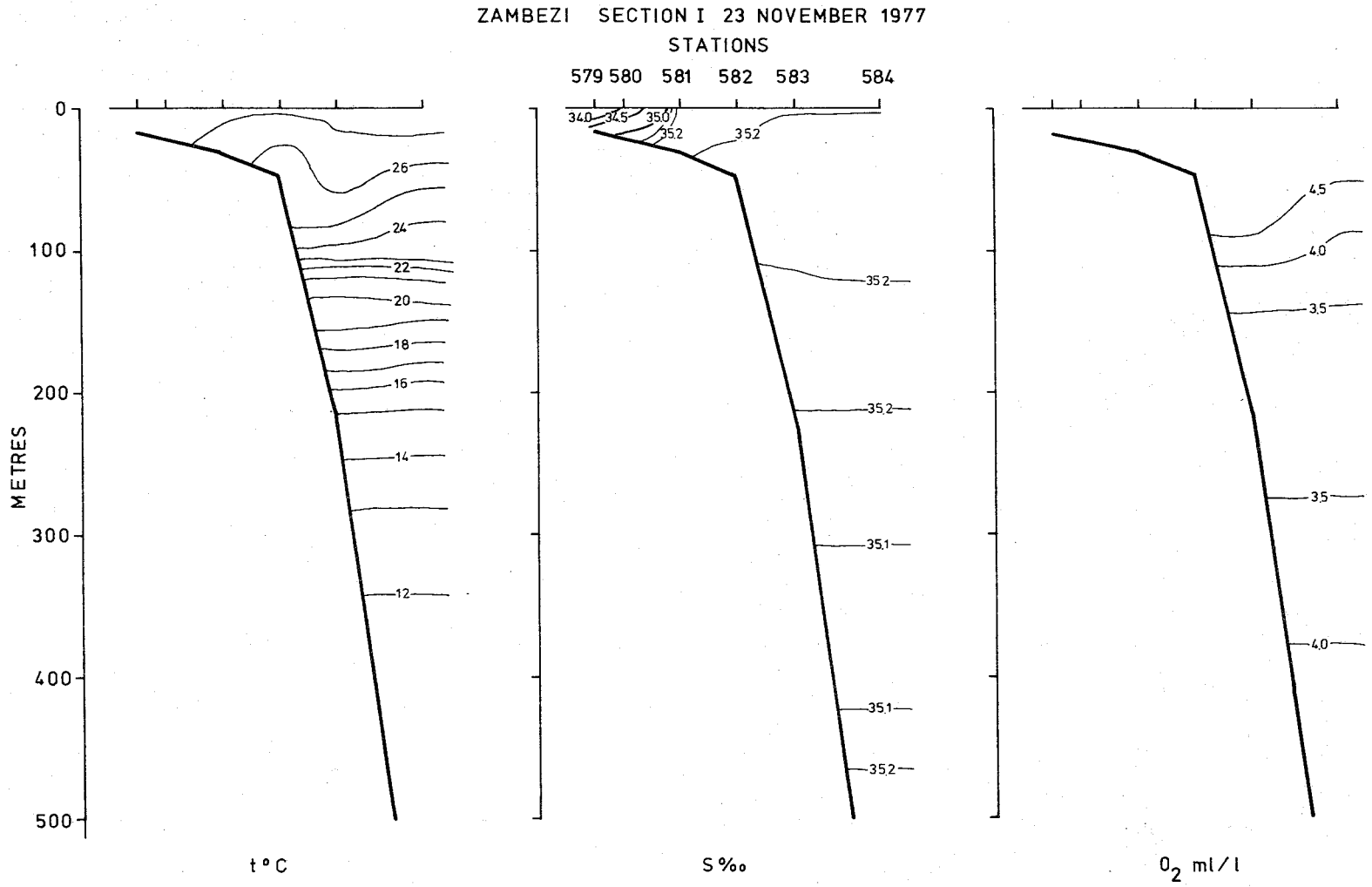

Fig. 4. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l outside the Zambezi River (Section I).

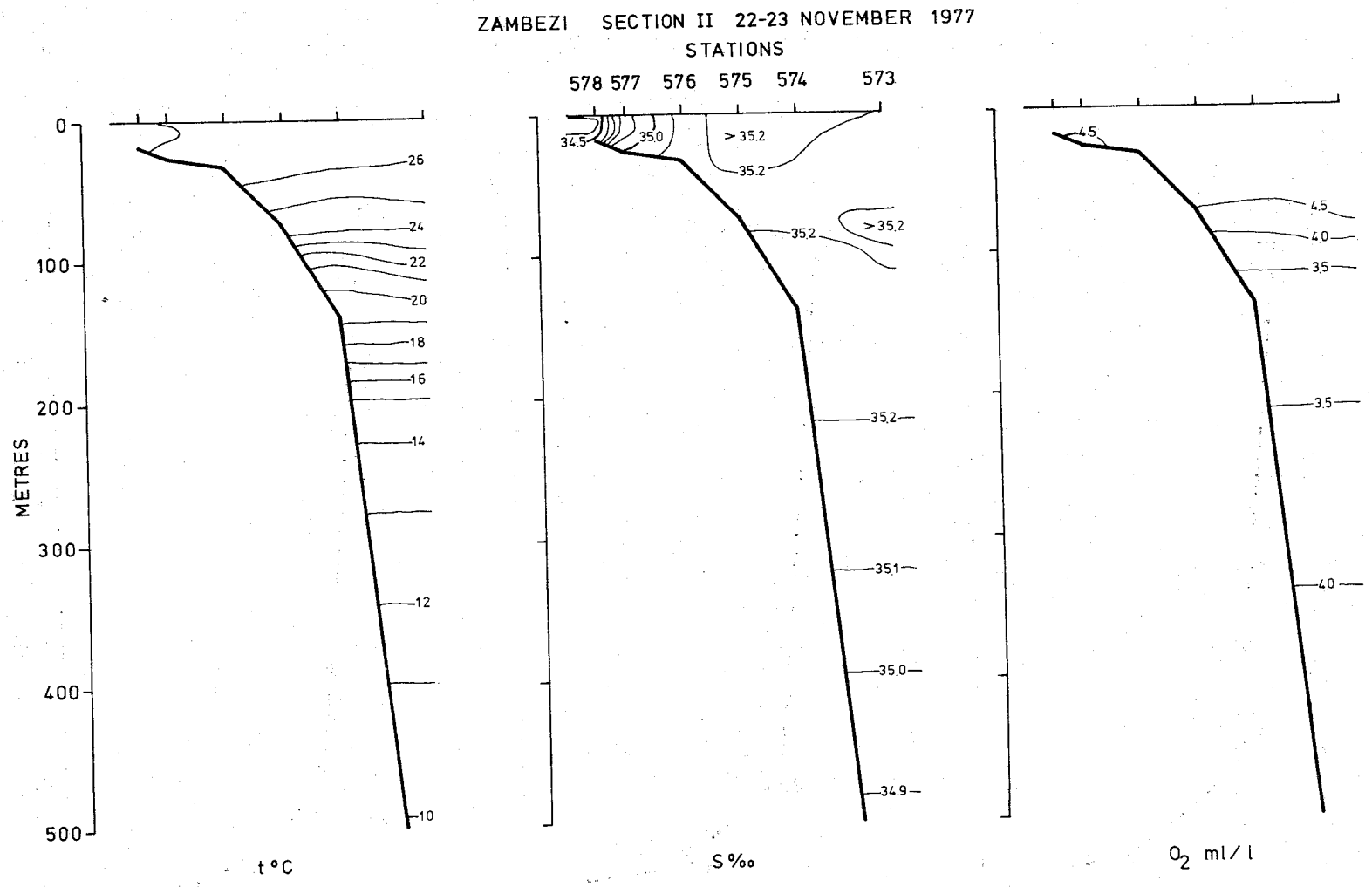

Fig. 5. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l outside the Zambezi River (Section II).

