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CRUISE REPORTS 'DR. FRIDTJOF NANSEN'

SURVEY OF THE FISH RESOURCES OF CONGO and GABON

Preliminary Cruise report No 1/96

12 - 18 August 1996

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Direction Régionale de la Pêche au Kouilou, Pointe Noire, Congo
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CHAPTER 1 INTRODUCTION

1.1 OBJECTIVES

The main objectives of the survey were to:

- Conduct an acoustic survey to map the distribution and estimate the abundance of the main pelagic species:
 - * sardinella
 - * Cunene horse mackerel
 - * other pelagic/semipelagic species
- Map the general hydrographic regime by using a CTD-sonde on bottom trawl stations and monitor the temperature, salt and oxygen regimes on standard profiles.

A special request had been put forward by the Government of Congo through FAO (The Food and Agriculture Organization of the UNited Nations) regarding the inclusion of environmental studies (pollution) in the survey activities. Considering the limited time available for the present survey, from the one hand, and the need for more time to plan such type of activity, from the other, this request could not be satisfied. Efforts will be made in the future to evaluate the possibility of including this type of work in the survey plan.

1.2 PARTICIPATION

From the Direction Générale de la Pêche et de l'Aquaculture, Libreville (Gabon):
Agnes Boulingui-Ilama and Jean de Dieu Doumambila-Bantsantsa

From the Direction Générale de la Pêche, Brazzaville (Congo):
Appolinaire Ngouembe, Antoine Olingou

From the Centre ORSTOM, Pointe Noire (Congo):
Lucien Maloueki

From the Institute of Marine Research, Bergen (Norway):
Martin Dahl, Ole Gullaksen, Gabriella Bianchi, Christian Rohleder

1.3 NARRATIVE

The survey started at Port Gentil on 12 August 1996 and the vessel steamed southward to avoid the oil-drilling area between Cape Lopez and Iguela. Systematic transects, 20 nm apart, were sailed starting from Iguela, from close to the shore (20 m depth) to beyond the 200 m isobath. Echo-integration was carried out during day and night time, to map the distribution and estimate the acoustic abundance of pelagic species. Pelagic trawling was carried out to identify targets on the echograms or on the sonar. After completing the survey off Gabon, the vessel steamed to Pointe Noire to fetch the participants from Congo, on 16 August. The shelf and slope off Congo were covered from 16 to 18 August.

The survey terminated on 18 August just north of Pointe Noire where the vessel called to disembark the scientists from Congo and Gabon.

1.4 SURVEY EFFORT

Figure 1 shows the course track, with fishing stations and the hydrographic profiles and Table 1 presents the number of CTD and trawl stations and the distance surveyed.

Table 1. Number of hydrographic (CTD), pelagic (PT), bottom (BT) trawl stations, successful swept-area hauls and distance surveyed (nm) by area.				
Area	CTD	PT	BT	Distance surveyed (nm)
Congo	7	13	0	370
Gabon	8	11	2	730
Total	15	28	2	1100

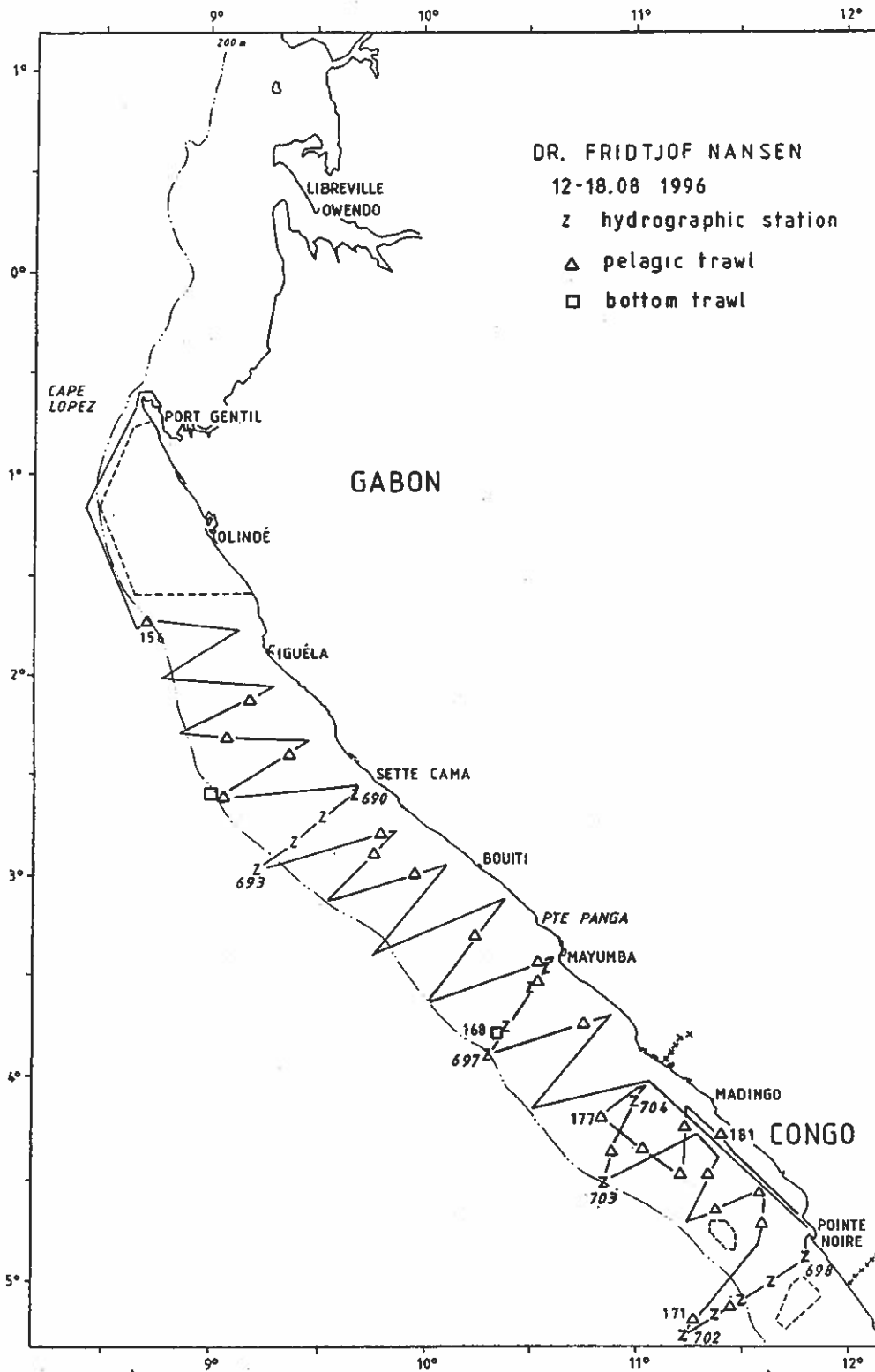


Fig. 1 Course tracks with fishing stations and CTD-stations.

CHAPTER 2 METHODS

2.1 Hydrographic sampling

A Seabird 911 CTD plus was used to obtain vertical profiles of temperature, salinity and oxygen. Real time plotting and logging was done using the Seabird Seasave software installed on a PC. The profiles were taken down to a few metres above the bottom. Two Niskin bottles were triggered for water samples on each station, one near the bottom and one near the surface (5 m depth). The samples were analysed for salinity using a Guildline Portasal salinometer, and the oxygen content was determined using the Winkler method. These laboratory values were used for calibration of the CTD after removing obvious outliers.

The results of the CTD sensor calibrations on the cruise just prior to the present one were used for the present survey. Including 103 points for the salinity calibration the average difference between the Seabird values and the laboratory analysis was -0.048 (± 0.039). Thus the CTD values were a little bit low compared to the Portasal. However, as the difference was only marginally larger than the standard deviation, the salinity values presented here are taken from the CTD without any correction.

Fourty-four samples were accepted for oxygen calibration. A linear regression gave the following formula for correcting the oxygen values:

$$O_2 = O_{2\text{ctd}} * 1.023 + 0.024$$

When applying this formula, a standard deviation of 0.120 was obtained.

ADCP current measurements

A ship born Acoustic Doppler Current Profiler (ADCP) from RD Instruments was activated on every CTD station with bottom depths greater than about 25 m. The ADCP was set to ping every 8 seconds, the depth cell was chosen to 8 m and the number of cells to 50. As a routine the data were averaged over 300 seconds for analyses onboard. Both the raw and averaged data were stored on files. The data were analysed by the PC software UMS (Underway Mapping System).

Meteorological observations

Wind (direction and speed), air temperature, global radiation and sea surface temperature (5 m depth) were logged automatically every nautical mile using an Anderaa meteorological station.

2.2 Fish sampling and acoustics

The catches were sampled for species composition, by weight and numbers. Length distributions were taken for the main species. Biological samples, i.e. length, body weight, sex and maturity were recorded for sardinella and horse mackerel to the nearest 1 cm and 1 g below, respectively. Records of fishing stations are presented in Annex I.

A detailed description of the fishing gear used and of the acoustic instruments is presented in Annex II.

The following target strength (TS) function was applied to convert S_A -values (mean integrator value for a given area) to number of fish (sardinella and horse mackerel):

$$TS = 20 \log L - 72 \text{ dB} \quad (1)$$

or on the form

$$C_F = 1.26 \cdot 10^6 \cdot L^{-2} \quad (2)$$

where L is total length and C_F is the fish conversion factor. The following formula was used to calculate the number of fish in length groups (cm) for each fish concentration:

$$N_i = A \cdot S_A \cdot \frac{P_i}{\sum_{i=1}^n \frac{P_i}{C_{Fi}}} \quad (3)$$

where

N_i = number of fish in length group i

A = area (naut.miles²) of fish concentration

S_A = mean integrator value in area (A)

p_i = proportion of fish in length group i in samples from the area

C_{Fi} = fish conversion factor for length group i

The number per length group (N_i) was then summed and the total number of fish obtained:

$$N = \sum_{i=1}^n N_i \quad (4)$$

The length distribution of a given species within an area was computed by adding the length frequencies obtained in each trawl sample within the area. In the case of co-occurrence of *Sardinella aurita* and *S. maderensis* (these species cannot be separated in the echo traces), the respective contribution to the S_A value attributed to the 'sardinella' category was split using a factor obtained from their length frequency distributions and their CPUE in numbers. The biomass of fish per length group (B) was calculated by applying observed mean weights per length group (\bar{W}_i) multiplied by number of fish in the same length groups (N_i). The total biomass in each area was obtained by summing the biomass of each length group:

$$B = \sum_{i=1}^n N_i \bar{W}_i \quad (5)$$

The number and biomass per length group in each concentration were at last summed to obtain the totals for each region.

