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ON

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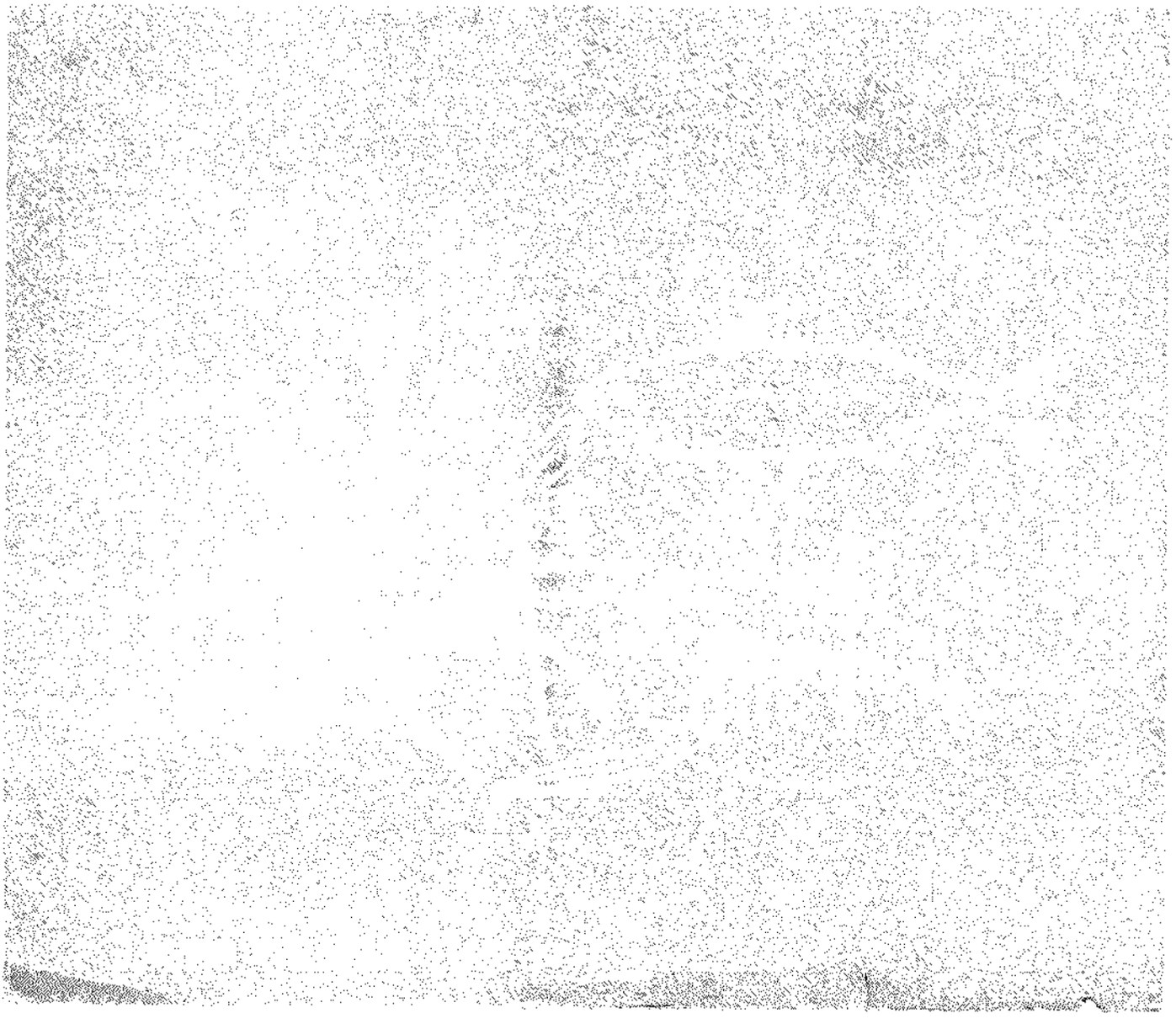

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EXPLORATORY TRAWLING ON THE CONTINENTAL SHELF ALONG THE NORTH-WESTERN PART OF THE BAY OF BENGAL

K. V. SEKHARAN,* M. S. MUTHU, K. VENKATA SUBBA RAO, V. RAMAMOHANA RAO, P. MOJUMDER AND S. REUBEN

Central Marine Fisheries Research Institute, Mandapam Camp

ABSTRACT

The results of exploratory trawling undertaken from 1961 to 1965 on the continental shelf along the north-western part of the Bay of Bengal, between latitudes 16° 40′ N and 21° 00′ N are presented. The composition of the catch, the distribution of the various categories of fishes and their relative abundance in space and time are indicated. It is estimated that in commercial fishing, with Visakhapatnam as the base, a 25 m side-trawler with 15 m trawl should be able to land 250–390 metric tons of fishes, a 14 m stern-trawler with 14 m trawl, 67–174 metric tons, and a 13·7 m stern-trawler with 12 m trawl, 56–94 metric tons per year from the area.

INTRODUCTION

A PRELIMINARY report on exploratory bottom trawling on the continental shelf along the north-western part of the Bay of Bengal was given by Shariff (1961), but it related to the year 1960 when the gear and the methods of operation were being standardised. The descriptions of the gear and operational methods tried, leading to their standardisation, were given by Poliakov (1961 and 1962), while the efficiency of performance of various types of vessels was estimated by Borisov (1962). A biological report on the exploratory fishing done from January to April 1960 was given by Naumov (1961). Since these preliminary accounts were published, considerable data have been collected on the bottom fisheries potential of this area through more intensive exploratory trawling. The present study, based on the observations and catch data collected from 1961 to 1965, deals with the nature of the bottom, the annual and seasonal relative abundance of fishes in different grounds and the minimum annual catches expected if commercial trawling is undertaken by vessels of different sizes.

Area of investigation.—The area of investigation comprised about 23,310 sq. km (9,000 sq. miles) of the continental shelf along the western part of the Bay of Bengal between latitudes 16° 40′ N and 21° 00′ N. This area was divided into squares 10 × 10 miles (16 × 16 km) each, by marking off each degree of latitude and longitude into 6 divisions. The divisions were marked alphabetically (A–F) along latitudes and numerically (1–6) along longitudes, so as to serve as co-ordinates of the positions of the squares (Fig. 1). For convenience the squares were marked numerically from 1 to 104 as shown in Fig. 1. A few squares to the south of 17° N Lat., not originally included in the programme, were fished on certain occasions and have been separately marked as A, B and D in the figure.

Method of sampling the squares.—Up to November 1963, the squares were fished at random. In December 1963, a new sampling programme was introduced, whereby systematic linear bottom

* Present address : Department of Fisheries. Calicut University, Calicut.

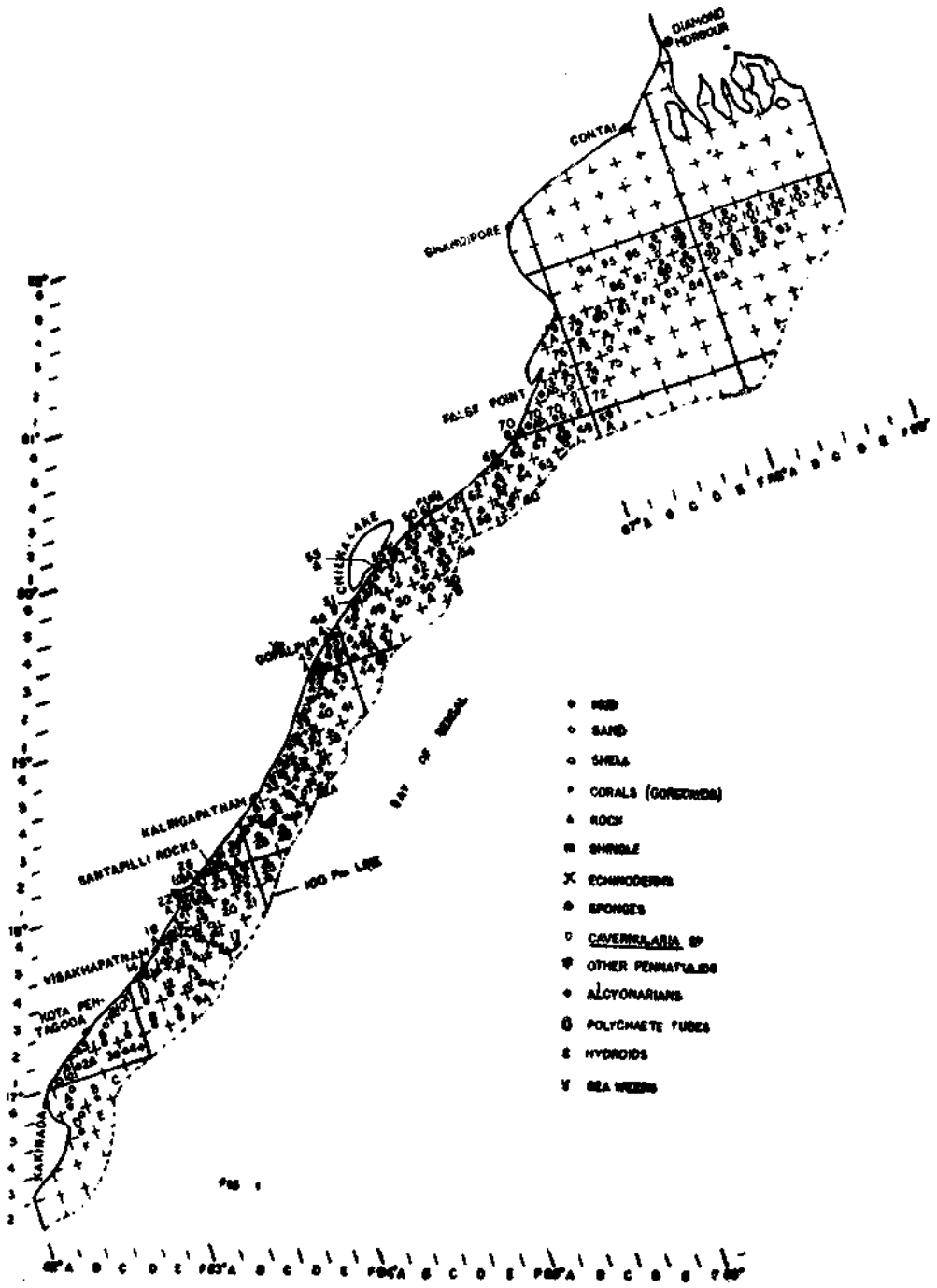

FIG. 1. The area explored from 1961–65 and the nature of bottom in different squares.

trawling was to be conducted every month in the squares along parallels of latitudes at 30′ intervals. The parallels are referred to in the section on " methods of analyses of data ". (They are designated by the latitudes forming the northern boundaries of the squares concerned.)

The programme called for a minimum of 5 hauls of one hour each in each square every month. The skippers could fish in other squares also after fulfilling the minimum programme.

Vessels.—During 1961–65, six vessels took part in exploratory trawling (Table I). Details of their design and deck arrangements have been given by Poliakov (1961, pp. 2–3; 1962, pp. 3–5) and Borisov (1962, pp. 6–8). m.t. *Ashok* and m.t. *Pratap*, being vessels that could stay out at sea for 10 days at a time, sampled the entire area under study, while the others, being only daily fishing vessels, sampled mostly the grounds within a 20-mile radius of Visakhapatnam (base) except when stationed for short periods at southern and northern bases. m.v. *Gudjon* fished only for a total of 7 months and m.v. *Sagarkumari* for 13 months in 1961 and 1962, which could not be considered adequate for purposes of this study. Only their annual catch and effort are referred to here. This study is therefore based only on the catch data of the other four trawlers. Since *Ashok* and *Pratap* had the same dimensions and used identical nets and fishing techniques, their catch data were pooled.

Gear used.—The gear used are mentioned in Table I. The details of their design and rigging are given by Poliakov (1962, Figs. 1–14). *Ashok*, *Pratap* and *Gudjon* did side-trawling and the others stern-trawling.

TABLE I

Vessels and gear used in exploratory fishing

	Side trawlers			Stern-trawlers		
	m.t. *Ashok*	m.t. *Pratap*	m.v. *Gudjon*	m.v. *Champa*	m.v. *Sea Horse*	m.v. *Sagar kumari*
Length (m) ..	25·4	25·4	17·1	14·3	13·7	10·4
Beam (m) ..	6·3	6·3	5·3	5·1	4·3	3·4
Draught (m) .	2·5	2·5	2·1	1·6	1·1	0·8
Tonnage (gross) ..	91·7	91·7	41·6	34·53	20·0	11·2
Tonnage (net) ..	23·2	23·2	16·7	10·0	12·0	7·0
HP (rated) ..	240	240	215	165	56	42
HP (trawling) ..	200	200	200	135	56	42
Gear ..	15 m Otter trawl	15 m Otter trawl	14 m Otter trawl	14 m Otter trawl	12 m Otter trawl	12 m Otter trawl
Mesh-size of the cod-end (bar size) (mm) ..	35–40	35–40	30	30	30	30

Duration of the hauls.—The duration of the hauls of *Ashok* and *Pratap* was mostly between 2 and 2½ hours, and that of *Champa* and *Sea Horse* between 1 and 1½ hours. Fishing was done only during daytime.

Trawling speed.—It was 1·5–3·5 knots, mostly 2–3 knots, for *Ashok* and *Pratap* and 2·0–2·5 knots for *Champa* and *Sea Horse*. No correction was made in the catch data for variation in trawling speeds.

