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STUDIES OF THE ABUNDANCE AND DISTRIBUTION OF FISH OFF WEST AFRICA NOVEMBER - DECEMBER 1972

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INTRODUCTION

A brief description of the acoustic survey and exploratory fishing made during the cruise with R/V "G.O. Sars" to West African waters in November - December 1972 is given in the cruise report (ØSTVEDT et al. 1973). The day and night variability and some other variance components in the acoustic estimation of nekton as observed during the cruise have been dealt with separately (MATHISEN, ØSTVEDT and VESTNES 1973).

The present paper deals with the abundance estimate in more detail and the changes in distribution of fish as observed during the cruise.

MATERIAL AND METHODS

The equipment onboard "G.O. Sars" used for the acoustic survey is described in the cruise report. All the acoustic data refered to in the present paper are based on recordings from a 38 kHz Simrad Scientific Sounder combined with three Simrad Echo Integrators QM. The echo intensities were logged by data recorder per nautical mile and an average per five nautical miles were plotted. The echo recordings were analysed every day, and whenever possible the integrated echo intensity assigned according to plankton, pelagic fish and demersal fish. For identification of echo traces

frequent fishing experiments were made using pelagic trawl or bottom trawl. The catch was measured in baskets and a portion, or the total catch, sorted and weighed according to species for estimation of catch in kilograms per hour and the percentage of each species.

During the period the survey was undertaken a commercial purse seine fishery was going on mainly off Cape Timiris and Cape Blanc. Data on catch composition and length distribution were collected during a part of the period onboard the factory vessel "Astra".

GENERAL DISTRIBUTION OF FISH

The relative fish abundance as indicated by integrator deflection obtained from the 38 kHz echo sounder during the period 2 - 18 November is shown in Fig. 1. No corrections have been made for the difference observed between day and night recordings, the latter on an average exceeding the day signals with about 125% (MATHISEN, ØSTVEDT and VESTNES 1973). The increase in night signals as compared with day signals is partly due to fish ascending from bottom thus also affecting the assignment of echo intensity to pelagic and demersal fish. All the data in the figures refer, therefore, to total echo intensity and total amount of fish, except Myctophidae and similar small fish which in several cases not could be separated from Euphausidae and other larger plankton forms. These have therefore been grouped under plankton. On several occasions the signals from plankton were extremely high and made fish traces in the recordings difficult to recognize. This is for instance appearant from the echogram shown in Fig. 7 in the cruise report (ØSTVEDT et al. 1973) where traces of Trachurus sp. were found together with dense plankton layers.

The overall mean of all the observations during the first survey shows that the plankton signals (including Myctophidae) exceeded the fish signals by five times during day and three times during night (MATHISEN, ØSTVEDT and VESTNES 1973). High abundance of plankton was also found over deep waters while, as appears from Fig. 1, the distribution of fish followed closely the continental shelf, beyond which the abundance of fish fell to almost zero. At the edge of the shelf, particularly where the shelf is bisected

by deep canyons as for example west of Cape Timiris and Cape Blanc, very dense concentrations of Myctophidae and Euphasidae often mixed with Trachurus sp. and Brama raji were observed. Fishing on such concentrations with pelagic trawl yielded up to 6 tons per hour. Myctophidae is probably one of the largest unexploited resources in this region

Relative high abundance of fish were found in the areas west of Cape Blanc, St. Louis and south of Cape Verde with slightly lower abundance west of Cape Timiris. On the northwards survey in the second half of November and early December more detailed studies of distribution and exploratory fishing were made in these areas.

The estimated catch in kg per hour and the dominant species for all the trawl hauls made during the survey are given in Table 1. Some of the hauls made with pelagic trawl resulted in no catch as the schools were moving too fast. The locations of the trawl stations are indicated in Fig. 1, 2, 3 and 4.

The composition of the catches particularly with bottom trawl showed a large diversity of species with a considerable variation within short distances. Some species seemed to be aggregated in small areas, sometimes in high abundance. An attempt was made to map the distribution of the most abundant species but identification of the echo traces was difficult and repeated surveys in small areas indicated considerable migration of the schools, even within a short time period.

The first survey in the Cape Blanc region (between 19°30'N and 22°30'N) early in November indicated a general high abundance in most of the region with denser concentrations close to Cape Blanc and southwards towards the edge of the continental shelf (Fig. 1). Also in the shallow water inside Cape Blanc in the shipping route to Nouadhibou several schools of fish were recorded (Fig. 5a), but as no further survey in the shallow waters of Banc D'Arguin was possible these recording are not included in the estimates. A great part of the fish resources in this region is probably to be found in these shallow waters.

