Reports on surveys with the R/V Dr Fridtjof Nansen.

Surveys on the Marine Fish Resources of Bangladesh

Nov.–Dec. 1979 and May 1980

Institute of Marine Research, Bergen

«Dr. Fridtjof Nansen»

The fishery research vessel «Dr. Fridtjof Nansen» belongs to the Norwegian Agency for Development Cooperation (NORAD). It was designed and built for scientific and exploratory investigations of fishery resources of developing countries, under a joint plan with the Fisheries Department of FAO based on a funding of operation to be shared by FAO and Norway.

The first six years of operation have included surveys of the pelagic fish resources of the NW Arabian Sea (1975-76), and of the coastal fish resources of Pakistan, Mozambique, Sri Lanka and Burma (1977-79), and finally those of Bangladesh described in this report. The Institute of Marine Research, Bergen is under a subcontract with NORAD responsible for the operation of the vessel, and the various research programmes were planned and conducted jointly with the relevant fisheries research organizations in the countries concerned.

Results of the previous surveys have been reported on in a number of cruise- and progress reports under each programme.

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by

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1. INTRODUCTION

During the periods 25 November - 12 December 1979 and 7-24 May 1980 surveys of the local fish resources were carried out off Bangladesh by the Norwegian research vessel "Dr. Fridtjof Nansen". The preliminary results from these investigations are included as Appendices I and II in the present report.

The current marine fish production in Bangladesh is placed at about 100 000 tonnes. This estimate seems to be purely conjectural (ANON, 1980) and not based on any systematic survey of fish landings. Probably as much as 95% of the catch is credited the traditional fishery carried out by the non-mechanised boats operating mainly gill nets, set bag nets and stake nets. Some modern commercial trawlers are operated by the Bangladesh Fishing Development Corporation (RAJA 1980). KARIM (1978) gives a comprehensive description of the organisation and structure of the Bangladesh fisheries.

2. METHODS

Table 1 reviews the number of stations from the two surveys.

During the first survey the bottom trawl was a high opening shrimp trawl, 1800 meshes (40 mm mesh size) in circumference. Its headline was 96 feet long and the 63 feet ground rope was equipped with 0.5 m rubber bobbins. The trawl was operated with 40 m bridles giving it a horizontal distance between the net wings of 15 m.

Table 1. Number of stations.

	NOV/DEC 1979	MAY 1980
BOTTOM TRAWL	50	61
PELAGIC TRAWL	16	7
LONGLINE	7	
GILLNET	4	1
HYDROGRAPHIC STATIONS	19	19
BATHYTHERMOGRAPH STATIONS	23	20

During the second survey in May 1980 the bottom trawl was a 134-foot headline shrimp trawl which was adapted also to demersal fish trawling. Bridles of 40 m gave it a horizontal distance between the wings of 22 m.

In Nov./Dec. 1979 the 38 kHz echo sounder was connected to an analog echo integrator for abundance estimation, while in May 1980 the 120 kHz acoustic system was applied. The two systems had the following settings:

	38 kHz-Nov./Dec. 1979	120 kHz-May 1980
Basic range	0-100 or 0-250 m	0-100 m
Transmitter	Ext. (10/1)	1/1
Bandwidth	1 kHz	3 kHz
Pulselength	0.6 m sec.	0.6 m sec.
TVG and gain	20 log R - 20 dB	20 log R - 0 dB
Recorder gain	6	3
Integrator threshold	3	8

Other survey methods and observational procedures are fully described in Appendices I and II.

3. SURVEY RESULTS

3.1 Bottom conditions

The present investigation covered the whole shelf off Bangladesh deeper than 10 m. The area of the shelf zone from 10 m depth to the shelf edge or to the 200 m depth contour is about 40 000 km^2. The areas of the different depth zones appear in Table 2. Additionally, there is an area of about 24 000 km^2 which is

Table 2. Area of the shelf of Bangladesh (km^2).

DEPTH ZONES (m)	Area (km^2)
10 - 24	8 400
25 - 49	4 800
50 - 74	5 580
75 - 99	13 410
100 - 199	10 250
TOTAL	42 440

shallower than 10 m. The traditional fishery is mostly carried out at depths less than 20 m.

The shelf area down to about 150 m appeared to be very even and obstacles hazardous to bottom trawling were only observed in the northern part of Swatch of No-Ground and southwest of St. Martin Island at about N 20°00,, E 91°40'. The continental edge is found at depths between 150-180 m. The slope is very precipitious and it seems impossible to carry out bottom trawling in waters deeper than 180 m.

3.2 Hydrography

The surface temperature in Nov.-Dec. 1979 was between 28° and 29°C as seen in Fig. 2 Appendix I. In May 1980 it was about 1.5°C higher.

The fresh water runoff from the Ganges-Brahmaputra river system results in sharp horizontal salinity gradients, as seen from the surface salinity distribution of Fig. 3 Appendix I and Fig. 2 Appendix II. The lowest salinities were observed in November/December which is approximately the time of maximum fresh water runoff. During this time also, the vertical salinity gradients are strongest, as can be seen from the hydrographic sections (Figs. 4-6 Appendix I and Figs. 3-5 Appendix II). The depth to the thermocline was about 70 m in November-December 1979 while in May 1980 it was usually 30-40 m. From November-December 1979 to May 1980 the low oxygen water had risen to about 20 m, thus exposing additionally about 10 000 km^2 of the shelf to water of low oxygen content.

Table 3. Distribution of average catch rates (kg/h) from bottom trawl catches at different depth zones.

DEPTH ZONE (m)	10 - 24		25 - 49		50 - 74		75 - 99		100 - 149	
TIME	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980
PELAGIC FISH	71.0	75.0	58.3	74.7	123.0	918.0	194.2	13.1	0.1	0.6
DEMERSAL FISH	173.5	363.0	185.3	73.5	537.6	68.0	258.8	62.5	13.7	50.3
SHARKS/RAYS	18.4	59.2	3.7	11.4	7.3	0.7	2.5	0.3		
CRUSTACEANS	4.7	53.5	13.9	20.7	2.3	2.3	12.0	2.3	5.5	11.1
SQUIDS	1.1	0.6	4.9	1.2	1.7	6.1	5.0			
TOTAL	268.7	551.3	266.1	181.5	671.9	995.1	472.5	78.2	19.3	62.0
NO. OF HAULS	9	13	10	11	11	11	14	15	5	11

3.3 The fishing experiments

Table 3 gives the average catch rate with bottom trawl in different depth zones for the two coverages. The bottom trawl used in May 1980 had a horizontal opening approximately 50% larger than the trawl used in November-December 1980. Higher catch rates should therefore be expected during the last cruise.

There seems to be a significant reduction in the average catch rate of demersal fish at depths between 25 and 100 m from November/December 1979 to May 1980. One of the reasons for this might be the reduction in oxygen content which occurred over a large part of the shelf during the same time. The apparent increase in the average catch at the 10-24 m depth zone could be explained by the same mechanism in terms of a fish migration towards shallower areas. The highest catch rates for demersal fish was obtained with catfish, Arius thalassinus.

In May 1980 the catch of pelagic fish in the 50-74 m depth zone was significantly higher than in November/December 1979, with Indian macherel, Rastrelliger kanagurta and round scad, Decapterus maruadsi occurring as dominant species. In the 75-99 m depth zone the catch of pelagic species decreased from November/December 1979 to May 1980.

The catch rate with pelagic trawl was low with about 50% of the hauls giving catch rates less than 10 kg/h. The maximum catch rate was 170 kg/h, of which the major contribution was the anchovy, Stolephorus sp.

Both the numbers of longline operations and the gill net settings were too few to draw any conclusion.

3.4 Fish distribution and species composition

The echo abundance of demersal fish (Fig. 8 Appendix I and Fig. 6 Appendix II) appears to be very similar in November/December 1979 and in August 1980. The highest densities during both cruises were found at the northeastern part of Swatch of No-Ground and west and southwest of Cox's Bazar.

Table 4. Species composition (kg/h) of demersal fish from bottom trawl catches at different depth zones. (+ indicates presence in the catches).

DEPTH ZONE (m)	10-24		25-49		50-74		75-99		>100	
FAMILIES	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980
ACROPOMATIDAE					0.2		2.0			
APOGONIDAE - Cardinal fish			1.3		0.8	0.9	0.3	+	+	6.4
ARIIDAE - Catfish	31.5	114.4	46.6	15.7	399.2	6.7	17.7			1.1
BALISTIDAE - Filefish						+	0.4			
BOTHIDAE - Flounder	0.3	0.3	3.2	0.1	1.7	0.6	0.1			
BREGMACEROTIDAE - Codlet				0.5		+				0.1
CENTROLOPHIDAE - Modusafish				0.3						
CENTROPOMIDAE - *Snooks*		0.6								
CEPOLIDAE - Bandfish								+		
CHIROCENTRIDAE - Wolf herring	0.3				1.8					
CHAMPSODONTIDAE -								+	+	0.5
CORYPHAENIDAE - Dolphins						0.4				
CYNOGLOSSIDAE - Tongue sole	0.3	4.0	0.3	0.1	0.1	0.1	0.2	+		+
DACTYLOPTERIDAE - Flying gurnard					0.4		0.1			
DIODONTIDAE - Porcupinefish	0.3									
DREPANIDAE - Sicklefish	0.8	1.2	0.6	0.1	+	+				
ECHENEIDAE - Suckerfish				+	0.3					
EPHIPPIDAE - Spadefish	0.3				+					
FISTULARIIDAE - Pipefish		+	0.2	+	0.1	0.9	0.3			
FORMIONIDAE - Black pomfret	0.2	+	+	0.1	3.5	+	3.5			
GEMPYLIDAE - Snake mackerel									+	
GERREIDAE - Mojarra	0.6	0.1	16.2	10.2	4.1	1.4	11.6	+		
HARPADONTIDAE - Bombay-duck	14.6	68.8		1.7						
HOLOCENTRIDAE - Squirrelfish										
KURTIDAE - Humphead	0.4		0.5							
LACTARIIDAE - False trevally	0.1	0.6	0.5	+	3.3	0.2				+
LUTJANIDAE - Snapper	1.7	14.1	0.2		37.4	2.8	4.2			+
MENIDAE - Moonfish			0.1		0.6		0.1			
MUGILIDAE - Grey mullet	0.2									
MULLIDAE - Goatfish	1.7	+	20.6	1.5	14.1	2.3	1.8			
MURAENESOCIDAE - Pike conger	1.8		4.0	7.3	0.6	3.4				
NEMIPTERIDAE - Threadfin bream	+		5.1	0.9	4.0	13.3	169.2	41.3	4.5	+
NOMEIDAE - Man-of-war fish									0.7	
OSTRACIONTIDAE - Boxfish			0.1			0.2	0.1			
PLATYCEPHALIDAE - Flathead		1.5	0.4	+	0.1	0.2	0.1	0.2		
POLYNEMIDAE - Threadfin	7.2	4.0	0.5	0.1	0.9	0.3				
POMADASYIDAE - Grunt	11.2	4.1	2.0	1.9	11.4	0.8	0.5			
PRIACANTHIDAE - Bigeye					0.3	1.1	19.0	12.5	6.3	39.9
PSETTOIDAE - Indian halibut	0.3				1.0		+			
RACHYCENTRIDAE - Cobia			2.1		1.4					
SCIAENIDAE - Croaker	64.3	108.9	50.1	22.8	12.7	10.9	6.1	5.4	0.3	0.6
SCORPAENIDAE - Firefish			+	+	0.2	+	+			
SERRANIDAE - Seabass				+	0.5					
SILLAGINIDAE - Sillago	2.5	1.6								
SPARIDAE - Seabream	2.6		1.2		0.4	1.9	0.3			
STROMATEIDAE - Pomfret	9.6	15.4	1.2	3.6	8.6		0.7			
SYNACEIIDAE - Stonefish					0.2	+				
SYNODONTIDAE - Lizardfish	6.1	+	21.0	1.9	6.2	9.1	19.2	1.9	1.9	1.8
TETRAODONTIDAE - Pufferfish	1.2	3.4	+	0.9	0.1	10.1				
THERAPONIDAE - Therapon	0.2	0.2	1.7		0.3					
TRIACANTHIDAE - *Tripodfish*	4.6	+	0.2	1.1						
TRIACANTHODIDAE - Spikefish				+						
TRICHIURIDAE - Hairtail	7.9	19.5	5.2	1.8	21.1		0.8			
TRIGLIDAE - *Searobin*		+		0.7		+	0.4	0.5	+	+

The echo abundance of pelagic fish during November-December 1979 (Fig. 9 Appendix I) reflects observations of more isolated schools rather than a coherent scattering layer. During May 1980 the highest concentrations were observed in the northern central part of the investigated area and southwest of Cox's Bazar (Fig. 7 Appendix II).

Table 4 gives the species composition (in kg catch per trawling hour - kg/h) of demersal fish from bottom trawl catches at different depth zones. In the 10-24 m depth zones the following species dominated the catches: Catfish (Ariidae), Bombay duck, Harpadon nehereus and croakers (Sciaenidae) of which Chrysochir aureus seems to be the most abundant.

Croakers and catfish were important species also in the depth zones between 25 and 100 m. Additionally, mojarra, Pentaprion longimanus made a significant contribution and in November/December 1979 the goatfish (Mullidae) and lizardfish (Synodontidae) were also present. Deeper than 75 m the most important species appeared to be threadfin bream, Nemipterus japonicus, followed by bigeye, Priacanthus hamrur, and lizardfish, Saurida spp.

Table 5. Species composition (kg/h) of pelagic fish from bottom trawl catches at different depth zones. (+ indicates presence in the catches).

DEPTH ZONES (m)	10 - 24		25 - 49		50 - 74		75 - 99		100 - 149	
TIME	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980	NOV/DEC 1979	MAY 1980
ARIOMMIDAE - Driftfish					0.1	95.5	31.2	0.1		
CARANGIDAE - Jack/scad	4.0	14.9	7.0	16.8	10.4	288.3	56.1	12.1	0.1	0.6
CLUPEIDAE - Herring/scad	37.9	43.4	4.1	3.9	22.4	1.1	0.6			
ENGRAULIDAE - Anchovy	18.5	11.4	8.6	1.3	13.2	0.1	+			
LEIOGNATHIDAE - Ponyfish	4.6	1.5	19.4	50.5	4.2	1.0	5.0	+		
SCOMBRIDAE - Mackerel	6.0	3.8	19.3	1.5	71.4	502.2	99.7			
SPHYRAENIDAE - Barracada			+	0.5	1.2	29.9	1.6	0.2		

Table 5 shows the species composition (kg/h) of pelagic fish from bottom trawl catches at different depth zones. Of the Ariommidae only the Indian driftfish, Ariomma indica, was recorded. Of the family Carangidae the Malabar cavalla, Carangoides malabaricus and the Kuweh trevally, Atropus atropus dominated the catches at shallower depths than 50 m

while the round scad, Decapterus maruadsi was more important in deeper water. Of the Clupeidae family, Raconda russeliana and Sardinella fimbriata were most abundant in depths shallower than 50 m, while Ilisha megaloptera dominated in deeper water. The hairfin anchovy, Setipinna taty and the grenadier anchovy, Coilia dussumieri, contributed most to the Engraulidae catches at depths less than 50 m, while Stolephorus spp. dominated in deeper water. Of the Leiognathidae Leiognathus equulus and Leiognathus bindus dominated the catches in waters deeper and shallower than 50 m, respectively. The Spanish mackerel, Scomberomorus spp. contributed most to the Scombridae catches from shallower depths than 50 m, while the Indian mackerel, Rastrelliger kanagurta was more abundant in deeper water. Sphyraena obtusata was the dominant species from the Sphyraenidae family.

Table 6 shows the species composition (kg/h) of catches from the pelagic trawl over bottom depth less than 150 m. The number of hauls over deeper waters are too few to be included.

Table 6. Species composition (kg/h) of catches from pelagic trawl over bottom depths less than 150 m. (+ indicates presence in the catches).

	NOV/DEC 1979	MAY 1980
ARIOMMIDAE - Driftfish	+	0.2
ARIIDAE - Catfish	0.3	
BREGMACEROTIDAE	1.5	0.6
CARANGIDAE - Jack/scad	1.0	4.0
CHIROCENTRIDAE - Wolf herring	0.1	0.4
CLUPEIDAE - Shad, herring	8.7	0.9
ENGRAULIDAE - Anchovy	5.8	3.0
EXOCOETIDAE - Flying fish		+
FORMIONIDAE - Black pomfret		0.3
HARPODONTIDAE - Bombay-duck	3.3	0.5
LACTARIIDAE - False trevally	+	
LEIOGNATHIDAE - Pony fishes	0.4	1.6
MYCTOPHIDAE - Lantern fish		1.0
POMADASYIDAE - Grunt	+	
SCOMBRIDAE - Mackerel	3.2	2.4
SCIAENIDAE - Croaker	3.1	0.3
SPHYRAENIDAE - Barracuda	0.2	0.2
STROMATIDAE - Pomfret	1.4	0.8
SYNODONTIDAE - Lizard fish	+	0.1
TRICHIURIDAE - Hair tail	6.7	7.4
FISH LARVAE	1.0	1.9
SHARKS/RAYS		1.0
CRUSTACEANS	2.3	0.7
SQUIDS	0.2	+
TOTAL	39.3	27.3
NO. OF HAULS	9	6

3.5 Abundance

Demersal fish

An acoustic abundance estimate of demersal fish will usually be an underestimate, due to the limitation of the echo sounder and integrator in making recordings very close to the bottom. The demersal stock sizes reached by the acoustic methods were 40 000 and 35 000 tonnes for November/December 1979 and May 1980 respectively. These values are quite obviously too low.

Another method is to estimate the standing stock by trawl data. This requires that the following assumptions are made:

1. That the effective area covered by the trawl is known;
2. That the proportion of fish caught in this area is known;
3. That the density of fish in the area actually covered by the trawl is the same as the average density in the whole survey area;

Table 7. Biomass of demersal fish calculated by means of the bottom trawl catches.

DEPTH ZONES (m)	NOV/DEC 1979		MAY 1980	
	DENSITY (kg/km^2)	STOCK (tonnes)	DENSITY (kg/km^2)	STOCK (tonnes)
10 - 24	2282	17489	3267	27443
25 - 49	2223	10670	661	3172
50 - 74	6451	35997	612	3415
75 - 99	3105	41638	561	7536
100 - 149	164	1681	453	4643
TOTAL		107475		46209

Table 7 shows the results of such calculations for the "Dr. Fridtjof Nansen" data. The area covered by the trawl was taken to be the distance between the wings multiplied by the length of the tow. The area of the different depth zones were taken from Table 2, and the average catch from Table 3. As seen from this last table the average catch rate in the 50-74 m depth

zone in November/December 1979 was very high. This was mostly due to one trawl station giving a catch rate of about 4000 kg/h. If this station is deleted, the abundance estimate is reduced to about 80 000 tonnes for November/December 1979.

In these calculations the efficiency coefficient of the trawl was taken as 1, i.e. all the fish ahead of the trawl were supposed to be caught. The validity of the abundance estimate depends highly on the efficiency coefficient chosen. In similar calculations coefficients ranging from 0.3 to 1.0 have been applied. A value of 0.5 appears to give reliable results for the "Dr. Fridtjof Nansen" type of trawl both off Mozambique (SÆTRE and SILVA, 1979) and in the waters of Sri Lanka (BLINDHEIM et al., 1980). If this efficiency coefficient is used, abundance estimates of 160 000 tonnes and 92 000 tonnes for November/ December 1979 and May 1980 respecitvely, are reached.