Reporting of catches.—In the log reports of the skippers, passed on to the C.M.F.R. Sub-station, Waltair, for analysis, the catches were recorded in terms of six categories of fishes: (1) Sharks and Skates, (2) Rays, (3) Cat-fishes, (4) Prawns, (5) Miscellaneous small fishes and (6) other varieties* (Miscellaneous big fishes). The authors noted the catch composition in greater detail, identifying the fishes usually up to the genus and sometimes up to the species, by direct shipboard observations, and when this was not possible, by observations at the jetty at the time of unloading. Sharks consisted mostly of *Scoliodon* spp. and *Carcharhinus* spp., skates of *Rhynchobatus* spp. and *Rhinobatus* spp. and rays of *Dasyatis* spp., *Aetomylus* spp., *Aetobatus* spp., and *Mobula* spp. Cat-fishes consisted almost exclusively of two species, *Tachysurus thalassinus* (Rüpp.) and *T. tenuispinis* (Day). Prawns were mostly of the following species: *Penaeus indicus* Milne Edwards, *P. monodon* Fabricius and *Metapenaeus monoceros* (Fabricius). The following were the main fishes included under the category "Miscellaneous small fishes": *Ilisha* spp., *Opisthopterus tardoore* (C), other clupeids, *Lactarius lactarius* (Schn.), *Leiognathus* spp., *Trichiurus* spp., *Drepane* sp., *Ephippus* sp., *Upeneus* spp., *Saurida* spp., *Nemipterus* spp., *Cynoglossus* spp., sciaenids and carangids. Under "other varieties" were included the following fishes: *Pomadasys* spp., other perches, *Psettodes erumei* (Schn.), *Chirocentrus* sp., *Scomberomorus* spp., eels, pomfrets, mackerel, big sciaenids (> 30 cm) and big carangids (> 30 cm).

Nature of the bottom.—The "nature of the bottom" here refers not only to the bottom substratum but also to the bottom fauna and flora brought up in the trawls. The descriptions given are based mainly on the observations of the authors, supplemented by the skippers' reports. No special equipment was used. Only the bottom material sticking to the otter boards and the net and contained in the cod-end were described according to general appearance and feel. The bottom fauna were mostly described in gross systematic terms in the field itself.

Methods of analysis of data.—Catch is referred to in kg, effort in hours and catch per hour in kg. The catch per hour is regarded as the measure of the relative abundance of fishes. The data were first analysed square-wise for various periods of time, the basic time unit being a month. The sampling programme having envisaged fishing in the squares along latitudes at 30′ intervals, further analysis of data had to conform to that pattern. But since the squares between these parallels had also been fished, they were grouped into 30′ latitude zones in such a way that the sampling lines were in the middle of the zones. The zones could then be designated by these parallels and the data for the squares in the zones pooled and averaged for various periods of time. The zones are mentioned below:—

Latitude Zone		*Region covered by the zone*
16° 40′ N	Between	16° 21′ N and 16° 50′ N Lat.
17° 10′ N	„	16° 51′ N and 17° 20′ N Lat.
17° 40′ N	„	17° 21′ N and 17° 50′ N Lat.
18° 10′ N	„	17° 51′ N and 18° 20 ′N Lat.
18° 40′ N	„	18° 21′ N and 18° 50′ N Lat.
19° 10′ N	„	18° 51′ N and 19° 20′ N Lat.
19° 40′ N	„	19° 21′ N and 19° 50′ N Lat.
20° 10′ N	„	19° 51′ N and 20° 20′ N Lat.
20° 40′ N	„	20° 21′ N and 20° 50′ N Lat.
21° 10′ N	„	20° 51′ N and 21° 20′ N Lat.

* A term will be in current use and hence retained here.

The data of 1962–65 were also analysed in respect of 10 m depth ranges in each half degree latitude zone (The mid-point of the depth range of each haul was regarded as the depth of that haul).

Squares, Zones and Depth-Ranges Fished

Squares fished by *Ashok*, *Pratap*, *Champa* and *Sea Horse* from 1961 to 1965 were A, B, D, 1–13, 14A, 14–17, 18A, 18–21, 22A, 22–25, 26A, 26–31, 32A, 32–40, 42–44, 45A, 45–47, 48A, 48, 51A, 51B, 51, 53, 55B, 55–59, 60A, 61–64, 66A, 66, 70, 70A, 70B, 71, 73, 74, 76, 77, 79–81, 88–92 and 97–104 (Fig. 1). All the squares were not fished equally.

Table II shows the latitude zones fished and the percentages of annual effort spent in each zone by the vessels. For purposes of this study, it is considered that a zone fished for 6 months or more in a year was sampled adequately during that year. The zones 17° 10′ N–19° 40′ N, which were fished for 6–12 months per year, come under this category. About 65% of the total effort of *Ashok* and *Pratap* was spent in the 17° 40′ N and 18° 10′ N zones (*i.e.*, the zones nearest the base).

Table II

Distribution of fishing effort in the Latitude Zones from 1961–65

(*m* = The months when the zone was fished during a year; ×age = Percentage of annual fishing effort spent in the zone; *n* = Number of months per year when the zone was sampled during 1961–65; %A*g* = Percentage of the total effort from 1961–65 spent in the zone.

Latitude Zones	m.t. *ASHOK*											
	1961		1962		1963		1964		1965		1961–1965	
	m	%g	m	%g	m	%g	m	%g	m	%g	m	%Ag
16° 40′	..	..	..	..	..	..	..	..	Apr.	2·2	1	0·3
17° 10′	Aug., Oct.	0·4	Sept-Dec.	23·8	Jan.-Mar., Dec.	17·8	Mar., June; Sep.	5·6	Jan., Apr.	11·5	2–4	12·7
17° 40′	Mar.-May; Aug.-Dec.	54·3	Jan., Feb., April, June–Dec.	30·0	Jan.-Mar., June. July, Sep.-Dec.	30·7	Feb.-Dec.	31·2	Jan., Feb., Apr, May, Dec.	27·5	5–11	34·6
18° 10′	Mar.-May; Sept-Dec.	36·6	Jan.-Apr.; Aug., Oct.-Dec.	29·7	Jan.-Apr., June July, Sep.-Dec.	37·6	Feb.-June; Aug.-Dec.	21·4	Jan., May, Dec.	19·4	6–10	30·1
18° 40′	Apr., Nov.	4·1	Feb.-Apr.; Dec.	3·7	Jan.-Apr.; Oct.-Dec.	12·4	Feb., Apr.-July; Sep.-Nov.	11·2	Feb.-May	5·0	2–8	7·7
19° 10′	..	..	Jan.-Apr.	2·6	Nov., Dec.	1·5	Feb., Apr.-July; Sep.-Dec.	16·6	Jan., Mar.	3·0	2–9	4·8
19° 40′	Mar., Apr.	4·8	Jan., Feb.	8·7	..	..	Feb., Apr., June. Sep., Oct., Dec.	11·2	Jan., Mar.	9·2	2–6	6·2
20° 10′	Mar.	0·3	Jan., Feb.	1·5	..	..	Dec.	2·0	Jan.-Mar.	7·9	1–3	1·7
20° 40′	..	..	..	..	..	..	Dec.	0·8	Jan.-Mar.	6·9	1–3	1·0
21° 10′	..	..	..	..	..	..	..	..	Feb., Mar.	7·4	2	0·9
Total effort (hrs.)	..	701·62	..	875·70	..	994·10	..	796·18	..	451·75	..	3819·35

TABLE II—*Contd.*

Latitude Zones	m.t. *PRATAP*							
	1961		1962		1963		1961-63	
	m	%g	m	%g	m	%g	n_m	$\%A_g$
16°40′	..	..	..	..	..	..	..	..
17°10′	Oct., Nov.	3·3	Jan., April; Sep.-Dec.	19·1	Jan.-April	21·8	2-6	17·4
17°40′	Oct.-Dec.	52·5	Jan.-May; July-Dec.	46·6	Jan.-July; Sep.	30·9	3-11	41·8
18°10′	Oct.-Dec.	41·2	Jan.-May; Oct.-Dec.	17·6	Jan.-June	33·8	3-8	27·8
18°40′	Dec.	2·5	Jan., Feb., April	4·1	Jan.-April	13·5	1-4	7·3
19°10′	..	..	Jan., Feb.	3·3	..	..	2	1·5
19°40′	..	..	Jan., Feb.	7·0	..	..	2	3·2
20°10′	..	..	Jan.	2·3	..	..	1	1·0
20°40′	..	..	..	..	..	..	..	..
21°10′	..	..	..	..	..	..	..	..
Total effort (hrs.)	..	323·00	..	827·60	..	687·99	..	1838·59

TABLE II—*Contd.*

Latitude Zones	m.v. *CHAMPA*											
	1961		1962		1963		1964		1965		1961-65	
	m	%g	m	%g	m	%g	m	%g	m	%g	n_m	$\%A_g$
17° 10′	Aug.	2·5	..	..	..	..	..	..	..	..	1	0·4
17° 40′	April-Dec.	86·6	Jan.-May; July-Sept., Dec.	83·3	Jan.-Dec.	89·7	Jan.-May; July-Oct.; Dec.	83·3	Feb.-Dec.	84·9	9-11	85·5
18° 10′	April-June; Aug.-Oct.; Dec.	11·0	Jan.-May; July, Oct.-Dec.	16·7	Jan.-April; June,-Dec.	10·3	Jan.-April July., Aug., Oct., Dec..	16·7	Feb.-June; Aug., Oct.-Dec.	13·7	6-9	13·7
21° 10′	..	..	..	..	..	..	..	..	Feb.	1·4	1	0·4
Total effort (hrs.)	..	570·85	..	817·41	..	695·12	..	447·83	..	866·90	..	3398·11

TABLE II—*Contd.*

Latitude Zones	m.v. *SEA HORSE*											
	1961		1962		1963		1964		1965		1961–65	
	m	%g	m	%g	m	%g	m	%g	m	%g	n_m	$\%A_\rho$
16° 40′	Aug., Sep.	4·2	..	..	..	..	..	..	..	..	2	0·9
17° 10′	Feb., Mar.; Aug., Sep.	12·7	..	..	..	..	..	..	..	..	4	2·7
17° 40′	Mar., Apr.; July, Sept-Dec.	63·7	Jan.-Aug.; Nov.	92·9	Feb., May,; May-Dec.	94·3	Jan.-Dec.	96·2	Jan.-June	89·7	6–12	87·4
18° 10′	Mar.; Apr.; Oct., Nov.	7·5	Feb.-Ma.; July, Aug., Nov.	7·1	Feb., Mar., July, Aug., Oct.-Dec.	5·7	June, July, Oct., Dec.	3·7	Jan.-April	10·3	4–7	6·6
20° 10′	Jan., Feb.	11·2	..	..	..	..	..	..	..	..	2	2·
20° 40′	Jan., Feb.	0·6	..	..	..	..	..	..	..	..	2	0·01
Total effort (hrs.)	..	617·97	..	751·58	..	717·50	..	504·47	..	342·39	..	2933·94

Note.—(1) m.t. *Pratap* fished from the Visakhapatnam base from October 1961 to September 1963.

(2) m.v. *Champa* did not fish in the following Latitude Zones: 60° 40′ N, 18° 40′ N, 19° 10′ N, 19° 40′ N, 20° 10′ N and 20° 40′ N.

(3) m.v. *Sea Horse* did not fish in the following Latitude Zones: 18° 40′ N, 19° 10′ N and 19°40′ N.

The four vessels fished in the depth-ranges 10–129 m. The percentage of the trawling time spent in 10 m depth intervals is given in Table III, from which it will be seen that less than 1% of the effort of *Ashok* and *Pratap* was spent each in depths less than 20 m and also in depths beyond 79 m. Slightly more than 1% of the total effort of *Champa* and *Sea Horse* was spent in the 10–19 m depth-range also. In general the depth ranges between 30 and 59 have been more intensively fished than others.

General Sea and Weather Conditions

From the point of the roughness of the sea and meteorological conditions, a year may be divided into three periods, each with its own characteristic features, as mentioned below:

1. *January–April*: The best part of the year for fishing when the sea is normally calm;

2. *May–August*: The south-west monsoon period with occasional gales and cyclones and intervening periods of calmness;

3. *September–December*: The period of the north-east monsoon, when the sea is generally rough and frequent cyclonic conditions are recorded in the Bay.

The Nature of the Bottom

A summary of the observations from 1963 to 1965 are given in Table IV. Observations made on board different trawlers and in different months are pooled. With regard to bottom fauna,

TABLE III

Percentages of the total fishing effort from 1961–65 spent by the trawlers in different depth-ranges

Depth range (m)	Percentage of the total effort from 1961–65			
	Ashok and *Pratap*	*Champa*	*Sea Horse*	All vessels
10–19	0·1	1·1	1·3	0·7
20–29	2·0	7·1	10·8	5·6
30–39	20·7	24·3	25·9	23·0
40–49	55·7	35·6	43·1	46·9
50–59	13·8	23·4	11·6	16·0
60–69	4·6	6·6	3·5	4·9
70–79	2·0	1·5	2·5	2·0
80–89	0·7	0·2	1·3	0·7
90–99	0·1	0·2	0·03	0·1
100–109	0·1	0·03	not fished	0.04
110–119	0·1	not fished	do.	0·04
120–129	0·1	do.	do.	0·04
Total effort from 1961–65 (hrs.)	5657·94	3398·11	2933·91	11989·96

only the important elements found in the cod-ends are mentioned. The observations are also represented in Fig. 1.

