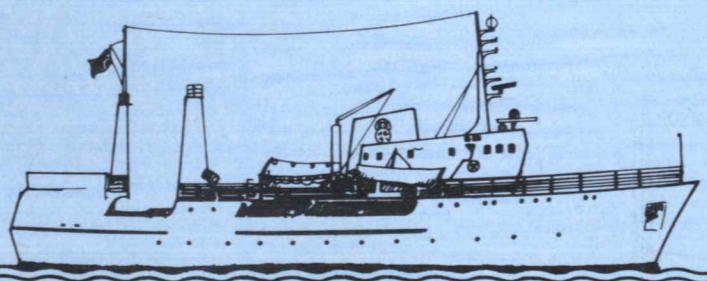
Reports on surveys with the R/V Dr Fridtjof Nansen.

Preliminary Results from a Survey on the Marine Fish Resources of Bangladesh Nov.-Dec. 1979



Sub-contractor: Institute of Marine Research
Bergen-Norway

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.

By

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1. INTRODUCTION

A survey of the fish resources of the waters off Bangladesh was carried out during the period 25 November - 12 December 1979 with the Norwegian research vessel "Dr. Fridtjof Nansen". The investigation was 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 following scientific staff participated during the cruise:

Institute of Marine Research, Bergen	Fisheries Research Station Chandpur, Comilla
H. Abrahamsen	W.N. Chowdhury
S. Myklevoll	Md. G. Kahn.
H.T. Pettersen	
K. Strømsnes	
R. Sætre	

The above staff took part in the observational work and carried out the analysis and processing of the data as far as it could be done on board. The preparation of the present report has been done during the stay of the two Bangladesh scientists at the Institute of Marine Research, Bergen, in February - March 1980.

A repeat cruise is planned for May 1980.

2. METHODS

The R/V "Dr. Fridtjof Nansen" is a 150-foot combined stern trawler/purse seiner. A main engine of 1500 horsepower gives a maximum speed of 13 knots. The bottom trawl is a 96-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 and the effective vertical opening of the net is 6.5 - 7.0 m.

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.