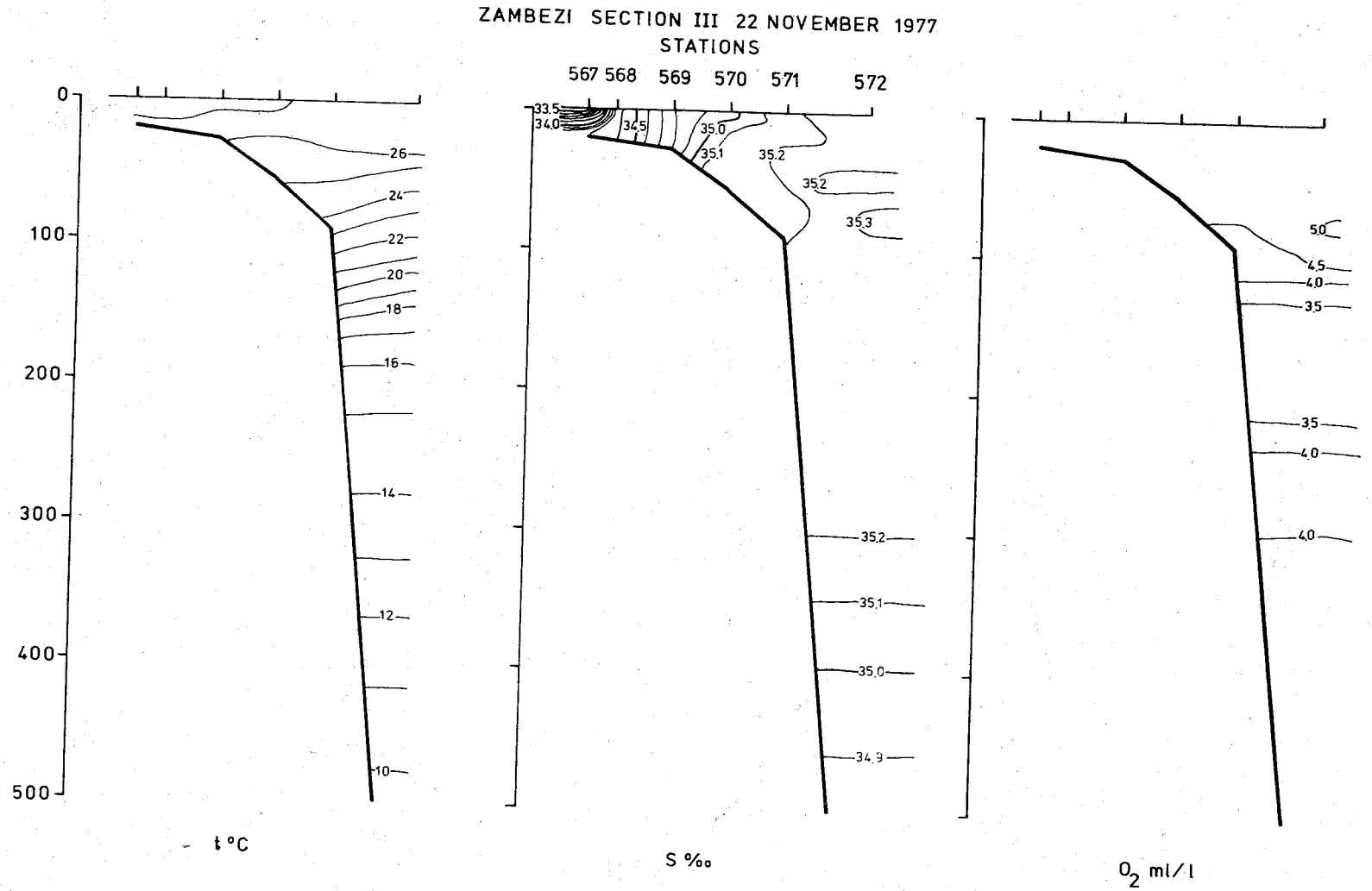

Fig. 6. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l outside the Zambezi River (Section III).

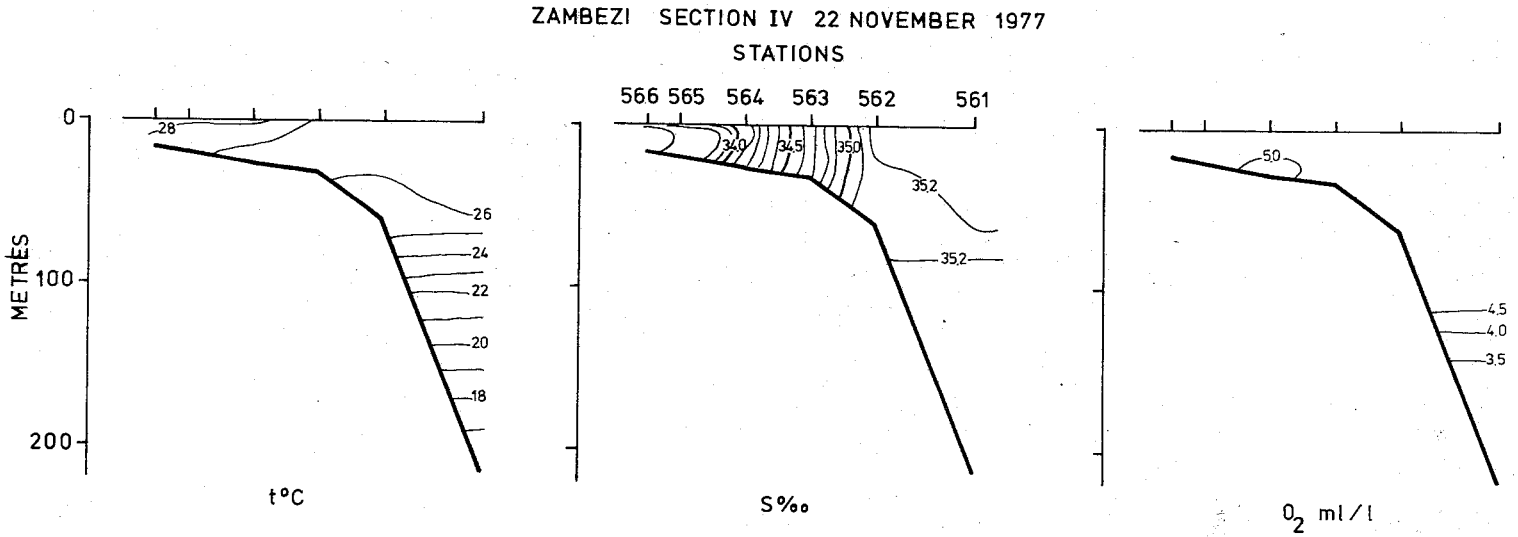

Fig. 7. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l outside the Zambezi River (Section IV).