From the table and Fig. 1, it may be seen that the bottom in the area is predominantly muddy, especially in the depth-range 25–110 m. In depths less than 25 m, sand is the dominant element of the bottom. A notable feature of the 18° 10′ to 19° 10′ zones is the occurrence of black (or dark grey) sand. Corals (gorgonids) are characteristic of the 18° 40′ and 19° 10′ N Lat. zones, being found mainly in the 50–130 m depth-range. Madreporarian corals were not recorded. Shells were found mainly in the 17° 40′ to 19° 10′ zone, in the depth-ranges 30–90 m. The fine mud and sand of the three northernmost zones (20° 10′ to 21° 10′ zone) may be attributed to the discharge by the Ganga and the Brahmaputra.

The study showed that the bottom of the area is mostly suitable for trawling. No trenches or sudden slopes were found, at least up to 79 m, the depth up to which fairly intensive fishing was done. For deeper grounds, more exploratory work has necessarily to be undertaken to delineate the fishable areas.

ANNUAL RELATIVE ABUNDANCE OF FISHES

The annual catch and effort of the vessels.—Table V gives the annual catch data of all vessels. It will be seen that generally the annual catch per hour increased with the size of the vessels and the catch per horse-power-hour decreased. The data of *Ashok*, *Pratap*, *Champa* and *Sea Horse* also show that considerable variation in the annual abundance of demersal fishes may be expected in the area, the maximum observed annual catch per hour of the various vessels having been

TABLE

Observations on board the trawlers (only those observations which were complete in regard to the details mentioned only; the suffixes spp. *are omitted; squares which have common features are combined)*

Square	Month of observation	Depth-range of fishing (m)	Vessel	Nature of bottom
1	2	3	4	5
A, B, D	4/65	20–66	Ash	Mud, sand
1	3 & 6/64	31–37	do.	Mud, sand, shell
2	do.	37–46	do.	Fine mud, rock
3	3/64	51–66	do.	Fine mud
4	3/64 & 1/65	64–82	do.	Fine mud, Gorgonids
6	1/65, 3 & 4/65	27–46	do.	Mud, sand
10	3/64, 1 & 4/65	27–42	do.	Fine mud, echinoids
11	3/54, 1 & 5/65	22–42	Ash, Cha	Fine mud, sand
12	4/65	27	do.	Mud
14 A	2/65	26	Sah	Mud, sand
14 & 15	Almost all months	18–55	Ash, Cha Sah	Mud, sand, shell (> 25 m)
16	3, 7, 9, 11 & 12/64	44–80	Ash Cha	Fine mud (< 60 m), shell pieces, hydroids, gorgonids (> 60 m)
18 & 19	All months	15–60	Ash Cha Sah	Mud, sand, rock, coral, echinoids, *Cavernularia*, other pennatulids, Lamellibranch and Gastropod Shells
20	1/65	59–60	Ash	Mud
22 A	3/65	9–15	Cha	Sand, mud, sea-weeds (< 15 m), shells (> 25 m), polychaete tubes, hydroids corals (gorgonids) pennatulids, star-fishes, echinoids, holothurians
22	Almost all months	13–55	Ash Cha Sah	
23	12/63; 6, 10 & 12/64; 1 & 3/65	32–49	Ash Cha Sah	Mud

IV

in column headings are included in the table. The scientific names of fishes are given mostly in terms of genera
Ash = m.t. *Ashok*; Cha = m.v. *Champa*; Sah = m.v. *Sea Horse*

Important fishes landed	Remarks
6	7
Pomadasys, Psenes, Trichiurus, Gerres, Cat-fishes, sciaenids, pomfrets, eels, prawns.	Mackerel in the catches.
Pomadasys, big *Drepane, Saurida, Leiognathus, Psettodes,* cat-fishes, pomfrets, eels, carangids, prawns.	Mackerel and lobster (*Thenus*) in the catches.
Pomadasys, Trichiurus, Anodontosoma, Nemipterus, cat-fishes, eels, carangids.	Mackerel and lobster (*Thenus*) in the catches.
Pomadasys, Psenes, pomfrets.	Mackerel in the catches.
Pomadasys, Psenes, Nemipterus, cat-fishes, pomfrets, prawns.	Crabs in large numbers in the catches in 3/64.
Pomadasys, Nemipterus, Psettodes, small *Drepane,* cat-fishes, carangids.	Small sharks in the catch in 1/65.
Pomadasys, small *Drepane, Nemipterus, Priacanthus,* cat-fishes, carangids, sciaenids, sharks.	..
Nemipterus, Psettodes, Trichiurus, pomfrets, sciaenids, cat-fishes, carangids rays, prawns.	..
Leiognathus, sciaenids, cat-fishes, prawns.	
Lutjanus, Saurida, prawns.	..
Saurida, Nemipterus, Upeneus, Polynemus, Lactarius, Gerres, Leiognathus, Ilisha, Pomadasys, Lutjanus, Drepane, Trichiurus, Sphyraena, Fistularia, Psettodes, other flat-fishes, cat-fishes, sciaenids, carangids, eels, pomfrets, sharks, skates, rays, prawns.	Salps abundant in the water in 12/64; crabs in 4, 6 and 10/64; squids in 9/63, 4, 10 and 11/64; small *Leiognathus* seen escaping through cod-end in 7/64.
As in squares 14 and 15; also *Priacanthus.*	Crabs in 3 and 11/64; squids in 9 and 11/64; mackerel in 9/64; *Dactyloptena* in 11/64.
As in 14 and 15; also *Opisthopterus* and *Psenes.*	*Calappa,* other crabs and squids in 3–6 and 9 and 10/64; *Thenus* in 9/63, 6/64 and 2/65; *Murex* in 5 and 6/64 and 2/65; *Squilla* and *Dactyloptena* in 6/64 and 2/65; mackerel in 11/64; *Porpita* swarms in the sea in 12/64.
Ilisha, Saurida, cat-fishes, prawns.	
As in 14 and 15.	Crabs in 4 and 7/64 and 2 and 3/65; squids in 10 and 12/64 and 3/65; *Thenus, Panulirus* and *Dactyloptena* in 3/65; *Pyrosoma* in 12/64 and 3/65.
Saurida, Nemipterus, Leiognathus, Psettodes, cat-fishes.	Squids in 12/63 and 10/64; crabs in 12/64; *Pyrosoma* in 3/65.

TABLE

1	2	3	4	5
24 & 25	3/65	51–62	Ash	Fine mud, shells, corals (gorgonids), alcyonarians, crinoids
26	3/64	33–40	do.	Fine mud, scallops
27	11/63 & 3/65	33–44	Ash Cha	Mud, sand, rock
28, 30, 31, 32, 33, 34, 35	11/63, 5/64 & 3/65	31–86	Ash	Mud, sand, black sand (48–55 m), shells
36, 37, 39, 42, 45 A, 45, 46, 47	11/63; 2 & 5/64, 3/65	31–128	do.	Mud, sand, black sand, rock, shells, alcyonarians, corals (gorgonids), echinoids, holothurians, sponges; rock (?) in sq. 46 (52–73 m)
48 A	12/64	38	do.	Rock ?
48, 51 A, 55, 55 B, 56–59, 59	2, 5 & 12/64; & 3/65	16–44	do.	Mud, sand
60 A, 61–64	3/65	18–71	do.	Sand, mud, shingle (in sq. 63)
66 A, 66, 67, 70 A, 70, 71, 79	12/64 & 3/65	18–46	do.	Mud, sand
				SAND
88, 89, 90, 92, 97–99, 101, 104	3/65	18–93	do.	Fine mud, sand

Ash = m.t. Ashok; Cha = m.v. Champa; Sah = m.v. Sea Horse

IV—*Contd.*

6	7
Fistularia, cat-fishes, sharks.	*Dactyloptena* present; plenty of medusae in water; *Pyrosoma* also present.
Lutjanus, *Fistularia*, cat-fishes, pomfrets, sharks.	*Thenus* in the catches.
Pomadasys, *Ilisha*, *Lactarius*, cat-fishes, sciaenids, carangids, pomfrets, sharks, rays.	
Pomadasys, *Nemipterus*, *Saurida*, *Psenes*, *Ilisha*, *Trichiurus*, *Leiognathus*, *Lactarius*, *Drepane*, catfishes, sciaenids, carangids, pomfrets, sharks, prawns.	*Thenus* in the hauls; mackerel in 11/63; Gastropod with egg-case in 11/63.
Perches (*Pomadasys*, *Lutjanus*, *Ephinephelus*, *Priacanthus*, *Nemipterus*), *Saurida*, *Psenes*, *Leiognathus*, *Lactarius*, *Ilisha*, *Upeneus*, *Drepane*, cat-fishes, sciaenids, carangids, pomfrets, eels, sharks, skates, rays, prawns.	*Thenus* and mackerel in 11/63, 2/64 and 3/65; squids in 3/65; sardine shoal observed in 3/65 in square 47; floats damaged in square 47 in 110–128 m depth in 3/65.
Net damaged probably due to rocks.	
Leiognathus, *Drepane*, *Nemipterus*, *Pomadasys*, *Lutjanus*, *Psettodes*, *Upeneus*, *Sphyraena*, cat-fishes, sciaenids, carangids, white pomfrets, sharks, skates rays, prawns.	*Thenus* and *Panulirus* and squids in the hauls; *Limulus* in 55 B; sharks abundant; small *Pomadasys* in sq. 57–59 in 2 and 12/64; plenty of medusae in 51 A in 3/65.
Leiognathus, *Nemipterus*, *Pomadasys*, *Ephippus*, *Drepane*, *Argyrops*, *Ilisha*, *Psenes*, *Scomberomorus*, cat-fishes, carangids, white pomfrets, sharks.	Squids present; a fish shoal observed in sq. 64.
Scomberomorus, *Ilisha*, *Lactarius*, *Leiognathus*, *Psenes*, *Pomadasys*, *Saurida*, *Nemipterus*, *Drepane*, cat-fishes, sciaenids, carangids, white pomfrets, eels, sharks, prawns.	One big *Ephinephelus*, 191 cm. in total length, from 70 A in 3/65.
H E A D S	
Ilisha, *Nemipterus*, *Pomadasys*, *Lutjanus*, *Saurida*, *Psenes*, *Leiognathus*, *Trichiurus*, cat-fishes, sciaenids, carangids, white pomfrets, eels, sharks, skates, rays, prawns.	*Sharks* abundant; a number of them caught on hooks from the vessel; strong current in sq. 92, because of which the vessel drifted from the original course of 40°–80° while trawling.

TABLE V

Annual effort, catch and catch per unit of effort of the trawlers from 1961–65

R and A = Range and average over the period 1961–65. Average is the arithmetic mean of the five annual values. With regard to the catches, the annual figures are in kilograms and the range and average in metric tons.

		m.t. *ASHOK*						m.t. *PRATAP*			
		1961	1962	1963	1964	1965	R and A	1961	1962	1963	R and A
1	No. of days out of port ..	115	149	149	174	103	103-174 (138)	54	146	105	54-146 (102)
2	No. of days of fishing ..	107	133	139	142	80	80-142 (120)	50	132	98	50-132 (93)
3	No. of hauls ..	278	323	355	386	229	229-386 (314)	149	319	229	149-319 (232)
4	Fishing effort (hr.) ..	701·62	875·70	994·10	796·18	451·75	452-994 (764)	323·00	827·60	687·99	323-828 (613)
5	Catch ..	143500	123224	112306	139728	58235	58-143 (115)	82220	132477	88099	82-132a (101)
6	Catch per day out of port (kg.)	1248	927	754	803	565	565-1248 (836)	1523	907	839	839-1523 (993)
7	Catch per day of fishing (kg.)	1342	926	808	984	728	728-1342 (960)	1644	1004	899	899-164 (1081)
8	Catch per haul (kg.) ..	516	381	316	362	234	254-516 (367)	552	415	385	385-552 (434)
9	Catch per hour (kg.) ..	204·6	140·7	113·0	175·1	128·9	129-205 (151)	254·6	160·1	128·1	128-255 (165)
10	Catch per horse-power hour (kg.)	1·02	0·70	0·57	0·88	0·64	0·57-1·02 (0·76)	1·27	0·80	0·64	0·64-1·27 (0·90)

		m.v. *GUDJON*			m.v. *CHAMPA*					
		1961	1962	R and A	1961	1962	1963	1964	1965	R and A
1	No. of days out of port ..	78	23	23-78 (51)	128	155	144	140	196	128-196 (153)
2	No. of days of fishing ..	74	23	23-74 (49)	128	155	144	140	190	128-190 (151)
3	No. of hauls ..	172	63	63-172 (118)	298	444	384	386	534	298-534 (409)
4	Fishing effort (hr.) ..	335·07	120·15	120-335 (228)	570·85	917·41	695·12	447·83	866·90	448-867 (680)
5	Catch ..	26289·5	13540	14-26 (20)	93646	127875	79036	46137	54670	46-128 (80)
6	Catch per day out of port (kg.)	337	589	337-589 (394)	732	825	549	330	279	279-825 (526)
7	Catch per day of fishing (kg.) ..	355	589	355-589 (411)	732	825	549	330	288	288-825 (530)
8	Catch per haul (kg.) ..	153	215	153-215 (169)	314	288	206	120	102	102-314 (196)
9	Catch per hour (kg.) ..	78·5	112·7	79-113 (88)	164·0	156·4	113·7	103·0	63·1	63-164 (118)
10	Catch per horse-power hour (kg.)	0·39	0·56	0·39-0·56 (0·48)	1·21	1·16	0·84	0·76	0·47	0·47-1·21 (0·89)

TABLE V—*Contd.*

		m.v. *SEA HORSE*						m.v. *SAGARKUMARI*		
		1961	1962	1963	1964	1965	R and A	1961	1962	R and A
1	No. of days out of port ..	152	151	162	152	103	103–162 (144)	89	63	63–89 (76)
2	No. of days of fishing ..	152	151	162	152	103	103–162 (144)	89	63	63–89 (76)
3	No. of hauls ..	370	398	404	424	230	230–424 (365)	201	155	155–201 (178)
4	Fishing effort (hr.) ..	617·97	751·58	717·50	504·47	342·39	342–752 (587)	334·27	293·93	294–334 (314)
5	Catch ..	57889	68015	47118	30812	19067·25	19–68 (45)	28930	21270	21–29 (25)
6	Catch per day out of port (kg.)	381	450	291	203	185	185–450 (310)	325	338	325–338 (330)
7	Catch per day of fishing (kg.)	381	450	291	203	185	185–450 (310)	325	338	325–338 (330)
8	Catch per haul (kg.) ..	156	171	117	134	83	83–171 (122)	144	137	137–144 (141)
9	Catch per hour (kg.) ..	93·7	90·5	65·7	61·1	55·7	56–94 (76)	86·5	72·4	72–87 (80)
10	Catch per horse-power hour (kg.)	1·67	1·62	1·17	1·09	0·99	0·99–1·67 (1·31)	2·06	1·72	1·72–2·06 (1·89)

Note.—m.t. *Ashok* fished only for six months in 1965 (from January to May and in December); m.t. *Pratap* fished from here from October 1961 to September 1963; m.v. *Gudjon* fished only for 5 months in 1961 and 2 months in 1962; m.v. *Sea Horse* fished only for 6 months in 1965 (from January to June); m.v. *Sagarkumari* fished only for 9 months in 1961 and 4 months in 1962.

