A REPORT ON A SURVEY WITH THE R/V "ERNST HAECKEL"
IN JULY-AUGUST 1980

- Shallow-water shrimp and by-catch
- Oceanography

by

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C O N T E N T S

1. SURVEY OBJECTIVES

The main objectives of the present survey were:

1) Estimating the abundance of shallow-water shrimp over the area of Sofala Bank between 16º20'S and 20º20'S, from 5 to 100 meters.

2) Estimation of the shallow-water shrimp species composition and distribution pattern of the main species.

3) Biological data collection of the main species - Penaeus indicus and Metapenaeus monoceros.

4) Magnitude of the shrimp by-catch, species composition and biological data collection of the most abundant species of commercial value.

5) Collection of environmental data aiming to clarify the shelf circulation in the Sofala Bank and the main oceanic features in the regions 15°S to 18°S and South of 22°S.

2. SURVEY PROGRAMME

2.2.1. The survey area was divided into two strata - North of 19º00'S and South of 19º00'S. A low sampling effort was planned for the southern part, because, from information obtained in previous surveys, it is an area of lower shrimp density. Fishing positions were arranged on a rectangular grid pattern with the stations at fixed distances apart. A duration of 30 minutes per haul was planned.

2.2.2. Each haul should be sorted, the quantities recorded and shrimp and fish biological samples collected.

2.2.3 Shrimp biological samples should be collected only for Penaeus indicus and Metapenaeus monoceros. For each species the following data should be recorded:

- Tot'l length measured from the tip of the rostrum to the tip of the telsom.
- Carapace length measured from the post-orbital margin to the posterior dorsal midline.
- Sex
- Maturity stage. A scale of five maturation stages was used:

Stage I – The ovaries are thin, translucent, unpigmented and confined to the abdomen.

Stage II – The ovary is increasing in size and the anterior and middle lobes are developing. The dorsal surface is light yellow green.

Stage III – The ovary is light green and is visible through exoskeleton. The anterior and middle lobes are fully developed.

Stage IV – The ovary is dark green and clearly visible through the exoskeleton.

2.2.4 Fish biological samples should be collected in most abundant and with commercial value species. For each species the following data should be recorded:

- Total length
- Maturity stage. U.R.S.S. six stages scale was used.
- Stomach contents.

For identification of the species the following litterature was used: Smith (1953), FAO (1974) and Joseph and Nelson (1976).

2.2.5 Three oceanographic coverages have been made, one in each region considered in 1.5 (Figures 3.2, 3.14 and 3.21).

In the Sofala Bank stations were made to coincide with the end of each trawl station, except for the outer stations that were purely oceanographic ones.

In each station temperature and salinity were observed at 0-10-20-30--50-75-100-150-200-250-300-400-500-600 m (or bottom, whichever was less). In the Sofala Bank additional water sampling was made at 2 and 5 m in all stations shallower than 60 m. No unprotected thermometers were used and so all depths should be considered as nominal ones, as they were not subjected to any correction for wire angle. Secchi depth was also measured in all stations performed during daytime.

Temperature was measured by reversing thermometers and salinity determined on board by means of a BECKMAN RS7-B inductive salinometer.

In all stations the vertical distribution of temperature down to 250 m (or bottom, whichever was less) was observed by means of a bathythermograph.

In the region south of 22^{o}S (Figure 3.21) three additional bathythermograph sections were made between hydrographic sections in order to obtain details of the circulation system. Data on wind direction and force (BEAUFORT) as well as dry-bulb temperature were supplied by the navigation officers in all stations.

3. OCEANOGRAPHY

3.1 Introduction

Mozambique waters were covered more or less regularly by oceanographic surveys from August 1977 until July 1979. In addition, other oceanographic cruises have covered particular regions within the jurisdiction area of the People's Republic of Mozambique between February and November 1980. The preliminary results of those investigations have been published in different kinds of reports (SAETRE and PAULA E SILVA, 1979; ANON 1978; ANON, 1979; ISAENKO et al., 1980; BRINCA, REY, SILVA and SAETRE, 1981; BRINCA, SILVA and SILVA, 1981; ANON, 1981 a; ANON, 1981 b). JORGE DA SILVA, MUBANGO and SAETRE (1981) summarized all the information relevant to Mozambique waters that had not been previously published. That summary included results from the cruise now under consideration.

Making use of all available data until the end of 1980, SAETRE and JORGE DA SILVA (1981) have studied the distribution and propagation of water masses, as well as the general circulation pattern in the Mozambique Channel, particularly in the upper layers of its western part. They have not dealt, however, with shelf processes. According to these authors, the circulation in the upper layers off Mozambique seems to be characterized by the influence of three anticyclonic gyres, changing their positions along the coast, and four smaller cyclonic eddies moving normal to it. This circulation pattern seems to be most developped during the southern summer. During the southern winter a more or less continuous southward movement is observed, with geopotential gradients about half of those characteristic of the most intense pattern for the southern summer.

According to SAETRE and JORGE DA SILVA (1981), the upper layers off Mozambique are occupied by the following water masses:

- Equatorial Surface water and Subtropical water, interacting at the surface level (upper 100 m)
- Subtropical water, at the subsurface level, characterized by a salinity maximum centered at approximately 150-200 m
- Central water, below 300 m, with an oxygen maximum centered at 400-500 m.

One of the shelf areas, the Delagoa Bay-Boa Paz Bank area (south of latitude 24°40'S, Figure 3.1) has been specifically investigated in

October 1980 (BRINCA *et al.*, 1981). The results revealed a lifting of the water layers along the continental slope, at the coastal side of what seems to be a permanent topographically induced cyclonic eddy (SAETRE and JORGE DA SILVA, 1981), with subtropical water reaching the surface near the coast.

The other and most important shelf area, the Sofala Bank (between latitudes 16°S and 21°S, Figure 3.1), was investigated during two cruises in July-August 1979 (BRINCA, SILVA and SILVA, 1981) and November 1980 (BRINCA *et al.* 1981). Although there were differences in surface temperatures and salinities between the two cruises, that could be due to seasonal variations, there is no conclusive evidence of any clear seasonal change in the circulation pattern. The area seems to be characterized by the interaction of a southgoing oceanic current - the so-called "Mozambique Current" - with a northgoing coastal current. The Zambezi river seems to give a subtantial contribution to the onset of this coastal current (SAETRE and PAULA E SILVA, 1979). This current system determines globally a cyclonic circulation over the shelf, probably with several cyclonic cells separated by meanders of the oceanic current (BRINCA, SILVA and SILVA, 1981).
During 12 days in March 1980 an oceanographic section covering the outer part of the shelf, the slope and the oceanic area a little to the south of Quelimane was repeated 8 times (ANON, 1981 b). The repeated observations revealed the dependence of the oceanological fields in the area on the large-scale offshore dynamics. A cycle of about 11 days was confirmed by current measurements over the shelf during the same period.

A very interesting (and disturbing) feature is the presence of high salinity water (up to 36°/oo) near the coast approximately at latitude 20°30'S (BRINCA *et al.*, 1981).
The water was homohaline down to 10-15 m (BRINCA *et al.*, 1981) and its influence could be detected in July 1979 at a distance of 60 kilometers away from the coast (BRINCA, SILVA and SILVA, 1981).
Up to now, no satisfactory explanation has been found concerning the origin of this water.

3.2 Results

3.2.1 The area "Goa island- Fogo island"

This area was covered during approximately one week in July 1980 (Figure 3.2). Figures 3.3 and 3.4 reveal a seaward increase in both surface temperature and salinity within 20-40 kilometers from the coast, the conditions being more or less constant at the outer part of the sections. Figure 3.6 shows a weak thermal gradient at 150 m depth corresponding to a southgoing current. The shape of the isotherms also suggests the presence of a northgoing coastal current within 20-30 kilometers of the coastline. This is supported by the surface isotherms and isohalines and also by sections V-VII (Figures 3.11-3.13), showing low salinity shelf water proceeding from the Sofala Bank. The sections (Figures 3.7-3.13) reveal an intensification of the baroclinic structure with increasing depth, particularly below 300 m. Below this depth indications of a cyclonic eddy can still be found in sections I and II (Figures 3.7 and 3.8).

A degraded core of subtropical water, with salinities above 35.3$^{0}/_{oo}$ can only be detected in the outer part of sections II, III, V, VI and VII, centered between 150 and 250 m. Except for section V, the highest salinities found at the subsurface level at the inner part of the sections are only slightly above 35.25$^{0}/_{oo}$. This probably corresponds to occasional intrusions of the degraded core of Subtropical water towards the coast, associated with current pulses, followed by mixing with water coming from the north.

3.2.2 The Sofala Bank area

Figure 3.14 shows the oceanographic stations performed in this area. Stations 179-200 (Figure 3.2) overlap (Both in time and space) in the northern part, and values from these stations have been considered when constructing the charts presented in Figures 3.15-3.18.

Only isolated stations in the northern part were performed during daytime, which limited the number of observational points of Secchi depth. On the other hand, very few stations were made at depths shallower than 15 m, which probably accounts for the very few points with both very low salinity and Secchi depth values. Secchi depth values as low as 1 m were however found over the shelf north of latitude 17^{o}S, but they were useless for interpolation purposes.

In July 1960 all rivers, Zambezi included, were approaching their minimum runoff. The runoff of the Zambezi was however about 7 km^{3}, while Lúrio (the second most important river in the area) had a runoff of 0.2 km^{3}. Adding all freshwater contributions, the Zambezi outflow still represented about 90 percent of the total. Figure 3.17

shows that the influence of freshwater runoff (i. e., mainly the Zambezi river)is clearly detectable up to Pebane, with another pocket north of latitude 17°S

The circulation pattern that can be inferred from the distributions depicted in Figures 3.15–3.18 consists of an oceanic current flowing roughly along the direction of the isobaths (Figures 3.14–3.18 include de 50 m isobath as a dotted line) and a longshore northgoing coastal current. Seaward transport of low salinity shelf water can be clearly seen in front of the Zambezi mouth. A meander of the oceanic current is also apparent in all distributions off Quelimane. South of the Zambezi mouth the oceanic current apparently tends to flow over the shelf where it seems to interact both with low salinity shelf water and with high salinity water proceeding from the coast. This high salinity water showed salinities up to 35.7 ‰ at the coastalmost part of the research area. This water was homohaline in its distribution area down to 50 m depth (Figure 3.20). Small eddies of low salinity shelf water are found over the shelf edge from the Zambezi mouth southwards.

Like in the Goa island–Fogo island area, the baroclinic structure off the Sofala Bank seems to be intensified with depth (Figures 3.19 and 3.20). Section VIII reveals a strong and narrow southgoing current over the continental slope, while section IX provides some indication of a cyclonic eddy imeadiatly off the shelf edge. In section VIII the core of the Subtropical water is associated with the southgoing current,which may mean that it probably proceeds from the north.

In section IX, however, the small core with salinities above 35.3 ‰ is associated with the apparent cyclonic eddy. It is thus very difficult to say whether it comes from north or from south. Data from the stations performed between sections VIII and IX provide no conclusive evidence of any connection between the two observed cores.

3.2.3 The Southern area

The area south of latitude 22°S was covered during approximately 11 days in August 1980 (Figure 3.21). Unfortunately, this area was covered from south to north leaving a gap of about three weeks between sections IX (Figure 3.20) and XVIII (Figure 3.30), i.e. the sections that could provide a solution of continuity for the oceanic processes between the Sofala Bank and the Southern area.

Figure 3.25 reveals a complex dynamic situation. Two anticyclonic vortexes interact with two cyclonic eddies. A general cyclonic circulation over the shelf and slope of the Delagoa Bay-Boa Paz Bank area is apparently continued by a northgoing coastal current probably reaching the region of Inhambane.
All distributions (Figures 3.22-3.25) fit very well this description. Subtropical water (Salinity above 35.5^{0}/oo; temperature below 22^{0}C) was present at the surface at the southeastern part of the area. The presence of Subtropical water can also be detected at the surface near the coast between latitudes 22^{0}S and 23^{0}S. Its characteristics (salinity above 35.4^{0}/oo; temperature below 23^{0}C) reveal that this water has undergone some mixing process. Modified Equatorial Surface water (salinity lower than 35.1^{0}/oo; temperature greater than 23^{0}C, sometimes above 24^{0}C) was present near the coast and between the two tongues of Subtropical water.

The profiles shown in Figures 3.26-3.30 basically support the statements based on the horizontal distributions. Like in the other two regions, the baroclinic structure is stronger below 200 m. Dynamic upwelling over the shelf and slope is quite evident in sections X-XII (Figures 3.26 and 3.27). Antarctic Intermediate water (temperature below 8^{0}C, salinity below 34.7^{0}/oo) was approached near 500 m in sections X and XI (Figure 3.26).

3.3 Discussion

In December 1978 a well developped cyclonic eddy was present in the Goa island-Fogo island area (ANON, 1979). Such a feature, that seems to be more characteristic of the southern summer situation (SAETRE and JORGE DA SILVA, 1981) was absent in July 1980 at the surface layer. However, sections I and II (Figures 3.7 and 3.8) show below 300 m a dome shape of the isolines, characteristic of a cyclonic eddy. SAETRE and JORGE DA SILVA (1981) have already pointed to the fact that this cyclonic eddy is always detectable below 200 m even when it is not shown in the temperature distributions at 150 m.

Figures 3.5 and 3.6 show that the northward movement of Subtropical water at the subsurface level off the coast of Mozambique seems to be blocked between latirudes 15^{0}S and 16^{0}S due to the presence of an anticyclonic tongue probably extending from the northern part of the Channel. In so being, the subtropical water present in sections V-VII would have been supplied by northward transport along the coast of Madagascar followed by a westward component of movement at 16-17°S, and a subsequent southward movement along the coast of Mozambique. From section IV northwards the salinity core is weak and probably supplied by pulses of both the southgoing current along the Mozambique coast and a northgoing current along the west coast of Madagascar (DONGUY and PITON, 1969; CITEAU, PITON and MAGNIER, 1973). This current will probably introduce Subtropical water into the northern Mozambique Channel (SAETRE and JORGE DA SILVA, 1981)

Although a general cyclonic circulation system was dominating the Sofala Bank area, no clear indication of a well develloped cyclonic eddy was found off the Zambezi mouth. This contrasts with the situation in July-August 1979 (BRINCA, SILVA and SILVA, 1981). A large meander of the oceanic current is apparent off Quelimane (as in July-August 1979) with offshore transport of shelf water on both sides of the meander. The presence of such meander can also be inferred from the surface salinity distribution in November 1980 (BRINCA, et al., 1981). In this case it was probably located to the north of Quelimane, and induced dynemic upwelling of subsurface water up to the surface over the shelf. The fluctuation of such meander was apparently followed in March 1980 (ANON, 1981 b). A cycle of 260 hours was found and confirmed by current measurements over the shelf.

SAETRE and JORGE DA SILVA (1981) pointed to the possibility of low salinity pockets found south of latitude 21°S being the result of the southward transport of shelf water from the Sofala Bank. The eventual propagation of the meander off Quelimane could provide an explanation of that transport. It could also probably explain why the high salinity water found near the southern coast of the Sofala Bank is sometimes confined to a region close to the coastline (BRINCA et al., 1981) while in other occasions its influence is detectable away from the coast (present case and BRINCA, SILVA and SILVA, 1981). The tidal situation can however provide an important alternative explanation for the propagation of this high salinity water. TINLEY (1971) mentions mean tidal ranges of about 4 m in neap tides and 6 m in spring tides at Beira. Tidal currents may thus be a very important controlling factor of water distribution and propagation in the southern Sofala Bank.

In July-August 1979 the influence of the freswater runoff - mainly from Zambezi - could be detected until 300 kilometers to the northeast of the Zambezi mouth (BRINCA, SILVA and SILVA, 1981).
A similar situation occurred in July-August 1980, but in this case water with salinity below $33^{o}/oo$ was also found north of latitude 17^{o}S. The freshwater runoff north of 17^{o}S being about 0.05 km^3 in July 1980, the low salinity water found in that shelf area was most likely coming from south, transported in a longshore northgoing coastal current continuous from 19^{o}S to 16^{o}S.

Although it seems more or less plausible that the core of Subtropical water present in section VIII (Figure 3.19) proceeds from north - either as a continuous tongue extending southwards from section V (Figure 3.11) or as an isolated pocket - the same is not true for the core detected in section IX (Figure 3.20). If one accounts for the circulation pattern found in the southern area (Figure 3.22-3.25), the possibility remains for Subtropical water to turn partly northwards between latitudes 20^{o}S and 22^{o}S.

The circulation system revealed by Figure 3.25 for the Southern area supports the idea that the "Mozambique Current" divides at about latitude 25^{o}S. One branch will then recirculate at this latitude while another branch will continue past the Southern end of the Mozambique Channel after mixing with water coming both from east and south. The presence of water with temperature above 24^{o}C and salinity below $35.1^{o}/oo$ in the Southern area, between the tongues of Subtropical water, suggests that the penetration of Subtropical water at latitude 22^{o}S is probably a consequence of short-term variability. The amount of water recirculated at about latitude 25^{o}S will then also depend greatly on short-term variations.

Although its center has not been reached by the station grid, the presence of the permanent cyclonic eddy off Inhaca (SAETRE and JORGE DA SILVA, 1981) can be detected in Figures 3.24 and 3.25, with its associated dynamic upwelling affecting the subsurface and intermediate layers (Figure 3.26).

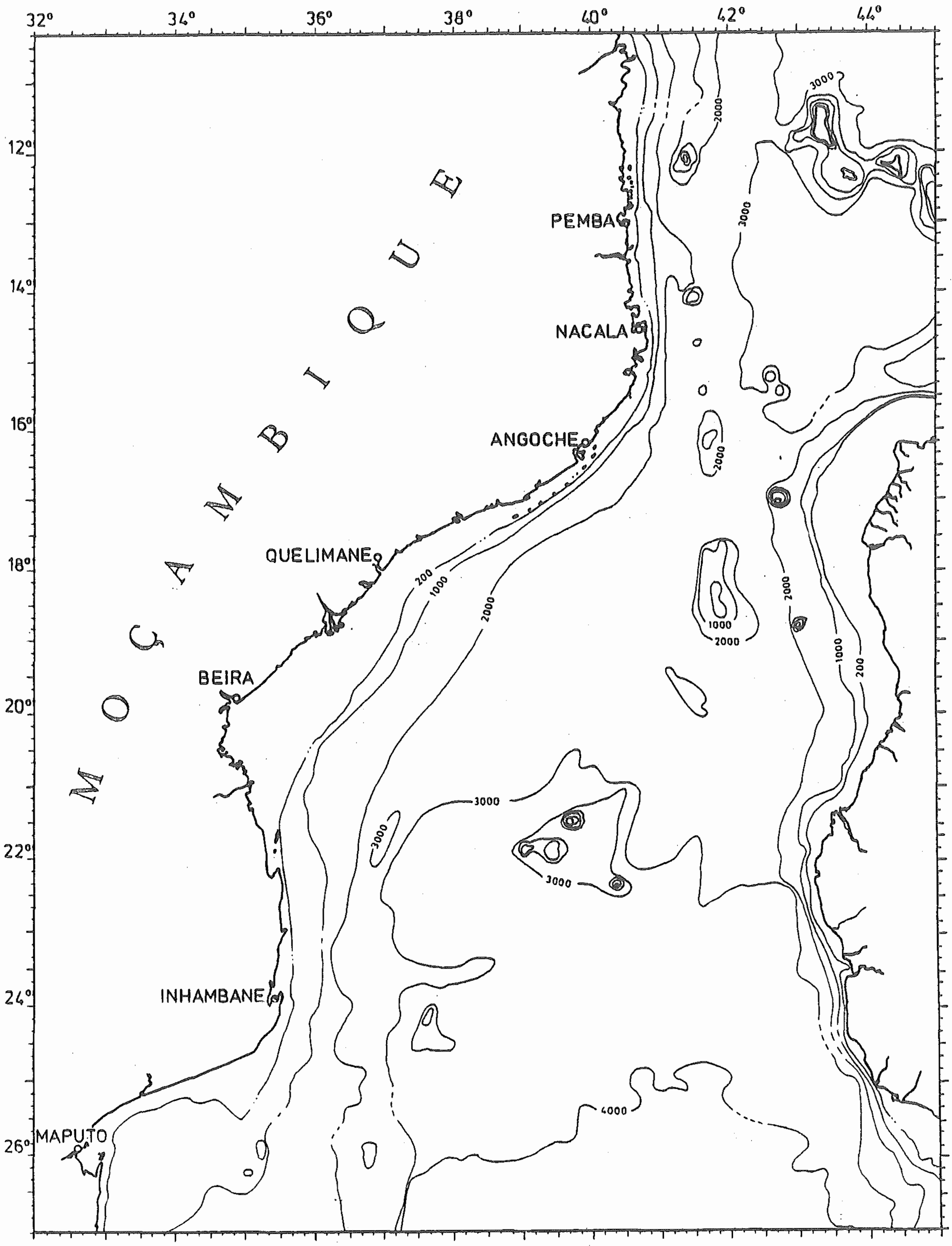


Figure 3.1. Bathymetric map of the Mozambique Channel. Depth in meters.

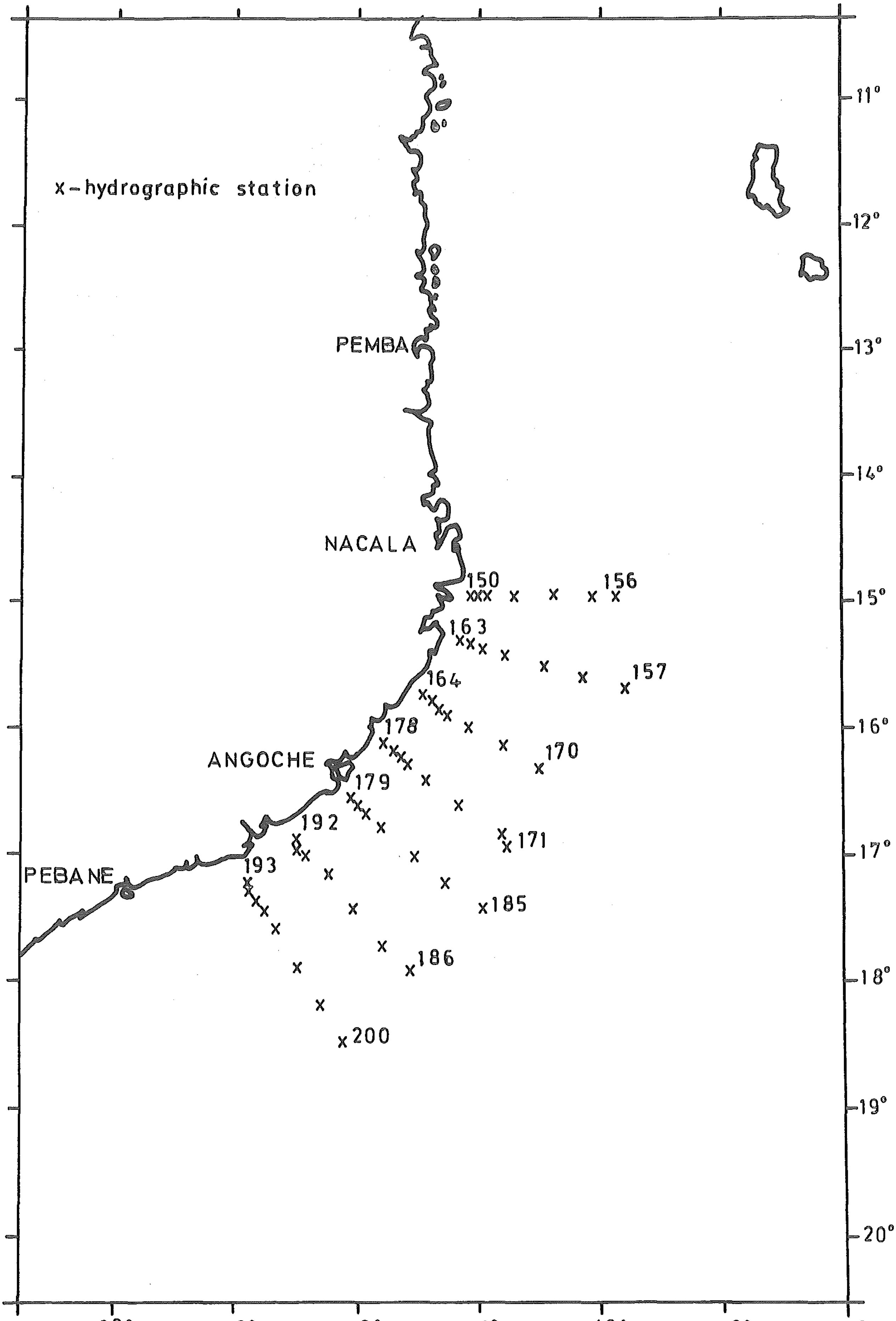


Figure 3.2. Region Goa island-Fogo island, 5-12 July 1980. Grid of stations

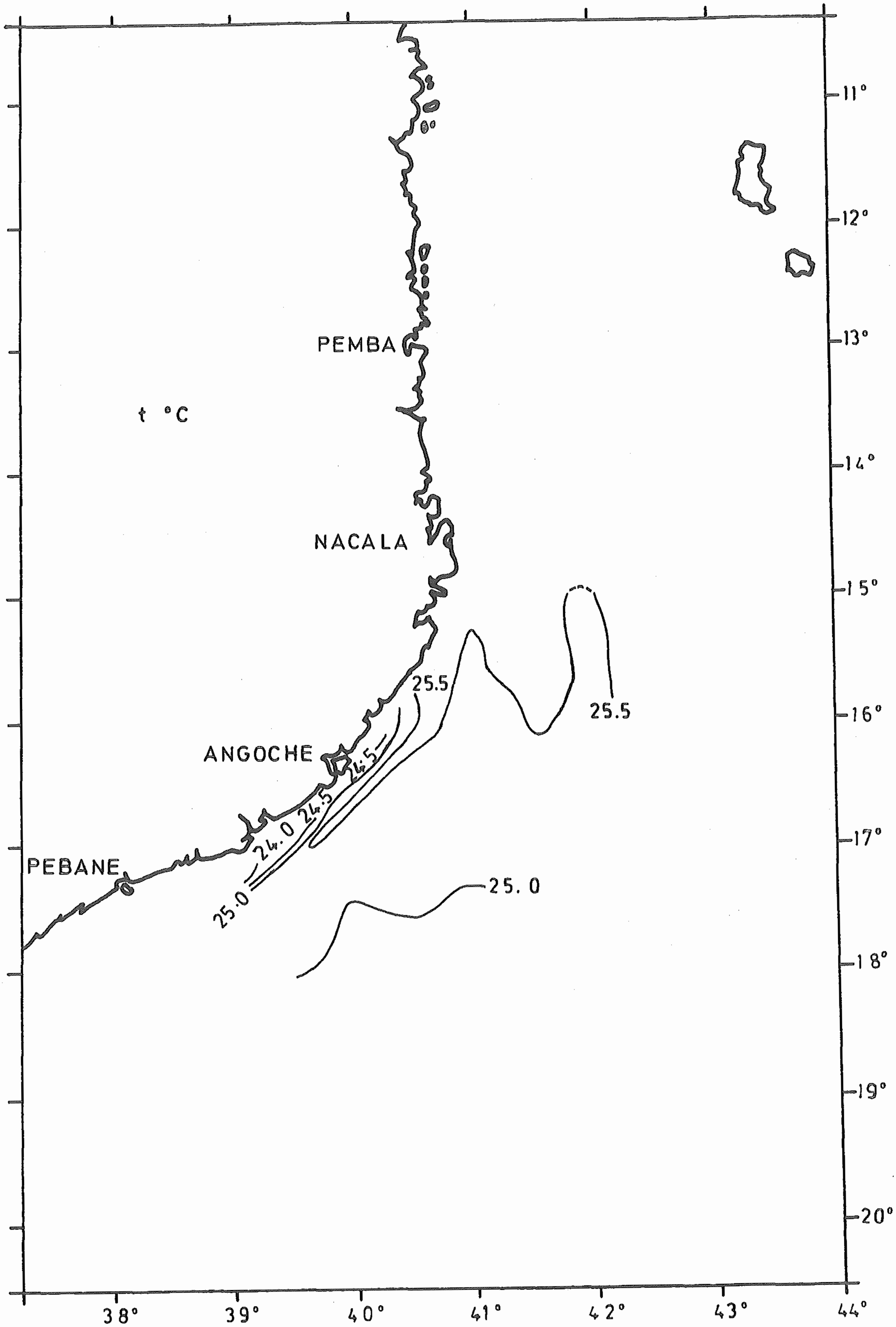


Figure 3.3. Region Goa island–Fogo island. Surface temperature.

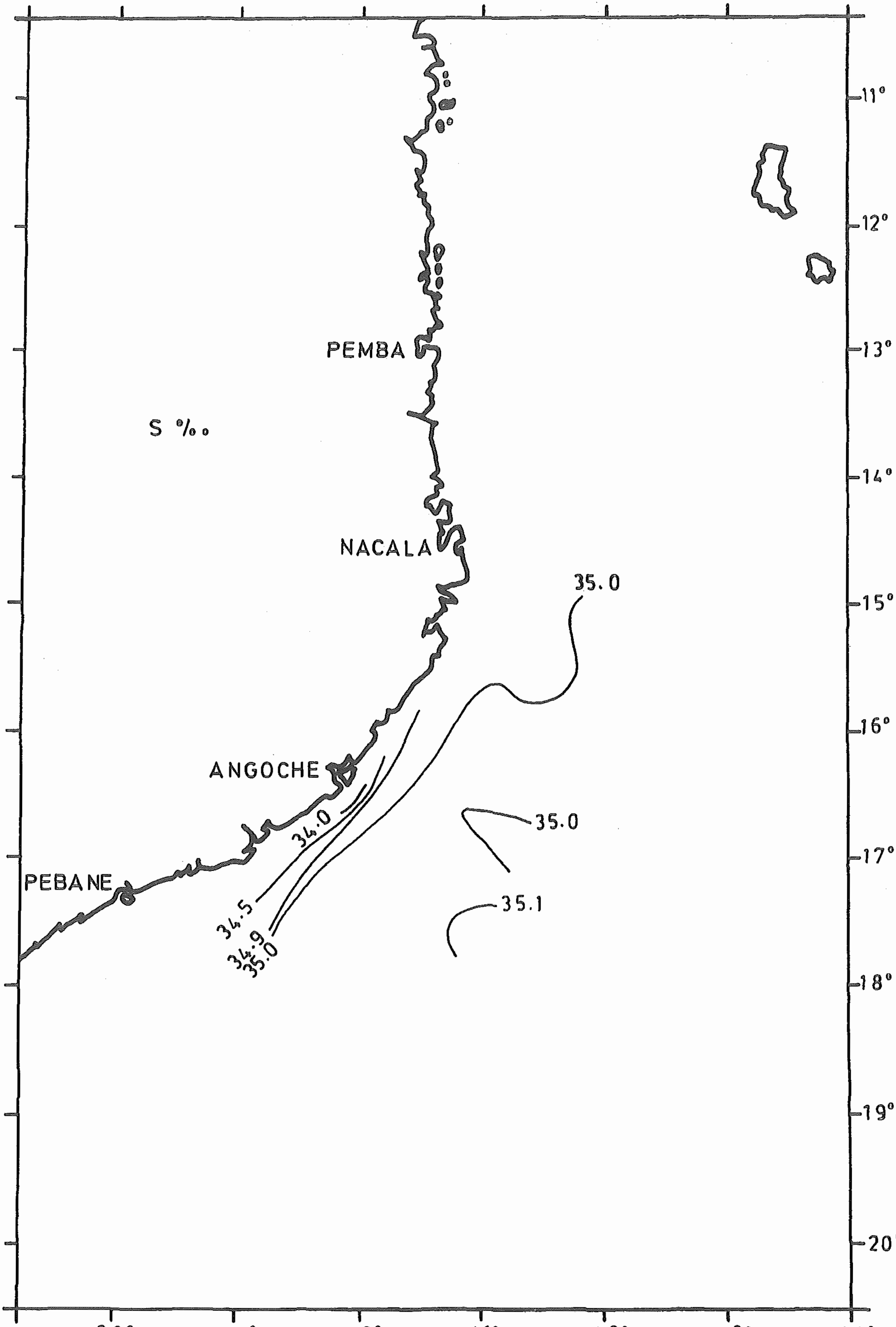


Figure 3.4. Region Goa island–Fogo island. Surface salinity.

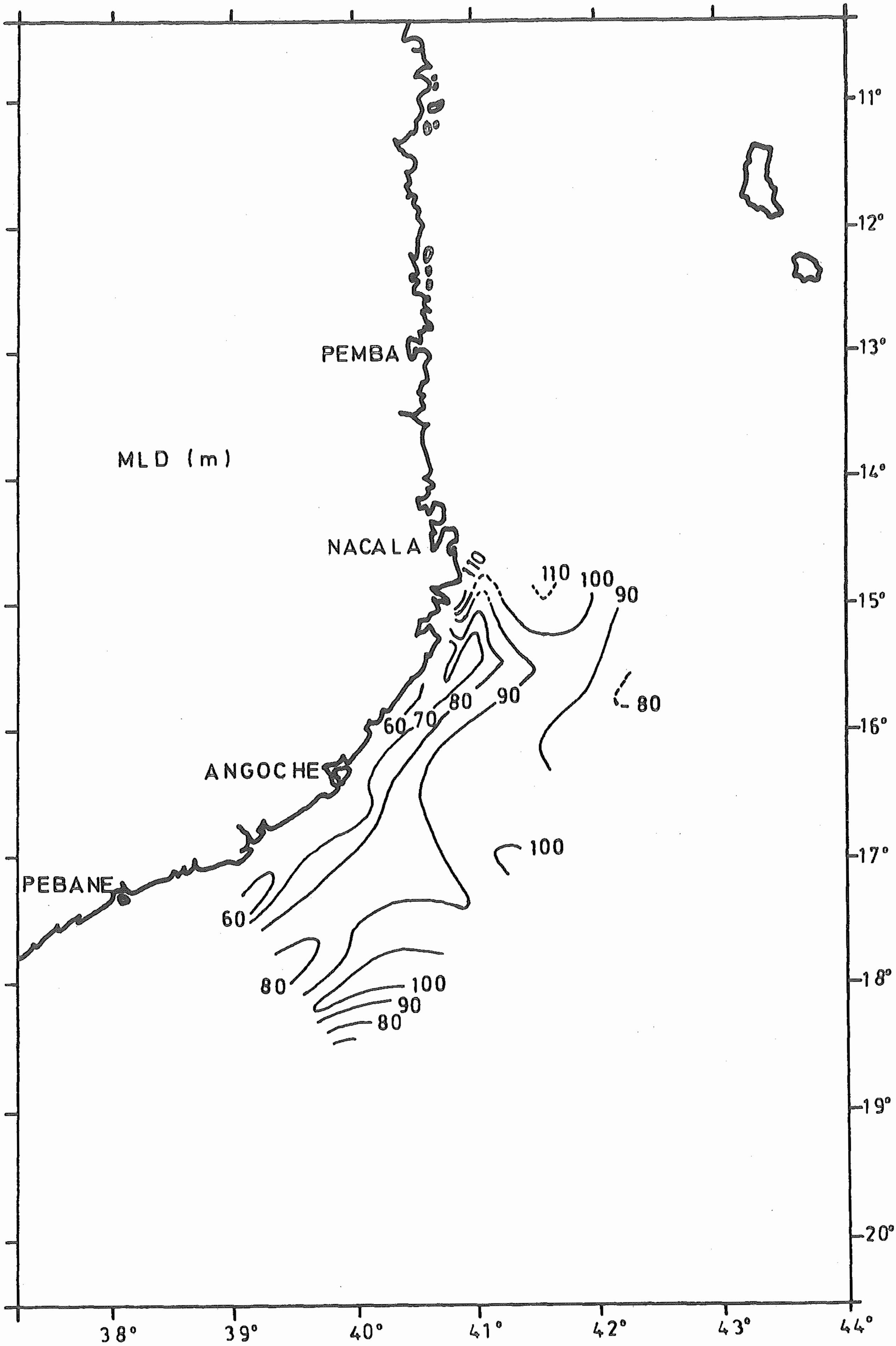


Figure 3.5. Region Goa island – Fogo island. Depth of the mixed layer.

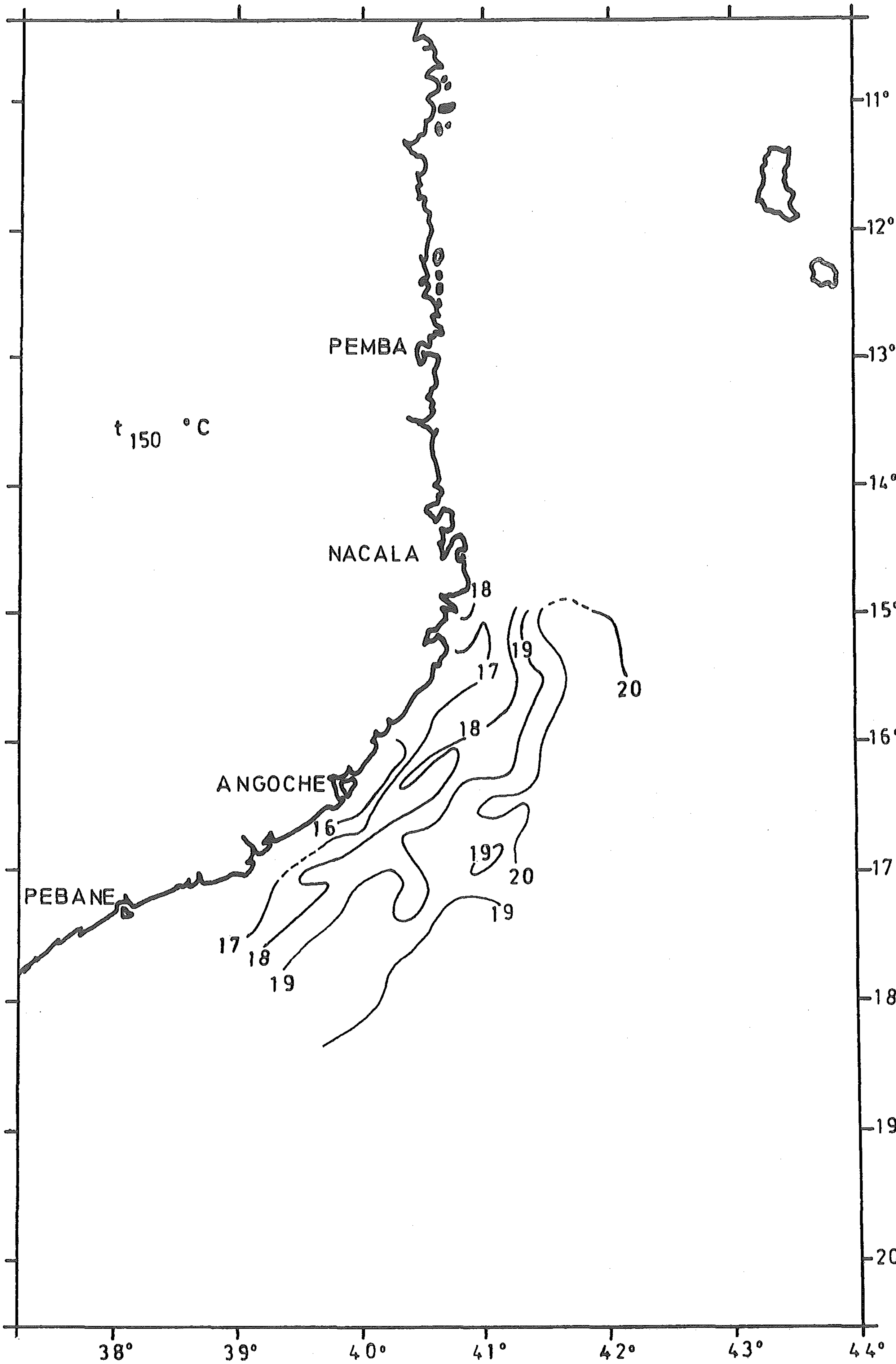


Figure 3.6. Region Goa island – Fogo island. Temperature at 150 metres.