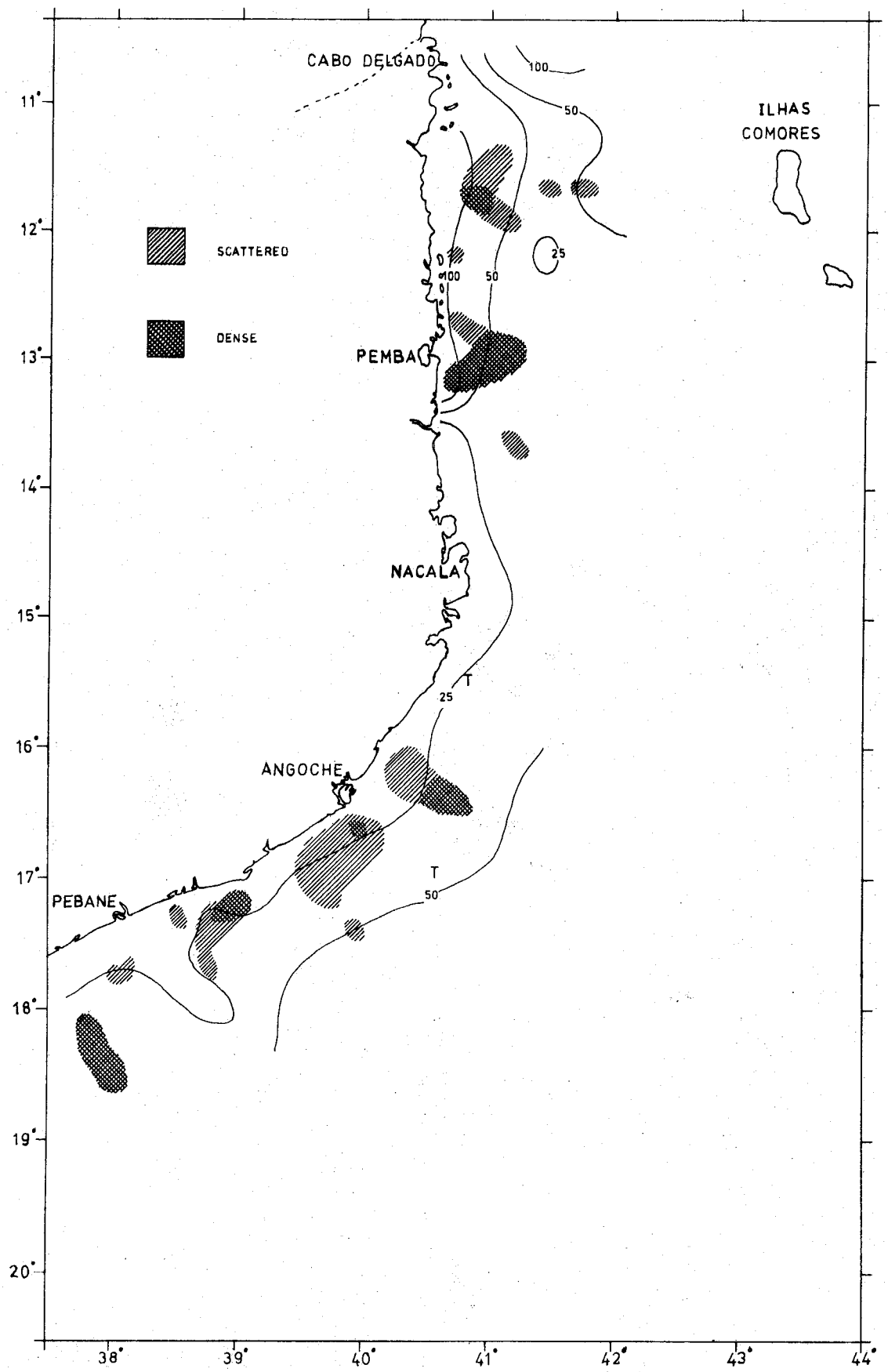

Fig. 8a. Depth to the thermocline, mesopelagic fish recordings and surface observations - northern part (T = tuna).

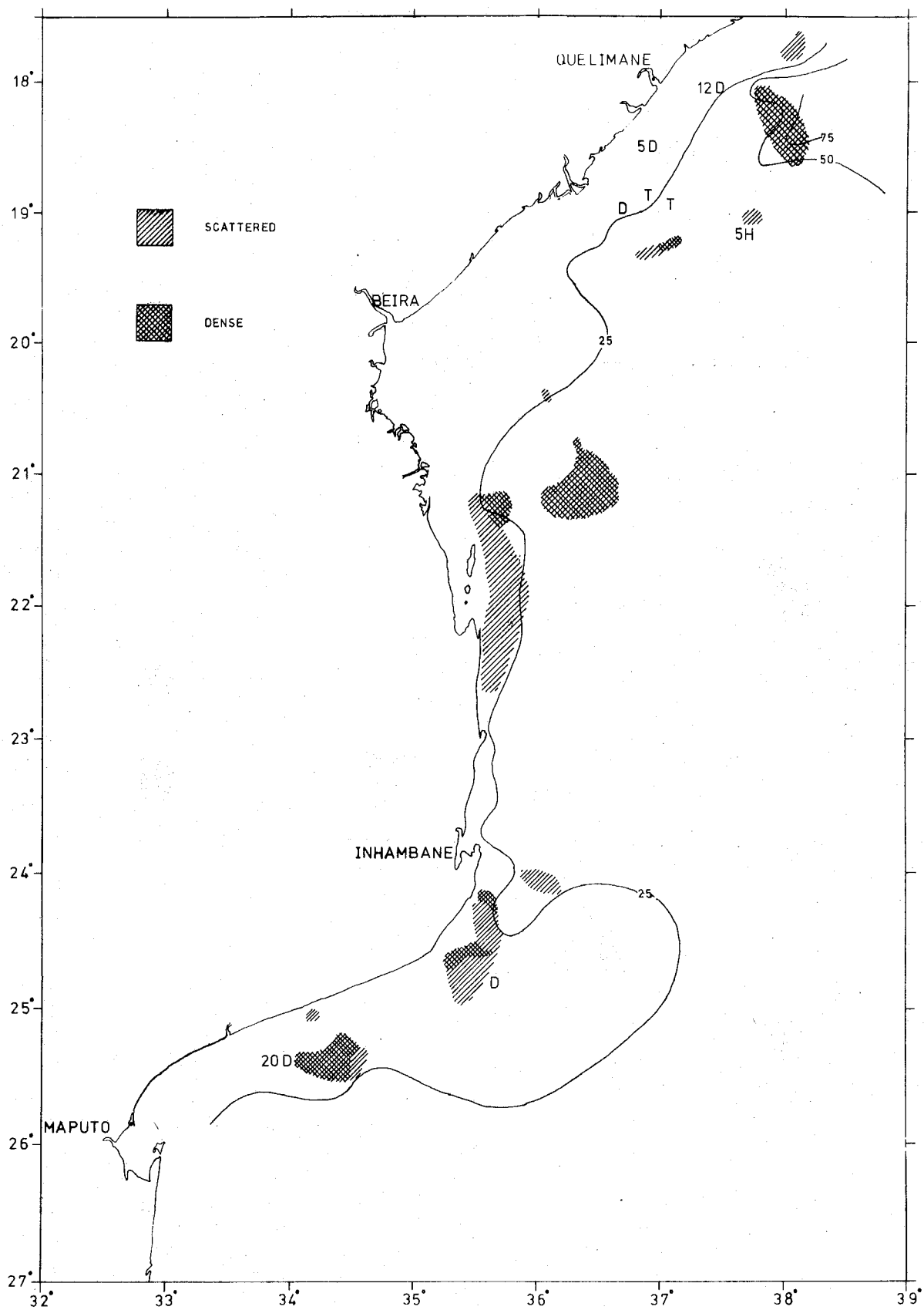

Fig. 8b. Depth to the thermocline, mesopelagic fish recordings and surface observations - southern part. (D = dolpleins; H = whales; T = tuna).