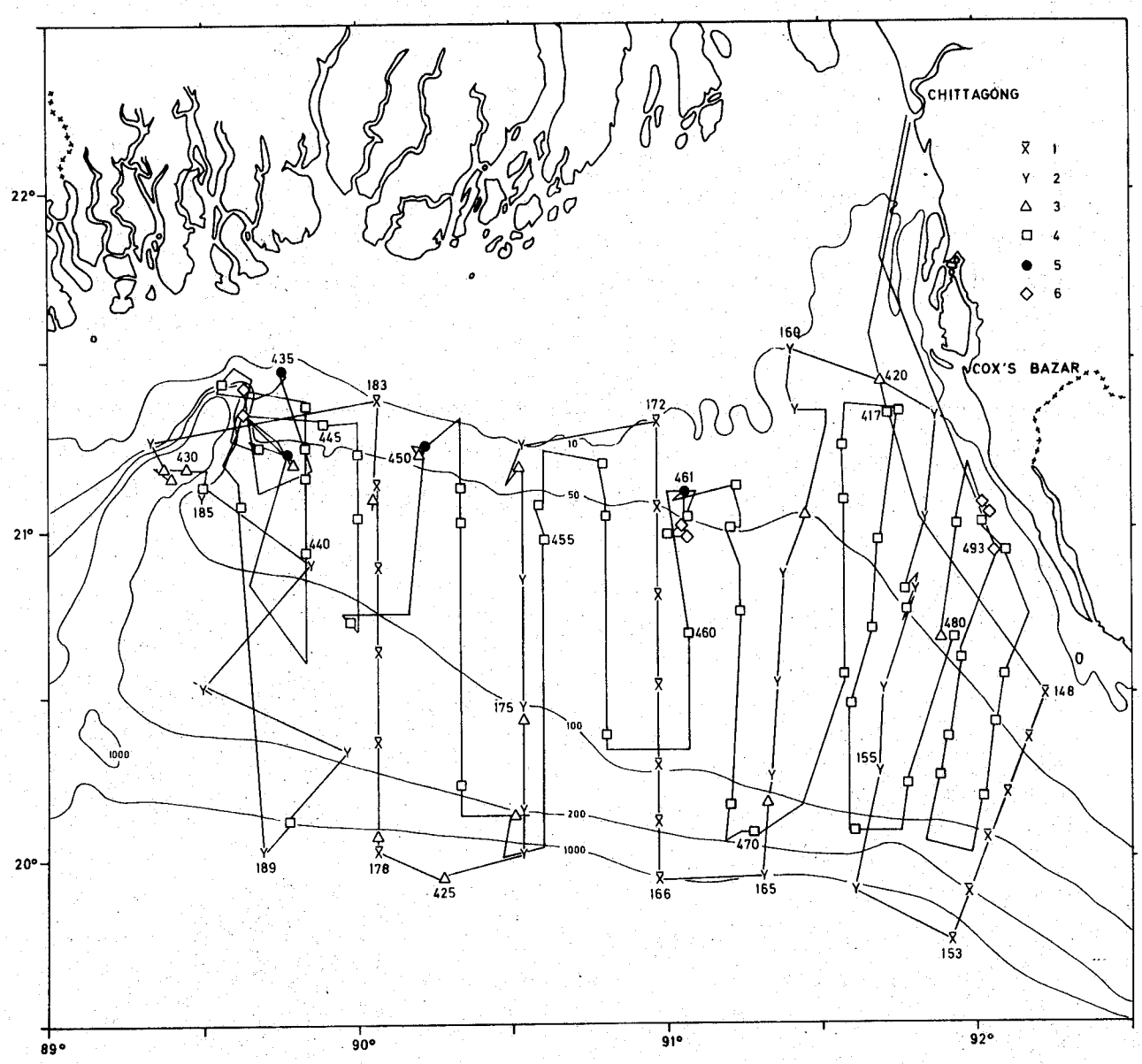

Fig. 1. Survey routes and stations.

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

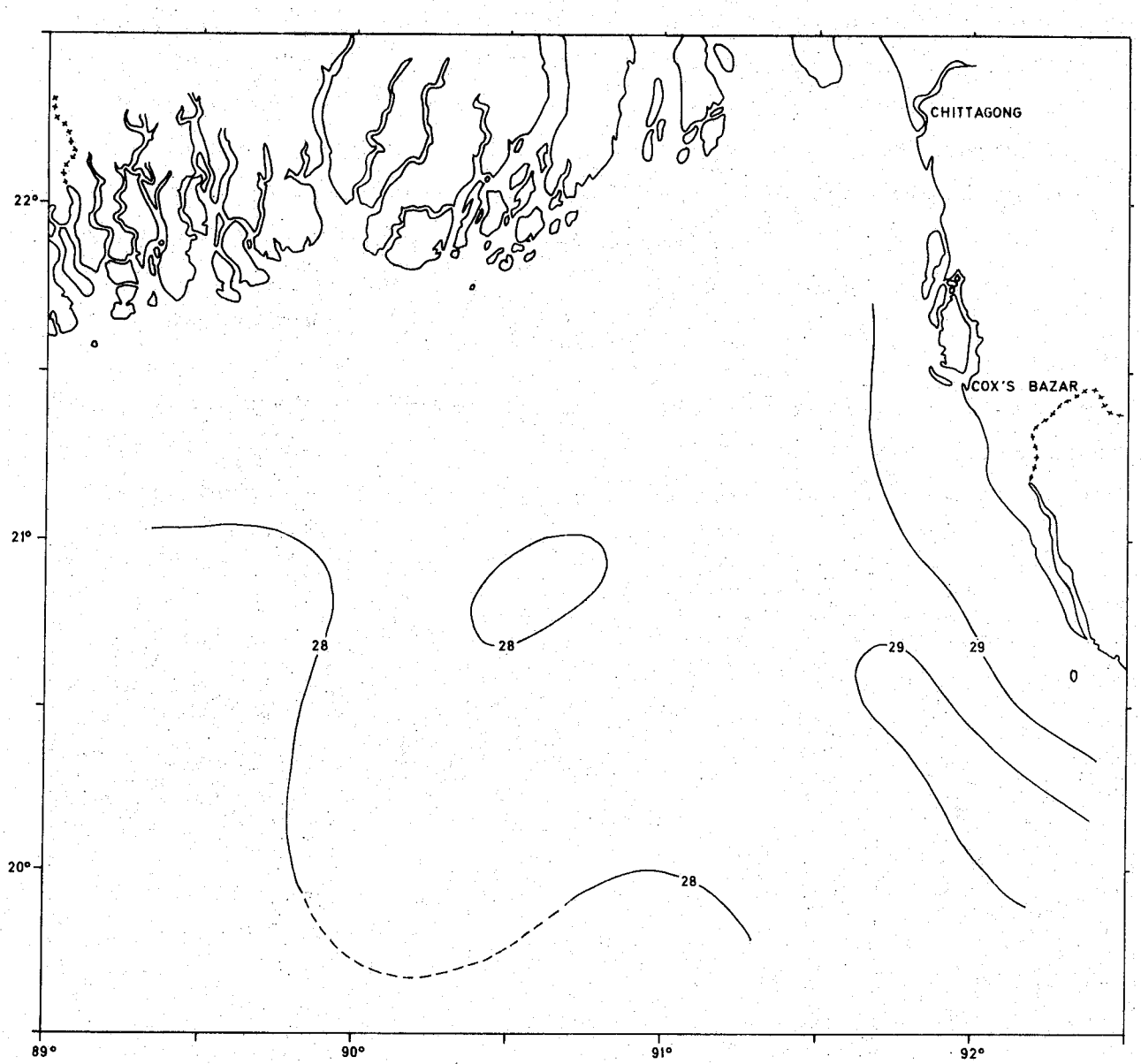

Fig. 2. Distribution of surface temperature.

showed a tongue-like structure related to the large freshwater outflow from the rivers with salinities varying from 10°/oo to 29°/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.