168–260% of the minimum. The highest annual c.p.h. for all vessels was recorded in 1961. The annual c.p.h. of *Champa* and *Sea Horse* declined regularly from 1961, which cannot be attributed to change of fishing grounds, since they fished mostly in the 17°40′ zone. It would appear that the decline in the c.p.h. of the two vessels was due not only to the variations in fish abundance but also perhaps to other factors.

Since *Ashok* and *Pratap* were identical with regard to size, horse-power and fishing methods (Table I), and fished mostly in the same zones, they could be expected to operate at the same level of efficiency. This was tested by an analysis of variance of their monthly catch per hour in respect of the same zones from 1961 to 1963, when 50 pairs of values (*i.e.*, c.p.h. of the vessels for the same months and the same zones) were available, as may be seen from Table VI.

The F-test showed that the difference between the monthly c.p.h. of the two vessels was probably not significant ($F = 1{\cdot}54$, $F_{1\%} = 6{\cdot}90$, d.f = 1; 98), which confirmed the expectation. The data of the two vessels were therefore pooled when estimating the relative abundance of fishes in the grounds.

The Annual Catch Per Hour in Different Squares

The squares were divided into two categories for this purpose: (1) Those which were fished for 6 months or more in a year, and (2) those which were fished for less than 6 months in a year. The catch per hour of *Ashok* and *Pratap* are given in Figs. 2 and 3, and of *Champa* and *Sea-Horse* in Tables VII and VIII.

TABLE VI

Monthly c.p.h. (kg.) recorded by m.t. Ashok *and m.t.* Pratap *when they fished in the same zones*

1961				1962				1963			
Zone	Month	c.p.h.		Zone	Month	c.p.h.		Zone	Month	c.p.h.	
		Ashok	*Pratap*			*Ashok*	*Pratap*			*Ashok*	*Pratap*
17° 10′	Oct.	225·0	257·3	17° 10′	Sept.	118·3	167·8	17° 10′	Jan.	86·6	30·9
17° 40′	Oct.	196·6	192·0		Oct.	133·1	71·6		Feb.	44·1	35·2
	Nov.	214·8	134·1		Nov.	153·2	108·7		Mar.	67·4	54·4
	Dec.	189·7	291·1		Dec.	69·0	81·1	17° 40′	Jan.	108·0	40·0
18° 10′	Dec.	239·0	414·2	17° 40′	Jan.	236·2	149·9		Feb.	82·1	92·5
					Feb.	87·4	83·9		Mar.	78·5	94·2
					Apr.	151·8	201·8		June	116·8	132·2
					July	173·1	141·3		July	84·2	60·0
					Aug.	151·5	139·0		Sept.	50·1	30·0
					Sept.	114·9	193·4	18° 10′	Jan.	93·7	58·2
					Oct.	117·8	186·7		Feb.	96·1	289·1
					Nov.	111·1	139·8		Mar.	93·9	167·5
					Dec.	86·4	51·6		Apr.	175·5	264·0
				18° 10′	Jan.	205·3	126·4		June	59·0	68·7
					Feb.	133·1	136·6	18° 40′	Jan.	59·4	118·3
					Mar.	71·9	211·3		Feb.	138·7	346·8
					Apr.	145·9	77·9		Mar.	267·4	234·8
					Oct.	296·0	176·1		Apr.	196·6	137·7
					Nov.	127·3	144·9				
					Dec.	73·7	130·2				
				18° 40′	Feb.	26·4	319·1				
					Apr.	268·4	333·3				
				19° 10′	Jan.	156·4	146·8				
					Feb.	224·2	219·5				
				19° 40′	Jan.	308·4	386·4				
					Feb.	162·2	113·4				
				20° 10′	Jan.	183·1	316·0				

Analysis of Variance

Source of variation		d.f.	Sum of squares	Mean square
Between vessels	..	1	11012·41	11012·41
Within vessels	..	98	699077·05	7133·44
				F = 1·54
				$F_1\%$ = 6·90

(*a*) *Ashok and Pratap.*—The number of squares that fell in different c.p.h. classes is mentioned below:

c.p.h. class (kg)	Squares fished for < 6 months in a year					Squares fished for 6 months or more in a year				
	1961	1962	1963	1964	1965	1961	1962	1963	1964	1965
0–100 ..	2	12	12	13	41	0	0	4	1	..
100–199 ..	19	20	6	11	14	3	7	3	7	..
200–299 ..	6	14	3	3	9	3	0	3	1	..
300–399 ..	3	4	1	2	6	1	0	0	1	..
400 and above ..	1	3	0	3	2	0	0	0	0	..
TOTAL ..	31	53	22	32	72	7	7	10	10	..

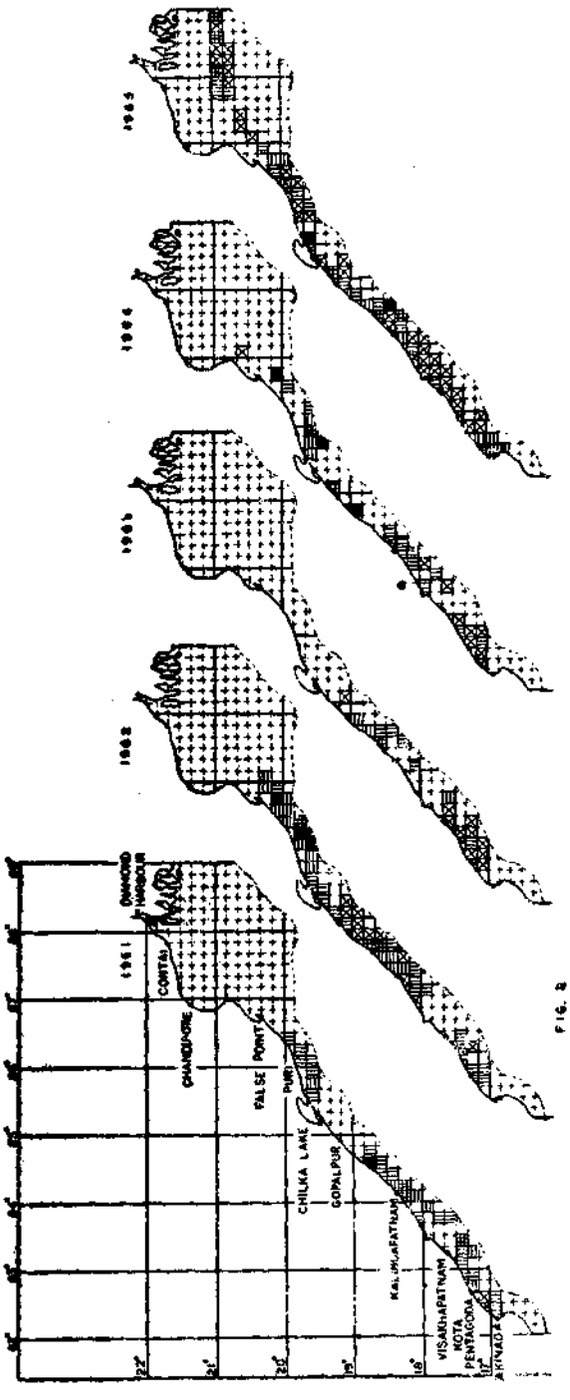

FIG. 2. Annual catch per hour recorded by m.t. *Ashok* and m.t. *Pratap* from squares fished for less than 6 months per year from 1961-65.

Every year the distribution of the squares in c.p.h. classes was positively skewed. Taking into account the squares fished for 6 months or more, it may be seen that more than 60% of them gave annual c.p.h. of $<$ 200 kg in all years except 1961. Figure 2 shows that most of the squares giving annual c.p.h. of $>$ 300 kg are situated in the north, especially off Calingapatnam, Gopalpur and Chilka Lake.

An average c.p.h. for each square from 1961 to 1965 was also calculated. This was the arithmetic mean of the annual c.p.h., whereby equal weight was given to each year's data. The squares were again divided into two categories: (1) those which were fished for 6 months or more in at least one of the years, and (2) those which were fished for less periods in all years. In estimating the average value for a square falling in the former category, all the five annual c.p.h. were taken into account, even though it might not have been fished for 6 months or more in all the years. The averages are represented in Fig. 4 A and 4 B; they conform to the conclusions mentioned above.

(*b*) *Champa and Sea Horse.*—The annual c.p.h. values of these vessels and the means from 1961 to 1965 were calculated as before. The data for the squares fished for 6 months or more per year indicated that the northern grounds have greater density of fishes than the southern ones (Tables VII and VIII).

TABLE VII

Annual catch per hour and their averages over the period 1961–65 *in the squares fished by m.v.* Champa
(The averages referred to are the arithmetic averages of annual c.p.h.) n.f. = Not fished

Square No.	Catch per hour (kg.)					
	1961	1962	1963	1964	1965	Average
	A. Squares fished for less than six months in all years					
1	55·0	n.f.	n.f.	n.f.	n.f.	55·0
2	113·3	n.f.	n.f.	n.f.	n.f.	113·3
5	90·0	n.f.	n.f.	n.f.	n.f.	90·0
6	54·9	n.f.	n.f.	n.f.	n.f.	54·9
7	47·5	n.f.	n.f.	n.f.	n.f.	47·5
10	91·8	n.f.	n.f.	n.f.	n.f.	91·8
11	75·4	36·0	54·3	n.f.	77·5	60·8
12	191·4	73·8	33·5	n.f.	629·1	232·0
13	126·0	11·1	n.f.	50·0	77·0	66·0
14A	49·6	162·0	243·9	n.f.	n.f.	151·6
16	192·2	157·9	19·2	73·7	98·3	108·3
18A	n.f.	29·0	238·6	n.f.	n.f.	133·8
20	n.f.	n.f.	33·3	28·0	n.f.	30·7
22A	159·5	79·6	n.f.	n.f.	32·6	90·6
26	n.f.	n.f.	4·5	131·4	0·0	45·3
27	n.f.	n.f.	169·4	144·8	0·0	104·7
28	n.f.	n.f.	n.f.	50 0	0·0	25·0
99	n.f.	n.f.	n.f.	n.f.	24·0	24·0
100	n.f.	n.f.	n.f.	n.f.	27·2	27·2
	B. Squares fished for six months or more in at least one of the years					
14	75·2	144·0	123·1	100·0	49·5	98·5
15	96·4	145·2	72·8	92·6	66·9	94·8
18	174·3	167·9	103·2	97·4	57·0	120·0
19	241·3	164·6	45·8	101·8	31·9	117·1
22	248·2	167·7	118·0	124·5	85·7	148·8
23	173·8	42·7	38·0	336·1	71·7	152·5

Note.—The square 19 was fished for 6 months or more in 1962 and 1964 and the square 22 in 1965. The other squares were fished for 6 months or more in all years.