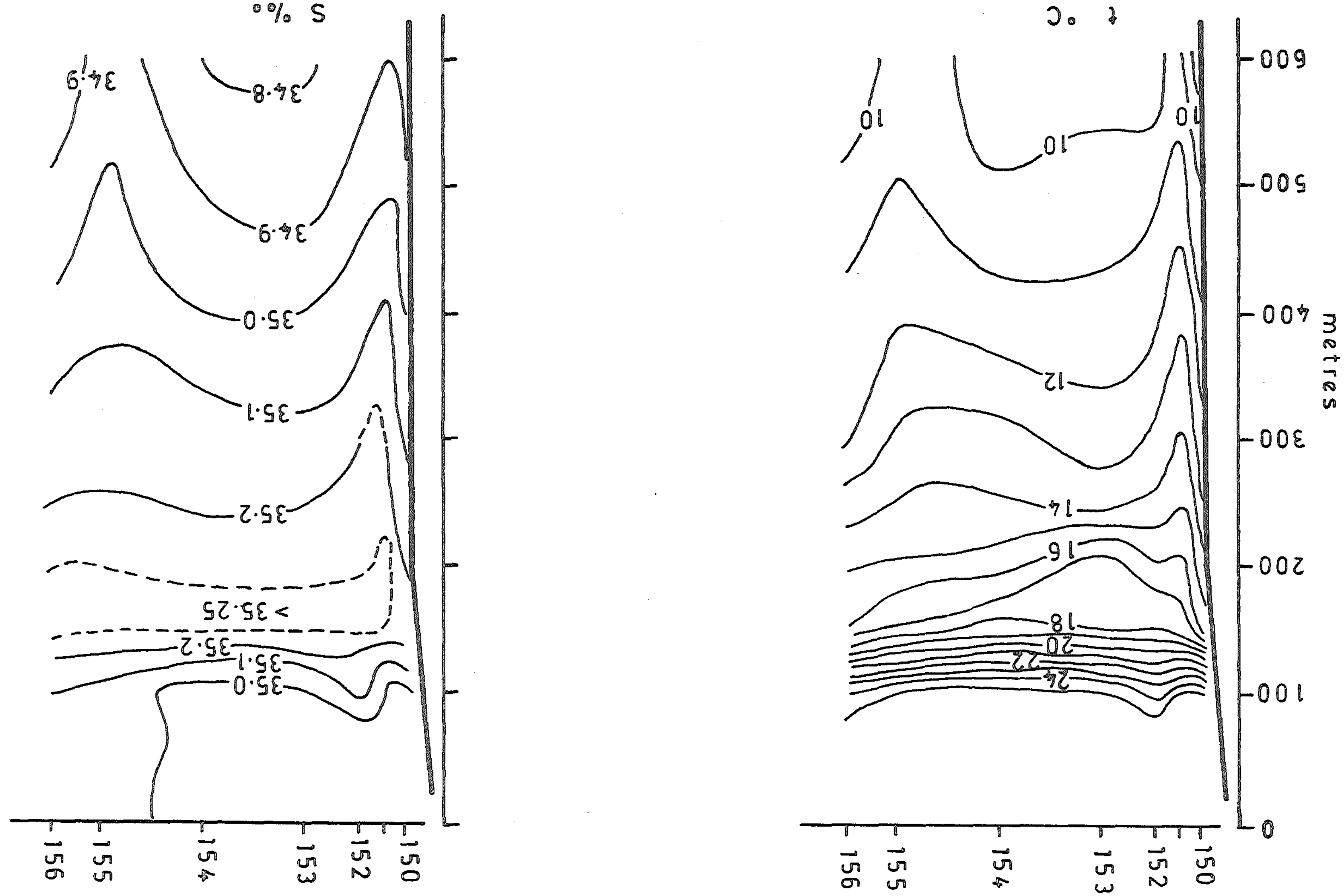


Figure 3.7. Section I, 5–6 July 1980.

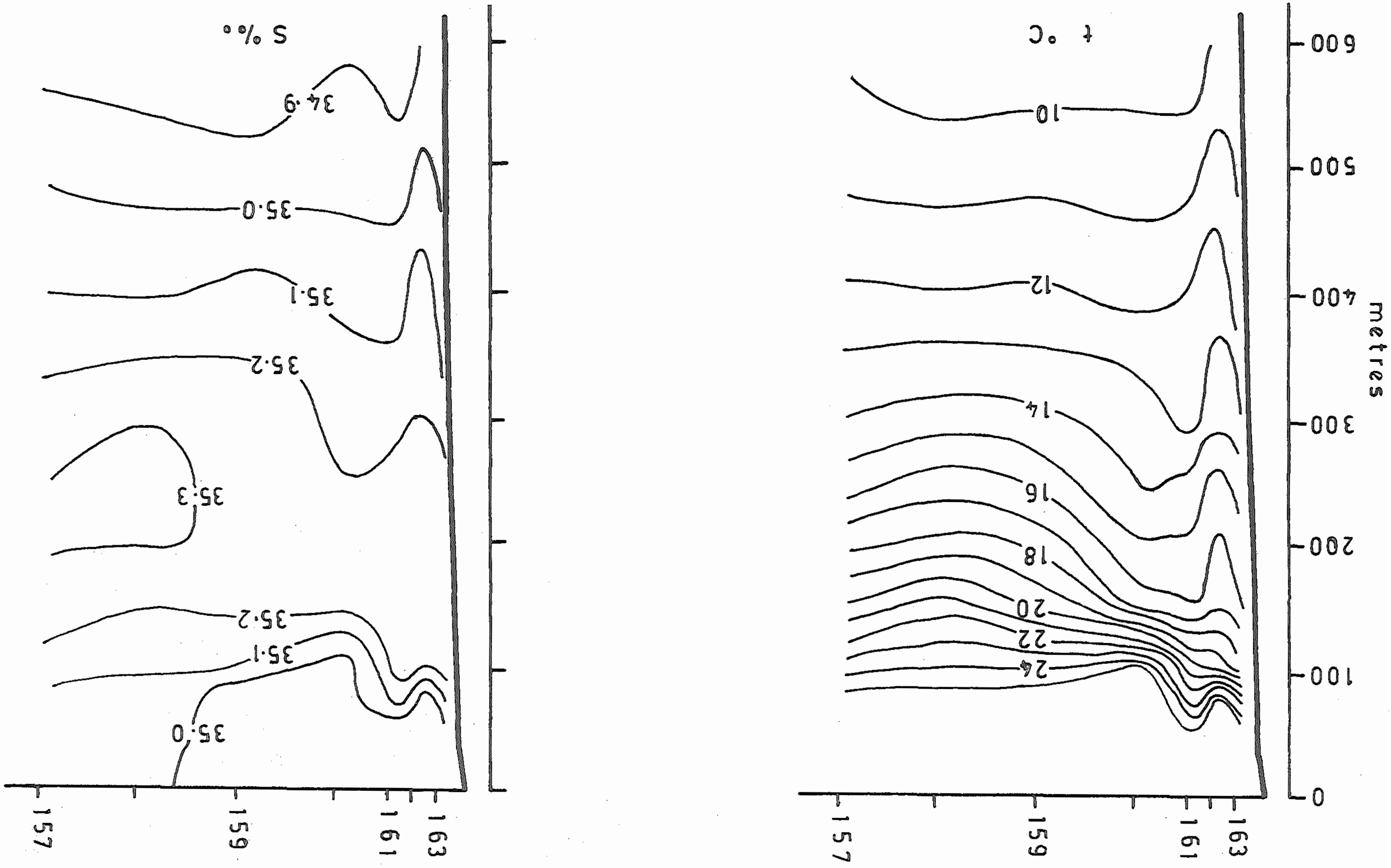


Figure 3. 8. Section II, 6-7 July 1980

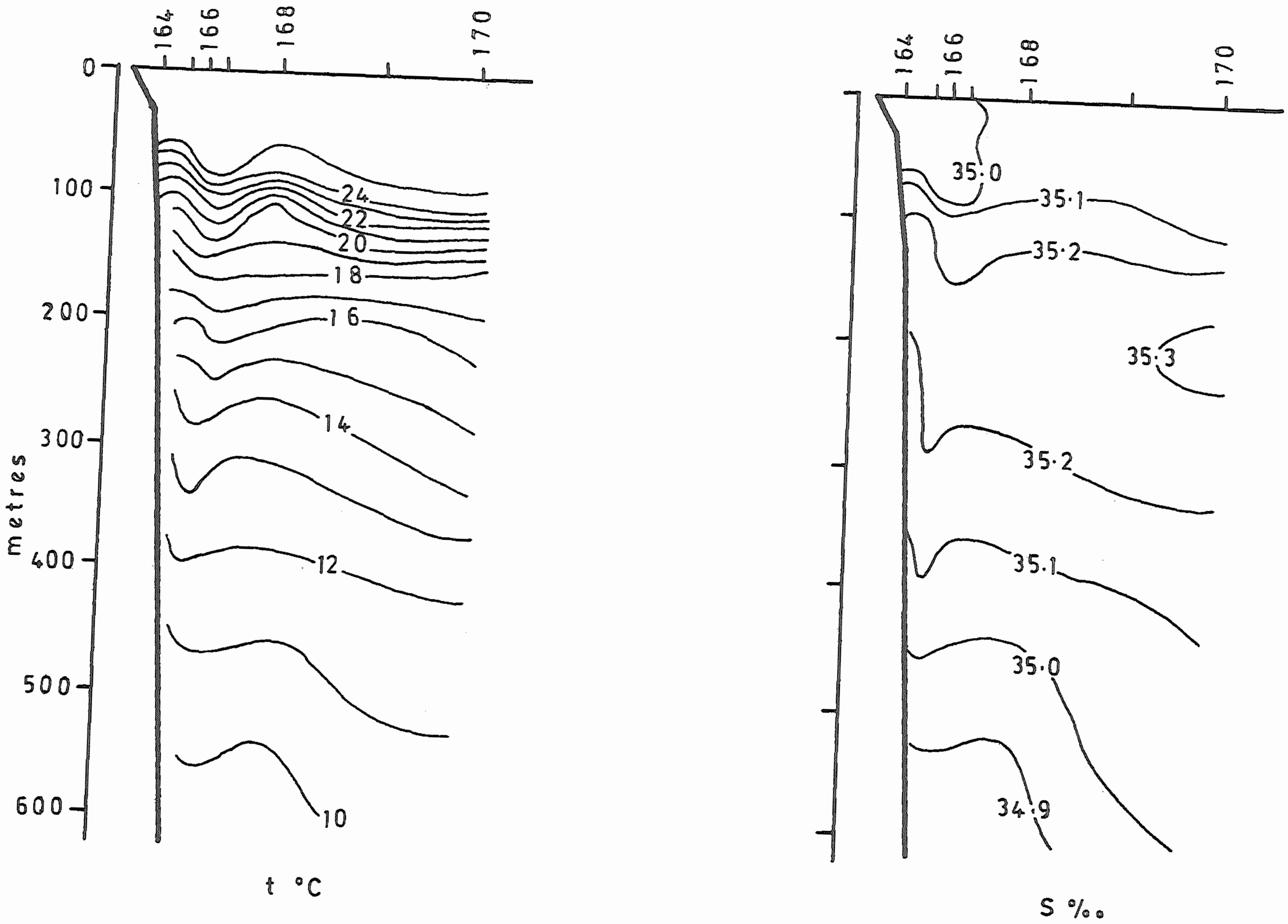


Figure 3.9. Section III, 7–8 July 1980

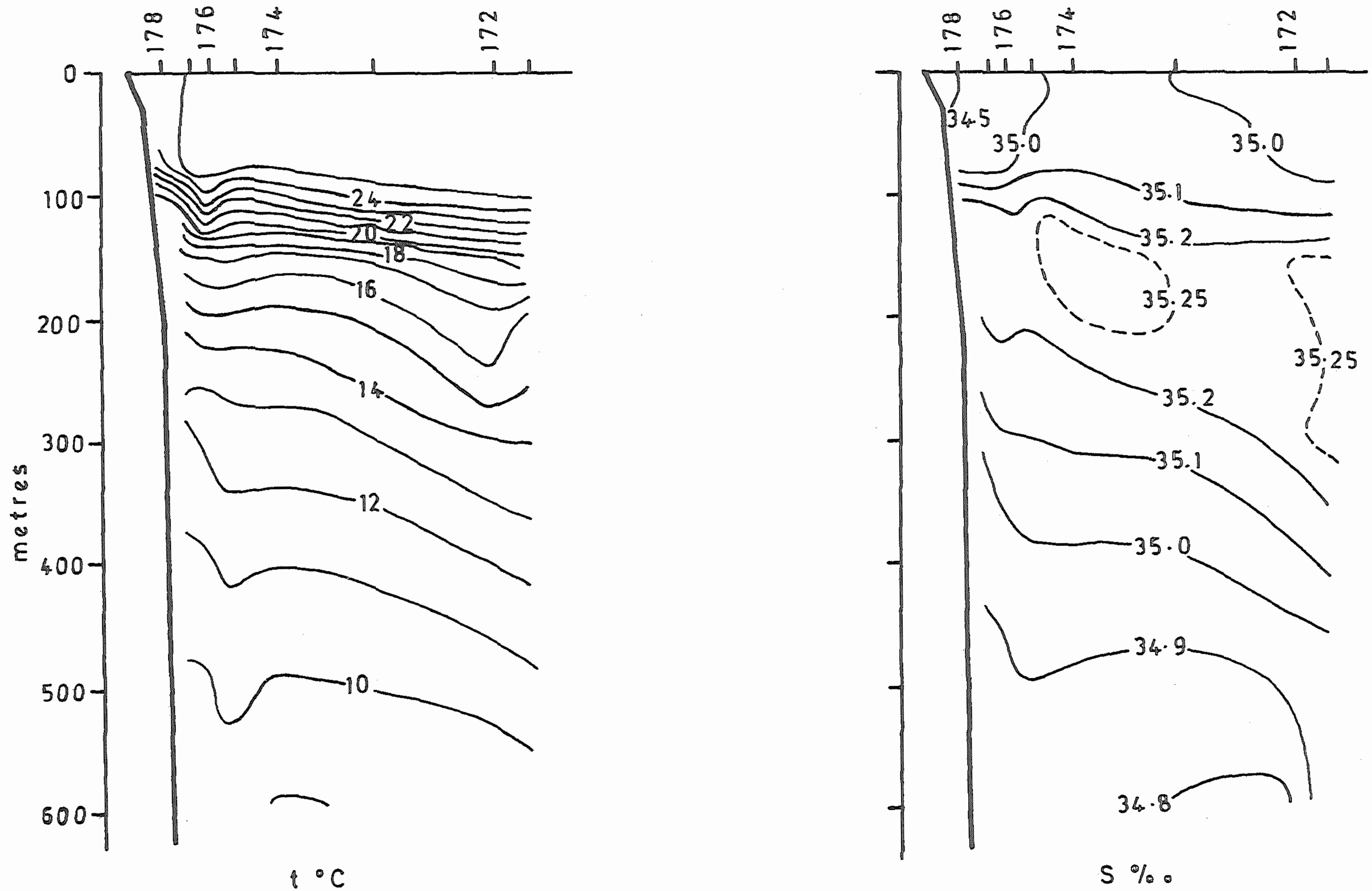


Figure 3.10. Section IV, 8—9 July 1980

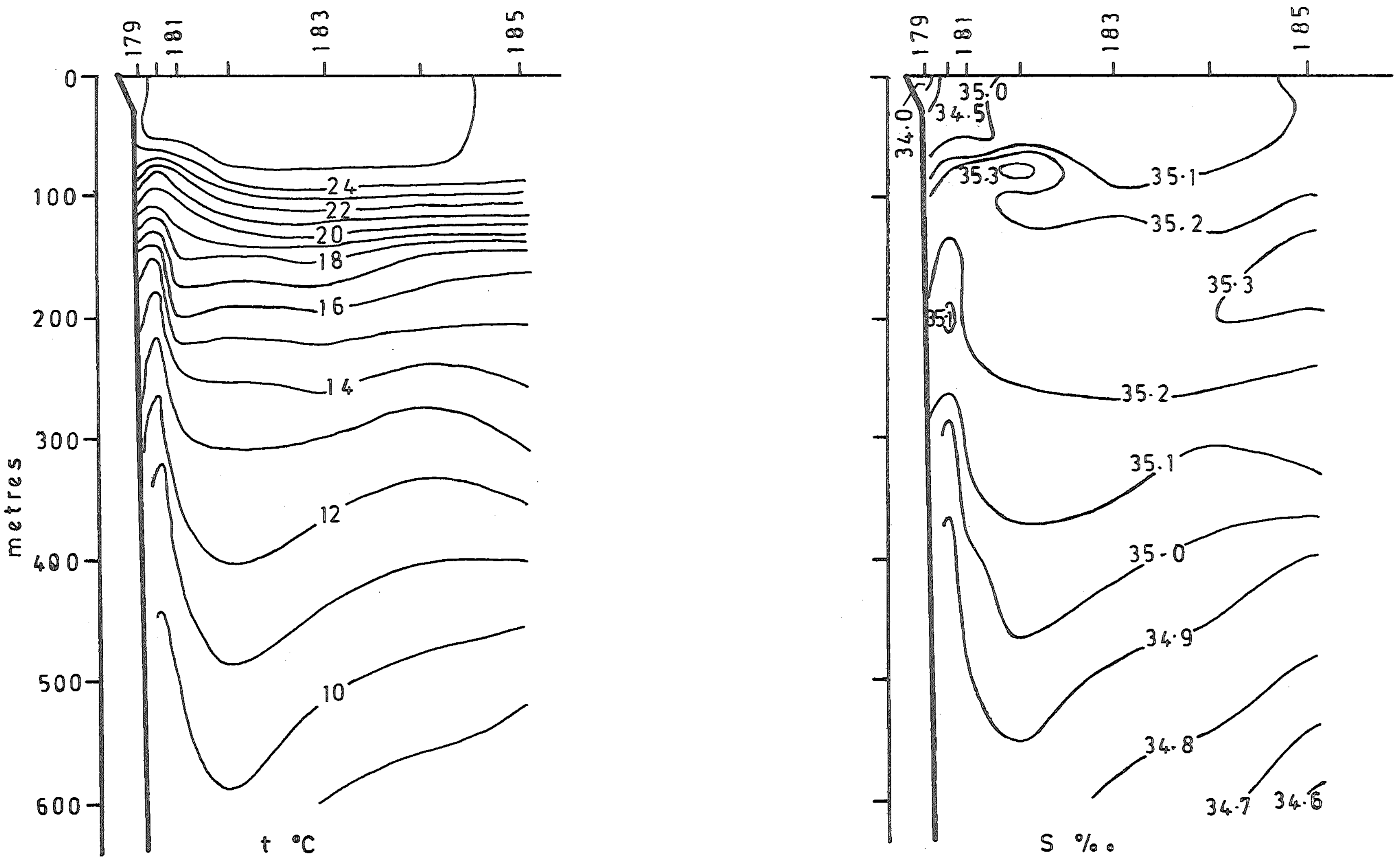


Figure 3.11. Section V, 9–10 July 1980.

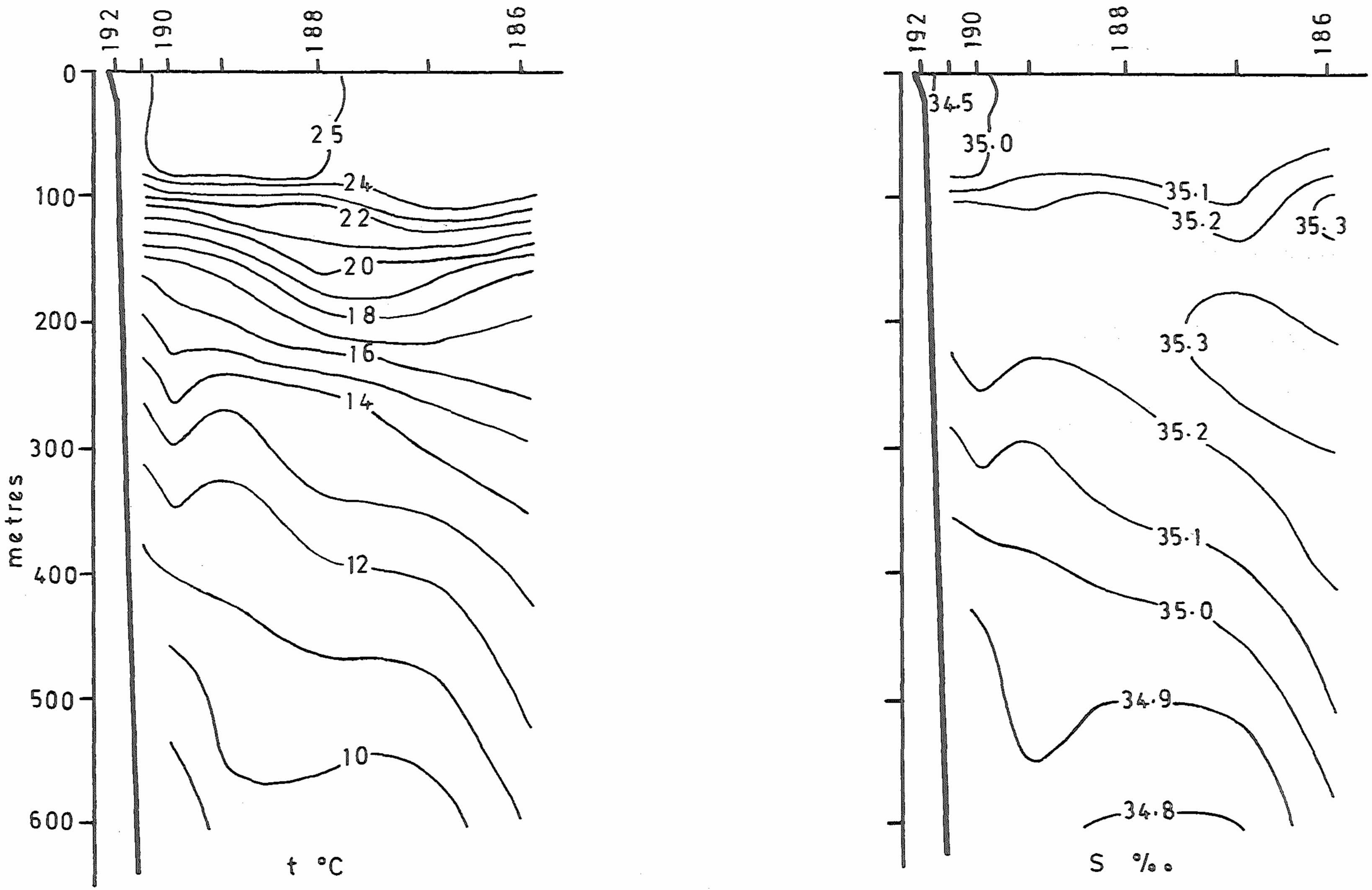


Figure 3.12. Section VI, 10–11 July 1980.

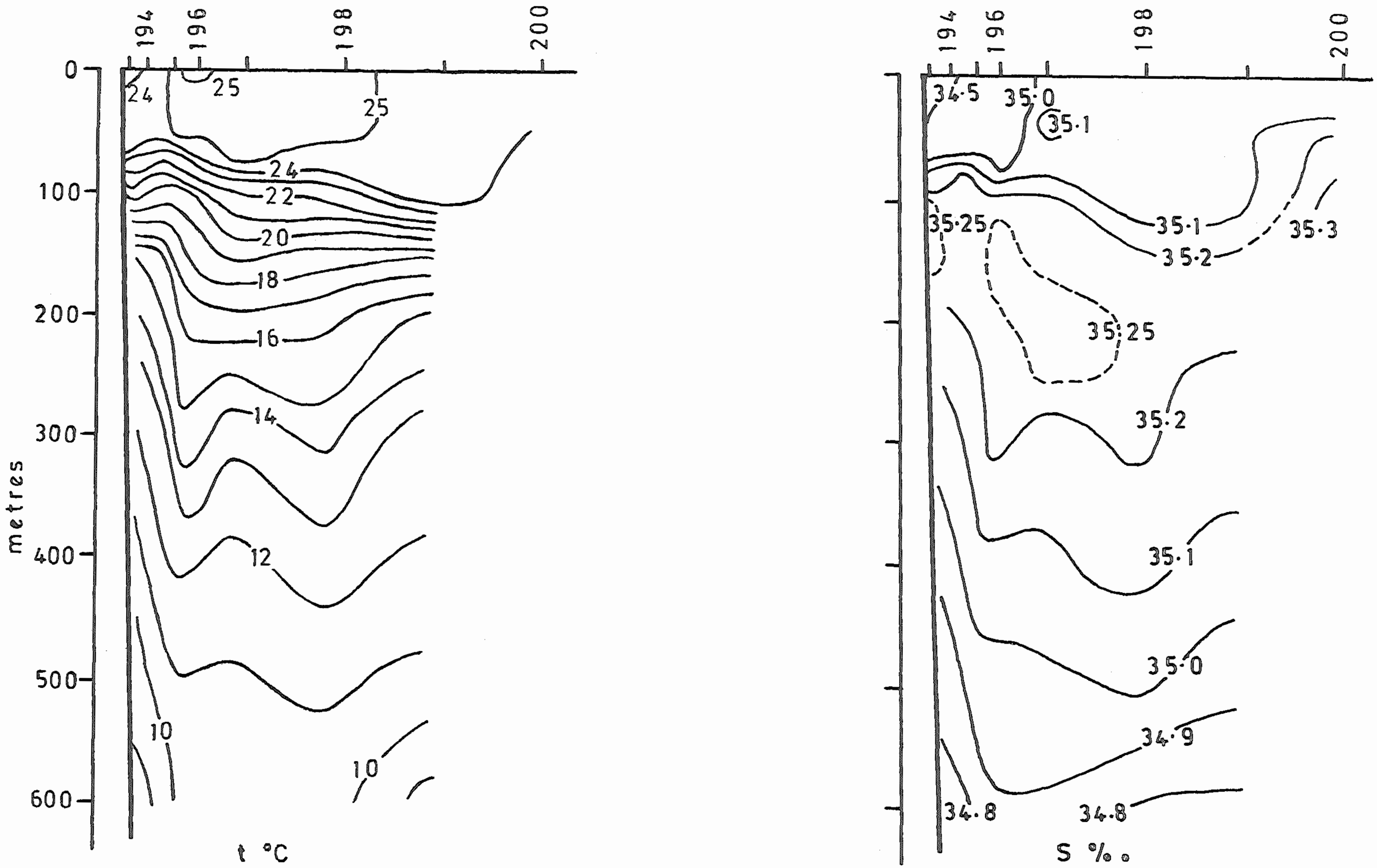


Figure 3.13. Section VII, 11–12 July 1980

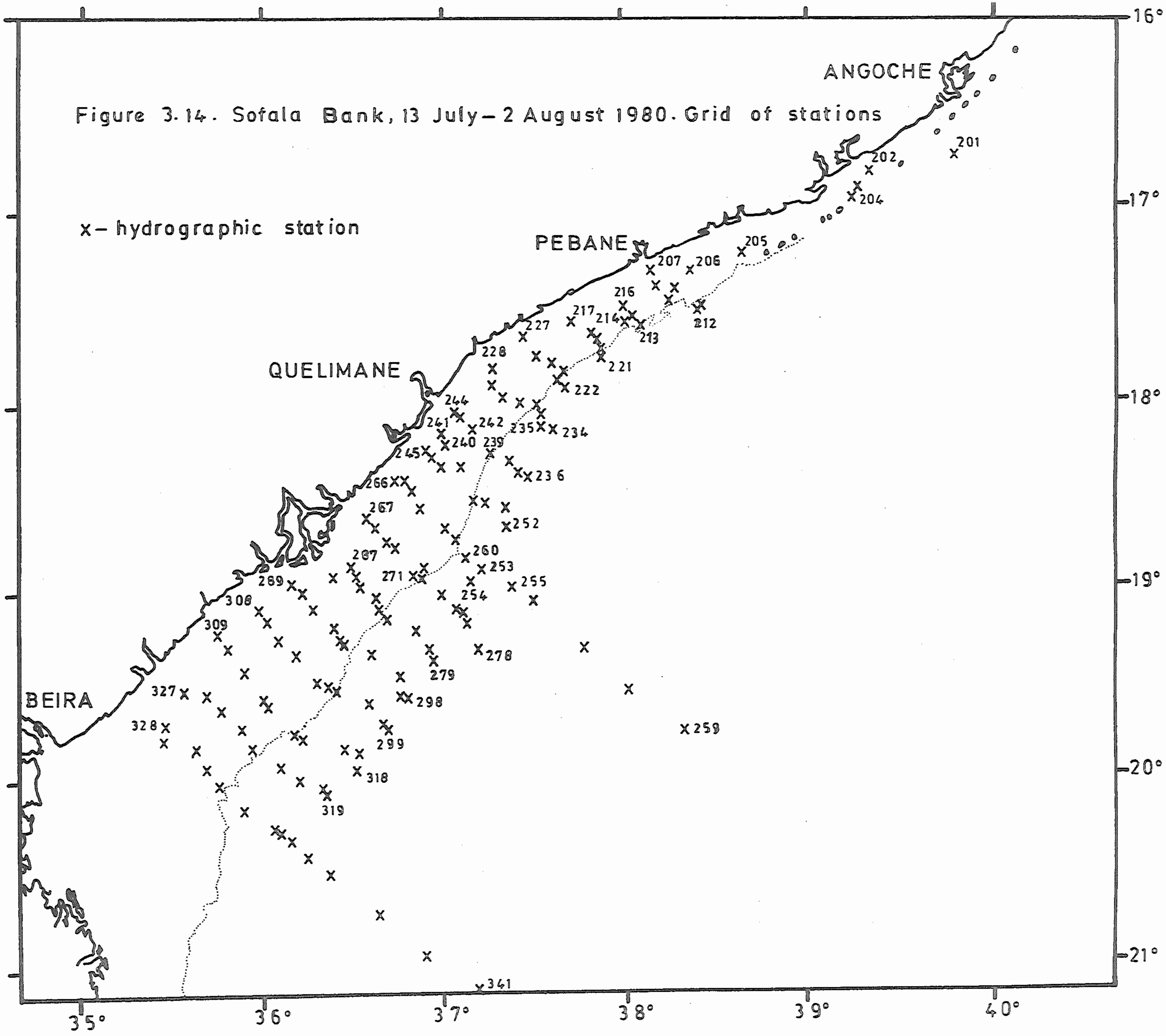


Figure 3.14. Sofala Bank, 13 July – 2 August 1980. Grid of stations

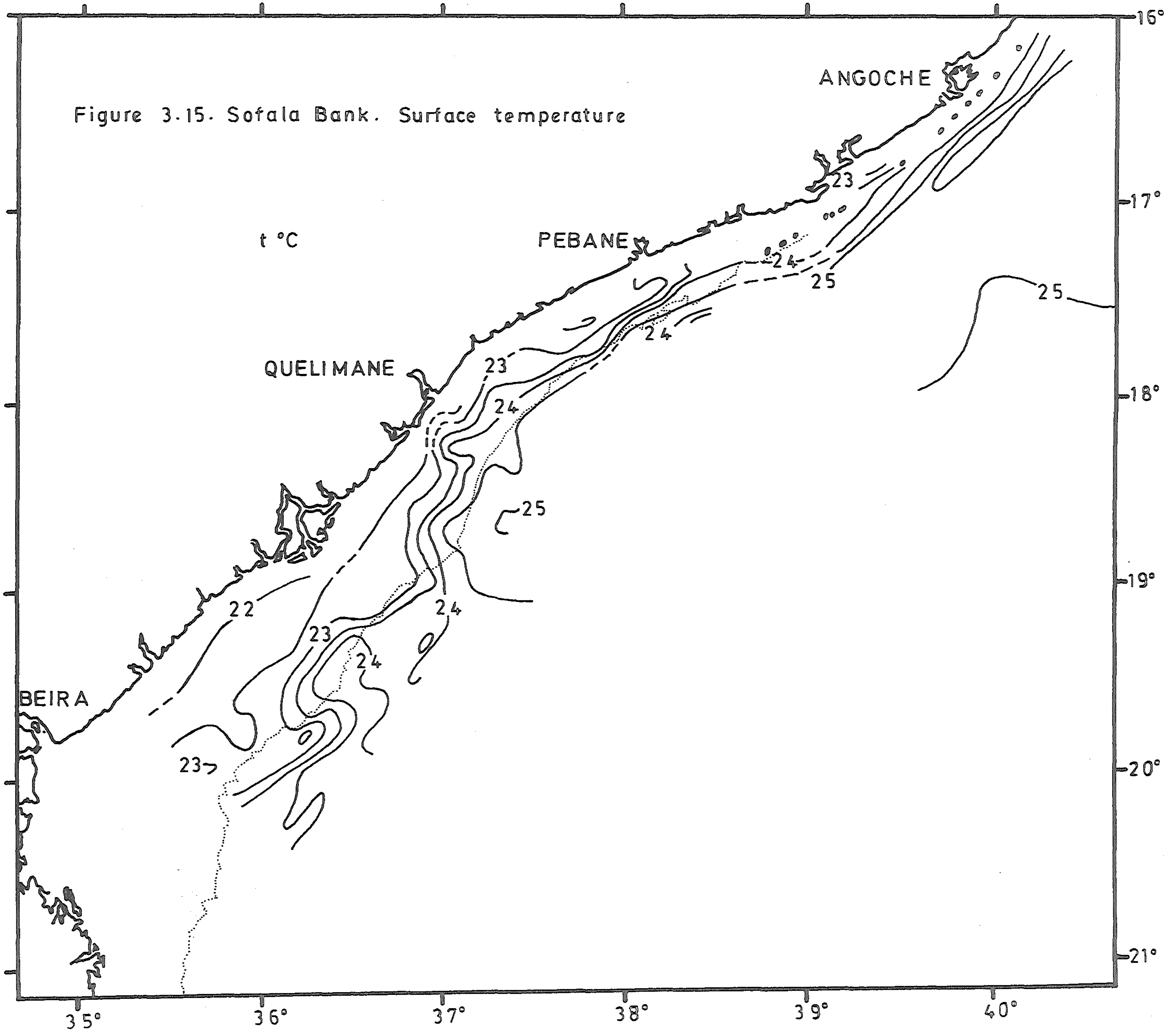


Figure 3.15. Sofala Bank. Surface temperature
t °C
ANGOCHE
PEBANE
QUELIMANE
BEIRA
23
24
25
25
23
24
24
25
22
23
24
24
23
16°
17°
18°
19°
20°
21°
35°
36°
37°
38°
39°
40°

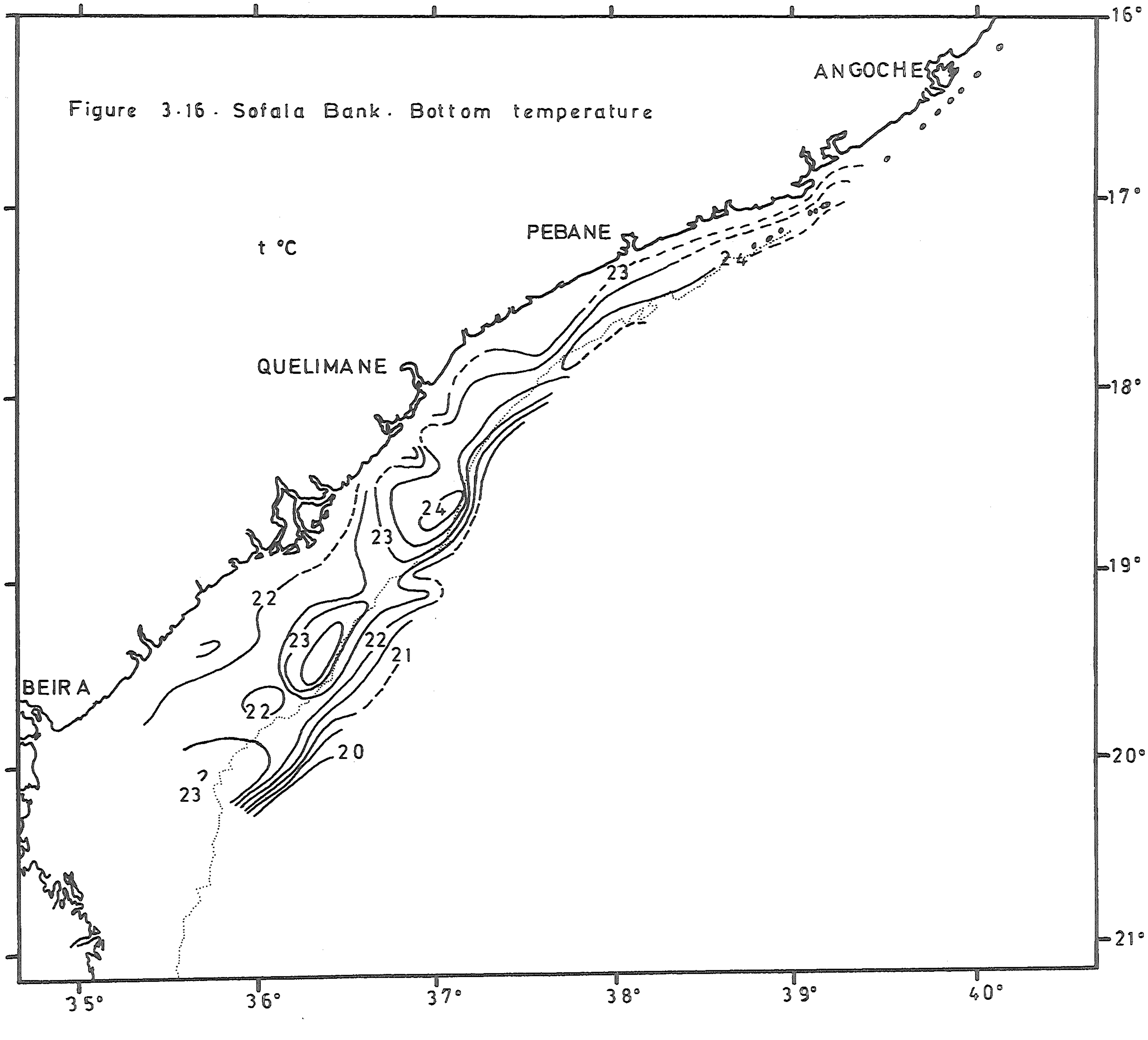
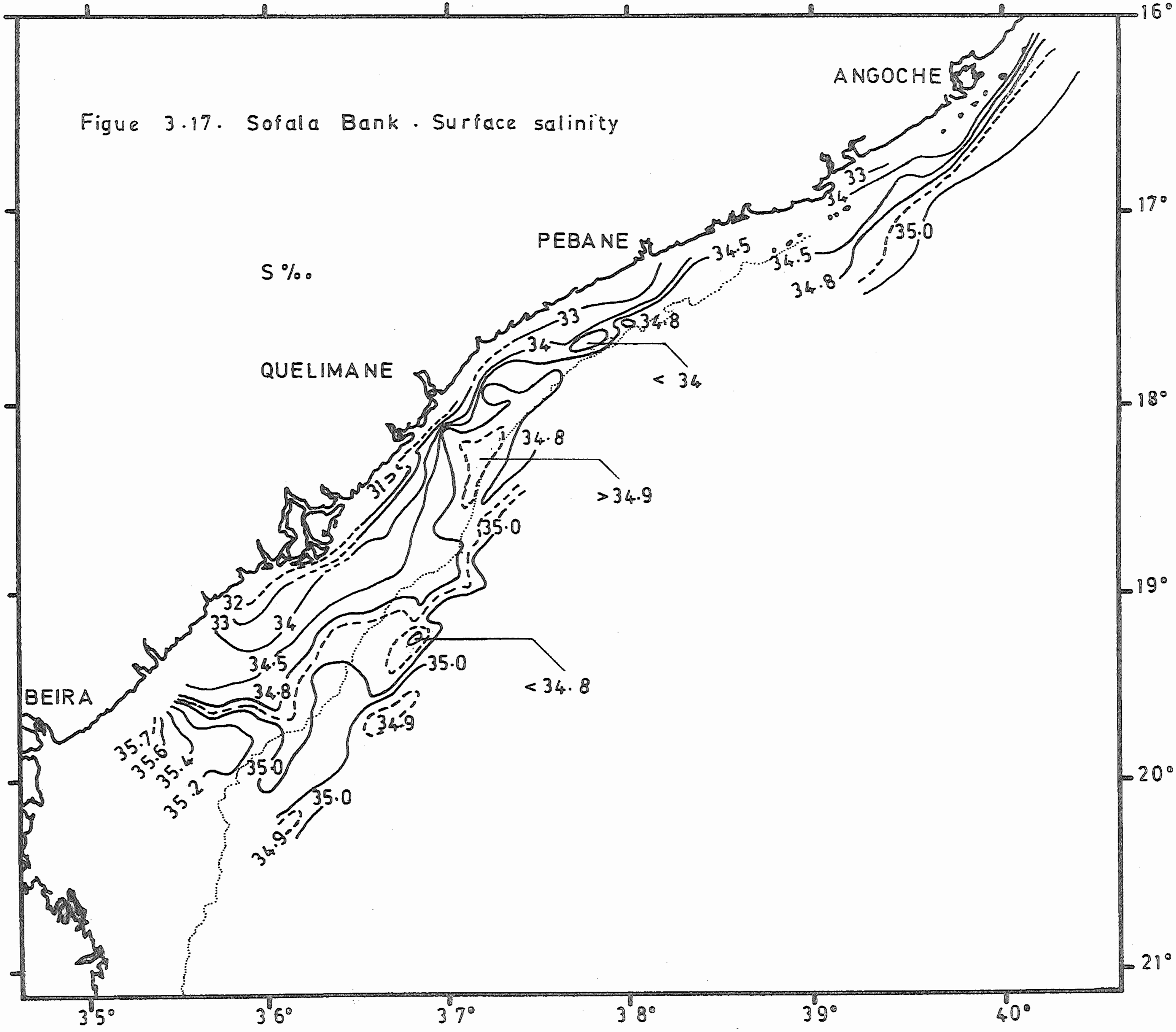