Along the coast of Spanish Sahara northwards from about 21°30'N low abundance of fish was observed. This area corresponds closely to an area with higher bottom temperature, above 18°C, than generally was found in the region (Fig. 6). Although the echo intensity was low, small pelagic schools were recorded and a haul with pelagic trawl yielded a few specimens of Sardina pilchardus, fish larvae and small squids. Similar conditions were also observed during the repeated survey by the end of November and early December and, according to verbal reports from fishing skippers in the area relatively good catches of Sardina pilchardus were taken near the coast of Spanish Sahara.

The acoustic survey by the end of November showed that the relative abundance of fish generally had increased on the Cape Blanc region with particular high concentrations near the coast and along the edge of the continental shelf (Fig. 2). Several pelagic schools were observed moving too fast to be caught with pelagic trawl (Table 1).

In the area west of Cape Blanc fishing with bottom trawl during the southwards survey yielded good catches of Diplodes senegalensis (st. 296) while further southwest at the edge of the shelf Dentex sp. (st. 297) were most abundant. On the return survey, also good catches of Sardina pilchardus (st. 330) and Trachurus trecae were taken south and west of Cape Blanc, while Caranx rhonchus (st. 339) and Trachurus trachurus (st. 340) mainly were found further north.

On the southward survey in the Cape Timiris region (between 17°00'N and 19°30'N) a concentration of pelagic schools were detected at about 19°00'N using sonar. Few of these schools were however recorded on the echosounder and thus not integrated. According to reports from purse seiners ("Astra") good catches of Trachurus sp. had been taken in the same area. In November the purse seiners continued fishing in the Cape Timiris region slowly shifting southwards. As the first acoustic survey gave relatively low abundance of fish in the region (Fig. 1) most of the concentrations of pelagic schools were apparently not recorded. More

dense tracks were therefore established during the second survey and the result is shown in Fig. 3. Considerable differences between the two surveys were observed.

The trawl hauls made during the survey yielded a large variety of species, but as shown in Table 1 Trachurus trecae seemed to be most widely distributed and the most abundant species in this region. This is also supported by preliminary catch data from the purse seiners ("Astra") which during the second half of November mainly operated around latitude 18°N where the estimated echo abundance was relatively low (Fig. 3). A more detailed comparison of the acoustic data including sonar observations and the commercial purse seine fishery will be made when all the catch data becomes available.

In St. Louis (between 15°00'N and 17°00'N) high abundance of fish were found in the region close to the shore. Similar conditions were observed during both surveys (Fig. 1 and 4). The conditions in this area are suggestive of coincidence between dense fish concentrations and intensive upwelling . Fishing with pelagic and bottom trawl yielded good catches of Trachurus trecae Brachydeuterus auritus and Anchovy guinensis (Table 1). Observation of length and weight of the different species showed that this region in general was occupied by young fish.

South of Cape Verde (between 12°30'N and 15°00'N) relative good concentrations of fish were found along the edge of the shelf, and during the first survey in a small area close to the coast of Gambia several pelagic schools close to the surface were observed (Fig. 1). Most of the schools moved too fast to be caught with a pelagic trawl. One haul yielded only a few Caranx senegalensis and a second haul mainly Brachydeuterus auritus. From visual observation, however, most of the schools were supposed to be Sardinella sp. A survey of the same area a week later failed to detect these schools (Fig. 4), but further west some schools of Sardinella aurita were found near the bottom (st. 311).

Considering the good commercial catches from all these regions of

pelagic species it is evident that most of the adult stocks of these species were not available to the fishing gears operated onboard "G.O. Sars". The length and weight data also show that mainly small fish were caught with trawl while the purse seiners during the same period were fishing on much bigger fish as shown in Fig. 20 in the cruise report (ØSTVEDT et al. 1973).

ACOUSTIC STOCK ESTIMATE

The behaviour, distribution and composition of a fish resource is of great importance when stock estimates are to be conducted with acoustic equipment. As mentioned for instance by MIDTTUN and NAKKEN (1973) the conditions are best when the fish stock to be estimated is distributed in continuous scattering layers in mid-water at moderate depths. Conditions are much more difficult when the fish stock appears in schools or close to the bottom. Difficulties are also met with when stocks of several species are mixed in the same area.

