

A SURVEY OF THE OFFSHORE DEMERSAL FISHERIES OF THE ANDHRA AND ORISSA COASTS, WITH SPECIAL REFERENCE TO THE BIOLOGICAL DATA COLLECTED DURING 1960

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INTRODUCTION

RELATIVELY little is known of the offshore fisheries potential of the Bay of Bengal. Previous records deal chiefly with either the deep-sea deposits and biology of the fauna in depths exceeding 200 metres (Alcock, 1889, 1890 *a, b, c*, 1891 *a, b, c*, 1892 *a, b*, 1893, 1894, 1895, 1896, 1898, 1899 *a, b*, 1902; Annandale, 1908; Borodin, 1930, 1932; Bolin, 1946; Lloyd, 1909; MacArdle, 1901; Sewell, 1912) or the intertidal and shoreline fauna (Alcock, 1890 *a-c*, 1892 *a-c*; Arora and Banerji, 1957; Blyth, 1861; Carpenter, 1885; Chacko, 1949; Day, 1878; Gravely, 1941, 1942; Jenkins, 1912; Koumans, 1941; Norman, 1927; Russell, 1803; Satyamurti, 1952, 1956). The Bengal Government Steam Trawler 'Golden Crown' made a few hauls off the Orissa Coast in intermediate depths in 1909-1910 (Anon., 1911; Jenkins, 1911; Annandale, 1909, 1910 *a, b*). In 1950, the West Bengal Government initiated a regular fishing program with two Danish trawlers, and in 1956 three Japanese trawlers were added to the fleet. Their operations were limited from 10 to 50 metres off the Orissa coast between False Point Lighthouse and the mouth of Chilka Lake. A very limited area is reported to have been fished by these trawlers and their data remain unpublished. A sound knowledge of the fishery resources of the Bay's continental shelf between the shoreline and the 200 m isobath (its neritic province) is therefore lacking; it is well known that the neritic province of the marine environment is far more productive than the oceanic one, and that the former harbours fish of great economic value (Sverdrup *et al.*, 1942, p. 279).

In 1958, the Government of India formulated plans for organizing exploratory fishing operations by its own vessels in the Bay, with the future

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rational exploitation of its resources in view. A plan of scientific observations was arranged on the vessels for an average duration of two hours in each square fished by them, these observations included the collection of representative samples of fishes, benthos, sediments, meteorological data, and the recording of the various species in the catches, their size-ranges and contributions to the total catch.

Shariff (1961) has given details of the vessels, their gears, the general characteristics of the area, and the general results of the fishing operations; while Naumov (1961) had dealt with the methodology of the survey, bottom profiles and sediments, and has given a preliminary report on the catches made, with an appraisal of the fishery resources. The present paper deals with the biological observations made on the salient characteristics of the catch composition, during this survey.

SURVEY PROGRAMME

The area for which a survey was planned is situated along the coastline of the Andhra and Orissa coasts between $17^{\circ} 0' N/82^{\circ} 20' E$ and $20^{\circ} 20' N/86^{\circ} 40' E$ —a distance of 359 nautical miles. The Chilka Lake and the rivers Jotdhar, Devi, Prachi, Kushbhadra, Rushikulya, Vamsadhara, Langulya and Godavari join the sea in this area. The whole area was divided into 4 zones, and each zone into squares of 258.9 sq. km. (approximately 100 sq. miles) each, as follows:

Zone "A" : Lat. $19^{\circ} 30' N/20^{\circ} 20' N$; Square nos. 55-79;

Zone "B" : Lat. $18^{\circ} 30' N/19^{\circ} 30' N$; Square nos. 36-54;

Zone "C" : Lat. $17^{\circ} 40' N/18^{\circ} 30' N$; Square nos. 18-35;

Zone "D" : Lat. $17^{\circ} 0' N/17^{\circ} 40' N$; Square nos. 1-17; (Chart I).

BIOLOGICAL COMPOSITION OF THE CATCHES

As the zonal distribution did not show any marked characteristics, the data were pooled into depthwise segments only. A striking feature which presented itself at once was that most of the bony fishes and prawns showed an increase of size with depth; this kind of distribution pattern is known for some bony fishes in European waters (for the whiting, *Gadus merlangus* L.: Ellis, 1950; Knudsen, 1950; Nagabhushanam, 1959). The cartilaginous fishes like sharks, on the other hand, did not show such a well-marked gradation of size with depth, and appeared to inhabit all depths in practically the whole size-range recorded for them.