The mean integrator values in each sampling unit (S_A -values) were divided between the following categories of fish on the basis of trawl catches and characteristics of the echo traces:

- plankton
- sardinella (*S. aurita* and *S. maderensis*)
- anchovy
- horse mackerel
- Pelagic fish type 2 (carangids, scombrids, barracudas and hairtails)
- other demersal fish

The biomass of Pelagic fish type 2, that includes a wide number of species of the groups indicated above, was roughly calculated with the following formula:

$$\text{Biomass (tons)} = A \cdot S_A \cdot C_F \cdot W$$

$$C_F = 1.26 \cdot 10^6 \cdot L^{-2}$$

$$W = K \cdot L^3 \cdot 10^{-8} \text{ (to obtain the weight in tons)}$$

A = Area (nm²)

C_F = Fish conversion factor

K = Condition factor

S_A = Mean integrator value for the distribution area

L = Mean length

W = Average weight of a single fish

CHAPTER 3 OCEANOGRAPHIC CONDITIONS

3.1 Surface distribution

The horizontal distribution of temperature and salinity at 5m depth are shown in Fig. 2 and 3 respectively. From Pointe Noire to Pte Panga the temperature increases with distance from the coast, while the tendency is opposite in the northern part of the survey area. Comparing with the salinity distribution (Fig.3) it is obvious that the low temperatures are associated with high salinity (oceanic) water. The influence of the Congo River is most readily seen in the section taken out from Pointe Noire, where the outer part show salinities as low as 34.6. Thus the River water carries a high temperature as well as a low salinity.

3.2 Vertical sections

In the section off Pointe Noire (Fig. 4) the minimum surface temperature ($\sim 18^{\circ}\text{C}$) was found near the coast. However, this is probably not due to an upwelling situation, but rather that the warm water from the Congo River was found further off-shore, as mentioned above. This is clearly seen in the salinity section, which reveal salinities at the surface layer be as low as 29 psu at the stations from the shelf break an further off-shore. It seems that the Congo River water has a relative high oxygen content. Below the surface layer the fields are relative flat with little structure. Note the local maximum salinity ($S > 35.8$) at about 25m depth on station 701.

In the section off Sette Cama (Fig. 5) the water close to the shore is the warmest and less saline, in contrast to the Pointe Noire section. Although the water salinity close to the shore in the Sette Cama section barely gets below 35.4 psu, it is quite possible that this water also origins from the Congo River, being brought there by the prevailing currents and eddies dominating the area.

In both sections the main thermocline was found near the surface, while a secondary thermocline was observed at about 250m depth. Associated with this deep thermocline a halocline is also seen. Compared to earlier surveys in the area, the conditions seem to be quite normal except for the temperature in the surface layer which was about 2 to 3°C colder than usual. A plot of the temperature versus depth for station 696 is shown in Fig. 6 and compared with a station in the same area last year. The graph clearly shows that the water was colder than last year not only at the surface but in the deeper water layers as well.

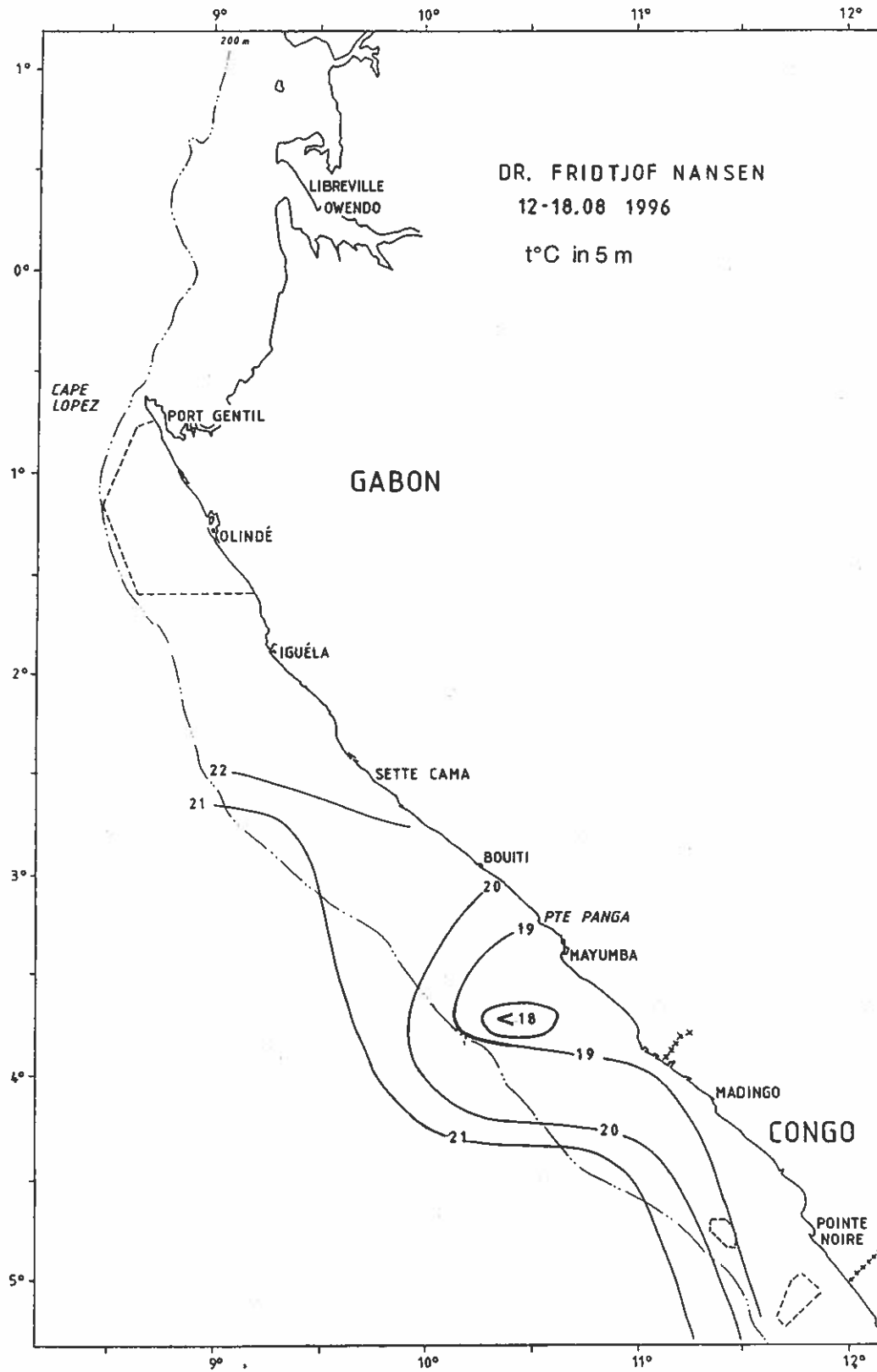


Figure 2. Horizontal distribution of surface (5m depth) temperature, Congo - Gabon.

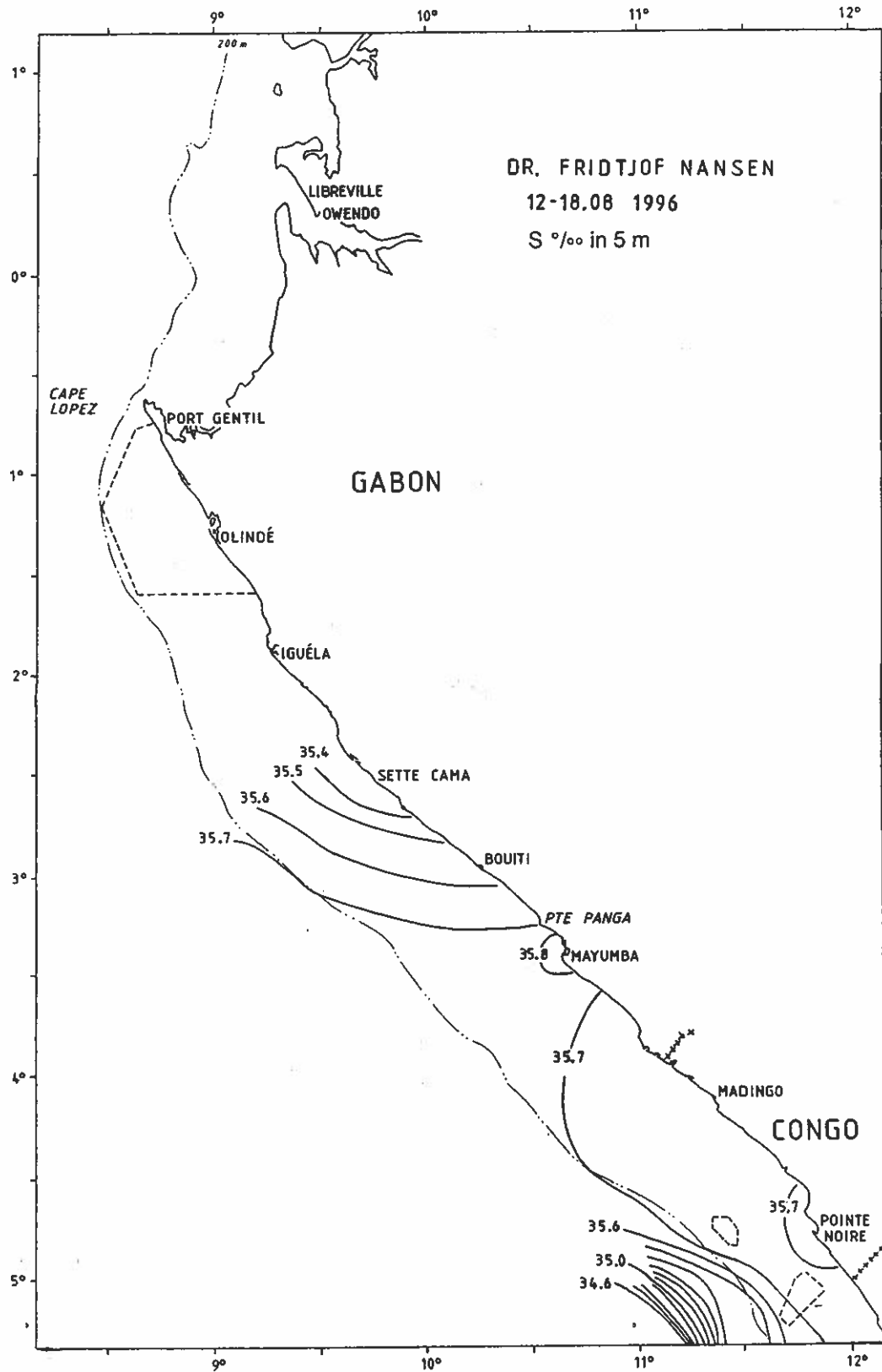


Figure 3. Horizontal distribution of surface (5m depth) salinity, Congo - Gabon.