During the present survey the conditions were in general unfavorable since none of the above mentioned favorable conditions were found. In all the areas a variety of species were mixed and the fish concentrations which were observed over the continental shelf occured in dense schools or semi-pelagic layers. It was therefore not possible to derive the constants which are necessary for an estimate of the absolute stock size by the method described by FORBES and NAKKEN (1973). However, an area integration (I) of the relative integrator deflections (M) plotted in Fig. 1 has been carried out by the equation

$$I = \int_A M \, dA = 2.7 \cdot 10^6 \text{ mm (n mile)}^2$$

An idea of the absolute value resulting from this may be obtained by using in the equation

$$T = m \int_A M \, dA \text{ tons}$$

values for m which are typical for similar species in other areas. For instance for blue whiting (Gadus poutassou) the value of m

in the equation above is found to be 0.4 measured with the equipment onboard "G.O. Sars" (MIDTTUN and NAKKEN 1973). Application of this constant on the relative abundance for the region from north of Cape Blanc to south of Cape Verde estimated during the southward survey (Fig. 1) results in an estimated total stock of $1.1 \cdot 10^6$ tons. This is evidently a considerable under-estimate since the catch per year of pelagic fish alone at present is about $1.2 \cdot 10^6$ tons (ELWERTOWSKY et al. 1972). The main reason for it is obviously found in the distribution of the fish. As already mentioned the pelagic fish were mostly concentrated in dense schools as illustrated in Fig. 5. These schools were often so dense that they caused blocking of the echosounder and saturation of the echo integrator (with normal setting of the instruments). Both these factors were reason for under estimation. It is further likely that the survey grid was too open for a representative sampling of a stock concentrated in schools. Further more, it is observed as described above that schools of mature fish avoided the ship much easier than young species, and it was very difficult to sample adult species with the pelagic trawl. This is clearly demonstrated by the difference in length distribution of horse makcerel and sardinella between commercial purse seine catches and trawl catches taken by "G.O. Sars" (Fig. 20 ØSTVEDT et al. 1973).

Considering the concentrations of fish close to the bottom, it is already mentioned that also these are very problematic to estimate, and particularly during daytime an underestimate is very likely. The results from the southward survey based on the data in Fig. 1 seems, therefore, to be an underestimate of young pelagic fish and bottom fish, the mature pelagic stock contributing very little.

During the last part of the cruise when the ship was returning northwards again the acoustic estimate resulted in somewhat higher values. The echo abundance observations south of $17^{\circ}00'N$ in the St. Louis and Cape Verde regions on the northward survey as shown in Fig. 4 gave an estimated stock size of about 330 000 tons as compared to 240 000 tons on the southward survey. This represents an increase of 41%. Similarly in the areas off Cape Blanc

and off Cape Timiris which are illustrated in Fig. 2 and 3 an increase of 38% and 56% respectively were observed. It is not likely that the amount of fish in the regions in question had increased that much during the short time between the two surveys. The discrepancies may therefore to some degree be explained by differences in the distribution of the fish, and also that the denser survey grid which now was worked in the most abundant areas may have given rise to increased values. The major part of the most abundant areas was surveyed during day-time, so it is not likely that the discrepancies between day and night recordings are important in this connection.

It is evident from the description above that for acoustic stock estimates to be carried out off West Africa in the future it is important to chose the most favourable season. More information on this might be available by analysing published research data and commercial catch statistics. The results obtained with R/V "Capricorne" on a cruise in March - April 1973 indicate that this period was more favourable for acoustic estimates, at least for the area south of Cape Verde (ANON 1973).

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Table 1. Catch in kg per hour and dominant species at each trawl station.

Pelagic trawl			Bottom trawl		
St. nr.	Catch kg/hr	Dominant species	St. nr.	Catch kg/hr	Dominant species
Cape Blanc (between 19°30'N and 22°30'N					
294	100	Myctophidae	296	2500	Diplodus senegalensis
295	4	Sardina pilchardus	297	700	Dentex sp.
331	0	-	298	620	Dentex sp.
333	6000	Myctophidae	329	2150	Capros aper
334	1225	Trachurus trecae	330	1336	Sardina pilchardus
337	0	-	332	227	Myctophidae
338	14	Sardina pilchardus	335	800	Pomadasys incisus
339	300	Caranx rhonchus	336	3100	Diplodus senegalensis
340	1906	Trachurus trachurus			
341	0	-			
342	0	-			
Cape Timiris (between 17°00'N and 19°30'N)					
330	30	Synagrops microlepis	299	100	Pagellus coupei
320	94	Synagrops microlepis	301	1500	Merluccius sp.
323	15	Trachurus trecae	321	1330	Trachurus trecae
325	140	Myctophidae	322	90	Epinephelus sp.
326	605	Trachurus trecae	324	1450	Trachurus trecae
327	3	Trachurus tracae	328	570	Dentex sp.
St. Louis (between 15°00'N and 17°00'N)					
302	157	Trachurus trecae	304	500	Brachydeuterus auritus
303	10	Pomatomus saltatrix	315	4700	Brachydeuterus auritus
305	160	Brachydeuterus auritus	317	2600	Trachurus trecae
314	625	Myctophidae	319	1100	Pagellus coupei
316	1370	Anchoa guineensis			
318	490	Trachurus trecae			
Cape Verde (between 12°30'N and 15°00'N)					
307	60	Trachurus trecae	306	830	Boops boops
308	5	Caranx senegalensis	310	440	Scyris alexandrinus
309	360	Brachydeuterus auritus	311	1100	Sardinella aurita
312	0	-	313	408	Boops boops