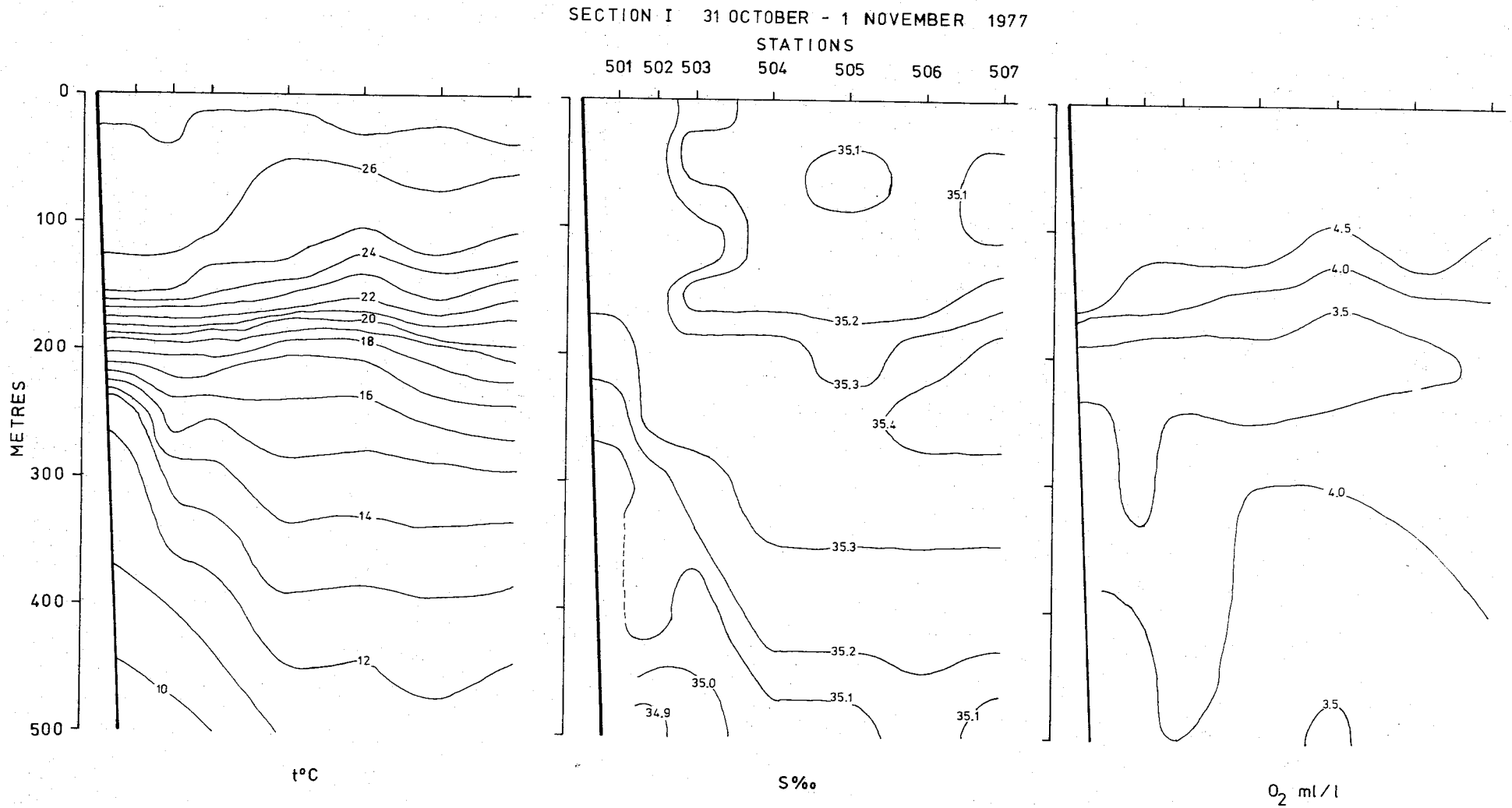

Fig. 9. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l at SECTION I.