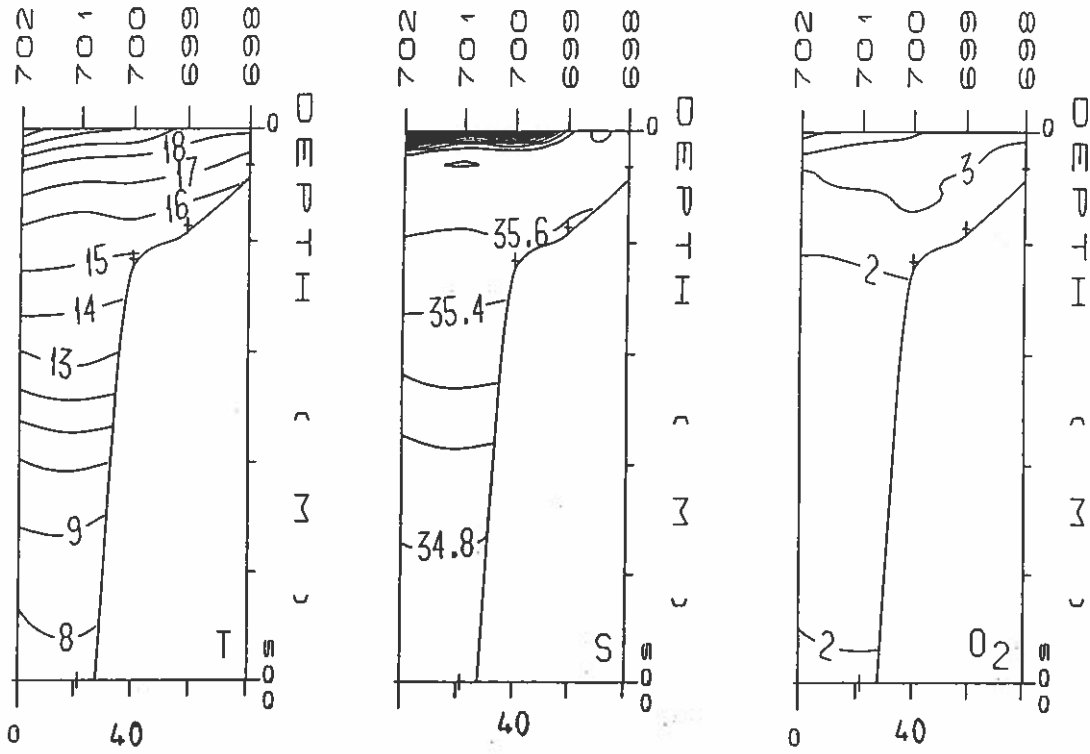


Fig. 4 Pointe Noire. Vertical sections of temperature, salinity and oxygen.

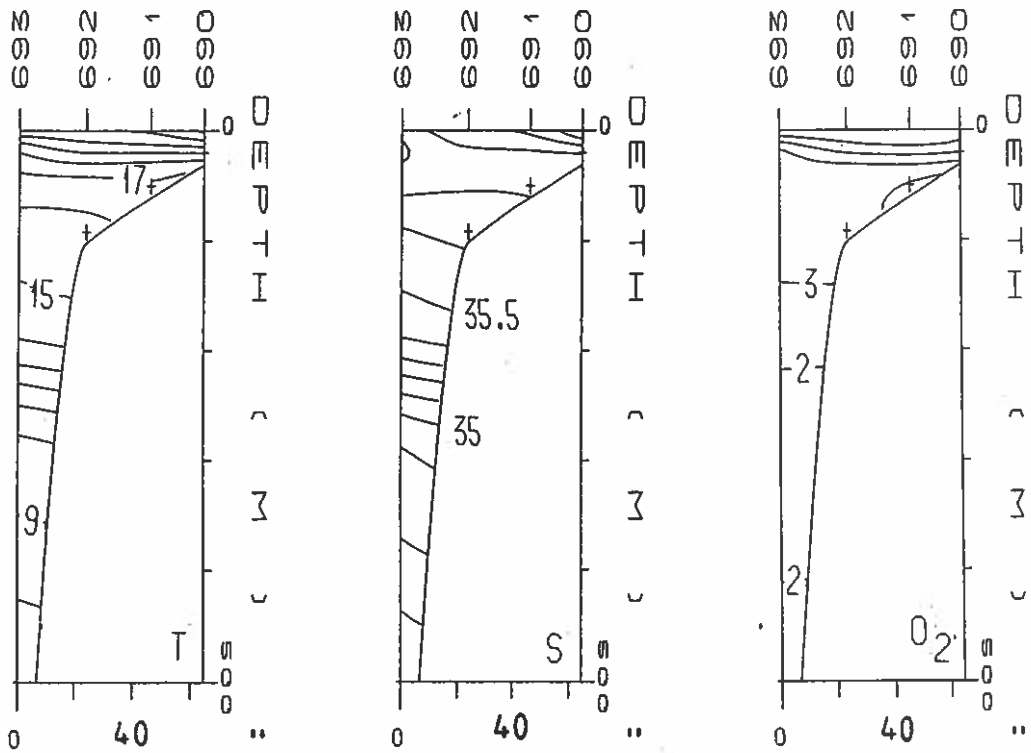


Fig.5 Sette Cama. Vertical sections of temperature, salinity and oxygen.

3.3 ADCP measurements

The ADCP measurements from 35m depth are shown in Fig. 6. All the 5 main registrations obtained are shown. There are several observations at the deep stations, giving the idea of the variability of the signal. Although the picture seems rather confusing, some general features seem to emerge. There is a tendency of a strong (~ 25cm/s), NW current at the continental slope. Also note that the current at the innermost station is weak, but has an on-shore component. This is where the relatively fresh and warm water was observed close to the coast.

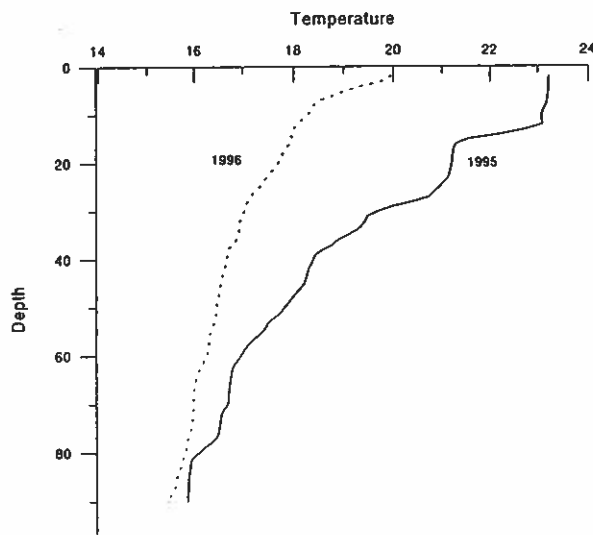


Fig. 6 Temperature profile from CTD station 696 (Mayumba) and the corresponding profile from August 1995

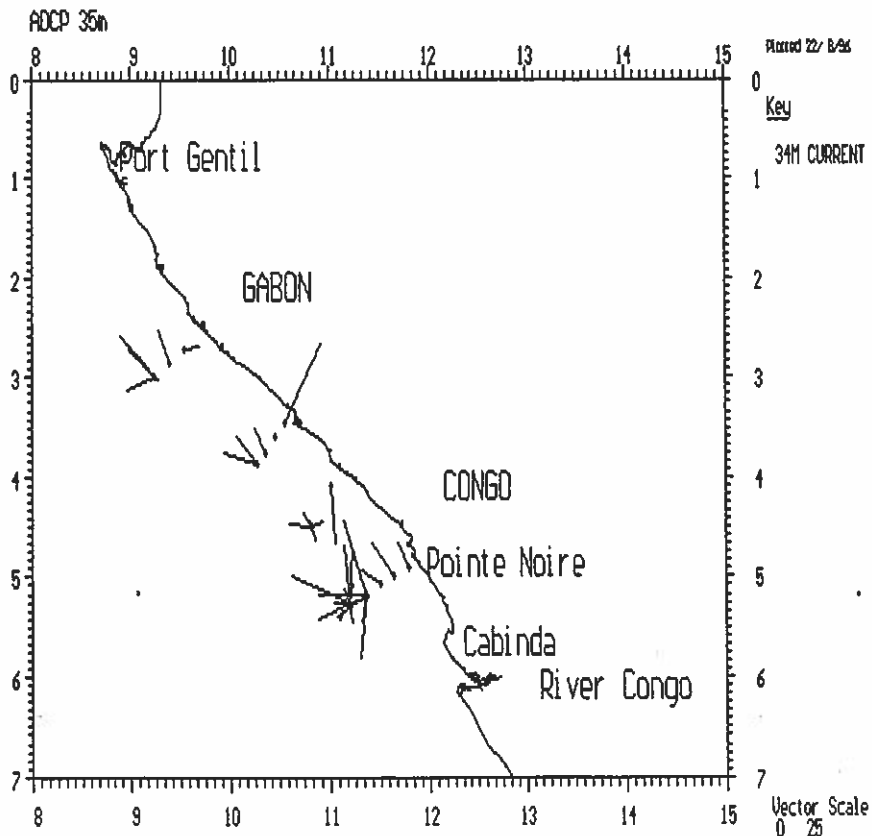


Fig.7. ADCP current measurements from 35m depth.

CHAPTER 4 ACOUSTIC SURVEY: FISH DISTRIBUTION AND ABUNDANCE ESTIMATES OF PELAGIC SPECIES

In addition to the utilization of the echo-sounder, the equipment usually employed in acoustic surveys, sonar equipment was also run in the present survey. A software newly developed at IMR allows storing and processing of the recordings coming from this type of equipment. The sonar allows the acoustic sampling of the 'blind zone', an area from the surface to about 10 m depth where fish occurrences cannot be detected by the echo-sounder. The utilization of this equipment in the course of this survey was very fortunate as sardinellas, the main target species, occurred very close to the surface throughout the survey area. Fig. 8 shows the echogram obtained by the vertical echo-sounder (a) and the images obtained from the sonar for the upper water layers (b) for the same stretch of the course track. The estimation of the biomass has however not been possible as the knowhow to use the above mentioned software is still limited to a few experts at IMR. The data collected will therefore be analyzed in Norway and the results included in the final report.