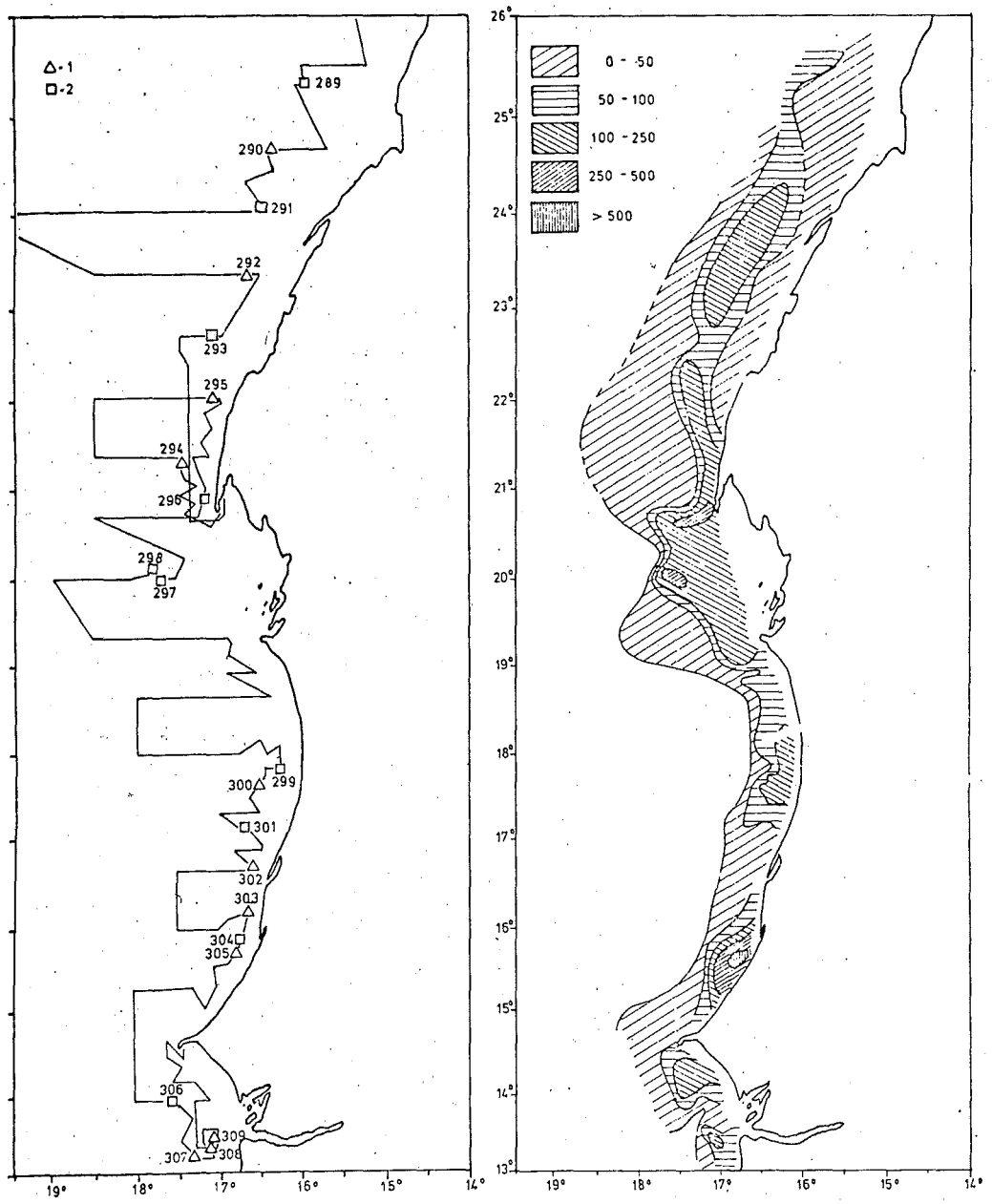


Fig. 1. Cruise tracks, trawl stations and total fish abundance in relative units, 2 - 18 November 1972.
1) pelagic trawl, 2) bottom trawl