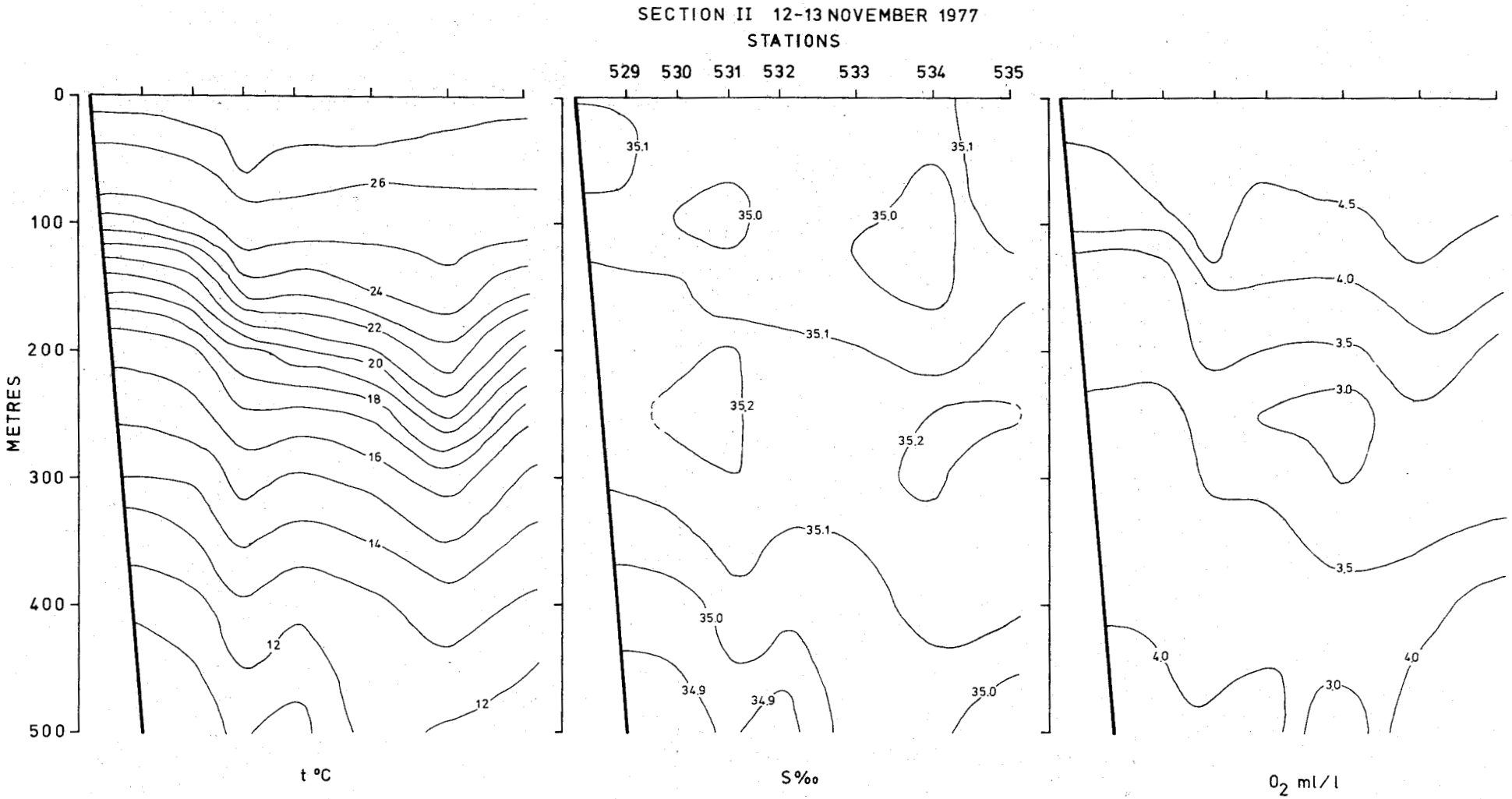

Fig. 10. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l at SECTION II.

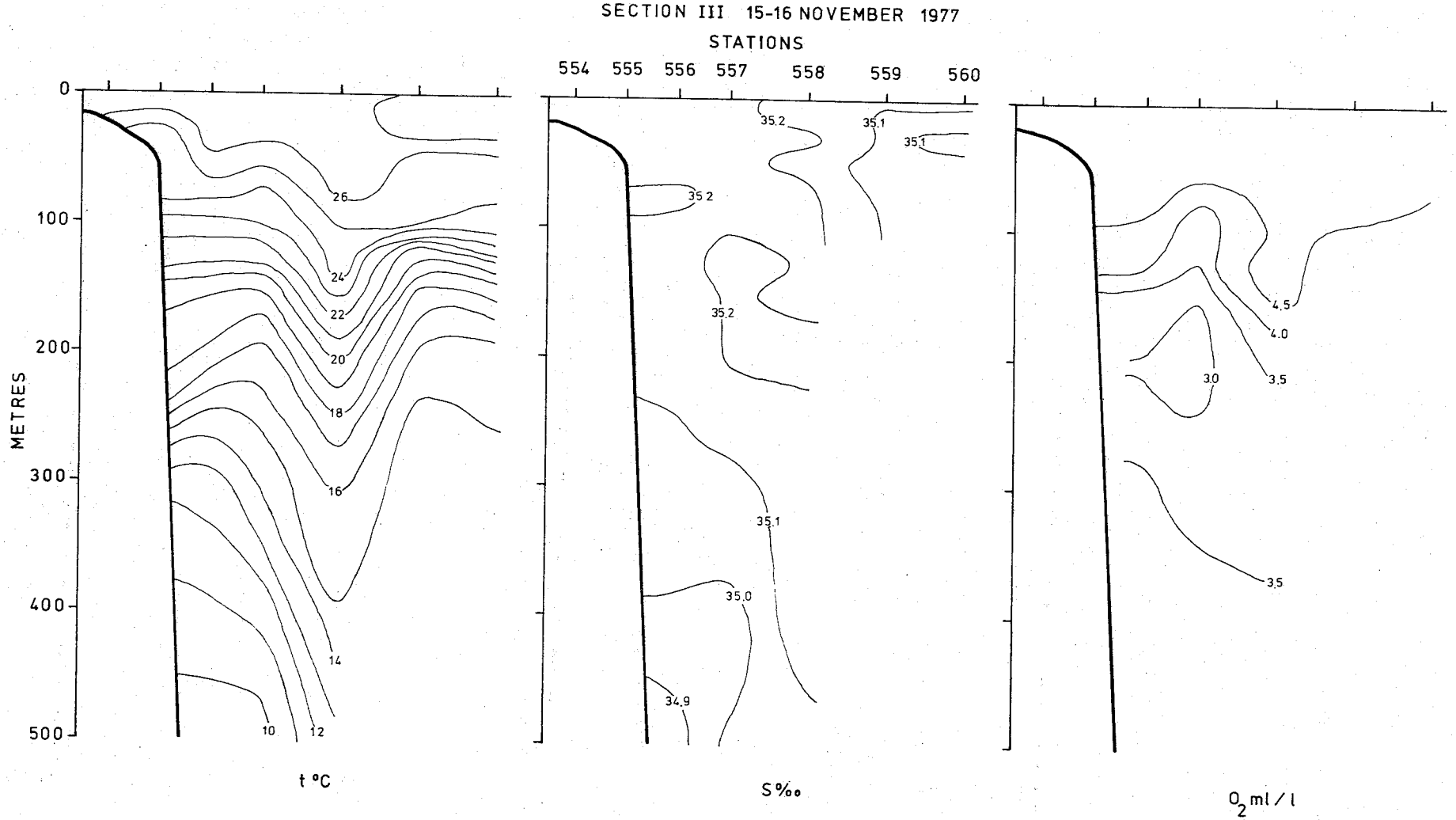

Fig. 11. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l at SECTION III.