Figure 3.16. Sofala Bank. Bottom temperature
t °C
ANGOCHE
PEBANE
QUELIMANE
BEIRA
24
23
22
21
20
16°
17°
18°
19°
20°
21°
35°
36°
37°
38°
39°
40°



Figue 3.17. Sofala Bank . Surface salinity
S ‰
ANGOCHE
PEBANE
QUELIMANE
BEIRA
33
34
35.0
34.5
34.5
34.8
33
34.8
34
< 34
34.8
> 34.9
31
35.0
32
33
34
34.5
34.8
35.0
< 34.8
34.9
35.7
35.6
35.4
35.2
35.0
35.0
34.9
16°
17°
18°
19°
20°
21°
35°
36°
37°
38°
39°
40°

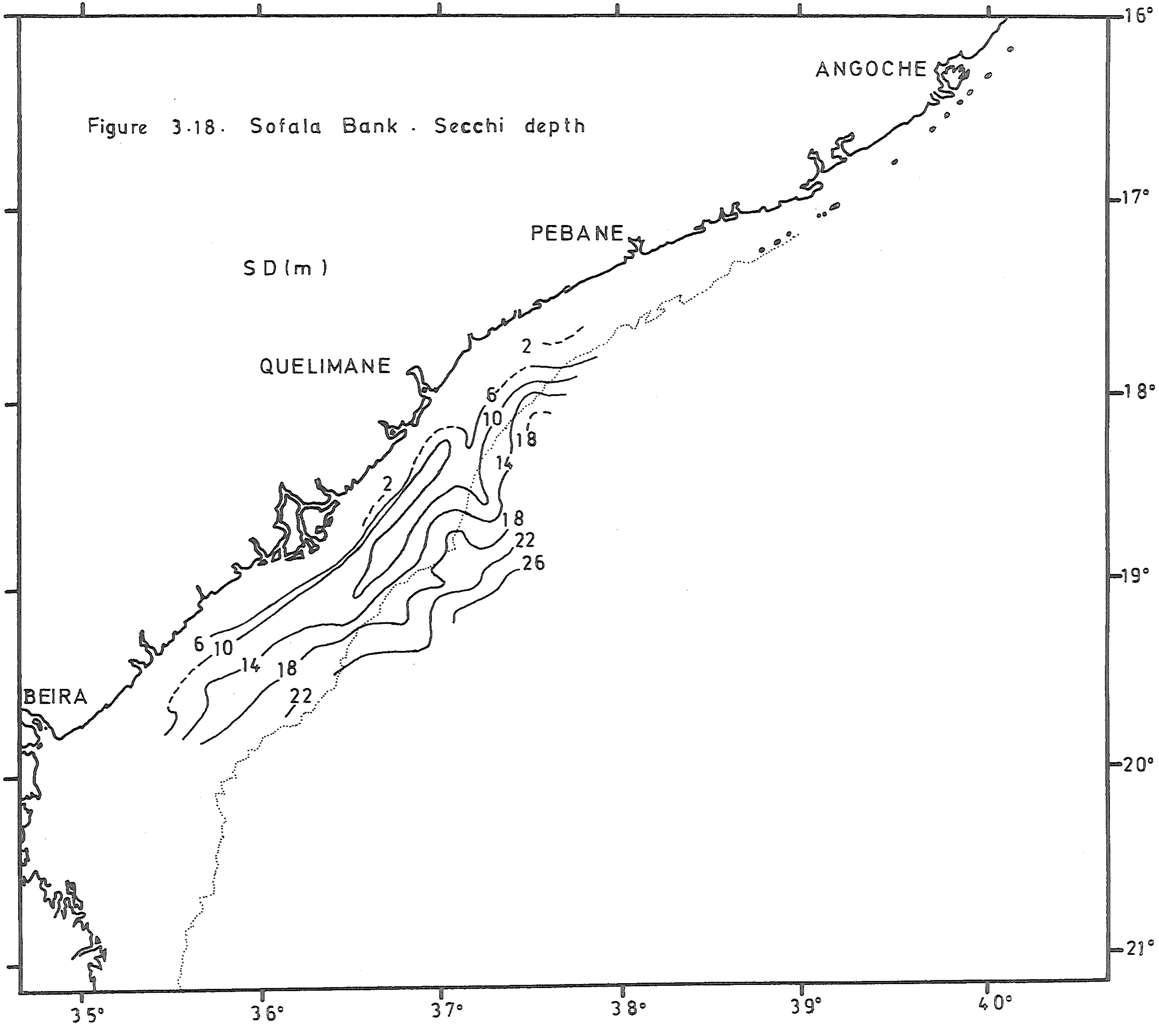


Figure 3.18. Sofala Bank. Secchi depth
SD(m)
ANGOCHE
PEBANE
QUELIMANE
BEIRA
2
6
10
14
18
22
26
16°
17°
18°
19°
20°
21°
35°
36°
37°
38°
39°
40°

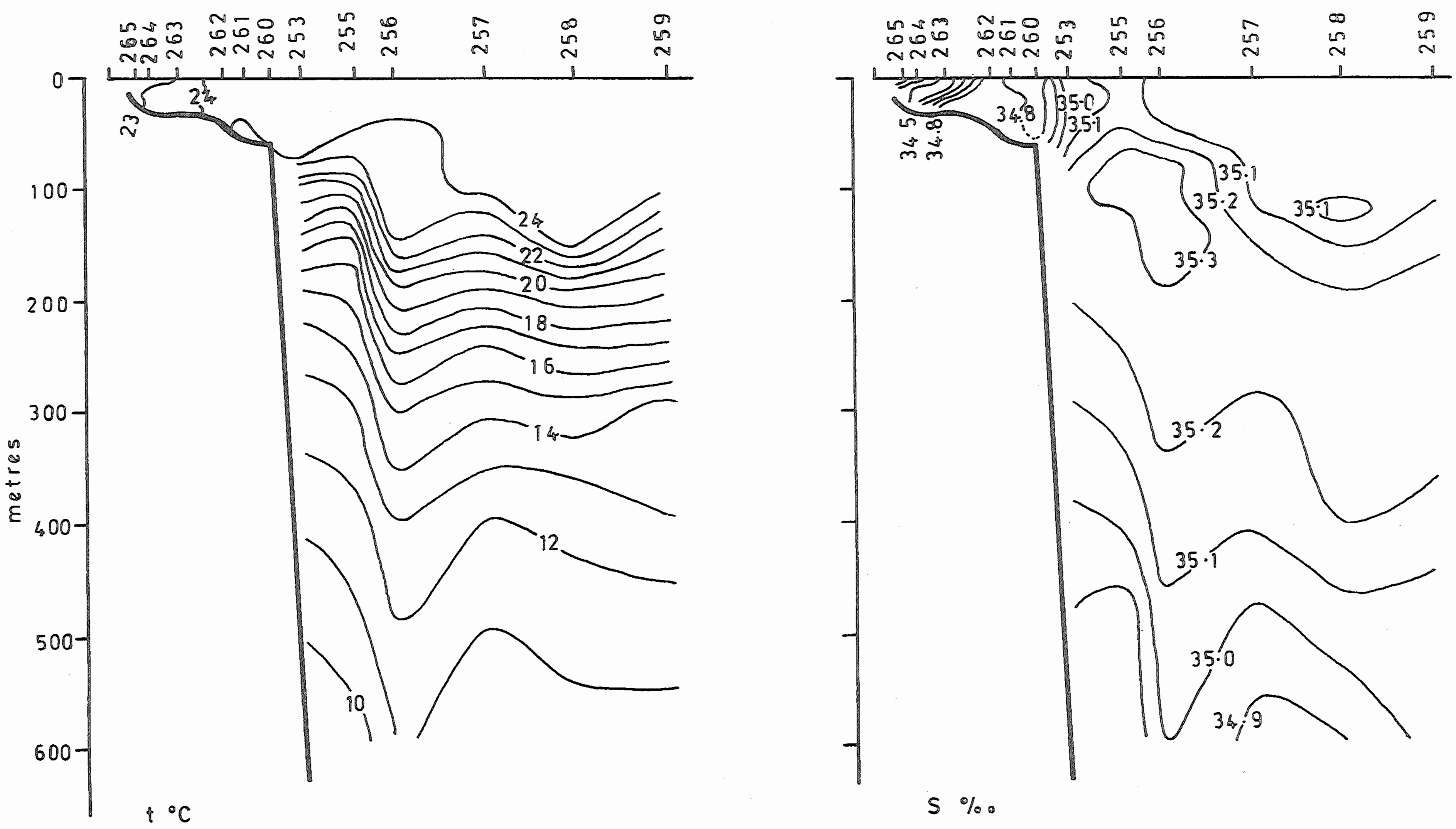


Figure 3.19. Section VIII. 21–23 July 1980

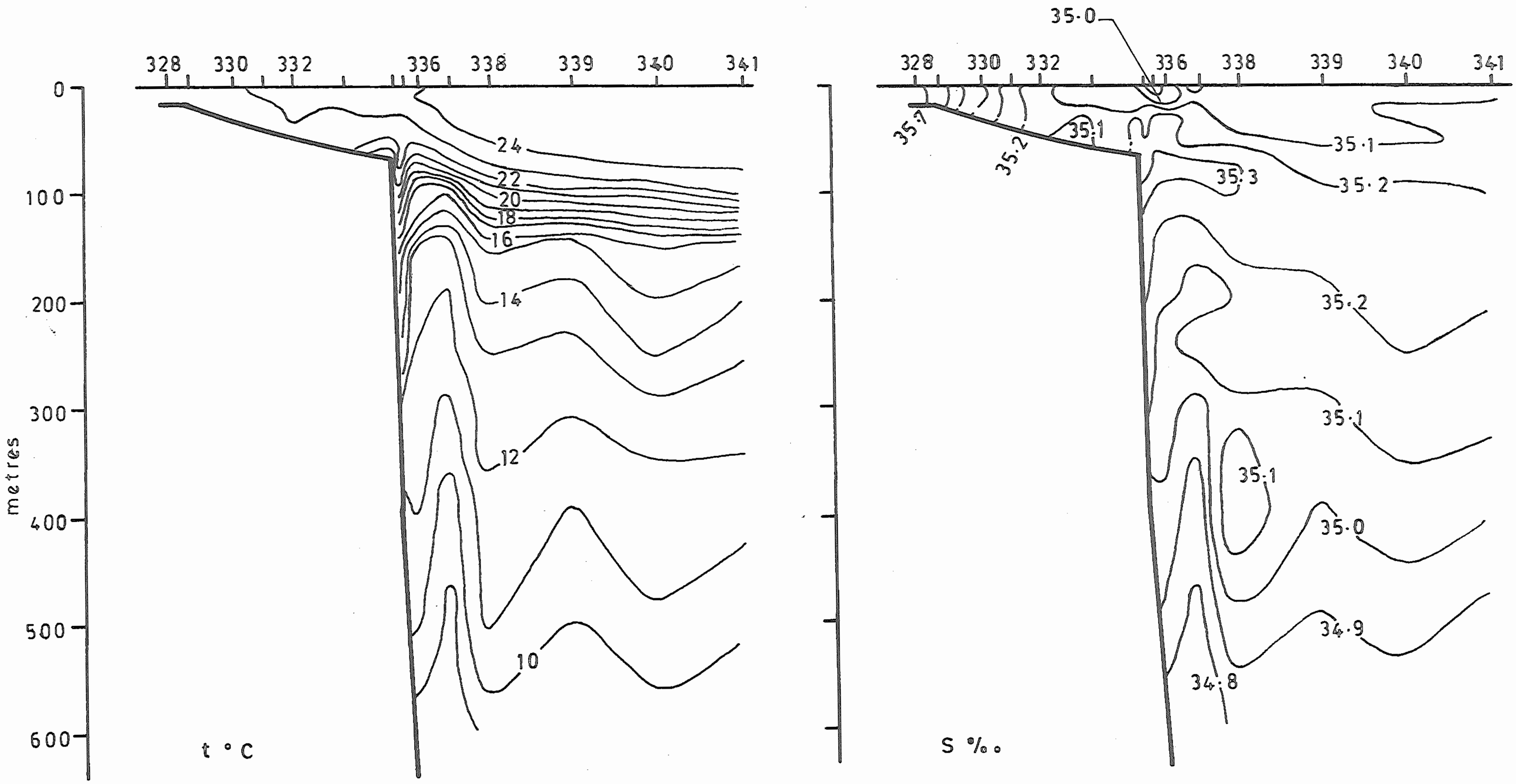


Figure 3·20 - Section IX, 1-2 August 1980

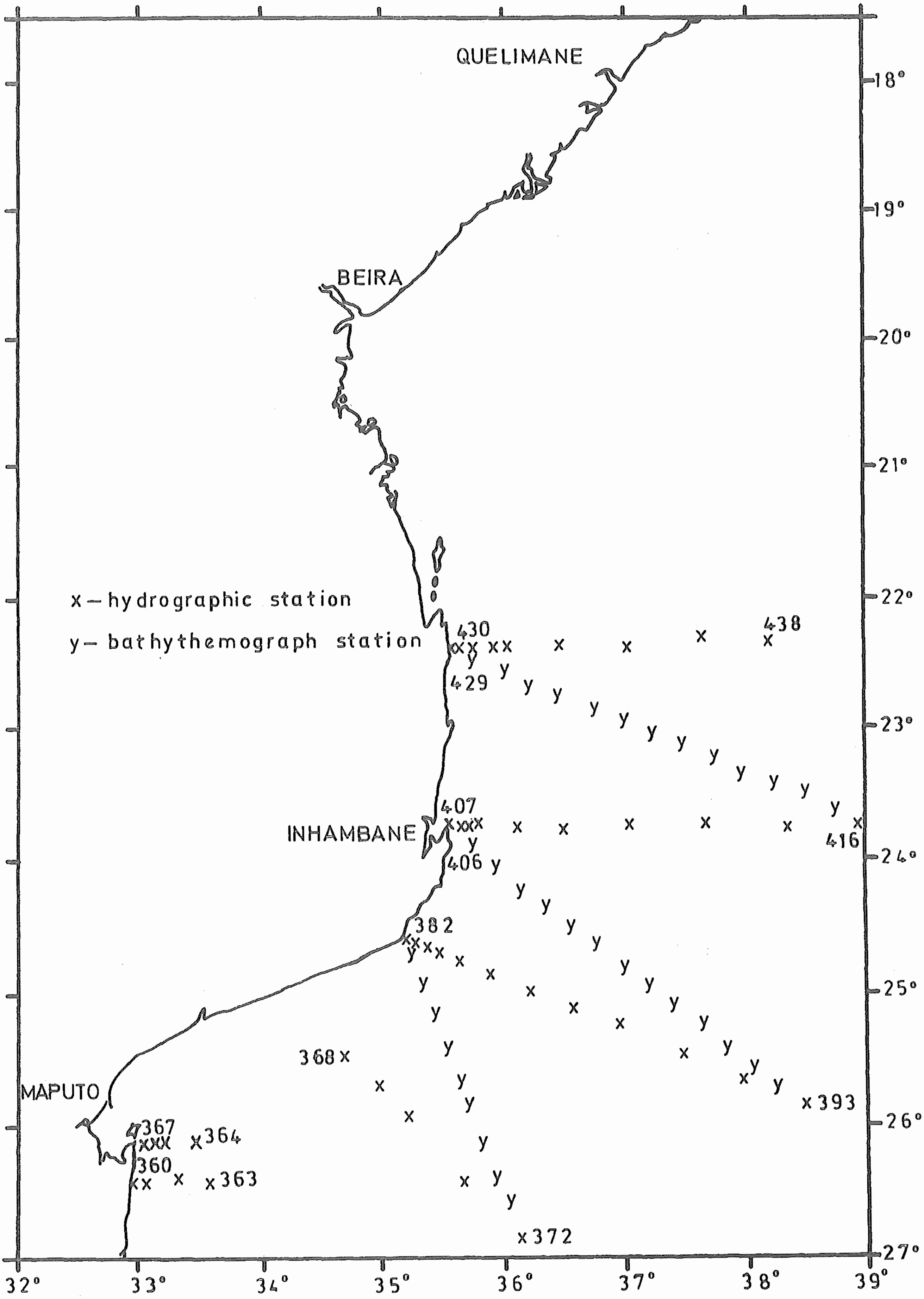


Figure 3.21. Southern area, 11–21 August 1980. Grid of stations

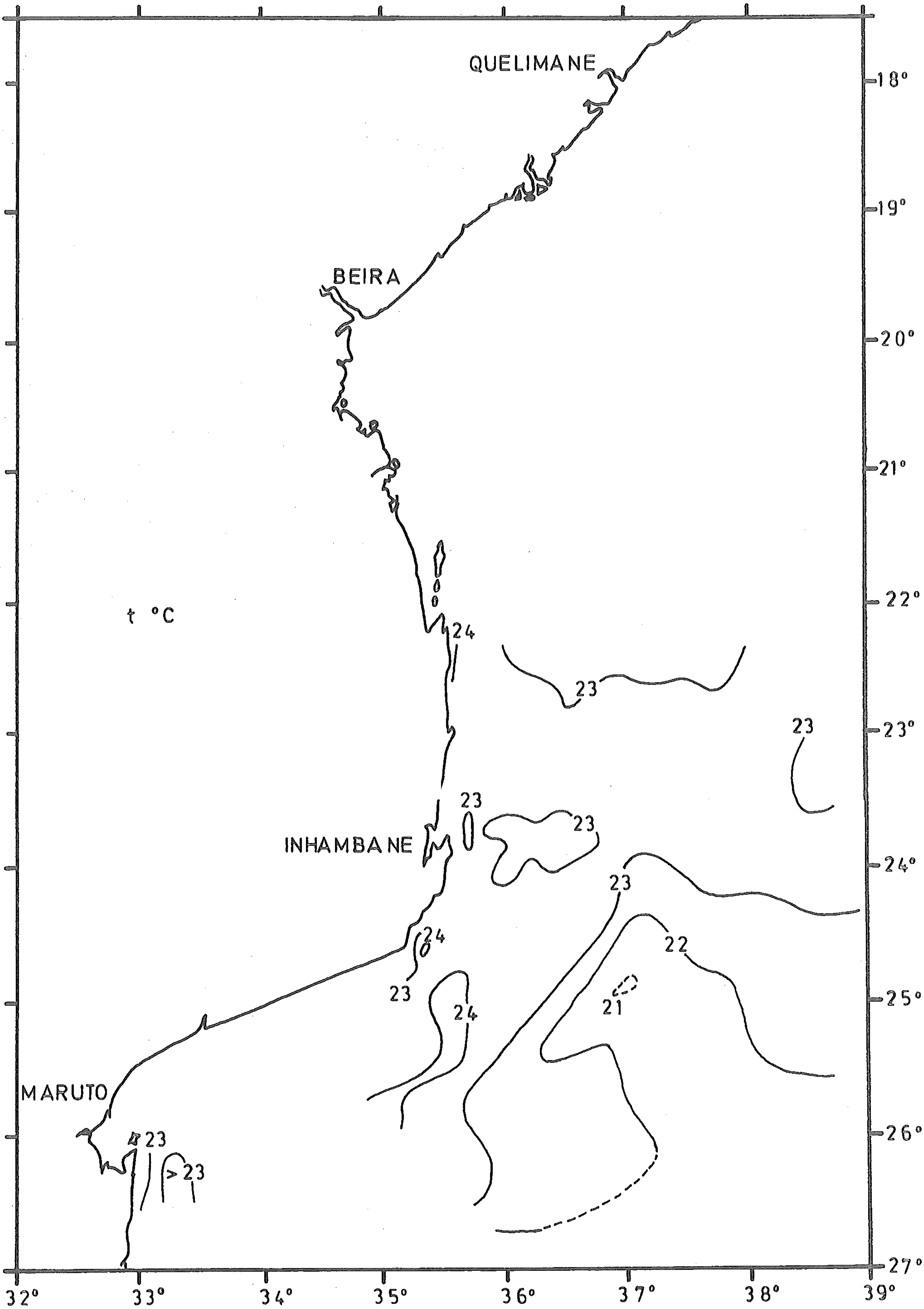


Figure 3.22. Southern area. Surface temperature

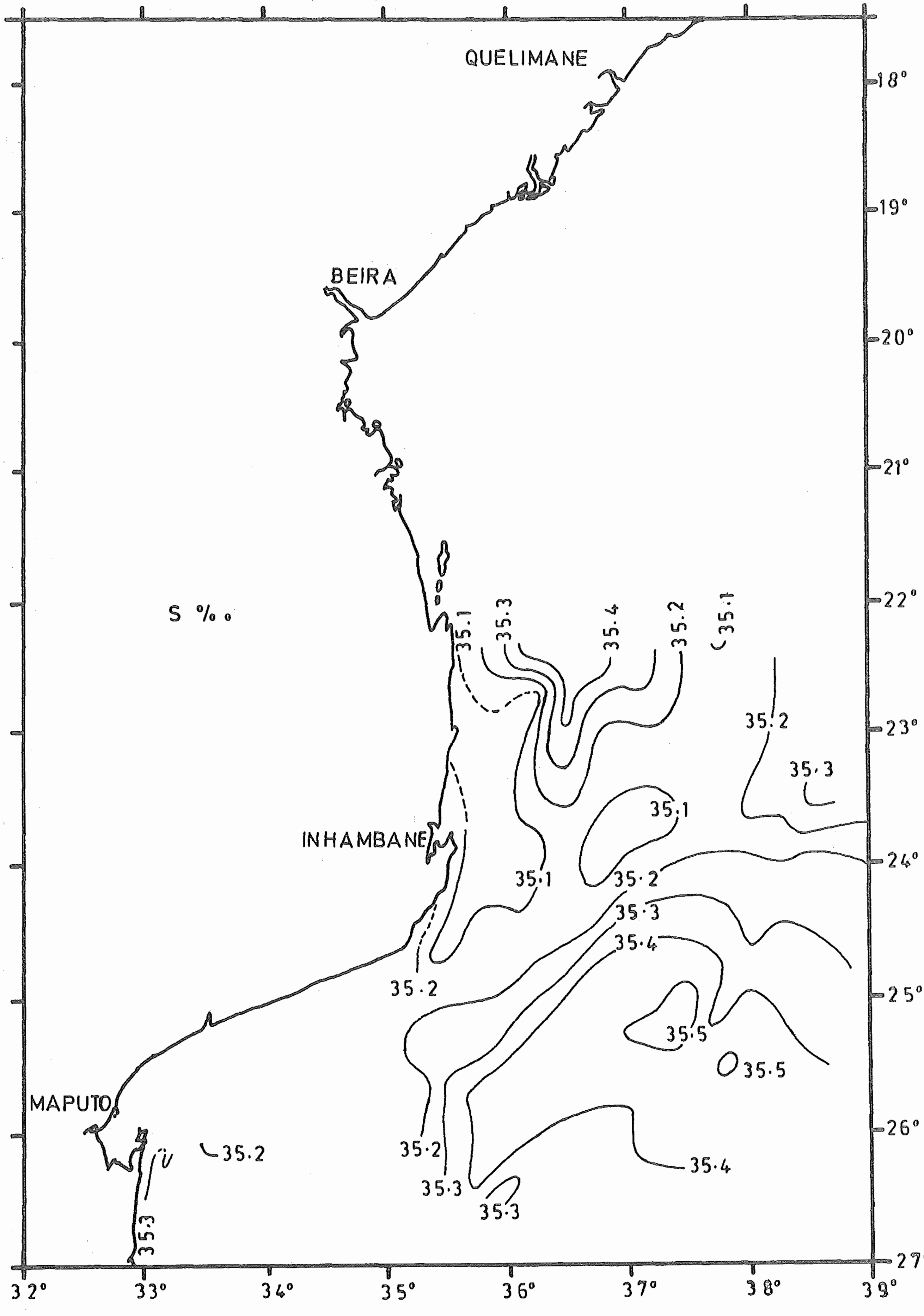


Figure 3. 23. Southern area. Surface salinity.

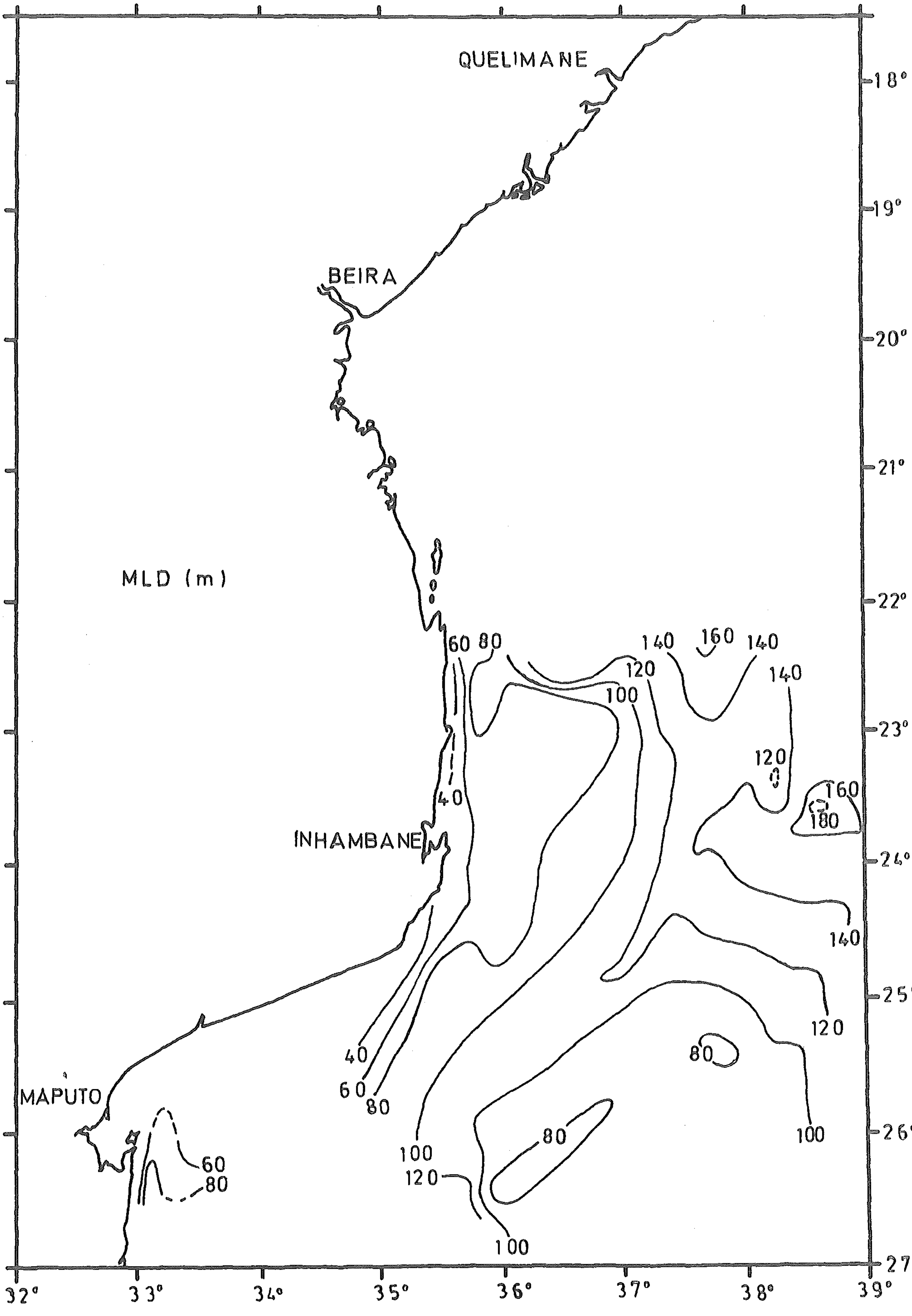


Figure 3.24. Southern area. Depth of the mixed layer.