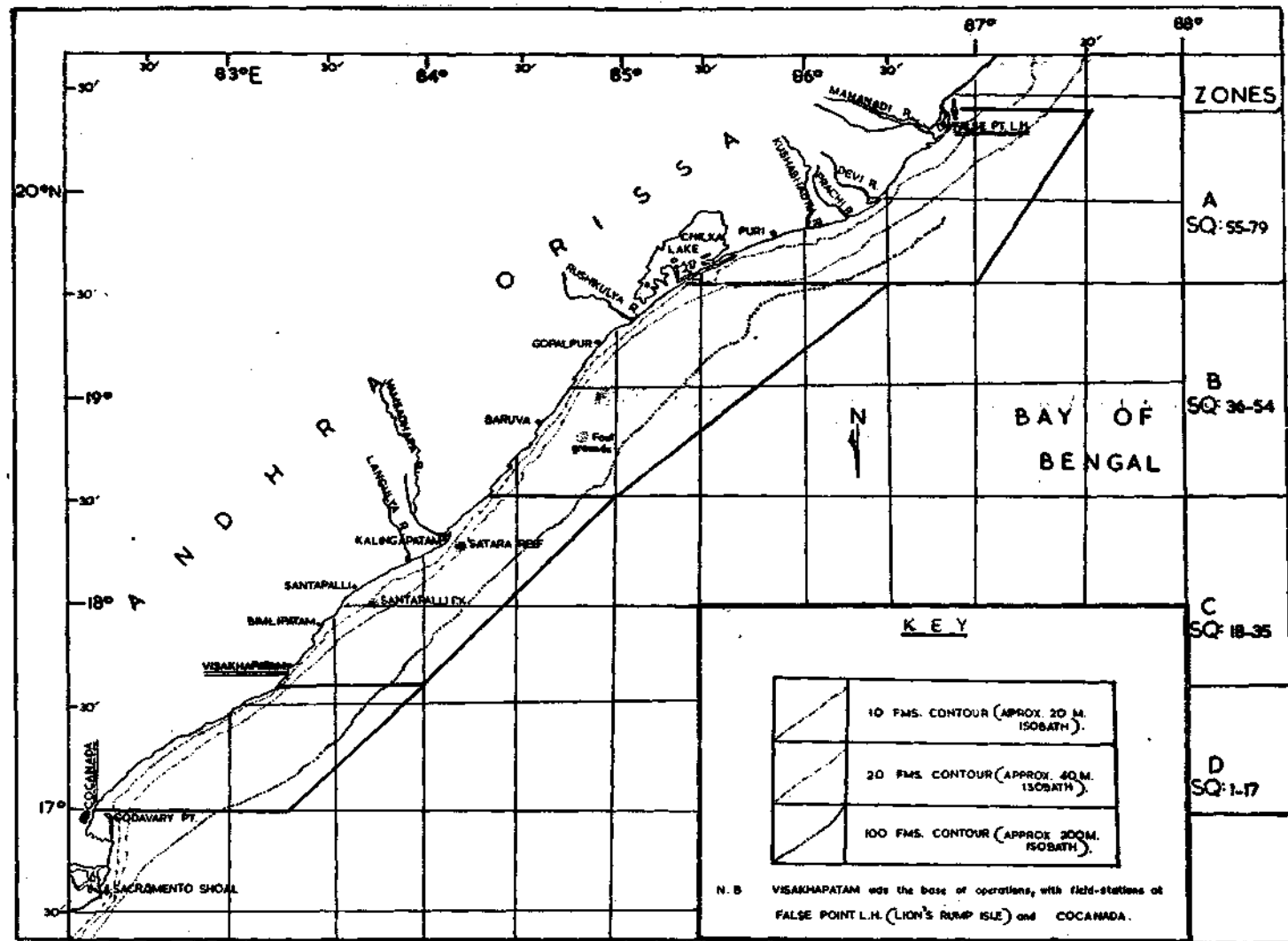


FIG. 1. Chart showing area of operations. Note the narrowness of the fishing grounds; the grounds off Baruva (in Zone B) proved very rich. The square numbers (given at the right-hand of the chart) under each Zone, indicate the grid which was used to cover the area; however, for the ecological distribution of the organisms, depth-ranges (of twenty meters each) were found more convenient.