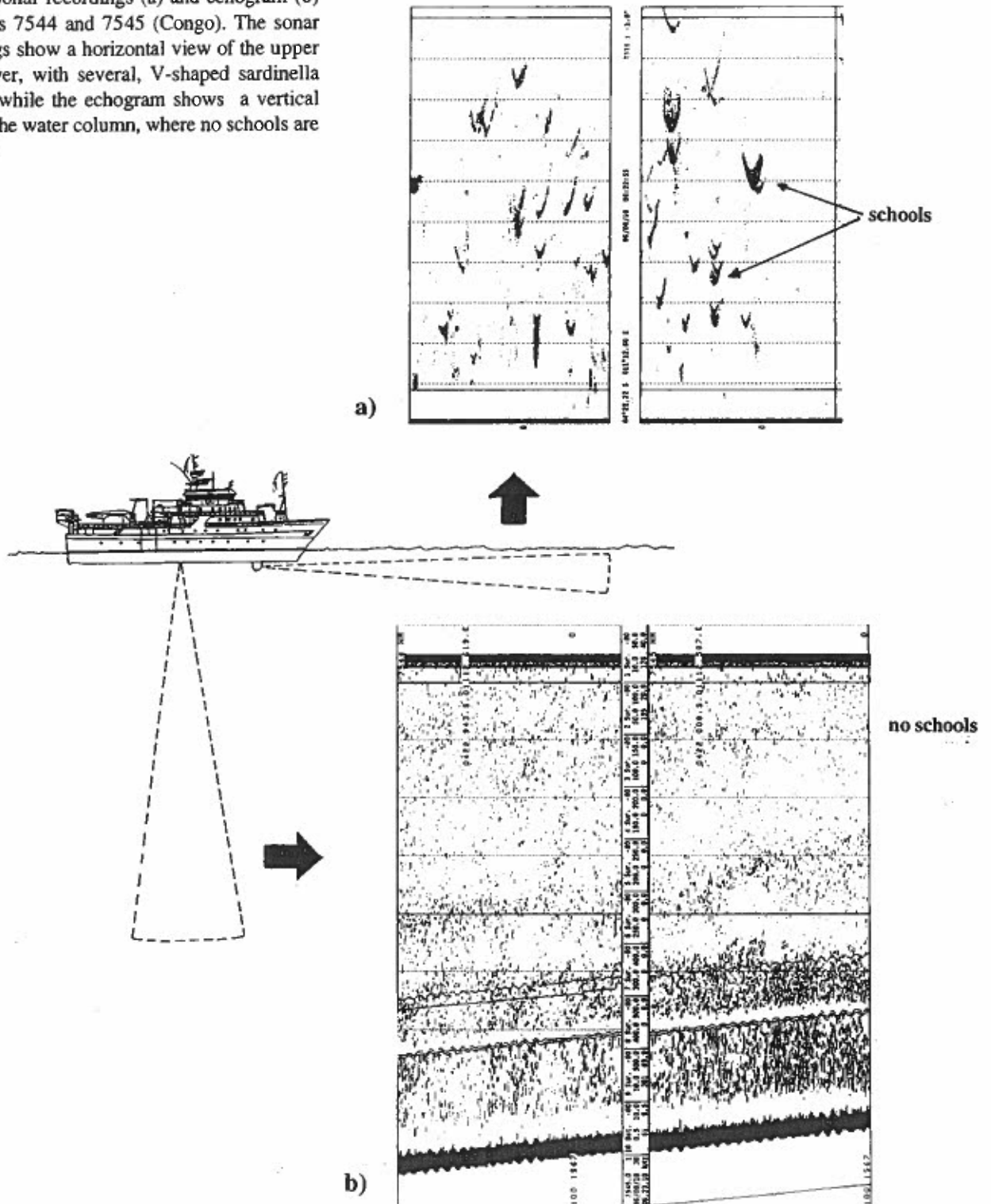
4.1 GABON

The survey covered the area between Iguéla and the border with Congo. Very weak recordings characterize the whole area, particularly in depths greater than about 40-50 metres. In the inshore waters some weak acoustic recordings were identified as juveniles. In these areas, the waters had a brownish reddish colour, particularly between Setté Cama and Mayumba. Water samples showed that the colour was due to the presence of diatoms.

Clupeids

Sardinella was only recorded and identified by pelagic trawling in a small area off Mayumba. The catch consisted mainly of *Sardinella maderensis* (98%) and only 2 % of *Sardinella aurita*. Both species had a mode of 14.5 cm. No biomass estimate was attempted on the basis of this occurrence. Fig.9 shows the distribution as recorded by the echo-integration system. When compared to Fig. 10, an output of the BEI (Bergen Integrator) and of the sonar occurrences, the distribution of sardinella appears to be more extended. This reflects the presence of this species in the very upper water layer. The reason of this apparently extreme behaviour could be attributed the lower temperatures at the surface (only 18° to 22° C) and a sharp and shallow thermocline, observed in the region in the course of the present survey, as compared to earlier years.

Fig. 8. Sonar recordings (a) and echogram (b) from logs 7544 and 7545 (Congo). The sonar recordings show a horizontal view of the upper water layer, with several, V-shaped sardinella schools, while the echogram shows a vertical image of the water column, where no schools are recorded.



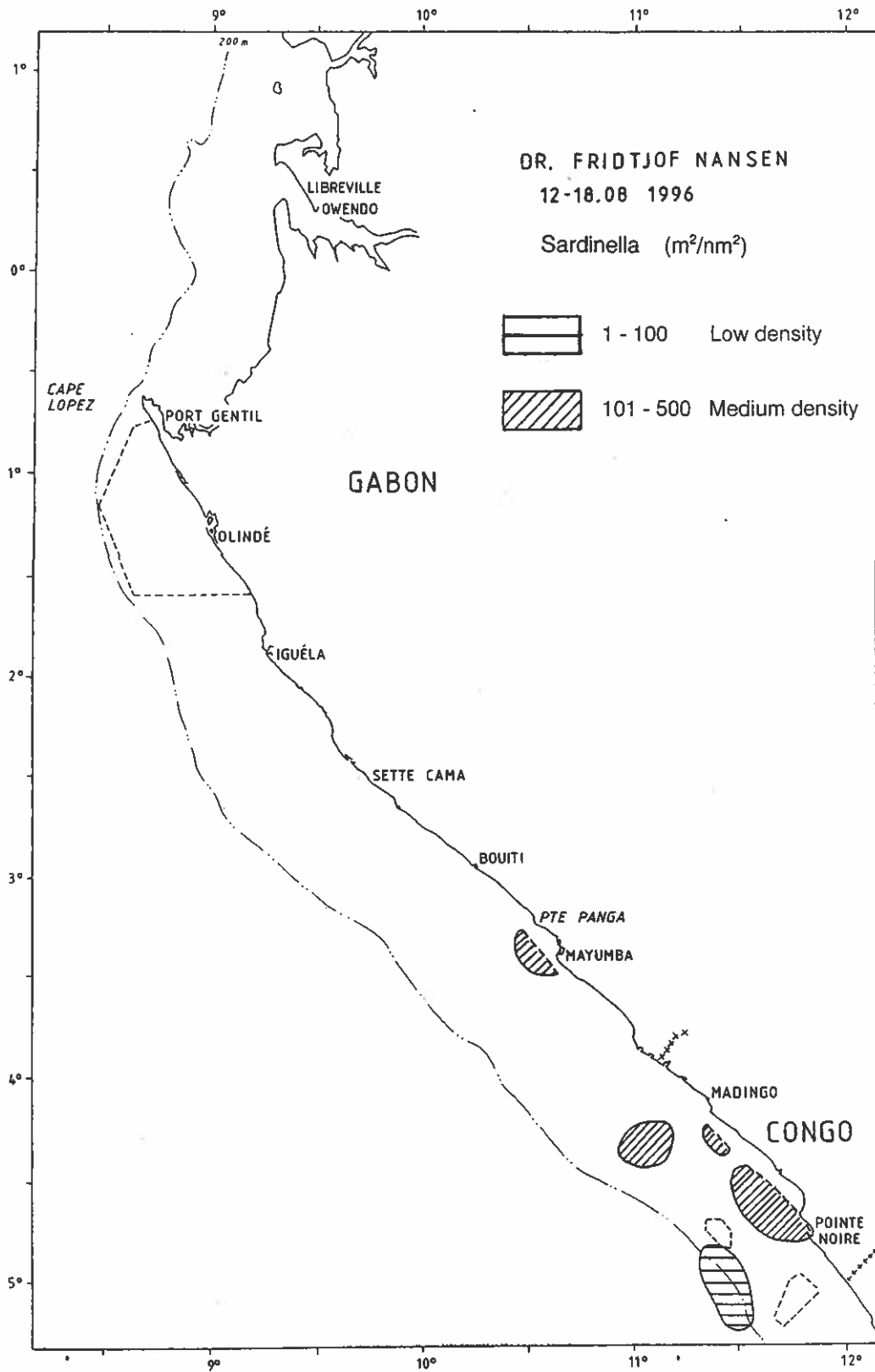


Fig. 9 Distribution and abundance of sardinellas from the echo-integration system

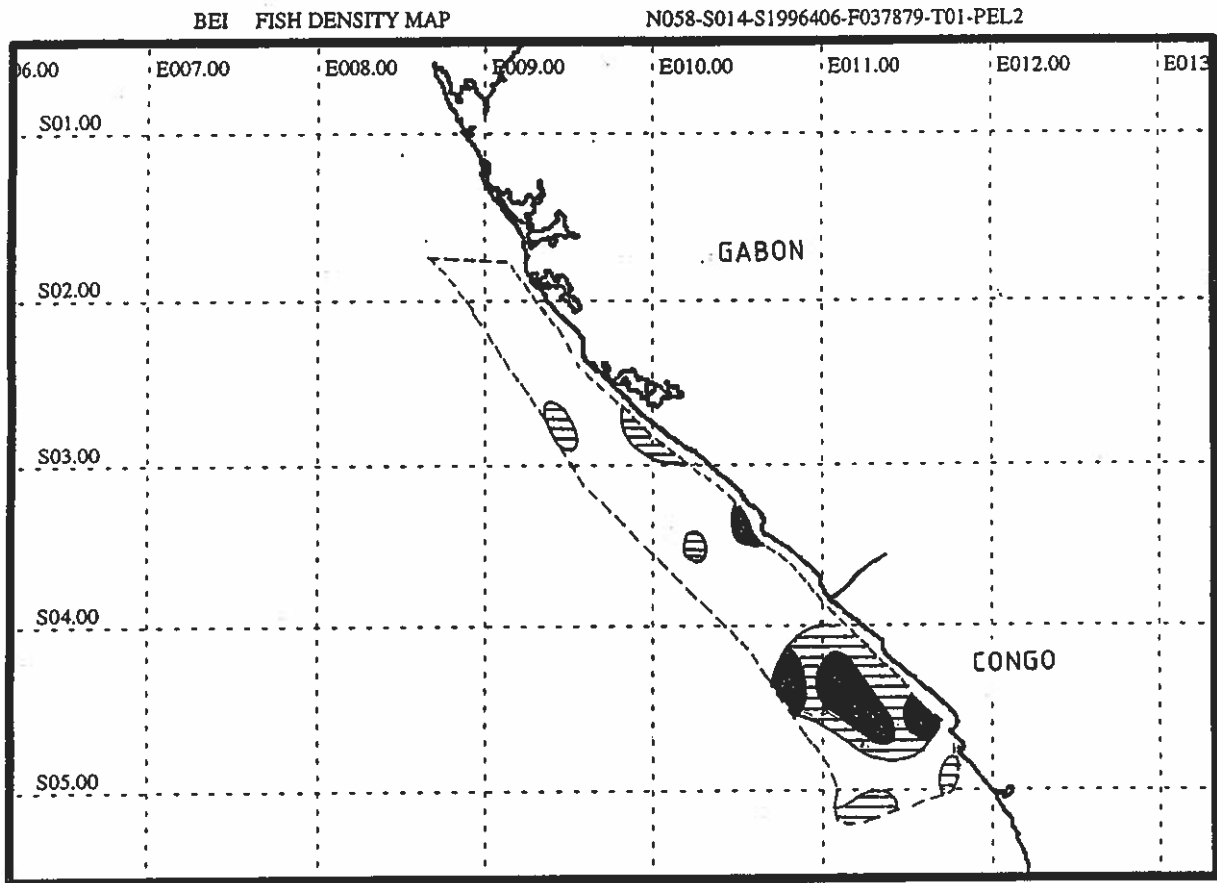


Fig. 10. Distribution and abundance of sardinellas as recorded with the sonar equipment

According to the results obtained in the present survey, this result shows the lowest abundance ever recorded by the RV 'Dr. Fridtjof Nansen'. In August 1994 the biomass was estimated at about 130 000 tonnes (70% *Sardinella maderensis*, 30% *S. aurita*); in August 1995 the biomass was estimated at about 100 000 tonnes with equal share between the two species. During this survey sardinella seemed to have almost disappeared, at least according to the echo-sounder

sounder observations. As already mentioned, however, the situation may appear less dramatic once the data from the sonar are processed.