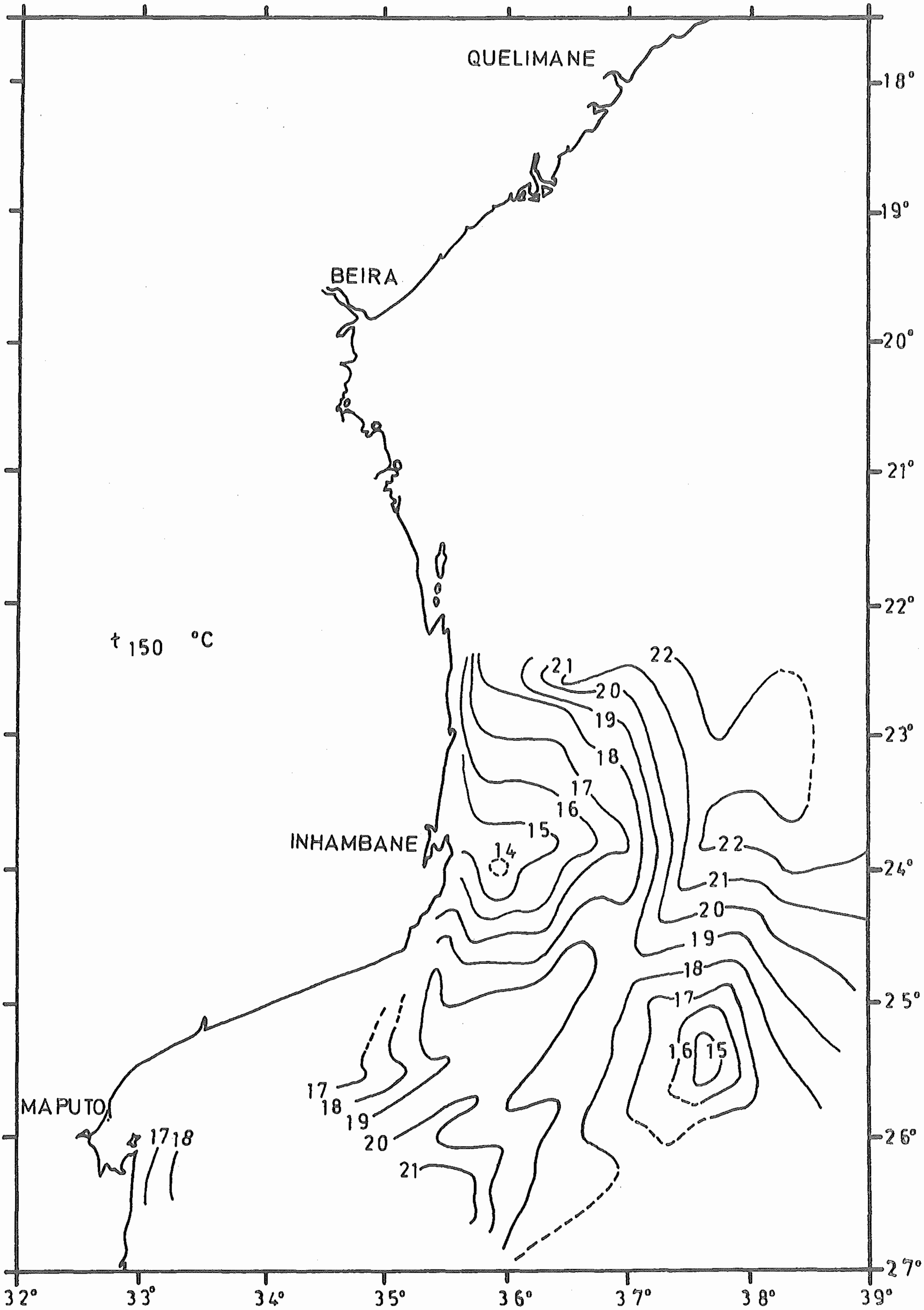


Figure 3.25. Southern area. Temperature at 150 metres

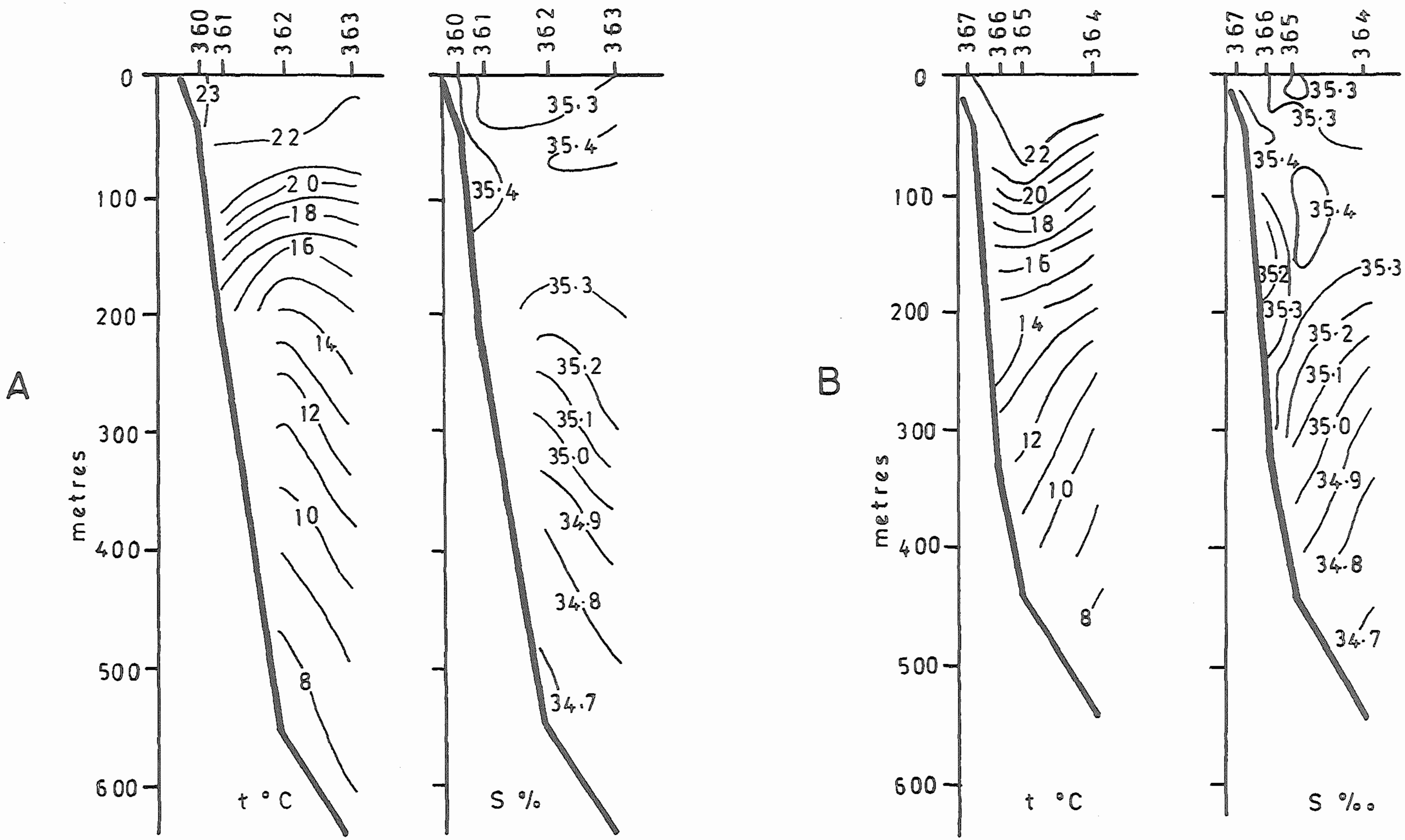


Figure 3. 26. A) Section X, 11 August 1980. B) Section XI, 12 August 1980

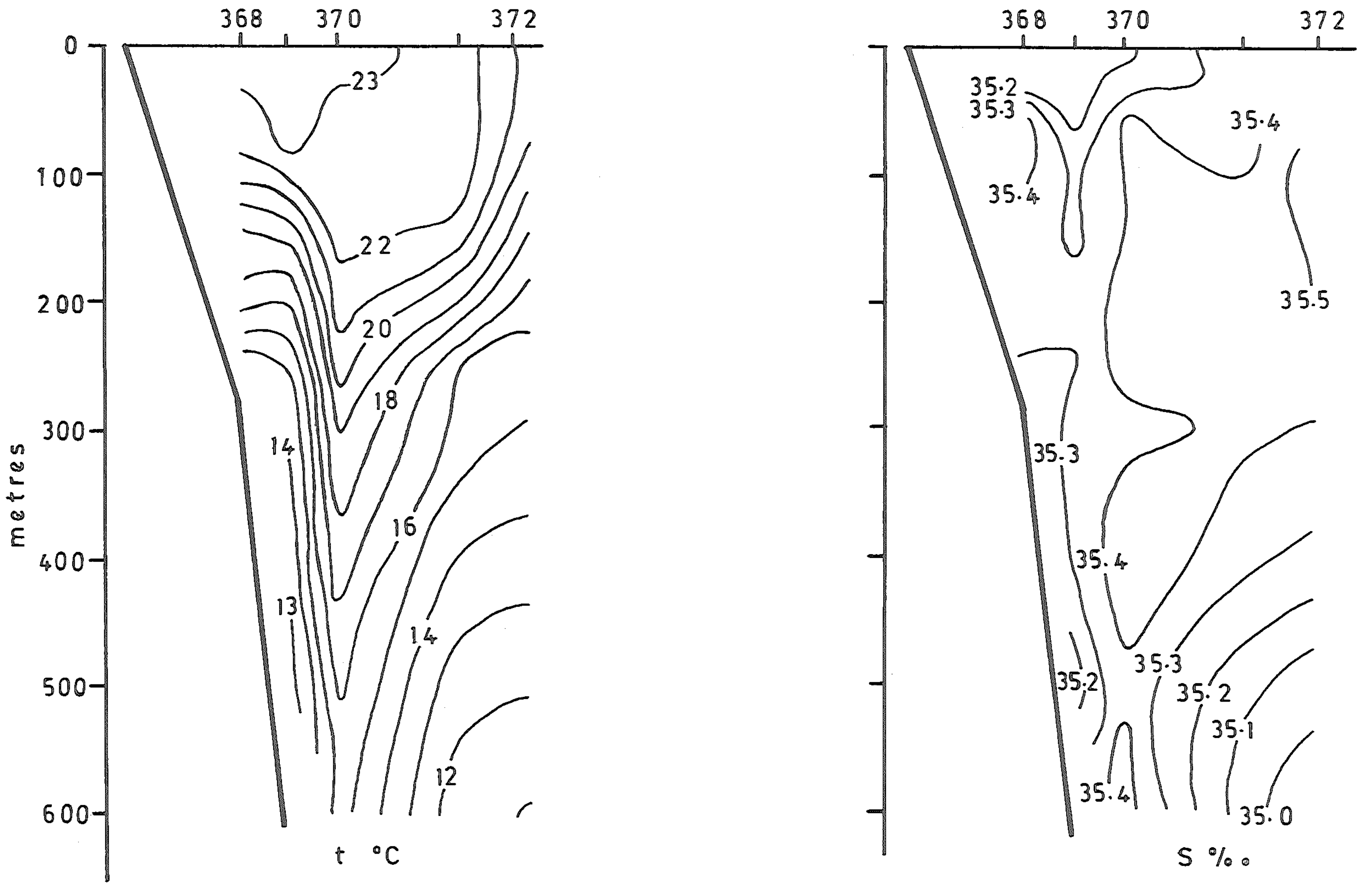


Figure 3.27. Section XII, 13 August 1980

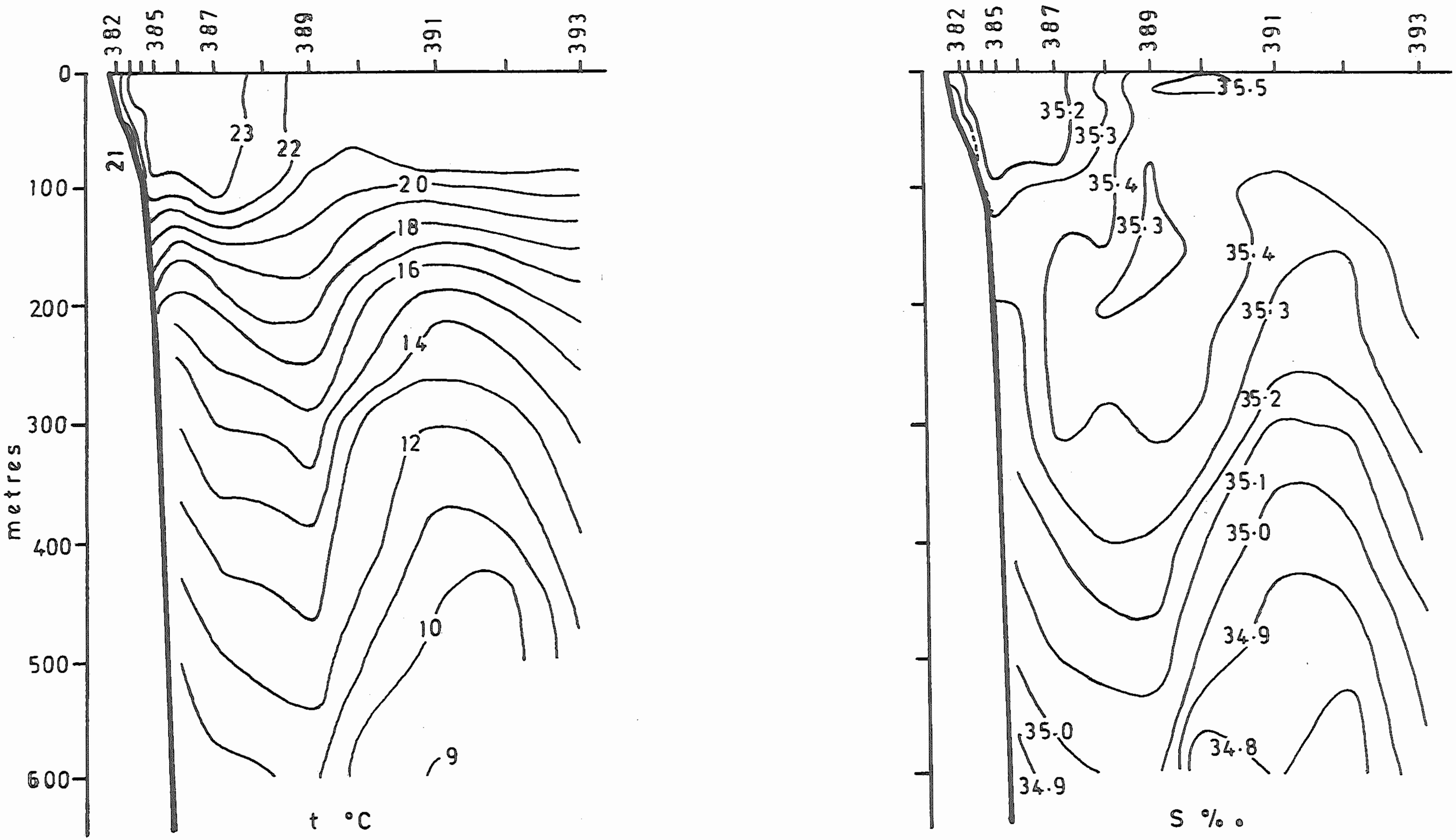


Figure 3. 28. Section XIV 14–16 August 1980

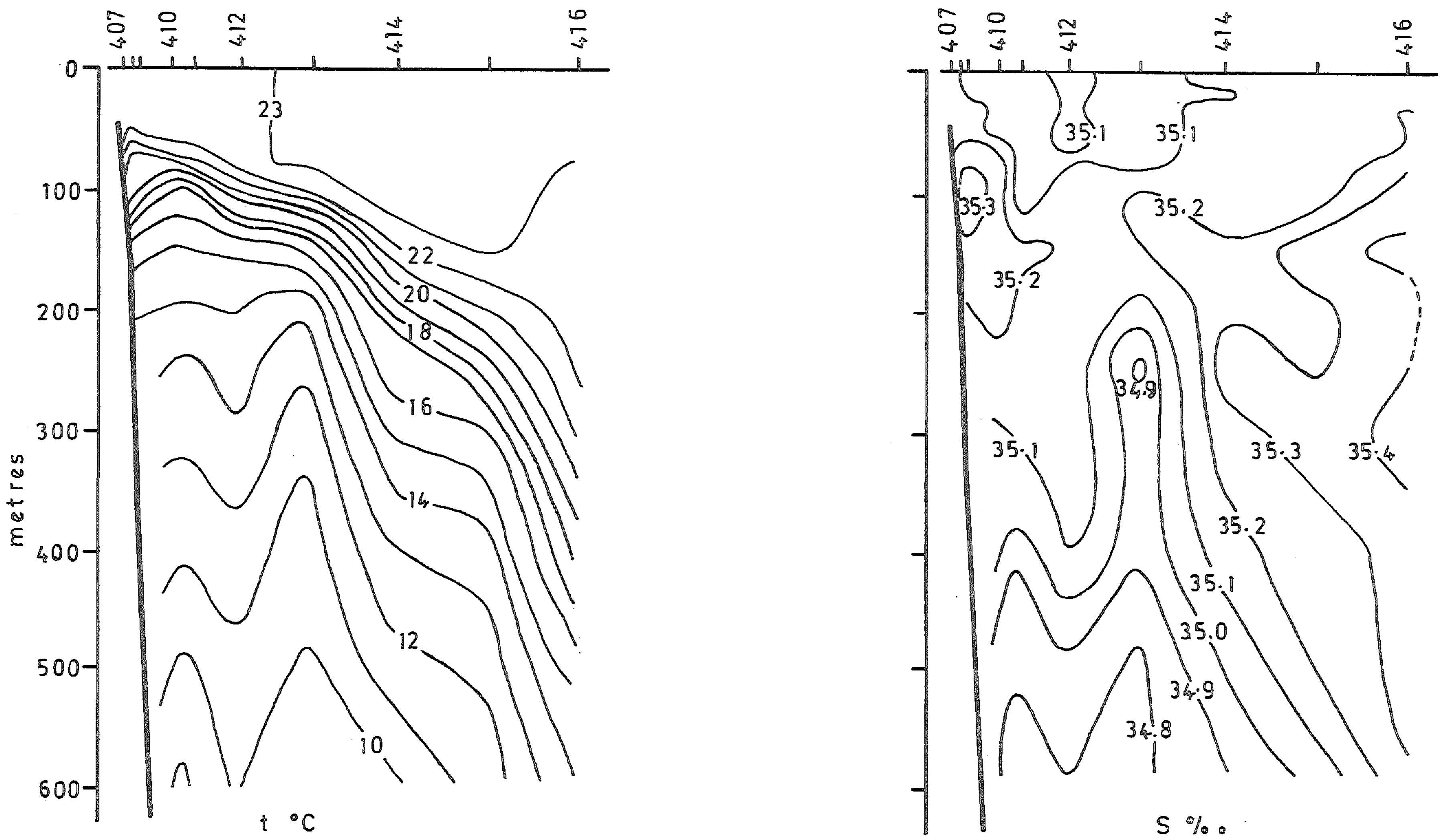


Figure 3. 29. Section XVI, 17–18 August 1980

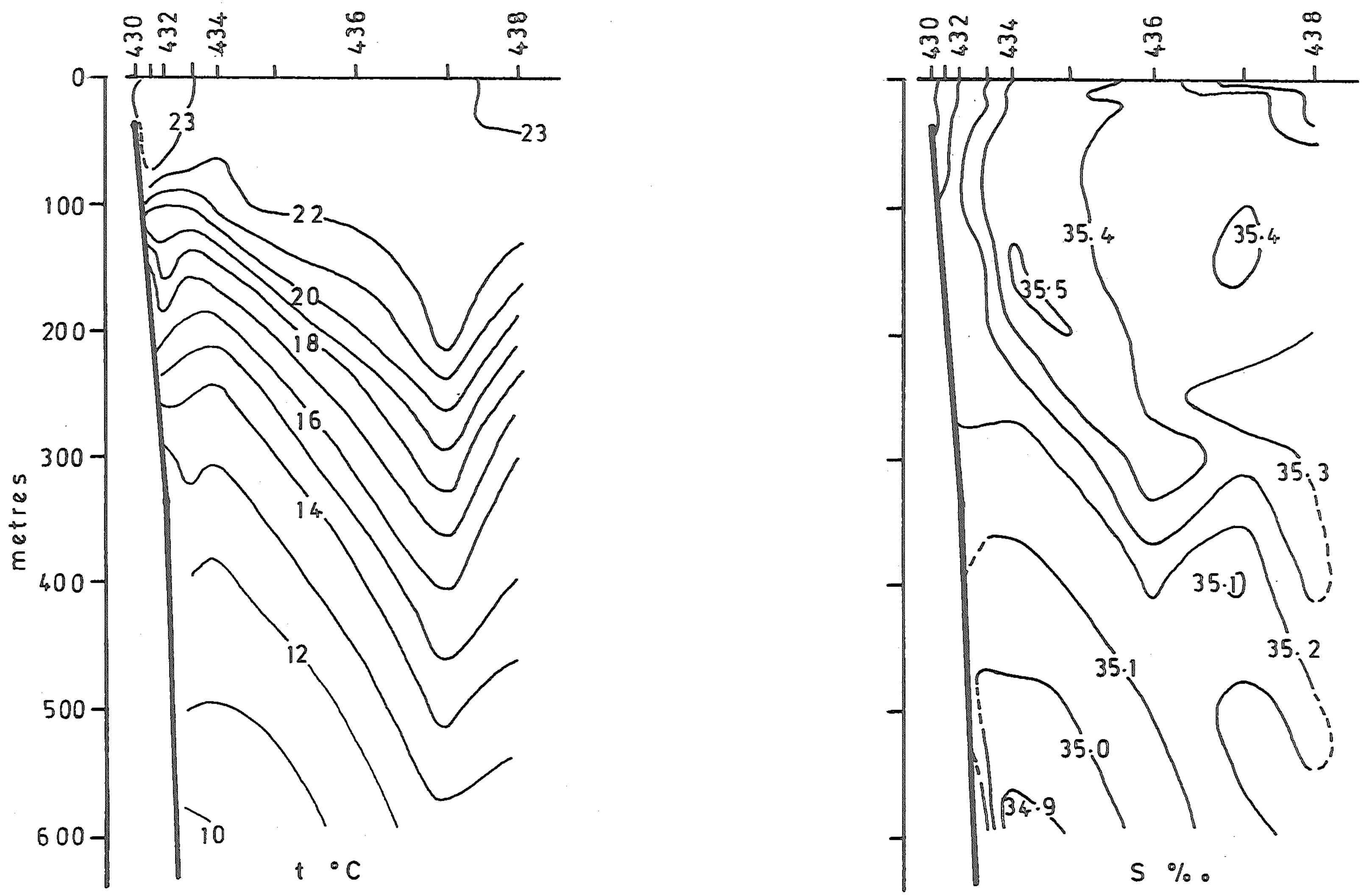


Figure 3. 30. Section XVIII, 19–21 August 1980

4. SHALLOW-WATER SHRIMP

4.1 Introduction

The planned grid of fishing stations was not carried out. This was mainly due to the following:

1º - For safety reasons it was not advisable to trawl in very shallow water. A few number of hauls were done in waters shallower than 15 meters.

2º - The gear used seems to be too heavy for muddy bottoms. Areas traditionally fished by the national fleet were not covered by the present survey.

The result was that the stations that could be considered (figure 4.2) cover less than 50% of the total shrimp distribution area with trawlable bottom (figure 4.1).

For the area covered by the present survey no attempt was made to use catch data to estimate the standing stock; because the gear fishing power is very different from the gears used in previous surveys, and as comparative fishing was not carried out, results could not be compared with previous abundance estimates.

Survey data was used to estimate the species composition, the distribution pattern of the main species and to get an index of the relative abundance of shrimp on the different sub-areas of Sofala Bank. Information on biological conditions of the main species was also obtained.

4.2 Geographic and bathimetric distribution

Shrimp was found all over the surveyed area. Figure 4.3 shows isolines of catch per hour of trawling, calculated by interpolation of the values of each station.

Based on information from previous surveys and from commercial fleet, Sofala Bank was divided in six areas (fig. 4.2), which differ in yields and in patterns of shrimp distribution. The present survey covers the areas of Machese, Quelimane 1 and Quelimane 2; in the northern areas a small number of stations were made and the southern part of Sofala Bank was not covered.

Table 4.1 - Catch (kg) per hour of trawling by area and by depth strata.

		depth (m)			
		<25	25-45	>45	Total
Machese	Kg/h	4.59	0.73	15.75	5.86
	Nº of hauls	8	10	7	25
Quelimane 1	Kg/h	30.79	2.36	4.53	18.59
	Nº of hauls	15	10	3	28
Quelimane 2	Kg/h	6.93	19.46	-	12.56
	Nº of hauls	11	9	1	21
Moebase + Angoche	Kg/h	42.65	-	-	42.65
	Nº of hauls	4	-	-	4
Total	Kg/h	20.44	6.92	12.83	14.38
	Nº of hauls	33	29	11	78

Table 4.1 show catch per hour of trawling splitted by area and depth. Due to the irregular coverage of the areas analysis by 10 m strata was not possible. Data was grouped in three depth strata: 25, 25-45 and 45 meters.

Although the highest yields were obtained north of Pebane, results are not reliable du to the weak coverage of the area.

South of Pebane, the main concentration of shrimp is between Zambezi River and Quelimane - a high density area was found in waters shallower than 25 m.

From table 4.1 and fig. 4.3 we can reach the following conclusion shrimp was present all over the surveyed area (from 10 to 88 meters). The main area of distribution is north of Zambezi River in shallower depths than 45 m, with high density areas between 12 and 25 m.

4.3 Species composition and distribution of the main species

In the surveyed area were present two groups of shallow-water shrimp - Penaidea (all species belonging to the family Penaeidea) and Caridea. Caridean shrimps had a very low occurence. The following species of penaeid shrimps dominated the catches:

Penaeus indicus

Metapenaeus monoceros

Penaeus monodon

Penaeus japonicus

Penaeus latisulcatus

Table 4.2 (annex) shows catch per hour of trawling of these species splitted by area and by depth intervals. P. indicus and M. monoceros were the dominant species.

P. indicus was present in waters shallower than 25 m, with the exception of the area of Quelimane 2 where the species occurred until 45 m (with the highest yields between 25 and 45 m).
The main concentrations were found North of Pebane and between Zambezi delta and Quelimane (figure 4.4).

M. monoceros were normally found together with the previous species, with the exception of the area of Machese where the species occurred until 45 m.
The main concentrations were found in the same areas defined for P. indicus (figure 4.5), although less abundant than this species.

P. latisulcatus occurred only South 18º 00' and in waters deeper than 25 meters (figure 4.6).
The main concentrations were found South of 19º 00' in waters deeper than 45 meters, where the species occurred alone or represented more than 80% of the catch.

P. japonicus was present all over the surveyed area in waters shallower than 45 m, but with low yields.
It is interesting to note that South of Quelimane the species had a much near-shore distribution than between Quelimane and Pebane (figure 4.7).

P. monodon was the species less frequent and abundant.
The species only occurred North of Zambezi River (figure 4.8).
Like the previous species South of Quelimane, *P. monodon* had a much near-shore distribution than between Quelimane and Pebane where the highest yields were found between 25 and 45 meters.

Table 4.2 - Catch (Kg) per hour of trawling splitted by species, area and depth intervals.

Area: Machese

	< 25	25-45	> 45	Total
Penaeus indicus	1.78	-	-	0.57
Metapenaeus monoceros	1.66	0.03	-	0.55
Penaeus monodon	-	-	-	-
Penaeus japonicus	1.01	0.46	-	0.52
Penaeus latisulcatus	0.07	-	15.75	4.10
Others	0.07	0.24	-	0.12
Total	4.59	0.73	15.75	5.86
Nr of hauls	8	10	7	25

Area: Quelimane 1

	< 25	25-45	> 45	Total
Penaeus indicus	18.71	-	-	10.59
Metapenaeus monoceros	9.41	-	-	5.33
Penaeus monodon	0.31	-	-	0.17
Penaeus japonicus	2.34	1.95	-	2.04
Penaeus latisulcatus	-	0.37	3.90	0.39
Others	0.02	0.04	0.63	0.07
Total	30.79	2.36	4.53	18.59
Nr of hauls	15	10	3	28

Table 4.2 - Catch (Kg) per hour of trawling splitted by species, area and depth intervals.

Area: Quelimane 2

	< 25	25-45	> 45	Total
Penaeus indicus	2.53	10.51	-	6.14
Metapenaeus monoceros	2.80	2.37	-	2.56
Penaeus monodon	0.88	1.26	-	1.04
Penaeus japonicus	0.33	3.92	-	1.97
Penaeus latisulcatus	-	1.18	-	0.54
Others	0.39	0.22	-	0.31
Total	6.93	19.46	-	12.56
Nr of hauls	11	9	1	21

Area: Moebase + Angoche

	< 25	25-45	> 45	Total
Penaeus indicus	19.88	-	-	19.88
Metapenaeus monoceros	17.08	-	-	17.08
Penaeus monodon	4.64	-	-	4.64
Penaeus jqponicus	1.06	-	-	1.06
Penaeus latisulcatus	-	-	-	-
Others	-	-	-	-
Total	42.65	-	-	42.65
Nr of hauls	4	-	-	4

4.4 Biological characteristics of the main species

PENAEUS INDICUS

4.4.1 Length frequency distribution

Data was processed separately for males and females, due to their different growth pattern. Individual measurements of carapace length were grouped in 2 mm classes.

a) Females

Carapace length varied between 24 and 53 mm ($\overline{LC}$ = 39.47 mm) with most of the individuals (73%) being between 34 and 43 mm (fig. 4.9). Mean length was calculated in each station where the species was analysed. Figure 4.10 shows that size composition was different from north to south, the bigger individuals occuring south of Quelimane; size composition seems not to have significant bathimetric variation.

b) Males

Carapace length varied between 20 and 41 mm ($\overline{LC}$ = 32.60 mm) with most of the individuals (78%) being between 30 and 35 mm. Size composition had a geographic and bathimetric distribution similar to the pattern found for females (fig. 4.11).

4.4.2 Gonad maturity stages of females and sex-ratio

Biological sampling was carried out in eleven stations. North of Moebase and south of Zambezi River the coverage was very bad. The following table shows the percentage of the different gonad maturity stages for a total of 513 sampled females.

Maturity Stages	1	2	3	4
% (in nr)	33.3	16.8	20.5	29.4

About 50% of the population was formed by late maturing and mature females. The highest percentages were found in one station between Pebane and Quelimane (depth = 28 to 30 m) and in all stations south of Quelimane, in waters shallower than 22 meters (fig. 4.12). Mean length was calculated in each station and the values plotted against percentage of late maturing + mature females calculated for the same station. Comparing the figures 4.10 and 4.12, it may be concluded

METAPENAEUS MONOCEROS

Biological sampling on this species was not very accurate:

1) because only seven stations were sampled and
2) because the samplers had difficulties to clearly define the difference between mature and late maturing females.

   The data collected was processed, but the results are not as reliable as those obtained for P. indicus.

4.4.4 Length frequency distribution

Individual measurements of carapace length were grouped in 2 mm classes.

a) Females

   Length varied between 20 and 47 mm ($\bar{LC}$ = 32.47 mm) with most of the individuals (79%) being between 26 and 35 mm (fig. 4.15).
   Size composition seems not to have big geographic variations, except one sample taken south of Zambezi River where bigger individuals were found (fig. 4.16).

b) Males

   Carapace length varied between 20 and 43 mm ($\bar{LC}$ = 27.73 mm) with most of the individuals (80%) being between 24 and 29 mm (fig. 4.15).
   Size composition seems not to have significant geographic differences (fig. 4.17).

4.4.5 Gonad maturity stages of females and sex-ratio

Because sampling on mature females was not well done, stages 3 and 4 were considered together.
The following table shows the percentage of the different gonad maturity stages for a total of 422 females

Maturity stages	1	2	3+4
% (in nr)	37.9	31.5	30.6

About 31% of the population was formed by late maturing and mature females. The highest percentages (50%) were found in two stations: one taken in Moebase area and another south of Zambezi River (fig. 4.18).
Sex-ratio was calculated for a total of 703 individuals sampled. Females were dominant (60%).

4.4.6 Morphometric relations

a) Relation between total weight and total length

This relationship was calculated applying the formula $Y=aX^b$.
Mean weight was calculated by 1 cm classes of total length (fig. 4.19). Predictive regression was applied with both variables transformed to logarithms.
The following regression equations were calculated:

Females	n = 99 (N = 422)
	$\log W = 3.2619 \log LT - 2.4454$
	r = 0.9838
Males	n = 62 (N = 281)
	$\log W = 2.7332 \log LT - 1.8863$
	r = 0.9123

b) Relation between total length and carapace length

To make the computation easier mean carapace length was calculated by 1 cm classes of total length (fig. 4.20). Predictive regression was applied with both variables transformed to logarithms.
The following regression equations were calculated:

Females	n = 52 (N = 425)
	$\log LT = 0.8238 \log LC - 0.1109$
	r = 0.9930
Males	n = 31 (N = 281)
	$\log LT = 0.8297 \log LC - 0.0997$
	r = 0.9805

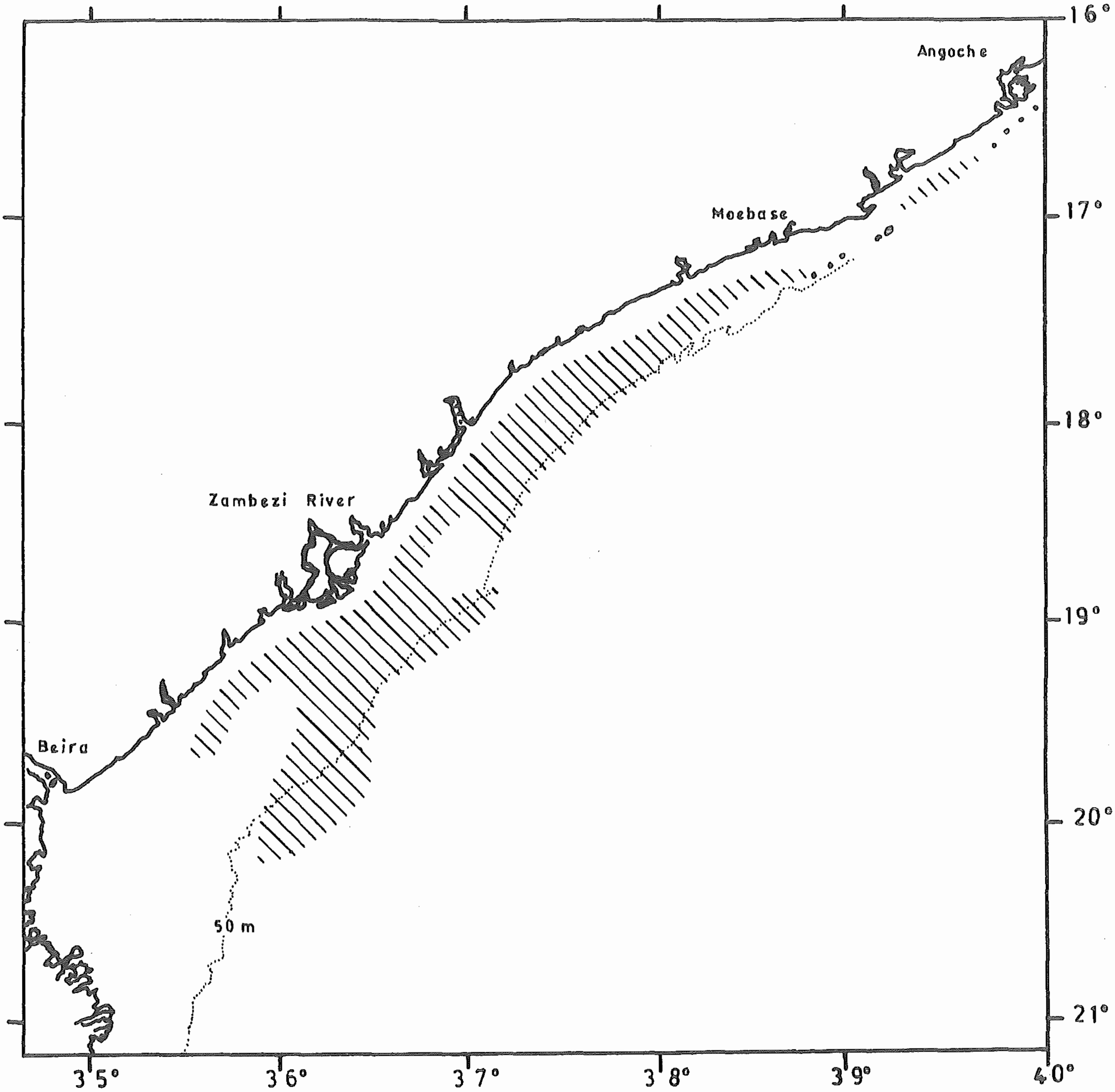


Fig. 4.1 SOFALA BANK – Area covered by the survey

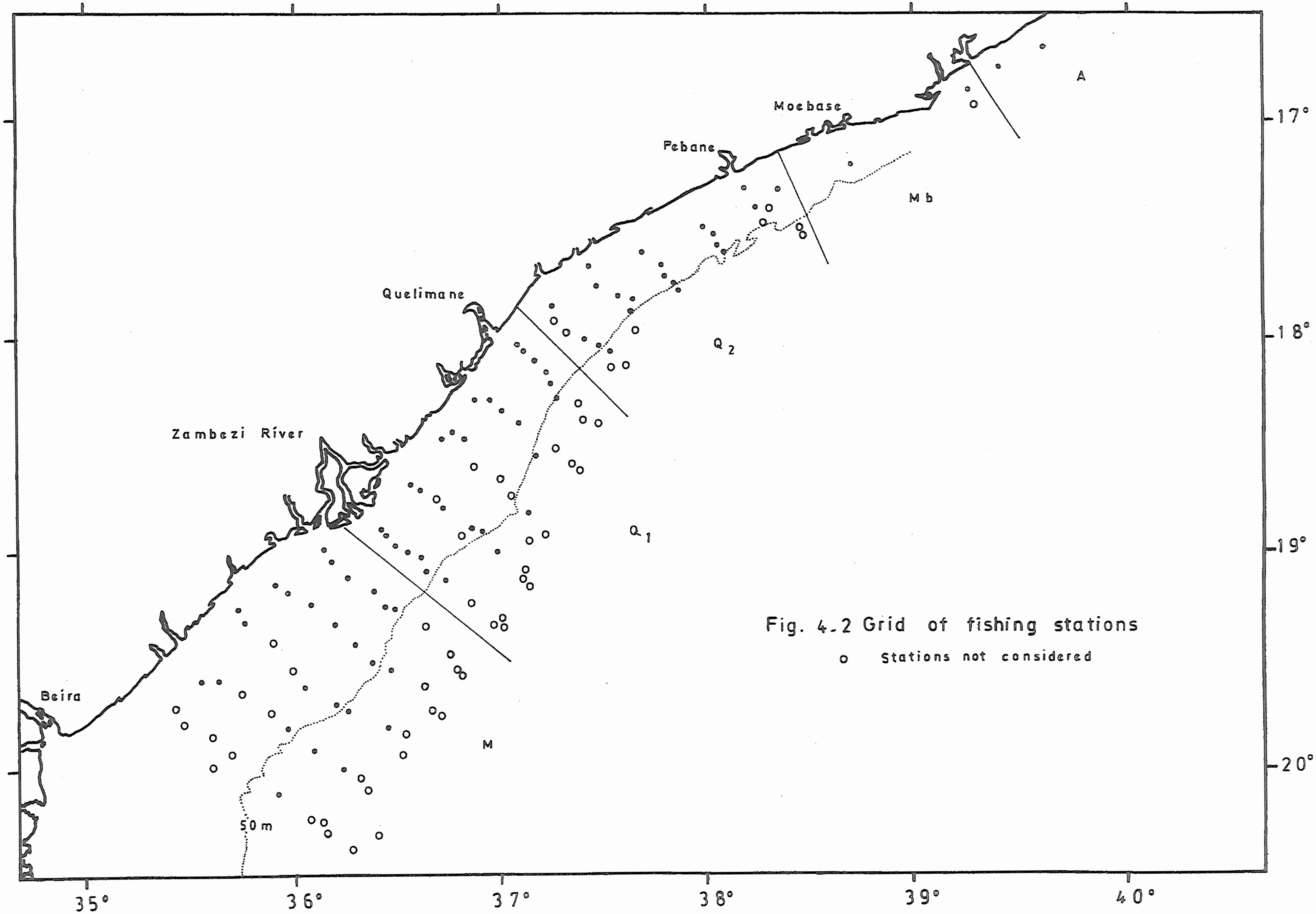


Fig. 4.2 Grid of fishing stations

o Stations not considered

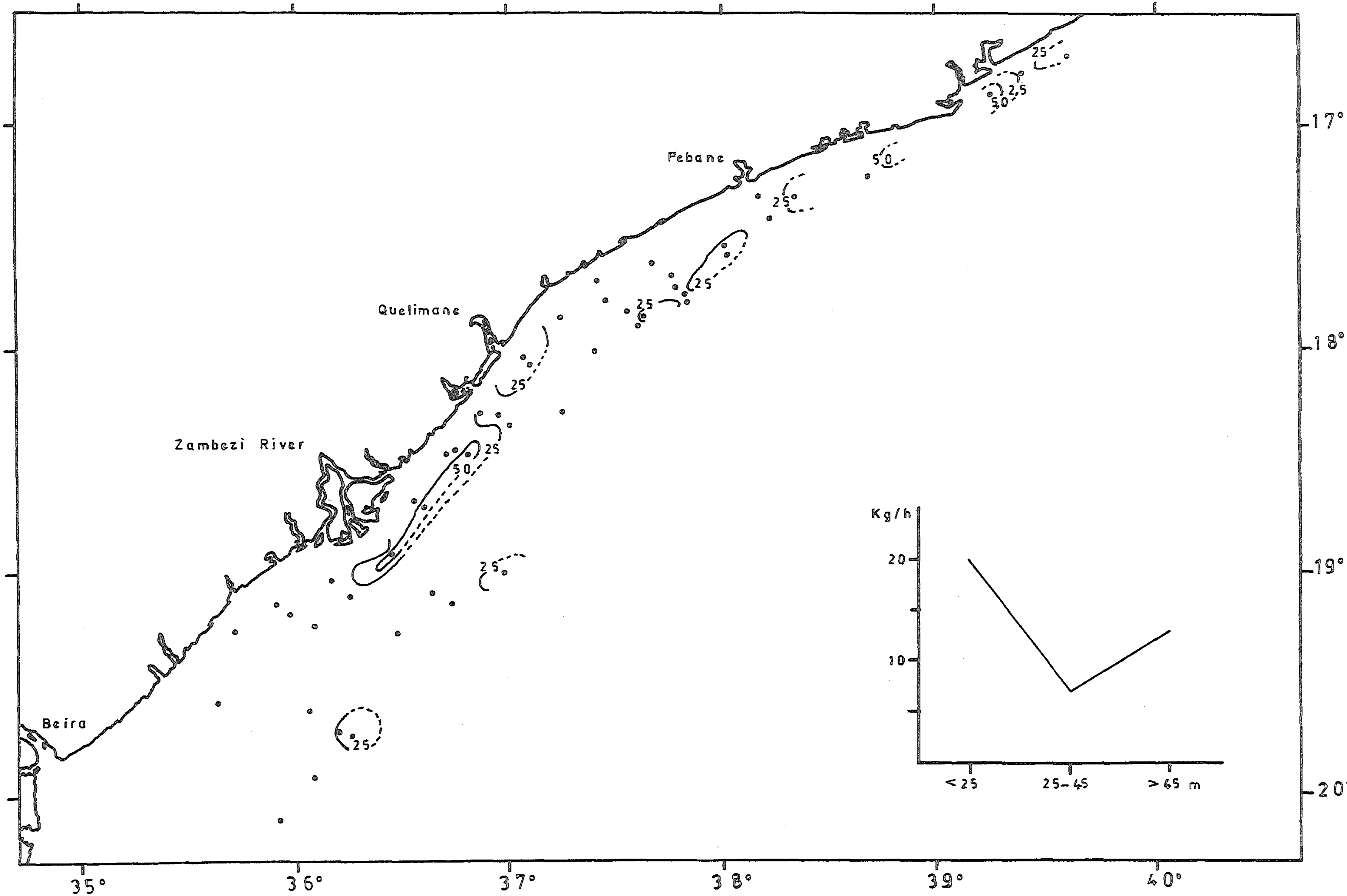


Fig. 4.3 Shallow-water shrimp - Main distribution areas defined by isolines of kg/hour
Dots indicate stations where shrimp occurs.

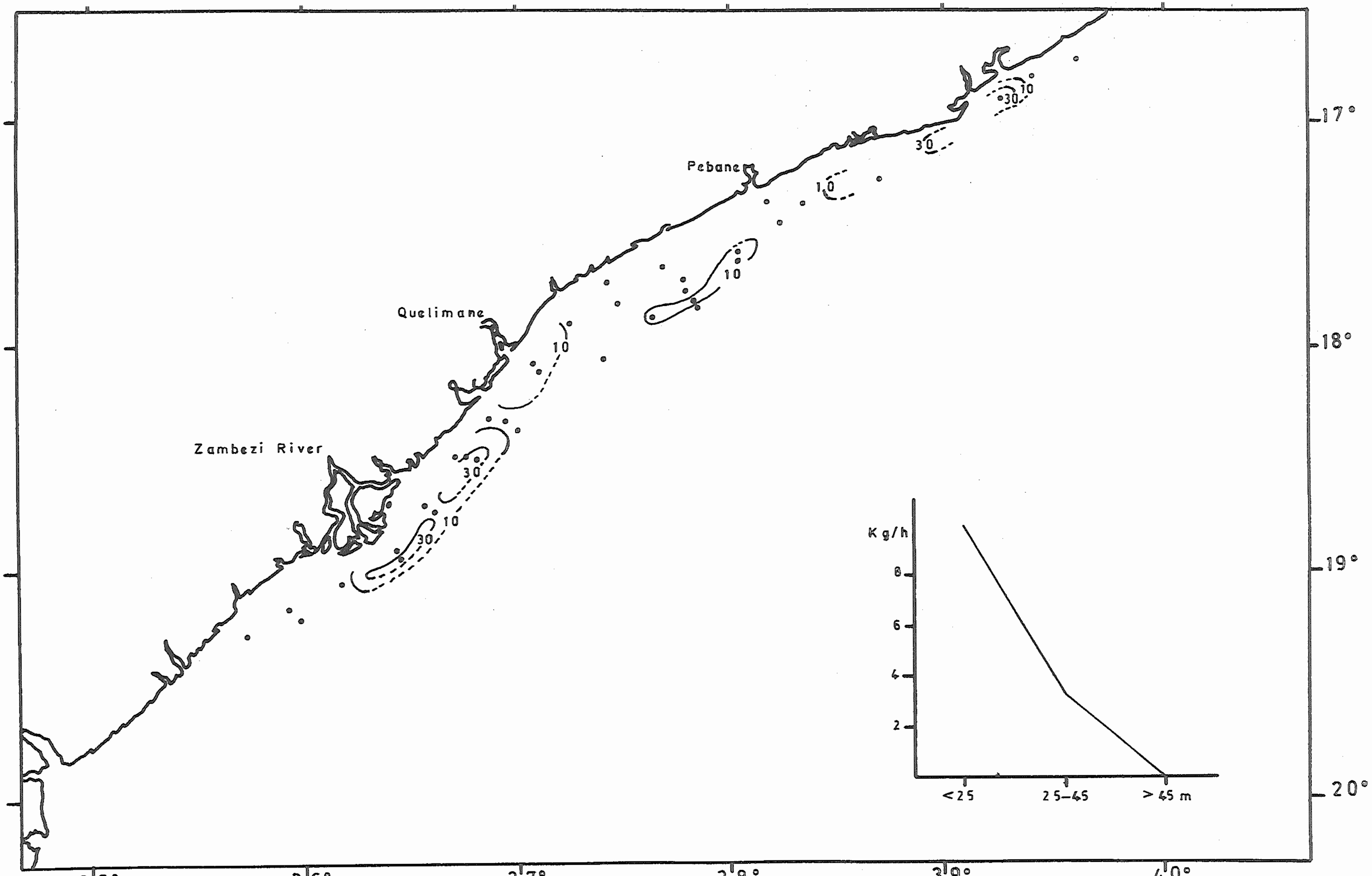


Fig. 4.4 Penaeus indicus – Main distribution areas defined by isolines of Kg/hour
Dots indicate stations where the species occurs.

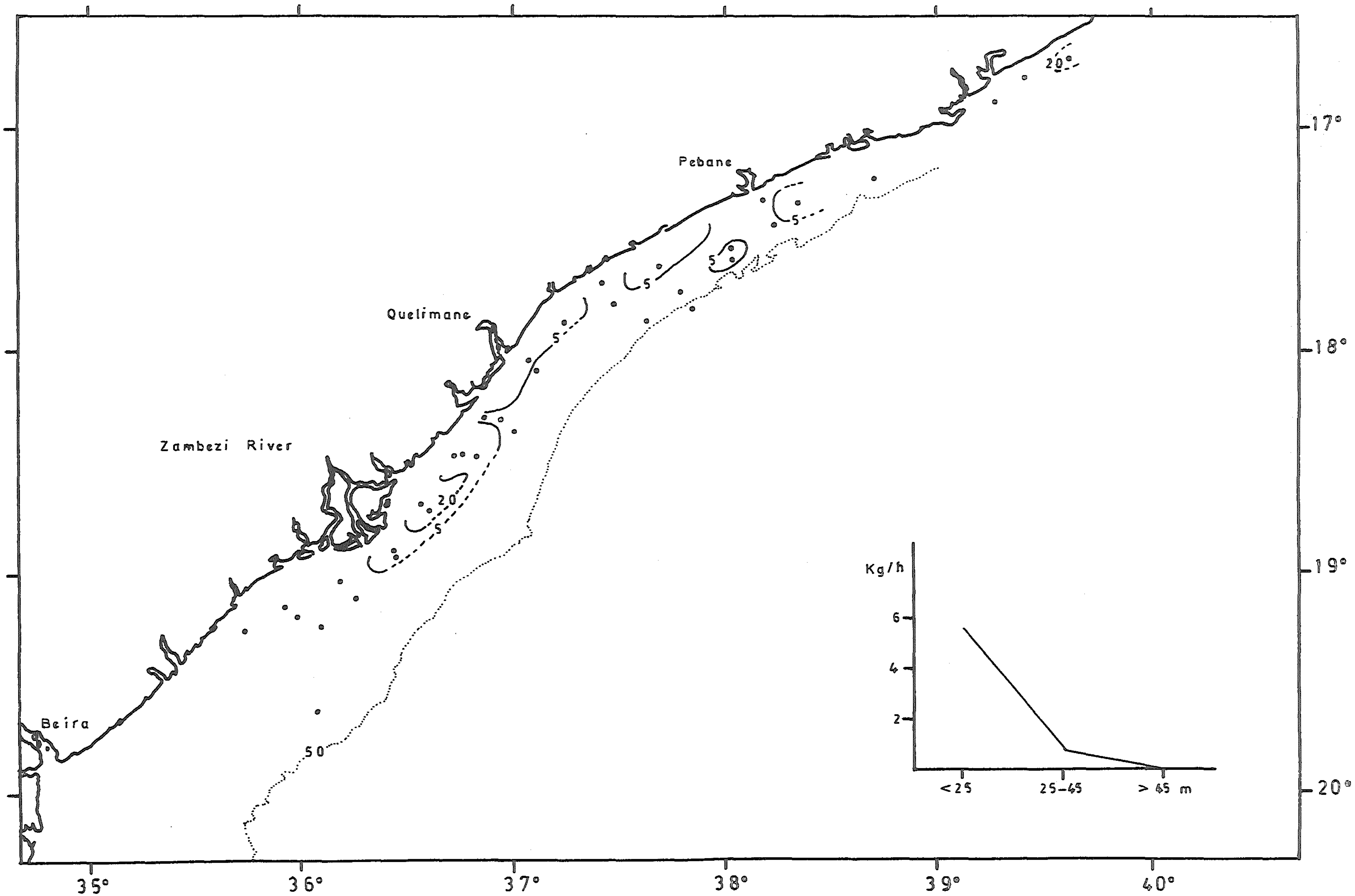


Fig. 4.5 *Metapenaeus monoceros* — Main distribution areas defined by isolines of Kg/hour
Dots indicate stations where the species occurs.