TABLE I *Size-ranges and other characteristics observed for prawns, explored by*

Common Name	Variety	Upto 20 metres		21 to 40 metres		41 to 60 metres	
		Length - range (mm)	% of grp. total	Length - range (mm)	% of grp. total	Length - range (mm)	% of grp. total
Prawns	Large or Tiger-Medium & small	143-278	46.60	190-280	28.00	175-305	86.50
		43-150	53.40	50-170	72.00	90-160	13.50
			100.00		100.00		100.00
ELASMOBRANCHS							
Cartilaginous fishes or sharks	Yellow and grey dogfish	312-820	16.00	280-412	26.00	273-475	15.00
	Cat-, grey, black and blacktip sharks	680-1180	55.00	275-545	8.00	265-1600	25.00
	Hammerhead sharks	1000-1700	7.00	..	..	800-1800	4.00
	Guitar sharks	900-7000	5.00	500-7000	16.00	500-6500	9.00
	Sawfish	3000-6000	3.00	3000-6000	10.00	3000-6000	4.00
	Rays and skates	100-300	14.00	85-616	40.00	85-750	43.00
		100.00		100.00		100.00	
TELEOSTS (EXCLUDING CATFISHES)							
Sardines	various spp.	60-80	1.60	130-182	0.07	117	0.05
Shads	Slender	139-231	0.40	85-325	1.71	180-420	1.35
Herring	Longfinned and Smoothback	35-215	1.00	150-215	0.70	..	..
Sprats	Van Hasselt's	48-83	2.00	57-184	1.70	75-112	0.25
Anchovies	Tapertail, Hairfin and Glassnose	90-177	1.40	32-175	5.62	73-152	1.60
Wolf-herring	Dorab	345-392	0.40	310-501	0.02	480-600	0.10
Lizard-fish	<i>Saurida</i>	23-121	0.40	43-345	11.86	61-355	6.00
Eels	Congers	600-1068	0.60	..	..	..	..
Bombay-ducks	<i>Harpodon</i>	200-233	2.20	200-296	0.04	..	..
Cods	Longfinned	..	..	..	..	66-99	0.80
Flute-mouths	Pipefish	93-330	0.60	112-542	1.82	..	..
Soldierfish	<i>Holocentrus</i>	..	..	..	..	120-161	1.70
Sea-pikes	Barracuda	..	..	..	..	245-290	0.20
Mullets	<i>Liza</i>	110-190	0.50	130-150	0.01	..	..
Threadfins	<i>Polynemus</i>	35-147	6.40	110-265	3.41	150-338	1.15
Rock-cods	Giant perch	..	..	..	..	250-800	6.50
Croakers	<i>Theapon</i>	90-120	2.00	110-225	0.03	150-257	0.55
Goggle-eyes	<i>Priacanthus</i>	..	..	67-182	0.03	110-175	0.30
Cardinal fish	<i>Apogon</i>	40-47	0.40	36-125	9.01	44-130	1.80
Whiting, Smelt	<i>Sillago</i>	95-150	1.10	179	0.01	..	..
Whitefish	<i>Lactarius</i>	33-80	2.90	80-205	5.10	80-220	0.10
Torpedo fish	<i>Megalaspis</i>	85-176	0.40	197-225	0.03	..	..
Russel's shad	<i>Decapterus</i>	..	..	..	..	164-178	0.40
Threadfish	<i>Alectis</i>	76-100	0.40	76	0.01	..	..
Atropus	<i>Atropus</i>	28-130	1.10	145-205	0.06	150-190	1.30
Kingfish	Carangids	109-182	1.50	126-210	0.10	135-360	0.60
Albacores	<i>Seriola</i>	..	..	..	..	225-270	0.10
Queenfish	<i>Chorinemus</i>	930	0.20	184-227	0.04	220-235	0.10
Elacate	<i>Elacate</i>	..	..	260	0.01	..	..
Mene	<i>Mene</i>	..	..	173	0.01	..	..
Snappers	<i>Lutjanus</i>	..	..	43-196	0.12	136-900	6.00

elasmo branches, Catfishes and other bony fishes in the various depths trawls

61 to 80 metres		81 to 100 metres		101-120 metres		REMARKS		
Length-range (mm)	% of grp. total	Length-range (mm)	% of grp. total	Length-range (mm)	% of grp. total			
180-250	77.00	210-310	93.00	210-310	91.00	2	zool.	Species
90-170	23.00	101-120	7.00	120-170	9.00	9	do.	do.
	100.00		100.00		100.00			
300-450	17.30	500-510	7.00	510-600	3.20	2	do.	do.
600-1200	30.30	280-1500	58.00	600-1200	42.00	5	do.	do.
900-1200	4.40	..	..	1000	3.20	2	do.	do.
1700-4000	4.20	346-5000	7.00	700-4000	22.60	3	do.	do.
3000-5000	4.40	3000-7000	7.00	4500	3.20	2	do.	do.
100-700	39.40	200-500	21.00	100-800	25.80	12	do.	do.
	100.00		100.00		100.00			
185-520	11.90	200-345	16.80	400	0.50	3	do.	do.
..	..	..	..	..	..	2	do.	do.
80-190	3.50	..	..	..	..	1	do.	do.
80	1.00	..	..	..	..	8	do.	do.
70-300	11.40	309	0.40	..	..	1	do.	do.
..	..	..	..	..	..	4	do.	do.
..	..	..	..	..	..	1	do.	do.
70-80	1.70	..	..	..	..	1	do.	do.
..	..	..	..	..	..	3	do.	do.
130-170	13.00	150-190	11.20	151-200	23.00	1	do.	do.
..	..	..	..	..	..	1	do.	do.
..	..	..	..	..	..	1	do.	do.
160-300	3.50	175-195	5.00	200	0.50	4	do.	do.
..	..	..	..	..	..	7	do.	do.
..	..	..	..	..	..	4	do.	do.
140-180	6.00	151-190	5.40	160-190	64.50	2	do.	do.
..	..	..	..	..	..	4	do.	do.
..	..	..	..	..	..	1	do.	do.
250	1.00	..	..	..	..	1	do.	do.
..	..	166-171	0.90	170-180	1.00	1	do.	do.
200	1.00	..	..	..	..	1	do.	do.
..	..	..	..	..	..	1	do.	do.
..	..	200	0.40	..	..	1	do.	do.
200-350	2.00	..	..	..	..	7	do.	do.
..	..	..	..	..	..	1	do.	do.
230-240	1.70	..	..	..	..	1	do.	do.
300	2.00	..	..	..	..	1	do.	do.
..	..	..	..	..	..	1	do.	do.
230-300	2.70	162	0.40	170-700	1.00	5	do.	do.