Based on trawl surveys conducted during 1968-71 WEST (1973) estimates the standing stock of demersal fish off Bangladesh to be between 264 000 and 373 000 tonnes, assuming an efficiency coefficient of 0.5. The surveyed area was mostly the shelf between 10 and 75 m and the standing stock estimates of demersal fish were reached by assuming the same average catch rate for the whole continental shelf from 0 to 200 m. For the depth zone 75-200 m this assumption will obviously result in an overestimate, as the catch rates decrease in deeper water. For the area shallower than 10 m the information on catch rates is sparse.

As the horizontal opening of the trawl WEST (1973) used an estimated distance between the danlenos or swivels at the junction of the towlines and bridles. This distance is probably 1.5-2 times the distance between the wings. Consequently, his stock estimates would have exceeded 500 000 tonnes if WEST (1973) had calculated the area covered by the trawl in the same way as in the present report.

The estimates of the "Dr. Fridtjof Nansen" investigations of 160 000 and 92 000 tonnes for November/December 1979 and May 1980 respectively, do not include the shelf area shallower than 10 m. If the fish density in this area of about 24 000 km^2 is assumed to be the same as in the 10-24 m depth zone (Table 7), this will add about 100 000 tonnes to November/December 1979 and 158 000 tonnes to May 1980. The total stock of demersal fish will then be 250-260 000 tonnes or an average density of about 4 tonnes/km^2.

For estimating the potential annual yield the formula of GULLAND (1971) can be applied:

$$Y_{max} = 0.5 \cdot M \cdot B_o \qquad (1)$$

where M is the natural mortality rate and B_o the virgin or unexploited stock. When fishing is significant some modifications are needed and:

$$Y_{max} = 0.5(C + M \cdot B_1) \qquad (2)$$

has been suggested (ANON, 1979). C is the present catch and B_1 the biomass at the time of the survey.

Both the available catch statistics and the results from the "Dr. Fridtjof Nansen" survey indicate that pelagic fish contribute only about a quarter of the total landings. That means that the present catch of demersal fish is about 75 000 tonnes. There is a lack of estimates of M for the fish of the region. Investigations from other areas, however, suggest that M=0.5 is reasonable for the demersal stock as a whole (ANON, 1979, SÆTRE and SILVA, 1979). If these values are put into equation (2) together with B_1=250 000 tonnes, a potential yield of demersal fish of 100 000 tonnes is reached.

Pelagic fish

The present catch of pelagic fish is probably about 25 000 tonnes per annum. The acoustic estimates for pelagic fish were

60 000 tonnes and 120 000 tonnes for November/December 1979 and May 1980, respectively. These estimates are probably too low, as the large part of the shelf, which is shallower than 10 m, was not surveyed. Neither were fish occurring above the depth of the transducer included. The pelagic resources of Bangladesh have not been subject to any previous assessment. However, a stock size of 200-250 000 tonnes has been indicated (ANON 1980).

The abundance of pelagic species in an area is known to fluctuate widely, both seasonally and inter-annually. As a first approximation to the stock size of pelagic species in Bangladesh, 200 000 tonnes seems to be an acceptable "guestimate" for the maximum value. If M=1 is applied in equation (1), this gives a potential yield of 100 000 tonnes.

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REPORTS ON SURVEYS WITH THE R/V DR. FRIDTJOF NANSEN

PRELIMINARY RESULTS FROM A SURVEY ON THE MARINE FISH RESOURCES OF BANGLADESH NOV. - DEC. 1979.

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The 1600-mesh pelagic trawl had dimensions of 16 x 16 fathoms around the trawl mouth. When fishing it was always equipped with a net sonde and the vertical opening was normally observed to be about 17 m. It was operated with 120 m bridles.

The bottom long-lines used had the following specifications: Line: monofilament no. 120, snood: monofilament no. 80, hooks no. 8 with long leg. One hundred hooks were used on the long-line fishing stations.

The floating gillnets were both of the monofilament 120 mm mesh size and multifilament 60 mm mesh size type. Each gillnet was approximately 30 m long and 5 m deep and at each setting five gillnets were used.

The vessel was equipped with two echo sounders, one operating at 38 kHz and one at 120 kHz. Two analog echo integrators were connected to the 38 kHz echo sounder. The settings of the 38 kHz echo sounder were: Basic range 0-100/0-250 m. Transmitter 10/1, external. Pulse length 0.6 milliseconds, band width 1 kHz. Receiver TVG and gain 20 log R - 20 dB. Recorder gain 6 and beam angle 8 x 8^{o}.

The 120 kHz echo sounder was operated with the following settings: Basic range 0-100 m, Pulse length 0.6 milliseconds, band width 3 kHz. TVG and gain 20 log R, 0 dB. Recorder gain 6 and beam angle 8 x 8^{o}.

Echo integrator values were recorded for each nautical mile sailed and averages over 5 nautical miles were worked out and logged. The echo integrator reading (unit: mm/nautical mile) are relative measures proportional to fish density. This means that one unit of 1 mm/nautical mile represents a certain number of individual fish per square nautical mile of the species recorded. A conversion factor or density coefficient is needed for conversion from the relative echo integrator values to absolute fish biomass.

Nansen bottles were used for the oceanographic work. Temperature, salinity and dissolved oxygen were observed at standard depths

to the bottom or maximum 500 m. The depth and structure of the transition layer (thermocline) was also observed with a bathythermograph. The salinity samples were analysed onboard with an inductive salinometer. Dissolved oxygen was determined by the Winkler method.

Table 1 reviews the number of the different fishing stations as well as the hydrographic stations. Fig. 1 shows the survey routes and the location of the stations during the investigations.

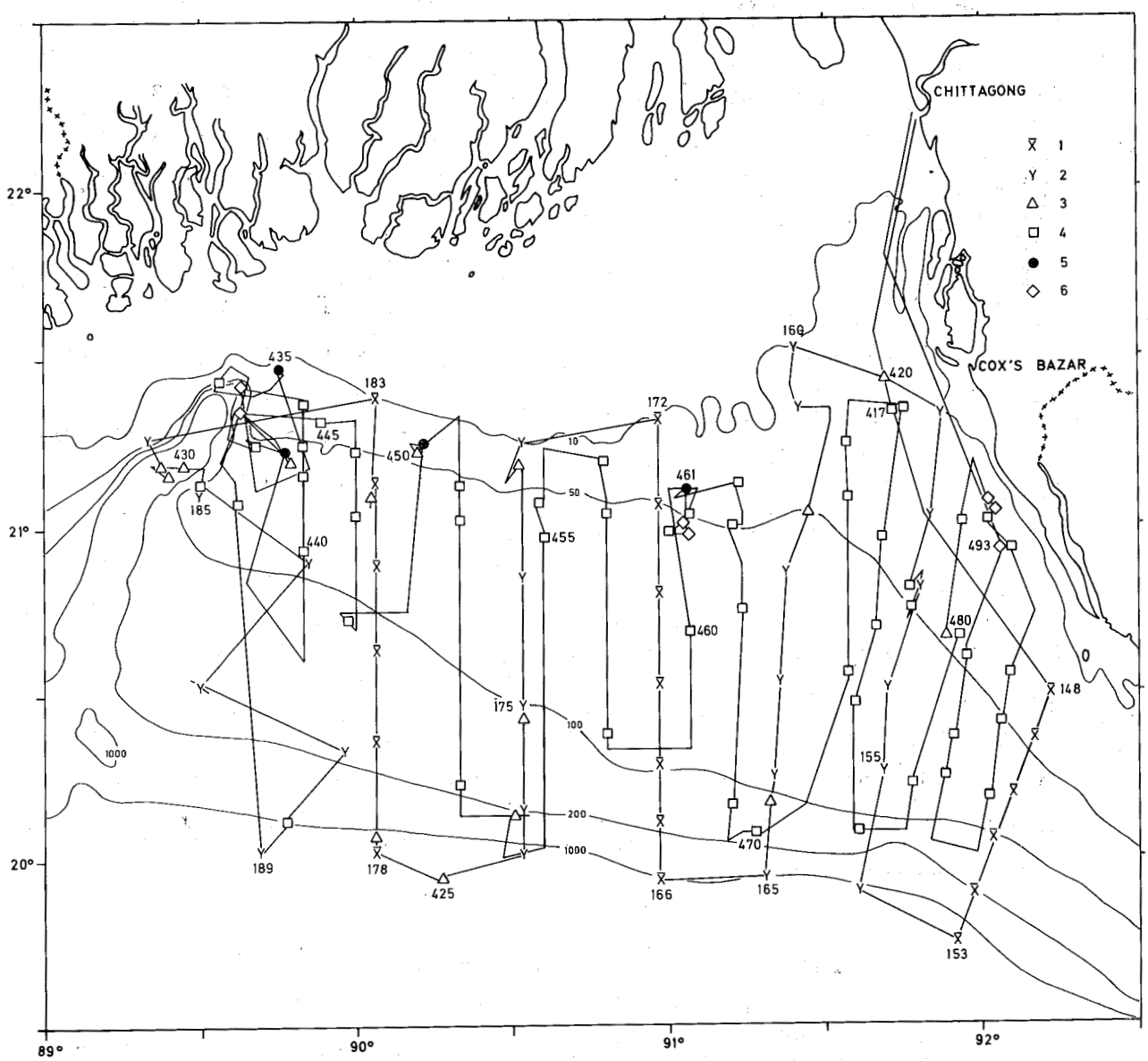

Fig. 1. Survey routes and stations.

1) Hydrographic station, 2) Bathythermograf station, 3) Pelagic trawl, 4) Bottom trawl, 5) Gillnet, 6) Long-line.

Table 1. Number of stations

Bottom trawl	50
Pelagic trawl	16
Longline	7
Gillnet	4
Hydrographic stations	19
Bathythermograph stations	23

3. SURVEY RESULTS

3.1 Bottom conditions

The depth conditions of the shelf off Bangladesh appear in Fig. 1. As can be seen, a large proportion of the shelf is shallower than 10 m. This area was not covered during the present investigation.

A conspicuous feature of the western part of the area is the submarine canyon, Swatch of No-Ground, reaching depths of more than 800 m. The continental edge is usually found at depths between 160 and 180 m. The slope is very precipitious and it seems difficult to carry out bottom trawling in waters deeper than 180 m. A possible exception is the nortnern part of Swatch of No-Ground.

The shelf area between 10 and 160-180 m appeared to be very even and obstacles hazardous to bottom trawling were only observed at depths of more than 80 m in the northern part of Swatch of No-Ground. According to ANON (1975) the bottom sediments of the shelf are mostly terrigenous with the predominant grain-size in the fraction 0.1 - 0.01 mm.

Table 2. Area of the shelf of Bangladesh (km^2)

Depth zones	Area (km^2)
10 - 24	8 400
25 - 49	4 800
50 - 74	5 580
75 - 99	13 410
100 - 199	10 250
Total	42 440

The area of the shelf zone from 10 m depth to the shelf edge or about 200 m depth is about 40 000 km^2. The areas of the different depth zones appear in Table 2. The eastern and western borderline of the Bangladesh shelf were, in these calculations, taken as being lines approximately at right angles to the coastline at the border to Burma and India respectively.

3.2 Hydrography.

Figs. 2-3 show the surface temperatures and surface salinities respectively. As can be seen, the temperature in the investigated area was between 28° and 29°C. The surface salinity distribution

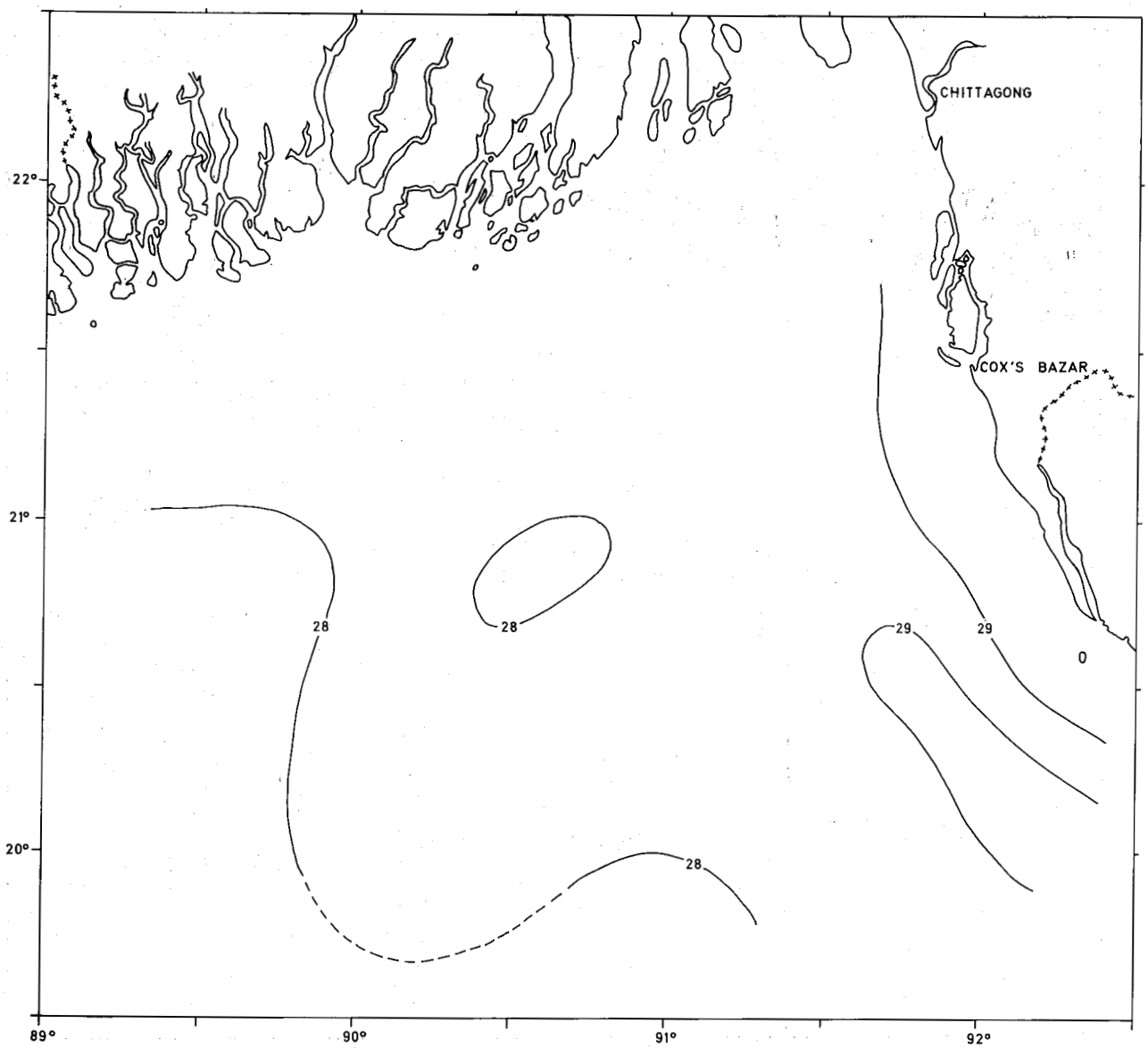

Fig. 2. Distribution of surface temperature.

showed a tongue-like structure related to the large freshwater outflow from the rivers with salinities varying from $10^{o}/oo$ to $29^{o}/oo$.

The hydrographic sections I-III appear in Figs. 4-6 numbered from east to west. The vertical temperature distribution showed a subsurface maximum at about 10-30 m depths due to cooling of the surface layer. The depth to the thermocline was usually about 70 m. The salinity increased rapidly with depth in the upper 20-30 m, and as a consequence a strong density gradient was found in that layer. The vertical mixing was significantly reduced, which was the main cause for the subsurface temperature maximum.

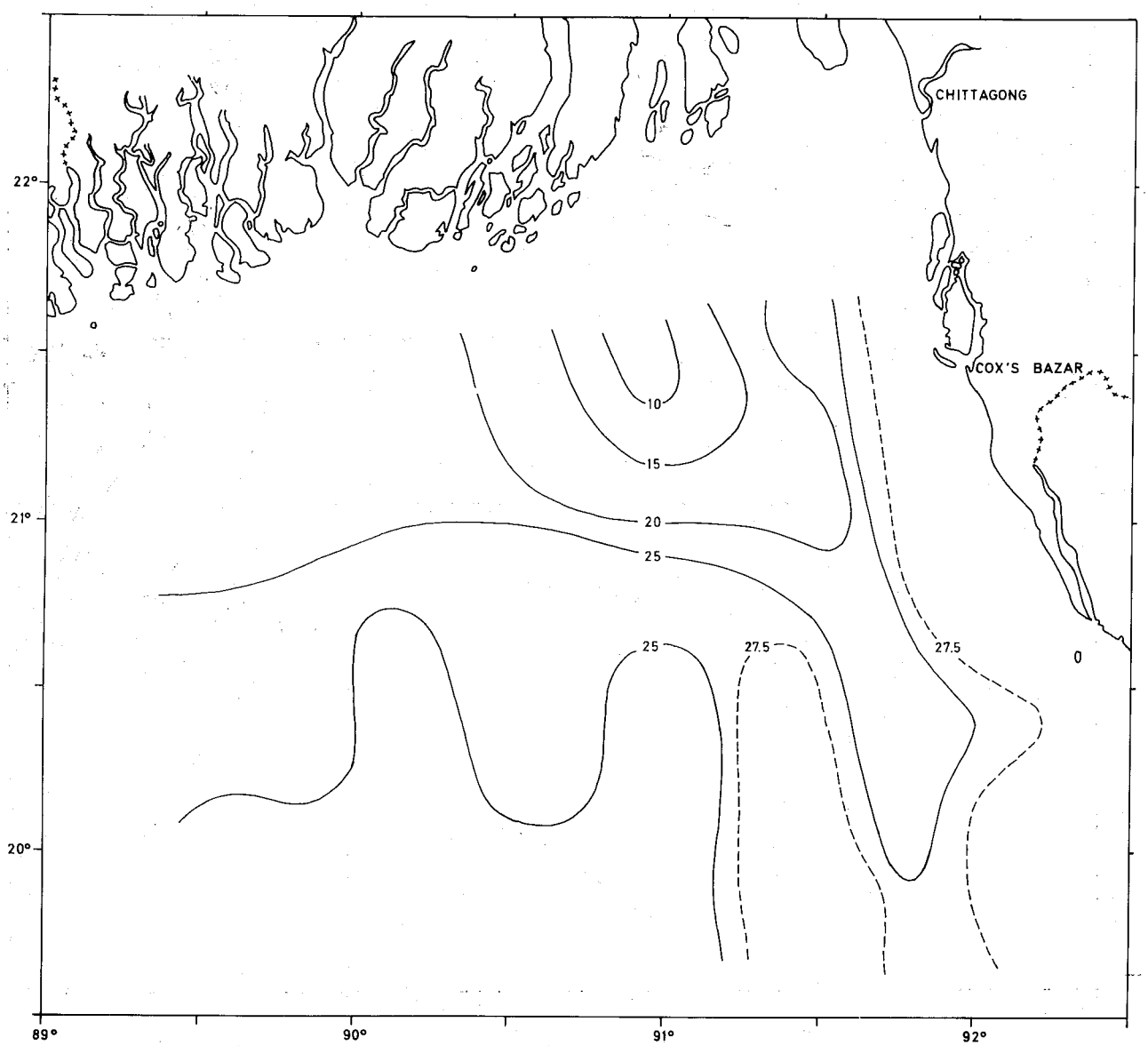

Fig. 3. Distribution of surface salinity.