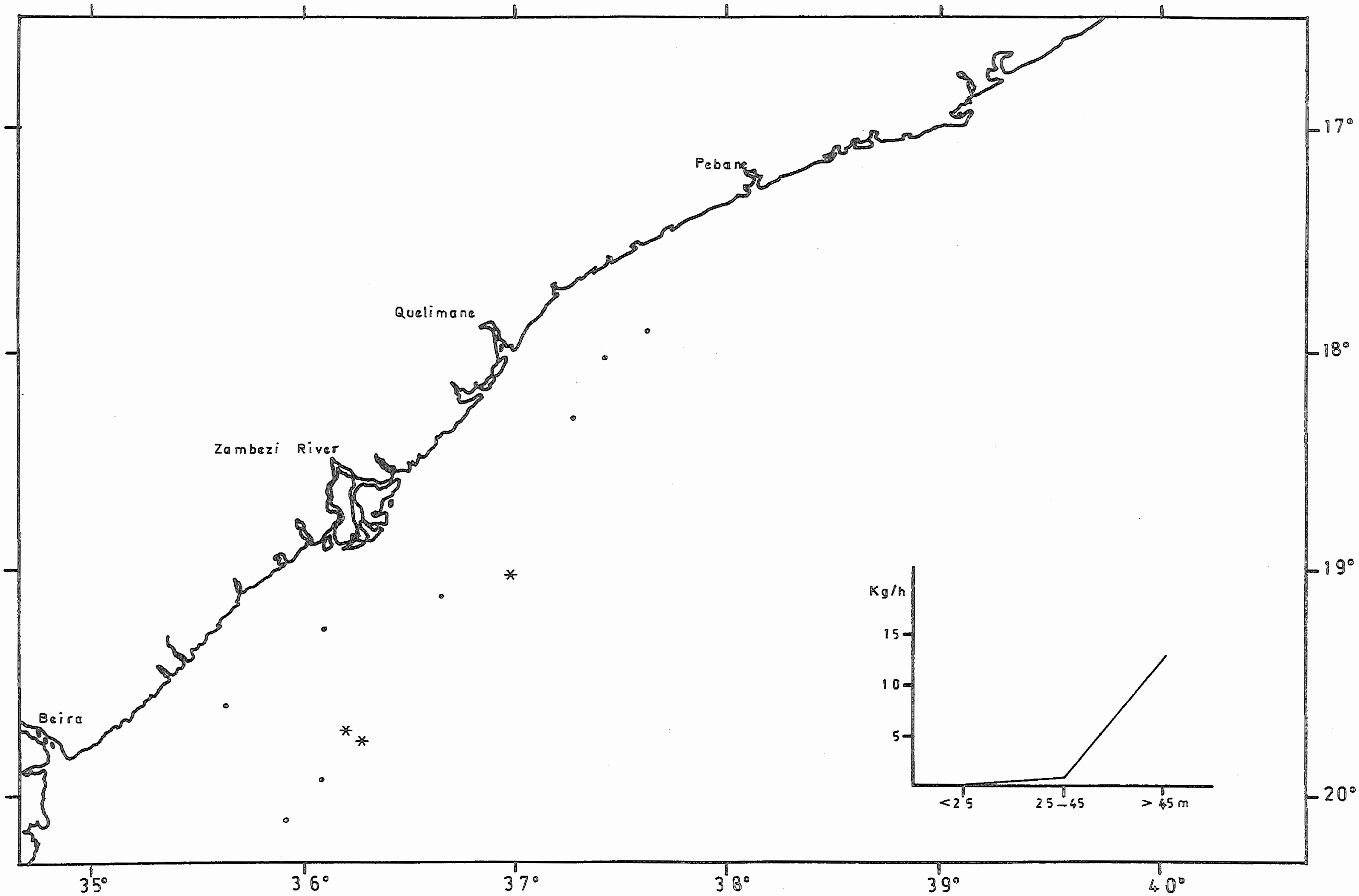


Fig. 4.6 Penaeus latisulcatus– Dots indicate stations where the species occurs
* indicate the highest yields (30 to 48 Kg/hour)

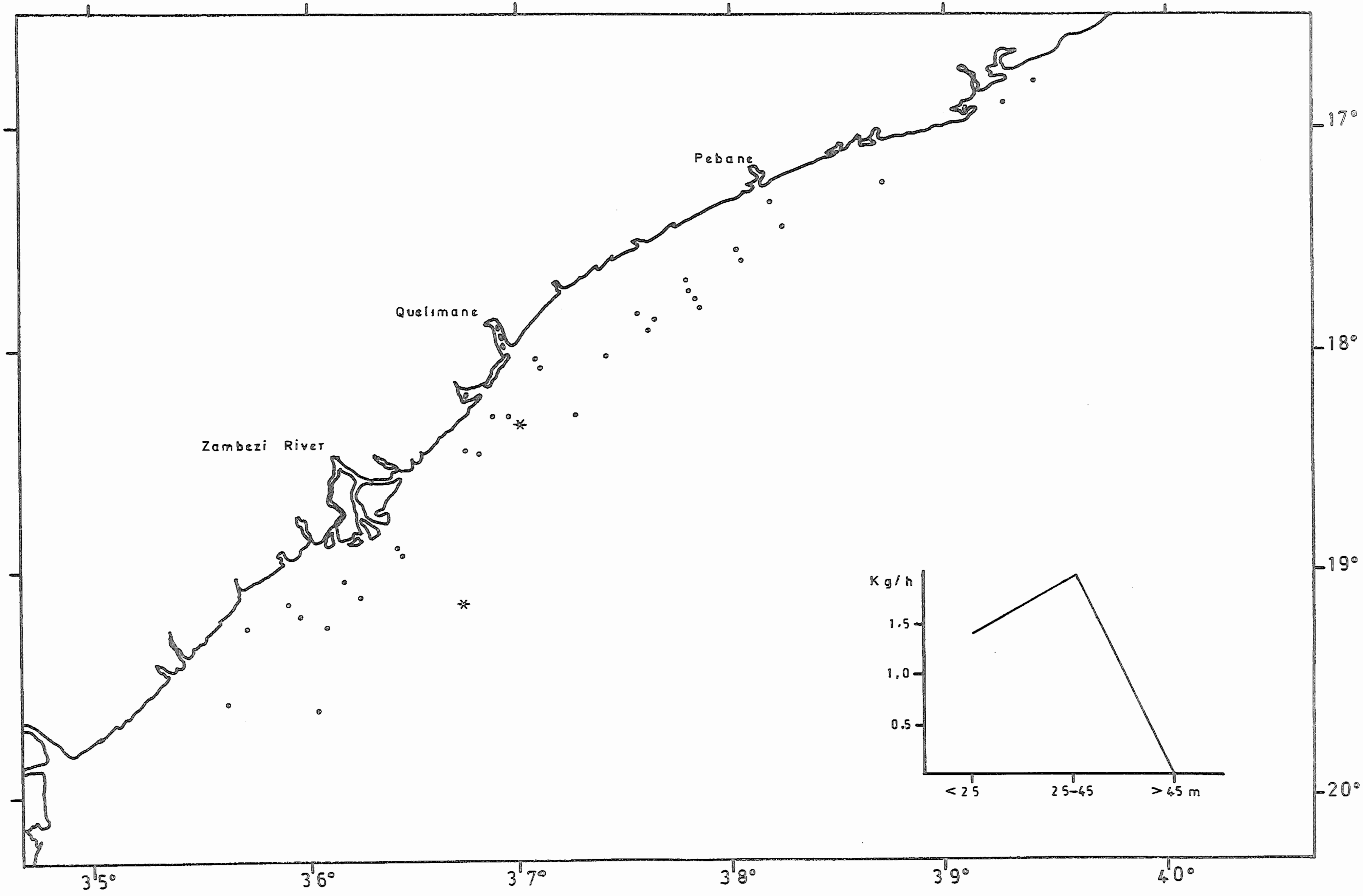


Fig. 4.7 Penaeus japonicus – Dots indicate stations where the species occurs
* indicate the highest yields (=15 Kg/hour)

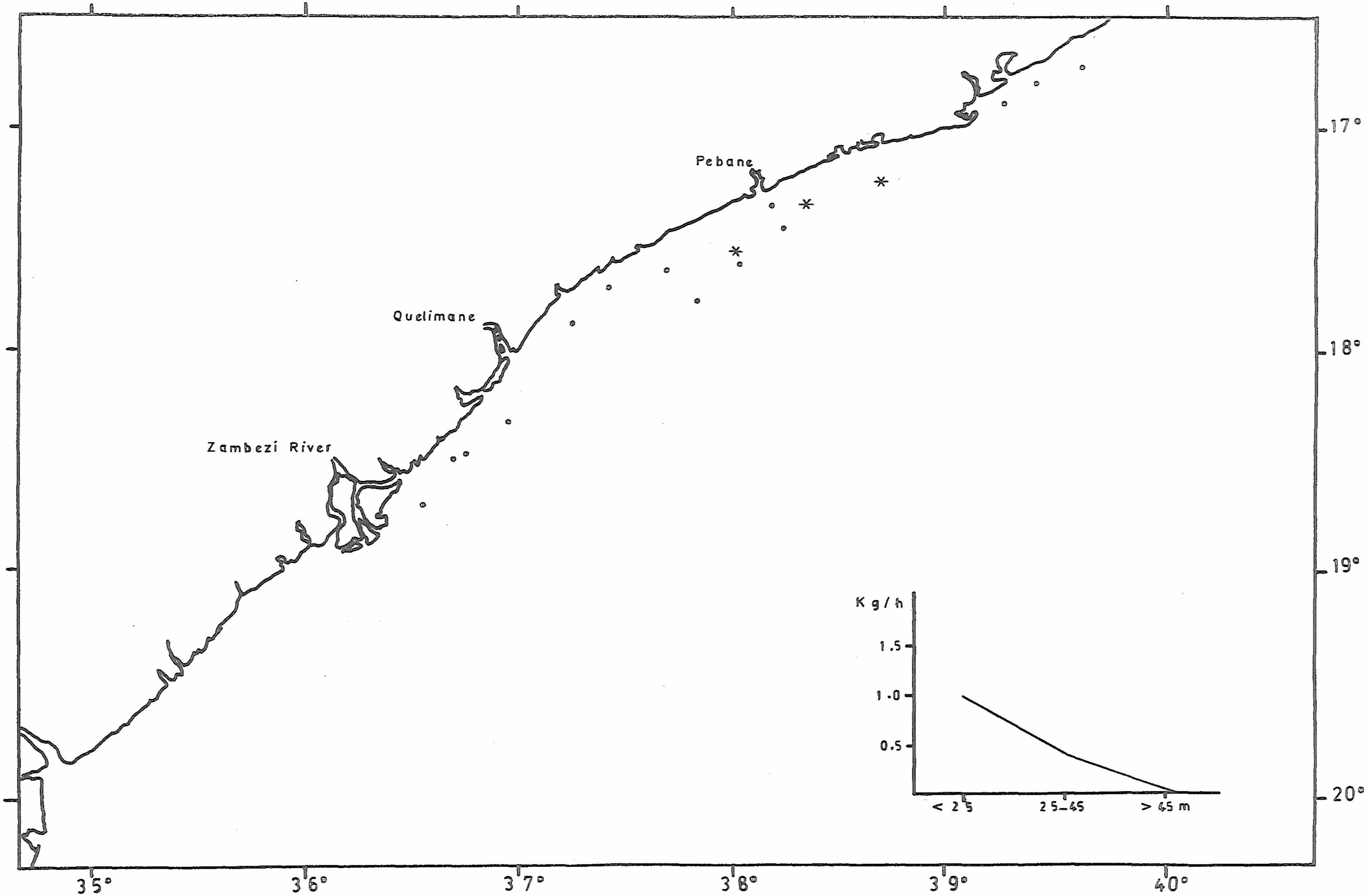
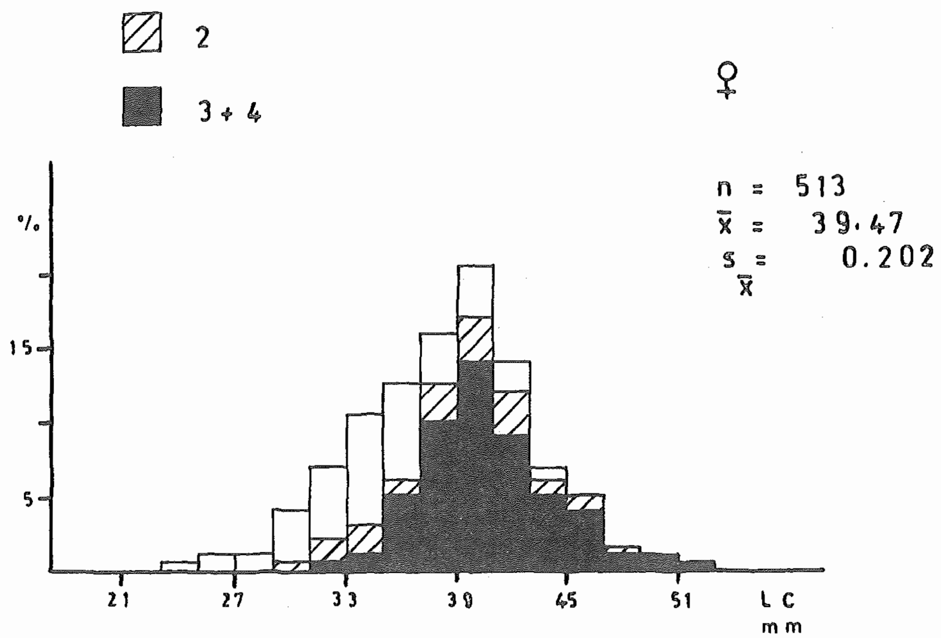
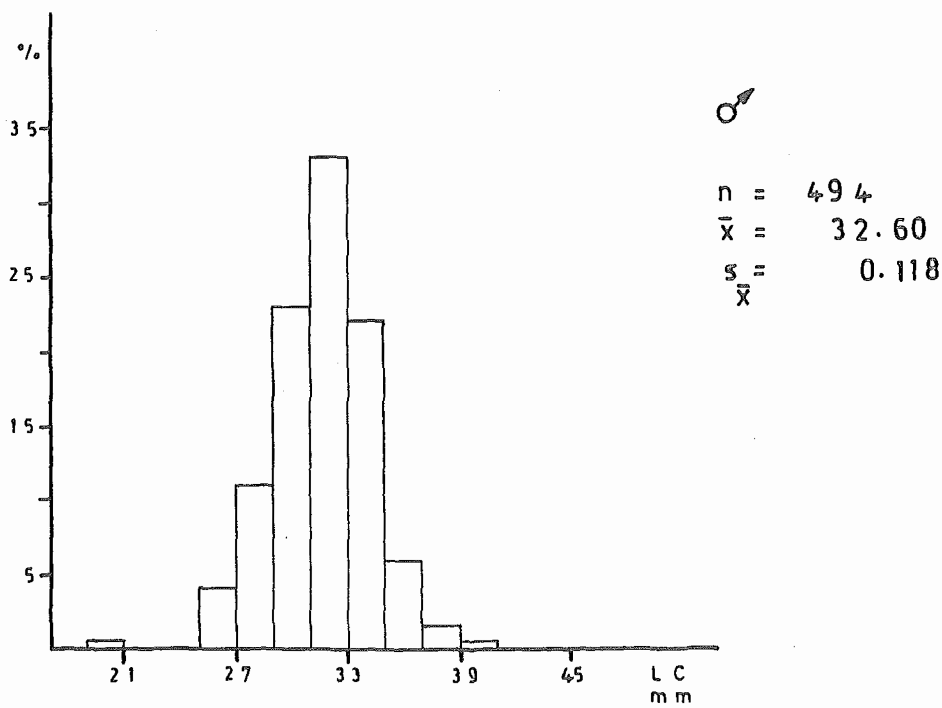


Fig. 4.8. Penaeus monodon - Dots indicate stations where the species occurs

* indicate the highest yields (8 to 11 Kg/hour)

Fig. 4.9 P. indicus – L-F distribution (carapace length-classes of 2 mm)





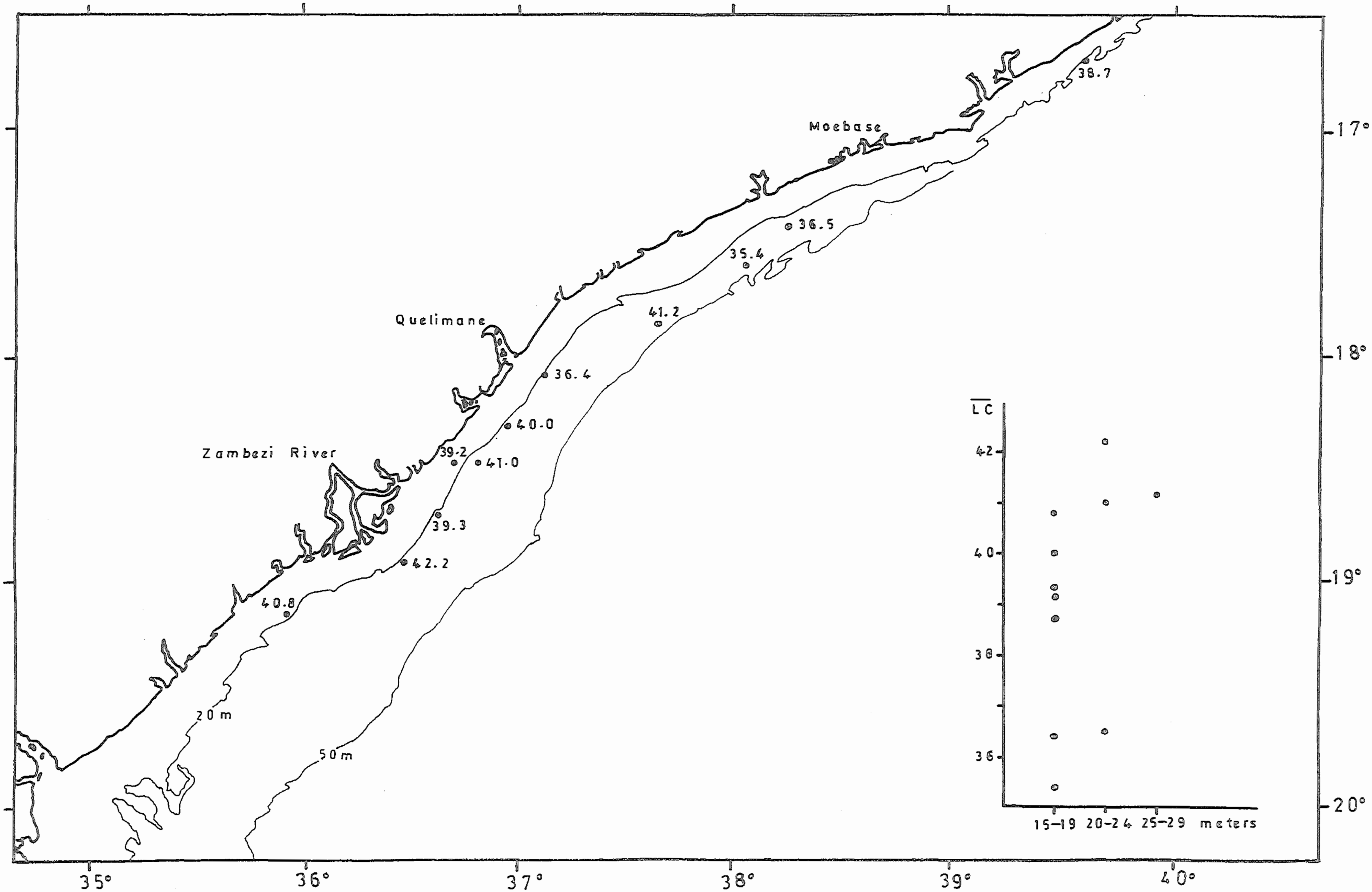


Fig. 4.10 P. indicus ♀ – Mean carapace length in each station sampled

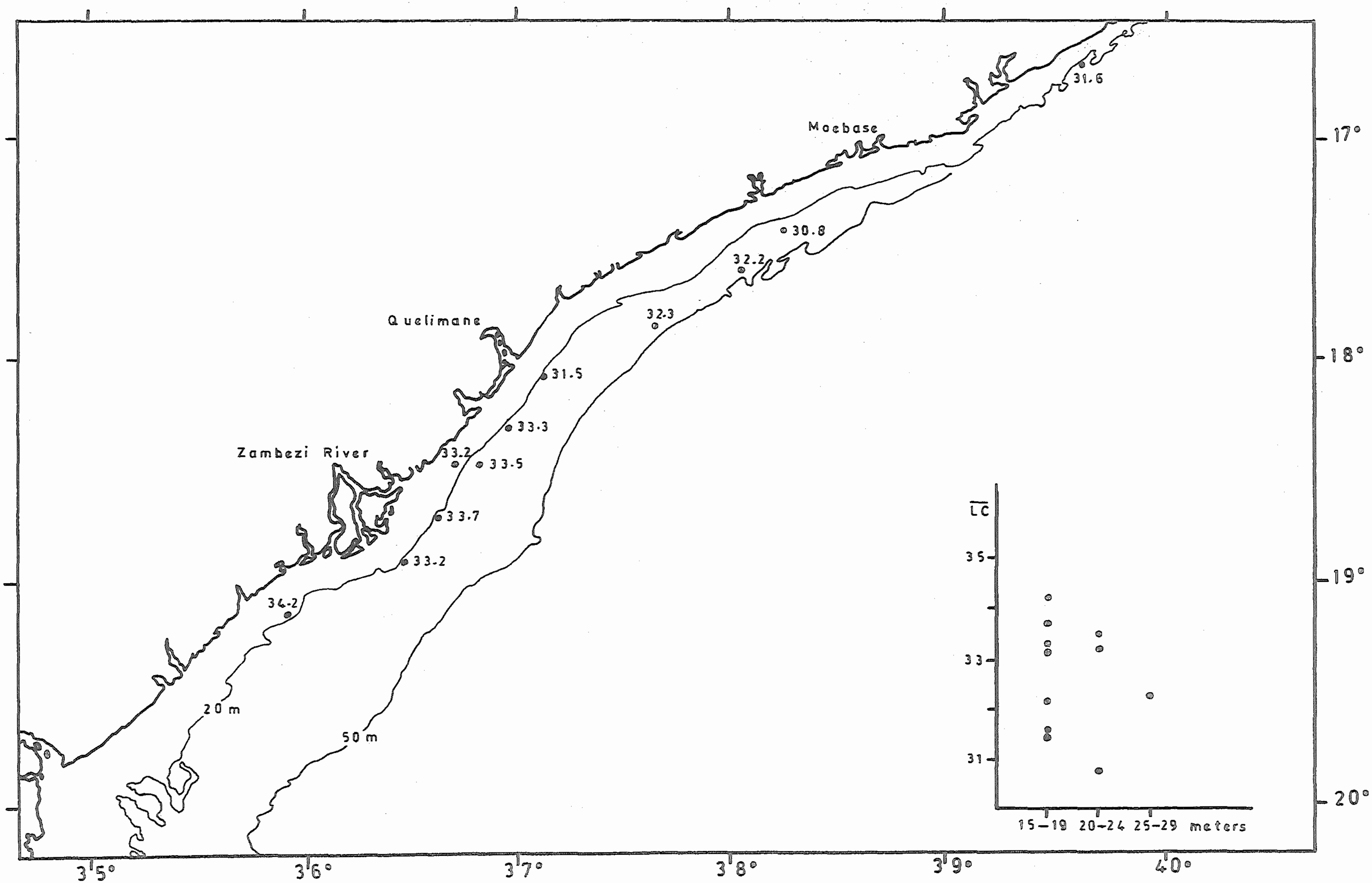


Fig. 4.11 P. indicus ♂ – Mean carapace length in each station sampled

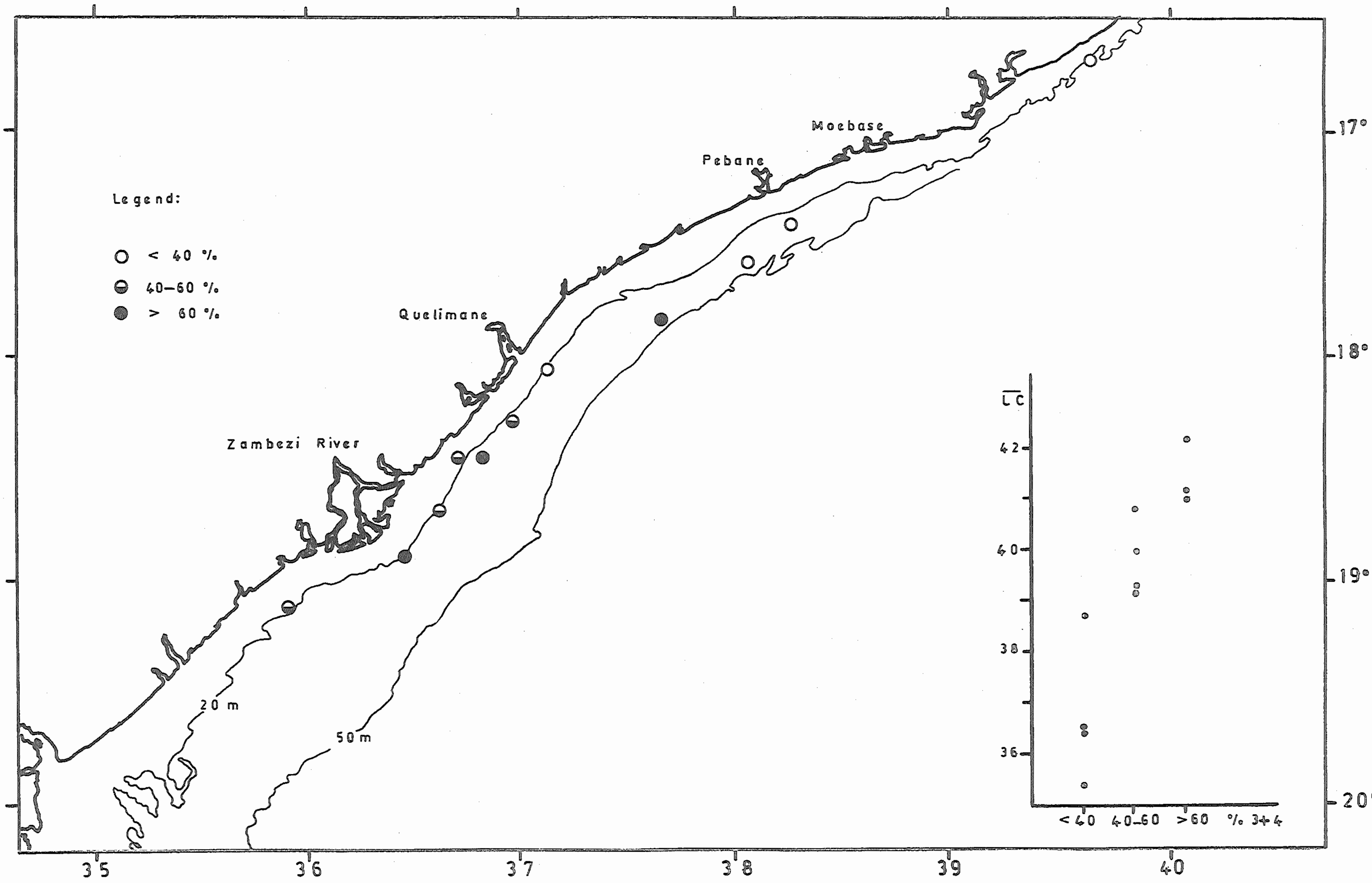


Fig. 4.12 P. indicus – Percentage of females of mature and late maturing females in each station sampled

Fig. 4.13 P. indicus – Relation Total Weight / Total Length

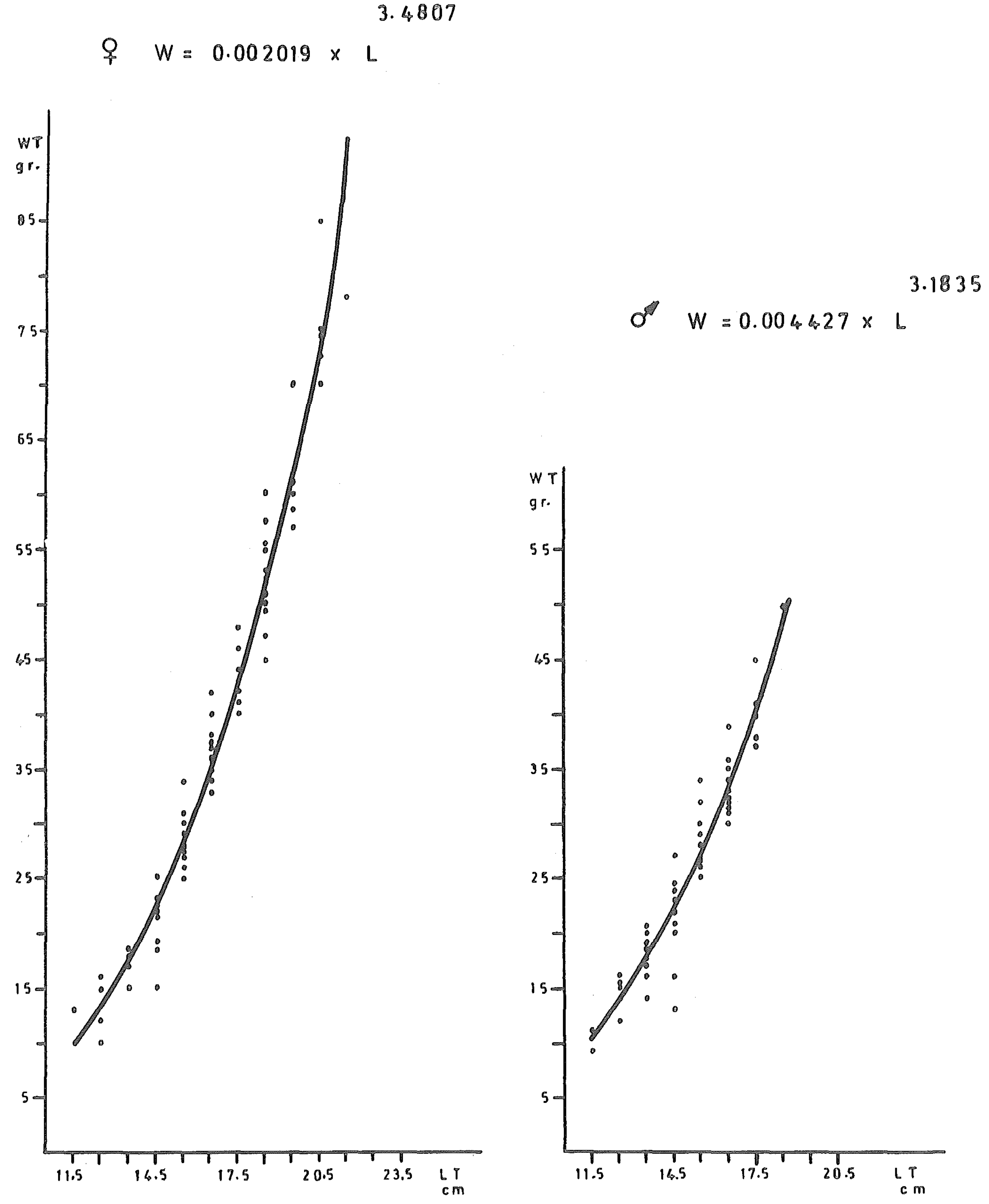
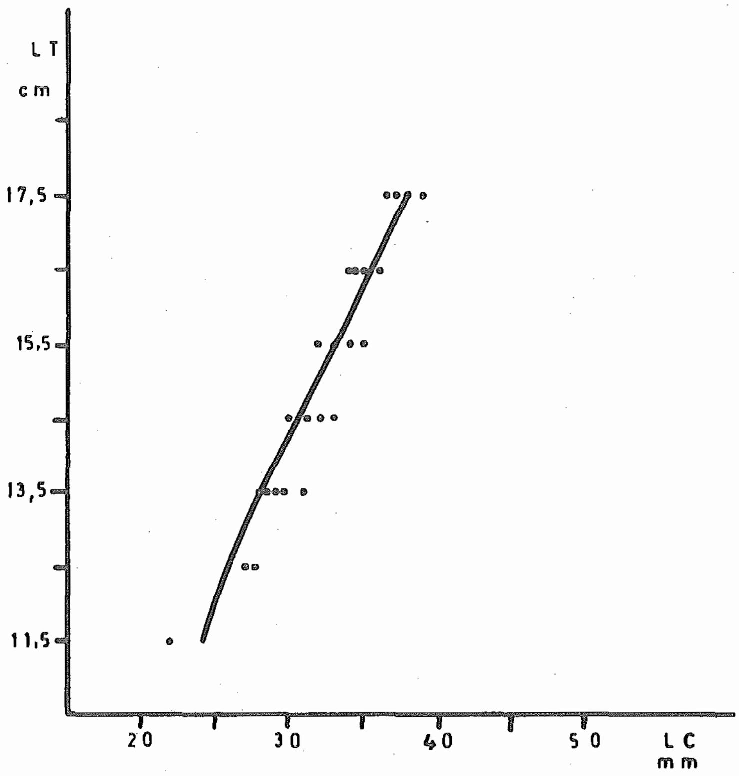
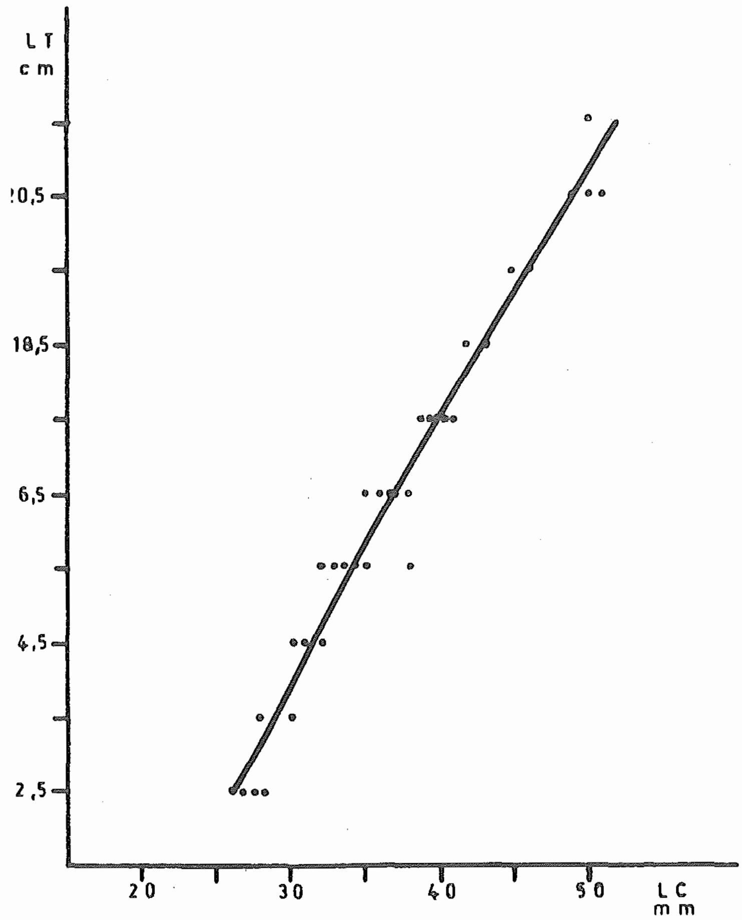


Fig. 4.14 P. indicus — Relation Total Length/Carapace Length



♂

log LT = 0.9074 log LC − 0.1888



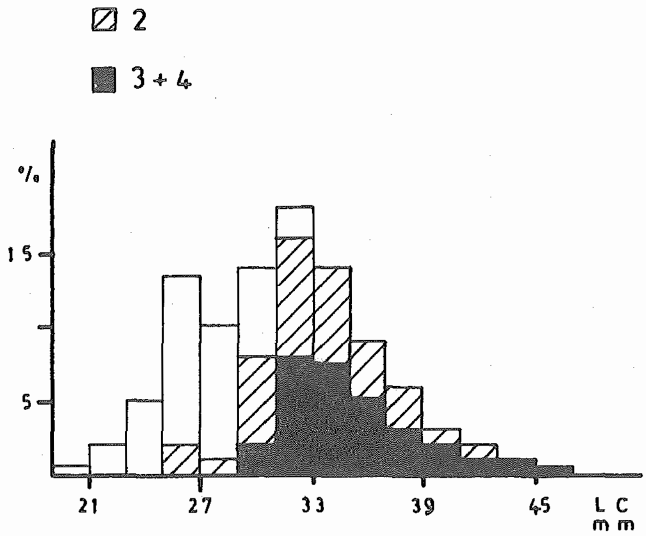
♀

log LT = 0.7972 log LC − 0.0331

Fig. 4.15 M. monoceros – L F distribution (carapace length – classes of 2 mm)