Anchovy

Anchovy (*E. encrasicolus*) were found in a small area between Bouiti and Pointe Panga. This species was represented by juveniles only, with a mode of 6 cm. Annex II shows the length frequency distribution of this species.

Horse mackerel

Fig 11 shows the distribution and the abundance of horse mackerel (*Trachurus trecae*) off Congo and Gabon. This species was recorded in dense concentrations in the inner shelf between Pte. Panga and Setté Cama. The length frequency distribution showed the presence of two modes of juvenile fish, at 4 and 11 cm. Another area of distribution was detected on the outer shelf in an area just north of the Congo border to south of Mayumba. In this area the specimens were very large, with a mode of 38 cm (33 to 42 cm). A few juveniles (length about 6 cm) however also appeared in the catches. Fig. 12 shows the length distribution for the whole shelf of Gabon. The biomass was estimated to about 13 000 tonnes, which is at the same level as August 1994.

P2 (carangids, scombrids, barracudas and hairtails)

Figure 13 shows the distribution of this large group and Table 2 the catch rates of the main groups and of cephalopods. In the category 'Other Carangids' the most common species of this family are included (*Selene dorsalis*, *Decapterus punctatus* and *Alectis alexandrinus*), but not horse mackerel, considered under a separate chapter. The catch rates were very low, and the usually most abundant species, *Chloroscombrus chrysurus*, was never caught. This is also a warm water species that might have moved into inshore waters in search of higher water temperatures. Scombrids were represented by *Scomberomorus tritor* and *Scomber japonicus*, but these species were also caught sporadically and in low quantities. *Trichiurus lepturus* was caught mainly on the outer stations.

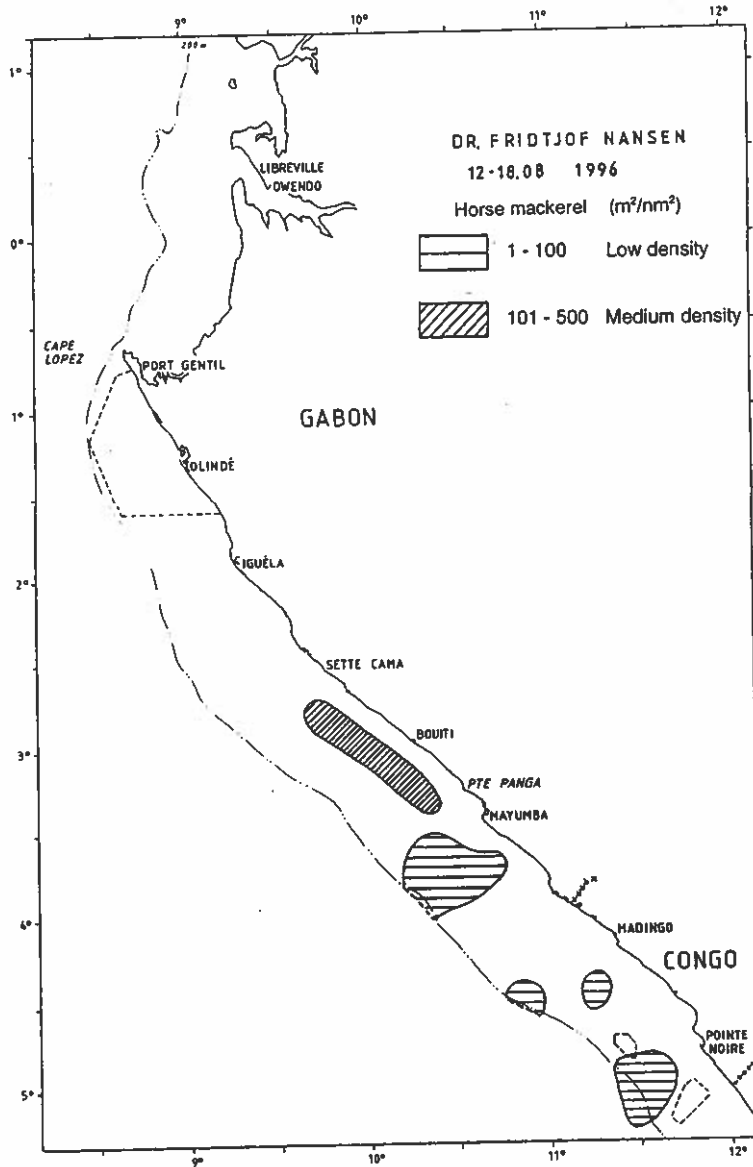


Fig.11 Distribution and abundance of horse mackerel, Congo-Gabon

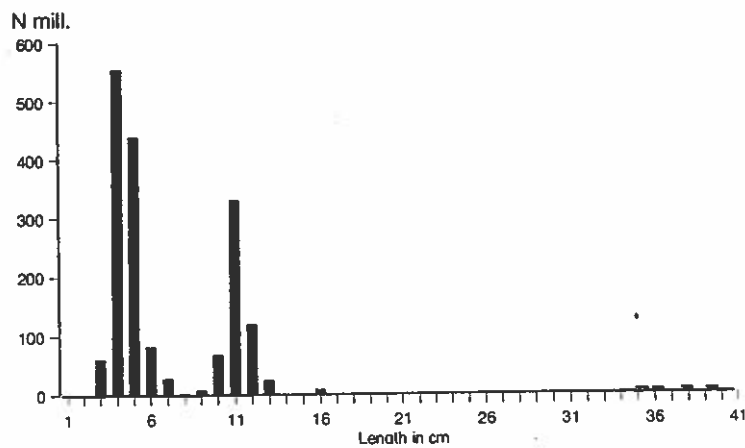


Fig. 12. Length distribution of horse mackerel, Gabon

A rough estimate of the total biomass of this group was 85 000 tonnes.

Table 2. Catch rates in the pelagic trawl of main groups of pelagic fish type 2, Gabon (kg/h)

ST.NO.	DEP.	Oth. Carang	Scombrids	Barracudas	Hairtail	Cephal.	Other
157	10	0.1	0.2			0.7	60.74
158	5					0.5	445.80
159	0	3.0	22.6				6.04
160	105						0.02
161	146					2.3	58.66
162	15		7.6	25.4		6.0	205.60
163	5	0.0	22.6			1.2	80.62
164	5	24.3	19.1			1.3	32.74
165	0		0.3		4.5	1.7	7.36
166	0		6.9				90.16
167	0	0.0	1.6			1.1	3.28
168	103					6.3	455.72
169	0			93.1	101.0		133.66
MEAN		2.1	6.2	9.1	8.1	1.6	121.57

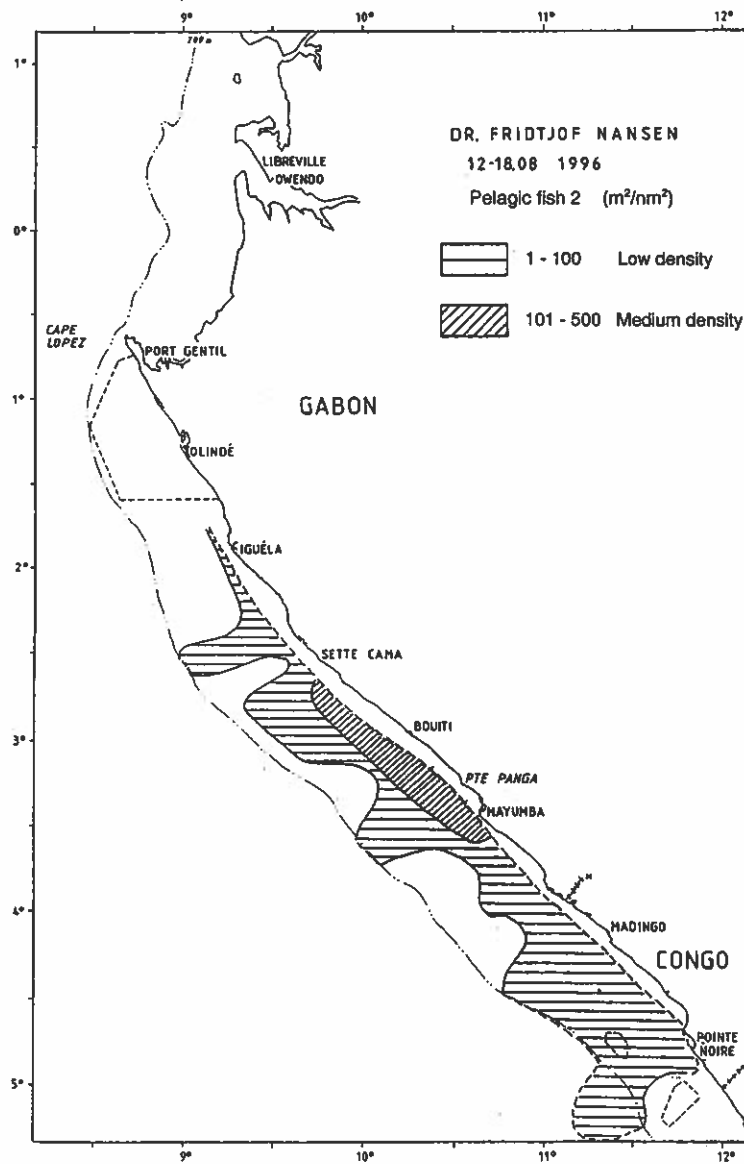
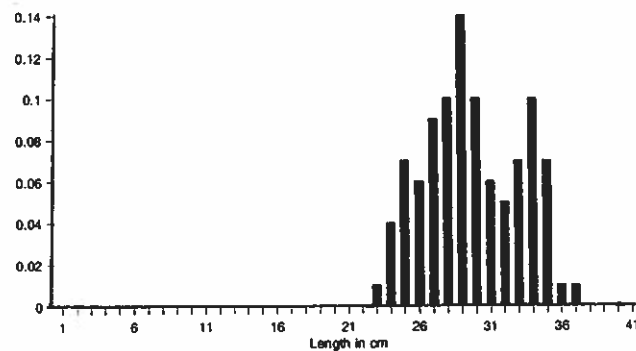