The oxygen content decreased rapidly with depth within the upper part of the thermocline. The isoline for 1 ml/l was situated at about 100 m. Deeper it decreased to less than 0.2. There seemed to be a minimum in the vertical oxygen content between 200 and 400 m.

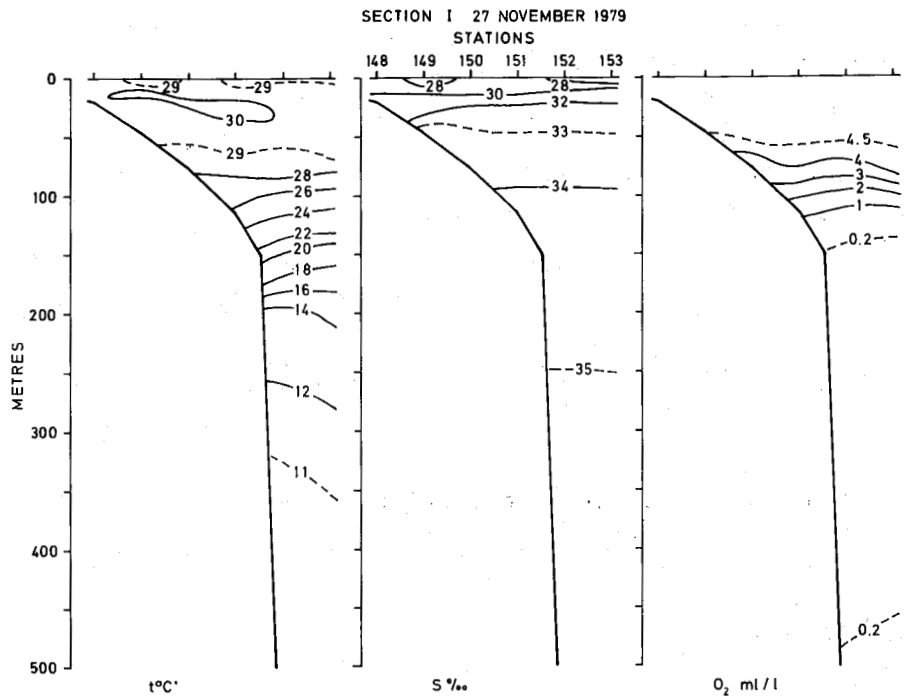

Fig. 4. Vertical distribution of temperature, salinity and oxygen - SECTION I.

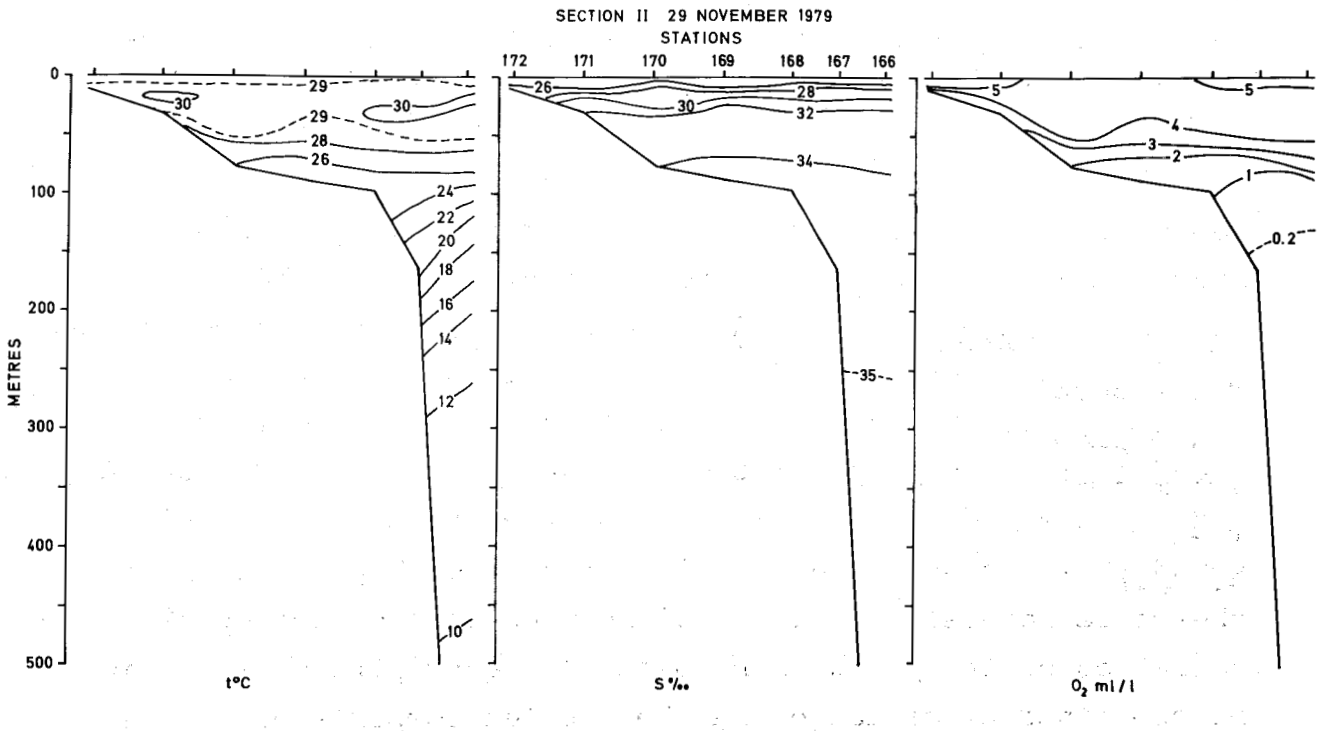

Fig. 5. Vertical distribution of temperature, salinity and oxygen - SECTION II.

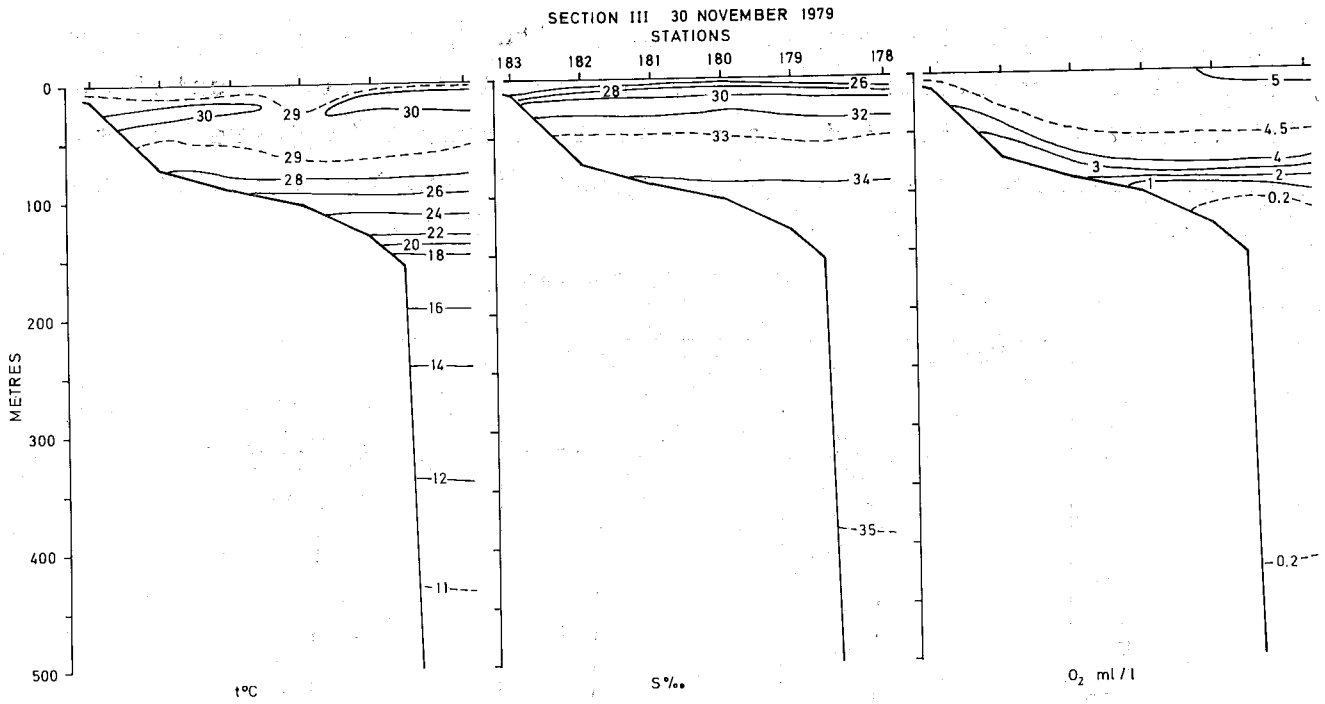

Fig. 6. Vertical distribution of temperature, salinity and oxygen - SECTION III.

3.3 Plankton.

The distribution of echo abundance of plankton expressed in mm integrator reading is shown in Fig. 7. In addition to phytoplankton and zooplankton, fish larvae were also included in the scattering layer labeled 'plankton'. Over deeper water than 150 m lantern fish migrated to the surface layer during the night and mixed with the plankton as well.

There was a maximum zone of echo abundance of plankton over depths between 50 and 100 m with decreasing values on both sides. There was no obvious relationship between the distribution of plankton echo abundance and the hydrographic parameters. The acoustic abundance of plankton is a function not only of the total plankton biomass but also of the species composition. The sound reflecting properties of a plankton layer depend on the size of the organisms as well as on the frequency of the echo sounder. The echo abundance distribution of Fig. 7 does not therefore necessarily give a correct measure of the relative variation of the plankton biomass. At least part of this might be explained by variation in the species composition of the plankton.

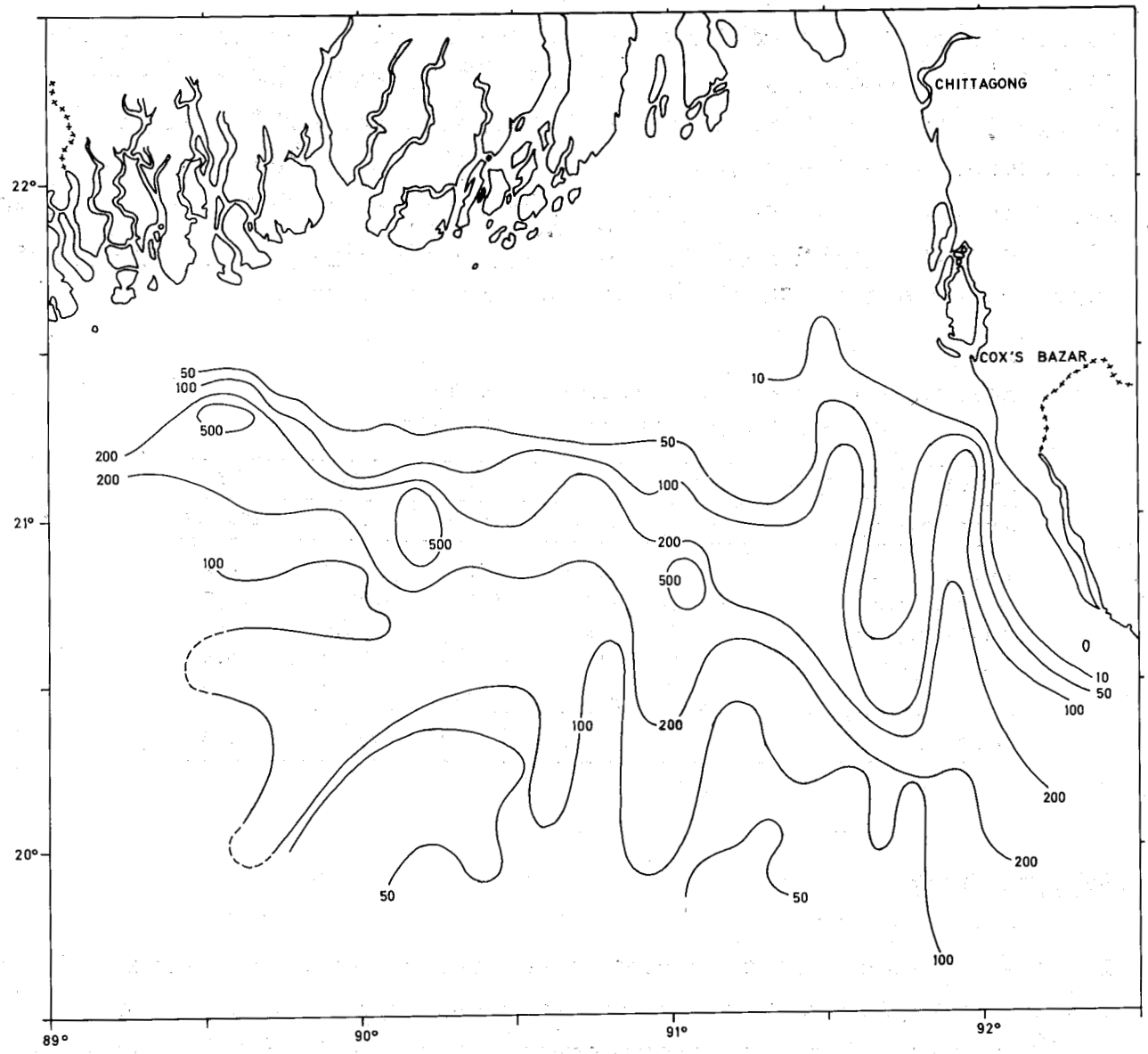

Fig. 7. Echo abundance of plancton in mm integrator reading.

3.4 The fishing experiments.

A record of the fishing operation is listed as APPENDIX A.

Bottom trawl

Table 3 gives the average catch rates with bottom trawls at different depth zones. The group 'Pelagic fish' consists of species which usually forms schools and have a diurnal vertical migration pattern. The following families have been included in this group: Ariommidae, Carangidae, Clupeidae, Engraulidae, Leiognathidae, Scombridae and Sphyraenidae.

As can be seen, the maximum average catch rates occurred at 50-74 m depths, reaching a value of 672 $^{kg}/h$. There was an abrupt change in the catch rate at depths of more than 100 m which corresponded to the sharp decrease in oxygen content in this layer (Figs. 4-6). The highest catch rate, 4000 $^{kg}/h$, was obtained with catfish, Arius thalassinus. Also bream, Nemipterus japonicus, contributed significantly to the higher catch rates.

Table 3. Distribution of average catch rates (kg/h) from bottom trawl at different depth zones.

No. of Tr. Stations	9	10	11	14	5
Depth zone (m)	10-24	25-49	50-74	75-99	100-150
Pelagic fish	71.0	58.3	123.0	194.2	0.1
Demersal fish	173.5	185.3	537.6	258.8	13.7
Sharks/Rays	18.4	3.7	7.3	2.5	-
Crustaceans	4.7	13.9	2.3	12.0	5.5
Squids	1.1	4.9	1.7	5.0	-
Total	268.7	266.1	671.9	472.5	19.3

Pelagic trawl

The catch rates with this gear were usually low. Of a total of sixteen pelagic trawl stations eight gave catch rates below 10 $^{kg}/h$, six had catch rates between 10 and 100 $^{kg}/h$, while only at two did the catch rate exceed 100 $^{kg}/h$. The maximum catch rate was 170 $^{kg}/h$, of which the major contribution was the anchovy, Stolephorus sp.

Long line

Seven long-line operations were carried out at depths between 10 and 95 m. Only small catches were obtained, with a maximum of 12 $^{kg}/100$ hooks. The dominant species were catfish, Arius sp.

Gillnet

Two of the four gillnet settings produced no catch at all. At fishing station no. 435 (Fig. 1) a total catch of 68 kg, mainly of Spanish mackerel, Scomberomorus guttatus, was obtained.

3.5 Fish distribution and species composition.

The length frequency distribution of the most important species appear in APPENDIX B.

Demersal fish

Fig. 8 shows the distribution of echo abundance of demersal fish expressed in mm integrator readings. The highest densities were observed off Cox's Bazar at 20-30 m depths and along the north-eastern edge of Swatch of No-Ground between 60 and 100 m depths.

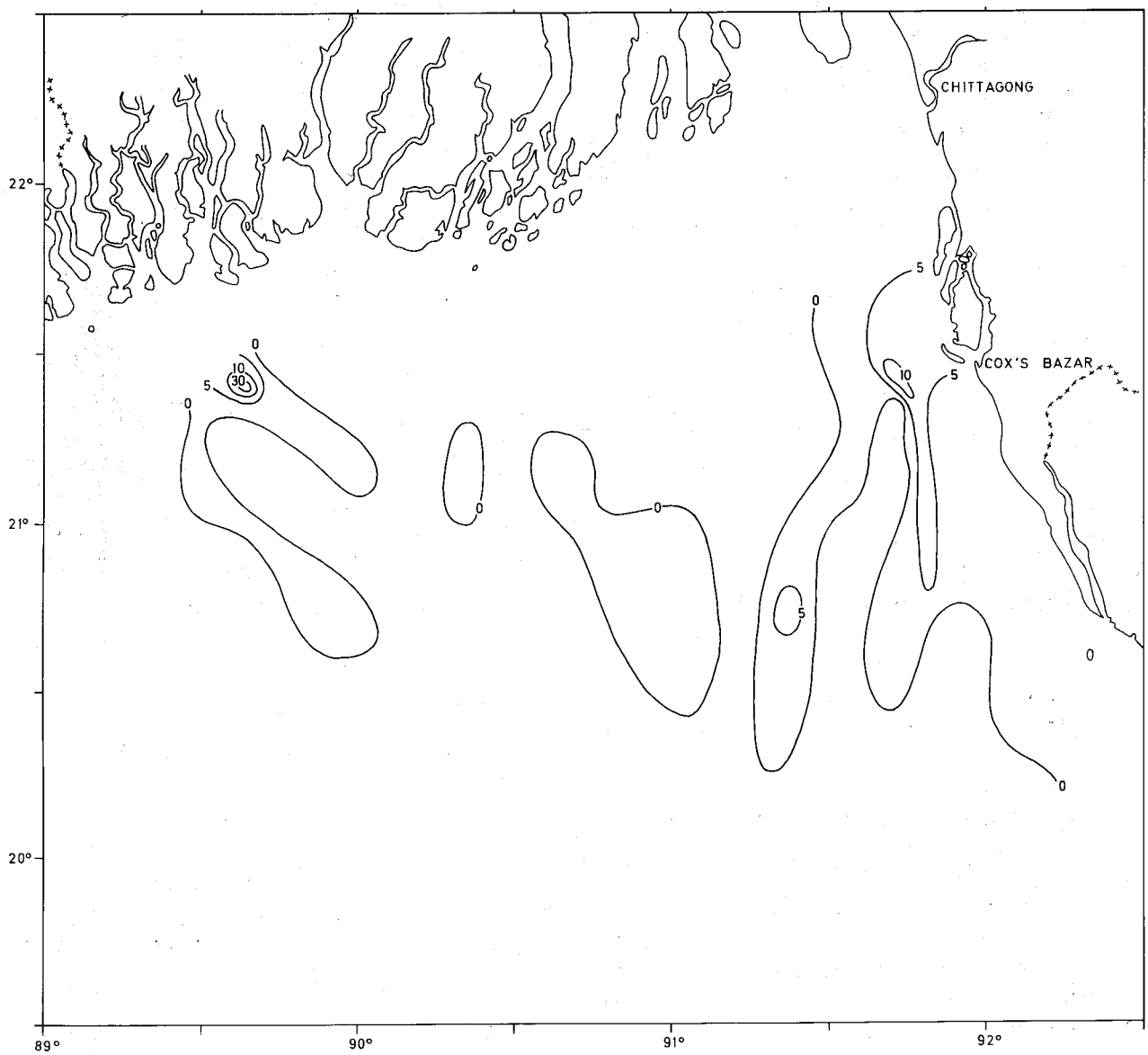

Fig. 8. Echo abundance of demersal fish in mm integrator reading.