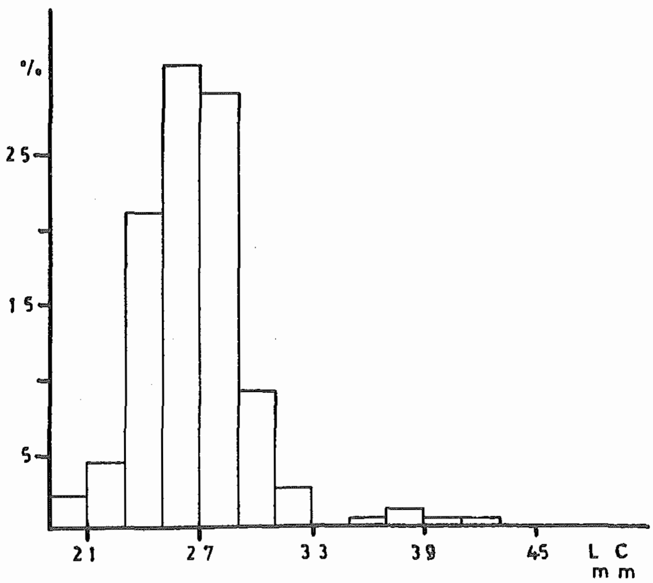
♀

n = 422
$\bar{x}$ = 32.47
$s_{\bar{x}}$ = 0.237



♂

n = 242
$\bar{x}$ = 27.73
$s_{\bar{x}}$ = 0.195



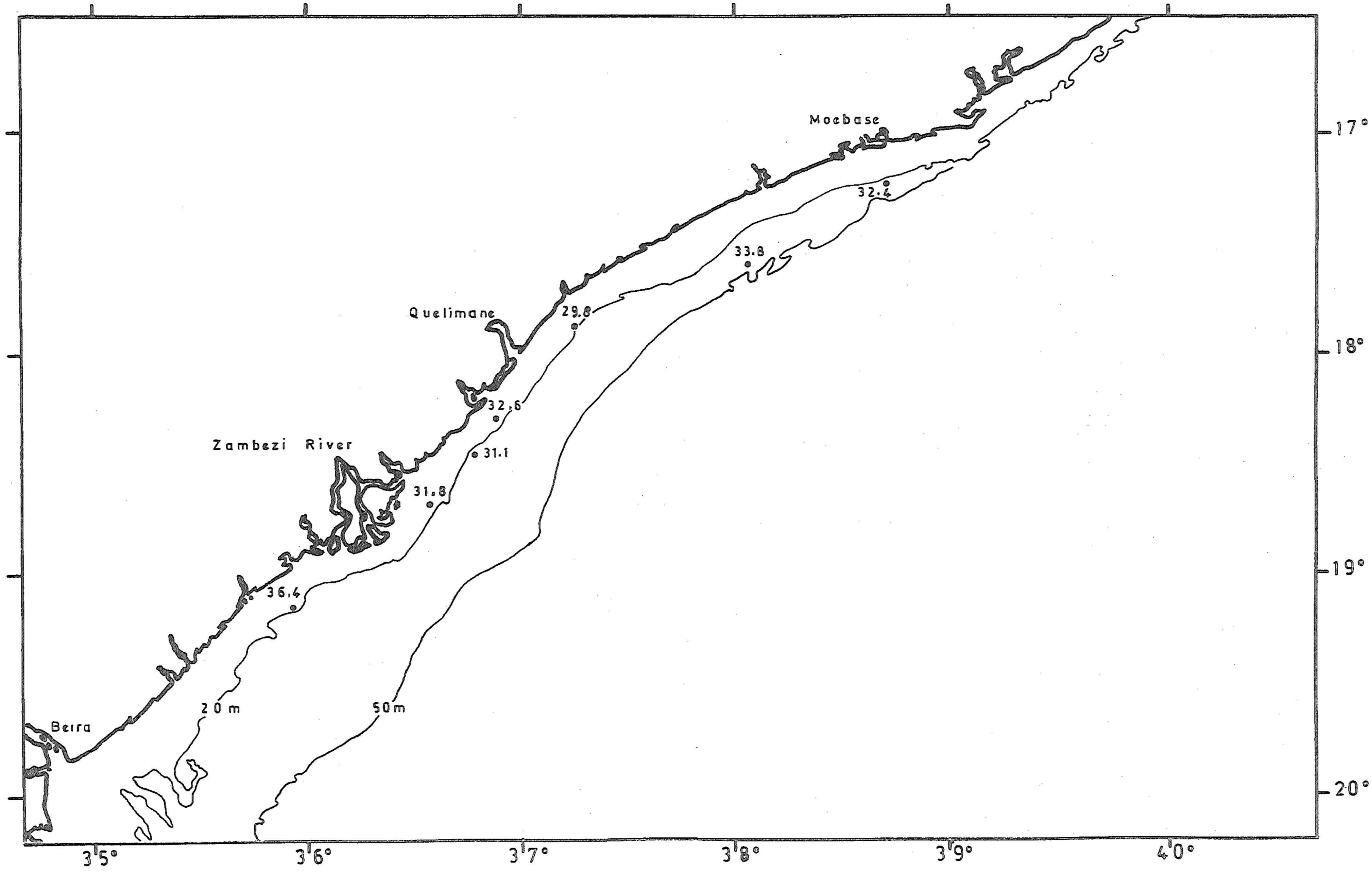


Fig. 4.16 M. monoceros ♀ — Mean carapace length in each station sampled

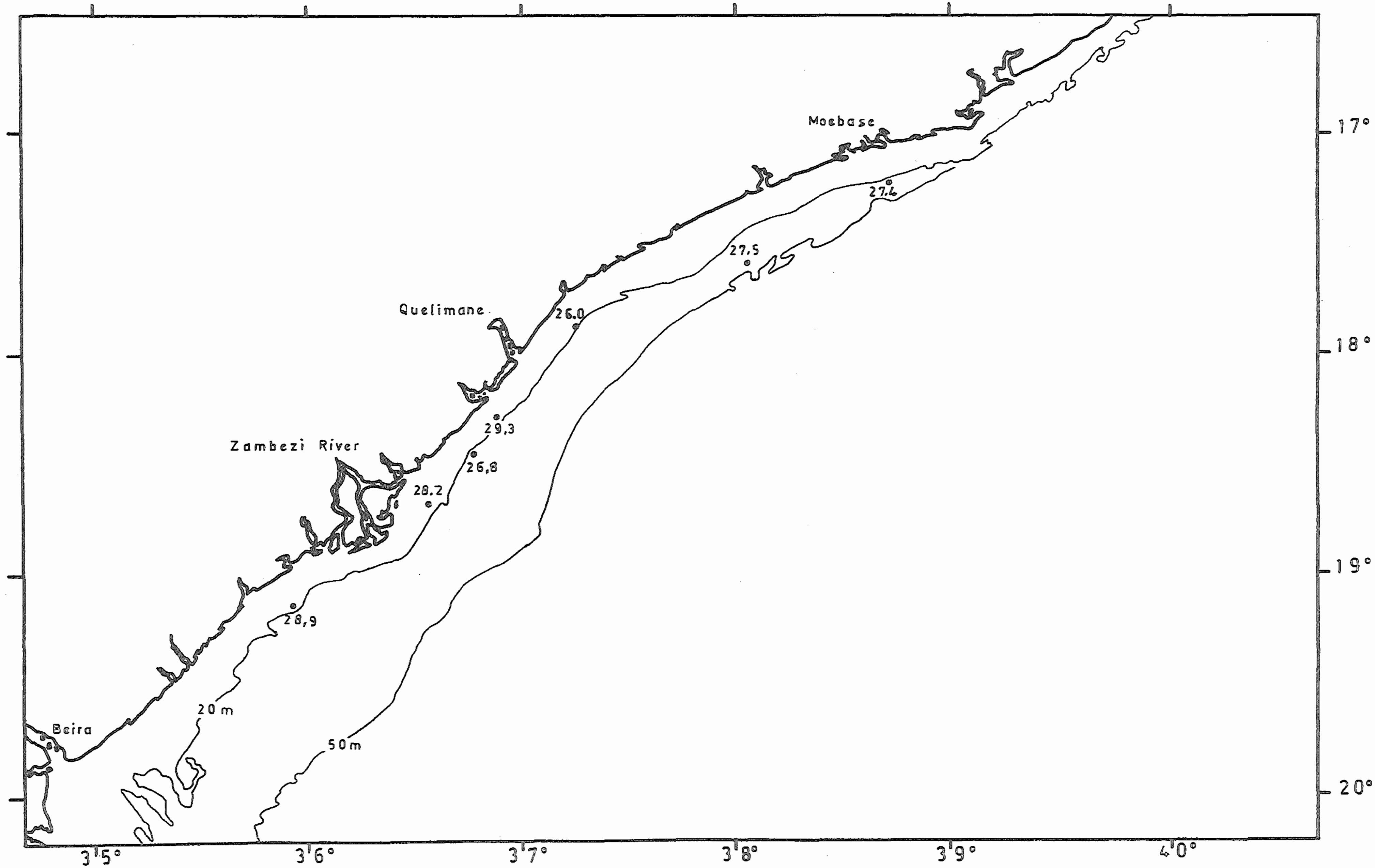


Fig. 4.17 M. monoceros ♂ — Mean carapace length in each station sampled

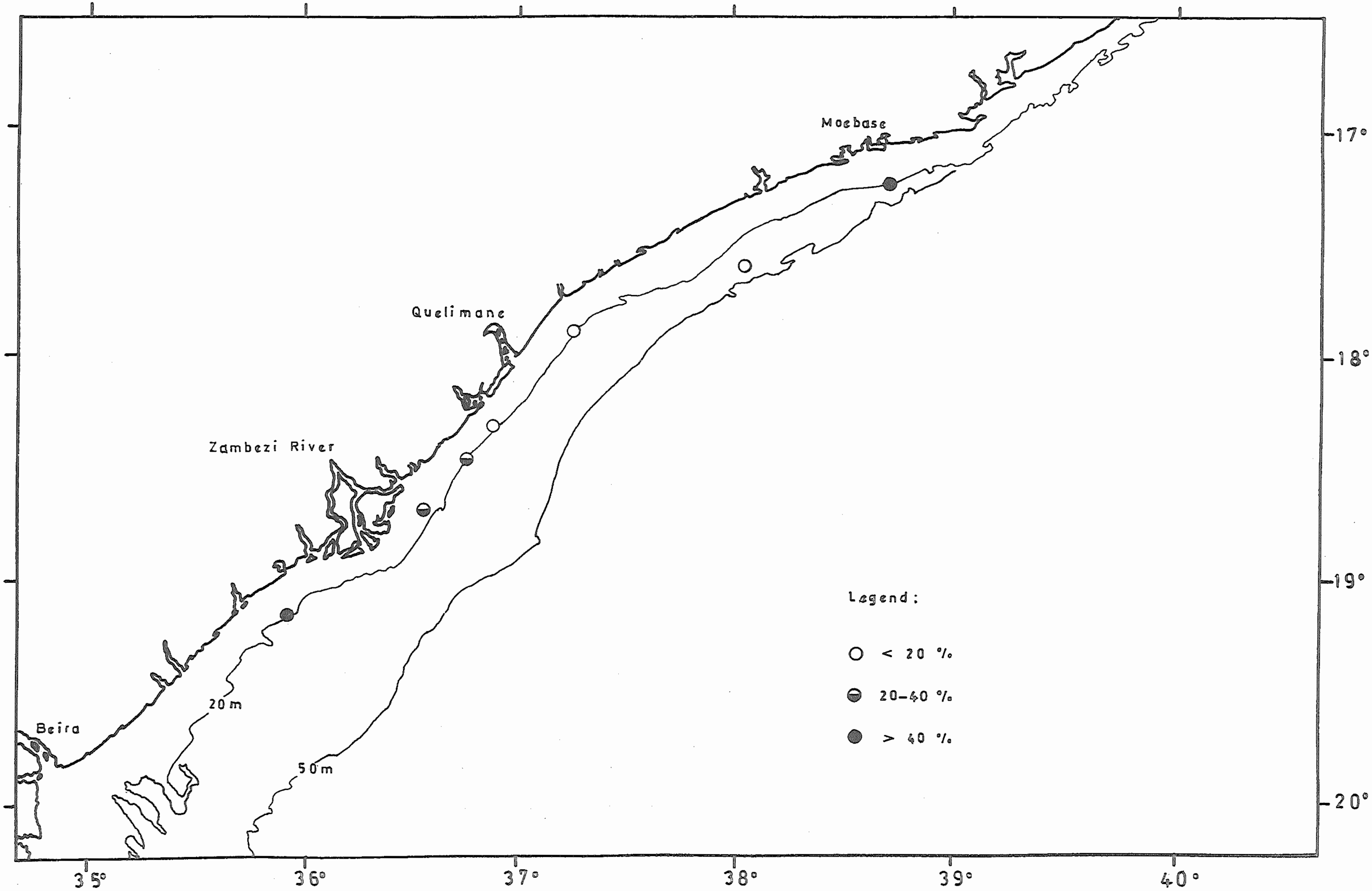
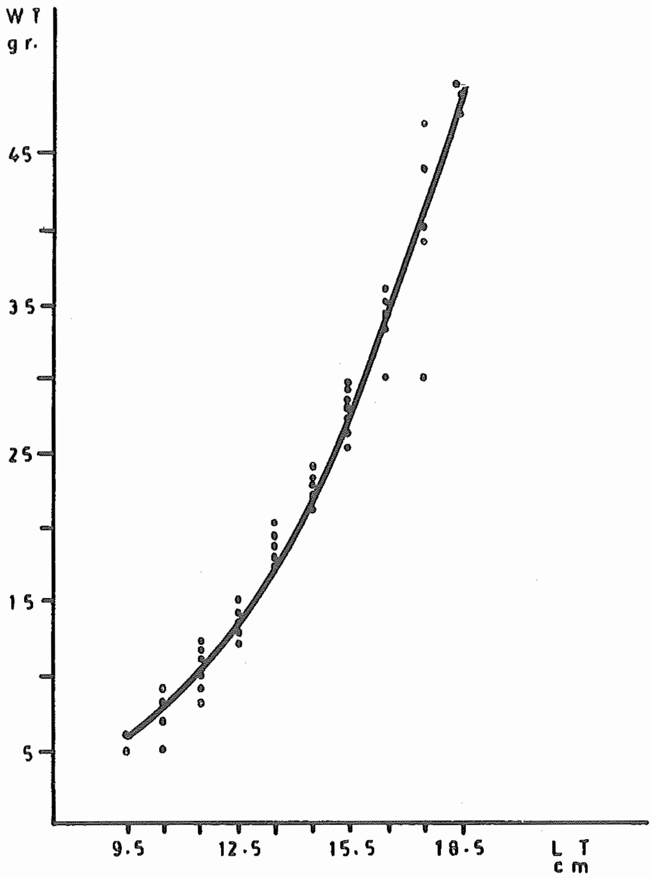


Fig. 4.18 – M. monoceros _ Percentage of late maturing and mature females in each station sampled

Fig. 4. 19 M. monoceros - Relation Total Weight / Total Length

♀ $W = 0.003585 \times L^{3.2619}$



♀ $W = 0.012991 \times L^{2.7332}$

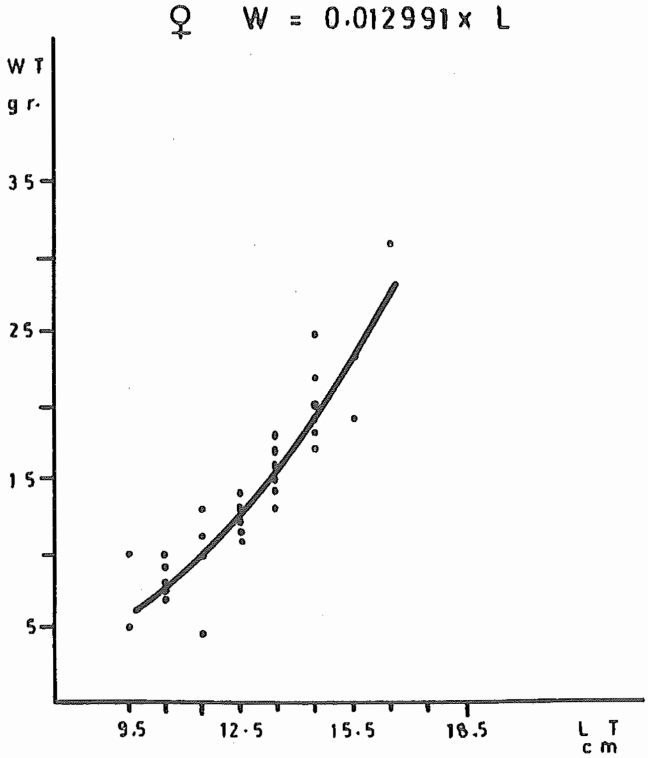
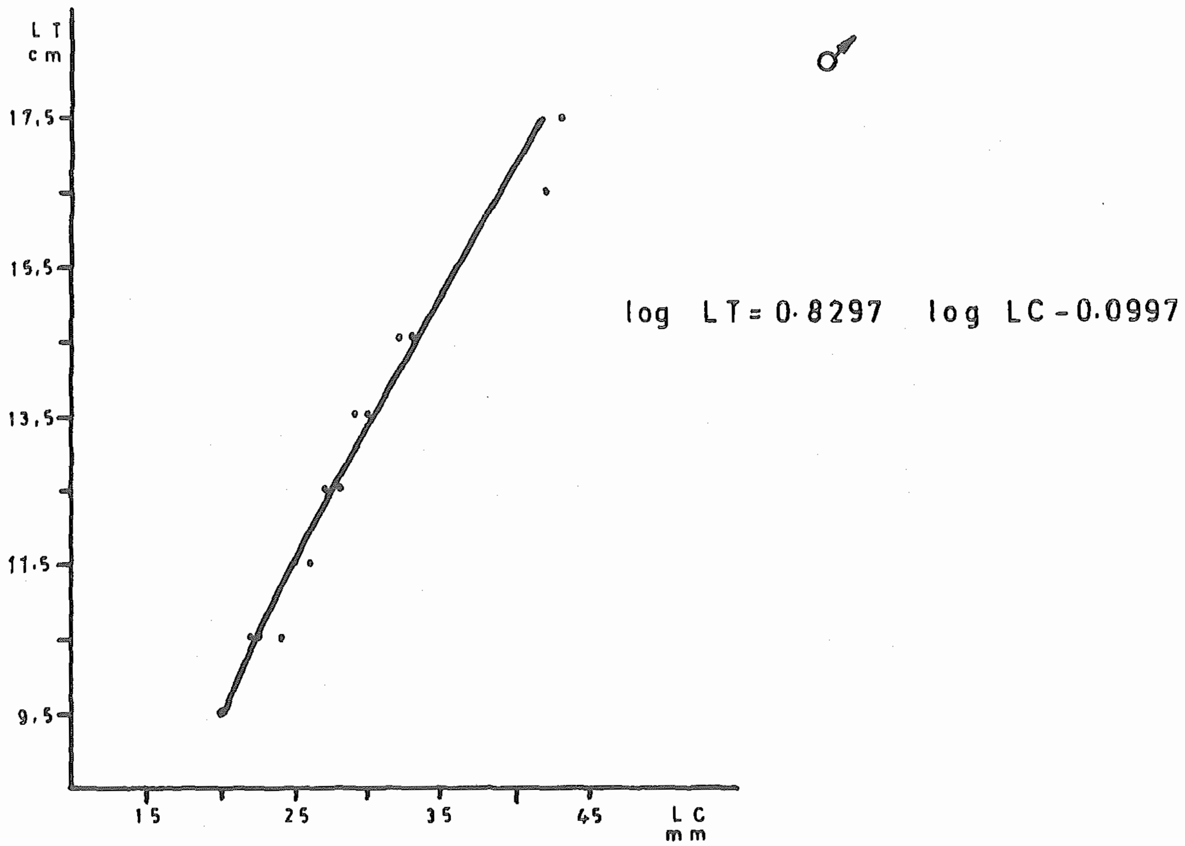
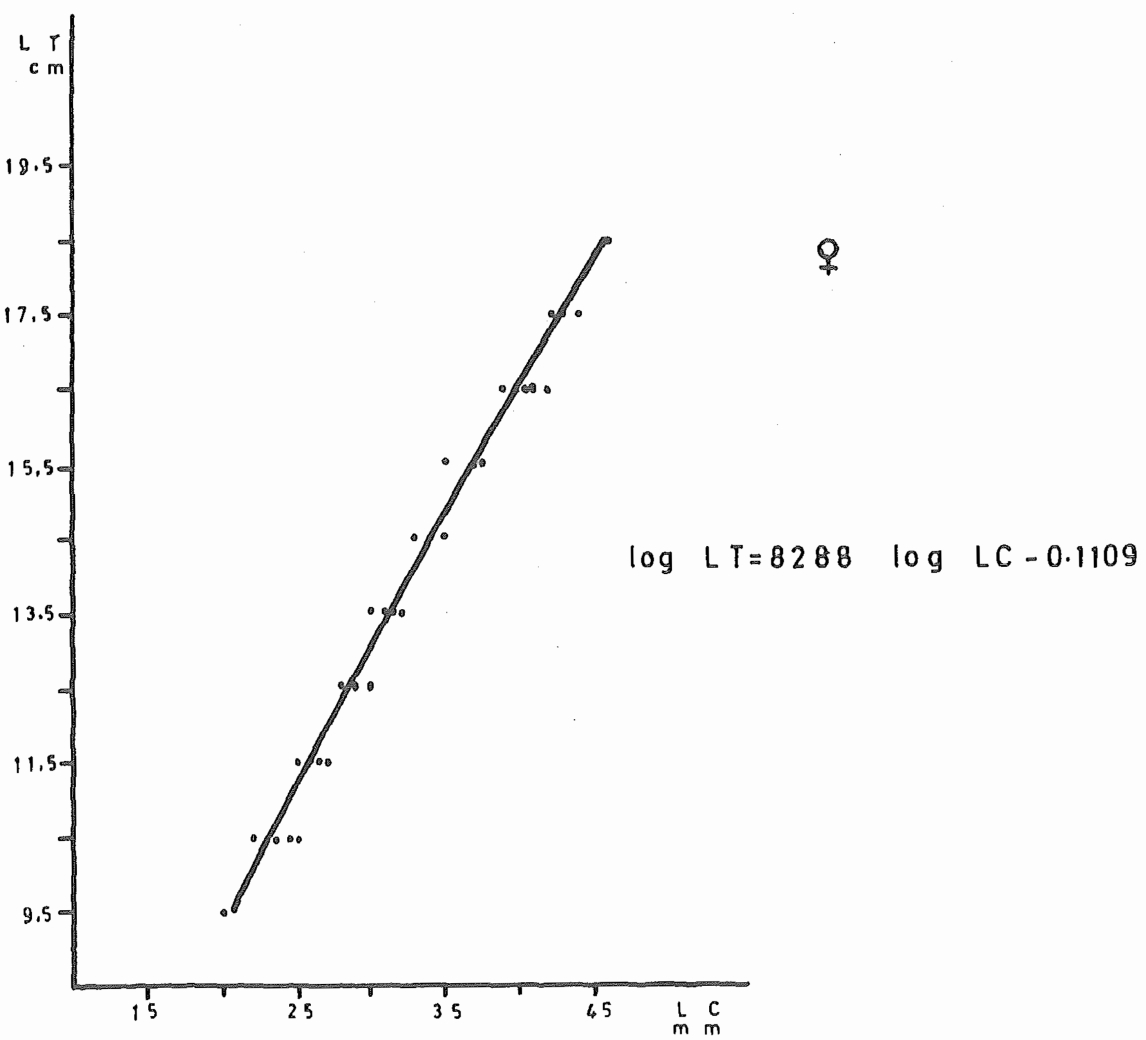


Fig. 4.20 M. monoceros - Relation Total Length / Carapace Length





5. SHALLOW-WATER SHRIMP BY-CATCH (FISH)

5.1 Species composition

The fish fauna of Sofala Bank is characterized by a great variety of species. In "E. Haeckel" survey, 341 species were recorded: 288 demersal species (110 families), 45 pelagic species (8 families) and 8 mesopelagic species (5 families).

Fish fauna of Sofala Bank can be included in four ecological groups:

Coastal-estuarine group	- fish occurring in the mouths of the rivers.
Transition group	- fish inhabiting the zone where coastal waters mix with oceanic waters.
Neritic-oceanic group	- fish inhabiting waters with high values of salinity (lower limit of continental shelf and upper limit of the slope).
Oceanic group	- open ocean fish

Based on oceanographic data and species distribution, an attempt was made to include the species recorded into these four ecological groups. Hilsa kelee is the most important species in the COASTAL-ESTUARINE group. The species has been commercially fished by the national small--scale fishery.

Shallow-water shrimp by-catch belongs to the TRANSITION group. The most important pelagic species are:

<u>Carangoides malabaricus</u>

<u>Carangoides chrysophrys</u>

<u>Megalaspis cordyla</u>

<u>Pellona ditchela</u>

<u>Thryssa ~~malabaricus~~ vitrirostris</u>

<u>Leiognathus equula</u>

The most important demersal groups are:

Sciaenidae (Otolithes ruber, Johnius belengerii, J. dussumieri)

Pomadasyidae (Pomadasys hasta, P. maculatus)

Mullidae (Upeneus vittatus, U. bensasi)

Nemipteridae (N. delagoae)

Symodontidae (Trachinocephalus myops)

Theraponidae (T. jarbua)

Polynemidae (Polynemus sextarius)

Ephippidae (Drepane punctata)

Cynoglossidae (genus: Cynoglossoides)

Sillaginidae (Sillago sihama)

Ariidae (Arius dussumieri)

In NERITIC-OCEANIC group 99 species (12 pelagic and 87 demersal) were recorded. Catches from fish industrial fleet are mainly formed by species belonging to neritic-oceanic group. The dominant pelagic groups and with greatest commercial value are:

Carangidae (genus: Decapterus, Scomberoides, Sellar)

Scombridae (Rastrelliger kanagurta)

Scomberomoridae

The most important demersal species belong to two families:

Synodontidae (Saurida undosquamis, S. tumbil)

Trichiuridae (Trichiurus lepturus)

Sharks (Carcharhinidae and Squalidae) are frequent in the catches.

In OCEANIC group 69 species (8 mesopelagic and 61 demersal) were recorded. The most abundant groups are:

Myctophidae }
Gonostomidae } mesopelagic

Coryphaenidae Chlorophthalmidae Nomeidae (Cubiceps natalensis) Perichthyidae (Neoscombrops annectens)	demersal

Sharks (Squalidae) are frequent in the catches.

5.2 Species distribution

Figure 5.1 show the grid of stations carried out in the present survey and relative distribution of catches.
Based on information from previous surveys, two areas were defined for Sofala Bank - a northern area (north of 18º 50' S) and a southern area (south of 18º 50'S).

5.2.1 Continental shelf

Tables 5.1, 5.2 and 5.3 show catch splitted by area (north and south) and by depth intervals.
For the whole area non commercial species are present in 6.3% of the total catch. Catches of the commercial species have the following proportions:

	% weight
Demersal	80.0
Pelagic	14.9
Sharks/Rays	5.1

Catch composition varies greatly with depth. In waters shallower than 20 m Sciaenidae, Ariidae, Engraulidae, Clupeidae and Cynoglossidae dominate the catches; between 20 and 50 m the most abundant families are Mullidae, Synodontidae, Pomadasyidae, Nemipteridae, Carangidae and Scombridae; between 50 and 100 m Mullidae, Synodontidae, Nemipteridae and Triglidae dominate the catches.
For the whole area the mean catch per hour of trawling is 144 Kg/h; the southern area has a slightly higher catch/hour rate. In the northern area Sciaenidae and Pomadasyidae dominate the catches; in the southern area the most abundant groups are Synodontidae, Nemipteridae and Carangidae.

5.2.2 Continental slope (400-800 m)

The following table shows the proportions of demersal, mesopelagic and sharks/rays in total catches of continental slope.

	% weight
Demersal	72.3
Mesopelagic	11.1
Sharks	9.1
Rays	7.5

Table 5.4 show catch splitted by area and by depth intervals.
In demersal catches the most abundant families are: Coryphaenidae Chlorophthalmidae, Ophididae, Synodontidae, Gempylidae and Nomeidae. Demersal species and sharks (Squalidae) constitute the by-catch of deep water shrimp.
Myctophidae is the dominant group in mesopelagic catches.
For the whole area covered, the mean catch per hour of trawling is 72 Kg/h. The best yields occur in the southern area, between 400 and 600 m, where the mean catch per hour is 86 Kg.

5.3 Some biological characteristics of the main species of the continental shelf

5.3.1 Demersal group

Figures 5.2 to 5.7 show distribution areas of the demersal fish and of the main families of this group.

SCIAENIDAE

The most important species of this family are Otolithes ruber, Johnius belengerii and J. dussumieri.

OTOLITHES RUBER

The species occurs between 6 and 100 m, being more frequent and abundant in waters shallower than 20 m. Mean catch per hour of trawling was 11.2 Kg, with the highest yields in the northern area between 16 and 20 m.

a) Length distribution and mean weight

Total length varied between 10 and 33 cm ($\overline{LT}$ = 19.94 cm), 74,5% of the total number sampled being in the range of 14 to 24 cm.

For the whole area sampled, mean weight was 73.31 gr.

Length and weight varied with depth occurring the smallest individuals in shallower waters (fig. 5.8).

b) Sexual maturity

The following table sh--s percentage of the different maturity stages in females and males. $\left(\frac{\text{females}}{\text{males}}\right)$

Maturity stages (% number)							Total number sampled
JUV.	II	II-III	III	III-IV	IV	V	
	56.2	2.4	39.0	1.2	-	1.2	82
	11.7	10.4	54.5	6.5	16.9	-	77
10.2							18

The population was mainly in stages II and III.

c) Stomach-contents (Frequency of occurrence)

Shrimp	97.2%
Small fish (Trissocles sp)	2.8%

JOHNIUS BELENGERII

The species has the same occurrence as Otolithes ruber but is less abundant. Mean catch per hour of trawling was 9.5 Kg, with the highest yields in the northern area between 12 and 15 m.

a) Length distribution and mean weight

Total length varied between 6 and 21 cm ($\overline{LT}$ = 11.75 cm), 84,4% of the total number sampled being in the range of 8 to 15 cm.

For the whole area sampled mean weight was 23.49 gr.

Length and weight varied with depth; the smallest individuals were present in shallower waters (fig. 5.9).

b) Sexual maturity

Maturity stages (% number)					Total number sampled
JUV.	II	II-III	III	III-IV	
	43.7	10.2	41.0	5.1	39
	80.0	-	20.0	-	10
2.0					1

The population was mainly in stage II.

c) Stomach-contents (Frequency of occurrence).

Shrimp 50.0%

Small fish 50.0%

JOHNIUS DUSSUMIERI

The species occurs between 6 and 50 m, being more frequent in waters shallower than 20m. Johnius dussumieri is the species with lowest abundance - mean catch per hour of trawling was 5.03 Kg. The highest catch rates were present in the northern area between 16 and 35 m.

a) Length distribution and mean weight

Total length varied between 8 and 23 cm ($\bar{LT}$ = 12.43 cm) 64,6% of the population being in the range 10 to 14 cm. Mean weight was 26.58 gr. Relation between length and weight with depth is not as clear as with the previous species (fig. 5.10).

b) Sexual maturity

Maturity stages (% number)						Total number sampled
JUV.	II	II-III	III	III-IV	V	
	66.7	-	19.0	9.5	4.8	21
	52.9	-	47.1	-	-	17
5.0						2

The population was mainly in stage II.

c) Stomach-contents (Frequency of occurrence)

Stomatopods 50%

Small fish 50%

POMADASYIDAE

The most important species is Pomadasys maculatus which forms 55% of total catch of this family.

POMADASYS MACULATUS

The species is present all over the surveyed area, being more frequent in waters shallower than 20 m.

Pomadasys maculatus is the most abundant species in Pomadasyidae catches; mean catch per hour of trawling was 5.3 Kg with the highest yields in the northern area between 35 and 45 m.

a) Length distribution and mean weight

Total length varied between 9 and 22 cm ($\bar{LT}$ = 13.58 cm) 75,3% of the individuals being in the range of 11 to 16 cm. Mean weight was 41,23 gr. Length and weight varied with depth; the largest individuals were present in shallower depths (fig. 5.11).

b) Sexual maturity

Maturity stages (% number)					Total number sampled
II	II-III	III	III-IV	V	
18.2	-	81.8	-	-	22
-	-	16.7	6.7	76.6	32

Females were mainly at stage II and males at stage III.

c) Stomach-contents (Frequency of occurrence)

Only shrimp was identified in the stomach-contents.

MULLIDAE

The most important species are Upeneus vittatus and U. bensasi.

UPENEUS VITTATUS

The species is present all over the continental shelf, being more frequent between 20 and 50 m. Upeneus vittatus is the most abundant species in Mullidae catches (63%).

Mean catch per hour of trawling was 20 Kg with the highest yields between 22 and 63 m.

a) Length distribution and mean weight

Total length varied between 9 and 17 cm ($\bar{LT}$ = 12.66 cm) 90,4% of the individuals being in the range of 11 to 14 cm. Mean weight was 31.47 gr. Length and weight varied with depth; the smallest individuals were present in shallower depths (fig. 5.12).

b) Sexual maturity

Maturity stages (% number)					Total number sampled
II	II-III	III	III-IV	IV	
41.8	1.5	55.2	1.5	-	67
3.0	6.1	81.8	6.1	3.0	33

The population was mainly in stage III.

c) Stomach-contents (Frequency of occurrence)

Shrimp - 90%

Crabs - 5%

Stomatopods - 5%

UPENEUS BENSASI

The species is present all over the continental shelf being more frequent between 50 and 100 m. Mean catch per hour of trawling was 11 Kg, with the highest yields between 32 and 62 m.

a) Length distribution and mean weight

Total length varied between 10 and 18 cm ($\overline{LT}$ = 14.18 cm) 90,4% of the individuals being in the range of 12 to 16 cm. Mean weight was 33.23 gr. Length and weight varied with depth; the smallest individuals were found in shallower depths (fig. 5.13).

b) Sexual maturity

Maturity stages (% number)						Total number sampled
II	II-III	III	III-IV	IV	IV-V	
18.5	2.2	33.7	16.3	27.1	2.2	92
3.1	6.3	87.5	3.1	-	-	64

The population was mainly in stage III.

SYNODONTIDAE

The most important species are Saurida undosquamis, S. tumbil and Trachinocephalus myops.

SAURIDA UNDOSQUAMIS

The species is present all over the shelf with the highest frequency between 50 and 100 m, and a low occurrence in waters shallower than 20 m. S. undosquamis was the dominant species in Synodontidae catches (52% of the total). Mean catch per hour of trawling was 13 Kg with the highest yields in the southern area between 30 and 75 m.

a) Length distribution

Total length varied between 15 and 40 cm. Length varied with depth; the smallest individuals were found in shallower depths (fig. 5.14).

b) Sexual maturity

Maturity stages (% number)					Total nr
II	II-III	III	III-IV	IV	sampled
4.0	-	72.0	12.0	12.0	25
5.7	-	77.3	15.1	-	53

c) Stomach-contents (Frequency of occurrence)

Anchoviella sp.	- 30%
Decapterus sp.	- 5%
Other small fish	- 60%
Squids	- 5%

SAURIDA TUMBIL

The species is present all over the shelf area but with a low occurrence in waters shallower than 20 m; the highest frequency was between 20 and 50 m. Mean catch per hour of trawling was 8 Kg with the highest yields between 28 and 57 m.

a) Length distribution and mean weight

Total length varied between 12 and 34 cm ($\overline{LT}$ = 22.47 cm) 65,1% of the individuals being in the range of 20 to 25 cm (fig. 5.15).

b) Sexual maturity

M. stage (% number)		Total nr
III	III-IV	sampled
10.0	-	8
96.8	3.2	31

The population was mainly in stage III.

c) Stomach-contents (Frequency of occurrence)

Anchoviella sp.	-40%
Upeneus bensasi	-20%
Other small fish	-80%
Shrimp	-40%
Squids	-20%

TRACHINOCEPHALUS MYOPS

The species have an occurrence similar to the previous species but is less abundant. The highest yields were found in a depth range smaller than the previous species - 35 to 45 m.

a) Length distribution

Total length varied from 12 to 26 cm ($\bar{LT}$ = 17.24 cm) 73% of the population being in the range of 15 to 19 cm.

Length varied with depth; the smallest individuals were found in shallower depths (fig. 5.16).

b) Sexual maturity

Maturity stage (% number)					Total nr sampled
II	II-III	III	III-IV	IV	
38.9	11.1	33.3	-	16.7	18
4.9	4.9	64.0	18.0	8.2	61

Females were mainly at stage II and males at stage III.

c) Stomach contents (Frequency of occurrence).

Upeneus bensasi	-	11.1 %
Small fish	-	11.1
Crabs		33.3
Shrimp		22.2
Squids		11.1
Non-identified item		11.1

NEMIPTERIDAE

The dominant species in Nemipteridae catches was Nemipterus delagoae (99.1 % of total catch). The species occurs between 20 and 100 m, with the highest frequency between 50 and 100 m.

Mean catch per hour of trawling was 10.3 Kg, with best yields between 32 and 72 m.

a) Length distribution and mean weight

Total length varied between 11 and 26 cm ($\bar{LT}$ = 17.13 cm) 63% of the population being in the range of 15 to 19 cm. Mean weight was 61.32 gr. Variation of length and weight with depth is not very clear; there seems to be a tendency of small individuals to concentrate in shallower waters (fig. 5.17).

b) Sexual maturity

Maturity Stage (% number)				Total nr sampled
JUV	II	II-III	III	
	25.8	7.0	67.2	128
	22.2	13.0	64.8	54
0.5				1

The population was mainly in stage III.

c) Stomach-contents (Frec ency of occurrence)

Small fish	- 33.3 %
Crabs	- 33.3
Shrimp	- 20
Squids	- 13.3
Ophioroids	- 13.3

POLYNEMIDAE

This family was represented in the catches by only one species - Polynemus sextarius. The species was present all over the shelf area with the highest frequency in waters shallower than 20 m.

a) Length distribution and mean weight

Total length varied between 10 and 20 cm (LT = 14.74 cm), 79,1% of the population being in the range of 12 to 17 c . Mean weight was 31.09 gr.

b) Sexual maturity

Maturity Stage (% number)						
JUV	II	II-III	III	III-IV	IV	Total nr sampled
	7.5	-	13.2	71.8	7.5	53
	4.4	-	20.0	22.2	53.4	45
2.0						2

Females were mainly at stage III-IV and males at stage IV.

c) Stomach contents (Frequency of occurrence)

Shrimps	-92.6%
Non identified material	-11.1%

4.3.2 Pelagic group

Pelagic species are present in 14.4% of total catch (16.1% in the southern area and 12.7% in the northern area).

Figure 5.18 shows the distribution area of pelagic and mesopelagic fish.

Biological samples were collected for the most important pelagic species.

CARANGIDAE

The most important species are *Decapterus macrosoma* and *Decapterus maruadsi*.

DECAPTERUS MACROSOMA

The species is present all over the shelf area being more frequent in waters shallower than 20 m. The best catches (more than 20 Kg per hour of trawling) were found at 90 and 95 m.

a) Length distribution and mean weight.

Total length varied from 12 to 20 cm ($\bar{L}T$ = 16.1 cm) 87,5% of the population being in the range of 14 to [illegible] cm. Mean weight was 36,62 gr. Length and weight varied with depth; the smallest individuals were found in waters shallower than 50 m (fig. 5.19).

b) Sexual maturity

Maturity stage (% number)				Total nr
II-III	III	III-IV	IV	sampled
56.3	18.7	18.7	6.3	16
-	39.4	6.1	54.5	33

Females were mainly at stages II and III. Males were mainly at stage IV.

DECAPTERUS MARUADSI

The species is present all over the shelf area being more frequent in waters shallower than 20 m; the lowest occurrence is between 50 and 100 m. The best catches were found between 60 and 65 m, some hauls with catch rates larger than 38 Kg/h.

a) Length distribution and mean weight

Total length varied from 15 to 21 cm ($\bar{L}T$ = 17.4 cm). Mean weight was 51.21 gr (fig. 5.20).

b) Sexual maturity

Maturity stage (% number)					Total nr
II	II-III	III	III-IV	IV	sampled
6.0	1.0	24.0	23.0	3.0	57
-	-	7.0	7.0	29.0	43

Females were mainly at stages III and III-IV. Males were mainly at stage IV.

CARANGOIDES MALABARICUS

Total length varied from 17 to 22 cm ($\bar{LT}$ = 20.06 cm). Mean weight was 122.5 gr.

CARANGOIDES CHRYSOPHRYS

Total length varied from 12 to 17 cm ($\bar{LT}$ = 14.41 cm). Mean weight was 50 gr.

ENGRAULIDAE, LEIOGNATHIDAE and CLUPEIDAE

Data on length and weight was collected for the most important species of each family. The following table includes length range, mean length and mean weight of the sampled species:

Family	Species	Length Range (cm)	Mean Length (cm)	Mean weight (gr.)
Engraulidae	Thryssa vitrirostris	6-21	13.50	17.28
Leiognathidae	Leiognathus equula	9-19	13.02	37.53
	Secutor insidiator	8-12	10.19	15.35
Clupeidae	Pelloma ditchela	8-18	13.32	18.72

4.4 Some biological characteristics of the main species of the continental slope

4.4.1 Demersal group

CORYPHAENIDAE

This family forms 32% of the total catch of the slope. The dominant species was Coelorhynchus parallelus.

COELORHYNCHUS PARALLELUS

The species occurs between 400 and 800 m being more frequent in waters deeper than 600 m. Males were not present in the catches, the best yields were obtained in the range of 600 to 610 m.

a) Length distribution and mean weight.