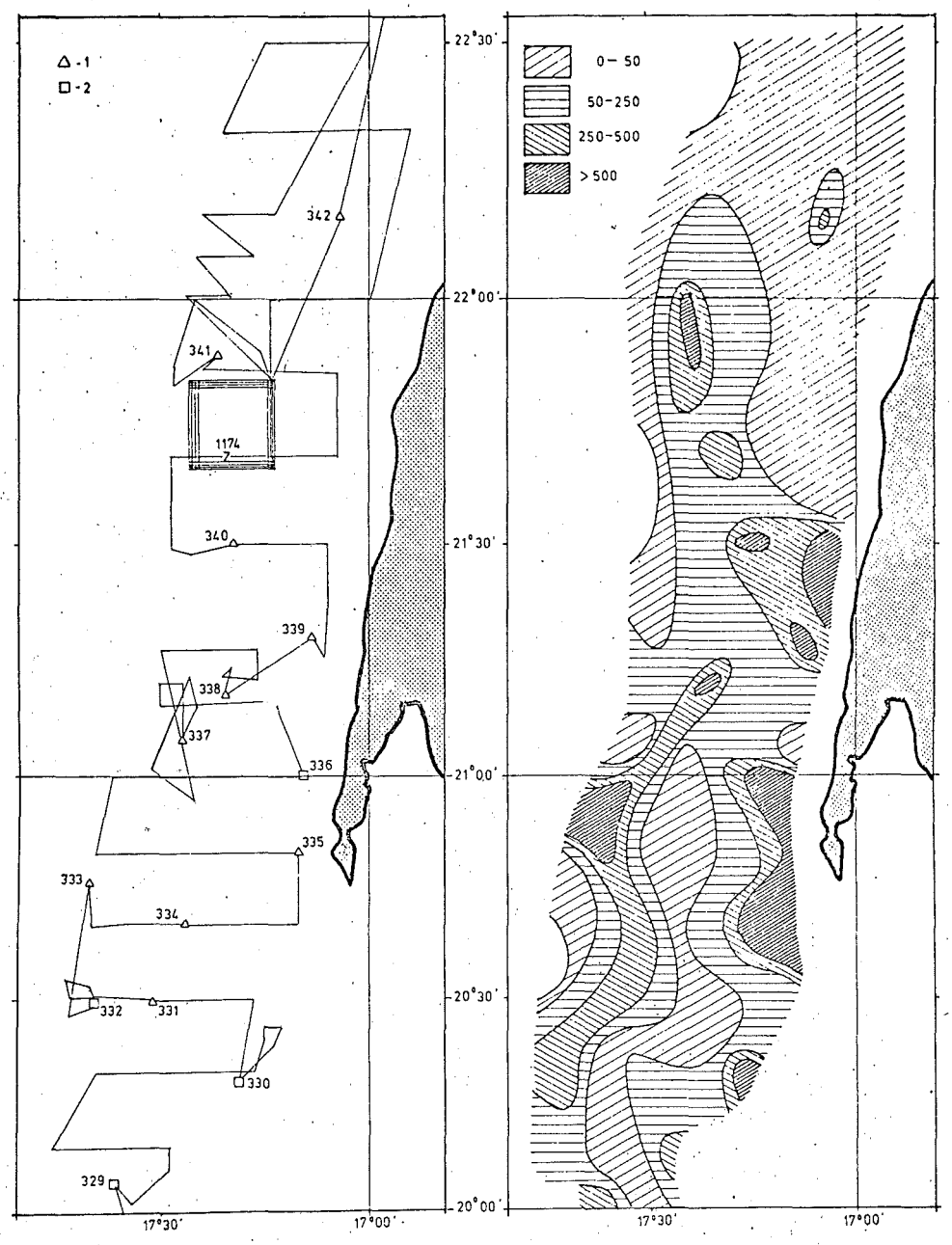


Fig. 2. Cape Blanc region, 30 November - 4 December 1972. Cruise tracks, trawl stations and total fish abundance in relative units.
1) pelagic trawl, 2) bottom trawl