Table 4. Species composition (%) of demersal fish from bottom trawl catches at different depth zones.

FAMILIES \ DEPTH ZONE (m)	10-24	25-49	50-74	75-99	≥100
ACROPOMATIDAE			0.03	0.76	
APOGONIDAE - Cardinal fish		0.71	0.15	0.11	0.15
ARIIDAE - Catfish	18.13	25.14	74.26	6.84	
BALISTIDAE - Filefish				0.15	
BOTHIDAE - Flounder	0.19	1.71	0.31	0.05	
CHIROCENTRIDAE - Wolf herring	0.56		0.33		
CHAMPSODONTIDAE -					0.15
CYNOGLOSSIDAE - Tongue sole	0.19	0.17	0.02	0.07	
DACTYLOPTERIDAE - Flying gurnard			0.07	0.05	
DIODONTIDAE - Porcupinefish	0.15				
DREPANIDAE - Sicklefish	0.44	0.32	0.01		
ECHENEIDAE - Suckerfish			0.05		
EPHIPPIDAE - Spadefish	0.15		0.01		
FISTULARIIDAE - Pipefish		0.10	0.02	0.10	
FORMIONIDAE - Black pomfret	0.13	0.02	0.66	1.36	
GEMPYLIDAE - Snake mackerel					0.29
GERREIDAE - Mojarra	0.32	8.77	0.77	4.58	
HARPADONTIDAE - Bombay-duck	8.43				
HOLOCENTRIDAE - Squirrelfish					
KURTIDAE - Humphead	0.20	0.26			
LACTARIIDAE - False trevally	0.03	0.26	0.62		
LUTJANIDAE - Snapper	0.96	0.11	6.95	1.62	
MENIDAE - Moonfish		0.06	0.11	0.03	
MUGILIDAE - Grey mullet	0.15				
MULLIDAE - Goatfish	0.99	11.13	2.62	0.57	
MURAENESOCIDAE - Pike conger	1.02	2.16	0.10		
NEMIPTERIDAE - Threadfin bream	0.03	2.76	0.75	65.38	32.50
NOMEIDAE - Man-of-war fish					5.27
OSTRACIONTIDAE - Boxfish		0.03		0.05	
PLATYCEPHALIDAE - Flathead		0.21	0.02	0.05	
POLYNEMIDAE - Threadfin	4.17	0.26	0.16		
POMADASYIDAE - Grunt	6.45	1.07	2.12	0.18	
PRIACANTHIDAE - Bigeye			0.05	7.35	45.82
PSETTOIDAE - Indian halibut	0.16		0.18	0.01	
RACHYCENTRIDAE - Cobia		1.16	0.26		
SCIAENIDAE - Croaker	37.10	27.05	2.37	2.34	2.05
SCORPAENIDAE - Firefish		0.02	0.04	0.01	
SERRANIDAE - Seabass			0.08		
SILLAGINIDAE - Sillago	1.43				
SPARIDAE - Seabream	1.52	0.65	0.08	0.12	
STROMATEIDAE - Pomfret	5.56	0.62	1.61	0.28	
SYNACEIIDAE - Stonefish			0.04		
SYNODONTIDAE - Lizardfish	3.51	11.35	1.14	7.42	13.62
TETRAODONTIDAE - Pufferfish	0.70	0.01	0.03		
THERAPONIDAE - Therapon	0.11	0.91	0.05		
TRIACANTHIDAE - Tripodfish	2.67	0.08			
TRICHIURIDAE - Hairtail	4.54	2.88	3.92	0.33	
TRIGLIDAE - Searobin				0.17	0.15

The dominant species in the area off Cox's Bazar were catfish and Bombay duck, Harpodon nehereus. Due to rough bottom no trawling was carried out on the concentration in the Swatch of No-Ground. Long-line catches, however, indicated that the major species in this area was catfish.

Table 4 gives the species composition (%) of demersal fish from bottom trawl catches at different depth zones. In the depth zone 10-24 m the catches were dominated by croakers, Scianidae sp., catfish and Bombay duck. The most abundant of the Sciaeniadae sp. seemed to be Chrysochir aureus.

Catfish and croakers were also among the important species at the 25-49 m depth zone and in addition, lizardfish Synodontidae sp., goatfish, Mullidae sp. and mojarra, Gerres sp. made significant contributions.

At 50-74 m depth, catfish contributed about 75% of the catch. This was mostly due to one large catch of 4000 kg/h. The species composition should therefore be treated with caution. Snapper, mainly Lutjanus johni, and hairtail Trichiuridae, were also important species in the catches.

At 75-99 m depths the contribution of catfish to the catches decreased sharply, and the most important species appeared to be threadfin bream, Nemipterus japonicus, followed by bigeye, Priacanthus hamrur, and lizardfish, Saurida spp. At depths deeper than 100 m these species also dominated the catches.

Table 5. Species composition (%) of pelagic fish from bottom trawl catches at different depth zones.

FAMILY \ DEPTH ZONE (m)	10-24	25-49	50-74	75-99	≥100
ARIOMMIDAE - Drift fish	-	-	0.10	16.07	-
CARANGIDAE - Jack/scad	5.64	11.92	8.44	28.88	100.00
CLUPEIDAE - Herring/Shad	53.40	7.05	18.19	0.32	-
ENGRAULIDAE - Anchovy	26.09	14.72	10.75	0.01	-
LEIOGNATHIDAE - Ponyfish	6.44	33.20	3.44	2.56	-
SCOMBRIDAE - Mackerel	8.43	33.06	58.06	51.35	-
SPHYRAENIDAE - Barracuda	-	0.05	1.00	0.82	-

Pelagic fish

Fig. 9 shows the distribution of echo abundance of pelagic fish expressed in mm integrator readings. As can be seen, the distribution was patchy, reflecting observations of more isolated schools rather than a coherent scattering layer. The high concentration in approximate position N 20°15', E 91°20' probably consisted of Indian mackerel, Rastrelliger kanagurta, settled on the bottom at about 80 m.

Table 5 gives the species composition (%) of pelagic fish from bottom trawl catches in different depth zones. At depths of 0-24 m most of the pelagic fish catches consisted of members of

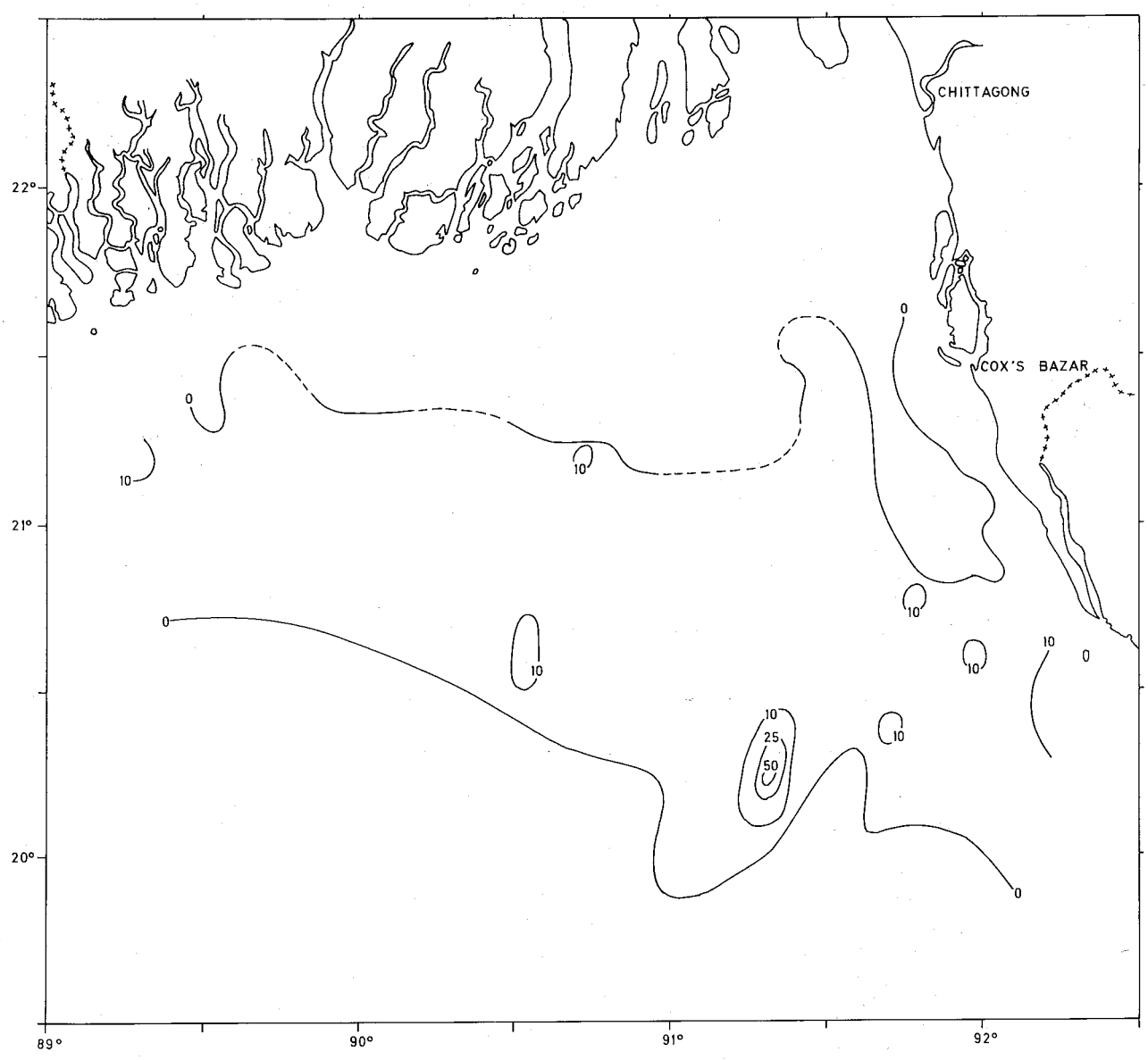

Fig. 9. Echo abundance of pelagic fish in mm integrator reading.

the Clupeidae and Engraulidae families with Sardinella fimbriata and Setipinna taty as dominant species.

Of the Ariommidae only the species Indian driftfish, Ariomma indica, was recorded. From the Carangidae family Carangoides malabaricus was the most abundant species down to 75 m depth, while round scad, Decapterus maruadsi, were dominant at 75-100 m. At depths deeper than 25 m Ilisha megaloptera dominated

Table 6. Species composition (%) of catches from pelagic trawl in different depth zones.

Families	Depth zones (m)	
	≤150 m	>150 m
ACROPOMATIDAE	-	1.04
ARIOMMIDAE - Driftfish	0.12	-
ARIIDAE - Catfish	0.72	-
BREGMACEROTIDAE	4.05	0.30
CARANGIDAE - Jack/scad	2.82	0.07
CHAULIODONTIDAE - Fang-fish	-	0.15
CHIROCENTRIDAE - Wolf herring	0.37	-
CLUPEIDAE - Shad, herring	24.23	-
ENGRAULIDAE - Anchovy	16.21	-
FORMIONIDAE - Black pomfret	0.37	-
GONOSTOMIATIDAE	-	0.74
HARPODONTIDAE - Bombay-duck	9.19	8.91
LACTARIIDAE - False trevally	0.12	-
LEIOGNATHIDAE - Pony fishes	1.05	0.15
MYCTOPHIDAE - Lantern fish	-	87.60
MENIDAE - Moonfish	-	1.04
POMADASYIDAE - Grunt	0.03	-
SCOMBRIDAE - Mackerel	8.91	-
SCIAENIDAE - Croaker	8.60	-
SPHYRAENIDAE - Barracuda	0.47	-
STROMATIDAE - Pomfret	3.87	-
SYNODONTIDAE - Lizard fish	0.12	-
TRICHIURIDAE - Hair tail	18.75	-

Table 7. Biomass of demersal fish calculated by means of bottom trawl catches.

Depth zones (m)	Density (kg/km^2)	Stock (tonnes)
10 - 24	2082	17 489
25 - 49	2223	10 670
50 - 74	6451	35 997
75 - 99	3105	41 638
100 - 150	164	1 681
Total		107 475

The validity of this estimate depends highly on the efficiency coefficient chosen. In similar calculations coefficients ranging from 0.3 to 1.0 have been applied. A value of 0.5 appear to give reliable results for the "Dr. Fridtjof Nansen" type of trawl both off Mozambique (SÆTRE and SILVA, 1979) and in the waters of Sri Lanka (BLINDHEIM et al, 1980). If this efficiency coefficient is used, an abundance estimate of about 160 000 tonnes of demersal fish is reached.

The acoustic abundance estimate is calculated by the equation

$$B = \oint P_A dA = C \cdot \bar{M} \cdot A$$

where B is the demersal fish biomass, P_A the fish density expressed in weight per unit area, C is a conversion coefficient, $\bar{M}$ is the average integrator reading and A the corresponding area. The numerical value of C applied in these calculations was:

$$C = \frac{L}{5} \text{ tonnes}/\text{mm} \cdot (\text{n.m})^2$$

where L is the average length in cm.

A more comprehensive discussion on the C value is carried out by BLINDHEIM et al (1980) and by NAKKEN and SANN AUNG (1980). The length frequency distributions for typical demersal species (APPENDIX B) show variation from 12-14 cm (Nemipteridae) to 50-60 cm (Lutjanidae). As catfish of length 30-40 cm made the most significant contribution to the catches, an average length of 25 cm for the demersal stock as a whole seems to be a reasonable

estimate. This correspond to C = 5 $^{tonnes}/_{mm(n.mile)^2}$. Under these assumptions the acoustic abundance estimate for demersal fish reaches a value of about 40 000 tonnes.

An acoustic estimate of demersal fish will usually be an underestimate, due to the limitation of the echo sounder and integrator in making recordings very close to the bottom. An examination of the bottom trawl catches in the depth zone 50-99 m revealed that catch rates up to 300 $^{kg}/_{h}$ were obtained even when no demersal fish were recorded by the echo sounder. This consisted of smaller demersal species such as Nemipteridae, Sciaenidae and Mullidae. It is thus obvious that the acoustic abundance estimate of demersal fish is a serious underestimate. Therefore, as a first approximation of the abundance of the demersal stock off Bangladesh, 150 000 tonnes is suggested.

Pelagic fish

For the pelagic species, the acoustic abundance estimate is considered more reliable. An average length of 15 cm was chosen for the pelagic stock. This gives C = 3 $^{tonnes}/_{n.mile)^2}$ and an acoustic abundance estimate of about 60 000 tonnes. The estimate is probably too low, as the large part of the shelf which is shallower than 10 m was not surveyed. Neither were fish occurring above the depth of the transducer included.

As seen from the applied equation for C, the acoustic abundance estimates are very sensitive to variations in the average length of the stock. The present estimate should therefore be used with caution, and regarded more as an approximation and guideline.

4. REFERENCES

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APPENDIX A. RECORD OF FISHING OPERATIONS

BT = Bottom trawl - PT = Pelagic trawl - GN = Gillnet - LL = Longline

DATE	ST.NO.	GEAR TYPE	BOTTOM DEPTH (m)	GEAR DEPTH (m)	POSITION NORTH	POSITION EAST	TOTAL CATCH (kg)	CATCH PER HOUR (kg)	IMPORTANT SPECIES
27.11.79	417	BT	19	19	21°22'	91°42'	86	172	Catfish (Arius sp.) Croaker (Otolithoides pama) Bombay duck (Harpadon nehereus)
28.11.79	418	BT	58	58	20°47'	91°48'	750	750	Catfish (Arius sp.) Anchovy (Stolephorus sp.) Ilisha (Ilisha megaloptera, I.melastoma)
28.11.79	419	BT	53	53	20°51'	91°48'	2000	4000	Catfish (Arius sp.)
28.11.79	420	PT	18	0	21°26'	91°41'	43	95	Bombay duck (Harpadon nehereus) Croaker (Otolithoides biauritus) Ribbon fish (Trichiurus sp.)
28.11.79	421	PT	47	0	21°10'	91°28'	10	20	Bombay duck (Harpadon nehereus) Ribbon fish (Trichiurus lepturus) Fish fry (Mainly Engraulidae)
29.11.79	422	PT	95	70	20°10'	91°19'	1.5	3	Spanish mackerel (Scomberomorus guttatus) Ilisha (Ilisha melastoma) Pomfret (Formio niger)
30.11.79	423	PT	65	0	21°10'	90°30'	8.6	17.2	Ribbon fish (Trichiurus lepturus) Fish fry (Mainly Bregmaceros sp.)
30.11.79	424	PT	100	10	20°26'	90°32'	1	2	Round scad (Decapterus maruadsi)
30.11.79	425	PT	>500	320	19°58'	90°18'	0.9	1.8	Lantern fish (Myctophidae)
30.11.79	426	PT	900	180	20°03'	90°03'	0.5	1	Bristlemouth (Gonostomatidae)
30.11.79	427	PT	81	0	21°08'	90°03'	7	14	Codlet (Bregmaceros sp.) Round scad (Decapterus maruadsi) Indian mackerel (Rastrelliger kanagurta)
1.12.79	428	PT	>500	40	21°10'	89°22'	2	2	Moonfish (Mene maculata) Codlet (Bregmaceros sp.)
1.12.79	429	PT	>500	190	21°10'	89°23'	15	30	Bombay duck (Harpadon sp.) Lantern fish (Myctophidae) Ponyfish (Leiognathidae)
1.12.79	430	PT	500	25	21°11'	89°20'	0.1	0.2	Fish fry (Harpadon sp. or Saurida sp.)
1.12.79	431	BT	90	90	21°07'	89°30'	215	430	Bream (Nemipterus sp.) Round Scad (Decapterus maruadsi) Bigeye (Priacanthus macracanthus)
2.12.79	432	PT	>500	0	20°07'	89°45'	0.2	0.2	Lantern fish (Myctophidae)
2.12.79	433	BT	85	85	21°05'	89°37'	14.4	28.8	Indian driftfish (Ariomma indica) Pony fish (Leiognathus equulus) Pomfret (Formio niger)
2.12.79	434	BT	9	9	21°27'	89°34'	201	402	Pomfret (Formio niger) Croaker (Johnius belangerii) Jack (Caranx kalla)
2.12.79	435	GN	20	0	21°28'	89°47'	68		Spanish mackerel (Scomberomorus guttatus) Shark (Carcharhinus sp.) Cobia (Rachycention canadus)
3.12.79	436	LL	70	70	21°25'	89°38'			No catch