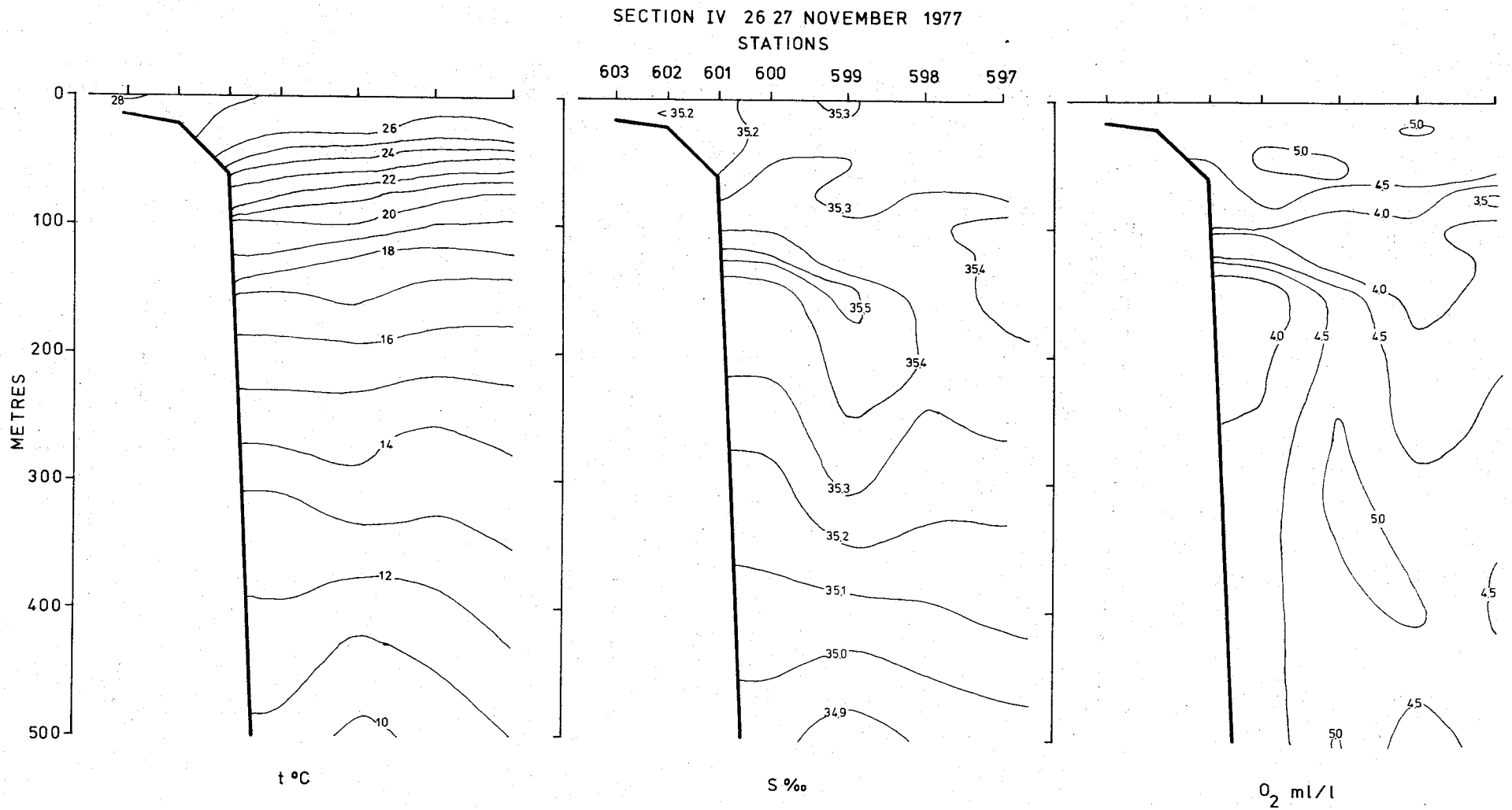

Fig. 12. Vertical distribution of t°C, S o/oo and O_2 ml/l at SECTION IV.

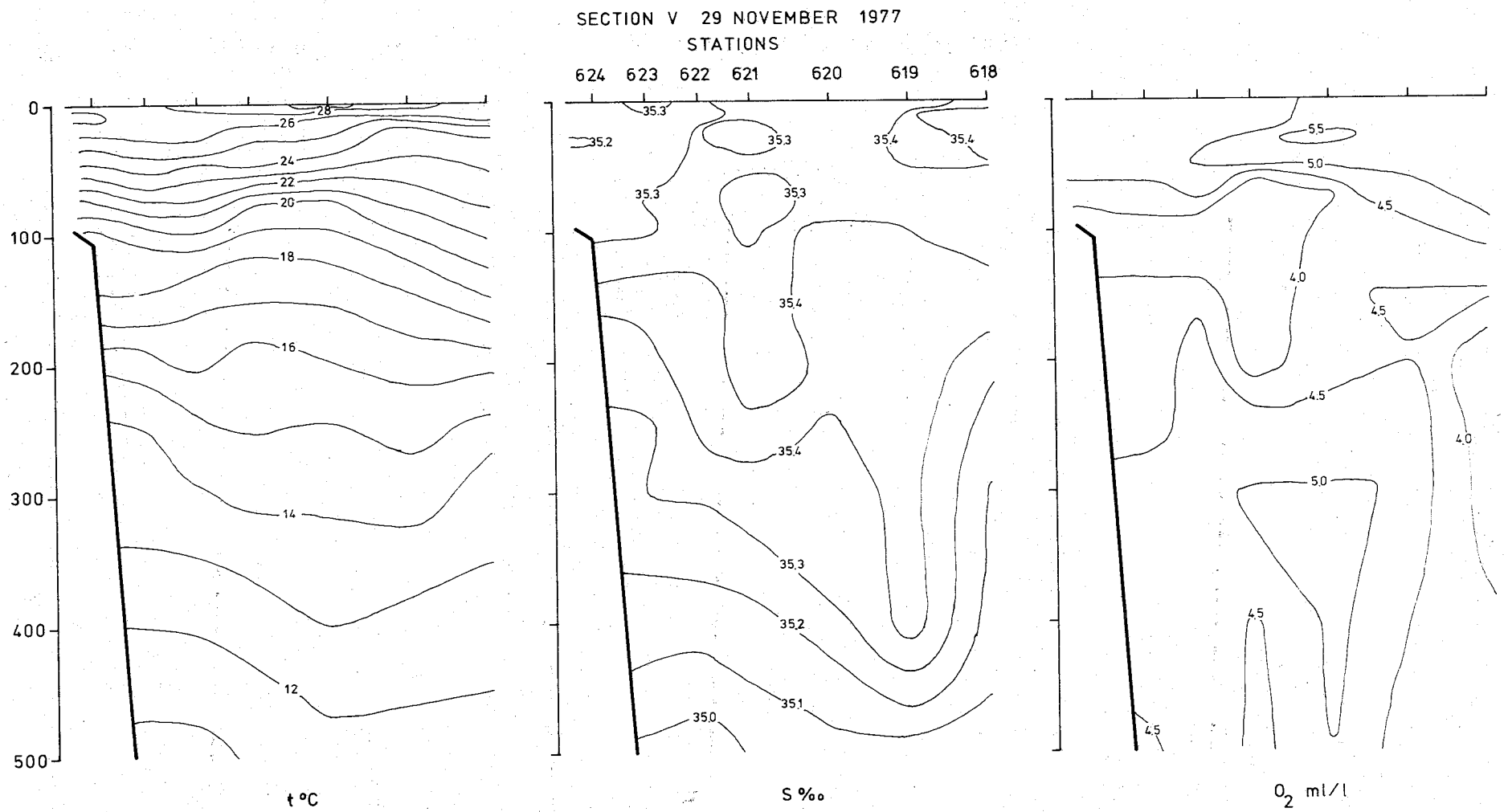

Fig. 13. Vertical distribution of $t^{o}C$, S o/oo and O_2 ml/l at SECTION V.