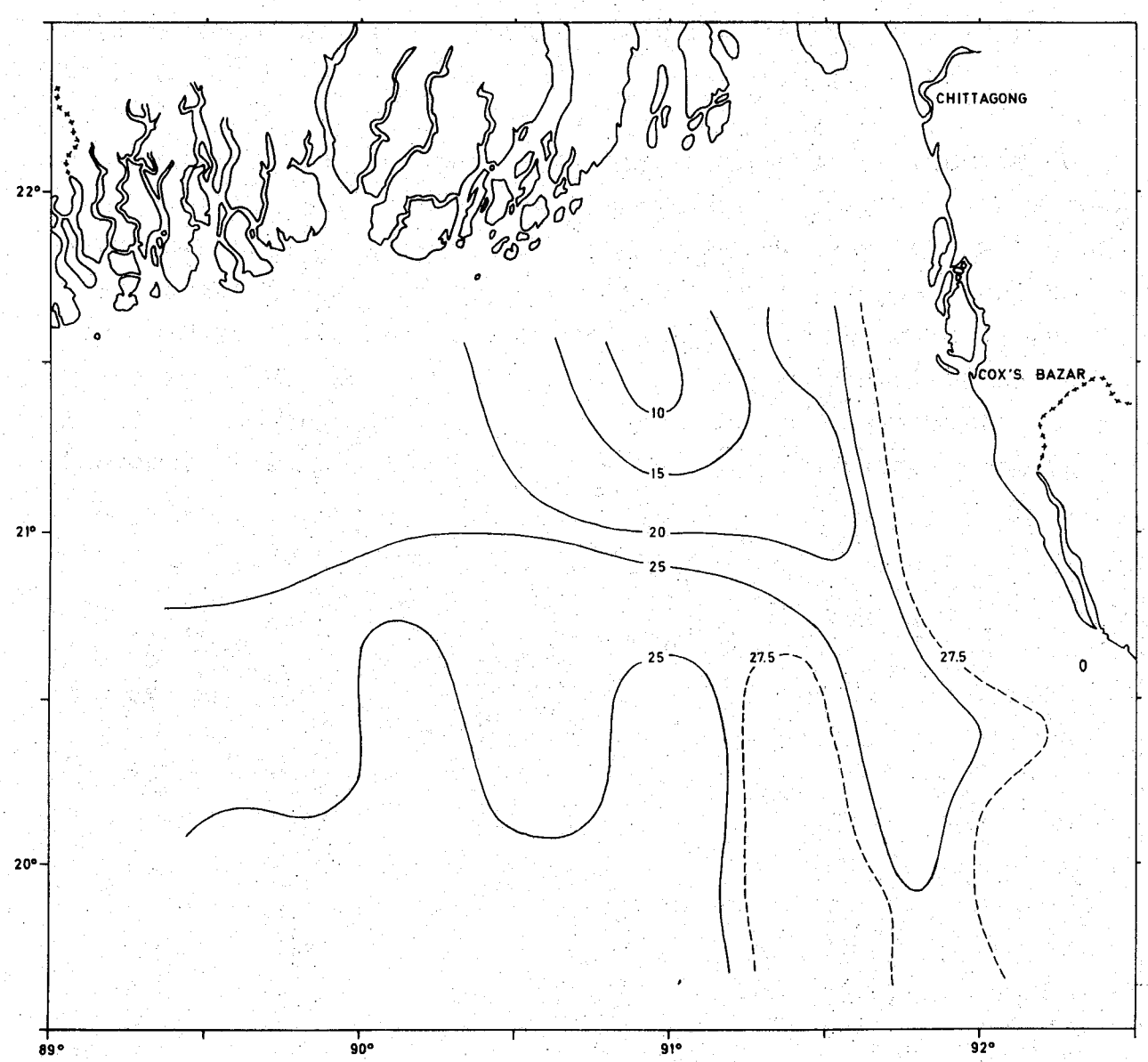

Fig. 3. Distribution of surface salinity.

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.