Fig. 13. Abundance and distribution of pelagic fish type 2, Congo-Gabon

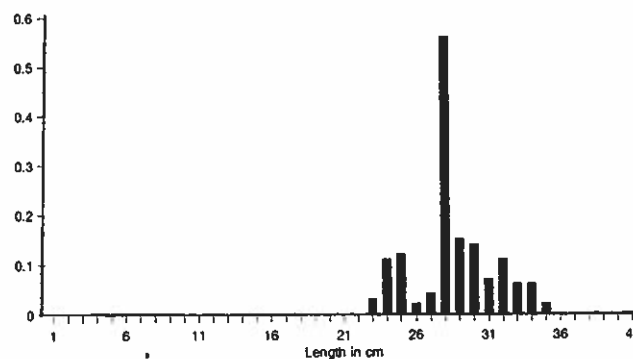
4.2 CONGO

Clupeids

A few areas of distribution were detected off Congo (see Fig. 9, based on the echo-sounder recordings). However, in large areas, where no sardinella were observed on the echograms, schools appeared in the sonar and were caught by pelagic trawl fishing at the surface. Fig. 10 shows the extension of the sardinella distribution from the sonar recordings, which certainly better represent the real distribution of these species. A preliminary assessment of the sardinella stock in Congo, based on the available echo-integrator values, produced the following results: 30 000 t for *Sardinella aurita* and 12 000 tonnes for *S. maderensis*, total 42 000 t. The former species had not been recorded last year while for the latter the estimate was 69 000 t. The cooler conditions found in the area, combined with a change in behaviour with subsequent more frequent occurrence in the upper water layers may, at least partly, explain the fluctuations observed.



a) *Sardinella aurita*



b) *Sardinella maderensis*

Fig. 14. Length distribution of sardinellas, Congo

The present estimate will probably result in an underestimate once the sonar data are processed. Figure 14 (a and b) shows the length frequency distribution of both species. Most sardinella were adults, with modes of 27 cm.

Anchovy

Like in past years, no typical schools of *Engraulis encrasicolus* were recorded and the species was never caught in Congo waters.

Horse mackerel

Trachurus trecae was caught in small amounts on a few stations on the inner and outer shelf between Madingo and Pointe Noire (Fig. 9). It consisted mostly of very large specimens with a mode of 38 cm (fig.14) but a few juveniles were also caught in the inshore waters. The biomass was estimated at 8 000 tonnes. This low level is consistent with previous observations. In 1995 the S_A -values were so low as not to allow the biomass estimate while in 1994 this was about 10 400 tonnes.

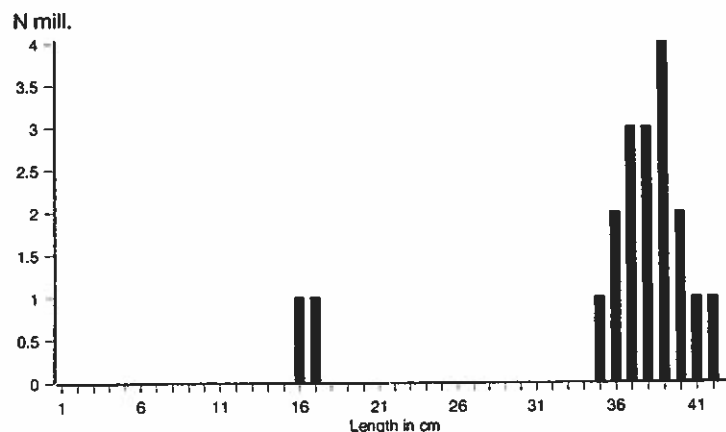


Fig. 15. Length distribution of horse mackerel, Congo

P2 (carangids, scombrids, barracudas and hairtails)

Pelagic fish type 2 was encountered throughout the shelf, although never in large concentrations. Table 3 shows the catch rates of the main groups of species included under this single denomination.

Table 3. Catch rates in the pelagic trawl of main groups of plagic fish type 2, Congo (kg/h)

ST.NO.	DEP.	Oth. Karang	Scombrids	Barracudas	Hairtail	Cephal.	Other
170		0.02	11.16		114.00	0.04	92.99
171		0.46			182.40	0.16	10.24
172							
173				0.32			51.08
174							0.02
175		0.02					
176		67.20	16.90		19.80		308.50
177					40.40	0.44	302.58
178		6.94			15.10	0.14	251.68
179		83.80	4.28		28.00	0.22	82.68
180		18.70		327.60			6.62
181				60.80		0.06	136.36
MEAN		14.76	2.70	32.39	33.31	0.09	103.56

Selene dorsalis (lookdown) and scombrids (*Sarda sarda* and *Scomber japonicus*) were caught in almost all hauls both on the inner and outer part of the shelf. *Sphyraena afra* (barracuda) was caught on several stations, all specimens of very large size (>100 cm). *Trichiurus lepturus* (hairtail) was common in the catches on the outer shelf.

The biomass of this group was estimated at about 23 000 tonnes.

CHAPTER 5 MATURITY OF MAIN PELAGIC SPECIES

Figures 16, a and b show the relative frequency of the maturity stages 1 to 5 for *Sardinella maderensis* and *Trachurus trecae*, respectively.

More than 50% of the sardinella measured were spawning and 100% of the specimens above 34 cm (TL) had running gonads. This large sardinella was found off Congo, at the edge of the continental shelf, in a zone of strong surface currents with northwest direction. Offshore spawning of sardinella has been observed off northern Angola. This suggests the presence of a mechanism that transports the eggs and larvae back to the shallow coastal areas.

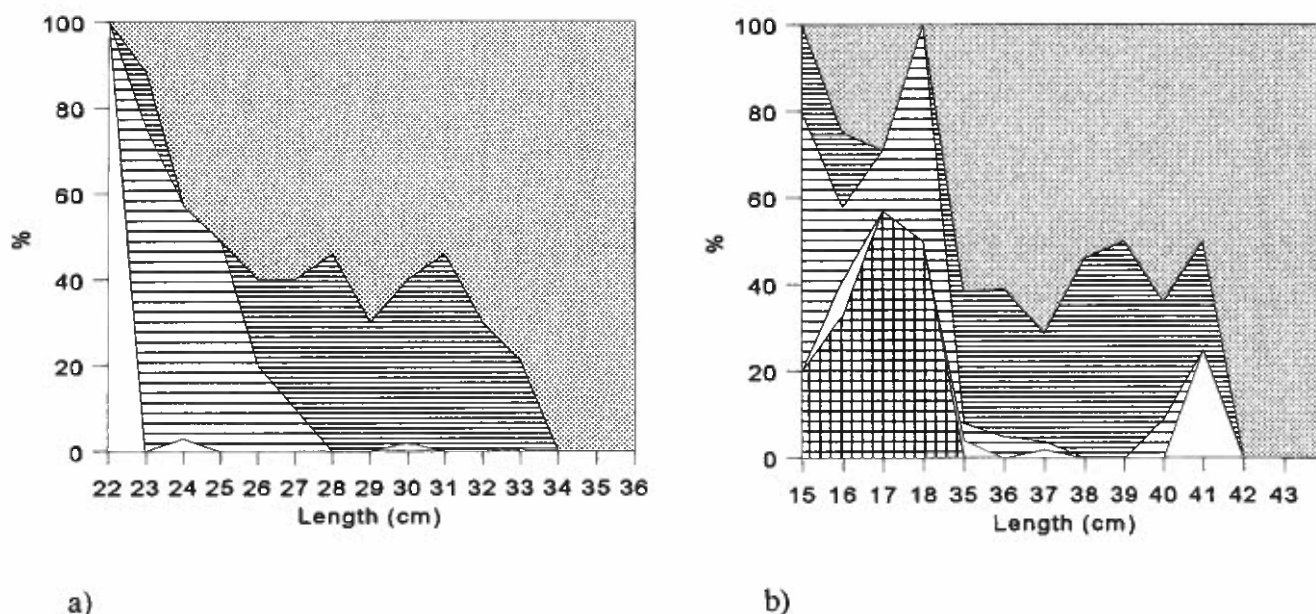


Figure 16. Relative frequency of maturity stages at different length groups.

a) *Sardinella maderensis*; b) *Trachurus trecae*

Large specimens (>42 cm TL) of horse mackerel were all spawning and also these occurred offshore. However, carangids in general are known to spawn in deep waters and juveniles of various species were caught pelagically in the deep-water stations. Young fish are found in the nursery areas of shallow coastal waters but the mechanisms of how the larvae and juveniles are transported towards the coast are not yet understood.

Annex I Records of fishing stations

PROJECT STATION: 157
 DATE: 13/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 207 Long E 912
 start stop duration
 TIME : 04:14:00 04:44:00 30 (min) Purpose code: 1
 LOG : 5546.10 5548.00 1.90 Area code : 2
 FDEPTH: 10 10 GearCond.code: 4
 BDEPTH: 42 46 Validity code: 4
 Towing dir: 244° Wire out: 180 m Speed: 38 kn*10
 Sorted: 30 Kg Total catch: 30.92 CATCH/HOUR: 61.84

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
T U R T L E S	40.00	2	64.58	
Trachurus trecae	18.58	11892	30.05	263
J E L L Y F I S H	1.40		2.26	
Lagocephalus laevis	0.36	6	0.58	
Sepia sp.	0.34	18	0.55	
Alloteuthis africana	0.30	130	0.49	
Ariomma bondi	0.22	104	0.36	
Scomber japonicus	0.20	16	0.32	
OMMASTREPHIDAE	0.14	62	0.23	
Sardinella aurita	0.10	5	0.16	
Decapterus punctatus	0.08	2	0.13	
Saurida brasiliensis	0.08	8	0.13	
Selene dorsalis, juveniles	0.04	20	0.06	
Total	61.84		100.00	

PROJECT STATION: 158
 DATE: 13/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 218 Long E 905
 start stop duration
 TIME : 08:33:00 09:03:00 30 (min) Purpose code: 1
 LOG : 6584.20 6585.90 1.70 Area code : 2
 FDEPTH: 5 5 GearCond.code: 4
 BDEPTH: 72 69 Validity code: 4
 Towing dir: 94° Wire out: 160 m Speed: 37 kn*10
 Sorted: 223 Kg Total catch: 223.15 CATCH/HOUR: 446.30

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Carcharhinus galapagensis	400.00	6	89.63	
Rachycentron canadum	41.00	4	9.19	
Lagocephalus laevis	4.72	42	1.06	
Sepiella ornata	0.50	24	0.11	
Echeneis naucrates	0.08	4	0.02	
Total	446.30		100.01	