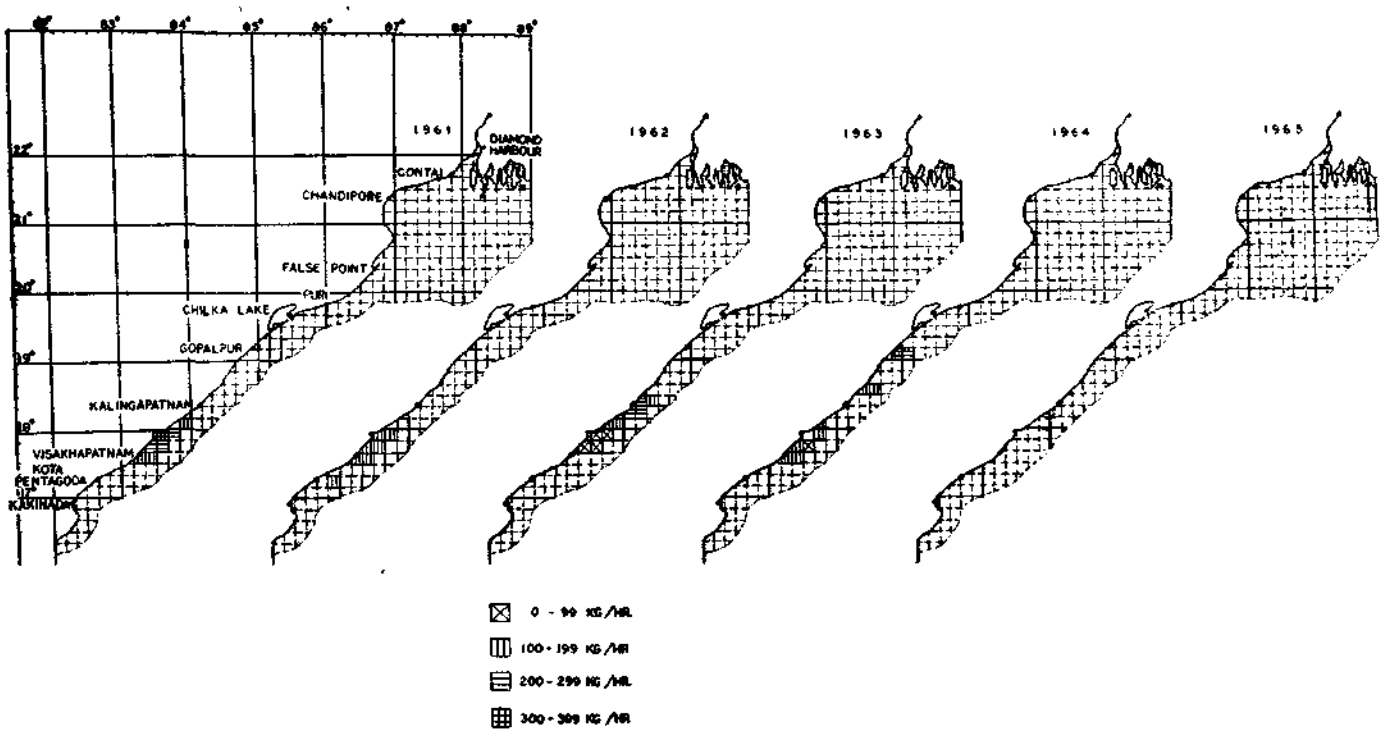

FIG. 3. Annual catch per hour recorded by m.t. *Ashok* and m.t. *Pratap* from squares fished for 6 months or more per year from1961–65

TABLE VIII

Annual catch per hour and their averages over the period 1961–65 *in the squares fished by m.v. Sea Horse*
(The averages referred to are the arithmetic averages of annual c.p.h.) n.f. = Not fished.

Square No.	Catch per hour (kg.)					
	1961	1962	1963	1964	1965	Average
	A. Squares fished for less than six months in all years					
A	50·1	n.f.	n.f.	n.f.	n.f.	50·1
1	39·8	n.f.	n.f.	n.f.	n.f.	39·8
2	61·7	n.f.	n.f.	n.f.	n.f.	61·7
5	48·4	n.f.	n.f.	n.f.	n.f.	48·4
11	25·0	113·3	83·6	n.f.	39·4	65·3
12	n.f.	n.f.	104·9	77·3	37·3	73·2
13	n.f.	n.f.	n.f.	83·9	61·3	72·6
14A	n.f.	n.f.	n.f.	n.f.	58·9	58·9
18A	n.f.	n.f.	45·3	n.f.	42·8	44·1
20	n.f.	n.f.	76·6	126·4	39·7	80·9
21	n.f.	n.f.	n.f.	n.f.	68·8	68·8
22A	30·8	74·2	16·7	n.f.	n.f.	40·6
23	n.f.	n.f.	n.f.	86·8	55·6	71·2
24	n.f.	n.f.	n.f.	n.f.	20·0	20·0
26	n.f.	n.f.	n.f.	n.f.	18·7	18·7
27	n.f.	n.f.	n.f.	n.f.	0·0	0·0
28	n.f.	n.f.	n.f.	n.f.	0·0	0·0
67	121·5	n.f.	n.f.	n.f.	n.f.	121·5
70A	102·4	n.f.	n.f.	n.f.	n.f.	102·4
70B	115·0	n.f.	n.f.	n.f.	n.f.	115·0
70	42·5	n.f.	n.f.	n.f.	n.f.	42·5
71	30·0	n.f.	n.f.	n.f.	n.f.	30·0
73A	76·3	n.f.	n.f.	n.f.	n.f.	76·3
73	41·9	n.f.	n.f.	n.f.	n.f.	41·9
74	21·0	n.f.	n.f.	n.f.	n.f.	21·0
76	107·5	n.f.	n.f.	n.f.	n.f.	107·5
77	14·0	n.f.	n.f.	n.f.	n.f.	14·0
	B. Squares fished for six months or more in at least one of the years					
14	111·7	63·8	69·1	36·5	61·8	68·6
15	83·2	64·0	80·8	54·2	63·4	69·1
16	186·0	19·3	n.f.	59·8	n.f.	88·4
18	115·8	92·6	64·0	68·2	59·9	80·1
19	142·9	100·7	72·4	77·5	44·5	87·6
22	67·6	118·4	56·8	n.f.	55·7	74·6

Note.—The squares 15 and 16 were fished for six months or more in 1964, square 18 from 1961–64, square 19 in 1964 and square 22 in 1963. The square 14 was fished for six months or more in all years.

The spatial difference in regard to the relative density of fishes is more clearly seen when the data are summed up for half-degree latitude zones. These are discussed below.

The Annual Catch Per Hour in Half-Degree Latitude Zones

The half-degree latitude zones were also divided into two categories: (1) Those which were fished for 6 months or more in a year, and (2) those which were fished for less than 6 months in a year. The annual c.p.h. in the zones fished by *Ashok* and *Pratap* are given in Figs. 5 and 6 A and 6 B and in those fished by *Champa* and *Sea Horse* in Tables IX and X. The discussion below is limited to the zones covered for 6 months or more per year, unless otherwise stated.

Ashok and Pratap.—The annual data showed that the relative abundance of fishes increased progressively from south to north. This trend was particularly seen in 1964, the most satisfac-

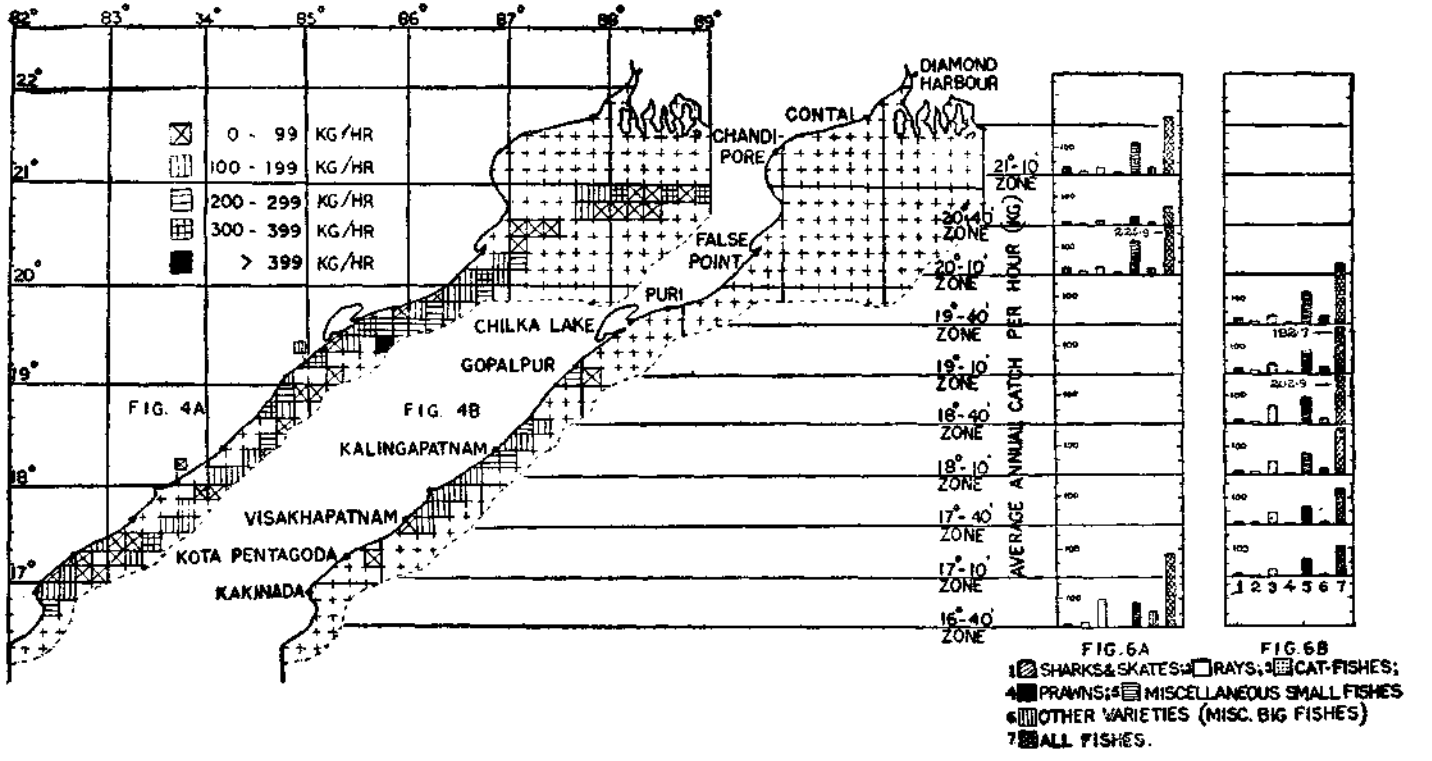

FIG. 4. (*a*) Average annual catch per hour (Arithmetic means) in 1961–65 recorded by m.t. *Ashok* and m.t. *Pratap* from squares fished for less than 6 months per year.

FIG. 4. (*b*) Average annual catch per hour (Arithmetic means) in 1961–65 recorded by m.t. *Ashok* and m.t. *Pratap* from squares fished for 6 months or more per year.

FIG. 6. (*a*) Average annual catch per hour (arithmetic means) in 1961–65 recorded by m.t. *Ashok* and m.t. *Pratap* from degree latitude zones fished for less than 6 months per year.

FIG. 6. (*b*) Average annual catch per hour (Arithmetic means) in 1961–65 recorded by m.t. *Ashok* and m.t. *Pratap* from half-degree latitude zones fished for 6 months or more per year.

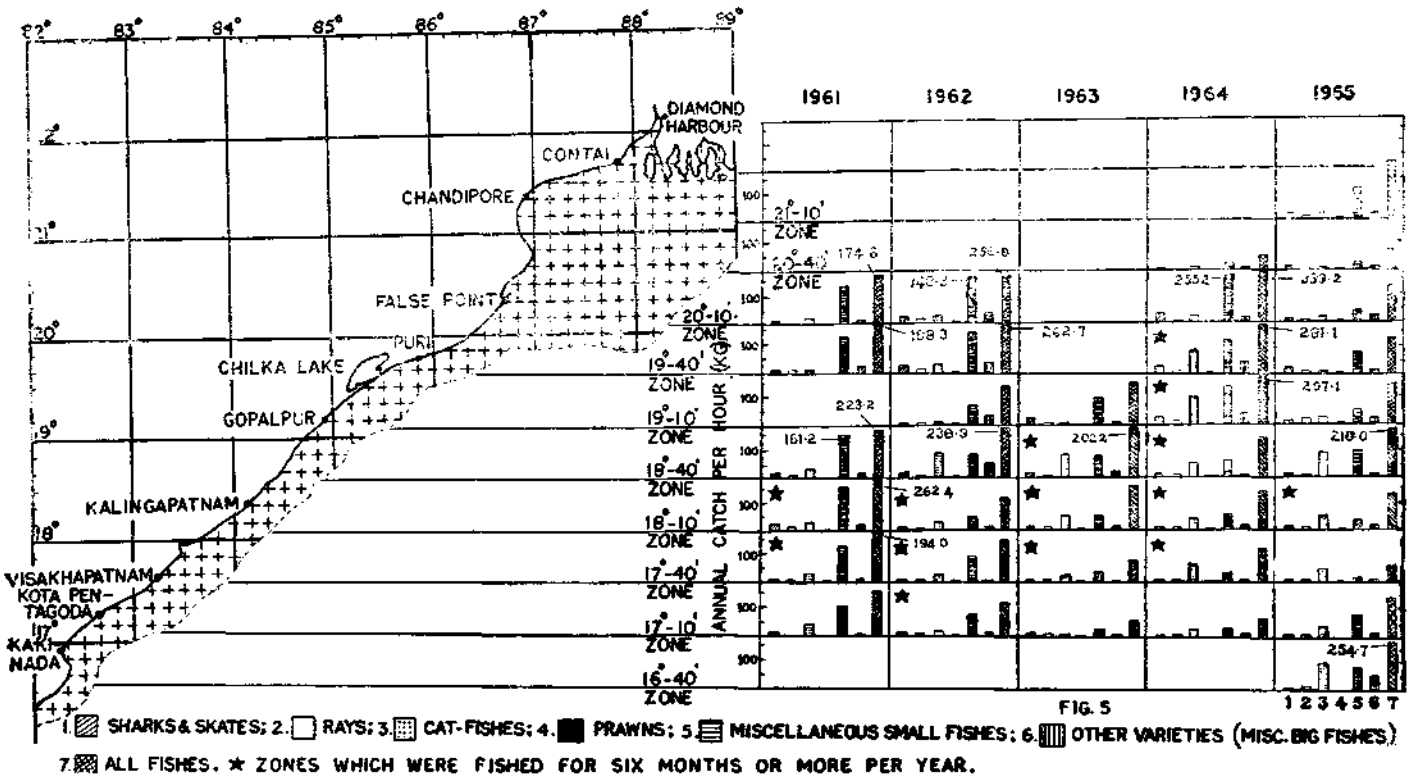

FIG. 5. Anual catch per hour (kg.) recorded by m.t. *Ashok* and m.t. *Pratap* from half-degree latitude zone fished from 1961–65.

tory year from the exploratory point of view, as many as 5 zones having been fished for 6 months or more each in that year.