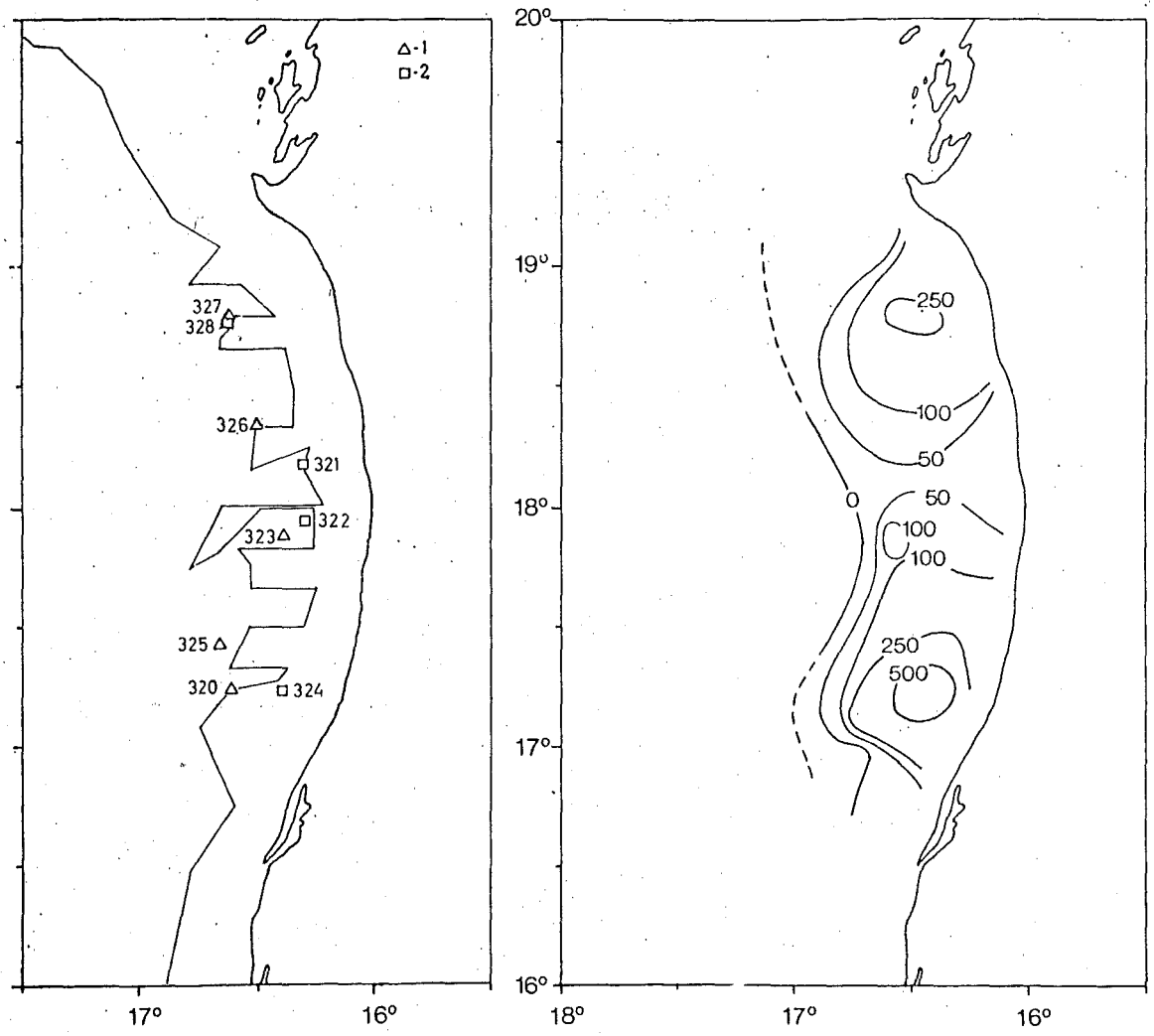


Fig. 3. Cape Timiris region, 25 - 29 November 1972. Cruise tracks, trawl stations and total fish abundance in relative units.
1) pelagic trawl, 2) bottom trawl