TABLE I

Common Name	Variety	Upto 20 metres		21 to 40 metres		41 to 60 metres	
		Length-range (mm)	% of grp. total	Length-range (mm)	% of grp. total	Length-range (mm)	% of grp. total
Threadfin Bream	<i>Nemipterus</i>	40-173	3.20	46-246	4.60	143-332	2.70
Silver-biddy	<i>Pertica</i> , etc.	..	..	66-126	3.80	60-154	0.85
Silver-belly	<i>Secutor</i>	29-96	21.50	26-119	6.50	45-120	2.70
Ponyfish	<i>Leiognathus</i>	36-110	3.70	32-265	6.50	49-265	8.80
Grunters	<i>Pomadasys</i>	60-82	4.50	96-840	0.15	130-365	4.20
Sweetlips	<i>Spilotichthys</i>	..	..	..	..	295-500	0.10
Jewfish	<i>Johnius</i> , etc.	30-182	15.60	85-290	10.26	134-700	15.55
Longtooth salmon	<i>Otolithus</i>	100-355	0.60	80-275	0.09	243-315	0.45
Redfin Bream	<i>Argyrops</i> , etc.	..	..	46-190	0.03	157-220	0.40
Red mullets	<i>Upeneus</i>	75-125	3.30	129-175	0.06	93-260	13.90
Sea-bats	<i>Ephippus</i>	..	..	82-183	0.04	100-190	0.30
Moonfish	<i>Drepane</i>	80-85	0.40	80-360	4.50	95-360	1.80
Coralfish	Pennant's, etc.	..	..	..	..	100-190	0.45
Grubfish	<i>Parapercis</i>	..	..	111	0.01	..	..
Stargazers	<i>Uranoscopus</i>	50-146	0.40	54-177	3.00	90-170	2.50
Blennies	<i>Xiphasia</i>	..	..	303-314	0.01	..	..
Dragonets	Arrowhead, etc.	..	..	37-267	3.41	..	..
Surgeonfish	<i>Ctenochaetus</i>	..	..	..	..	480	0.05
Ribbonfish	<i>Trichiurus</i>	185-360	2.00	75-552	0.07	280-474	0.30
Mackerel	<i>Rastrelliger</i>	36	0.20	45-235	0.01	215-240	0.40
Seerfish	<i>Indocybium</i>	480-880	1.80	..	..	365	0.05
Pomfrets	<i>Pampus</i> , etc.	83-203	7.00	152-310	0.13	126-310	6.00
Psenes	<i>Psenes</i>	..	..	175-196	0.01	175-180	0.40
Glassfish	<i>Kurtus</i>	46-110	0.40	92-116	1.60	..	..
Gobies	<i>Gobius</i>	..	..	..	..	79	0.10
Firefish	<i>Pterois</i> , etc.	..	..	100-225	0.01	181-190	0.10
Stingfish	<i>Minous</i> , etc.	..	..	41-105	0.02	86-105	0.20
Crocodile fish	<i>Grammopittes</i>	140	0.20	62-220	1.70	103-240	0.80
Sea-robins	<i>Pevistiedion</i>	..	..	75	0.01	..	..
Red-gurnards	<i>Lepidotrigla</i>	..	..	..	..	..	..
Flying-gurnards	<i>Dactyloptena</i>	..	..	126-220	0.05	135-220	0.80
Halibut	<i>Psettodes</i>	97-150	0.40	138-300	0.02	..	..
Flounders	<i>Pseudorhombus</i>	77-150	1.20	39-190	2.34	115-245	0.95
Soles	<i>Soles</i>	..	..	68-95	0.02	132	0.05
Tongue-soles	<i>Cynoglossus</i>	100-200	3.90	99-326	5.60	115-365	0.40
Suckerfish	<i>Echeneis</i> , etc.	..	..	135-320	0.02	225	0.05
Triggerfish	<i>Balistes</i> , etc.	..	..	80	0.01	125-375	0.20
Tripodfish	<i>Triacanthus</i> , etc.	..	..	122-209	0.02	130-180	0.40
Boxfish	<i>Tetrasomus</i>	..	..	..	..	115-150	0.20
Porcupine fish	<i>Diodon</i>	..	..	146-157	0.01	120	0.05
Pufferfish	<i>Gastrophysus</i> , etc.	48-115	2.20	38-225	3.62	108-470	1.70
Anglerfish	<i>Lophoides</i>	..	..	66	0.01	..	..
Rattlefish	<i>Halieuta</i>	..	..	108-130	0.01	116-130	0.10
Fishing frog	<i>Antennarius</i>	..	..	51-79	0.01	85	0.05
			100.00		100.00		100.00
CATFISHES							
Catfish or 'jellas'	<i>Pseudarius</i> and <i>Osteogeniosus</i>	78-200	59.00	80-575	99.90	26-450	100.00
	<i>Hexanematichthys</i> , and <i>Plotosus</i>	97-202	41.00	106	0.10	..	..
			100.00		100.00		100.00

(Contd.)