Females total length varied from 19 to 60 cm ($\bar{LT}$ = 31.74 cm) 46.9% of the population being in the range of 28 to 33 cm. Mean weight was 147.75 gr.

b) Sexual maturity

Maturity stage (% number)			Total nr
II	III	IV	sampled
60.0	22.9	17.1	105

Females were mainly in stage II.

CHLOROPHTHALMIDAE, GEMPYLIDAE, NOMEIDAE

Length data was collected for the most important species of each family. The following table includes range of depths where the species were more frequent, range of total length and mean length.

Family	Species	Depth (m)	Range of length (cm)	Mean length (cm)
Clorophthalmidae	Clorophthalmus agassizi	400-600	9-24	14.76
Gempylidae	Epinula orientalis	400-600	18-28	22.27
Nomeidae	Cubiceps natalensis	400-600	14-21	18.54

4.4.2 Mesopelagic group

Mesopelagic fish forms 9% of total catch in the continental slope. The dominant family is Myctophidae which occurs between 400 and 800 with the highest frequency between 400 and 600 m.

Table. 5.1 Continental Shelf - Catches splitted by area

Species composition		North		South		Total	
		Kg	%	Kg	%	Kg	%
Demersal	Scianidae	1352.2	27.5	262,86	5,5	1615.06	16.6
	Synodontidae	227.91	4.6	1248.62	26.0	1476.53	15.2
	Mullidae	706.84	14.3	647.31	13.5	1354.15	13.9
	Nemipteridae	170.49	3.5	490.39	10.2	660.88	6.8
	Pomadasyidae	573.64	11,6	29.92	0.6	603.56	6.2
	Platycephalidae	9.84	0.2	224.08	4.7	233.92	2.4
	Polynemidae	117.73	2.4	45.45	0.9	163.18	1.7
	Trichiuridae	107.08	2.2	27.06	0.6	134.14	1.4
	Bothidae	17.77	0.3	114.28	2.4	132.05	1.9
	Ariidae	126.46	2.6	2.66	0.1	129.12	1.3
	Cynoglossidae	114.95	2.3	12.77	0.3	127.72	1.3
	Sillaginidae	46.06	0.9	2.8	0.1	48.81	0.5
	Theraponidae	23.54	0.5	21.37	0.4	44.91	0.5
	Serranidae	30.4	0.6	7.32	0.2	37.72	0.4
	Muraenesocidae	32.0	0.6	-	-	32.0	0.3
	Sphyraenidae	6.18	0.1	17.78	0.4	23.96	0.3
	Lutianidae	20.63	0.4	3.28	0.1	23.91	0.2
	Priacanthidae	0.48	+	22.42	0.5	22.9	0.2
	Ephippidae	19.09	0.4	0.9	+	19.99	0.2
	Psettodidae	3.28	0.1	17.56	0.4	20.84	0.2
	Triglidae	-	-	16.42	0.3	16.42	0.2
	Lethrinidae	15.74	0.3	0.37	+	16.11	0.2
	Fistulariidae	-	-	14.64	0.3	14.64	0.1
	Sparidae	8.76	0.2	0.62	+	9.38	0.1
	Stromateidae Ariommidae	2.56	0.1	4.03	0.1	6.59	0.1
	Pomacentridae	3.87	0.1	0.75	+	4.62	
	Formionidae	4.11	0.1	-		4.11	0.1
	Rachicentridae	1.16		-		1.16	
	Pentapodidae	-		0.62	+	0.62	+
	Pleuronectidae	-		0.12	+	0.12	+
	TOTAL	3473.61	76.0	3239.76	67.7	6983.37	71.9
Pelagic	Carangidae	240.65	4.9	585.11	12.2	825.76	8.5
	Engraulidae	221.6	4.5	54.96	1.1	276.56	2.8
	Leiognathidae	89.93	1.8	68.21	1.4	158.14	1.6
	Clupeidae	36.01	0.7	31.7	0.7	67.71	0.7
	Scombridae						
	Rastrelliger	5.49	0.1	34.48	0.7	39.97	0.4
	Scomberomorus	27.39	0.6	0.3	+	27.69	0.3
	Gerridae	2.79	0.1	1.43	+	4.22	+
	Chirocentridae	0.27	+	-		0.27	+
	TOTAL	624.13	12.7	776.19	16.1	1400.32	14.4
	Rays	214.52	4.4	144.47	3.0	358.99	1.4
	Sharks	80.17	1.6	54.37	1.1	134.54	1.4
	TOTAL	294.69	6.0	198.84	4.1	493.53	5.1
	* Commercial	91.3	1.8	134,7	2.8	226.0	2.3
	* Non commercial	169.41	3.5	444.61	9.3	614.02	6.3
	* TOTAL	260.71	5.3	579.31	12.1	840.02	8.6
	Total catch (Kg)	4923.14	100	479.41	100	9717.24	100
	Mean catch (Kg/h)	139.1		151.09		144.75	
	Hours of trawling	35.4		31.73		67.13	
	N^{o}.of hauls	41		36		77	

* Non commercial - 100% demersal species.

Commercial - 70% demersal and 30% pelagic species.

Table 5.2 Continental Shelf - (Northern area) - Catches splitted by depth

Species composition		< 20 m		20-50 m		50- 100 m		Total	
		Kg	%	Kg	%	Kg	%	Kg	%
Demersal	Scianidae	956.13	42.7	361.07	14.9	35.0	13.6	1352.2	27.5
	Mullidae	36.26	1.6	527.07	21.7	143.51	55.9	706.84	14.3
	Pomadasyidae	123.77	5.5	437.07	18.0	12.8	5.0	573.64	11.6
	Synodontidae	17.29	0.8	190.34	7.8	20.28	7.9	227.91	4.6
	Nemipteridae	-	-	166.33	6.9	4.16	1.6	170.49	3.5
	Ariidae	123.1	5.5	3.36	0.1	-	-	126.46	2.6
	Polynemidae	46.31	2.1	68.44	2.8	2.58	1.0	117.33	2.4
	Cynoglossidae	103.69	4.6	11.26	0.5	-	-	114.95	2.3
	Trichiuridae	69.75	3.1	37.33	1.5	-	-	107.08	2.2
	Sillaginidae	43.41	1.9	2.65	0.1	-	-	46.06	0.9
	Muraenesocidae	32.0	1.4	-	-	-	-	32.00	0.6
	Serranidae	12.5	0.6	17.9	0.7	-	-	30.40	0.6
	Theraponidae	9.22	0.4	14.32	0.6	-	-	23.54	0.5
	Ephippidae	6.94	0.3	12.15	0.5	-	-	19.09	0.4
	Lutianidae	0.64	+	9.17	0.4	10.82	4.2	20.63	0.4
	Lethrinidae	-		15.74	0.6	-	-	15.74	0.3
	Sparidae	-		-		8.76	3.4	8.76	0.2
	Bothidae	1.1	0.1	16.67	0.7	-	-	17.77	0.3
	Platycephalidae	1.4	0.1	8.44	0.3	-	-	9.84	0.2
	Psettodidae	-	-	3.28	0.1	-	-	3.28	0.1
	Sphyraenidae	1.0	+	3.42	0.1	1.76	0.7	6.18	0.1
	Stromateidae Ariommidae	0.52	+	2.04	0.1	-		2.56	0.1
	Formionidae	4.11	0.2	-	-	-	-	4.11	0.1
	Pomacentridae	-		3.87	0.2	-		3.87	0.1
	Rachicentridae	-		1.16	0.1	-		1.16	0.1
	Priacanthidae	0.06	+	0.42	+	-		0.48	+
	Soleidae	0.88	+	0.36	+	-		1.24	+
	Pleuronectidae								
	TOTAL	1590.08	70.9	1913.86	78.8	239.67	93.3	3743.61	76.0
Pelagic	Carangidae	57.47	2.6	178.01	7.3	5.17	2.0	240.65	4.9
	Engraulidae	197.4	8.8	24.2	1.0	-	-	221.6	4.5
	Leiognathidae	31.91	1.4	58.02	2.4	-	-	89.93	1.8
	Clupeidae	34.97	1.6	1.04	0.1	-	-	36.01	0.7
	Scombridae								
	Scomberomorus	3.64	0.2	23.75	1.0	-		27.39	0.6
	Rastrelliger	-		5.49	0.2	-		5.49	0.1
	Gerridae	0.22	+	2.57	0.1			2.79	0.1
	Chirocentridae	-		0.27	+			0.27	+
	TOTAL	325.61	14.6	293.35	12.1	5.17	2.0	624.13	12.7
	Rays *	165.01	7.4	48.17	2.0	1.34	0.5	214.52	4.4
	Sharks **	16.93	0.8	59.5	2.4	3.74	1.5	80.17	1.6
	TOTAL	181.94	8.2	107.67	4.4	5.08	2.0	294.69	6.0
	Others								
	Commercial	49.5	2.2	39.4	1.7	2.4	0.9	91.3	1.8
	Non commercial	91.86	4.1	73.13	3.0	4.42	1.8	169.41	3.5
	TOTAL	141.36	6.3	112.53	4.7	6.82	2.7	260.71	5.3
	Total Catch (kg)	2238.99	100	2427.41	100	256.74	100	4923.14	100
	Mean catch(Kg/h)	125.43		143,0		442.7		139.1	
	Hours of trawling	17.85		16.97		0.58		35.4	
	No of hauls	20		19		2		41	

* Rays: Dasyatidae, Rhinobatidae.

** Sharks: Carcharhinidae, Sphirnidae, Sciliorhinidae.

Table. 5.3 Continental Shelf- (Southern area)-Catches splitted by depth

	Species composition	< 20 m		20-50 m		50-100 m		Total	
		Kg	%	Kg	%	Kg	%	Kg	%
Demarsal	Synodontidae	15.86	3.9	1006.06	31.1	226.7	19.5	1248.62	26.0
	Mullidae	18.36	4.5	434.07	13.4	194.88	16.8	647.31	13.5
	Nemipteridae	-	-	324.53	10.0	165.86	14.3	490.39	10.2
	Scianidae	170.22	42.2	92.64	2.9	-	-	262.86	5.5
	Platycephalidae	3.01	0.7	174.88	5.4	46.19	4.0	224.08	4.7
	Bothidae	0.52	0.1	103.64	3.2	10.12	0.9	114.28	2.4
	Polynemidae	9.84	2.4	35.61	1.1	-	-	45.45	0.5
	Pomadasyidae	12.66	3.1	10.36	0.3	6.9	0.6	29.92	0.6
	Trichiuridae	7.44	1.8	19.62	0.6	-	-	27.06	0.6
	Priacanthidae	-		6.29	0.2	16.13	1.4	22.42	0.5
	Theraponidae	6.54	1.6	14.67	0.5	0.16	+	21.37	0.4
	Sphyraenidae	2.16	0.5	7.29	0.2	8.33	0.7	17.78	0.4
	Psettodidae			11.86	0.4	5.7	0.5	17.56	0.4
	Triglidae	-	-	-	-	16.42	1.4	16.42	0.3
	Fistularidae	-	-	-	-	14.64	1.3	14.64	0.3
	Cynoglossidae	2.57	0.6	10.2	0.3	-	-	12.77	0.3
	Serranidae	-	-	3.12	0.1	4.2	0.4	7.32	0.2
	Stromateidae } Ariommidae	2.52	0.6	1.07	0.1	0.44	+	4.03	0.1
	Soleidae	0.21	0.1	2.87	0.1	0.28	+	3.36	0.1
	Lutianidae			2.52	0.1	0.76	0.1	3.28	0.1
	Sillaginidae	-		2.8	0.1	-	-	2.8	0.1
	Ariidae	2.66	0.7	-		-		2.66	0.1
	Ephippidae	-		-		0.9	0.1	0.9	+
	Pentapodidae	-		-		0.62	0.1	0.62	0.1
	Sparidae	-		-		0.62		0.62	
	Pomacentridae	-	-	0.75	+	-	-	0.75	+
	Lethrinidae	-	-	0.37	+	-	-	0.37	+
	Pleuronectidae	-	-	0.12	+	-	-	0.12	+
	TOTAL	254.57	62.8	2265.34	70.1	719.85	62.1	3239.76	67.7
Pelagic	Carangidae	27.55	6.8	349.52	10.8	208.04	13.0	585.11	12.2
	Leiognathidae	62.64	15.5	5.57	0.2	-	-	68.21	1.4
	Engraulidae	38.13	9.5	16.83	0.5	-	-	54.96	1.1
	Scombridae								
	Scomberomorus	0.3	0.1	-	-	-	-	0.3	+
	Rastrelliger	2.5	0.6	31.98	1.0	-		34.48	0.7
	Clupeidae	9.39	2.3	22.31	0.7	-		31.7	0.7
	Gerridae	-	-	1.43	+	-		1.43	+
	TOTAL	140.51	34.8	427.64	13.2	208.04	18.0	776.19	16.1
	Rays *	-		133.7	4.2	10.67	0.9	144.67	3.0
	Sharks **	-		6.64	0.2	47.73	4.1	54.37	1.1
	TOTAL			140.34	4.4	58.5	5.0	198.84	4.1
	Others								
	Commercial	9.16	2.3	96.94	3.0	28.6	2.5	134.7	2.8
	Non commercial	0.23	0.1	301.16	9.3	143.22	12.4	444.61	9.3
	TOTAL	9.39	2.4	398.1	12.3	171.82	14.9	579.31	12.1
	Total Catch (Kg)	404.47	100	3231.42	100	1158.21	100	4794.1	100
	Mean catch (Kg/h)	80.41		164.7		163.6		151.09	
	Hours of trawling	5.03		19.62		7.08		31.73	
	No of hauls	6		20		10		36	

* Rays: Rhinobatidae, Rajidae, Actobatidae, Torpedinidae.

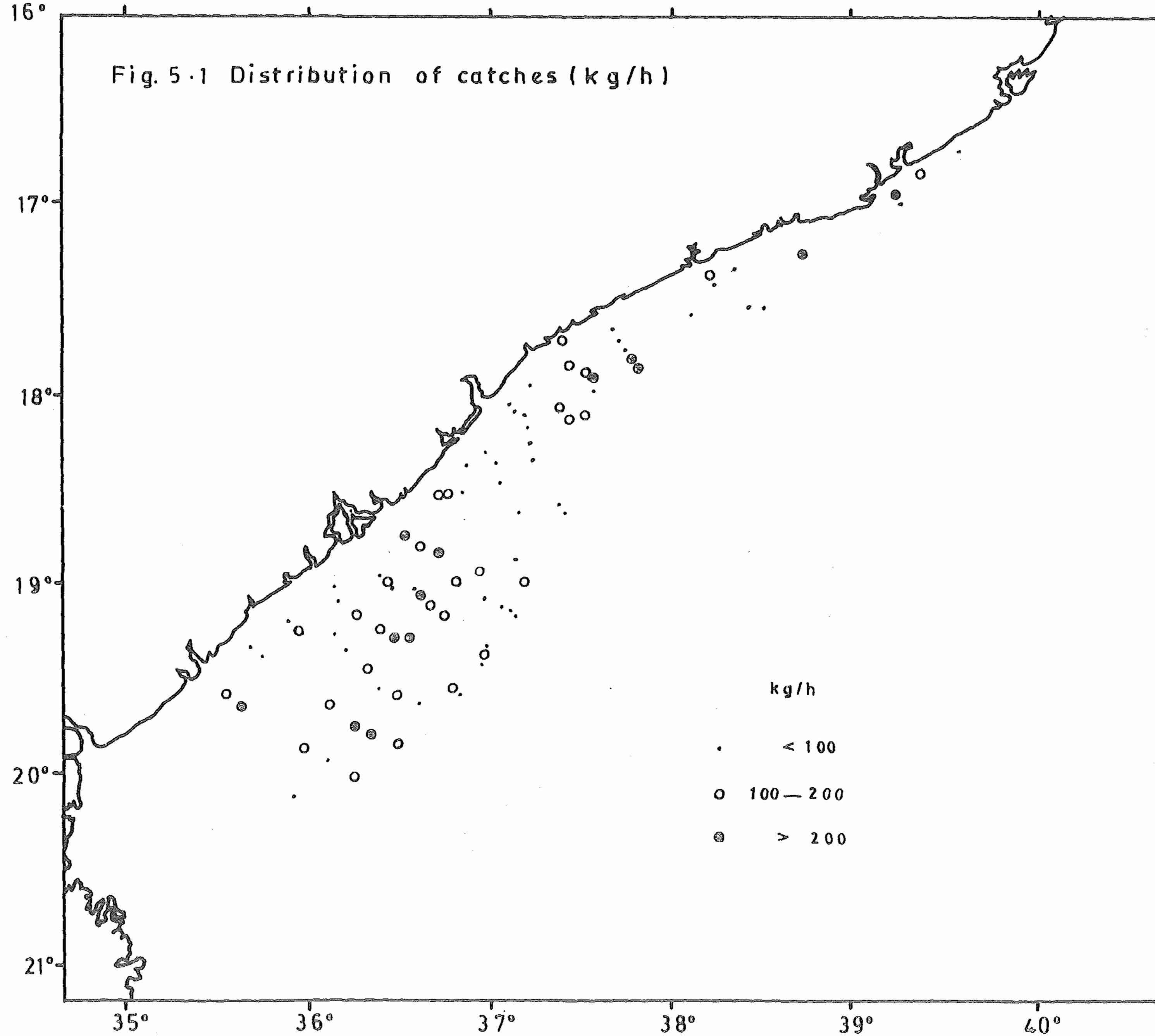
** Sharks: Carcharhinidae, Sciliorhinidae.

Table 5.4 Continental Slope - Catches splitted by area and by depth

Species Composition		North 400- 600 m		South 400- 600 m		South 600- 800 m		South Total		TOTAL	
		Kg	%	Kg	%	Kg	%	Kg	%	Kg	%
Commercial	Coryphaenidae	68.83	44.9	75.73	17.6	132.43	48.8	208.13	29.7	276.99	32.3
	Chlorophthalmidae	3.87	2.5	51.67	12.0	-	-	58.17	8.4	62.04	7.3
	Ophididae	10.31	6.7	4.0	0.9	34.94	12.9	38.94	5.6	49.25	5.7
	Synodontidae	-		38.07	8.8	-	-	38.07	5.4	38.07	4.4
	Gempylidae	0.95	0.6	17.79	4.1	1.48	0.5	19.27	2.7	20.22	2.4
	Nomeidae	0.35	0.2	11.57	2.7	3.08	1.1	14.65	2.1	15.0	1.7
	Perichthyidae	-	-	9.95	2.3	-	-	9.95	1.4	9.95	1.2
	Apogonidae	-	-	4.57	1.1	6.87	2.5	11.44	1.6	11.44	1.3
	Trichiuridae	-	-	4.03	0.9	1.67	0.6	5.7	0.8	5.7	0.7
	Gonorhynchidae	1.01	0.7	1.4	0.3	2.60	1.0	4.0	0.6	5.01	0.6
	Gadidae			4.78	1.1	0.1	+	4.88	0.7	4.88	0.6
	Triglidae			2.34	0.5	-		2.34	0.3	2.34	0.3
	Bothidae	2.1	1.4	-		-	-	-		2.1	0.2
	Platycephalidae	1.65	1.1	0.11	+	-	-	0.11	+	1.76	0.2
	Argentinidae			1.36	0.3	-	-	1.36	0.2	1.36	0.2
	Polymixidae	0.52	0.3	-		-	-	-		0.52	0.1
	Cynoglossidae			0.04	+	-		0.04	+	0.04	+
	TOTAL	89.59	58.4	227.41	52.6	189.67	69.8	417.08	59.5	506.67	59.2
Non-Commercial	Ateleopidae	4.05	2.6		-	18.5	6.8	18.5	2.6	22.55	2.6
	Chimaeridae	4.0	2.6	-	-	5.74	2.1	5.74	0.8	9.74	1.1
	Champsodontidae	-	-	7.87	1.8	-	-	7.87	1.1	7.87	0.9
	Lophiidae	4.63	3.0	0.22	0.1	2.77	1.0	2.99	0.4	7.62	0.9
	Chaunacidae	-		4.23	1.0	-		4.23	0.6	4.23	0.5
	Chauliodontidae	-		-		4.07	1.5	4.07	0.6	4.07	0.5
	Triglidae	0.45	0.3	2.92	0.7	0.19	0.1	3.11	0.4	3.36	0.4
	Trachichthyidae	1.26	0.8	-		1.36	0.5	1.36	0.2	2.62	0.3
	Sternoptychidae	-	-	1.41	0.3	0.46	0.2	1.87	0.3	1.87	0.2
	Nettastomidae	0.88	0.6	-	-	0.9	0.3	0.9	0.1	1.78	0.2
	Triacnthochidae	-	-	1.08	0.3	0.19	0.1	1.27	0.2	1.27	0.1
	Scorpaenidae	0.51	0.3	0.07	+	-		0.07	+	0.58	0.1
	Alepocephalidae	-		-	-	0.48	0.2	0.48	0.1	0.48	0.1
	Ogcocephalidae	-		-		0.46	0.2	0.46	0.1	0.46	+
	Balistidae	0.25	0.2							0.25	+
	Diretmidae	0.15	0.1	-		-		-	-	0.15	+
	Nemichthyidae	+		0.04	+	-		0.04	+	0.04	+
	TOTAL	16.18	10.5	17.84	4.2	35.12	13.0	52.96	7.5	69.14	8.1
TOTAL DEMERSAL		105.77	68.9	245.25	56.8	224.79	82.8	470.04	67.0	575.81	67.3
	Myctophidae	0.52	0.4	59.25	13.8	2.04	0.7	61.29	8.7	61.81	7.2
	Gonostomidae			5.69	1.3	2.78	1.0	8.47	1.2	8.47	1.0
	Neoscopelidae	0.61	0.4	4.4	1.0	1.43	0.5	5.83	0.8	6.44	0.8
	Microstomidae	0.51	0.3	-		0.5	0.2	0.5	0.1	1.01	0.1
TOTAL MESO-PELAGIC		1.64	1.1	69.34	16.1	6.75	2.4	76.09	10.8	77.73	9.1
	Squalidae										
	Squalinae	12.82	8.4	45.69	10.8	14.21	5.3	60.8	8.7	73.62	8.6
	Dalatinae	-		-	+	8.7	3.2	8.7	1.2	8.7	1.0
	Scyliorhinidae	-		3.44	0.8	9.5	3.5	12.94	1.8	12.94	1.5
	Carcharhinidae	-		0.18	0.1	-		0.18	+	0.18	+
TOTAL SHARKS		12.82	8.4	50.21	11.7	32.41	12.0	82.62	11.7	95.44	11.1
TOTAL RAYS (RAIDAE)		17.53	11.4	40.88	9.5	5.89	2.2	46.77	6.7	64.3	7.5
OTHER FISH *		15.58	10.2	25.19	5.9	1.69	0.6	26.88	3.8	42.46	5.0
Total catch (Kg)		153.34	100	430.87	100	271.53	100	702.4	100	855.74	100
Mean catch (Kg/h)		51.1		86.17		70.9		79.5		72.3	
Hours of trawling		3		5		3.83		8.83		11.83	
No of hauls		3		5		4		9		12	

* Demersal fish

Fig. 5·1 Distribution of catches (kg/h)



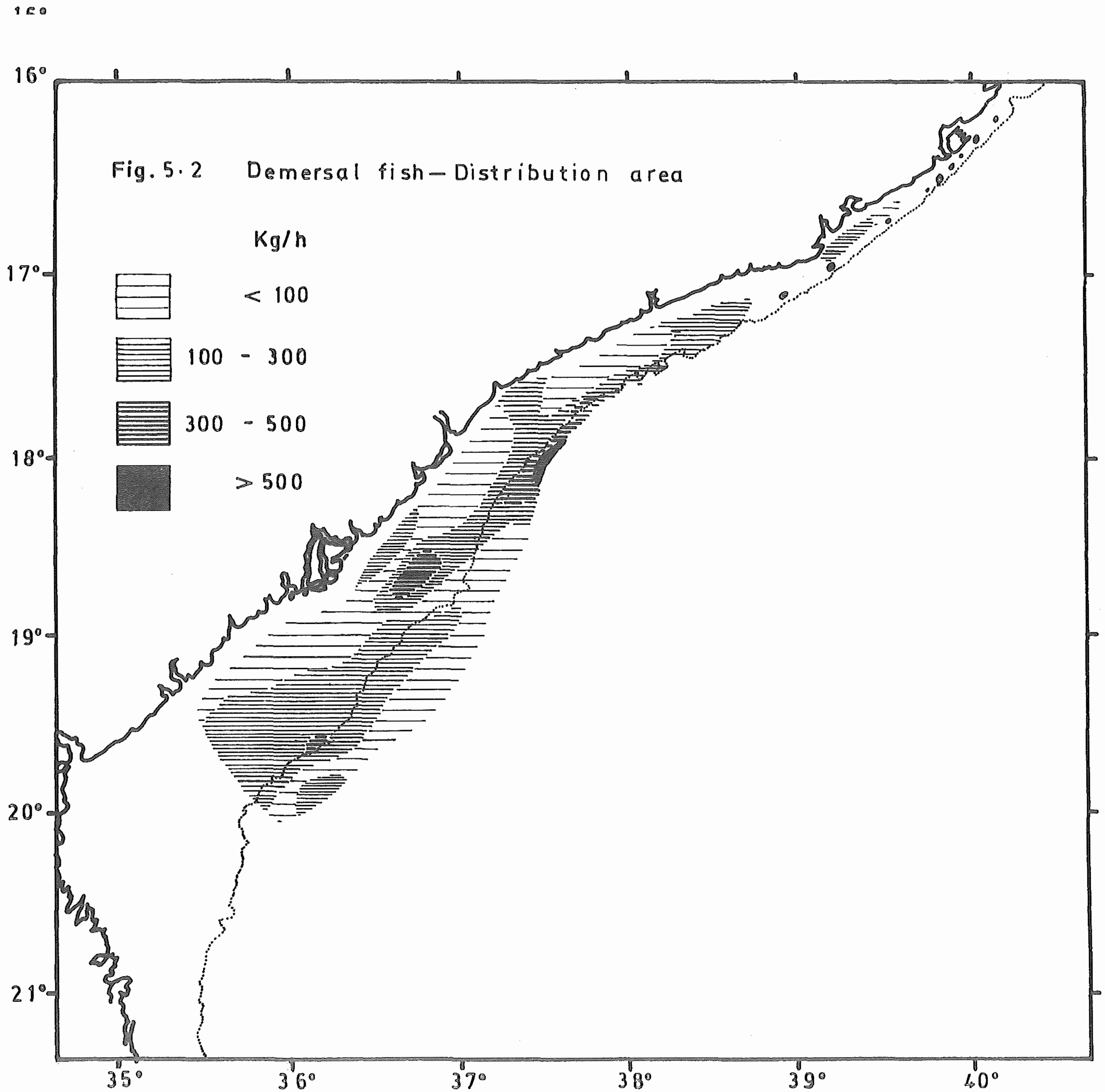
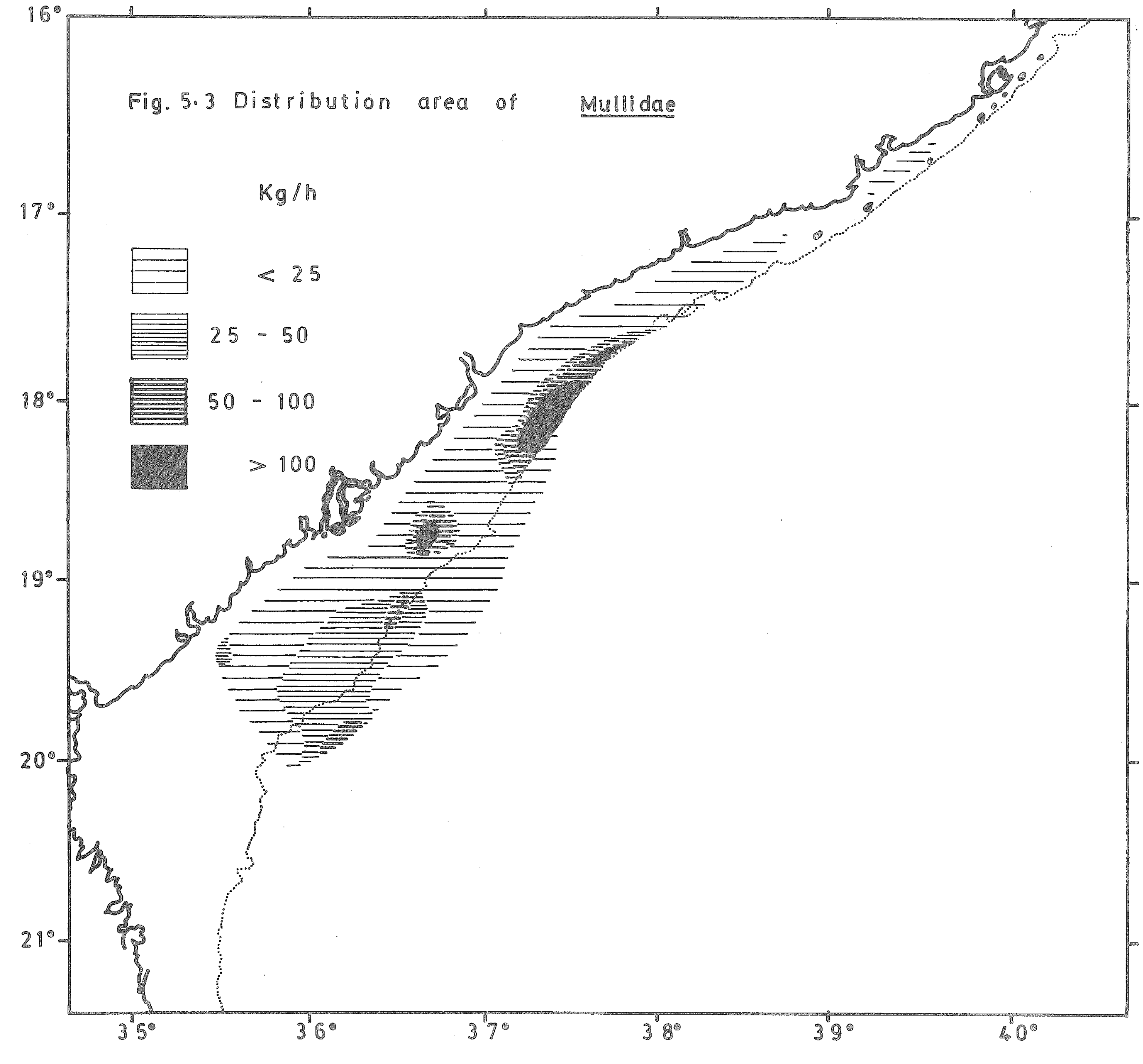


Fig. 5.2 Demersal fish – Distribution area
Kg/h
< 100
100 - 300
300 - 500
> 500
16°
17°
18°
19°
20°
21°
35°
36°
37°
38°
39°
40°