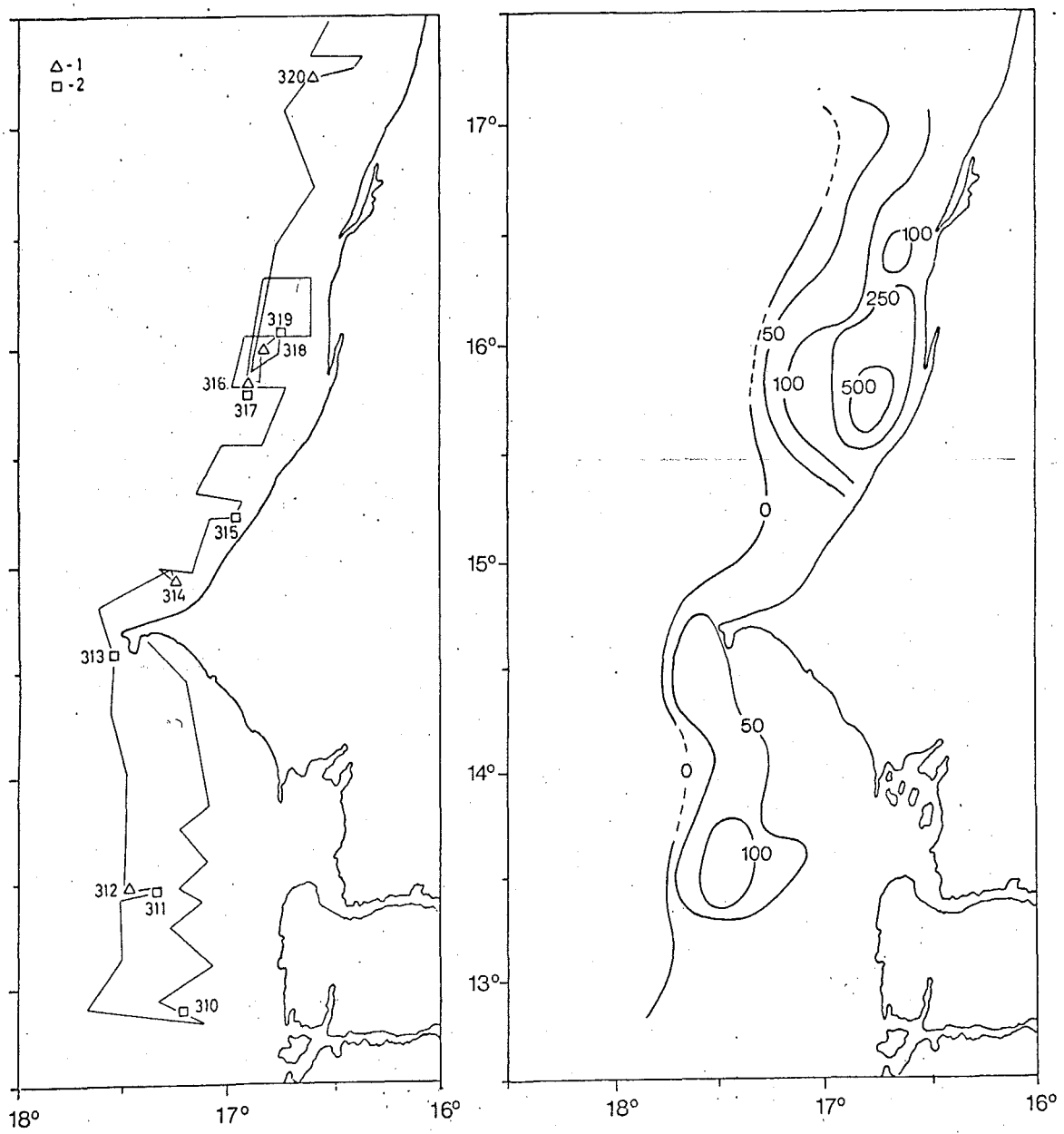
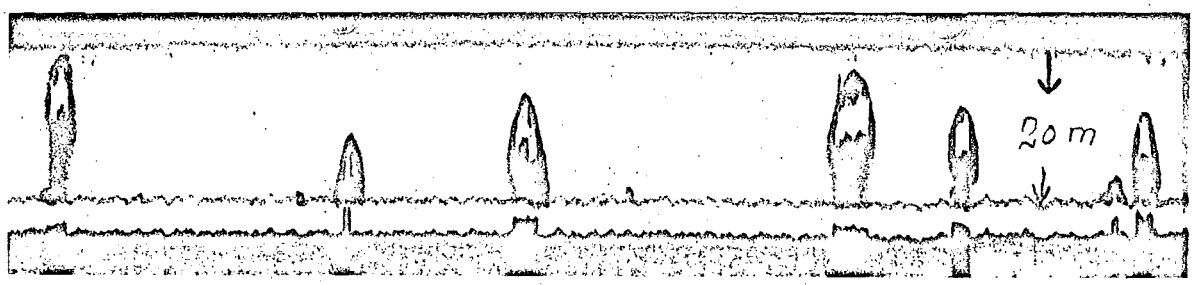
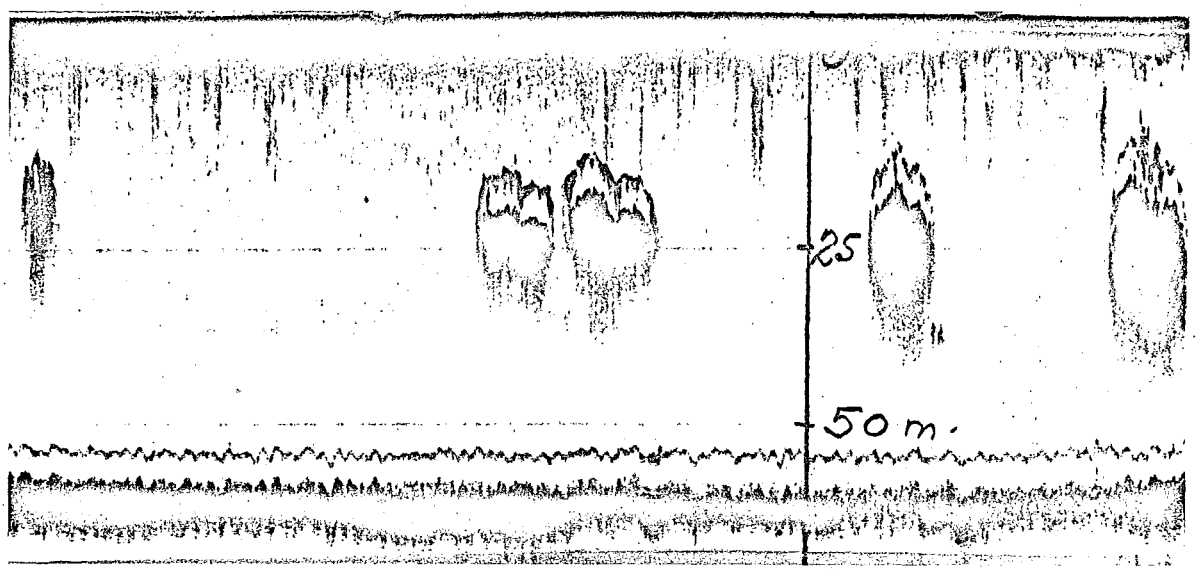