PROJECT STATION: 159
 DATE: 13/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 222 Long E 925
 start stop duration
 TIME : 11:51:00 12:21:00 30 (min) Purpose code: 1
 LOG : 5610.10 5611.80 1.70 Area code : 2
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 30 35 Validity code: 4
 Towing dir: 235° Wire out: 165 m Speed: 34 kn*10
 Sorted: 15 Kg Total catch: 15.88 CATCH/HOUR: 31.76

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Scomberomorus tritor	22.68	14	71.41	
J E L L Y F I S H	6.02		18.95	
Alectis alexandrinus	3.02	4	9.51	
Carangidae juveniles	0.02	30	0.06	
Selene dorsalis, juveniles	0.02	2	0.06	
Total	31.76		99.99	

PROJECT STATION: 160
 DATE: 13/ 8/96 GEAR TYPE: PT No:5 POSITION: Lat S 238 Long E 903
 start stop duration
 TIME : 15:30:00 16:08:00 38 (min) Purpose code: 1
 LOG : 6641.30 6643.50 2.20 Area code : 1
 FDEPTH: 100 110 GearCond.code: 4
 BDEPTH: 140 140 Validity code: 4
 Towing dir: 350° Wire out: 230 m Speed: 35 kn*10
 Sorted: Kg Total catch: 0.01 CATCH/HOUR: 0.02

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	0.02	3	100.00	
Total	0.02		100.00	

PROJECT STATION: 161
 DATE: 13/ 8/96 GEAR TYPE: BT No:9 POSITION: Lat S 235 Long E 901
 start stop duration
 TIME : 16:52:00 17:10:00 18 (min) Purpose code: 1
 LOG : 6646.60 6647.50 0.90 Area code : 2
 FDEPTH: 148 143 GearCond.code: 4
 BDEPTH: 148 143 Validity code: 4
 Towing dir: 350° Wire out: 520 m Speed: 28 kn*10
 Sorted: 18 Kg Total catch: 18.31 CATCH/HOUR: 61.03

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Erythrocles monodi	23.83	540	39.05	
Spicara alta	16.77	410	27.48	
Dentex congoensis	4.53	73	7.42	
Umbrina canariensis	2.60	7	4.26	
Ariomma bondi	2.60	33	4.26	
Dentex gibbosus	1.77	3	2.90	
Scorpaena scrofa	1.53	3	2.51	
Dentex angolensis	1.43	10	2.34	
Illex coindetii	1.37	27	2.24	
Raja miraletus	1.20	3	1.97	
Boops boops	1.03	47	1.69	
Todaropsis eblanae	1.00	37	1.64	
Zeus faber	0.53	3	0.87	
Citharus linguatula	0.30	7	0.49	
Lepidotrigla cadmani	0.20	3	0.33	
Lepidotrigla carolae	0.17	7	0.28	
Anthias anthias	0.10	3	0.16	
Sepia bertheloti	0.07	3	0.11	
Total	61.03		100.00	

PROJECT STATION: 162
 DATE: 14/ 8/96 GEAR TYPE: PT No:6 POSITION: Lat S 247 Long E 949
 start stop duration
 TIME : 06:20:00 06:23:00 3 (min) Purpose code: 1
 LOG : 6770.50 6770.60 0.10 Area code : 2
 FDEPTH: 15 15 GearCond.code: 4
 BDEPTH: 32 32 Validity code: 4
 Towing dir: 263° Wire out: 160 m Speed: 36 kn*10
 Sorted: 12 Kg Total catch: 12.24 CATCH/HOUR: 244.80

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Trachurus trecae	75.00	118420	30.64	
Engraulis encrasicolus	67.60	48500	27.61	265
J E L L Y F I S H	45.20	20	18.46	
Sphyræna guachancho	25.40	60	10.38	
Stromateus fiatola	11.20	20	4.58	
Scomber japonicus	7.60	3920	3.10	
Sepiella ornata	6.00	120	2.45	
Iliaha africana	3.00	140	1.23	
Brachydeuterus auritus	1.80	20	0.74	
CIUSL92	1.80	1420	0.74	264
Total	244.60		99.93	

PROJECT STATION: 163
 DATE: 14/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 253 Long E 946
 start stop duration
 TIME : 08:21:00 08:51:00 30 (min) Purpose code: 1
 LOG : 6784.40 6786.30 1.90 Area code : 2
 FDEPTH: 5 5 GearCond.code: 4
 BDEPTH: 48 46 Validity code: 4
 Towing dir: 42° Wire out: 160 m Speed: 31 kn*10
 Sorted: 52 Kg Total catch: 52.24 CATCH/HOUR: 104.48

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
J E L L Y F I S H	42.00		40.20	
Trachurus trecae	34.42	23602	32.94	266
Scomber japonicus	22.64	17432	21.67	268
Engraulis encrasicolus	3.84	1310	3.68	267
OMMASTREPHIDAE	1.12	374	1.07	
Echeneis naucrates	0.36	2	0.34	
Sepiella ornata	0.08	4	0.08	
Selene dorsalis, juveniles	0.02	2	0.02	
Total	104.48		100.00	

PROJECT STATION: 164
 DATE: 14/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 258 Long E 958
 start stop duration
 TIME : 14:29:00 14:59:00 30 (min) Purpose code: 1
 LOG : 6839.10 6840.70 1.60 Area code : 2
 FDEPTH: 5 5 GearCond.code: 4
 BDEPTH: 38 42 Validity code: 4
 Towing dir: 250° Wire out: 180 m Speed: 32 kn*10
 Sorted: 38 Kg Total catch: 38.80 CATCH/HOUR: 77.60

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Alectis alexandrinus	24.00	6	30.93	
Scomber japonicus	18.76	14576	24.18	270
Trachurus trecae	17.62	18942	22.71	269
J E L L Y F I S H	15.12	248	19.48	
Illex coindetii	1.14	456	1.47	
Selene dorsalis, juveniles	0.38	38	0.49	
Scomberomorus tritor	0.38	38	0.49	
Sepiella ornata	0.20	6	0.26	
Total	77.60		100.01	

PROJECT STATION: 165
 DATE: 15/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 318 Long E 1014
 start stop duration
 TIME :01:16:00 01:46:00 30 (min) Purpose code: 1
 LOG :6944.10 6945.90 1.80 Area code : 2
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 47 41 Validity code: 4
 Towing dir: 35° Wire out: 160 m Speed: 36 kn*10
 Sorted: 7 Kg Total catch: 7.01 CATCH/HOUR: 14.02

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Trichiurus lepturus	4.56	10	32.52
Trachurus trecae	3.06	272	21.83
Sardinella aurita	2.88	94	20.54
OMMASTREPHIDAE	1.52	238	10.84
J E L L Y F I S H	1.04	34	7.42
Boops boops	0.36	74	2.57
Scomber japonicus	0.32	12	2.28
Sepiella ornata	0.26	12	1.85
Monochirus hispidus	0.02	2	0.14
Total	14.02		99.99

PROJECT STATION: 170
 DATE: 16/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 505 Long E 1128
 start stop duration
 TIME :20:30:00 21:03:00 33 (min) Purpose code: 1
 LOG :7279.10 7281.80 2.70 Area code : 1
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 159 120 Validity code: 4
 Towing dir: 64° Wire out: 150 m Speed: 4 kn*10
 Sorted: 120 Kg Total catch: 120.02 CATCH/HOUR: 218.22

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Trichiurus lepturus	114.00	276	52.24
MYCTOPHIDAE	46.09	38822	21.12
Sardinella maderensis	33.18	116	15.20
Trachurus trecae	13.45	33	6.16
Sarda sarda	11.16	4	5.11
Paralepis sp.	0.22	22	0.10
Saurida brasiliensis	0.05	11	0.02
Sepiella ornata	0.04	2	0.02
Selene dorsalis, juveniles	0.02	13	0.01
Total	218.21		99.98

PROJECT STATION: 166
 DATE: 15/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 326 Long E 1032
 start stop duration
 TIME :08:15:00 08:45:00 30 (min) Purpose code: 1
 LOG :7008.00 7010.00 2.00 Area code : 2
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 30 35 Validity code: 4
 Towing dir: 250° Wire out: 150 m Speed: 39 kn*10
 Sorted: 48 Kg Total catch: 48.55 CATCH/HOUR: 97.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Sardinella maderensis	65.30	1850	67.25
J E L L Y F I S H	23.40	30	24.10
Scomberomus tritor	6.94	46	7.15
Sardinella aurita	1.32	42	1.36
Lagocephalus laevisgatus	0.14	6	0.14
Total	97.10		100.00

PROJECT STATION: 171
 DATE: 17/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 510 Long E 1116
 start stop duration
 TIME :01:45:00 02:15:00 30 (min) Purpose code: 1
 LOG :7313.90 7315.60 1.70 Area code : 1
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 1106 999 Validity code: 4
 Towing dir: 53° Wire out: 160 m Speed: 41 kn*10
 Sorted: 96 Kg Total catch: 96.63 CATCH/HOUR: 193.26

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Trichiurus lepturus	182.40	480	94.38
MYCTOPHIDAE	9.88	7904	5.11
Selene dorsalis, juveniles	0.46	220	0.24
Cubiceps sp.	0.32	14	0.17
OMMASTREPHIDAE	0.14	16	0.07
Arionma sp.	0.02	10	0.01
Sepiella ornata	0.02	2	0.01
Paralepis sp.	0.02	8	0.01
Total	193.26		100.00

PROJECT STATION: 167
 DATE: 15/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 330 Long E 1031
 start stop duration
 TIME :10:46:00 11:16:00 30 (min) Purpose code: 1
 LOG :7025.90 7027.80 1.90 Area code : 2
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 40 43 Validity code: 4
 Towing dir: 211° Wire out: 150 m Speed: 37 kn*10
 Sorted: 3 Kg Total catch: 3.03 CATCH/HOUR: 6.06

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
J E L L Y F I S H	3.22	62	53.14
Scomberomus tritor	1.62	2	26.73
Sepia sp.	1.12	462	18.48
Chaetodon marcellae	0.02	2	0.33
Selene dorsalis, juveniles	0.02	2	0.33
Chaetodon sp.	0.02	4	0.33
Lagocephalus laevisgatus	0.02	2	0.33
Scomber japonicus	0.02	2	0.33
Total	6.06		100.00

PROJECT STATION: 172
 DATE: 17/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 442 Long E 1135
 start stop duration
 TIME :06:36:00 06:51:00 15 (min) Purpose code: 1
 LOG :7356.00 7357.40 0.80 Area code : 1
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 48 49 Validity code: 1
 Towing dir: 135° Wire out: 150 m Speed: 32 kn*10
 Sorted: Kg Total catch: CATCH/HOUR:

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
N O C A T C H	0.00		
Total			

PROJECT STATION: 168
 DATE: 15/ 8/96 GEAR TYPE: BT No:9 POSITION: Lat S 346 Long E 1020
 start stop duration
 TIME :13:44:00 14:14:00 30 (min) Purpose code: 1
 LOG :7047.10 7048.60 1.50 Area code : 2
 FDEPTH: 104 102 GearCond.code: 4
 BDEPTH: 104 102 Validity code: 4
 Towing dir: 360° Wire out: 380 m Speed: 30 kn*10
 Sorted: 139 Kg Total catch: 231.05 CATCH/HOUR: 462.10

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Trachurus trecae	237.90	554	51.48
Dentex gibbosus	142.98	172	30.94
Epinephelus aeneus	33.80	4	7.31
Mutellus mustelus	15.58	8	3.37
Pagrus caeruleostictus	8.30	4	1.80
Dentex congosensis	6.90	178	1.49
OMMASTREPHIDAE	6.38	364	1.38
Dentex angolensis	5.74	98	1.24
Zeus faber	2.34	14	0.51
Sparus pagrus africanus *	1.20	4	0.26
Arionma bondi	0.88	22	0.19
Citharus linguatula	0.10	2	0.02
Total	462.10		99.99

PROJECT STATION: 173
 DATE: 17/ 8/96 GEAR TYPE: BT No:7 POSITION: Lat S 433 Long E 1136
 start stop duration
 TIME :08:28:00 08:58:00 30 (min) Purpose code: 1
 LOG :7369.50 7371.20 1.70 Area code : 1
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: Towing dir: 240° Wire out: 150 m Speed: 34 kn*10
 Sorted: 26 Kg Total catch: 25.70 CATCH/HOUR: 51.40

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Sardinella aurita	32.40	148	63.04
Sardinella maderensis	12.10	80	23.54
Brachydeuterus auritus	5.46	72	10.62
Trachurus trecae	0.96	20	1.87
Sphyrana guachancho	0.32	2	0.62
Sardinella aurita (Juvenile)	0.14	12	0.27
Trachurus trecae	0.02	24	0.04
Total	51.40		100.00

PROJECT STATION: 169
 DATE: 15/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 344 Long E 1044
 start stop duration
 TIME :18:37:00 19:07:00 30 (min) Purpose code: 1
 LOG :7087.90 7090.00 2.10 Area code : 2
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 41 44 Validity code: 4
 Towing dir: 254° Wire out: 150 m Speed: 37 kn*10
 Sorted: 108 Kg Total catch: 163.89 CATCH/HOUR: 327.78

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Trichiurus lepturus	101.00	1288	30.81
Sphyrana fra	92.30	4	28.16
J E L L Y F I S H	78.12	4360	23.83
Trachurus trecae	37.28	11184	11.37
Stromateus fiatola	8.04	18	2.45
Trachurus trecae	6.42	14	1.96
Sepia officinalis hierredda	3.80	12	1.16
Sphyrana guachancho	0.82	2	0.25
Total	327.78		99.99

PROJECT STATION: 174
 DATE: 17/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 440 Long E 1122
 start stop duration
 TIME :10:35:00 11:05:00 30 (min) Purpose code: 1
 LOG :7386.00 7387.80 1.80 Area code : 1
 FDEPTH: 0 0 GearCond.code: 4
 BDEPTH: 93 103 Validity code: 4
 Towing dir: 240° Wire out: 160 m Speed: 37 kn*10
 Sorted: Kg Total catch: 0.01 CATCH/HOUR: 0.02

SPECIES	CATCH/HOUR	% OF TOT. C	SAMP
weight	numbers		
Lagocephalus laevisgatus	0.02	2	100.00
Total	0.02		100.00

PROJECT STATION: 175
 DATE: 17/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 429 Long E 1120
 start stop duration
 TIME :13:20:00 13:50:00 30 (min) Purpose code: 1
 LOG :7408.99 7410.70 1.80 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 68 60 Validity code: 4
 Towing dir: 22° Wire out: 160 m Speed: 3 kn*10
 Sorted: Kg Total catch: 0.01 CATCH/HOUR: 0.02

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Selene dorsalis	0.02	2	100.00	
Total	0.02		100.00	

PROJECT STATION: 176
 DATE: 18/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 420 Long E 1052
 start stop duration
 TIME :19:34:00 20:04:00 30 (min) Purpose code: 1
 LOG :7464.50 7466.10 1.60 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 117 116 Validity code: 4
 Towing dir: 25° Wire out: 150 m Speed: 3 kn*10
 Sorted: 206 Kg Total catch: 206.20 CATCH/HOUR: 412.40

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	164.10	400	39.79	288
Selene dorsalis	67.20	242	16.29	
Trachurus trecae	54.96	138	13.33	290
Axius thazard	52.50	170	12.73	
Sardinella maderensis	36.60	126	8.87	289
Trichurus lepturus	19.80	44	4.80	
Scomber japonicus	16.90	26	4.10	
Ariomma bondi	0.28	16	0.07	
Saurida brasiliensis	0.06	8	0.01	
Total	412.40		99.99	

PROJECT STATION: 177
 DATE: 17/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 411 Long E 1050
 start stop duration
 TIME :23:58:00 00:28:00 30 (min) Purpose code: 1
 LOG :7501.20 7502.80 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 103 104 Validity code: 4
 Towing dir: 140° Wire out: 160 m Speed: 3 kn*10
 Sorted: 171 Kg Total catch: 171.71 CATCH/HOUR: 343.42

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Mobula rochebrunei	300.00	8	87.36	
Trichurus lepturus	40.40	118	11.76	
Trachurus trecae	1.14	12	0.33	291
Saurida brasiliensis	1.10	228	0.32	
Sepia sp.	0.44	18	0.13	
Echeneis naucrates	0.26	8	0.08	
Naucrates ductor	0.04	2	0.01	
Ariomma bondi	0.04	2	0.01	
Total	343.42		100.00	

PROJECT STATION: 178
 DATE: 18/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 421 Long E 1102
 start stop duration
 TIME :02:22:00 02:52:00 30 (min) Purpose code: 1
 LOG :7517.20 7518.90 1.70 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 103 103 Validity code: 4
 Towing dir: 130° Wire out: 160 m Speed: 3 kn*10
 Sorted: 134 Kg Total catch: 134.90 CATCH/HOUR: 269.80

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella maderensis	158.40	568	58.71	294
Sardinella aurita	90.70	254	33.62	293
Trichurus lepturus	15.10	48	5.60	
Selene dorsalis	6.94	64	2.57	
Trachurus trecae	1.84	26	0.68	292
Saurida brasiliensis	0.32	60	0.12	
Ariomma bondi	0.22	4	0.08	
Echeneis naucrates	0.20	2	0.07	
Sepiella ornata	0.08	2	0.03	
Todaropsis eblanae	0.06	4	0.02	
Total	273.86		101.50	

PROJECT STATION: 179
 DATE: 18/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 429 Long E 1111
 start stop duration
 TIME :04:12:00 04:42:00 30 (min) Purpose code: 1
 LOG :7529.90 7531.70 1.80 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 102 104 Validity code: 4
 Towing dir: 160° Wire out: 160 m Speed: 40 kn*10
 Sorted: 99 Kg Total catch: 99.49 CATCH/HOUR: 198.98

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Selene dorsalis	83.80	354	42.11	
Trachurus trecae	70.20	174	35.28	296
Trichurus lepturus	28.00	58	14.07	
Sardinella maderensis	10.94	32	5.50	295
Sarda sarda	3.24	4	1.63	
Scomber japonicus	1.04	2	0.52	
Sardinella aurita	0.84	2	0.42	
Saurida brasiliensis	0.56	134	0.28	
Sepiella ornata	0.22	6	0.11	
Ariomma bondi	0.14	2	0.07	
Total	198.98		99.99	

PROJECT STATION: 180
 DATE: 18/ 8/96 GEAR TYPE: PT No:2 POSITION: Lat S 411 Long E 1112
 start stop duration
 TIME :07:35:00 08:05:00 30 (min) Purpose code: 1
 LOG :7556.80 7558.60 1.80 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 31 37 Validity code: 4
 Towing dir: 164° Wire out: 150 m Speed: 16 kn*10
 Sorted: 176 Kg Total catch: 176.46 CATCH/HOUR: 352.92

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sphyræna afra	327.60	24	92.83	297
Alectis alexandrinus	17.64	14	5.00	
Rhizoprionodon acutus	4.96	2	1.41	
Trachurus trecae	1.62	4	0.46	
Selene dorsalis	1.06	10	0.30	
Echeneis naucrates	0.04	8	0.01	
Total	352.92		100.01	

PROJECT STATION: 181
 DATE: 18/ 8/96 GEAR TYPE: PT No:7 POSITION: Lat S 419 Long E 1123
 start stop duration
 TIME :10:47:00 11:17:00 30 (min) Purpose code: 1
 LOG :7583.00 7584.60 1.60 Area code : 1
 FDEPTH: 0 0 GearCond.code: 1
 BDEPTH: 22 20 Validity code: 4
 Towing dir: 130° Wire out: 150 m Speed: 3 kn*10
 Sorted: 98 Kg Total catch: 98.60 CATCH/HOUR: 197.20

SPECIES	CATCH/HOUR		% OF TOT. C	SAMP
	weight	numbers		
Sardinella aurita	79.70	392	40.42	298
Sphyræna afra	60.80	2	30.83	
Sardinella maderensis	52.50	334	26.62	299
Sphyrna lewini	4.00	2	2.03	
Brachydeuterus auritus	0.08	2	0.04	
Sepiella ornata	0.06	2	0.03	
Echeneis naucrates	0.04	2	0.02	
Trachurus trecae, juvenile	0.04	12	0.02	
Total	197.22		100.01	

Annex II Instruments and fishing gear used

The Simrad EK-500/38kHz scientific sounder was used during the survey for fish abundance estimation. The Bergen Echo Integrator system (BEI) was used to scrutinize the acoustic records from the 38kHz echo sounder, and to allocate integrator values to fish species.

The details of the settings of the 38kHz echo sounder where as follows:

Tranceiver-1 menu (38 kHz lowering keel)

Transducer depth	0.00 m
Absorbtion coeff.	10 dB/km
Pulse length	medium (1ms)
Bandwidth	wide
Max power	2000 Watt
2-way beam angle	-21.0 dB
SV transducer gain	28.1 dB
TS transducer gain	28.0 dB
Angle sensitivity	21.9
3 dB beamwidth	6.8 dg
Alongship offset	0.00 "
Athwardship offset	0.04 "

Display menu

Echogram	1 (38 kHz)
Bottom range	15 m
Bottom range start	10 m
Sv colour min	-67 dB

Printer- menu

Echogram	1 (38 kHz)
Range	100, 250 and 500 m
Range start	0
Bottom range	12 m
Bottom range start	10 m
Sv colour min	-72 dB
TVG	20 log R

Bottom detection menu Minimum level -50 dB