Fig. 5.3 Distribution area of <u>Mullidae</u>



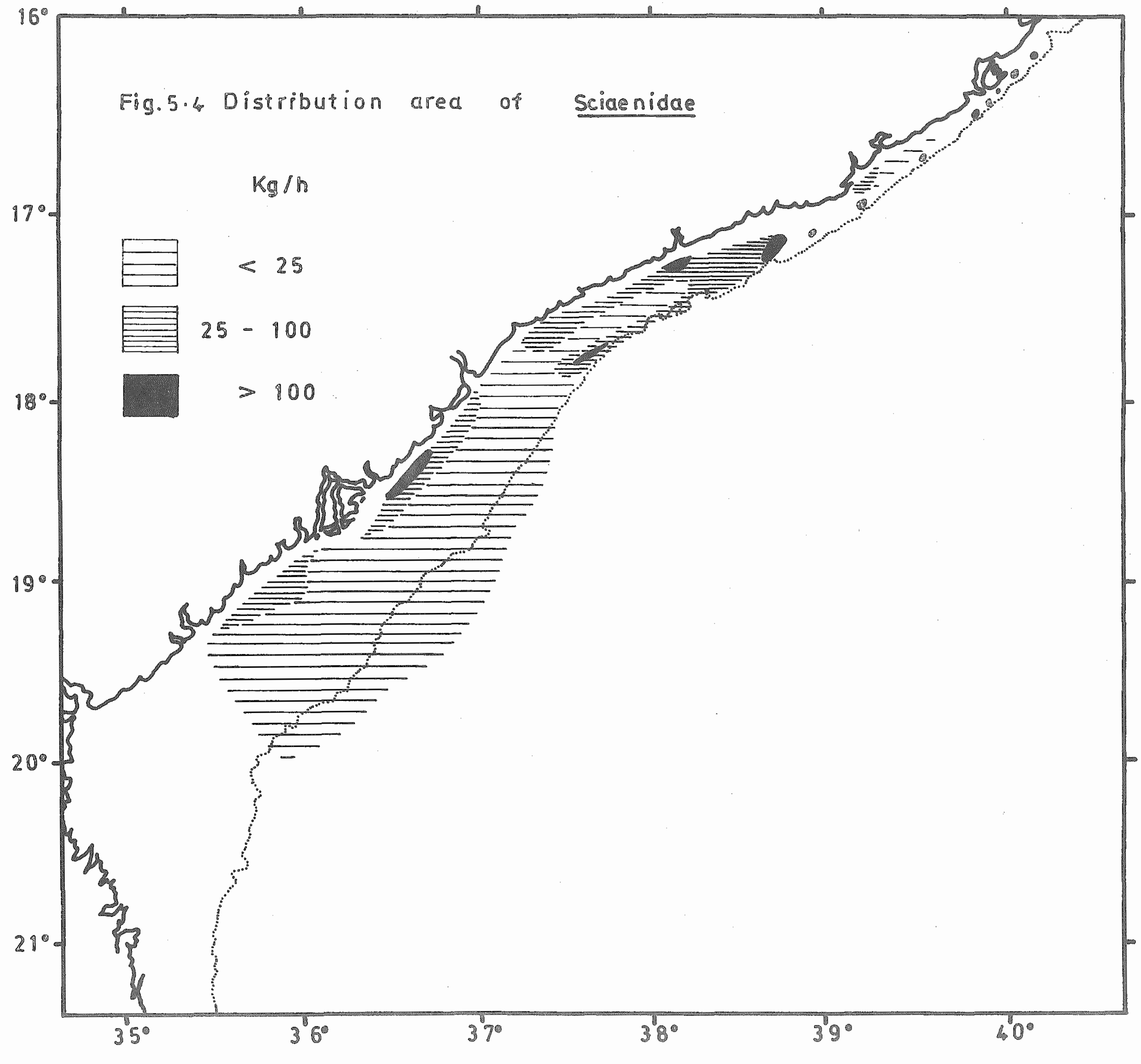


Fig. 5.4 Distribution area of Sciaenidae

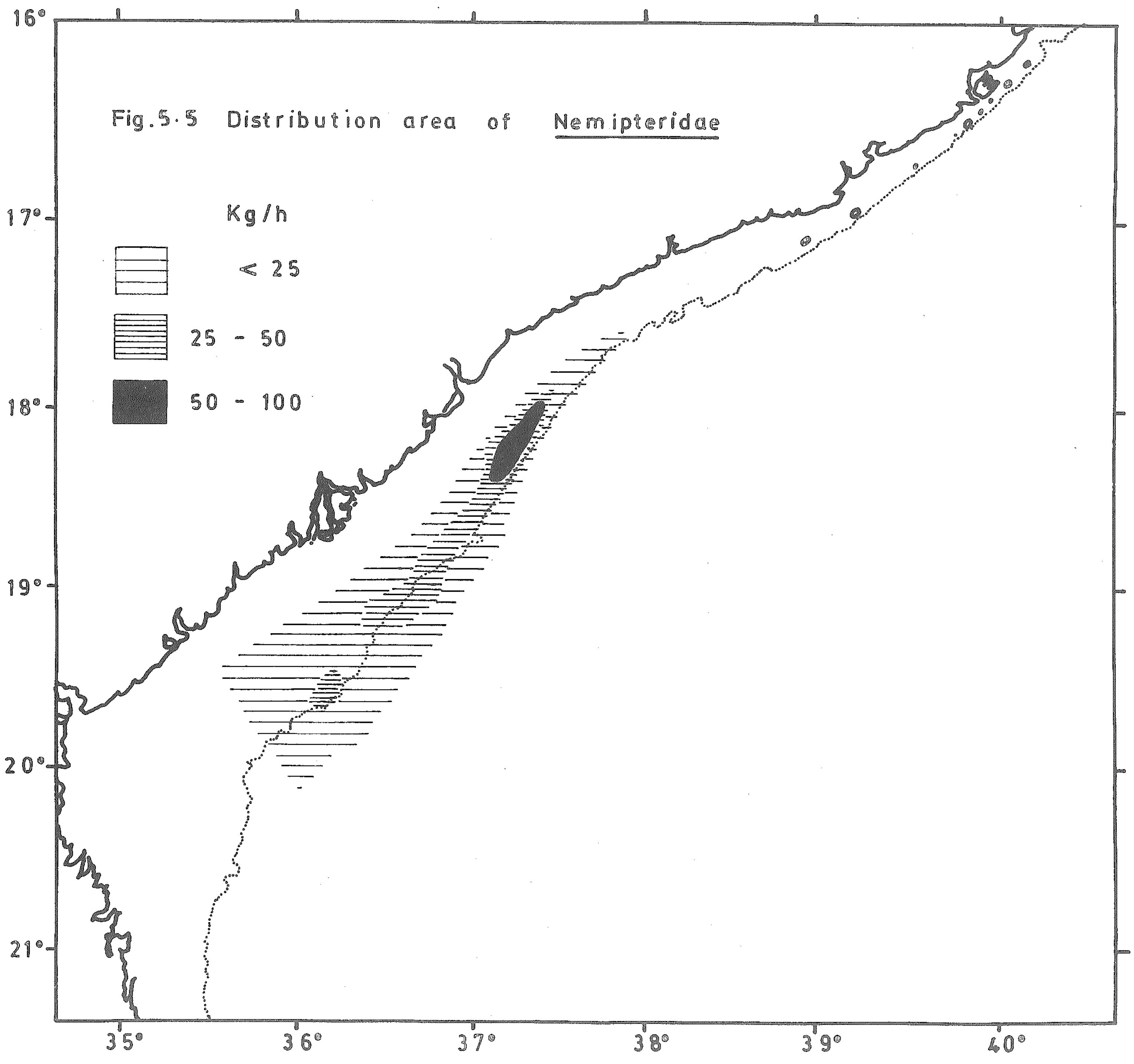


Fig.5.5 Distribution area of <u>Nemipteridae</u>

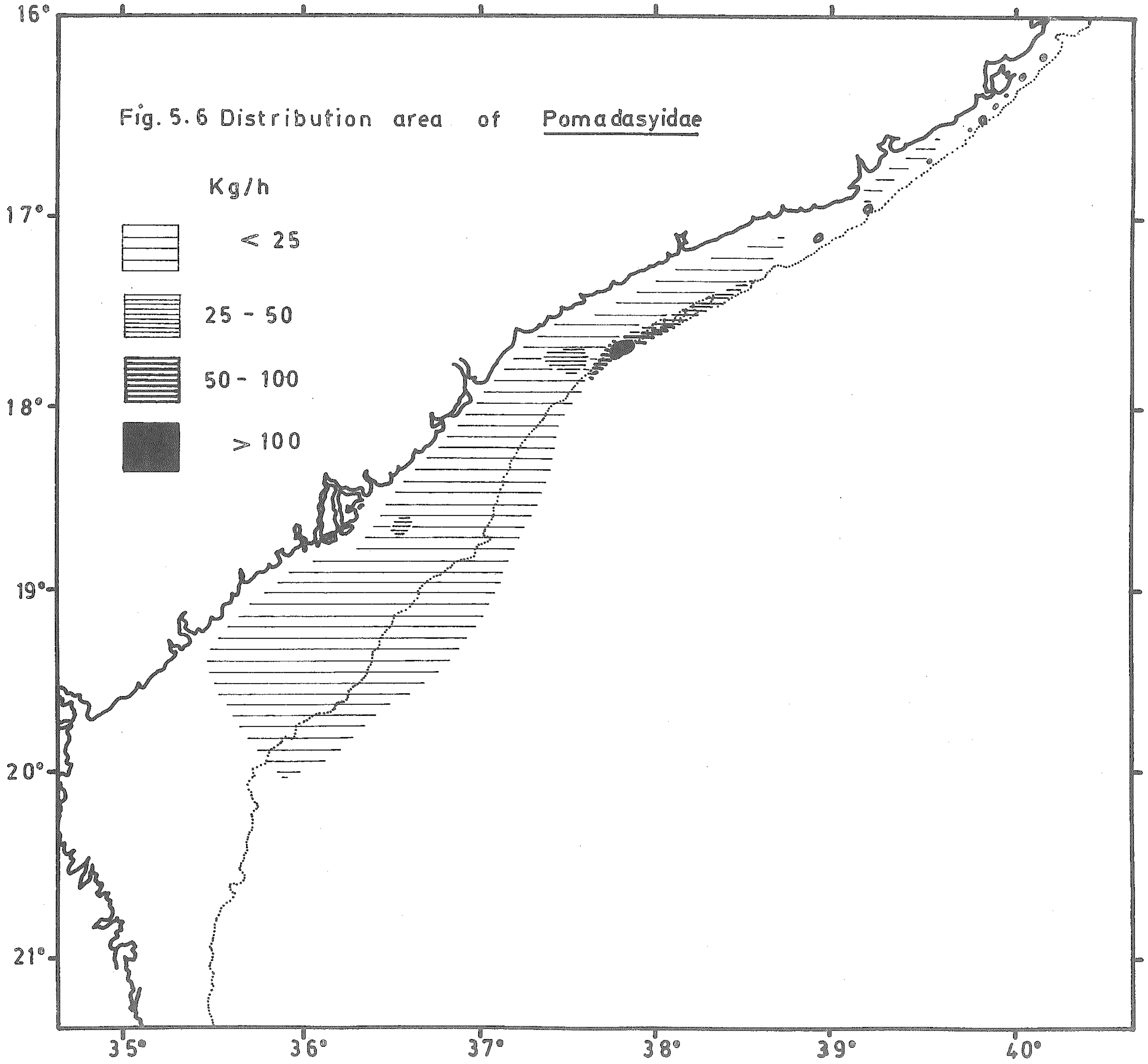


Fig. 5.6 Distribution area of *Pomadasyidae*

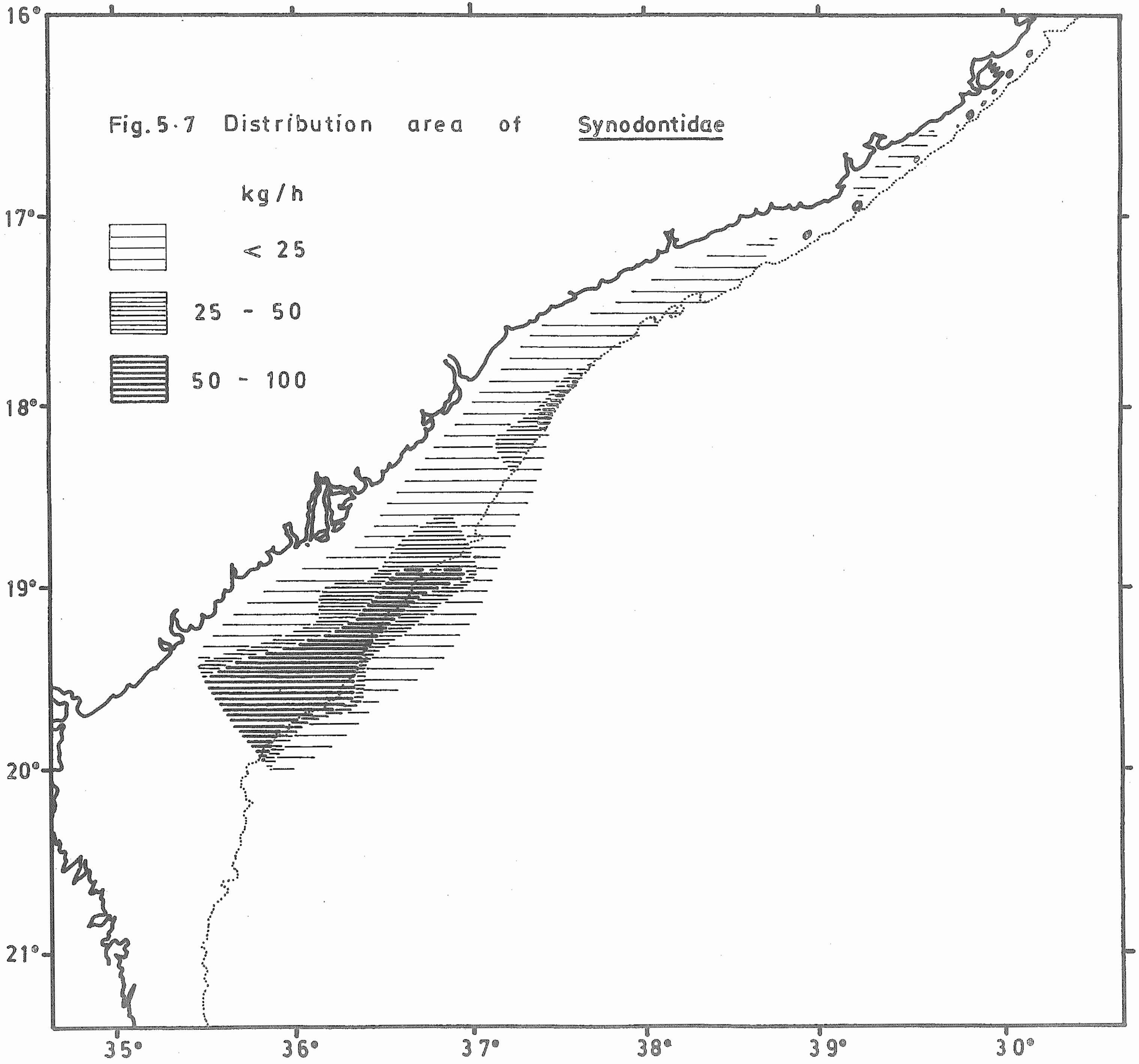


Fig. 5·7 Distribution area of Synodontidae
kg/h
< 25
25 - 50
50 - 100
16°
17°
18°
19°
20°
21°
35°
36°
37°
38°
39°
30°

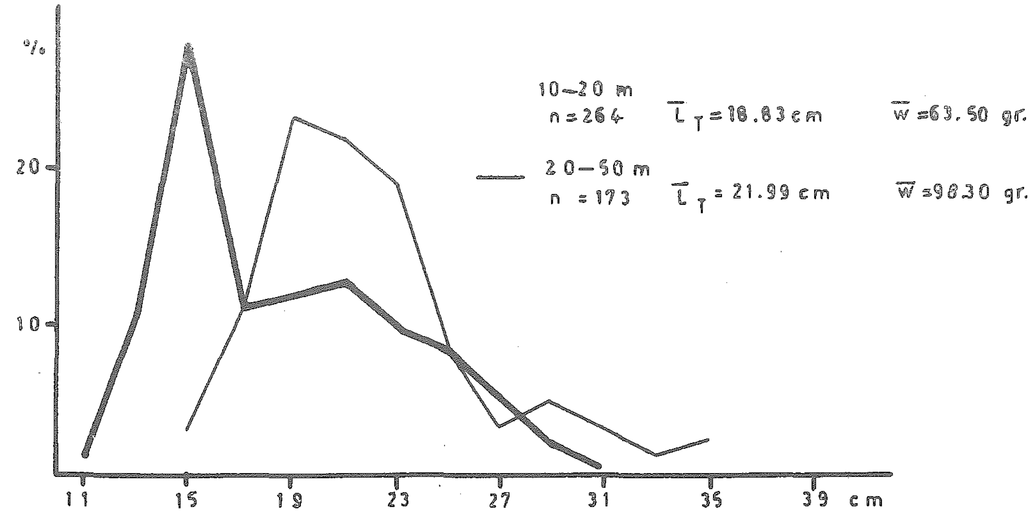


Fig.5.8 Otolithes ruber. Length— Frequency Distribution

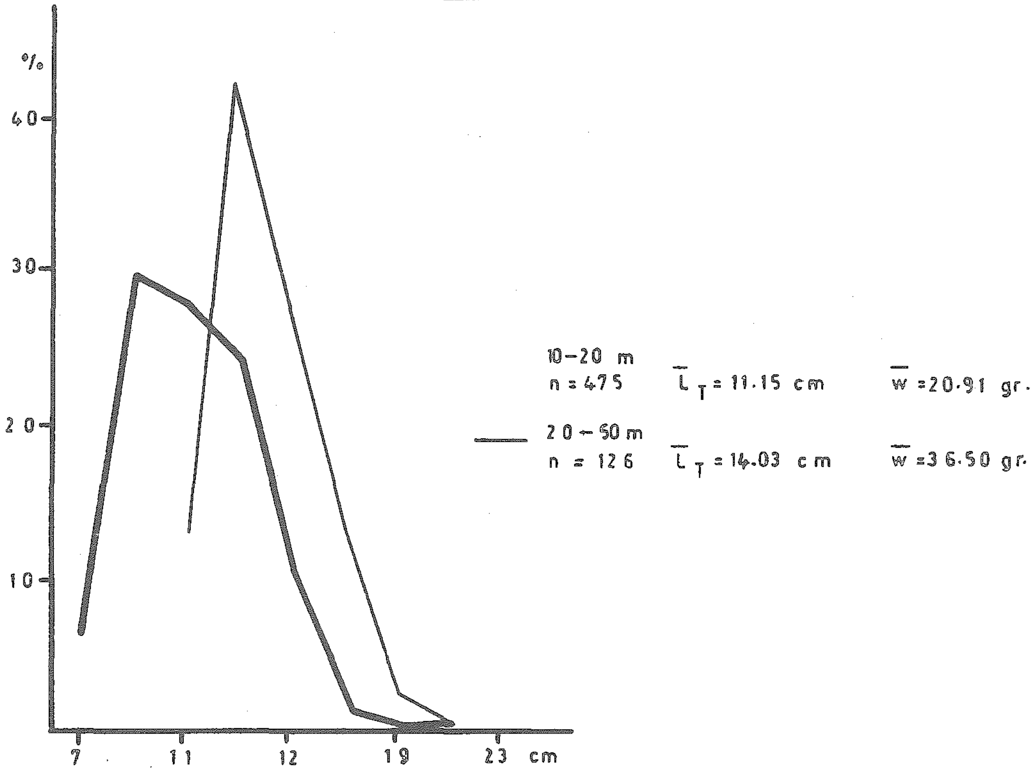


Fig. 5. 9 Johnius belengerii. Length–Frequency Distribution

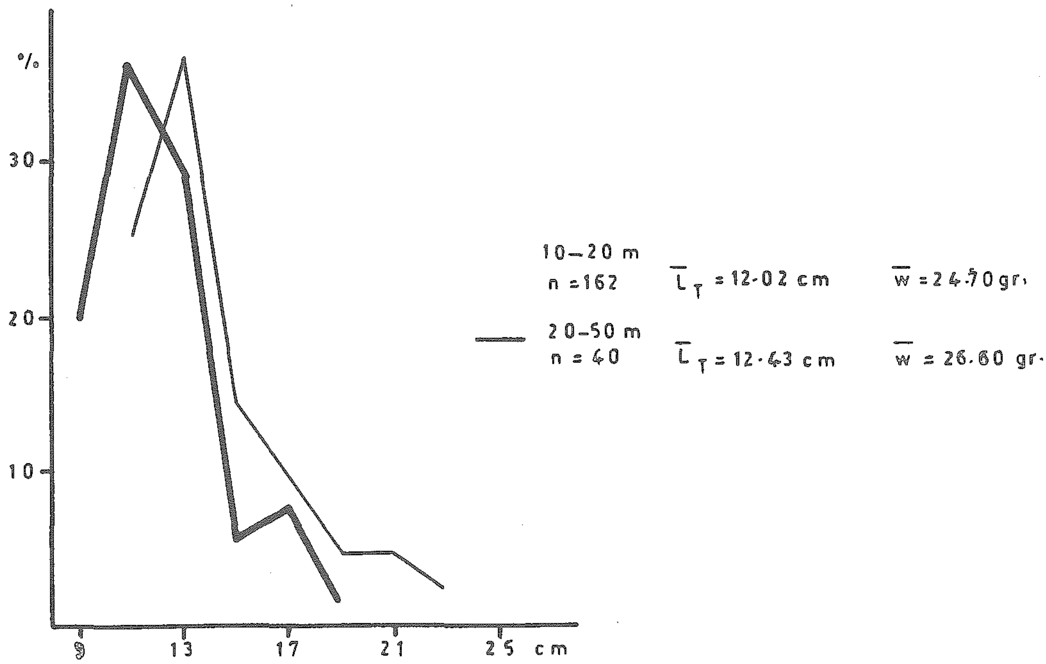


Fig. 5.10 Johnius dussumieri. Length–Frequency Distribution

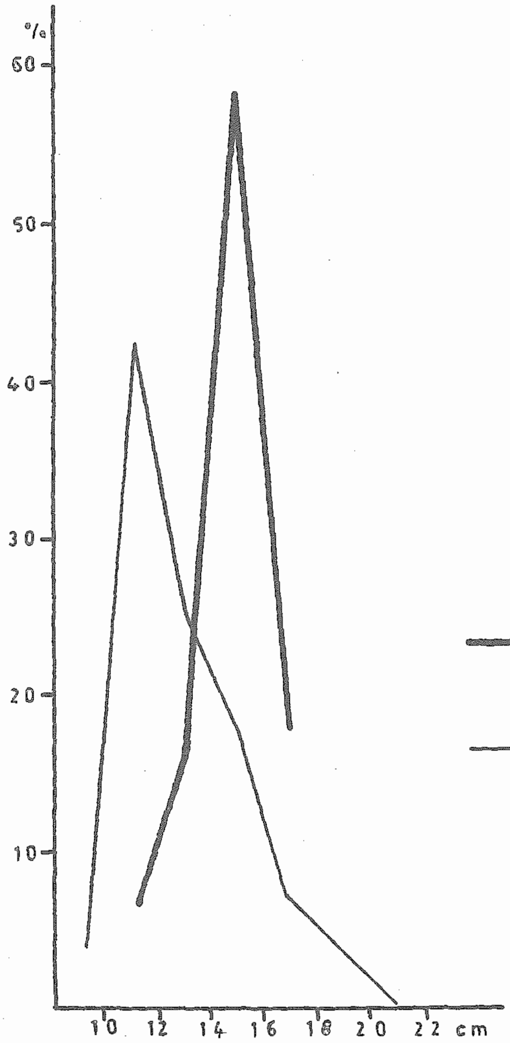


Fig. 5. 11 *Pomadasys maculatus*. Length–Frequency Distribution

10–20 m
n = 128 $\overline{L}_T$ = 14.69 cm $\overline{w}$ = 51.30 gr.

20–50 m
n = 241 $\overline{L}_T$ = 12.99 cm $\overline{w}$ = 39.00 gr.

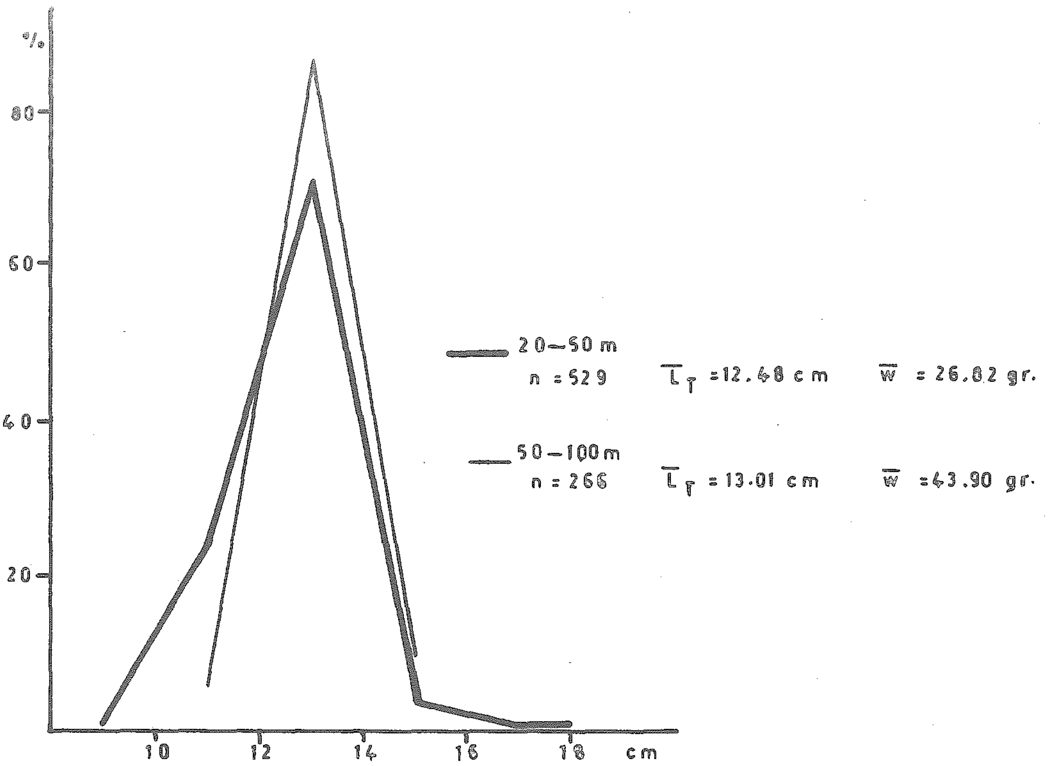


Fig. 5·12 Upeneus vittatus. Length–Frequency Distribution

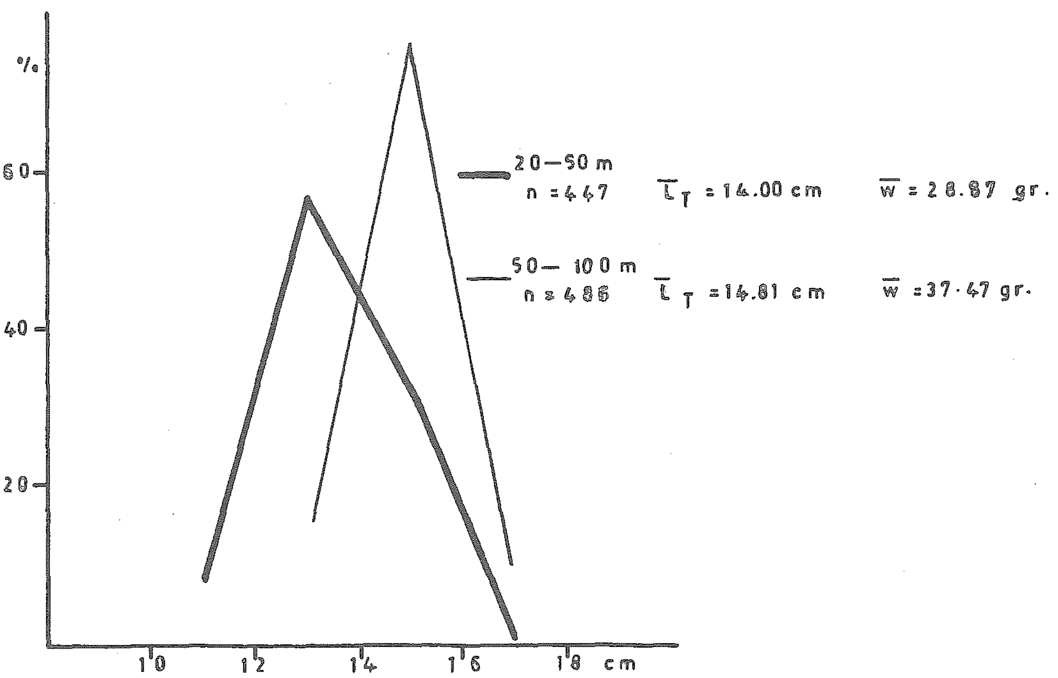


Fig. 5.13 Upeneus bensasi. Length–Frequency Distribution

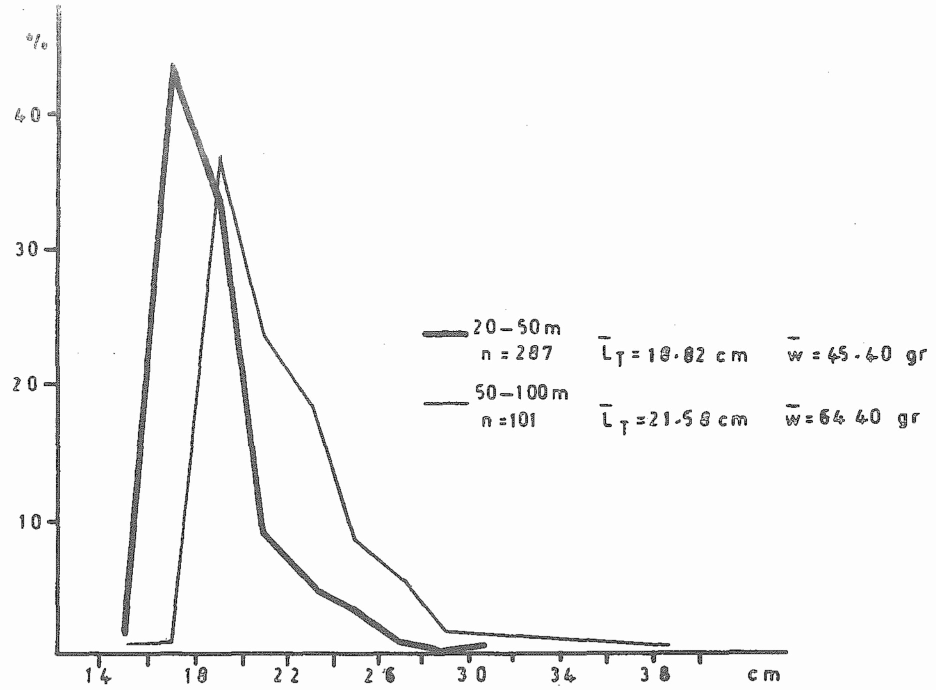


Fig.5.14 Saurida undosquamis. Length–Frequency Distribution

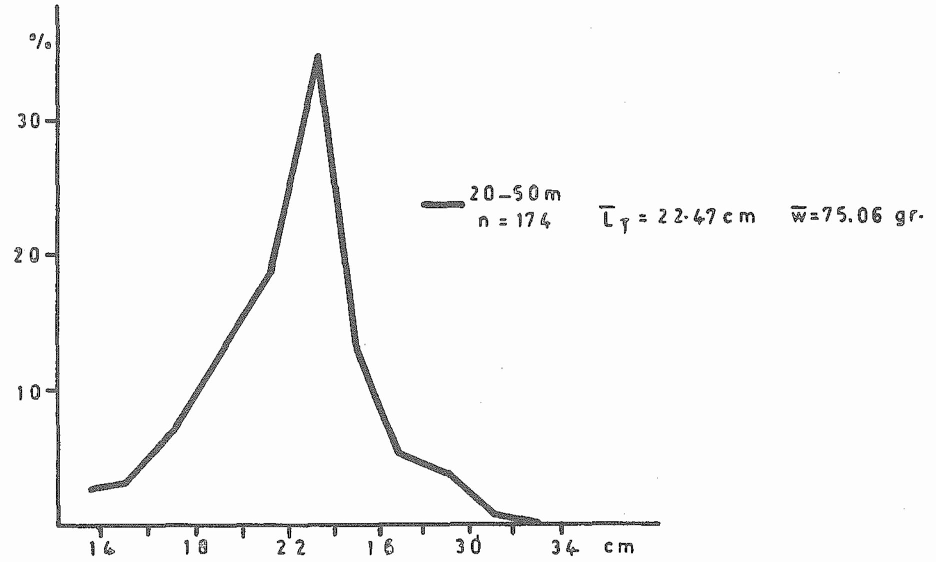


Fig.5.15 Saurida tumbil. Length–Frequency Distribution

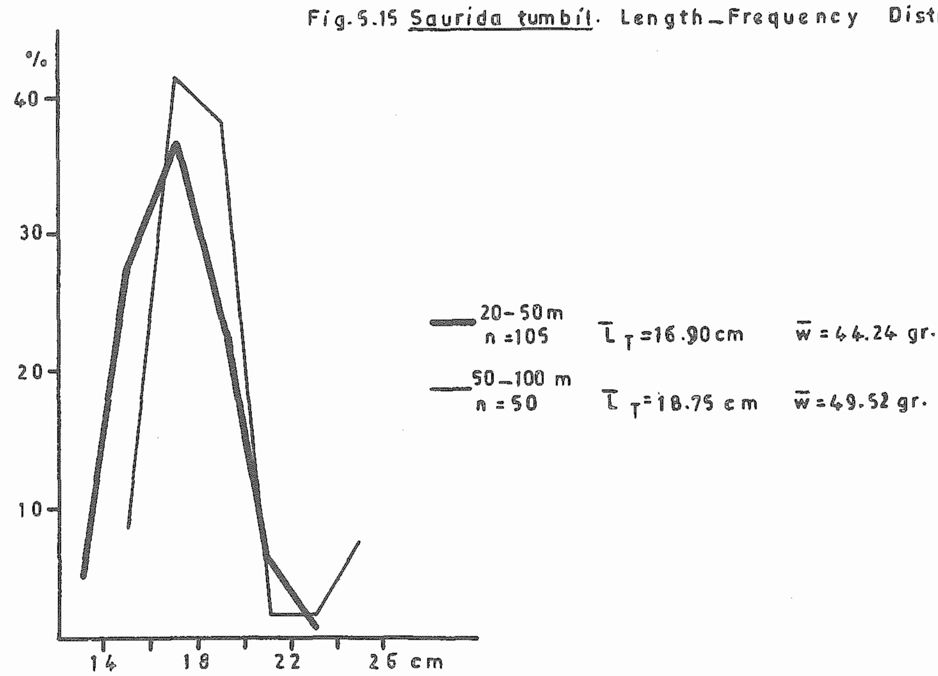


Fig.5.16 Trachinacephalus myops. Length Frequency Distribution

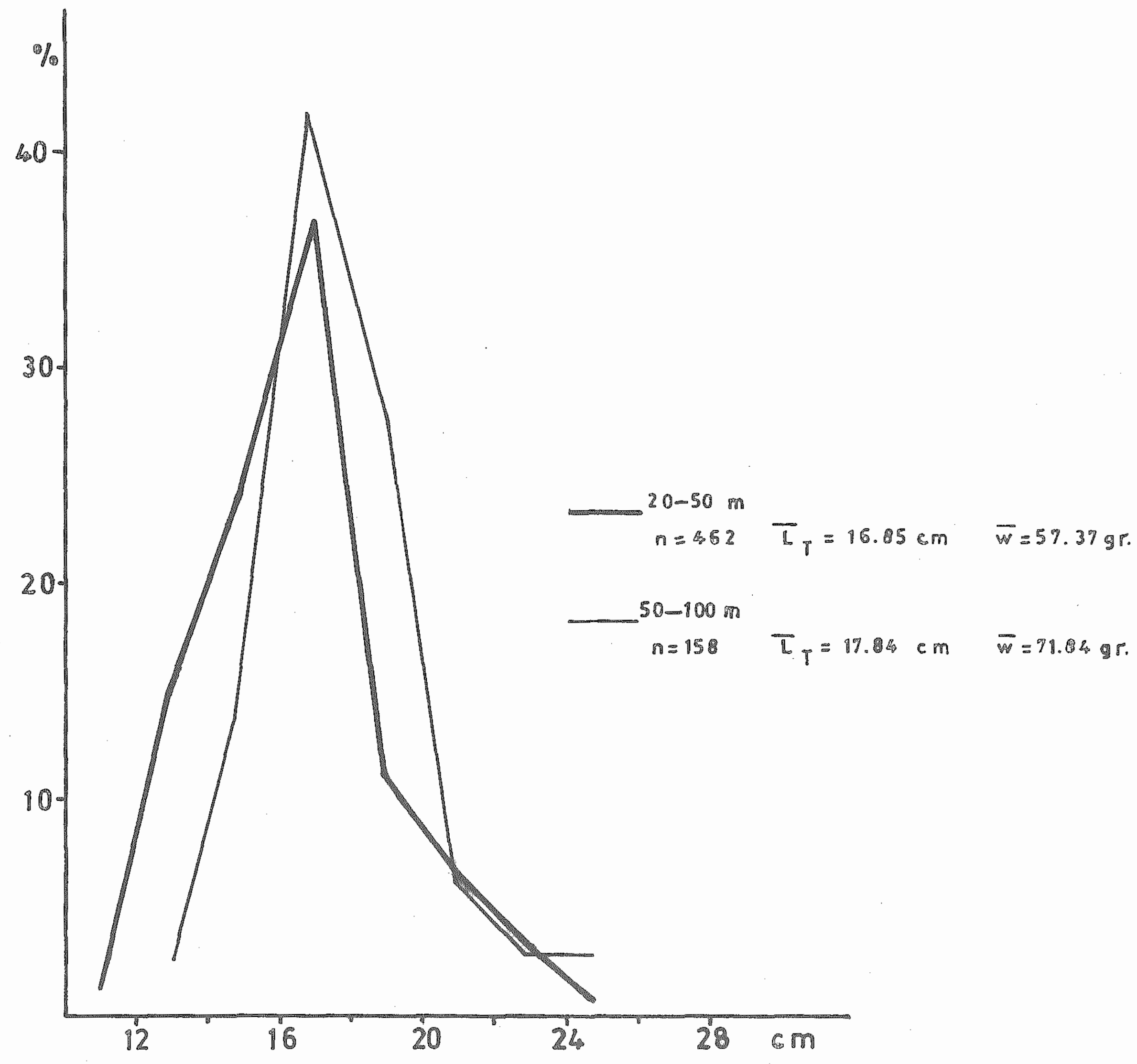
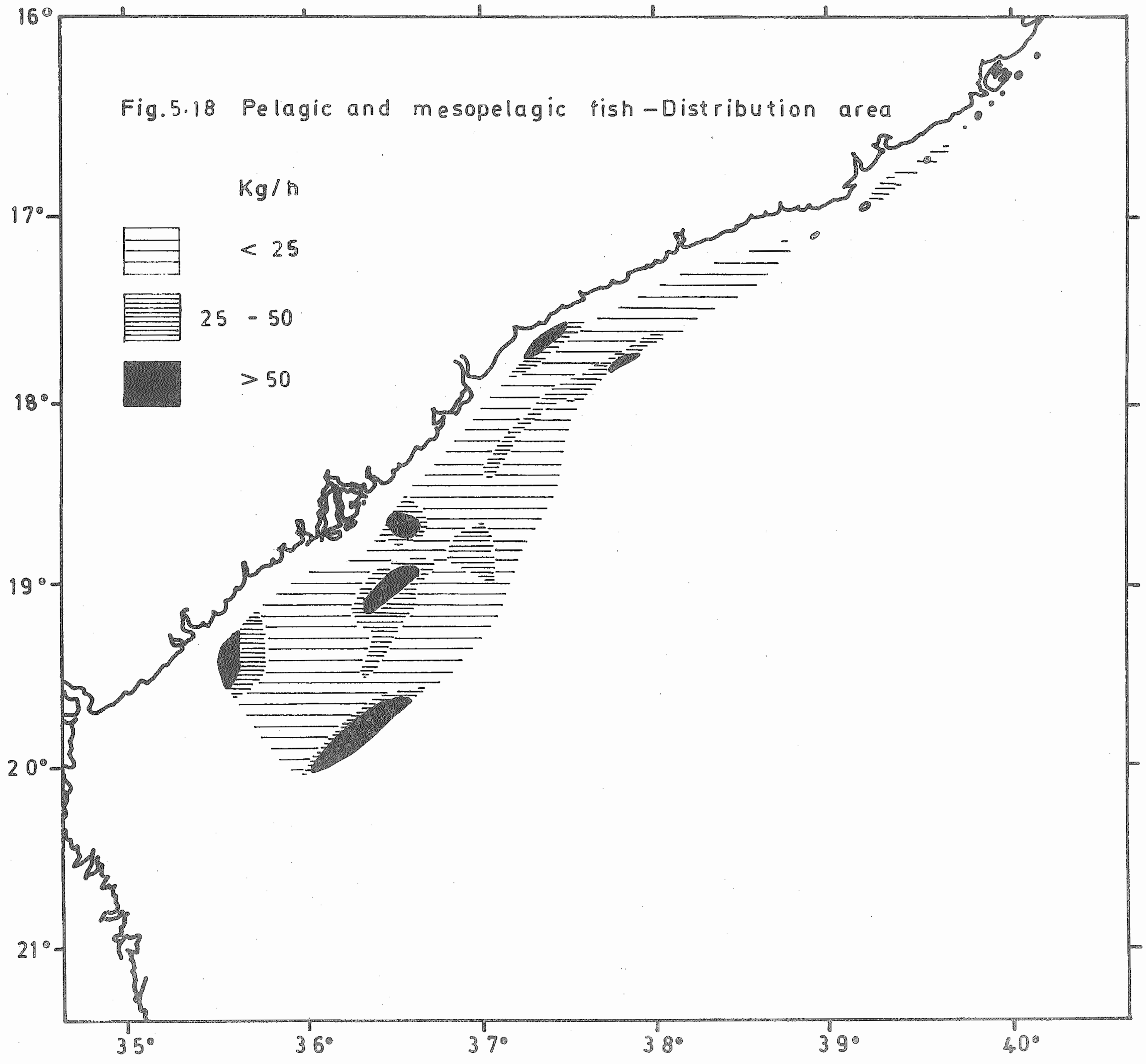


Fig. 5.17 *Nemipterus delagoae*. Length—Frequency Distribution

Fig.5.18 Pelagic and mesopelagic fish – Distribution area



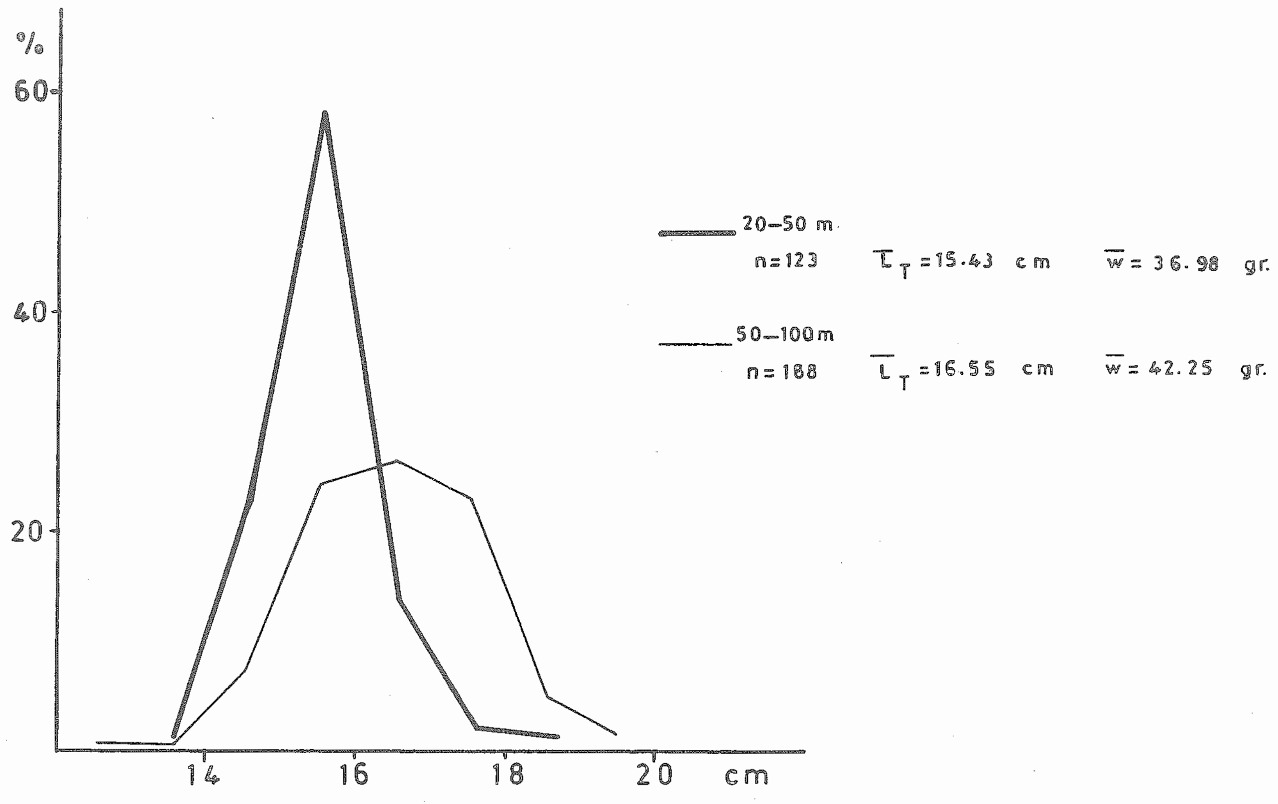


Fig. 5.19 Decapterus macrosoma. Length–Frequency Distribution

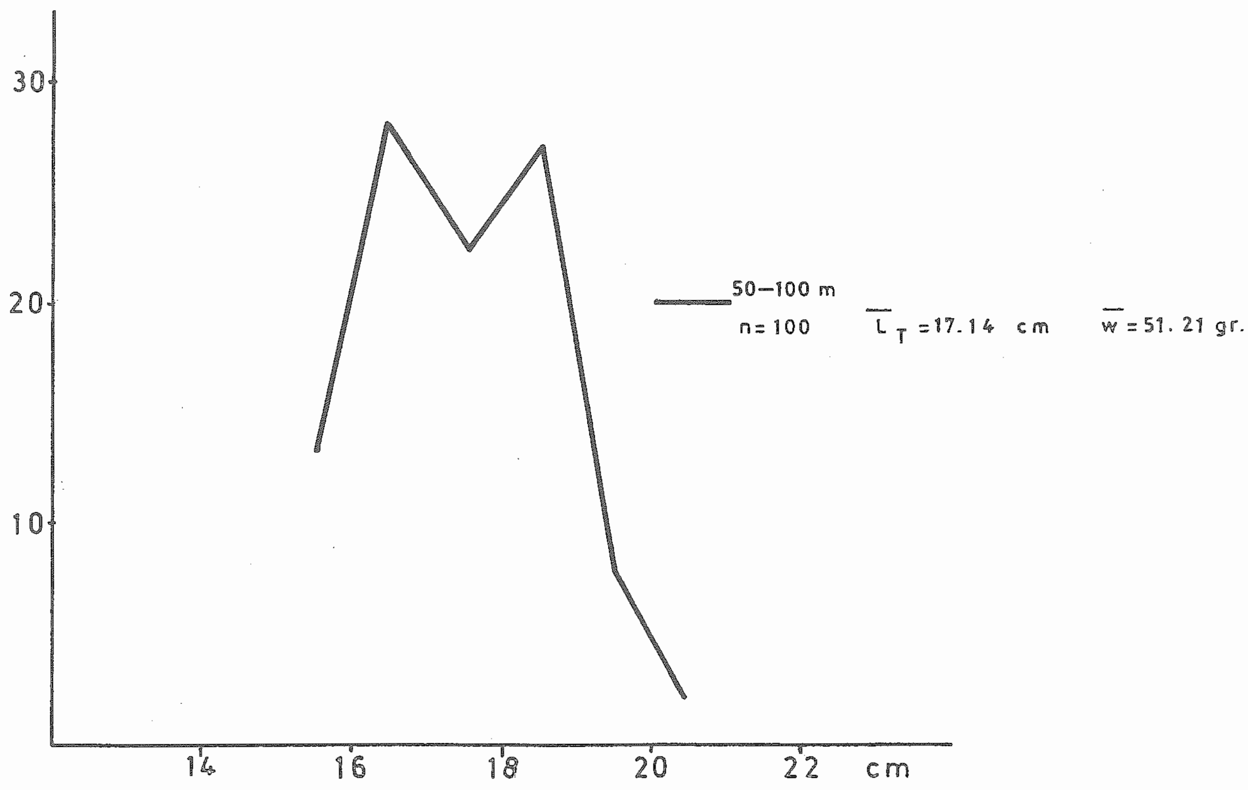


Fig. 5.20 Decapterus maruadsi. Length–Frequency Distribution

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