APPENDIX A. RECORD OF FISHING OPERATIONS

BT = Bottom trawl - PT = Pelagic trawl - GN = Gillnet - LL = Longline

DATE	ST.NO.	GEAR TYPE	BOTTOM DEPTH (m)	GEAR DEPTH (m)	POSITION NORTH	POSITION EAST	TOTAL CATCH (kg)	CATCH PER HOUR (kg)	IMPORTANT SPECIES
3.12.79	437	BT	16	16	21°23'	89°50'	24	48	Shark (Sphyrna blochii) Trippelspine (Triacanthidae) Spanish mackerel (Scomberomorus guttatus)
3.12.79	438	BT	40	40	21°15'	89°50'	18	36	Catfish (Arius sp.) Ponyfish (Leiognathus bindus) Lizardfish (Saurida tumbil)
3.12.79	439	BT	72	72	21°11'	89°50'	103	206	Catfish (Arius sp.) Spanish mackerel (Scomberomorus guttatus) Ribbon fish (Lepturacanthus savala)
3.12.79	440	BT	95	95	20°55'	89°50'	1003	2006	Bream (Nemipterus japonicus) Croaker (Otolithes ruber) Bigeye (Priacanthus hamrus)
3.12.79	441	GN	60	0	21°14'	89°41'			No catch
3.12.79	442	PT	70	30	21°13'	89°47'	2.4	4.8	Rainbow sardine (Dussumieria acuta) Sardine (Sardinella spp.) Indian mackerel (Rastrelliger kanagurta)
4.12.79	443	BT	65	65	21°15'	89°40'	98	196	Catfish (Arius sp.) Round scad (Decapterus maruadsi) Ilisha (Ilisha megaloptera)
4.12.79	444	LL	95	95	21°20'	89°38'	11.2		Catfish (Arius sp.) Shark (Carcharhinidae)
4.12.79	445	BT	22	22	21°19'	89°54'	16.5	33	Wolf herring (Chirocentrus dorab) Trippelspine (Triacanthidae) Spanish mackerel (Scomberomorus guttatus)
4.12.79	446	BT	41	41	21°14'	90°00'	103	206	Ponyfish (Leiognathus bindus) Goatfish (Upeneus sulphureus) Cavalla (Carrangaides malabaricus)
4.12.79	447	BT	82	82	21°04'	90°00'	± 229	458	Indian driftfish (Ariomma indica) Ponyfish (Leiognathus equulus) Bream (Nemipterus japonicus)
4.12.79	448	BT	100	100	20°42'	90°00'	15	30	Bream (Nemipterus japonicus)
4.12.79	449	GN	20	0	21°14'	90°13'			No catch
4.12.79	450	PT	32	15	21°13'	90°13'	15	30	Spanish mackerel (Scomberomorus guttatus) Anchovy juv. (Stolephorus sp.) Rainbow sardine - juv. (Dussumieria acuta)
5.12.79	451	BT	36	36	21°09'	90°20'	19	38	Ponyfish (Leiognathus bindus) Spanish mackerel (Scomberomorus guttatus) Anchovy (Stolephorus sp.)
5.12.79	452	BT	82	82	21°02'	90°17'	194	388	Indian mackerel (Rastrelliger kanagurta) Indian driftfish (Ariomma indica) Catfish (Arius sp.)
5.12.79	453	BT	133	133	20°15'	90°20'	16	32	Bigeye (Priacanthus hamrur) Shrimps - small
5.12.79	454	PT	152	55	20°07'	90°31'	50	100	Lantern fish (Myctophidae)
6.12.79	455	BT	78	78	20°57'	90°36'	765	1530	Indian mackerel (Rastelliger kanagurta) Catfish (Arius sp.) Shrimps

APPENDIX A. RECORD OF FISHING OPERATIONS

BT = Bottom trawl - PT = Pelagic trawl - GN = Gillnet - LL = Longline

DATE	ST.NO.	GEAR TYPE	BOTTOM DEPTH (m)	GEAR DEPTH (m)	POSITION NORTH	POSITION EAST	TOTAL CATCH (kg)	CATCH PER HOUR (kg)	IMPORTANT SPECIES
6.12.79	456	BT	42	42	21°05'	90°35'	126	252	Catfish (Arius sp.) Goatfish (Upeneus vittatus) Shrimps
6.12.79	457	BT	14	14	20°12'	90°48'	374	748	Ilisha (Ilisha megaloptera) Anchovy (Setipinna taty) Croaker (Johnius carutta)
6.12.79	458	BT	50	50	21°03'	90°48'	295	590	Ilisha (Ilisha megaloptera) Pomfret (Pompus argenteus) Goatfish (Upeneus sulphureus)
6.12.79	459	BT	95	95	20°22'	90°48'	427	852	Scad (Decapterus maruadsi) Bream (Nemipterus japonicus) Lizardfish (Saurida longimanus)
6.12.79	460	BT	79	79	20°40'	91°04'	45	90	Ilisha (Ilisha megaloptera) Lizardfish (Saurida tumbil) Shrimps
6.12.79	461	GN	18	0	21°05'	91°01'	12		Wolf herring (Chirocentrus dorab) Shark (Sphyrna blochii)
7.12.79	462	BT	30	30	21°03'	91°04	93	186	Indian mackerel (Rastrelliger kanagurta) Catfish (Arius sp.) Lizardfish (Saurida tumbil)
7.12.79	463	BT	58	58	20°59'	90°59'	372	744	Indian mackerel (Rastrelliger kanagurta)
7.12.79	464	LL bottom	53	53	21°00'	91°03'			Longline lost
7.12.79	465	LL Pelagic	55	10-20	20°59'	91°03'			2 Sailfish (Istiophorus sp.) 208-218 cm 1 Shark (Carcharhinus sp.) 165 cm
7.12.79	466	BT	17	17	21°08'	91°14'	193	386	Sardine (Sardinella fimbriata) Catfish (Arius sp.) Lizardfish (Saurida tumbil)
7.12.79	467	BT	53	53	21°00'	91°13'	85	170	Goatfish (Upeneus vittatus) Wolf herring (Chirocentrus dorab) Catfish (Arius sp.)
7.12.79	468	BT	80	80	20°53'	91°14'	70	140	Snappers (Lutjanus spp.) Mojarra (Pentaprion longimanus) Catfish (Arius sp.)
7.12.79	469	BT	120	120	20°09'	91°12'	4	8	Spider crab Shrimps Bigeye (Priacanthus hamrur)
7.12.79	470	BT	152	152	20°05'	91°15'	0.5	1	Spider crab Shrimps Lantern fish (Myctophidae)
8.12.79	471	BT	80	80	20°32'	91°34'	86	172	Mojarras (Pentaprion longimanus) Catfish (Arius sp.) Lizardfish (Saurida tumbil)
8.12.79	472	BT	46	46	21°06'	91°34'	216	432	Croaker (Sciaenidae) Anchovy (Setipinna taty) Indian pike-conger (Congresox talabonoides)
8.12.79	473	BT	24	24	21°14'	91°34'	157	314	Croaker (Chrysochir aureus) Croaker (Johnius belangerii) Catfish (Arius sp.)
8.12.79	474	BT	20	20	21°21'	91°44'	225	450	Bombay duck (Harpodon nehereus) Threadfin (Polynemus indicus) Catfish (Arius sp.)

APPENDIX A. RECORD OF FISHING OPERATIONS

BT = Bottom trawl - PT = Pelagic trawl - GN = Gillnet - LL = Longline

DATE	ST.NO.	GEAR TYPE	BOTTOM DEPTH (m)	GEAR DEPTH (m)	POSITION NORTH	POSITION EAST	TOTAL CATCH (kg)	CATCH PER HOUR (kg)	IMPORTANT SPECIES
9.12.79	475	BT	59	59	20°57'	91°41'	11.2	23	Ponyfish (Leiognathus bindus) Spanish mackerel (Scomberomorus guttatus) Pomfret (Pampus argenteus)
9.12.79	476	BT	64	64	20°43'	91°39'	333	666	Snapper (Lutjanus johni, L. malabaricus) Grunt (Pomadasys hasta) Ponyfish (Leiognathus bindus)
9.12.79	477	BT	83	83	20°30'	91°36'	30	60	Round scad (Decapterus maruadsi) Catfish (Arius sp.) Lizardfish (Saurida spp.)
9.12.79	478	BT	123	123	20°05'	91°35'	13	26	Bigeye (Priacanthus hamrur) Shrimps Spider crabs
9.12.79	479	BT	88	88	20°13'	91°46'	50	100	Catfish (Arius sp.) Bream (Nemipterus sp.) Lizardfish (Saurida spp.)
9.12.79	480	BT	46	46	20°39'	91°55'	111	222	Catfish (Arius sp.) Mojarra (Pentaprion longimanus) Lizardfish (Saurida tumbil)
9.12.79	481	PT	43	23	20°41'	91°54'	90	170	Anchovy (Stolephorus sp.) Rainbow sardine (Dussumieria acuta) Spanish mackerel (Scomberomorus guttatus)
10.12.79	482	BT	27	27	21°00'	91°56'	349	698	Catfish (Arius sp.) Croaker (Sciaenidae) Goatfish (Upeneus sulphureus)
10.12.79	483	LL Bottom	15	15	21°04'	92°02'	8.1		Catfish (Arius sp.)
10.12.79	484	LL Pelagic	15	10	21°03'	92°02'	3		Catfish (Arius sp.)
10.12.79	485	BT	15	15	21°02'	92°01'	81	162	Catfish (Arius sp.) Grunter (Pomadasys hasta) Ponyfish (Leiognathus bindus)
10.12.79	486	BT	15	15	20°55'	92°05'	146	292	Spanish mackerel (Scomberomorus guttatus) Catfish (Arius sp.) Grunter (Pomadasys hasta)
10.12.79	487	BT	32	32	20°34'	92°04'	118	236	Goatfish (Upeneus sulphureus) Lizardfish (Saurida tumbil) Ponyfish (Leiognathus bindus)
10.12.79	488	BT	52	52	20°26'	92°04'	22	44	Catfish (Arius sp.) Trevally (Atropus atropus) Bream (Nemipterus japonicus)
10.12.79	489	BT	80	80	20°12'	92°02'	101	202	Mojarra (Pentaprion longimanus) Bigeye (Priacanthus sp.) Bream (Nemipterus japonicus)
10.12.79	490	BT	86	86	20°14'	91°52'	32	64	Mojarra (Pentaprion longimanus) Catfish (Arius sp.) Lizardfish (Saurida tumbil)
10.12.79	491	BT	71	71	20°22'	91°54'	40	80	Mojarra (Pentaprion longimanus) Bream (Nemipterus japonicus) Lizardfish (Saurida spp.)
11.12.79	492	BT	44	44	20°35'	91°57'	274	548	Croaker (Scianidae spp.) Mojarra (Pentaprion longimanus) Ponyfish (Leiognathus bindus)
11.12.79	493	LL Bottom	16	16	20°56'	92°04			Catfish (Arius sp.)

APPENDIX B:

Length frequency distribution of some important species. (x indicates scale from 51 to 100 cm).

	St. No.	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40	1	2	3	4	5	6	7	8	9	50
ARIOMMIDAE																																																			
Ariomma indica	431											1	1	16	39	19	7	3																																				
Indian driftfish	433															7	26	16	4	1																																
	452															3	19	18	12	4																																
	468																8	28	11	1																																
CARANGIDAE																																																			
Atropus atropus	488														1		2		3	8	7	10	1	1																													
Kuweh trevally																																																			
Decapterus kurroides	459															5	7		7																																	
Decapterus maruadsi	424											1	14	20	4																																				
Round scad	431														6	5	13	38	10																																
	443																			1	6	5	1																													
	447																1	24	11	3																																
	452																	2	11	19	6	4																														
	459														34	63	2																																		
	460																		5	2	1																														
	471															2	9	17	7	5	1	1																												
	477															7	23	31	19	1																														
Megalaspis cordyla	452																								1	5	1	5			1																			
Hardtail scad	458																						1	5	3																									
Scomberoides commersonianus	486																										1			1	1		1	3	4	2	4	3	2									
Talang queenfish																																																			
CHIROCENTRIDAE																																																			
Chirocentrus dorab	486																																																		
Dorab wolf-herring	x							1																																												

	St. No.	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40	1	2	3	4	5	6	7	8	9	50
CLUPEIDAE																																																			
Dussumieria acuta	442							1	8	37	13																																									
Rainbow sardine	481								18	44	19	3																																								
Ilisha megaloptera	434													1	3	4	5	2			3						1	1																								
Bigeye ilisha	457									1	1	1	1		1		1	4	1	1		2	2	3	5	1	3	7	1		1	1																				
	460																										1	2	1	1	2	2																			
	462													1	2	2	12	1																																	
Raconda russeliana	434													6	16	28	23	13	3	4	1	1																												
"Russel's" tardoore	457													2	4	19	17	16	13	5	5																												
Sardinella fimbriata	442					5	23	6	1																																									
Fringescale sardinella	445					1	6	4		1	3	8	7	15	3	1	2																																
	450												2	15	4																																		
	466															4	27	25	12																															
	481							5	18	31	23	3	1																																					
Spratelloides sp.	437														3	9	8																																
ENGRAULIDAE																																																	
Setipinna taty	457							1	4	13	22	10	6	3	11	5	5																																
Hairfin anchovy																																																	
Stolephorus sp.	451							2	7	61	2																																						
(Anchovy)	481						2	36	25	1																																							
Thryssa malabarica	457												1			5	3	5		2	1																												
Malabar thryssa																																																	
FORMIONIDAE																																																	
Formio niger	452																					1	3	2	4	3		1																				
Black pomfret																																																	
LUTJANIDAE																																																	
Lutjanus johni	476x	1				1				1		4	4	4	5	4	4	3	1	1																												
John's snapper																																																	
Lutjanus malabaricus	476																													1																				
Malabar red snapper	x	1	6	5	7	2	1	2																																								
Lutjanus sanguineus	476													1		3	1	1					1	1	2					1	1		2	1	3			1	1	1	1								
Blood snapper	x		2	1	1			1	1			1																																					

	St. No.	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40	1	2	3	4	5	6	7	8	9	50
NEMIPTERIDAE																																																			
Nemipterus japonicus	440										5	15	30	16	1	2																																				
Japanese threadfin bream	459									7	8	9	27	20	10	5	11	4																																		
	487									1				2	10	6	10	6	2		1	1																													
	488												1	3	10	9	7	1	3	2	2				1	1																									
Nemipterus sp.	431												30	48	23	18	13	5																																
Threadfin bream																																																		
POMADASYIDAE																																																		
Pomadasys hasta	486																			1	1	1	2	6	5	4	5	3	6	6	3	2	1	1	2		3	2	2	2	1	3		3	3	2	1					
Lined silver grunt																																																		
PRIACANTHIDAE																																																		
Priacanthus sp.	431												1	1	16	39	19	7	3																																
Bigeye																																																		
SCIAENIDAE																																																		
Chrysochir aureus	434													1		2	1	1	1	3	2																														
Reeve's croaker	457																		1	2	1	3	2		1	2	2	1			1																			
	473																						1	1				2	2	1	1	1	3		2			2											
Johnius belangerii	473														1	4	10	10	7	7	3	5																												
Belanger's croaker																																																		
Otolithoides pama	417															1		8	19	14	19	9	15	9	5		1								1														
Pama croaker																																																		
Pennahia argentata	457									1	4	7								1	4	9	2	1																											
Silver pennah croaker																																																		
SCOMBRIDAE																																																		
Rastrelliger kanagurta	442					1	3	14	12	5																																								
Indian mackerel	447														1					2	2	2																												
	452												1		1				1	8	36	13	1																											
	455																			1	20	14	41	18																											
	462																				1		22	8																											
	463																				15	30	6	1																											

	St. No.	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	20	1	2	3	4	5	6	7	8	9	30	1	2	3	4	5	6	7	8	9	40	1	2	3	4	5	6	7	8	9	50
Scomberomorus guttatus	435																																																		
Indo-Pacific Spanish mackerel	x		1	2																																															
	437																								4	7	5	3	1																							
	439																																			3	2	5	7	11	6	4	2	4							
	x	1	2	2	3	1	1	1	1																																										
	481																															3	1	2		1	2	3		1			1							
	x		1								1																																								
	486																																				2	1	2	2	5	2	2							
	x	1	1		1																																													
SPARIDAE																																																			
Argyrops spinifer	486																4	2	3	1	2	3	5	8	2	1	3	3																							
Longspine seabream																																																		
STROMATEIDAE																																																		
Pampus argenteus	434															2	5	14	18	12	6	5	2	5																										
Silver pomfret	458																			1	4	6	3	1	5	1	1	1																							
SYNODONTIDAE																																																		
Saurida longimanus	460																	1	1	2																																
"Longfin" lizardfish																																																		
Saurida tumbil	460																									3	1	2	2	1	1		2	2	1	1														
Greater lizardfish	462								1	3	2						1	1				1		5	7	4	1	3	1		1	1	2	1														
Saurida undosquamis	460																			3	2	3	1	1																										
Brushtooth lizardfish																																																		

REPORTS ON SURVEYS WITH R/V DR. FRIDTJOF NANSEN

PRELIMINARY RESULTS FROM A SURVEY ON THE MARINE FISH RESOURCES OF BANGLADESH MAY 1980

By

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1. INTRODUCTION

A survey of the fish resources of the waters off Bangladesh was carried out during November - December 1979 with the Norwegian research vessel "Dr. Fridtjof Nansen" (CHOWDHURY, KHAN, MYKLEVOLL and SÆTRE, 1980). In May 1980 this investigation was repeated. Both surveys were carried out on a subcontract arrangement between FAO and the Institute of Marine Research, Bergen, which operate the vessel on behalf of the Norwegian Agency for International Development (NORAD).

The survey dealt with in this report was split in two parts, 7 - 9 May and 16 - 24 May, due to engine trouble and waiting for spare parts.

The scientific staff consisted of the following people:

Institute of Marine Research Bergen	Fisheries Research Station Chandpur, Comilla
H. Abrahamsen	W.N. Chowdhury
O. Alvheim	Md. G. Khan
S.A. Iversen	
A. Roald	
R. Sætre	

A final report on these investigations is scheduled to be finished in the first part of 1981.

2. METHODS

The vessel and gear applied are described in CHOWDHURY et al. (1980). In the present report only the deviations in gear and methods compared to the first cruise will be included.

The bottom trawl is a 134-foot head line shrimp trawl type which is adapted also to demersal fish trawling. The foot rope is equipped with 0.5 m rubber bobbins. The effective vertical opening of the net is about 6 m and the horizontal opening about 20 m.

For identification of fish the FAO Species Identification Sheets for Fishery Purposes were used and to a minor degree SMITH (1977). Family names are according to NELSON (1976).

On this cruise the 120 kHz echo sounder connected to an analog echo integrator was used for estimating the echo abundance of fish. The 38 kHz echo sounder was applied as an auxiliary system. The reason for using the 120 kHz echo sounder for estimating echo abundance instead of the 38 kHz sounder as on the previous cruise was that the 120 kHz sounder appeared to be much less influenced by the scattering layer produced by plankton.

The settings of the 120 kHz system were: Pulse 0.6 msec/3 kHz, transmitter 1/1, 20 log R-0dB, recorder gain 3, integrator gain 20 dB x 10, threshold 8.

At each hydrographic station a vertical plankton haul was taken with a Juday plankton net with an opening of 0.1 m^2 and a mesh size of 180 µ. The net was hauled from 5 m above the bottom or from 100 m to the surface. The samples were handed over for further processing to the people of the Fisheries Research Station, Chandpur.