Length-range (mm)	61 to 80 metres		81 to 100 metres		101-120 metres		REMARKS
	% of grp. total	Length-range (mm)	% of grp. total	Length-range (mm)	% of grp. total	Length-range (mm)	
60-300	5.00	170-211	1.60	..	..	1 zool	Species
70-130	2.50	..	..	..	..	2 do.	do.
60-130	1.70	..	..	..	..	2 do.	do.
70-140	5.00	166	0.40	..	..	6 do.	do.
..	..	..	..	..	..	3 do.	do.
148-200	5.00	155-225	21.50	..	..	1 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	13 do.	do.
..	..	..	..	..	..	2 do.	do.
..	..	..	..	..	..	3 do.	do.
120-200	1.70	..	..	..	..	1 do.	do.
130-400	5.00	..	..	..	..	1 do.	do.
..	..	..	..	..	..	2 do.	do.
95-107	1.70	107-190	1.60	107-190	1.00	2 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	2 do.	do.
300-400	2.50	364-452	3.20	..	..	1 do.	do.
240	1.00	197-229	6.80	..	..	2 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	127-152	1.30	..	..	3 do.	do.
..	..	155-200	18.80	200	0.50	1 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	1 do.	do.
107-210	2.50	250	0.40	120-130	1.70	2 do.	do.
..	..	100-130	0.90	300	0.50	3 do.	do.
..	..	120-240	0.40	..	..	1 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	1 do.	do.
200	1.00	95-115	1.80	100-120	3.10	1 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	6 do.	do.
..	..	..	..	..	..	1 do.	do.
..	..	..	..	..	..	2 do.	do.
..	..	..	..	..	..	4 do.	do.
..	..	..	..	..	..	2 do.	do.
300	1.00	..	..	..	..	2 do.	do.
..	..	..	..	..	..	3 do.	do.
..	..	..	..	..	..	1 do.	do.
500	1.00	..	..	..	..	1 do.	do.
70	1.00	120	0.40	500	0.50	4 do.	do.
..	..	116	0.40	130	..	1 do.	do.
..	..	..	..	..	..	1 do.	do.
CATFISHES							
150-300	100.00	300-500	100.00	200-500	100.00	3 do.	do.
..	..	..	..	..	..	2 do.	do.
100.00		100.00		100.00			
100.00		100.00		100.00			

The miscellaneous fishes (below 150 mm), which figured so prominently in the catches throughout the area, consisted in shallow depths of juvenile sciaenids, clupeoids, etc.; these juveniles were specially numerous in the shallows upto 20 m inshore, and as the depth increased their occurrence in the catches became less. In depths exceeding 60 m they were largely replaced by red soldier-fish [*Holocentrus rubrum* (Forsk.)] and goggle-eyes (*Priacanthus hamrur* Forsk.).

The presence, in quantity, of 'Bombay Ducks' (*Harpodon nehereus* Le Sueur) and glassfish or humpheads (*Kurtus indicus* Bloch) was observed chiefly in Zone "A", but even here they did not form a large part of the catch; however, a few stray specimens of these two species were taken as far south as Zone "C", though rarely.

Details of the % composition in the catches of various varieties, along with their common names and size-ranges for various depth-ranges, are given in Table I.

In the following account of the biological characteristics of the various depth-ranges, only those constituents which made a contribution in excess of 5% in each general group of varieties, are discussed.

(a) Trawl Catches

Depth-range upto 20 metres (Total number of hours fished: 36).—In this depth-range miscellaneous fishes formed 75% of the total catch, of this only 2% were over 150 mm (Table II, after Shariff, 1961). This contribution of miscellaneous fishes consisted chiefly of:

	% of group	Size-range (mm)
Silver-bellies (<i>Secutor</i>)	.. 21.5	29-96
Jewfishes (<i>Johrius</i> , <i>Sciaena</i>)	.. 15.5	30-182
Pomfrets (<i>Pampus</i> , etc.)	.. 7.4	83-203
Threadfins (<i>Polynemus</i>)	.. 6.4	35-147

Sharks, rays and skates contributed 17% (Table II), this being made up as follows:

	% of group	Size-range (mm)
Sharks (<i>Chiloscyllium</i> , <i>Eulamia</i>)	.. 55.0	680-1180
Dog fishes (<i>Scoliodon</i>)	.. 16.0	312-820
Skates, rays (<i>Himantura</i> , etc.)	.. 14.0	100-300
Hammerheads (<i>Sphyrna</i>)	.. 7.0	1,000-1700
Guitar-sharks (<i>Rhina</i> , etc.)	.. 5.0	900-7000

TABLE II Percentage composition of the total catch in the various depth-ranges

(Extract from Table 14, after Shariff, 1961, op. cit.)

Depth-range (metres)	Prawns	Catfish	Sharks rays and skates	Misc. fish (below 150 mm)	Misc. fish (over 150 mm)
Upto 20 metres ..	7	1	17	73	2
21- 40	3	7	13	67	10
41- 60	6	17	16	52	9
61- 80	4	16	11	54	15
81-100	1	26	27	40	6
101-120 .. ..	..	3	1	96	1

Prawns formed 7% of the total catch (Table II) and consisted of the following:

	% of group	Size-range (mm)
Small and medium prawns (<i>Metapenaeus</i>) ..	53.4	43-150
Large or tiger-prawns (<i>Penaeus</i>) ..	46.6	143-278

Catfish formed 1% of the total catch (Table II), and consisted of the following:

	% of group	Size-range (mm)
'Jellas' (<i>Pseudarius, Osteogeniosus</i>) ..	59.0	72-200
Dusky catfish (<i>Hexanematichthys</i>) ..	41.0	97-202

It will thus be seen that miscellaneous fishes normally below 200 mm in total length occur in this depth-range, like the silver-bellies and the smaller jewfishes; while the juveniles of larger species like pomfrets and threadfins are to be taken here in some appreciable quantity. The biggest prawns did not exceed 278 mm, and sharks of a quite large size-range were caught.