The average annual c.p.h. from 1961 to 1965, estimated as the arithmetic mean of the annual c.p.h., thereby giving equal weight to each year's data, was also calculated for the zones, dividing

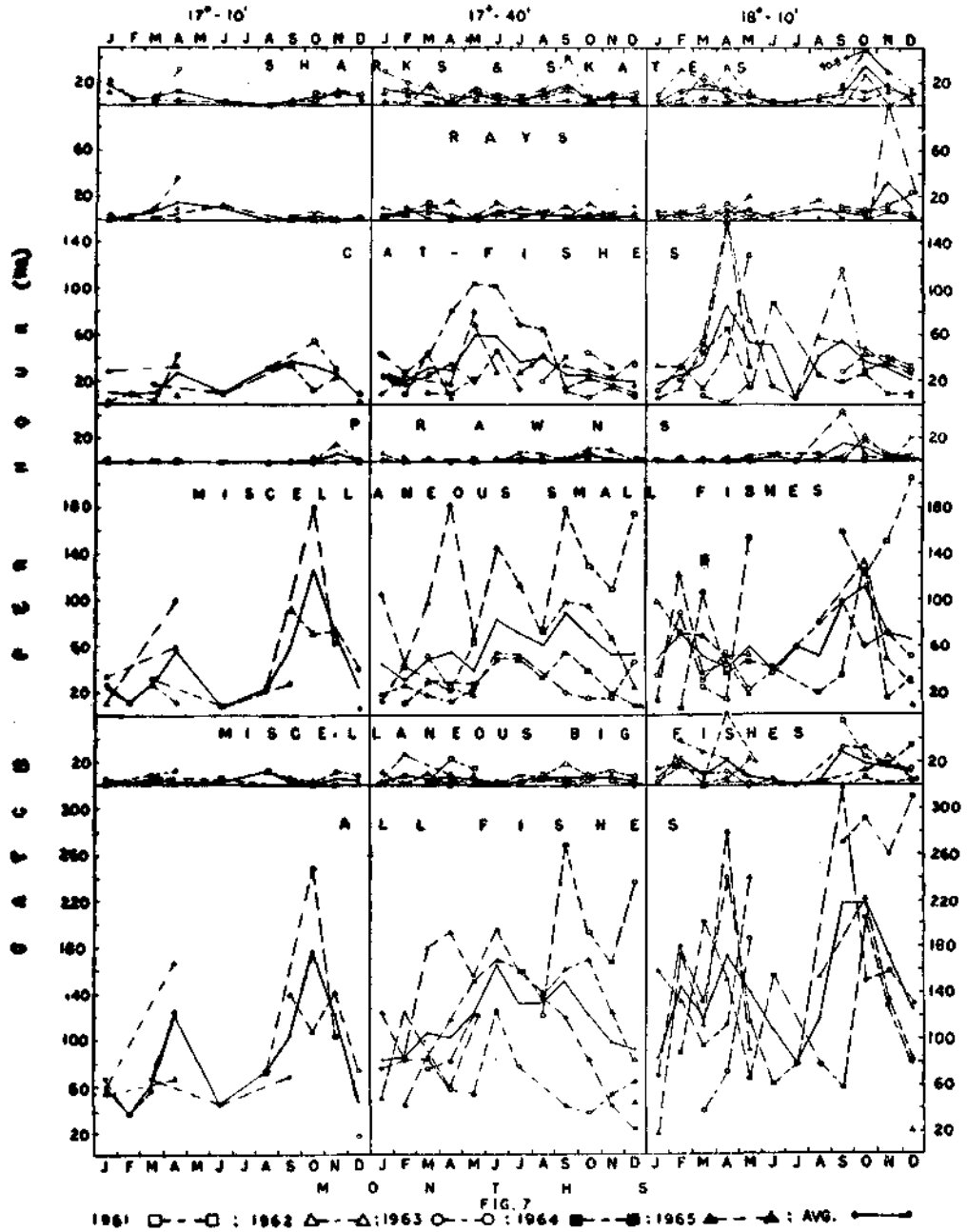

FIG. 7

FIG. 7. The monthly catch per hour (kg.) and arithmetic means (average) of the c.p.h. of the corresponding months of 1961–65 recorded by *Ashok* and *Pratap*.

TABLE IX

Annual catch per hour of the different categories of fishes and their averages over the period 1961–65 *in the Latitude Zones fished by m.v.* Champa

(The averages referred to are the arithmetic means of the annual c.p.h. from 1961-65. The percentage of each category in the five year average c.p.h. of all fishes is given within brackets)

Latitude Zones	SHARKS AND SKATES						RAYS					
	1961	1962	1963	1964	1965	Average	1961	1962	1963	1964	1965	Average
17° 10′	0·0	n.f.	n.f.	n.f.	n.f.	0·0 (0·0%)	0·0	n.f.	n.f.	n.f.	n.f.	0·0 (0·0%)
*17° 40′	9·4	8·9	6·6	7·2	4·9	7·4 (6·3%)	5·6	8·3	6·9	3·4	5·2	5·9 (5·1%)
*18° 10′	21·4	14·8	5·0	5·0	5·0	10·2 (7·0%)	15·8	8·7	7·7	6·1	6·9	9·0 (6·1%)
21° 10′	n.f.	n.f.	n.f.	n.f.	0·0	0·0 (0·0%)	n.f.	n.f.	n.f.	n.f.	0·0	0·0 (0·0%)
All Zones	10·5	9·9	4·6	6·9	4·8	7·3 (6·5%)	6·6	8·3	7·0	3·9	5·3	6·2 (5·6%)

Latitude Zones	CAT-FISHES						PRAWNS					
	1961	1962	1963	1964	1965	Average	1961	1962	1963	1964	1965	Average
17° 10′	0·0	n.f.	n.f.	n.f.	n.f.	0·0 (0·0%)	0·0	n.f.	n f.	n.f.	n f.	0·0 (0·0%)
*17° 40′	29·0	25·3	23·8	10·5	15·2	20·8 (17·8%)	1·9	8·3	2·3	3·5	3·3	3·9 (3·3%)
*18° 10′	42·5	14·3	17·1	50·9	13·9	27·7 (18·9%)	3·8	7·9	1·5	1·9	2·8	3·6 (2·5%)
21° 10′	n.f.	n.f.	n.f.	n.f.	9·5	9·5 (35·6%)	n.f.	n.f.	n.f	n.f.	0·0	0·0 (0·0%)
All Zones	29·8	23·5	23·1	17·2	15·9	21·7 (18·8%)	2·0	8·2	2·2	3·2	2·3	3·6 (3·1%)

Latitude Zones	MISCELLANEOUS SMALL FISHES						MISCELLANEOUS BIG FISHES					
	1961	1962	1963	1964	1965	Average	1961	1962	1963	1964	1965	Average
17° 10′	62·6	n.f.	n.f.	n.f.	n.f.	62·6 (86·1%)	10·1	n.f.	n.f.	n.f.	n.f.	10·1 (13·9%)
*17° 40′	94·5	94·	71·0	68·2	31·4	71·9 (61·7%)	16·2	11·0	3·0	2·8	2·2	7·0 (6·0%)
*18° 10′	137·1	100·6	80·5	72·8	49·5	88·1 (60·1%)	22·6	11·6	2·3	3·0	0·5	8·0 (5·5%)
21° 10′	n.f.	n.f.	n.f.	n.f.	11·7	11·7 (43·8%)	n.f.	n.f.	n.f.	n.f.	5·5	5·5 (20·6%)
All zones	98·4	95·4	72·0	69·0	33·6	73·7 (60·9%)	16·7	11·1	3·0	2·9	2·0	7·1 (5·2%)

Latitude zones	ALL FISHES					
	1961	1962	1963	1964	1965	Average
17° 10′	72·6	n.f.	n.f.	n.f.	n.f.	72·6
*17° 40′	156·6	156·2	113·6	95·6	61·2	116·6
18° 10′	243·1	157·8	114·2	139·8	78·5	146·7
21° 10′	n.f.	n.f.	n.f.	n.f.	26·7	26·7
All zones	164·0	156·4	113·7	103·0	63·1	120·0

* The zones which were fished for 6 months or more in at least one of the years (Refer also Table II).
n.f. = Not fished.

TABLE X

Annual catch per hour of the different categories of fishes and their averages over the period 1961–65 *in the Latitude zones fished by m.v.* Sea Horse (details as in Table IX)

Latitude Zones	SHARKS AND SKATES						RAYS					
	1961	1962	1963	1964	1965	Average	1961	1962	1963	1964	1965	Average
16° 40′	0·3	n.f.	n.f.	n.f.	n.f.	0·3 (0·6%)	0·5	n.f.	n.f.	n.f.	n.f.	0·5 (1·0%)
17° 10′	2·6	n.f.	n.f.	n.f.	n.f.	2·6 (5·1%)	2·8	n.f.	n.f.	n.f.	n.f.	2·8 (5·5%)
*17° 40′	6·3	4·5	6·3	3·8	3·0	4·8 (6·2%)	5·0	6·8	9·1	4·9	5·3	6·2 (8·0%)
18° 10′	4·8	2·7	1·3	4·1	1·6	2·9 (3·9%)	4·8	3·8	6·7	2·3	6·2	4·8 (6·4%)
20° 10′	5·0	n.f.	n f.	n.f.	n.f.	5·0 (7·4%)	3·5	n.f.	n.f.	n.f.	n.f.	3·5 (5·2%)
20° 40′	33·4	n.f.	n.f.	n.f.	n.f.	33·4 (48·3%)	9·4	n.f.	n.f.	n.f.	n.f.	9·4 (13·6%)
All Zones	5·5	4·4	6·1	3·8	2·9	4·5 (6·3%)	4·4	6·6	9·0	4·8	5·4	6·0 (8·7%)

Latitude Zones	CAT-FISHES						PRAWNS					
	1961	1962	1963	1964	1965	Average	1961	1962	1963	1964	1965	Average
16° 40′	3·5	n.f.	n.f.	n.f.	n.f.	3·5 (7·0%)	2·2	n.f.	n.f.	n.f.	n.f.	2·2 (4·4%)
17° 10′	2·8	n.f.	n.f.	n.f.	n.f.	2·8 (5·5%)	1·0	n.f.	n.f.	n.f.	n.f.	1·0 (2·0%)
*17° 40′	12·9	11·7	4·4	16·4	14·8	12·0 (15·6%)	1·2	2·1	1·7	1·2	3·1	1·9 (2·5%)
*18° 10′	10·2	20·1	1·9	24·2	7·8	12·8 (17·1%)	0·3	1·2	0·1	10·4	1·8	2·8 (3·7%)
20° 10′	0·1	n.f.	n.f.	n.f.	n.f.	0·1 (0·1%)	5·4	n.f.	n.f.	n.f.	n.f.	5·4 (8·0%)
20° 40′	0·0	n.f.	n.f.	n.f.	n.f.	0·0 (0·0%)	0·0	n.f.	n.f.	n.f.	n.f.	0·0 (0·0%)
All Zones	9·5	12·3	4·2	16·7	14·0	11·3 (16·5%)	1·6	2·0	1·6	1·5	3·0	1·9 (2·9%)

Latitude Zones	MISCELLANEOUS SMALL FISHES						MISCELLANEOUS BIG FISHES					
	1961	1962	1963	1964	1965	Average	1961	1962	1963	1964	1965	Average
6° 40′	40·4	n.f.	n.f.	n f.	n.f.	40·4 (80·6%)	3·2	n.f.	n.f.	n.f.	n.f.	3·2 (6·4%)
* ° 10′	32·6	n.f.	n.f.	n.f.	n.f.	32·6 (63·8%)	9·3	n.f.	n.f.	n.f.	n.f.	9·3 (18·2%)
* 40′	84·1	59·7	43·7	31·6	30·7	50·0 (64·8%)	3·8	4·8	1·0	1·4	0·6	2·3 (3·0%)
8° 10′	43·5	73·4	44·6	65·6	26·2	50·7 (67·6%)	0·8	1·7	0·8	0·6	1·4	1·0 (1·3%)
0° 10′	52·9	n.f.	n.f.	n.f.	n.f.	52·9 (78·4%)	0·5	n.f.	n.f.	n.f.	n.f.	0·5 (0·7%)
0° 40′	26·3	n.f.	n.f.	n.f.	n.f.	26·3 (38·1%)	0·0	n.f.	n.f.	n.f.	n.f.	0·0 (0·0%)
l Zones	68·8	60·6	43·8	32·9	29·7	47·2 (62·9%)	0·9	4·5	1·0	1·3	0·7	2·3 (2·8%)

Latitude Zones	ALL FISHES					
	1961	1962	1963	1964	1965	Average
16° 40′	50·1	n f.	n.f.	n.f.	n.f.	50·1
17° 10′	51·1	n.f.	n.f.	n.f.	n.f.	51·1
*17° 40′	113·4	89·5	66·3	59·3	56·9	77·1
*18° 10′	64·4	103·0	55·3	107·2	45·0	75·0
20° 10′	67·5	n.f.	n.f.	n.f.	n.f.	67·5
20° 40′	69·1	n.f.	n.f.	n.f.	n.f.	69·1
All zones	93·7	90·5	65·7	61·0	55·7	73·3