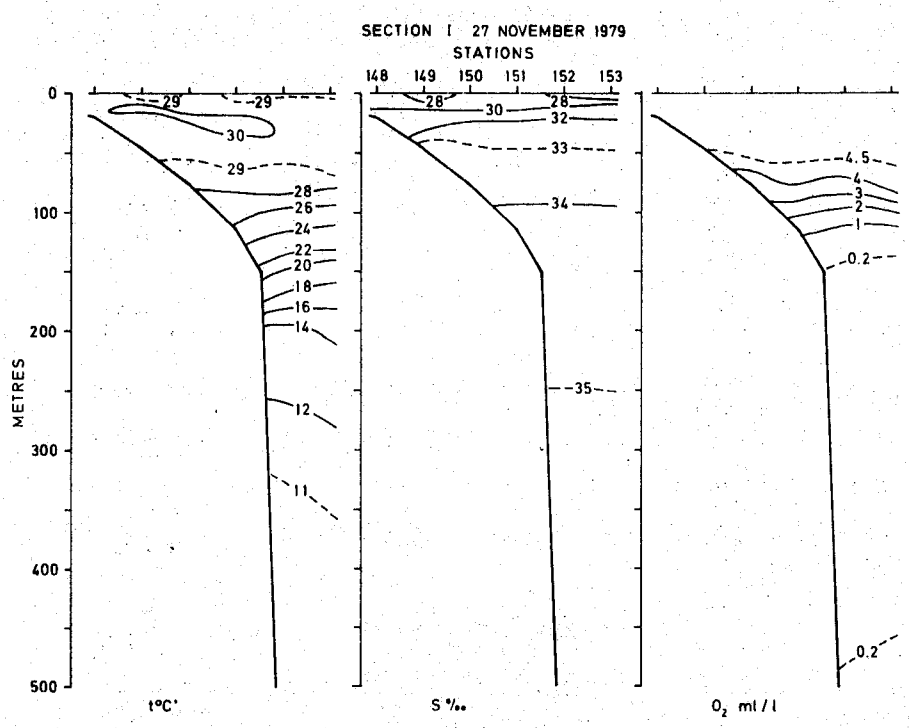

Fig. 4. Vertical distribution of temperature, salinity and oxygen - SECTION I.

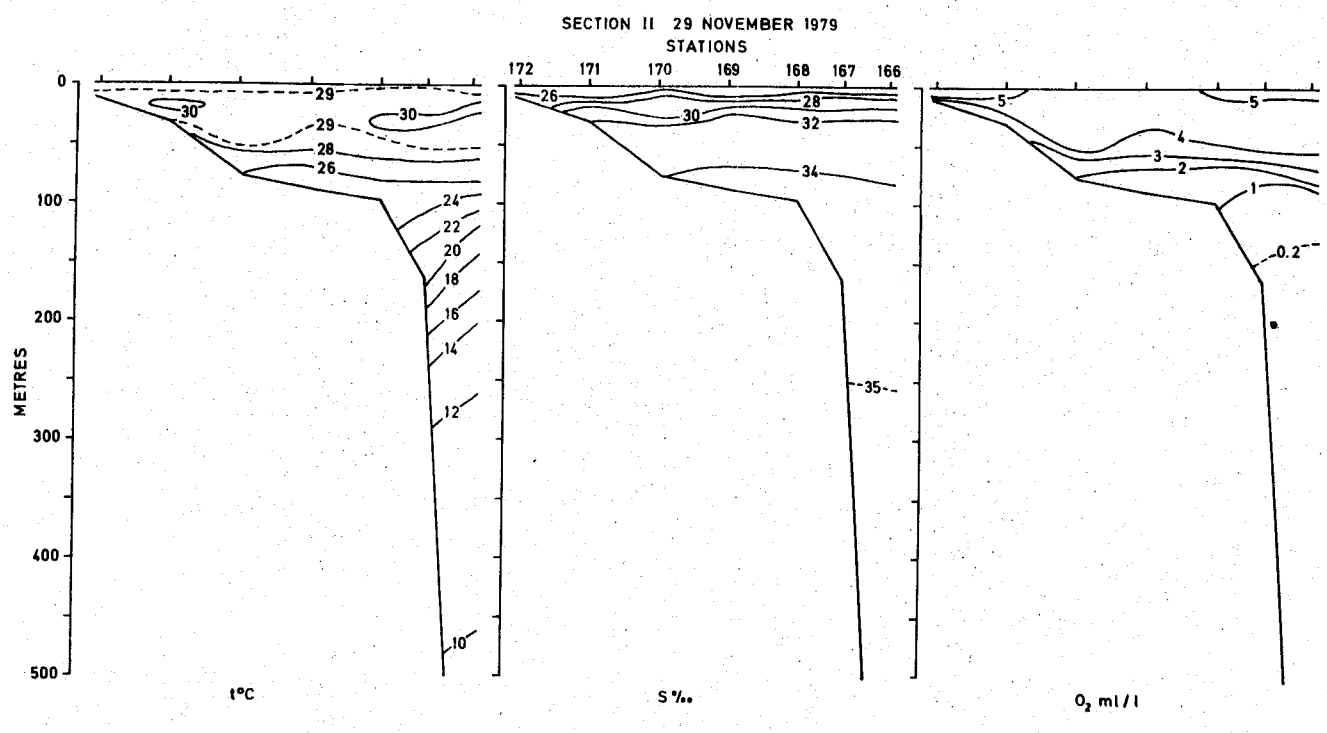

Fig. 5. Vertical distribution of temperature, salinity and oxygen - SECTION II.