Depth-range 21-40 metres (Number of hours fished: 514).—In this habitat miscellaneous fishes made up 77% of the total catch, of these 10% were

over 150 mm in length; the proportion of fish over 150 mm showed a distinct increase over their value in the preceding depth-range (Table II). The composition of the miscellaneous fishes was as follows:

	% of group	Size-range (mm)
Lizard-fishes (<i>Saurida</i>)	.. 11.8	43-345
Jewfishes (<i>Johnius</i> , <i>Sciaena</i>)	.. 10.2	85-290
Cardinal fishes (<i>Apogon</i>)	.. 9.0	36-125
Silver-bellies (<i>Secutor</i>)	.. 6.5	29-96
Ponyfishes (<i>Leiognathus</i>)	.. 6.5	32-265
Anchovies (<i>Anchoviella</i>)	.. 5.6	32-175
Tongue-soleks (<i>Cynoglossus</i>)	.. 5.6	99-326
Whitefishes (<i>Lactarius</i>)	.. 5.1	80-205

A greater variety of fishes was taken in quantity, and they were of a larger size-range compared to those taken in the previous depth-range. Though silver-bellies and jewfishes were taken in lesser quantity in this depth-range compared to their values in the previous one, yet they were still contributing appreciably to the catches.

Sharks, rays and skates contributed 13% of the total catch (Table II), and this contribution was chiefly made up of the following:

	% of group	Size-range (mm)
Skates, rays	.. 40.0	85-616
Dogfishes	.. 26.0	280-412
Guitar-sharks	.. 16.0	500-7,000
Sawfishes (<i>Pristis</i>)	.. 10.0	3000-6,600
Sharks	.. 8.0	275-545

The first four varieties had increased their values substantially over those in the previous depth-range, while the sharks had lost in value.

Catfishes contributed 7% of the total catch (Table II), and have shown a substantial increase in value over that in lesser depths. Also the fishes here are bigger. The constituents were:

	% of group	Size-range (mm)
'Jelas'	.. 99.9	80-575
Barbel-eels (<i>Plotosus</i>)	.. 0.1	106

The catch was almost purely of 'jellas', and the barbel-eels were met with only in this depth-range, and rarely. *Hexanematichthys* would appear to be confined to the lesser depths and were not met with in this or succeeding depths.

Prawns contributed 3% of the total catch (Table II), and they had the following composition:

	% of group	Size-range (mm)
Medium and small prawns	.. 72.0	50-170
Large prawns	.. 28.0	190-280

The proportion of small and medium prawns was nearly 20% more than in lesser depths.

Depth-range 41-60 metres (Number of hours fished: 843).—In this habitat miscellaneous fishes contributed 61% to the total catch; this figure included 9% of miscellaneous fishes over 150 mm in length (Table II). The catches chiefly consisted of:

	% of group	Size-range (mm)
Jew fishes	.. 15.5	135-700
Goat-fishes (<i>Upeneus</i>)	.. 13.9	93-260
Ponyfishes	.. 8.8	49-265
Giant-perch (<i>Epinephelus</i>)	.. 6.5	250-800
Red snappers (<i>Lutianus</i>)	.. 6.0	136-900
Pomfrets	.. 6.0	126-310

One of the richest grounds of this investigation was struck in these depths (Chart I—near the port of Baruva) in Zone "B". The nets came up torn badly, as the sea-bed is carpeted with coral, but with the cod end of the trawls bursting with fishes. The fishes caught were larger than those taken in previous depth-ranges, and goatfishes figured prominently in the hauls. Catfish contributed 17% to the total catch (Table II), an advance of nearly 10% over its preceding value in lesser depths, and consisted entirely of *Pseudarius* of a size-range between 126 and 450 mm.

Sharks, rays and skates constituted 16% of the total catch (Table II), and consisted of the following:

	% of group	Size-range mm
Skates, rays	.. 43.0	85-750
Sharks	.. 25.0	265-1,600
Dogfishes	.. 15.0	273-475
Guitar-sharks	.. 9.0	500-6,500

The skates and rays had practically maintained their values, but were larger than in the preceding depths. The sharks also were larger, and had gained in value by 17% compared to their previous value in lesser depths. The dogfishes and guitar-sharks were almost the same size as in the previous depths, but contributed much less than before.

Prawns contributed 6% to the total catch (Table II), a rise of 3% over their preceding value, and comprised:

	% of group	Size-range (mm)
Large prawns	.. 86.5	175-305
Medium and small prawn	.. 13.5	90-160

The proportion of large prawns was a great increase over their previous values, while that of medium and small prawns fell off appreciably. This is of interest as these proportions appeared to be maintained in succeeding depths and this could be a factor to be taken into account when exploiting the area for a prawn-fishing industry in the future.

Depth-range 61-80 metres (Number of hours fished 51):—In these depths miscellaneous fishes contributed 69% to the total catch (Table II); this figure included 15% of fishes over 150 mm—the highest contribution by fishes of this size in any depth-range. The composition of the miscellaneous fishes was as follows:

	% of group	Size-range (mm)
Red soldierfish (<i>Holocentrus</i>)	.. 13.0	130-170
Slender and shortnosed shads (<i>Ilisha, Anadontostoma</i>)	.. 11.9	185-420
Lizard fishes	.. 11.4	70-300
Goggle-eyes (<i>Priacanthus</i>)	.. 6.0	140-180
Japanese threadfin bream (<i>Nemipterus</i>)	.. 5.0	60-300
Ponyfishes	.. 5.0	70-140
Jewfishes	.. 5.0	148-200
Moonfishes (<i>Drepane</i>)	.. 5.0	130-400

It will be noted that the character of the miscellaneous fishes caught in this depth-range is different from that obtaining in lesser depths. Red soldier-fish which appeared in negligible quantities in the previous depths (Table I), now were the most prominent; a small contribution was made by the goggle-eyes (which first appeared in the catches in the 21-40 metre range); bream and moonfish showed the maximum contribution in this habitat. The ponyfishes and jewfishes showed a fall of 10% in value from their preceding value in the lesser depths.