Fig. 4. St. Louis and Cape Verde region, 20 - 25 November 1972. Cruise tracks, trawl stations and total fish abundance in relative units.
1) pelagic trawl, 2) bottom trawl



a)



b)

Fig. 5. Echo recordings of dense schools being underestimated a) inside Cape Blanc, b) northwest of Cape Blanc.

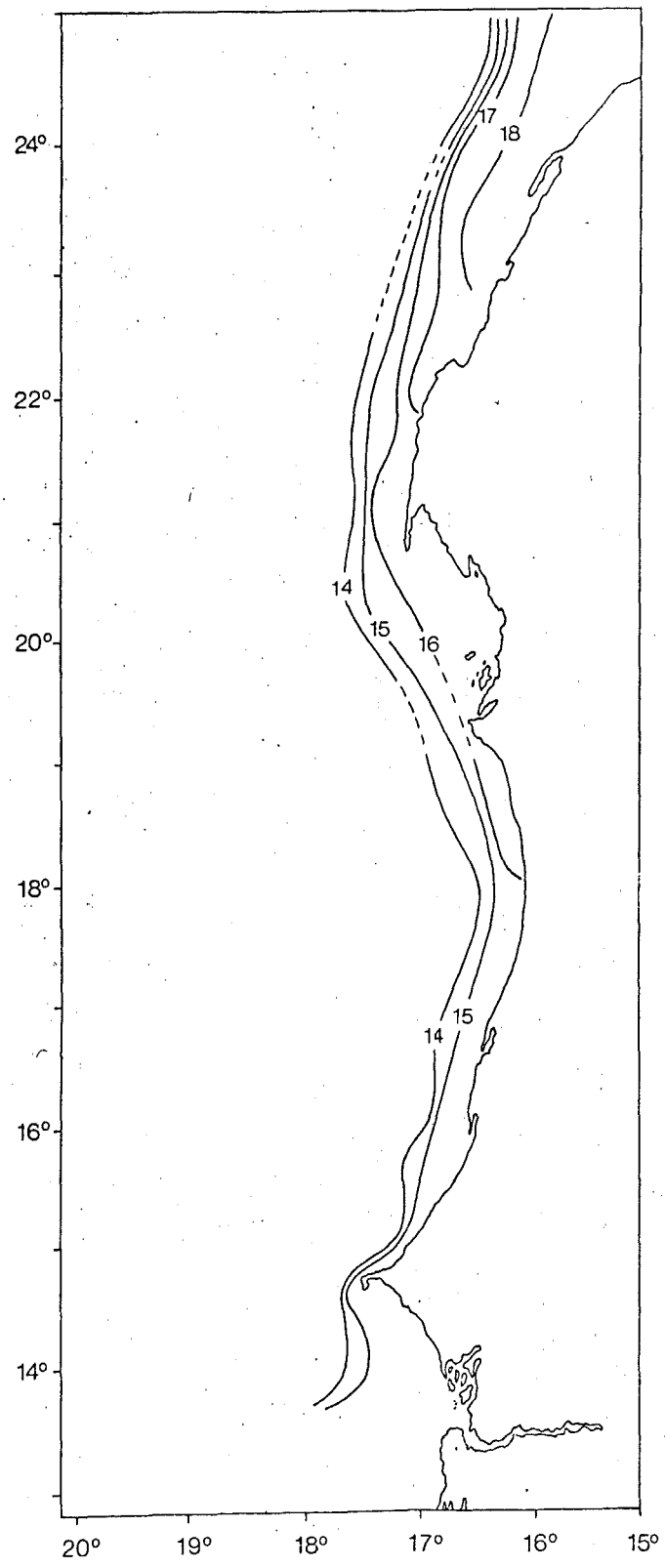


Fig. 6. Temperature, t°C at bottom,
2 - 18 November 1972.