Table 1 reviews the number of the different fishing stations as well as the hydrographic stations.

Fig. 1 shows the survey routes and the location of the stations during the investigations.

Table 1. Number of stations

Bottom trawl	61
Pelagic trawl	7
Gillnet	1
Hydrographic stations	19
Bathythermograph stations	20

this transition area followed approximately the 50 m isobath. The surface salinity had increased significantly since November - December 1979.

The hydrographic sections I-III appear in Figs. 3-5, numbered from east to west. The depth to the thermocline was usually 30-40 m, compared to about 70 m in November - December 1979. SECTION I seemed to be less influenced by the fresh water outflow from Bangladesh than SECTIONS II and III, as also is clearly demonstrated in Fig. 2. Especially SECTION II showed a

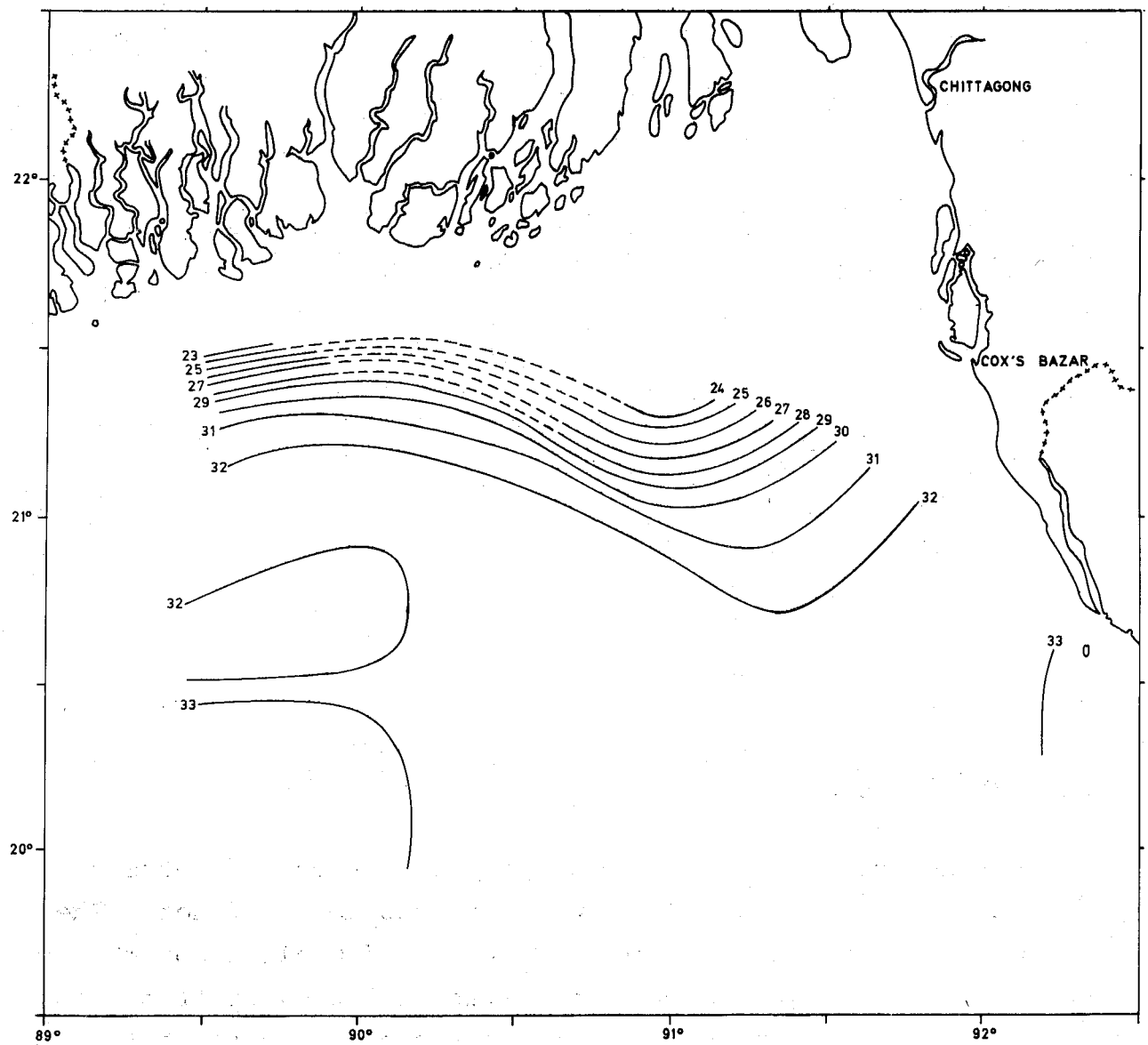

Fig. 2. Distribution of surface salinity.

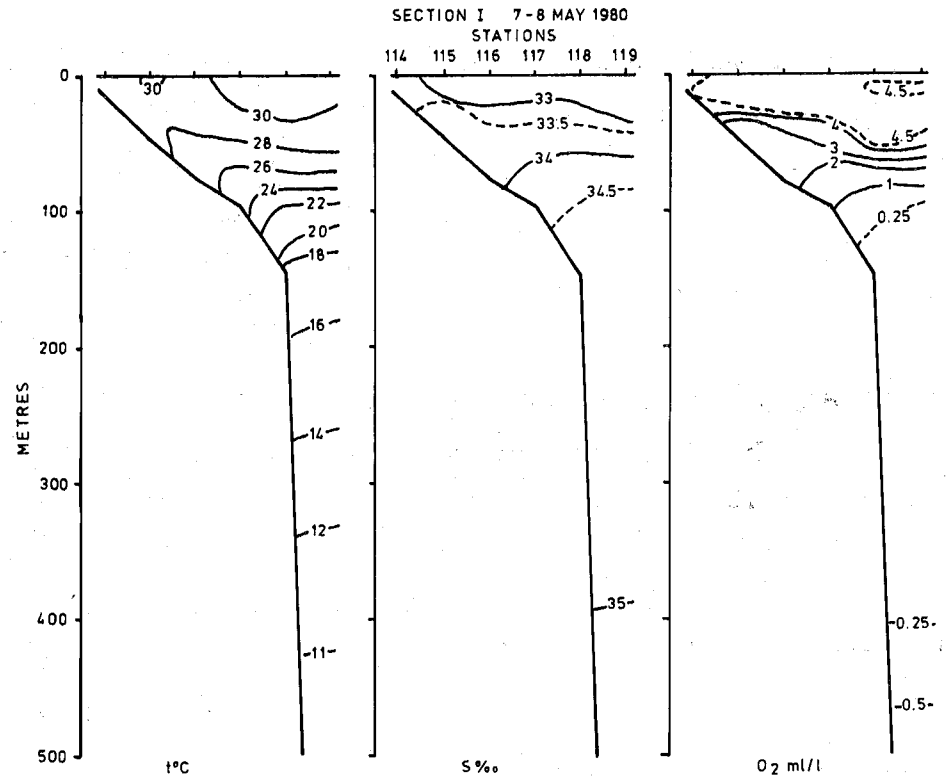

Fig. 3. Vertical distribution of temperature, salinity and oxygen - SECTION I.

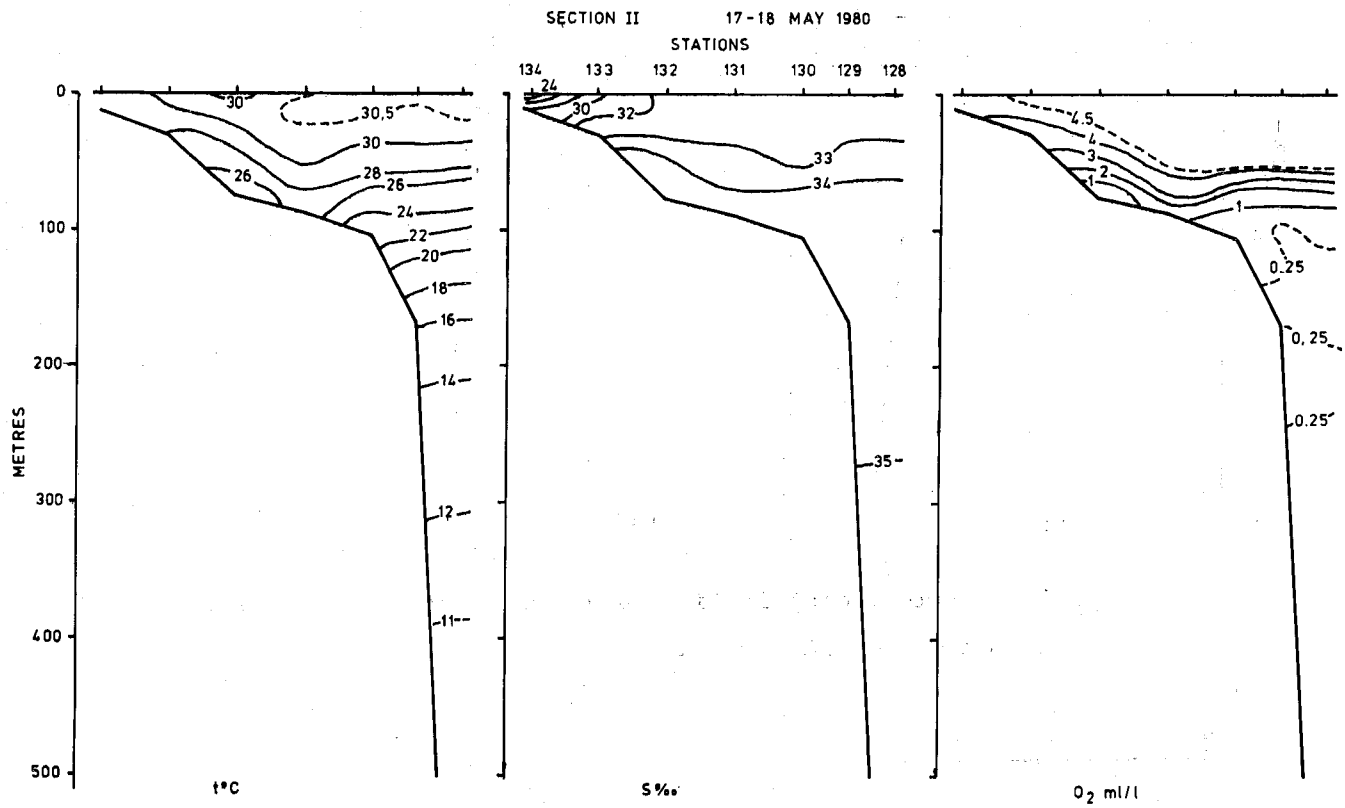

Fig. 4. Vertical distribution of temperature, salinity and oxygen - SECTION II.

strong haline stratification in the northern part, while in the more offshore areas the upper layer was more homohaline down to the thermocline. There was usually a slight increase in salinity towards the surface in the upper 20-30 m. This was probably caused by the increased evaporation during this time of the year.

The oxygen content decreased rapidly with depth within the upper part of the thermocline. The isoline for 1 ml/l was situated at about 80 m which was about 20 m higher up than in November - December. Deeper, the oxygen content decreased to less than 0.2 ml/l. There seemed to be a minimum in the vertical oxygen distribution between 200 and 400 m.

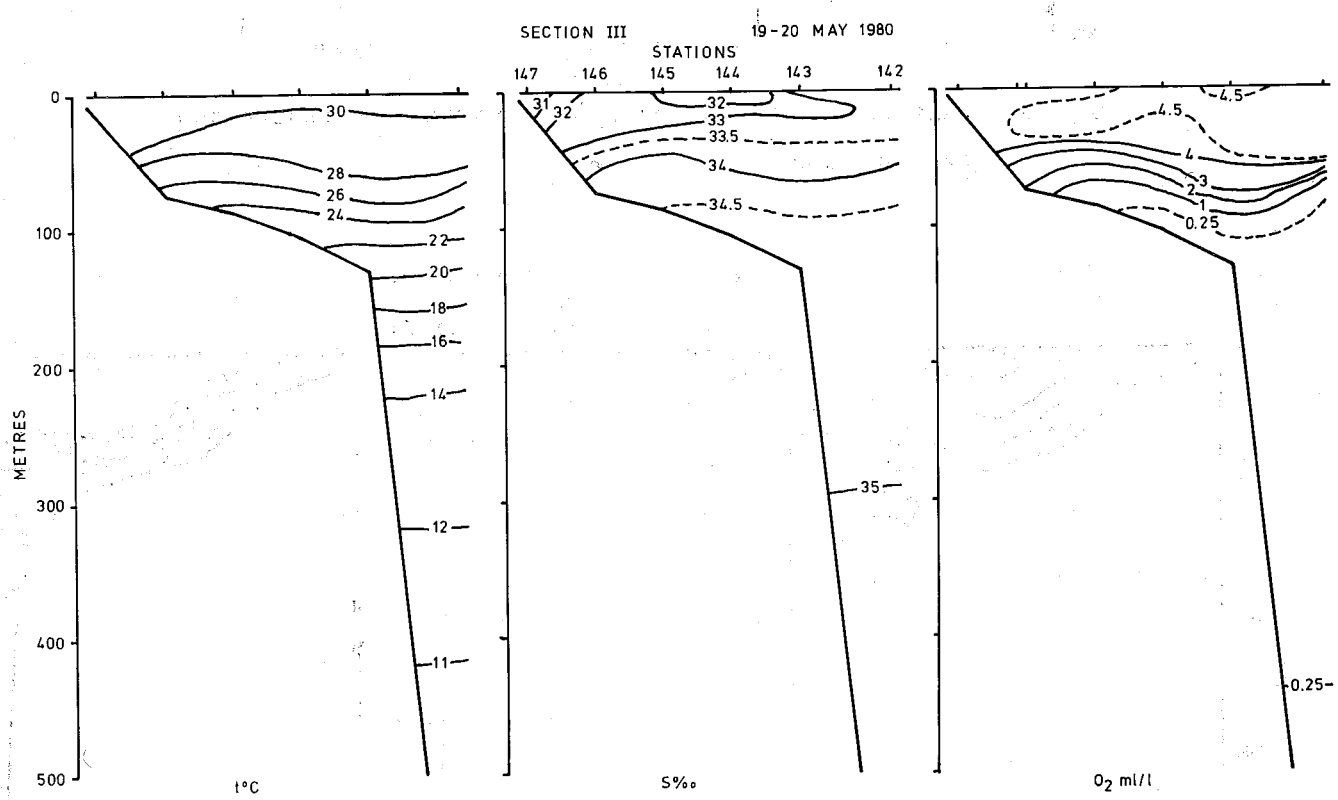

Fig. 5. Vertical distribution of temperature, salinity and oxygen - SECTION III.

3.3 Plankton

In November - December 1979 the echo abundance of plankton was obtained from the 38 kHz echo sounder, but during the present

cruise the values from the 120 kHz sounder were applied. On a typical scattering layer produced by plankton the echo abundance values obtained by the 38 kHz system were considerably higher than those from the 120 kHz. Therefore, indices of echo abundance from the two systems are not comparable and an echo abundance map of plankton is not included in the present report.

Two maximum areas of plankton were observed; one along the eastern coast from Cox's Bazar to St. Martin Island and another in the northern part of Swatch of No-Ground. In the first area juvenile shrimps contributed most, while in the second area the major contribution was attributed to lantern fish fry (Myctophidae).

3.4 The fishing experiments

A record of the fishing operations is listed as APPENDIX A.

Bottom trawl

Table 3 gives the average catch rates with a bottom trawl in different depth zones. The group "Pelagic fish" consists of species which usually form schools and have a diurnal vertical migration pattern. The following families have been included in this group: Ariommidae, Carangidae, Clupeidae, Engraulidae, Leiognathidae, Scombridae and Sphyraenidae.

Table 3. Distribution of average catch rates (kg/h) from bottom trawl at different depth zones.

No. of Tr. Stations	13	11	11	15	11
Depth zone (m)	10-24	25-49	50-74	75-99	100-150
Pelagic fish	75.0	74.7	918.0	13.1	0.6
Demersal fish	363.0	73.5	68.0	62.5	50.3
Sharks/Rays	59.2	11.4	0.7	0.3	-
Crustaceans	53.5	20.7	2.3	2.3	11.1
Squids	0.6	1.2	6.1	0.03	-
Total	531.3	185.2	995.1	78.23	62.0

The bottom trawl used on this cruise was a 134-foot head line trawl while on the November - December cruise a 96-foot head line trawl was applied. This corresponds to horizontal openings

of 20 m and 15 m respectively. If equal fish density is assumed, slightly higher catch rates should therefore be expected during the present cruise.

As can be seen, the maximum average catch rates occurred at 50-74 m depths, reaching values of 995 kg/h. Pelagic fish contributed most to the catches. The highest rate, 6000 kg/h, was obtained at this depth zone with Indian mackerel, Rastrelliger kanagurta, and round scad, Decapterus maruadsi.

In the shallowest depth zone the average catch rate reached 531 kg/h with the main contribution from the demersal fish. The maximum catch rate in this zone, 1360 kg/h, was obtained with catfish (Ariidae) and Bombay duck (Harpadontidae).

In the 25-49 m depth zone pelagic and demersal fish contributed approximately equally to the average catch rate. The highest catch rate was 620 kg/h, with catfish (Ariidae) and croakers (Scianidae) as dominant species.

In the 75-99 m zone and at depths more than 100 m the highest catch rates were 300 kg/h and 328 kg/h respectively. The bream, Nemipterus japonicus dominated in the 75-99 m zone and the bigeye, Priacanthus hamrur at depths more than 100 m.

The total average catch rates in 25-49 m and in 75-99 m were less than in November - December 1979, while in the other depth zones the present cruise gave higher values.

Pelagic trawl

As on the November - December 1979 cruise the catch rates with this gear were low. Of a total of seven pelagic trawl stations, three had catch rates below 10 kg/h and the maximum catch rate was 90 kg/h, mostly sharks.

3.5 Fish distribution and species composition

The length frequency distribution of the most important species

appears in APPENDIX B. At trawl station 403 a croaker, Otholithoides biaurithus, of 130 cm and a Indian threadfin, Polynemus indicus, of 144 cm were caught, which are not included in APPENDIX B.

Demersal fish

Fig. 6 shows the distributions of echo abundance of demersal fish expressed in mm integrator readings. The distribution was very similar to that of November - December 1979. The highest densities were recorded in the area northeast of Swatch of No-Ground with catfish, (Ariidae) and croakers, (Scianidae) as dominant species. In the eastern area, southwest of Cox's Bazar, lizardfish, (Synodontidae) and pomfret, (Stromateidae) also made significant contributions. The smaller fish concentrations in the area between Cox's Bazar and Swatch of No-Ground were mainly schools of bream, Nemipterus japonicus, settled on the bottom at depths 80-100 m.