Catfish contributed 16% to the total catch (Table II), and was composed entirely of 'jellas' measuring 150 to 300 mm.

Sharks, rays and skates contributed 11% to the total catch (Table II), showing a fall of 5% in value from that in the preceding depth-range; the composition of the catch was as follows:

	% of group	Size-range (mm)
Skates, rays	.. 39.4	100-700
Sharks	.. 30.3	600-1,200
Dogfishes	.. 17.3	300-450

The value of skates and rays showed a fall of nearly 4% from their preceding value; sharks had gained by a like value; the dogfishes gained by 2% and guitar-sharks ceased to be prominent in the catch.

Prawns contributed 4% to the total catch (Table II), and have thus lost 2% from their preceding value; their composition was as follows:

	% of group	Size-range (mm)
Large prawns	.. 77.0	180-250
Medium and small prawns	.. 23.0	90-170

Depth-range 81-100 metres (Number of hours fished: 11).—In this habitat miscellaneous fishes contributed 46% to the total catch, including 6% by fishes over 150 mm; these latter showed a drop of 9% from their preceding value (Table II); the composition of the miscellaneous fishes was as follows:

	% of group	Size-range (mm)
Jewfishes	.. 21.5	152-225
<i>Psenes indicus</i>	... 18.5	155-200
Shads	... 16.8	200-345
Red soldier-fish	.. 11.2	150-190
Mackerel (<i>Rastrelliger</i>)	... 6.8	197-229
Goggle-eyes	... 5.4	151-190
Threadfins	... 5.0	151-190

Jewfishes appeared to have regained their value in the catch (this was their highest contribution for all the depths). Varieties that have become prominent were *Psenes*, mackerel and threadfins. Most of the species were larger than in the preceding depths. Sharks, rays and skates contributed 27% to the total catch, their highest contribution in any depth-range (Table II); their composition was as follows:

		% of group	Size range (mm)
Sharks	..	58.0	280-1,500
Rays and skates	..	21.0	200-500
Saw fishes	..	7.0	3,000-7,000
Guitar-sharks	..	7.0	346-5,000
Dogfishes	..	7.0	500-510

Sharks and guitar-sharks seemed to have increased in value by 28% and 3% respectively over their preceding depth-values; the others showed a fall in values.

Catfishes contributed 26% to the total catch (Table II), their highest contribution in any depth-range so far; the catch was entirely of 'jellas' between 300 and 500 mm.

Prawns contributed 1% to the total catch (Table II), their lowest value in any depth-range fished in this study; the catch was made up of the following:

		% of group	Size-range (mm)
Large prawns	..	93.0	210-310
Medium and small prawns	..	7.0	100-120

Some of the largest prawns, recorded from Indian waters, were taken in this depth-range, a large proportion measured over 300 mm in total length.

*Depth-range 101-120 metres (Number of hours fished: 3).—*The hauls made in these depths yielded a catch composed of miscellaneous fishes chiefly; the contribution was 97%, including 1% over 150 mm in total length. The chief constituents were goggle-eyes (64.5%) and red soldier-fish (23.0%) with length-ranges of 100-150 mm and 90-150 mm respectively. Three per cent of the total catch was of catfishes, composed entirely of 'Jellas' 200-500 mm in length. One per cent of the total catch was made up of

sharks, rays and skates; of these, sharks measured 600–1,200 mm, guitar-sharks: 700–4,000 mm, and a variety of skates and rays: 100–800 mm.

(b) Gill-net Catches:

The gill-nets were set in Zone 'C' only in depths upto 40 metres. Table III gives the proportions in which various constituents occurred in each depth-range.

TABLE III Percentage composition of the gillnet catches in the two depth-ranges worked (length-range of the fishes are also given)

Depth-range (metres)	Hours fished	Sharks	Catfish	Perches	Misc. fish	Total
Upto 20 metres ..	500	87.57	9.87	2.17	0.29	100.00
21–40 metres ..	1000	92.39	3.95	3.63	0.03	100.00
Length-range (mm)† ..		200–1000	150–450	100–2000	100–700	100–2000

The sharks taken chiefly belonged to the genus *Eulamia*, viz., *E. melanoptera* (Quoy and Gaimard), *E. spallanzani* Le Sueur and *E. ellioti* (Day), and the genus *Scoliodon*, viz., *S. sorrakowah* (Cuv.). On occasion, hammer-head sharks *Sphyrna blochii* Cuvier, sawfishes *Pristis cuspidatus* Latham, cow-rays *Rhinoptera javanica* Muller and Henle, also occurred in the catches. The sharks appeared to inhabit deeper waters to a lesser extent than the shallows, as judged from the catches of the gillnets (Table III). This was also true for the perches, but the reverse held for catfishes and miscellaneous fishes.

The catfishes were mostly *Pseudarius jella* (Day), *P. jaius* (Ham Buch.) and *Osteogeniosus militaris* (L).

The perches taken included medium and large-sized (upto 2,000 mm long) jewfishes of the following species: *Sciaena macropterus* (Bleeker), *Johnius aneus* Bloch and *J. diacanthus* (Lacepede).