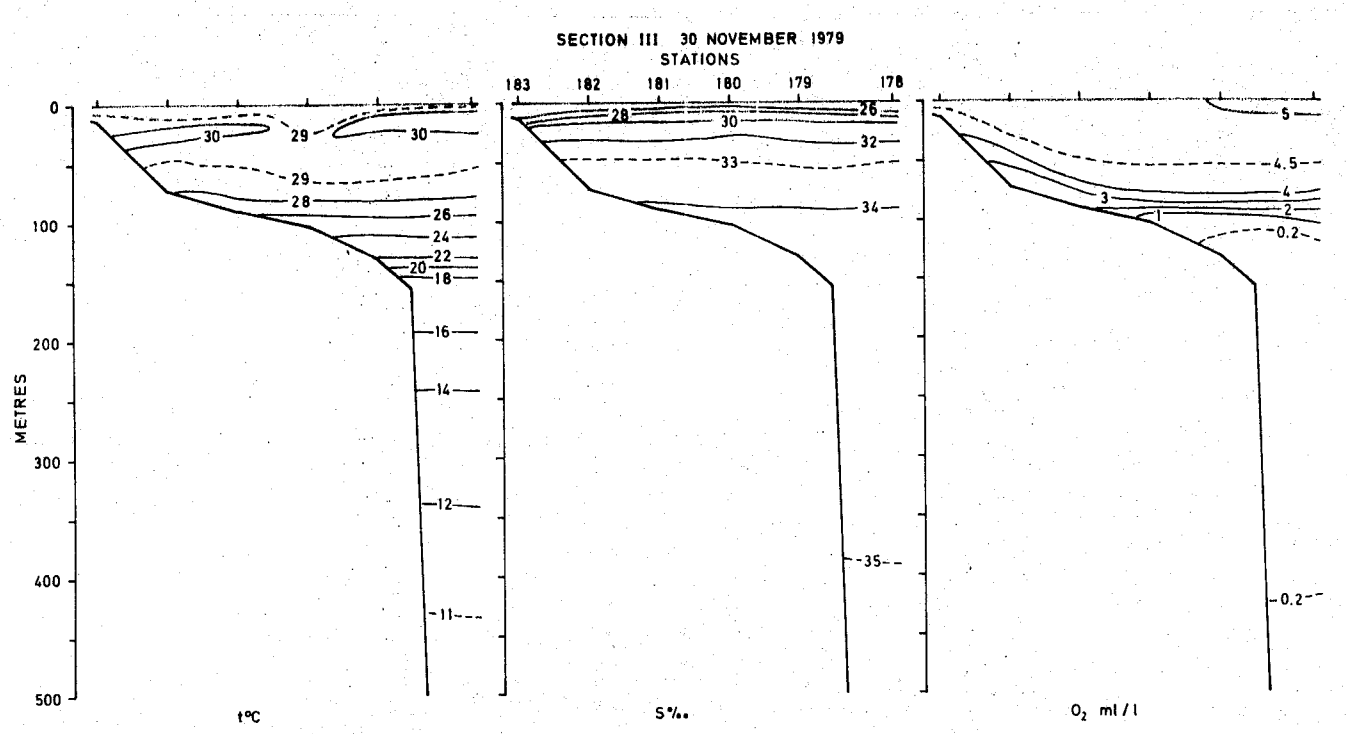

Fig. 6. Vertical distribution of temperature, salinity and oxygen - SECTION III.

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.