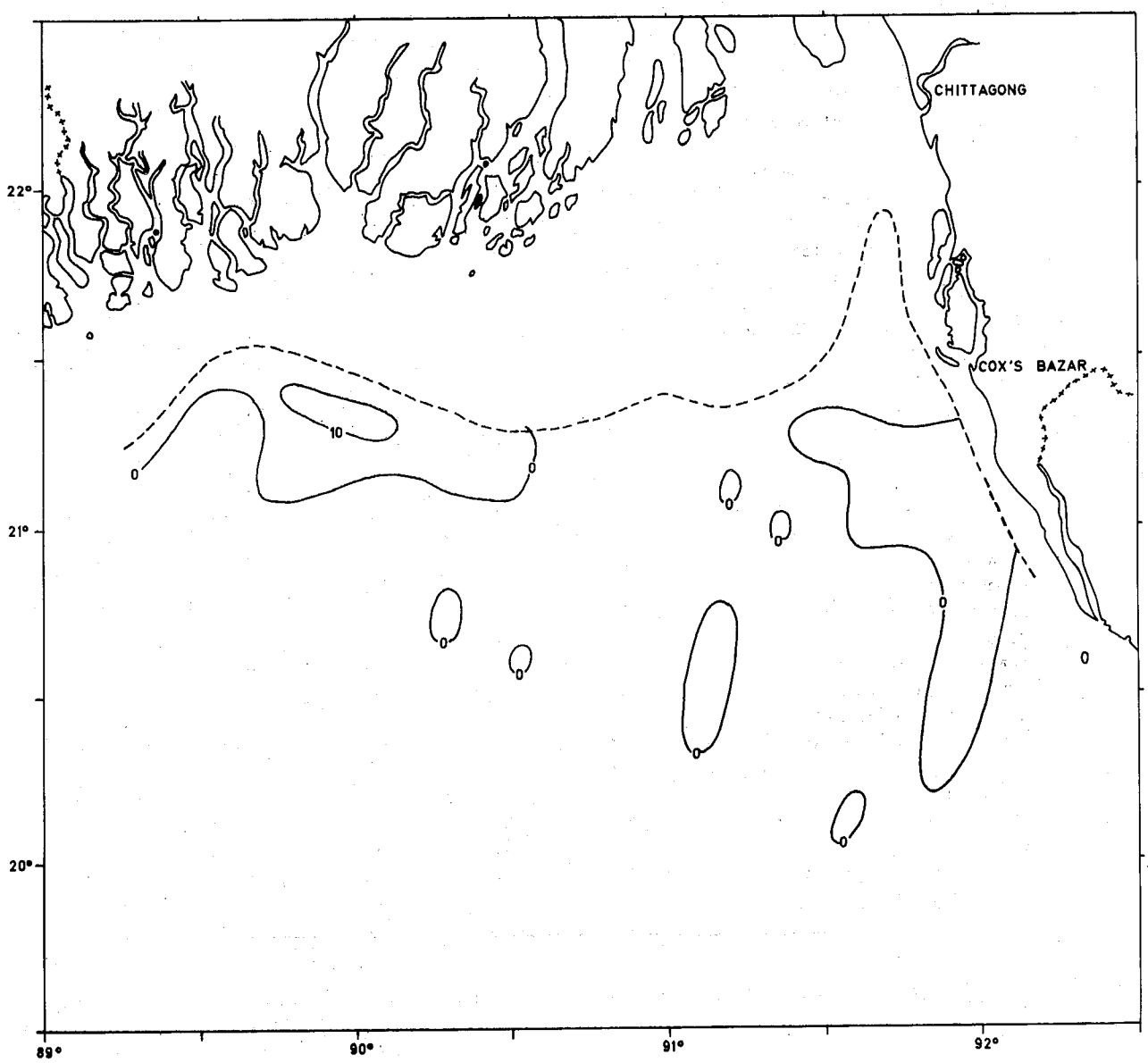

Fig. 6. Echo abundance of demersal fish in mm integrator reading.

and lizardfish in the catches from November - December 1979, the catch composition was approximately the same for the two investigation periods.

Pelagic fish

Fig. 7 shows the distribution of echo abundance of pelagic fish expressed in mm integrator readings. The highest concentrations were observed in the northern part of the investigated area and southwest of Cox's Bazar. Due to shallow waters in these areas only two pelagic trawl hauls were carried out. The catch of pelagic fish in the bottom trawl, however, is believed to give a reliable pelagic species composition in these shallow waters. The most important species in the eastern area was the hairfin anchovy, Setipinna taty and the Indian ilisha, Ilisha melastoma.

For the northern area the hairfin and the grenadier anchovy, Coilia dussumieri were the most important of the Engraulidae family. Of the Clupeidae, Russel's tardoore, Raconda russeliana, and Ilisha pristigastroides contributed most, and from the Carangidae family the Malabar cavalla, Carangoides malabaricus and Kuweh trevally, Atropus atropus.

Table 5 gives the species composition of pelagic fish from bottom trawl catches in different depth zones. The depth zone 10-24 m was dominated by the Engraulidae, Clupeidae and Carangidae

Table 5. Species composition (% weight) of pelagic fish from bottom trawl catches at different depth zones.

DEPTH ZONE (m) / FAMILY	10-24	25-49	50-74	75-99	>100
ARIOMMIDAE - Drift fish	-	-	10.4	0.5	-
CARANGIDAE - Jack/scad	19.9	22.5	31.4	97.9	100
CLUPEIDAE - Herring/Shad	57.9	5.2	0.12	-	-
ENGRAULIDAE - Anchovy	15.2	1.7	0.01	-	-
LEIOGNATHIDAE - Ponyfish	2.0	67.6	0.11	0.01	-
SCOMBRIDAE - Mackerel	5.0	2.0	54.7	-	-
SPHYRAENIDAE - Barracuda	-	0.7	3.26	1.6	-

consisting of the species mentioned above. The ponyfish, Leiognathus bindus, contributed most at 25-49 m. As can be seen in Table 3, the largest catches of pelagic fish were obtained in the 50-74 m depth zone. About 85% of these consisted of the two species Indian mackerel, Rastrelliger kanagurta and round scad, Decapterus maruadsi. These two species were observed in schools just above or at the bottom and were seen to be pressed to the bottom due to the trawling operations. In deeper waters, nearly all the pelagic catch consisted of round scad.

Table 6 gives the species composition of the catches from pelagic trawling in the areas shallower than 150 m. There was only one trawl station over a bottom depth of more than 150 m.

Table 6. Species composition (% weight) of catches from pelagic trawl in area with bottom <150 m.

Families	
ARIOMMIDAE - Driftfish	0.7
BREGMACEROTIDAE - Codlet	2.2
CARANGIDAE - Jack/Scad	14.8
CHIROCENTRIDAE - Wolfherring	1.5
CLUPEIDAE - Shad, Herring	3.2
ENGRAULIDAE - Anchovy	11.1
EXOCOETIDAE - Flyingfish	0.01
FORMIONIDAE - Black pomfret	1.0
HARPADONTIDAE - Bombay-duck	1.7
LEIOGNATHIDAE - Pony fish	6.0
MYCTOPHIDAE - Lantern fish	3.8
SCIAENIDAE - Croaker	0.9
SCOMBRIDAE - Mackerel	8.9
SPHYRAENIDAE - Barracuda	0.6
STROMATEIDAE - Pomfret	2.9
SYNODONTIDAE - Lizardfish	0.4
TRICHIURIDAE - Hair tail	27.0
FISH LARVAE - Mixed species	7.1
RAYS	3.7
SHARKS	0.2
CRUSTACEANS	2.4
SQUIDS	0.08

As can be seen in Table 6, the most abundant families were the Trichuridae, Carangidae and Engraulidae. The Carangidae contributed more and the Clupeidae less than in November - December 1979. The dominant species from these two families were round scad and hairfin anchovy, while Stolephorus sp. dominated the catches on the previous cruise.

Mesopelagic fish

Mesopelagic fish, mainly lanternfish, (Myctophidae) were recorded over most of the area studied in waters deeper than 150 m. In the northern part of Swatch of No-Ground large concentrations of Myctophidae fry (length 1 cm) were recorded.

3.6 Abundance

Demersal fish

By using the average catch rate for demersal fish in the different depth zones and the area swept by the trawl a mean value for the fish density can be obtained. Such calculations were carried out using the areas of Table 2 and the catch rates of demersal fish of Table 3. The results are shown in Table 7. If an efficiency coefficient of 0.5 is chosen, i.e. half of the fish ahead of the trawl are supposed to be caught, an abundance estimate of about 90 000 tonnes of demersal fish is reached.

Table 7. Biomass of demersal fish calculated by means of bottom trawl catches.

Depth zones (m)	Density (kg/km^2)	Stock (tonnes)
10 - 24	3267	27 443
25 - 49	661	3 172
50 - 74	612	3 415
75 - 99	562	7 536
100 - 150	453	4 643
Total		46 209

The acoustic abundance estimate is calculated by the equation:

$$B = \oint P_a \, dA = C \cdot \bar{M} \cdot A$$

where B is the demersal fish biomass, P_a the fish density expressed in weight per unit area, C is a conversion coefficient, $\bar{M}$ is the average integrator reading, and A the corresponding area. The value for C is a function of species as well as of fish length (BLINDHEIM et al., 1980, NAKKEN and SANN AUNG, 1980). The average length for the demersal fish was calculated in the following way:

For each depth zone the mean lengths of the dominant families were calculated, and by using the species composition of Table 4, an average length for each depth zone was reached. The average length of the total demersal stock was then calculated as a weighted mean using the average catch rates for each depth zone of Table 3. By this method, an average length of 20 cm was obtained. The numerical value of C applied in the calculation was:

$$C = \frac{L}{4} \text{ tonnes/mm (n.mile)}^2 \text{ (NAKKEN and AUNG, 1980)}$$

where L is the average length in cm. With an average length of 20 cm, C = 5 tonnes/mm $(\text{n.mile})^2$. Under these assumptions the acoustic abundance estimate for demersal fish reached a value of about 35 000 tonnes, which is slightly less than on the previous cruise.

The acoustic abundance estimate of demersal fish will usually be an underestimate, due to the limitation of the echo sounder and integrator in making recordings very close to the bottom. On several occasions good catches were obtained even when no demersal fish were recorded by the acoustic system. Therefore, the abundance estimate based on the bottom trawl catches is regarded as being more reliable and a total demersal stock of 90 000 tonnes is suggested. This is considerably less than on the previous cruise, when a figure of about 160 000 tonnes was reached by the same method.

Pelagic fish

For pelagic species, the acoustic abundance estimate is considered more reliable. The average length for the pelagic stock, $\bar{l}$ = 18 cm, was calculated in the same way as for the demersal stock. This gives C = 4.5 tonnes/mm · $(\text{n.mile})^2$ and an acoustic abundance estimate of about 120 000 tonnes. This is approximately twice as much as in November - December 1979.

The estimate is probably too low, as the large part of the shelf, which is shallower than 10 m, was not surveyed. Neither were fish occurring above the depth of the transducer included.

4. REFERENCES

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APPENDIX A

APPENDIX A. RECORD OF FISHING OPERATIONS

BT = Bottom trawl - PT = Pelagic trawl - GN = Gillnet - LL = Longline

DATE	ST.NO.	GEAR TYPE	BOTTOM DEPTH (m)	GEAR DEPTH (m)	POSITION NORTH	POSITION EAST	TOTAL CATCH (kg)	CATCH PER HOUR (kg)	IMPORTANT SPECIES	%
8.5.80	355	BT	97	97	20°11'	91°33'	203	203	Bream (Nemipterus japonicus)	89.6
									Lizardfish (Saurida longimanus)	5.9
									Croaker (Johnius carutta)	2.4
8.5.80	356	PT	63	0	20°41'	91°44'	4.5	9.0	Round scad (Decapterus maruadsi)	92.0
									Frigate mackerel (Auxis thazard)	6.7
									Indian mackerel (Rastrelliger kanagurta)	1.1
9.5.80	357	PT	62	30	20°37'	91°45'	4.7	4.7	Fish larvae mixed	48.7
									Round scad (Decapterus maruadsi)	22.2
									Rainbow sardine (Dussumeria acuta	11.1
9.5.80	358	PT	26-29	10	21°05'	91°54'	32.7	65.4	Hairfin anchovy (Setipinna taty)	26.3
									Ribbon fish (Lepturus savala	13.5
									Fish larvae mixed	10.4
9.5.80	359	GN			21°08'	91°50'	2		Spanish mackerel (Scomberomorus guttatus)	61.0
									Black pomfret (Formio niger)	29.3
									Rudder fish (Kyphosus cinerascens	9.8
16.5.80	360	BT	30-40	30-40	21°02'	91°20'	60.6	121.2	Croaker (Johnius belangerii)	37.1
									Small shrimps	16.1
									Croaker (Chrysochir aureus)	7.7
17.5.80	361	PT	84	30	20°38'	91°18'	1.4	4.2	Round scad (Decapterus maruadsi)	66.7
									Lizardfish (Saurida longimanus)	14.8
									Swimming crab	14.8
17.5.80	362	BT	97	97	20°09'	91°19'	3.3	3.3	Bream (Nemipterus japonicus)	52.2
									Bigeye (Priacanthus hamrur)	15.3
									Swimming crab	30.7
17.5.80	363	BT	129	129	20°06'	91°14'	30	60	Cardinal fish (Synagrops japonicus)	51.3
									Bigeye (Priacanthus hamrur)	44.7
									(Champsodon)	3.7
17.5.80	364	BT	135-145	135-145	20°09'	91°58'	0.5	1	Shrimps	99
									Swimming crab	1
17.5.80	365	BT	91-88	91-88	20°24'	90°58'	4	8	Bream (Nemipterus japonicus)	54.6
									Lizardfish (Saurida undosquamis)	13.7
									Bigeye	12.4
17.5.80	366	BT	74	74	20°49'	90°59'	5.8	11.6	Bream (Nemipterus japonicus)	78.1
									Rays	8.7
									Lizardfish (Saurida longimanus)	3.5
18.5.80	367	PT	72	25	20°53'	90°58'	15.3	30.6	Ribbon fish (Trichiurus lepturus)	54.2
									Round scad (Decapterus maruadsi)	28.1
									Codlet (Bregmaceros sp.)	11.8
18.5.80	368	BT	26-34	26-34	21°04'	90°58'	19.6	39.2	Sardinella (Sardinella fimbriata)	66.8
									Kuwe trevelly (Atropus atropus)	4.3
									Pony fish (Leiognathus bindus)	3.1
18.5.80	369	BT	21	21	21°08'	90°40'	16.3	21.7	Rays	30.3
									Raconda (Raconda russeliana)	20.2
									Pomfret (Pampus chinensis)	17.3
18.5.80	370	BT	30	30	21°05'	90°40'	58.7	117.4	Pomfret (Pampus chinensis)	27.3
									Pony fish (Leiognathus bindus)	20.4
									Kuwe trevally (Atropus atropus)	20.4
18.5.80	371	BT	72	72	21°00'	90°44'	247	484	Indian mackerel (Rastelliger kanagurta)	92.5
									Indian driftfish (Ariomma indica)	4.4
									Mojarra (Pentaprion sp.)	1.5
18.5.80	372	BT	82	82	20°53'	90°44'	2.7	5.4	Bigeye (Priacanthus hamrur)	96.3
									Swimming crab	3.7
18.5.80	373	BT	109-115	109-115	20°53'	90°41'	3.8	7.6	Bigeye (Priacanthus hamrur)	44.5
									Lizard fish (Saurida longimanus)	41.9
									(Champsodon sp.)	6.5
18.5.80	374	BT	130	130	20°11'	90°30'	27.2	54.4	Bigeye (Priacanthus hamrur)	81.5
									Cardinal fish (Synagrops japonicus)	6.4
									Croaker (Johnius carutta)	2.2
18.5.80	375	BT	96	96	20°29'	90°30'	270	360	Bream (Nemipterus japonicus	71.1
									Croaker (Johnius carutta)	18.5
									Bigeye (Priacanthus hamrur)	3.2
18.5.80	376	BT	87	87	20°45'	90°30'	60	120	Bream (Nemipterus japonicus)	69.9
									Swimming crab	22.4
									Croaker (Johnius carutta)	2.2
19.5.80	377	BT	71-61	71-61	21°03'	90°30'	61.3	122.6	Pufferfish (Tetraodontidae)	22.4
									Squids	21.0
									Bream (Nemipterus japonicus)	17.1

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19.5.80	378	BT	34-48	34-48	21°08'	90°30'	17.1	34.2	Catfish (Arius spp.)	32.2
									Round scad (Decapterus maruadsi)	10.5
									Spanish mackerel (Scomberomorus guttatus)	10.5
19.5.80	379	BT	16-20	16-20	21°15'	90°30'	147.6	295.2	Catfish (Arius spp.)	51.6
									Croaker (Johnius belangerii)	12.2
									Ribbon fish (Trichiurus lepturus	10.1
19.5.80	380	BT	12	12	21°16'	90°17'	285.7	571.4	Catfish (Arius spp.)	21.9
									Rays	6.4
									Bombay duck (Harpodon nehereus)	1.4
19.5.80	381	BT	29	29	21°11'	90°17'	29.6	59.2	Catfish (Arius spp.)	87.8
									Bombay duck (Harpodon nehereus)	6.4
									Ribbon fish (Lepturacanthus savala)	1.4
19.5.80	382	BT	64	64	21°07'	90°17'	614	1228	Indian mackerel (Rastrelliger kanagurta)	35.8
									Indian driftfish (Ariomma indica)	30.8
									Round scad (Decapterus maruadsi)	20.1
19.5.80	383	BT	86	86	20°54'	90°17'	60	120	Bigeye (Priacanthus hamrur)	100.0
19.5.80	384	BT	90	90	20°48'	90°18'	13	26	Bream (Nemipterus japonicus)	99.8
									Pony fish (Leiognathus equulus)	0.1
									Swimming crab	0.1
19.5.80	385	BT	96-101	96-101	20°35'	90°17'	0,4	0.8	Bigeye (Priacanthus hamrur)	85.4
									Swimming crab	12.2
19.5.80	386	BT	123	123	20°20'	90°17'	35.4	70.8	Bigeye (Priacanthus hamrur)	61.6
									Cardinal fish (Synagrops japonicus)	31.6
									Croaker (Johnius carutta)	2.8
19.5.80	387	BT	142	142	20°18'	90°04'	1.5	3.0	(Champsodon sp.)	33.6
									Swimming crab	66.6
20.5.80	388	BT	122	122	20°29'	90°04'	0.6	1.2	Croaker (Otholithes ruber)	48.4
									Shrimps small	32.2
									(Champsodon sp.)	16.1
20.5.80	389	BT	85	85	20°54'	90°03'	1.1	2.2	Bigeye (Priacanthus hamrur)	75.1
									Croaker (Otolithes ruber)	18.9
									(Squilla)	4.7
20.5.80	390	BT	68	68	21°09'	90°04'	3000	6000	Indian mackerel (Rastrelliger kanagurta)	68.7
									Round scad (Decapterus maruadsi)	21.8
									Indian driftfish (Ariomma indica)	8.0
20.5.80	391	BT	41	41	21°12'	90°04'	180	360	Mojarra (Pentaprion longimanus)	28.1
									Ponyfish (Leiognathus bindus)	22.2
									Rays	27.8
20.5.80	392	BT	20	20	21°17'	90°00'	321	642	Raconda (Raconda russeliana)	19.2
									Catfish (Arius spp.)	16.6
									Rays	15.6
20.5.80	393	BT	10	10	21°23'	90°03'	364	728	Croaker (Chrysochir aureus)	32.2
									Catfish (Arius spp.)	27.5
									Croaker (Johnius belangerii)	13.3
20.5.80	394	BT	17	17	21°24'	89°48'	243	486	Catfish (Arius spp.)	24.8
									Malabar cavalla (Carangoides malabaricus)	21.1
									Bombay duck (Harpodon nehereus)	14.8
20.5.80	395	BT	42-55	42-55	21°16'	89°49'	210	420	Ponyfish (Leiognathus bindus)	72.2
									Longnose cavalla (Carangoides chrysophrys)	13.2
									Bombay duck (Harpodon nehereus)	3.6
20.5.80	396	BT	84	83	21°07'	89°47'	4	8	Catfish (Arius spp.)	100.0
20.5.80	397	BT	104	104	20°47'	89°49'	0.4	0.8	Croaker (Johnius carutta)	97.2
20.5.80	398	BT	129	129	20°33'	89°44'	1.6	3.2	Croaker (Johnius carutta)	84.1
									Bigeye (Priacanthus hamrur)	15.4
21.5.80	399	BT	89	89	20°57'	89°37'	0	0		
21.5.80	400	BT	61-51	61-51	21°14'	89°44'	112	224	Croaker (Pennahia pawak)	44.3
									Catfish (Arius spp.)	11.8
									Squids	10.1
21.5.80	401	BT	30	30	21°20'	89°41'	1.6	3.2	Croaker (Pennahia pawak)	51.3
									Squids	19.2
									Indian ilisha (Ilisha melastoma)	19.2