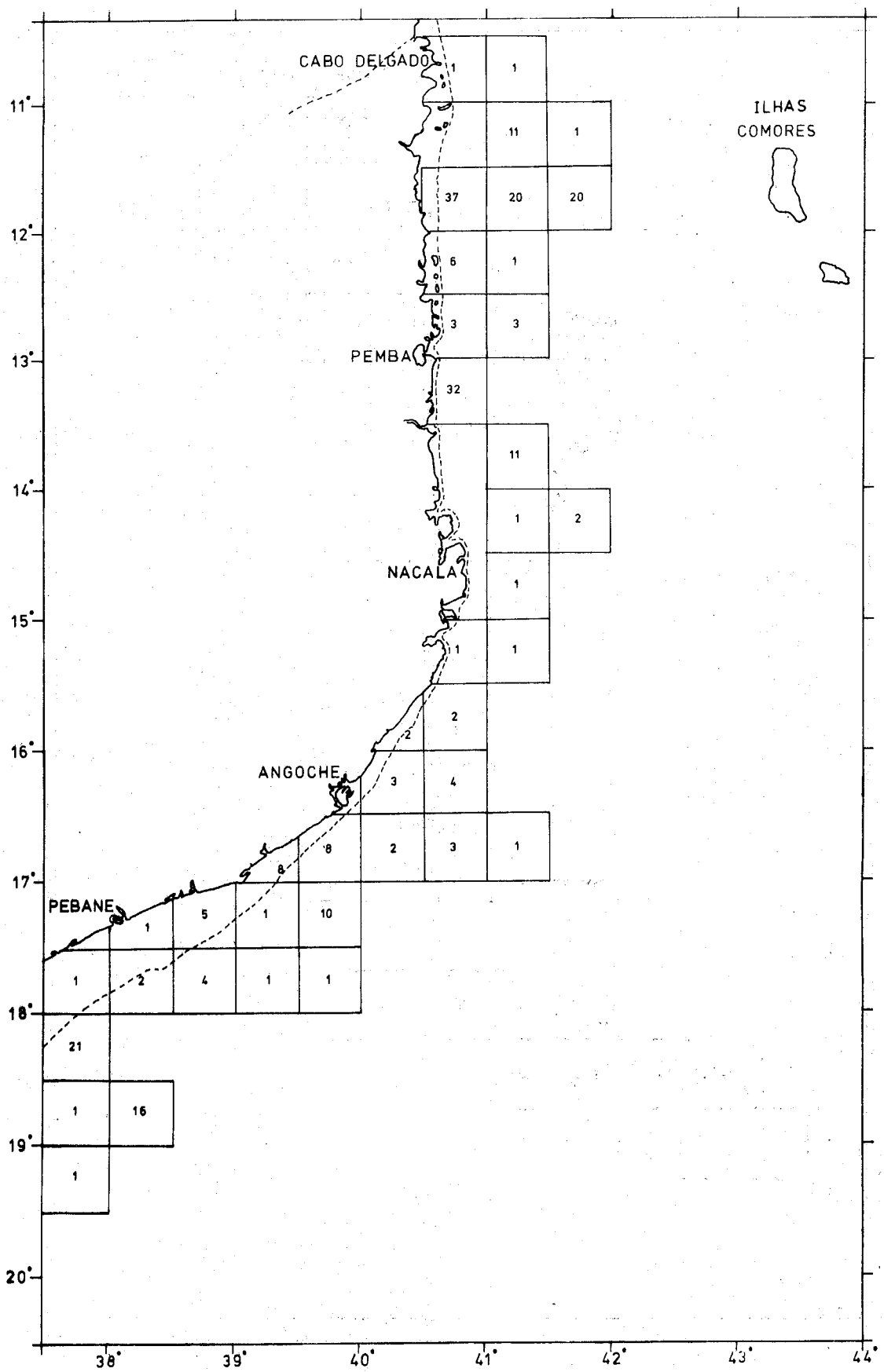

Fig. 14. Plankton - Average integrator deflection in mm per nautical mile - northern part (broken line shows the extension of the continental shelf).

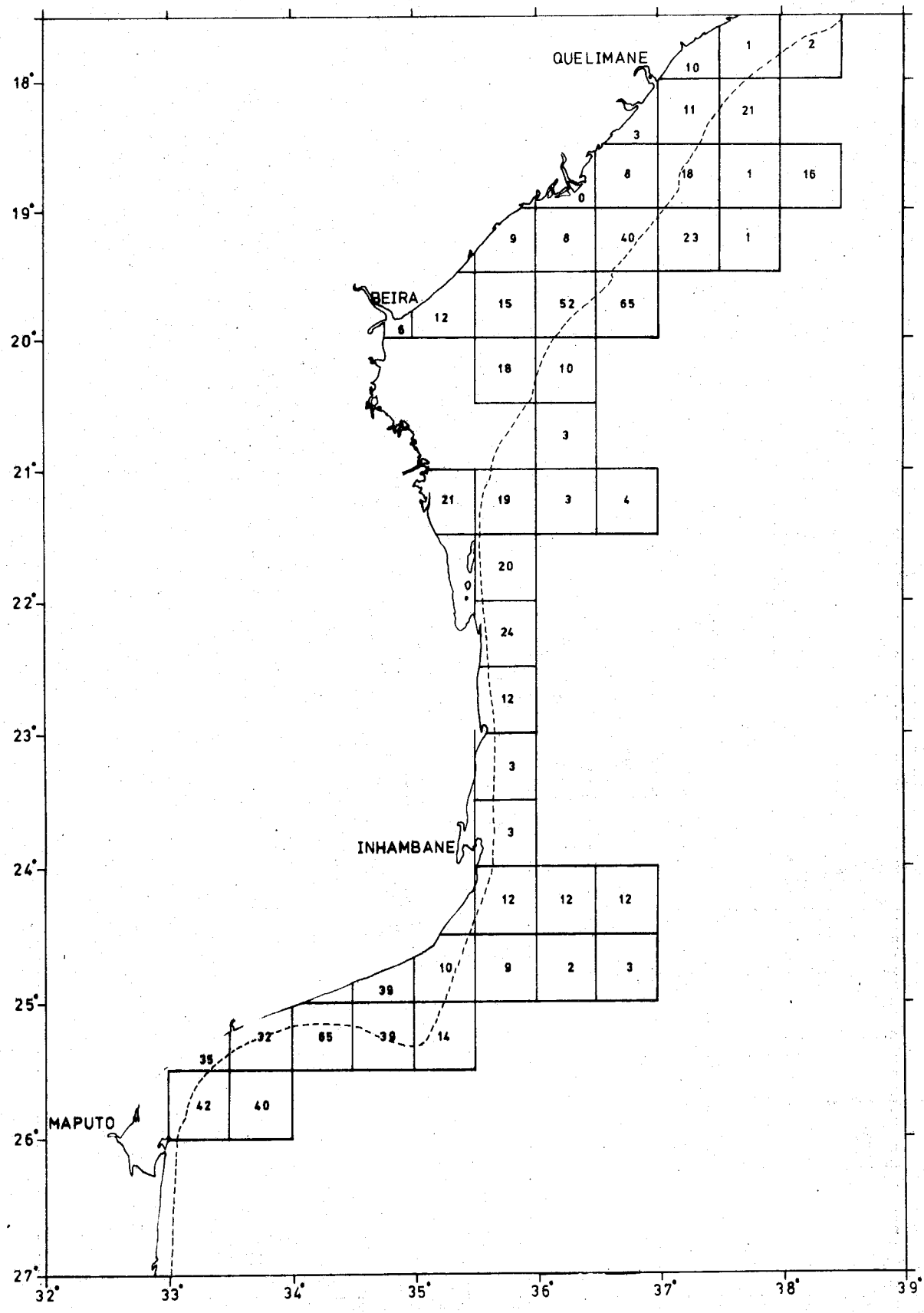

Fig. 14b. Plankton - Average integrator deflection in mm per nautical mile - southern part. (broken line shows the extension of the continental shelf).