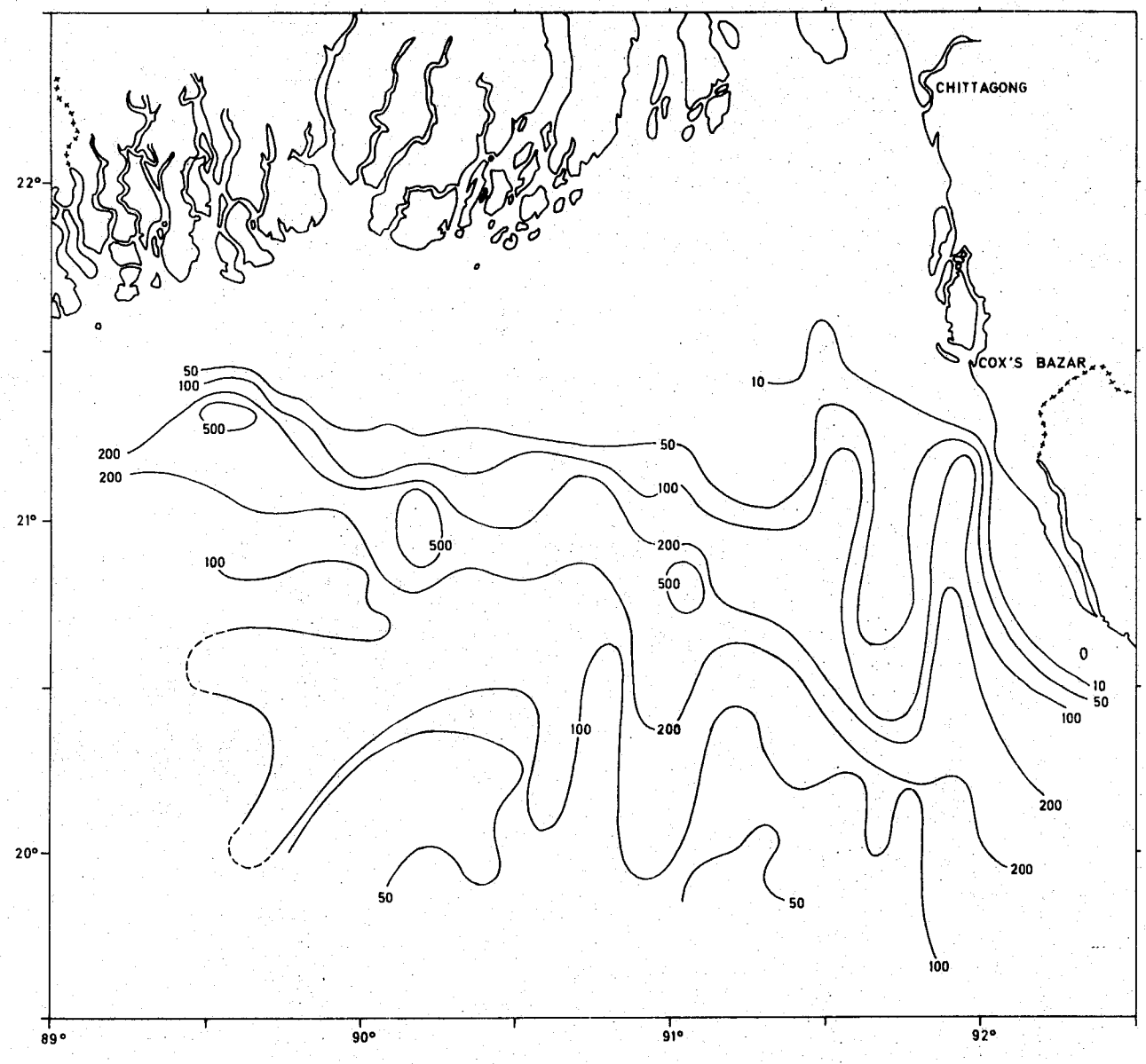

Fig. 7. Echo abundance of plancton in mm integrator reading.

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.

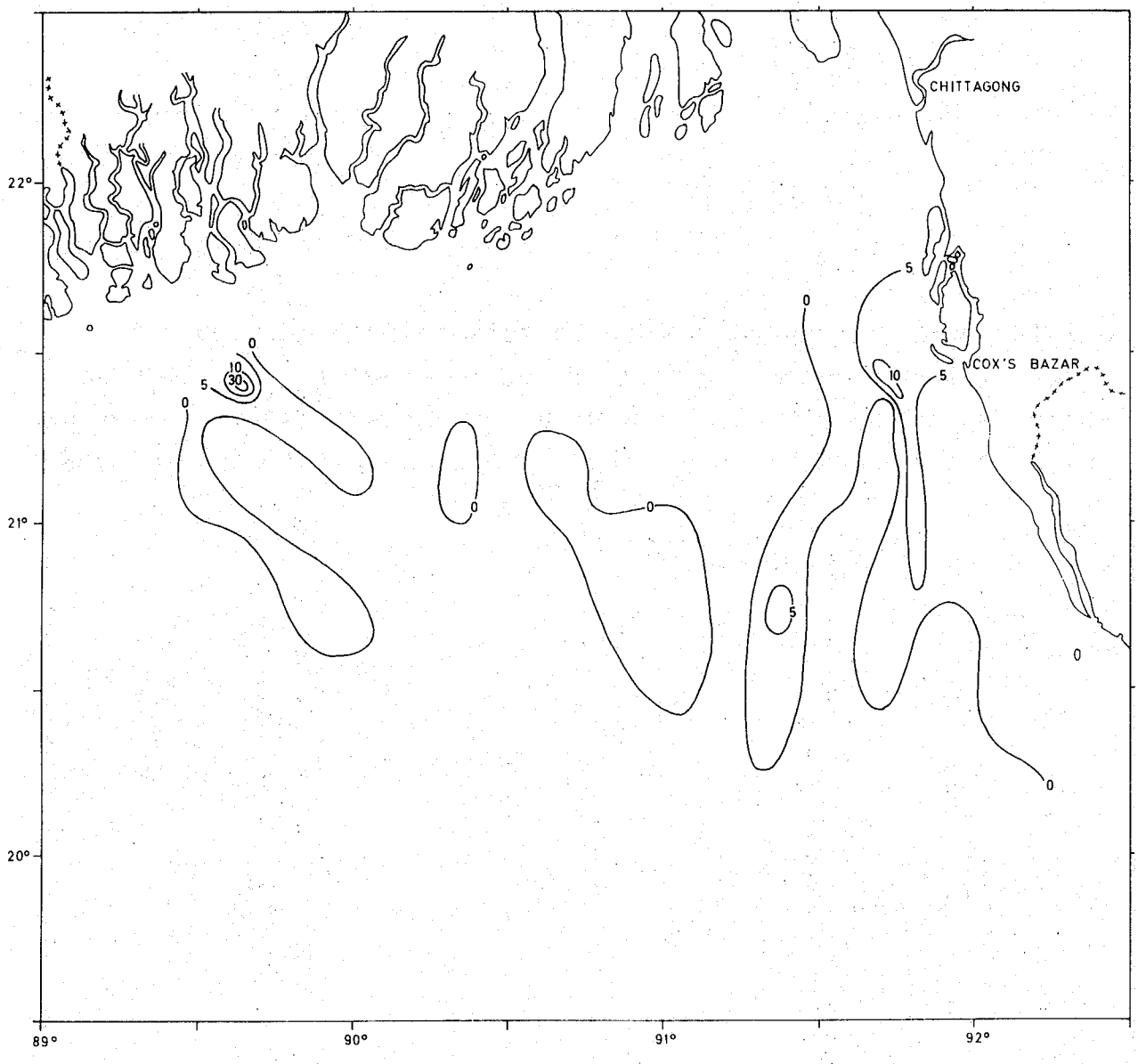

Fig. 8. Echo abundance of demersal fish in mm integrator reading.