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21.5.80	402	PT	72	25	21°25'	89°39'	16.8	33.6	Ribbonfish (Trichiurus&Lepturacanthus spp.)	36.9
									Ponyfish (Leiognathus bindus)	13.1
									Lanternfish (Myctophidae fry)	12.5
21.5.80	403	BT	11	11	21°30'	89°37'	680	1360	Bombay duck (Harpodon nehereus)	30.3
									Catfish (Arius spp.)	20.8
									Rays	8.8
21.5.80	404	BT	22	22	21°23'	89°28'	241	717	Bombay duck (Harpodon nehereus)	41.8
									Croaker (Johnius belangerii)	7.5
									Catfish (Arius spp.)	7.1
21.5.80	405	BT	107	107	20°54'	89°22'	164	328	Bigeye (Priacanthus hamrur)	99.8
21.5.80	406	PT	0	324	21°17'	89°27'	45.8	91.6	Requim shark (Scoliodon sp.)	59.1
									Swimming crab	13.1
									Ribbon fish (Trichiurus lepturus)	3.9
22.5.80	407	BT	91	91	20°19'	91°06'	35	70	Bream (Nemipterus japonicus)	81.8
									Bigeye (Priacanthus hamrur)	12.0
									Lizardfish (Saurida longimanus)	
22.5.80	408	BT	83	83	20°36'	91°08'	3.1	6.2	Baracuda (Sphyraena jello)	50.3
									Bream (Nemipterus japonicus)	32.5
									Swimming crab	9.7
22.5.80	409	BT	71	71	20°51'	91°10'	800	1600	Round scad (Decapterus maruadsi)	81.9
									Barracuds (Sphyraena optusata)	11.7
									Indian driftfish (Ariomma indica)	4.4
22.5.80	410	BT	41-30	41-30	21°01'	91°12'	33.5	67	Trevally (Atropus atropus)	26.2
									Catfish (Arius spp.)	20.7
									Ponyfish (Leognathus bindus)	15.7
22.5.80	411	BT	19-16	19-16	21°05'	91°12'	245.4	490.8	Catfish (Arius spp.)	18.3
									Pomfret (Pampus chinensis)	13.6
									Croaker (Pennanhia pawak)	8.6
22.5.80	412	BT	10	10	21°15'	91°14'	262.7	523.4	Croaker (Chrysochir aureus)	33.5
									Catfish (Arius spp.)	29.3
									Rays	6.3
22.5.80	413	BT	21	21	21°17'	91°39'	376	752	Small shrimps	71.8
									Snapper (Lutjanus russelli)	10.4
									Croaker (Chrysochir aureus)	8.1
22.5.80	414	BT	35	35	20°11'	91°58'	310	620	Small shrimps	32.4
									Catfish (Arius spp.)	13.0
									Croaker (Chrysochir aureus)	13.0
22.5.80	415	BT	54	54	21°02'	91°38'	50	85	Pike eels (Congresox talabon)	40.0
									Catfish (Arius spp.)	12.0
									Lizard fish (Saurida tumbil)	8.0
23.5.80	416	BT	74	74	20°30'	91°30'	29.6	58.9	Catfish (Arius spp.)	42.1
									Lizard fish (Saurida tumbil)	19.7
									Lizard fish (Saurida undosquamis)	6.8
23.5.80	417	BT	91	91	20°15'	91°26'	120	240	Scad (Decapterus maruadsi)	80.3
									Bigeye (Priacanthus hamrur)	13.9
									Bream (Nemipterus sp.)	2.6
23.5.80	418	BT	106	106	20°09'	91°24'	20.6	41.2	Lizardfish (Saurida longimanus)	36.8
									Catfish (Arius spp.)	27.6
									Round scad (Decapterus maruadsi)	16.0
23.5.80	419	BT	134	134	20°03,5	91°38,5	trawl torn, fished only 5 min.		Catfish (Arius spp.)	
									Small shrimps	
23.5.80	420	BT	69	69	20°25'	91°53'	42.1	84.2	Lizardfish (Saurida tumbil)	20.9
									Snapper (Lutjanus sanguineus)	20.2
									Seabream (Argyrops spinifer)	13.1
23.5.80	421	BT	44-41	44-41	20°37'	91°58'	90.9	181.8	Ponyfish (Leiognathus bindus)	67.7
									Ponyfish (Leiognathus elongatus)	6.1
									Squids	5.5
23.5.80	422	BT	24-21	24-21	20°47'	92°03'	221.2	221.2	Indian ilisha (Ilisha melastoma)	19.3
									Lined silver grunt (Pomadasys hasta)	16.6
									Catfish (Arius spp.)	14.2
23.5.80	423	BT	17	17	21°05'	91°57'	260	520	Sharks (Rhinobatidae)	33.2
									Catfish (Arius spp.)	29.3
									Croaker (Johnius belangerii)	9.6

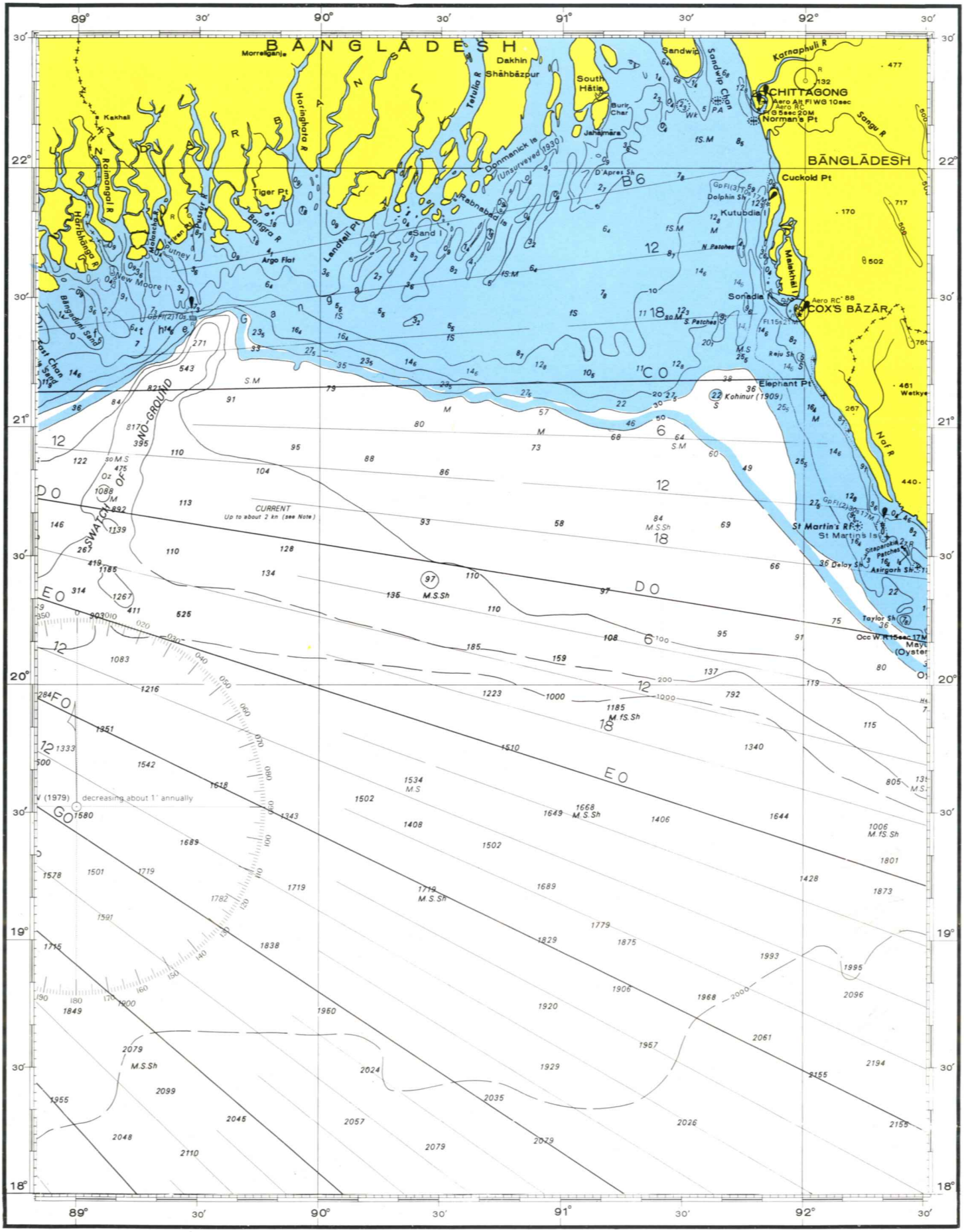
APPENDIX B : Length frequency distribution of some important species. (x indicates scale from 51 to 100 cm).

	St. No.	1 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0
APOGONIDAE						
Synagrops japonicus	363	42 8				
Cardinalfish	386	1 22 1				
ARIOMMIDAE						
Ariomma indica	371		1 4 7 5 1			
Indian driftfish	382		1 1 16 12 4 2			
Stage III - VII - VIII	390		1 6 13 27 5			
	409		2 11 4 2 4 1			
CARANGIDAE						
Alepes djeddaba	395		3 14 6			
Djeddaba crevalle	411		8 23 11 3			
Atropus atropus	368		2 1 4 2			
Kuweh trevally	410		1 1 11 19 4 2 2			
Carangoides malabaricus	394		6 20 10			
Malabar crevalle	410	2 6 2 5 8 3				
	415	3 8 2				
Decapterus maruadsi						
(stage III-IV)	356			3 3 3 3 1 3 1	2	
stage IV-V	357			1 3 2 1	1	
	361	16 26 7 1				
stage VII-VIII	367	20 11 6 4 3 1 1				
	377	9 12 13 2				
	378	1 16 18 6				
	382	2 4 10 29 13 4 2				
stage VII-VIII(III)	390	3 31 46 35 12 3				
stage VIII	409	4 3 1 10 27 15 1				
stage VII-VIII	417	1 9 29 8				
	418	14 22 2				
CLUPEIDAE						
Dussumia acuta(stage III-IV)	357	2 3 6 10 2				
Rainbow sardine	358	2 2 1				
	394	11 13 1				
Ilisha megaloptera	368	3	35 2 1 11 3 1 3 2	1 1		
Bigeye ilisha	369	1 1 1		2		
	404			4 3 1 1 2 1		
Ilisha melastoma	392	2 7 8 3				
Indian ilisha	411	1	21 23 2 19 9 2			
	422	1 1	18 19 4 8 10 2			
Ilisha pristigastroides	379	1 2		1 1	1	
	422	1		1 2 1 1 1	1 1	
Raconda russeliana	358	4 7	4 2			
"Russel's" tardoore	369		1 19 19 18 10 5 2 1			
	380	13 15 15 4 2	1 7 9 8 5 1 1			
	392	5 15 20	8 4 4 5 4 2			
	393	2 1 2 7 4 6 6 4	5 11 1 8 1 1			
	411		3 37 20 11 5 1			
Sardinella fimbriata	368		2 13 21 23 13 2			
Fringescale sardinella	394		10 5			
stage IV-V	411		2 1 5 3			

	St. No.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 20	1 2 3 4 5 6 7 8 9 30	1 2 3 4 5 6 7 8 9 40	1 2 3 4 5 6 7 8 9 50
ENGRAULIDAE						
Setipinna taty	358	1 1 7 26	14 9 4			
Hairfin anchovy	380	1 3 11	12 14 4 4 2			
	392	1	7 12 2			
	404	2 10 2 1 3	1 2 3 2 1			
	411	1 1 4	8 11 13 1			
Stolephorus indicus	357		5 2			
Indian anchovy	378	3 2 1				
Thryssa setirostris	368	1	1 2 2 2 2			
Longjaw thryssa						
FORMIONIDAE						
Formio niger	357		1 1	1		
Black pomfret						
HARPADONTIDAE						
Harpodon nehereus	358		2 4	1 2		
Bombay duck	380		1 1 1 1 3 3	5 5 3 1		
	403		1 1 1 2 2 3 5			
LUTJANIDAE						
Lutjanus johni	403		1 1			
John's snapper						
Lutjanus sanguineus	420	2 1				
Blood snapper						
MULLIDAE						
Upeneus sundaicus	400		7 6 5 1 1			
Ochreband goatfish						
Upeneus sulphureus	410	1	11 13 7 3			
Yellow goatfish						
NEMIPTERIDAE						
Nemipterus japonicus						
(stage II-III)	355	5	31 39 29 24 6 1			
	362		3 9 17 20 3			
	365	3 14	11 20 7 6 7 4 1			
	366	16 17	8 10 8 4 1 1 2			
	375	2 4	20 37 26 14 2 3 1			
	377	1 2	5 12 19 9 5 1			
	382		1 2 4 7 1 1 2	1		
stage II-III	384	2	15 40 24 6 3			
	407	9	12 20 17 6 6			
	420		2 2 6 3 1 2 1	2 1 1		
Nemipterus nematophorus	420		2 3 4 1 1			
Doublewhip threadfin bream						
POMADASYIDAE						
Pomadasys hasta	411					1 1
Lined silver grunt	422			2 1	1 2 1 1 1 1	
Pomadasys maculatus	410	4	13 19 2			
Blotched grunt						
PRIACANTHIDAE						
Priacanthus harmur	355	1 10	10 3 1			
Bigeye	362		4 6 2 4 1			
	372		2 6 6 9 3 5 2	1		
	374	2 11 9	27 15 3 2 3			
	386	4 11 10	21 18 9 4			
	405	2	4 6 14 11 7 3 2 2	1		
	407		1 7 3 2 3 1			

	St. No.	1 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0
SCIAENIDAE						
Chrysochir aureus	360			1 2 3 1 2		
Reeve's croaker	379		1 1 2 4	4 1 1		
	380		3	1 2	1 4	4 7 3 4 5 3 1 1
	393		2 1		1	1 1 1 2 1
	394		1 2 1	1 1		1
	412				1	3 4 1 3 2
Johnius belangerii	379	1 2 3	5 3 8 11 3 10 4 6 3 4	1		1
Belanger's croaker	380		1 2 2 2 1 2	1		
	393	1 1	4 8 6 6 5 1 3 1 3 2			
	394	1 1 3 3	4 7 10 10 4 1 3 3 2 1			
	404	2 6	6 1 8 7 11 8 2 4			
	412		1 1 1 2 4			
	422	1 1 13 14	13 10 3 2			
Johnius carutta	375		2 9 13 6 3			
Karut croaker	398		1 1 4 3 5	2 1 1		
Johnieops sina	380	1 5 7 1	3 2 2			
Sin croaker						
Otolithoides pama	393	1 2	5 9 3 1 1 1			
Pama croaker						
Otolithoides biauritus	411	1	3 1 5 1 3 5 2 2 1	1 1 1		
Bronze croaker						
Panna microden	394		4 13 17 10 8 3 2 2 2			
Panna croaker	404		3 8 15 23 17 2 1 2	1		
Pennahia pawak	379	1 3 12 10	1			
Pawak croaker	400	2 5	4 11 5 11 22 9 7 4 1	1		
	411		3 1 3 1 3 5 11 2 2	1		
	412	3 5 14	4 2 1			
	422	3 11 5 6 4				
Pennahia sp.	404		1 1	2 6 3 5 1		

	St. No.	1 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	2 1 2 3 4 5 6 7 8 9 0	3 1 2 3 4 5 6 7 8 9 0	4 1 2 3 4 5 6 7 8 9 0	5 1 2 3 4 5 6 7 8 9 0
SCOMBRIDAE							
Rastrelliger brachysoma Short bodied mackerel	357			1 4			
Rastrelliger kanagurta Indian mackerel	358 371			2 3 3 19 31 2			
stage (III), VII	382			2 5 6 3	3 19 9 1		
stage VII	390			3	28 37 9		
Scomberomorus commerson Narrow-barred Spanish mackerel	411x				1		
Scomberomorus guttatus Indo-Pacific Spanish mackerel	358 369					2 1 1 1	1
SPARIDAE							
Argyrops spinifer Longspine seabream	420		1	1 2 2 4	3 2		
SPHYRHENIDAE							
Sphyraena obtusata	378				1 1 1		
Obtuse barracuda (stage IV)	390			1 2	2 1 1		
(stage VII-VIII)	409			8 9 17	15 6 4 1		
STROMATEIDAE							
Pampus argenteus Silver pomfret	380 411 422			1 2 2	1 3 2 1 1 1 1 2 2 1 1 2 2 3 1	1	
Pampus chinensis Chinese pomfret	411		1		5 3 1 1		
SYNODONTIDAE							
Saurida longimanus Longfin lizardfish	355 361 362 373 375 377 418	5	13 20 25 20 7 6 1 3 1 1 1 1 1 1 2 14 10 3 5 2 1 1 4 3 16 14 15 6 5 3 2 2 6 3 1 1 1 1 1 2 3 3 2 1 8 18 22 26 13 3 2 2		1		
Saurida tumbil Greater lizardfish	360 377 415 416 420			1 1 1 1 1	1 1 1 1 1 1 2 2 1 4 1 1 3 1 2 1 1 1 2 1 1 1 1 5 3 5 2 3 1 1 2	1 2 1 2 2	
Saurida undosquamis Brushtooth lizardfish	365 415 416 420		1	1 1 1 2 1 3 7 1 1 1 1	1 4 1 2 1 1 1 1 1		


BANGLADESH
BAY OF BENGAL
Morrelganj
Kakhali
Raimangal R
Haribhanga R
Tiger Pt
Bangro R
Argo Flat
Lenthall Pt
Sand I
Rabnabad Is
Dakhin Shahbazpur
Tetulia R
Horinghata R
Donmanick Is (Unsurveyed 1930)
South Hatia
Burir Char
Jahajmara
Sandwip
Sandwip Chan
Karnaphuli R
CHITTAGONG
Aero Alt Fl WG 10sec
Aero RC
G 5sec 20M
Norman's Pt
Sangu R
BANGLADESH
Cuckold Pt
D'Apres Sh
Dolphin Sh
Kutubdia I
N Patches
S Patches
Sonadia
Maiskhali I
COX'S BAZAR
Aero RC 88
Elephant Pt
Kohinur (1909)
Reju Sh
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NO-GROUND
SWATCH OF
CURRENT
Up to about 2 kn (see Note)
St Martin's Rf
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Asirgarh Sh
Taylor Sh
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V (1979) decreasing about 1' annually
89°
90°
91°
92°
30'
22°
21°
20°
19°
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