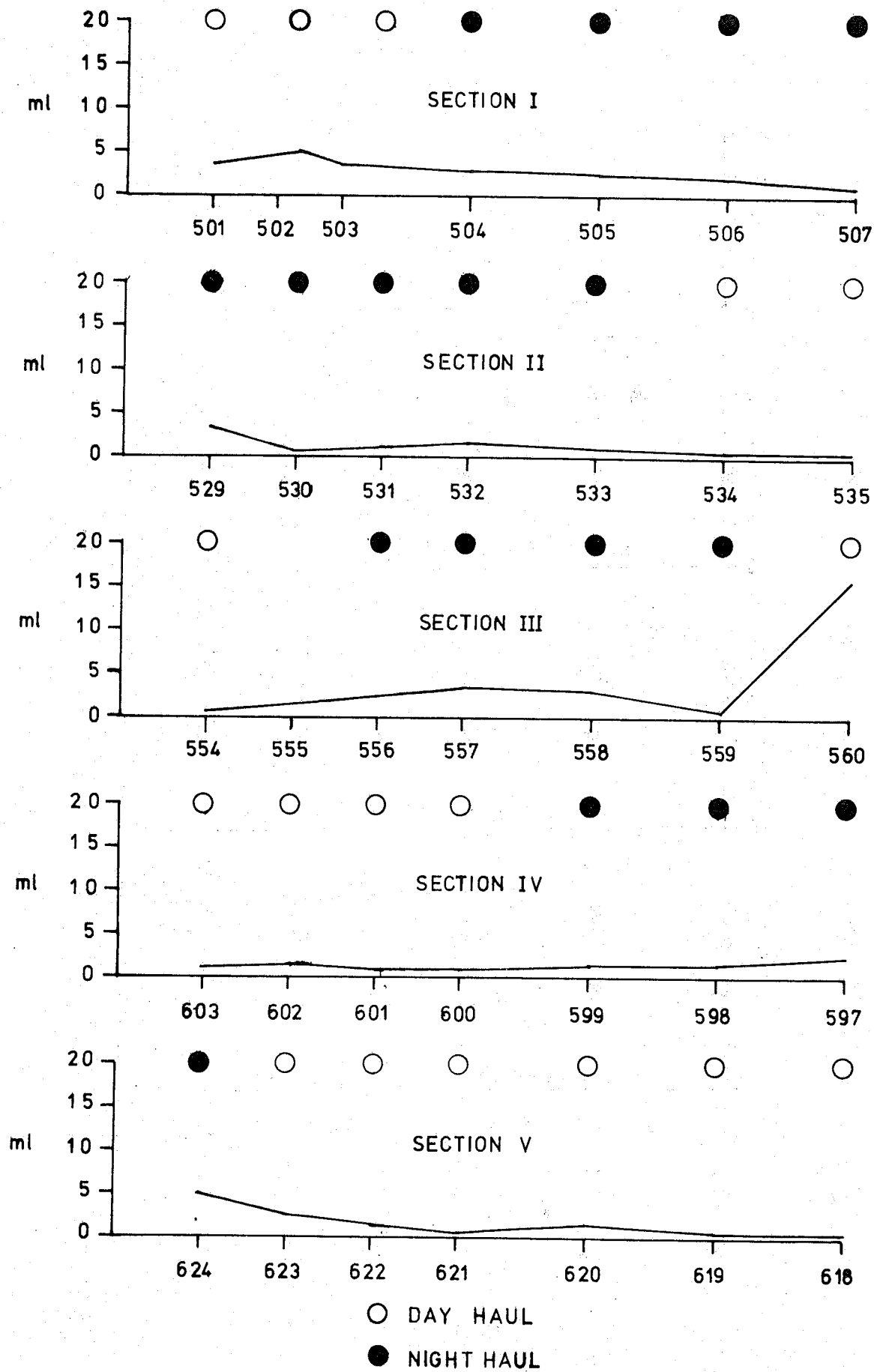

Fig. 15. Wet displacement volume of plankton at the hydrographic SECTION I - V.

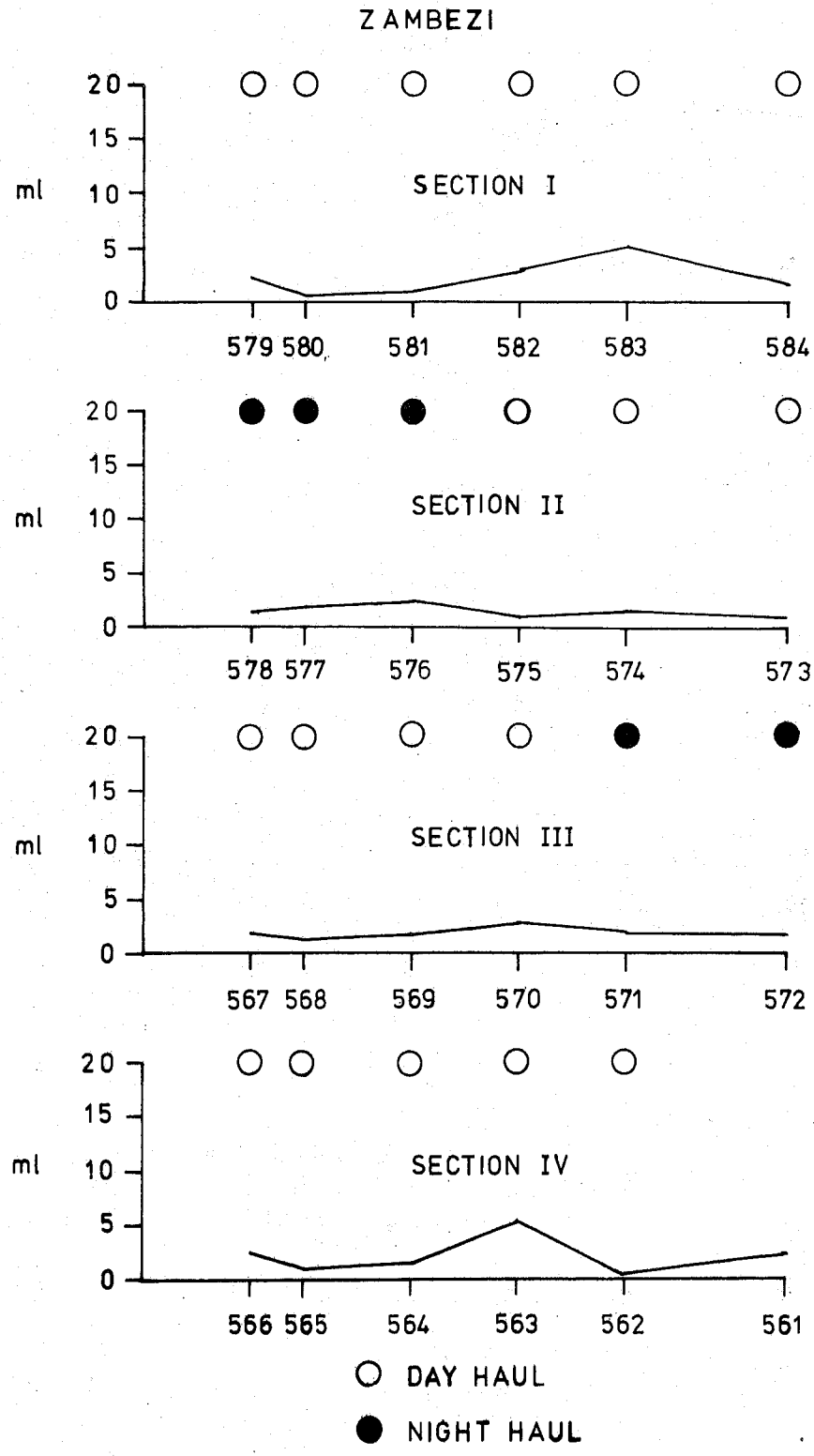

Fig. 16. Wet displacement volume of plankton at the hydrographic sections outside the Zambezi River.