The miscellaneous fishes consisted of queenfish, *Chroinemus lysan* (Forsk.), and bonitos, *Indocybium guttatum* (Bloch and Schneider). These fishes measured upto 700 mm in total length.

DISCUSSION

The first year of establishment of the Offshore Fishing Station, Visakhapatnam, having many difficulties of a practical nature to encounter, a much smaller amount of time, than originally planned, could be devoted for studying the different parts of the area. This is, therefore, only a preliminary report, as there is need to further explore all depth-ranges of Zone B, depths upto 20 metres, and those depths exceeding 80 metres in all zones; and the 21-40 and 41-60 metres depth ranges of Zones A and D. A detailed study of the current systems and bottom temperatures is vital for a proper survey by bottomset nets and trawls, and this study should be extended to all levels of the water-mass over the continental shelf for a proper understanding of the area being exploited by the gears, and the final preparation of fishing charts for the industry.

The present report reveals a wealth of varieties inhabiting the area in different depths. The trawls caught many groups like prawns, sharks, rays, skates, various types of small, medium and large bony fishes; the gill-nets, on the other hand, caught almost wholly sharks and large catfishes. Thus, the selectivity of the gears used is very apparent, although both fished very close to the sea-bed. Again, the fairly slow trawling speed (about 3-3½ knots over the ground) would allow the faster swimming fishes to escape capture. No dense shoals of any one species were met with in this study.

Prawns appeared to inhabit the shallows upto 20 metres to a greater extent than deeper water; however, it was apparent that larger prawns were to be taken in markedly larger proportions in 21-80 metres. Since prawns are of great value for export and internal markets, it would be of interest to the industry if further work is planned on this aspect of distribution with different kinds of gears besides trawls with different meshes.

Catfishes appeared chiefly to inhabit depths between 21 and 100 metres while miscellaneous fishes (below 150 mm) chiefly occurred in depths upto 20 metres. The juveniles of various valuable species occurred less with an increase in depth, until in depths exceeding 80 metres they were found to be largely replaced by red soldierfish and goggle-eyes; miscellaneous fish (over 150 mm) including the valuable market-fishes—of which juveniles had been taken inshore—formed a sizeable portion of the catches in depths exceeding 20 metres.

Sharks, rays and skates were present in good proportions of the total catch in all depths upto 100 metres.

The very rich coralline beds in Zone B, struck off Baruva in the 41-60 metres depth-range, merit special attention for future commercial exploitation. The very nature of the sea-bed precludes use of conventional trawling gear, and an answer would be to use fairly large bobbins on the foot-rope of the trawls which should be further modified by attaching a series of floats (the disposition of the floats have to be determined by devising a series of experiments) in the wings and specially towards the codend of the net, to ensure that snagging on the corals (with resultant damage to the gear) does not occur.

An important problem that revealed itself, specially in the shallows upto 20 metres, was the presence in the catches of great quantities of juvenile fishes belonging to the valuable larger marketable fishes which inhabited deeper waters offshore; the juveniles formed over 70% of the total catch in depths upto 20 metres. As fairly good prawning grounds also overlap with these 'nursery' grounds inhabited by the juvenile fishes, the problem of retaining the prawns and larger fishes in the nets while allowing the escape of at least a fair proportion of the juvenile fishes comes up for further attention; and this problem must be tackled before actual commercial exploitation on a large scale takes place, as otherwise there is every chance of depletion of stocks (due to wiping out of juveniles on a large scale) which has occurred in other parts of the world, repeating itself in our waters also. But recommendations for legislation and enforcement of mesh-limits and/or 'closed' areas/seasons will follow only after fairly detailed experiments with gears, etc.

The ecological study of various marine invertebrates and vertebrates, other than fishes and prawns, is of value as many of the former could prove of commercial value; besides, such a study would help towards a better understanding of the biological links between the valuable species and those not so valuable. In this work, a beginning has been made towards the clarification of this interrelationship, *viz.*, finding out what species of animals are present over each type of habitat. A future detailed study of the populations of these animal-groups (to be done with specialized gear like dredges, etc.) and their occurrence in the diet of the more valuable species in each ecological niche, would help in assessing where concentrations of the valuable species might be expected.

SUMMARY

The present paper deals with the biological data concerning mainly prawns and fishes in general, collected during a survey of the fishing grounds of the neritic province of the continental shelf off the Andhra and Orissa coasts during 1960.

The fishing grounds are fairly narrow, 33 nautical miles being their greatest width. There was a sandy floor down to a depth of about 20 metres with a muddy-sand or muddy floor deeper down; a few intermittent coralline patches were scattered in depths of 41-60 metres, specially in Zone B, near the mouths of the larger rivers, the sea-bed was muddy or clayey.

No dense concentrations of any one species were met with. The bulk of the trawl catch consisted of miscellaneous fishes (64%) the rest of the catch consisted of sharks, rays and skates (14%), catfishes (11%), perches (7%) and prawns (4%). The gillnets chiefly landed sharks and a few large catfish. Appreciable proportions of the prawns, taken in depths exceeding 20 metres, were 100-300 mm in length.

A fairly well-marked gradation of size with depth for the prawns and bony fishes, in particular, was apparent, larger individuals being present in increasingly greater depths.

The nursery areas of valuable bony fishes overlap with prawning grounds, and this is a problem that merits further research.

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