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

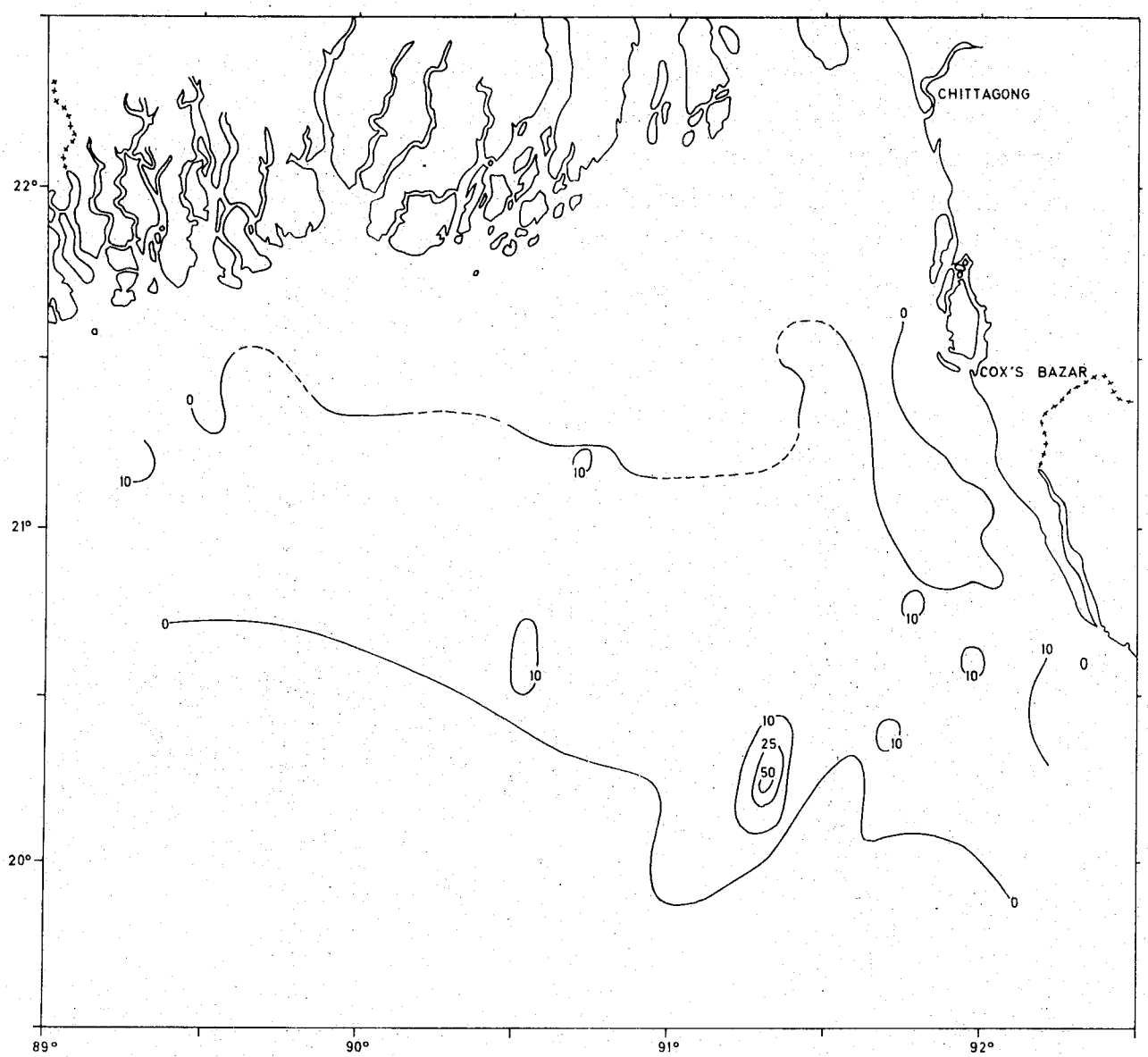

Fig. 9. Echo abundance of pelagic fish in mm integrator reading.

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	-

the catches of the Clupeidae family. The most abundant species of the Scombridae and Leiognathidae families were Rastreliger kanagurta and Leiognathus bindus respectively.

Table 6 gives the species composition of the catch from the pelagic trawl divided into two depth zones. As can be seen, the most abundant families in the catches from bottom depths less than 150 m were the Clupeidae, the Engraulidae and the Trichiuridae. It should be noted, however, that the dominant species within the first two of these families was not the same as in the bottom trawl catches. From the Engraulidae family the Stolephorus sp. contributed most, while this species was not observed in the bottom trawl catches. From the Clupeidae family the rainbow sardine, Dussumieria acuta, dominated the pelagic trawl catches.