TABLE XI

Average annual catch per hour of the different categories of fishes in the Latitude Zones fished by m.t. Ashok *and m.t.* Pratap *over the period* 1961–65

(These are the arithmetic averages of annual c.p.h. from 1961–65)

Latitude Zones	Sharks and skates	Rays	Cat-fishes	Prawns	Miscellaneous small fishes	Miscellaneous big fishes	All fishes
16° 40′	4·5 (1·8%)	15·0 (5·9%)	96·7 (38·0%)	0·0 (0·0%)	84·3 (33·1%)	54·2 (21·3%)	254·7
*17° 10′	7·7 (7·3%)	4·8 (4·5%)	24·1 (22·8%)	1·0 (0·9%)	61·2 (57·9%)	6 9 (6·5%)	105·7
*17° 40′	8·9 (7·1%)	5·6 (4·4%)	39·2 (31·1%)	2·1 (1·7%)	63·2 (50·1%)	7·1 (5·6%)	126·2
*18° 10′	14·9 (9·1%)	9·2 (5·6%)	44·9 (27·4%)	2·3 (1·4%)	73·3 (44·7%)	19·4 (11·8%)	164·1
*18° 40′	15·0 (7·4%)	6·6 (3·3%)	64·4 (31·7%)	2·0 (1·0%)	94·9 (46·8%)	20·0 (9·9%)	202·9
*19° 10′	17·4 (9·5%)	11·4 (6·2%)	36·4 (19·9%)	2·5 (1·4%)	88·8 (48·6%)	26·2 (14·3%)	182·7
*19° 40′	22·6 (10·6%)	11·0 (5·1%)	32·4 (15·1%)	3·2 (1·5%)	114·8 (53·6%)	30·2 (14·1%)	214·2
20° 10′	21·4 (9·5%)	7·5 (3·3%)	24·3 (10·8%)	3·1 (1·4%)	145·5 (64·4%)	24·2 (10·7%)	225·9
20° 40′	11·2 (16·3%)	2·3 (3·3%)	13·0 (18·9%)	0·5 (0·7%)	29·5 (43·0%)	12·4 (18·1%)	68·7
21° 10′	27·8 (13·6%)	9·1 (4·4%)	25·1 (12·3%)	5·3 (2·6%)	113·3 (55·3%)	24·5 (12·0%)	204·9
All Zones	13·6 (8·8%)	7·5 (4·9%)	40·7 (26·8%)	2·4 (1·6%)	79·0 (48·0%)	15·5 (9·9%)	158·8

The percentage of each category in the five year average c.p.h. of all fishes is given within brackets.

* The Zones which were fished for six months or more in at least one of the years. Those without asterisks were fished for less than 6 months in all years.

them into two categories: (1) Those which were fished for 6 months or more in at least one of the years, and (2) those which were fished for less than 6 months in all years. The averages for the zones falling in the first category were calculated in the same way as those for the squares. The data (Table XI, Figs. 6 A and 6 B, "All Fishes") again indicate a general south to north increase in demersal fisheries potential, in the area between 16° 50″ N and 19° 50′ N. The 18° 40′ and 19° 40′ zones appear to be particularly rich in demersal fishes; both gave average annual c.p.h. of > 200 kg. But the 17° 10′–and 17° 40′ zones recorded 5-year averages of < 130 kg/hr each.

Champa and Sea Horse. (Tables IX and X, "All Fishes").—These two vessels fished mostly in the 17° 40′ and 18° 10′ zone. The results indicate that the latter zone had a greater abundance of demersal fishes than the former one, which conforms to what was seen from the data of the other two vessels. *Sea Horse* fished in the zones 16° 40′ N to 18° 10′ N Lat. and 20° 10′ N and 20° 40′ N Lat. in 1961. Only the 17° 40′ zone was fished for more than 6 months in that year by this vessel. The data for the other zones in that year showed a progressive increase in the annual abundance of fishes from south to north.

CATEGORIES OF FISHES LANDED

Pooling the catches of all the six vessels which fished from 1961 to 1965, the average percentages of the six categories of fishes in the entire area were found to be as follows: Sharks and skates: 7·5; Rays: 5·5; Cat-fishes: 20·8: Prawns: 2·3; Miscellaneous small fishes: 56·4; Other varieties (Misc. big fishes): 7·5.

The observations on the important fishes landed from various squares are given in Table IV. Single species or single genus hauls were rare. Diversity of species characterised the fish fauna at all places.

Annual Catch Per Hour of the Different Categories of Fishes in the Half-Degree Latitude Zones

The annual c.p.h. of the different categories of fishes in the zones fished by *Ashok* and *Pratap* is given in Fig. 5, and the five-year average in Figs. 6 A and 6 B, and Table XI. The annual c.p.h. and the average in respect of the zones fished by *Champa* and *Sea Horse* are given in Tables IX and X. The following account is confined to the zones fished for 6 months or more per year unless otherwise stated.

(*A*) *Ashok and Pratap*

(*i*) *Sharks and skates.*—Every year a south to north increase in the relative abundance of this group was evident. The same was also true of the 5-year average, which had its maximum in the 19° 40′ zone.

(*ii*) *Rays.*—The 18° 10′ zone was consistently one of high abundance of this category of fishes from 1961 to 1964; the 5-year average also showed this. The 1964 data as also the 5-year average indicated another zone of peak abundance: the 19° 10′–19° 40′ zone.

(*iii*) *Cat-fishes.*—Two zones of peak abundance could be recognised from the five annual values of c.p.h.: one around the 17° 40′ N and another around 18° 40′–19° 10′N Lat. In the 5-year average the former one was masked, but the latter one was distinct around 18° 40′ N Lat.

(*iv*) *Prawns.*—Two zones of high abundance were apparent from values of the annual c.p.h. and the 5-year average: 17° 40′–18° 10′ 19° 40′.

(*v*) *Miscellaneous small fishes.*—The c.p.h. values in 1961, 1963 and 1964 indicated a general south to north increase in the relative abundance of this group. The 17° 40′ zone was best in 1962, but was poorer than the northern zones in other years. The 5-year average c.p.h., in which the 18° 40′ and 19° 40′ zones stand out prominently also indicate a general south to north increase in the relative concentration of this category of fishes.

(*vi*) *Other varieties* (*Misc. big fishes*),—In 1964 and 1965, there were indications of high abundance of this group of fishes around 18° 10′ N Lat., but it was not evident in the 5-year average which showed a south to north increase in the relative abundance of this category of fishes.

(*B*) *Champa and Sea Horse*

Between the 17° 40′ and 18° 10′ zones fished by *Champa*, the latter gave higher catch per hour, on a 5-year average, than the former, in respect of all categories of fishes except prawns, which was consistent with the trend revealed by the data of *Ashok* and *Pratap*. On the other hand, *Sea Horse* recorded, on a 5-year average, a better catch per hour from the 17° 40′ zone than from the 18° 10′ zone in respect of sharks and skates, rays, and "other varieties"; the reverse was true

in respect of cat-fishes, prawns and miscellaneous small fishes. It may be mentioned that *Sea-Horse*, the smallest among the four vessels considered here, fished mostly in the 17° 40′ zone.

Average Annual Percentage Composition of the Catches in the Half-Degree Latitude Zones

The average percentages of the different categories of fishes in the zones from 1961 to 1965 are also given in Tables IX–XI. They follow roughly the same trend as the c.p.h. values. Taking into account the zones fished by *Ashok* and *Pratap* for 6 months or more per year, it may be seen that the percentage of sharks and stakes was highest in the northermost one (19° 40′ N), that of rays in the 18° 10′ and 19° 10′ zones, that of cat-fishes in the 17° 40′ and 18° 40′ zones, that of prawns in the 17° 40′ and 19° 40′ zones, that of miscellaneous small fishes in the 17° 10′ and 19° 40′ zones and that of the miscellaneous big fishes in the 18° 10′ and 19° 10′–19° 40′ zones. It may also be seen that in all zones except 16° 40′, miscellaneous small fishes formed the dominant group.

Seasonal Variations in the Relative Abundance of Fishes

The discussion will be confined to zones fished for 6 months or more per year. Two terms are used to denote the monthly variations in catch rates: (1) periods of high c.p.h. in a zone (periods of peak relative abundance) and (2) the period of the highest c.p.h. in a zone (the period of the highest relative abundance).

(*A*) *Ashok and Pratap*

In Figs. 7–9 are plotted the monthly c.p.h. and the (arithmetic) average of c.p.h. of the corresponding months of the five years in each zone.

(*i*) *All fishes.*—There are at least three periods of high catch rates in the 17° 40′–19° 40′ N Lat. zones which, broadly speaking, are: January–February, April–June and September–November. In January–February the catch rates are generally lower than in the other two periods.

The period of highest c.p.h. for all fishes among the three mentioned above is April–June in the 17° 40′ zone, but September–November in the 17 °10′, 18° 10′ and 19° 10′ zones; April–June and September–November appear almost equally good in the 18° 40′ zone. In the 19° 40′ zone, however, fishing during the September–November period was undertaken for only one year, and the indication that June is the month of best catch rates there requires confirmation by future studies. What is noteworthy is that the data indicate a contrast between the 17° 40′ and the other zones in regard to the period of the best catch rates (of "all fishes").

(*ii*) *The different categories of fishes.*—For each category at least three periods of high c.p.h. are generally seen in each zone, corresponding roughly with those mentioned for "all fishes". Here again the 17° 10′–17° 40′ zones show some difference compared to the northerly zones in regard to the period of the highest abundance of certain categories of fishes. The best season for sharks and skates is January–March in the 17° 10′–17° 40′ zones, but October–December in the others. Similarly February–May and August are the periods of highest yield rates of miscellaneous big fishes in the 17° 40′ and 17° 10′ zones respectively, but in the other zones the best season for this category of fishes is September–November. For rays the best period is November–December in the 18° 10′ zone, but January–April in others. In regard to prawns and miscellaneous small fishes the period of the highest relative abundance is roughly the same in all zones, *i.e.*, September–November. Cat-fish density appears to be highest in September–November in 17° 10′ zone and April–June in other zones.

(*B*) *Champa and Sea Horse*

The data of the various years in respect of only the 17° 40′ and 18° 10′ zones are taken into account, for reasons already stated. The monthly c.p.h. in 1964 and the five year averages

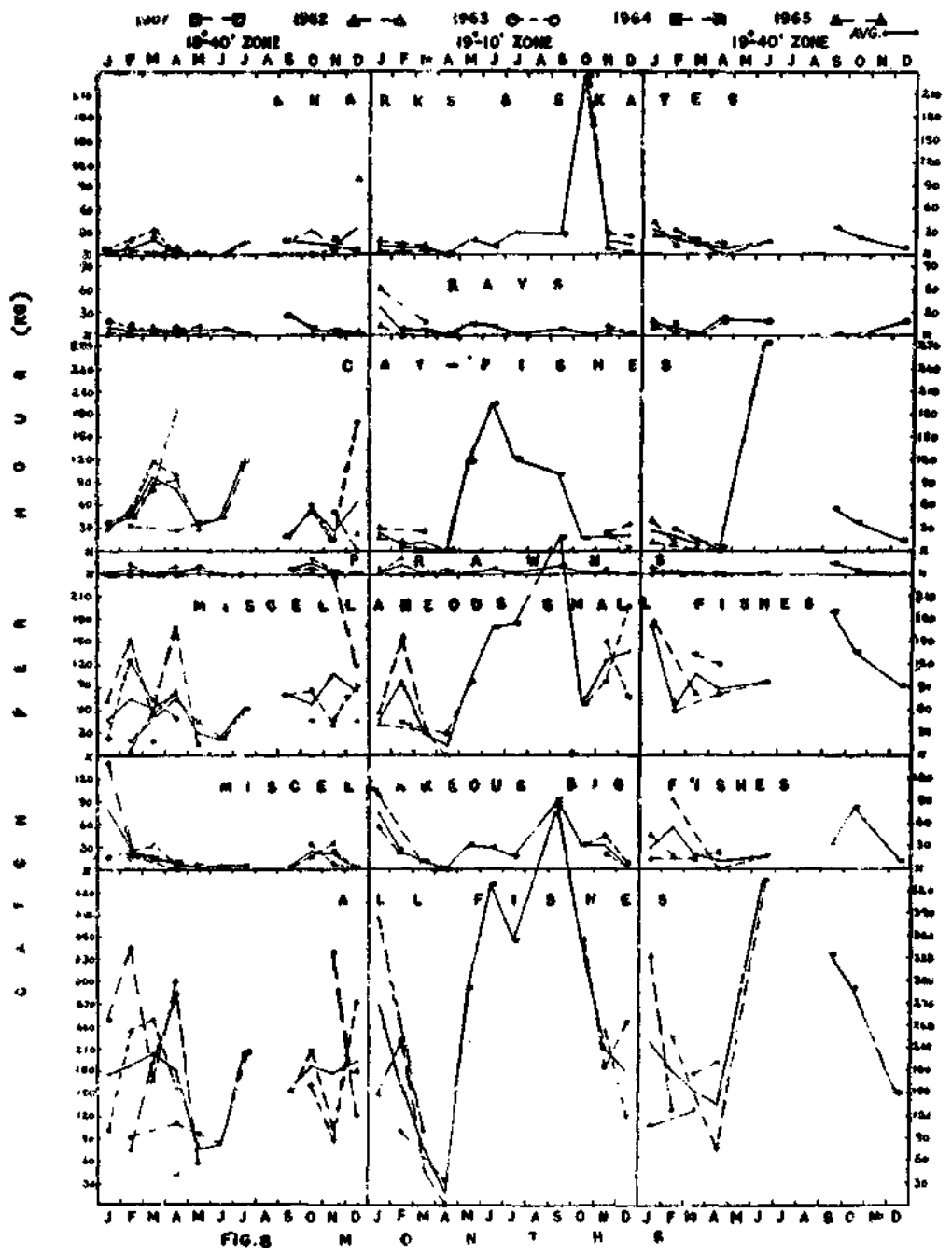

FIG. 8

FIG. 8. The monthly catch per hour (kg.) and the arithmetic means (average) of the c.p.h. of the correspondin months of 1961–65 recorded by *Ashok* and *Pratap* in the zones 18° 40′–19° 40′.