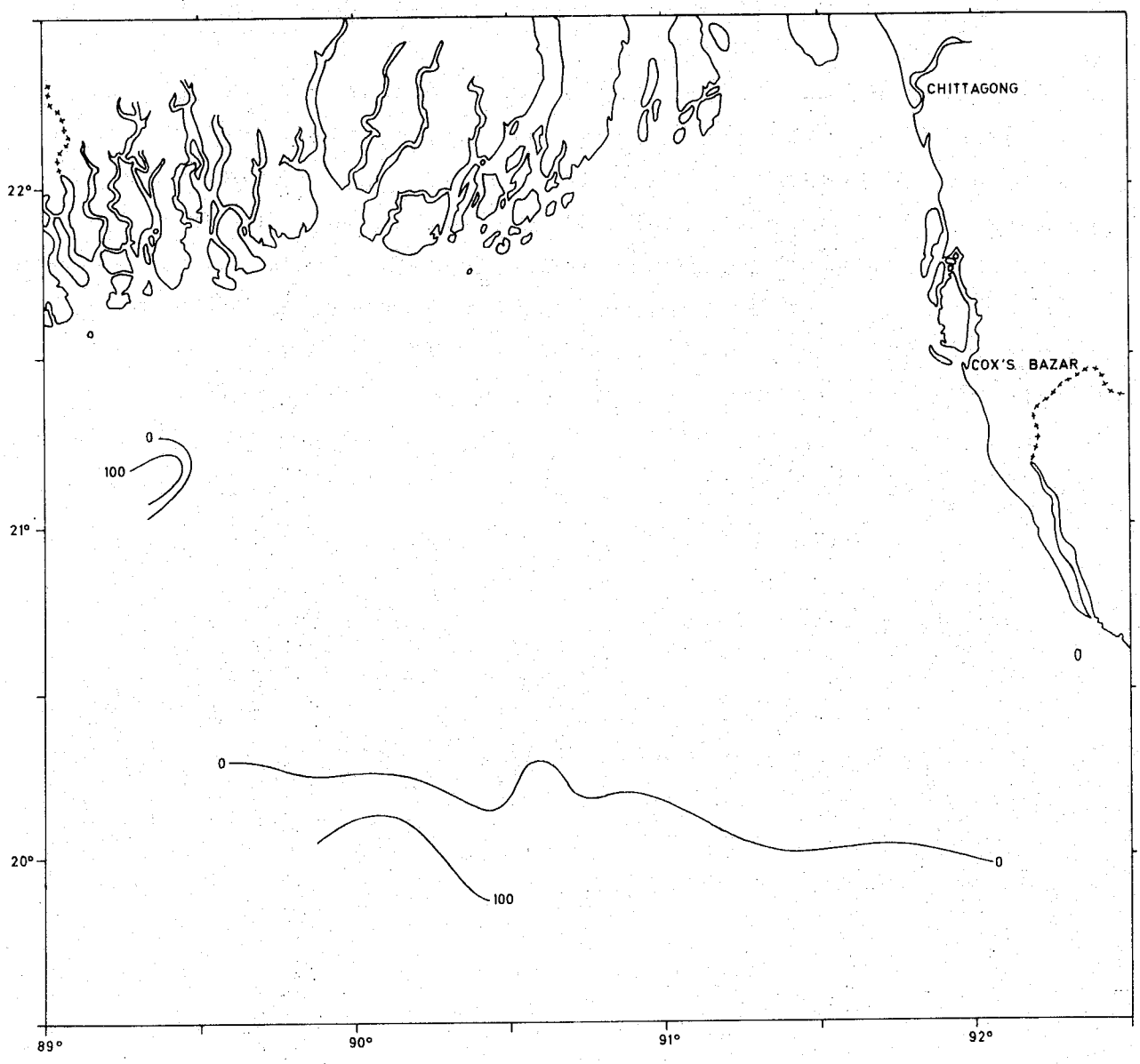

Fig. 10. Echo abundance of mesopelagic fish in mm integrator reading.

Mesopelagic fish

Fig. 10 gives the distribution of echo abundance of mesopelagic fish expressed in mm integrator readings. As seen in Table 6, lantern fish, Myctophidae, dominated the pelagic trawl catches over bottom depths more of 150 m. Below are listed the identified species of the Myctophidae family according to their importance in the catches:

Diaphus thiollierei
Benthosema pterotum
Symbdophorus evermanni
Benthosema fibulatum

Mesopelagic fish, mainly Myctophidae, were recorded over most of the area studied, in waters deeper than 150 m. A deep scattering layer was often observed below 500 m. At sunset this layer, or part of it, migrated towards the surface and during night-time it was situated in the upper 100 m. Usually the scattering layer consisted of dispersed fish, and schools were only observed close to the bottom at the continental edge, where generally the fish density was highest.

3.6 Abundance.

Demersal fish

By using the average catch rates for the bottom trawl a crude abundance estimate can be made. The method make the basic assumption that catch-per-effort is a function of the stock density in the area being surveyed. The fish density is obtained from the mean catch rates and the area swept by the trawl. The latter is the distance between the trawl wings multiplied by the length of the tow. The efficiency coefficient of the trawl was taken as 1, i.e. all the fish ahead of trawl were supposed to be caught. The calculations were carried out using the areas of Table 2 and the catch rates of demersal fish of Table 3 divided into depth zones. The results are shown in Table 7. The high density in the 50-74 m depth zone was 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.

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:

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

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

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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

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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.)

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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																																																	
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																																																		