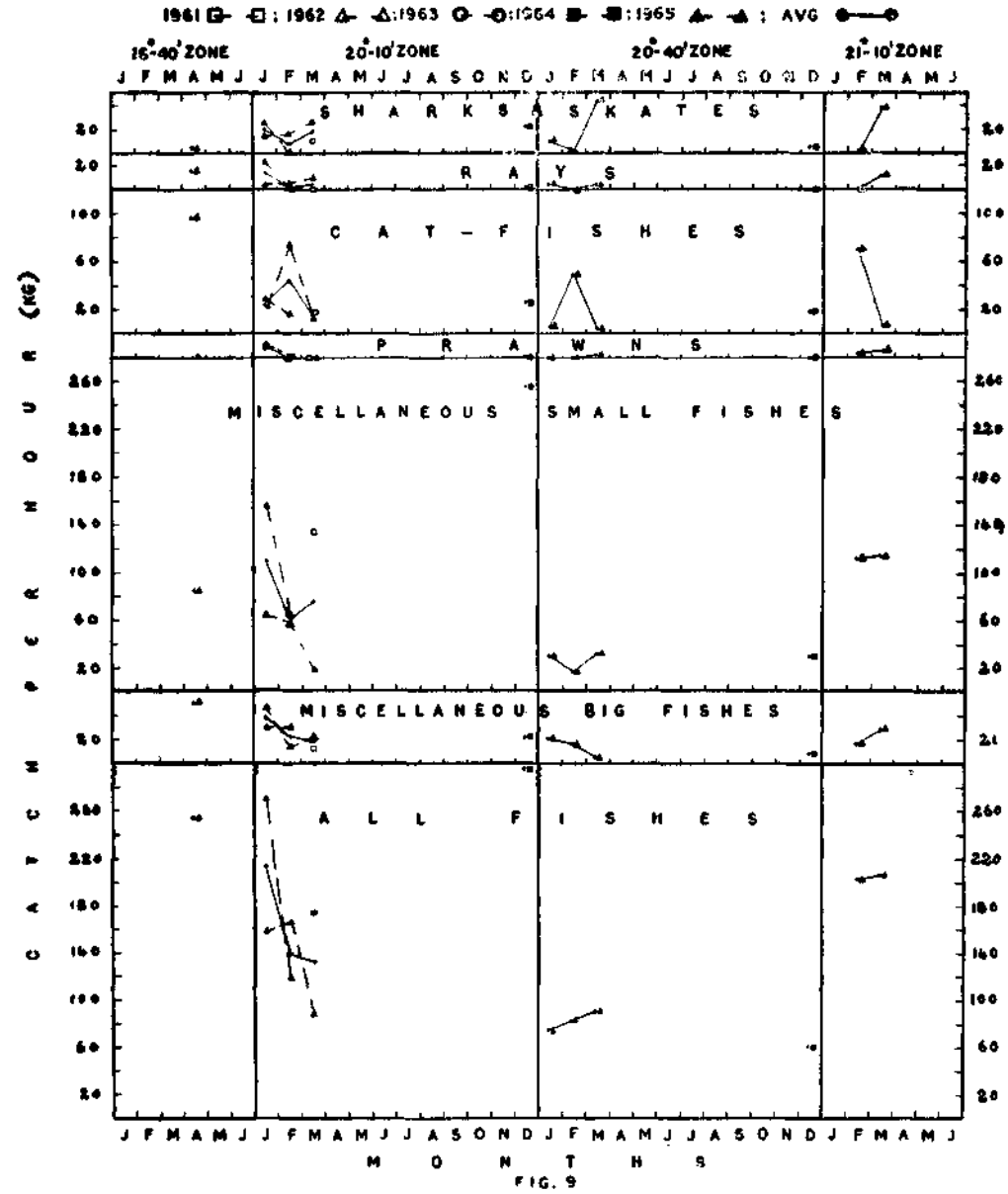

FIG. 9

FIG. 9. The monthly catch per hour (kg.) and the arithmetic means (average) of the c.p.h. of the corresponding months of 1961–65 recorded by *Ashok* and *Pratap* in the zones 16° 40′ and 20° 10′–21° 10′.

recorded by *Champa* and *Sea Horse* are given in Tables XII and XIII (The 1964 data are given to illustrate the trends in monthly c.p.h. in an individual year).

(*i*) *All fishes.*—Three periods of high yield rates are seen in each zone, which are roughly March–June, August–September and November–January. The period of the best catch rates in the 17° 40′ zone conforms to what is seen from the data of *Ashok* and *Pratap*. But in the 18° 10′ zone,

TABLE XII

Monthly catch per hour (kg.) recorded by m.v. Champa *from different zones*

(The year 1964 is chosen to illustrate the trend in an individual year. The arithmetic averages of the c.p.h. of the corresponding months of 1961–65 are also given)

Fishes	Year/months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						A. 17° 40′ Zone							
sh.	1964	2·2	0·0	3·4	6·0	7·4	n.f.	4·9	8·5	4·1	5·9	n.f.	14·5
	1961–65 (Average)	5·8	3·7	6·6	6·7	5·4	4·3	6·5	6·7	9·6	5·5	7·3	10·7
r.	1964	0·0	8·0	0·1	6·2	0·6	n.f.	2·9	6·0	5·3	0·5	n.f.	2·7
	1961–65 (Average)	7·1	10·0	4·9	5·0	3·7	5·5	4·5	5·0	4·9	5·1	9·5	11·6
cf.	1964	2·0	10·7	11·1	11·9	15·4	n.f.	28·3	6·4	3·6	7·2	n.f.	9·7
	1961–65 (Average)	10·2	16·0	18·2	28·0	51·0	14·0	9·0	13·3	19·1	21·1	13·6	25·3
pr.	1964	0·0	0·0	1·0	2·1	0·0	n.f.	5·2	3·5	6·6	3·8	n.f.	0·3
	1961–65 (Average)	4·6	0·5	2·2	2·6	3·4	4·8	3·9	1·2	3·8	7·5	5·0	2·9
msf.	1964	14·6	50·0	80·6	202·1	21·3	n.f.	46·3	41·4	53·6	42·2	n.f.	15·7
	1961–65 (Average)	51·7	45·2	89·3	111·8	44·4	36·2	56·7	65·6	67·9	57·4	76·3	70·6
mbf.	1964	1·6	14·7	9·7	1·3	1·4	n.f.	2·3	2·7	1·7	2·8	n.f.	0·0
	1961–65 (Average)	4·6	8·4	9·3	7·6	5·5	6·6	3·8	6·1	5·5	9·0	9·2	5·3
All fishes	1964	20·4	83·3	105·9	229·6	46·1	n.f.	89·9	71·5	74·9	62·4	n.f.	87·1
	1961–65 (Average)	83·9	83·8	130·3	161·7	138·6	71·3	84·3	98·0	110·7	105·7	120·9	134·8
						B. 18° 10′ Zone							
sh.	1964	3·3	0·8	13·2	1·8	n.f.	n.f.	38·4	2·2	n.f.	3·0	n.f.	1·0
	1961–65 (Average)	11·1	3·2	12·0	1·3	0·3	6·6	20·2	5·9	1·0	7·8	10·4	11·8
r.	1964	0·0	0·7	7·8	7·2	n.f.	n.f.	12·8	11·0	n.f.	2·0	n.f.	0·0
	1961–65 (Average)	6·9	3·6	8·9	3·1	5·8	18·8	6·4	6·7	11·6	7·6	2·6	10·6
cf.	1964	0·0	1·1	254·0	7·8	n.f.	n.f.	6·0	6·1	n.f.	5·0	n.f.	3·5
	1961–65 (Average)	12·0	10·4	75·2	7·4	3·2	33·5	3·0	47·6	21·2	7·4	7·5	13·1
pr.	1964	0·0	0·0	0·0	0·9	n.f.	n.f.	4·4	1·5	n.f.	23·8	n.f.	0·0
	1961–65 (Average)	3·3	0·1	0·5	2·3	1·9	3·2	2·2	1·7	0·0	12·4	4·5	2·3
msf.	1964	1·9	20·8	99·0	95·3	n.f.	n.f.	28·0	38·1	n.f.	168·0	n.f.	17·5
	1961–65 (Average)	44·5	45·9	101·8	106·6	74·3	52·5	55·7	90·5	132·8	88·0	96·4	65·9
mbf.	1964	0·0	1·2	7·5	1·3	n.f.	n.f.	4·4	5·3	n.f.	2·5	n.f.	0·0
	1961–65 (Average)	4·8	3·3	12·5	1·6	4·2	3·3	3·6	9·6	4·8	4·8	4·6	6·9
All fishes	1964	22·0	24·6	381·5	114·3	n.f.	n.f.	94·0	64·2	n.f.	204·3	n.f.	22·0
	1961–65 (Average)	88·2	66·6	210·8	122·2	89·8	117·7	90·7	161·7	221·4	127·9	125·9	110·3

n.f. = No fishing; sh. = Sharks and skates; r. = Rays; cf. = Cat-fishes; pr. = Prawns; msf. = Miscellaneous small fishes; mbf = Miscellaneous big fishes.

a difference is seen in that these vessels record the best catch rates in June–August, whereas the other two vessels record it in September–November, as already mentioned.

(*ii*) *The different categories of fishes.*—The periods of high abundance are mostly comparable to those mentioned in the case of *Ashok* and *Pratap*. However, some differences are also noted, especially in 18° 10′ zone, where *Champa* obtained the best catch rates of rays in May–July, of miscellaneous small fishes in March–June and of miscellaneous big fishes in March. *Sea Horse* obtained the best c.p.h. of cat-fishes in October–December, miscellaneous small fishes in April–August and miscellaneous big fishes in June–July from the same zone, which were different from the trends seen from the data of *Ashok* and *Pratap*.

TABLE XIII

Monthly catch per hour (kg.) recorded by m.v. Sea Horse *from different zones.* (Details as in Table XII)

Fishes	Year/months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec
						A. 17° 40′ Zone							
sh.	1964	0·0	9·9	3·5	6·4	2·2	6·6	1·4	2·2	3·8	2·3	6·4	2·2
	1961-65 (Average)	5·2	4·6	4·2	3·1	2·9	5·5	4·5	3·9	6·9	4·1	5·9	5·3
r.	1964	8·6	2·6	4·6	0·0	1·6	1·6	13·5	3·7	5·6	2·5	3·7	8·0
	1961-65 (Average)	5·5	5·0	6·2	2·7	6·3	9·8	8·0	3·9	6·2	5·4	4·5	8·1
cf.	1964	3·3	2·5	4·6	4·1	14·0	68·4	22·8	12·9	8·6	5·6	9·0	14·2
	1961-65 (Average)	93·0	4·7	3·7	9·1	17·6	28·1	8·6	14·4	17·3	7·5	9·0	11·9
pr.	1964	0·0	2·2	0·0	0·0	0·3	0·8	1·0	3·1	3·6	1·9	0·0	0·5
	1961-65 (Average)	1·8	1·5	2·1	1·0	1·4	1·0	1·4	1·1	1·2	1·8	2·5	2·6
msf.	1964	38·5	45·3	33·5	31·8	20·2	36·7	27·7	18·6	61·1	33·5	18·4	26·9
	1961-65 (Average)	48·9	41·3	41·0	38·2	42·1	32·0	46·4	36·4	55·1	39·2	51·8	66·1
mbf.	1964	0·0	0·9	1·9	0·9	0·4	1·1	0·8	0·9	1·0	4·3	1·4	0·8
	1961-65 (Average)	2·5	1·7	1·9	2·8	1·5	0·6	1·6	1·7	2·8	2·5	2·3	2·8
All fishes	1964	50·4	63·4	48·1	43·2	38·7	116·4	67·3	41·4	83·7	50·3	38·9	51·2
	1961-65 (Average)	157·0	58·8	59·3	56·7	71·7	76·9	70·6	61·4	89·5	60·5	75·9	97·8
						B. 18° 10′ Zone							
sh.	1964	n.f.	n.f.	n.f.	n.f.	n.f.	3·8	0·0	n.f.	n.f.	0·6	n f.	9·1
	1961-65 (Average)	1·5	3·0	0·6	0·6	0·4	3·8	1·5	2·5	n.f.	4·9	3·8	4·6
r.	1964	n.f.	n.f.	n.f.	n.f.	n.f.	2·6	0·0	n'f.	n.f.	0·4	n.f.	4·8
	1961-65 (Average)	1·5	10·2	1·2	3·2	0·6	2·6	5·6	5·6	n.f.	6·1	0·0	2·4
cf.	1964	n.f.	n.f.	n.f.	n.f.	n.f.	9·6	0·0	n.f.	n.f.	12·7	n.f.	52·5
	1961-65 (Average)	32·5	4·7	0·2	10·3	7·6	9·6	12·1	19·2	n.f.	16·3	7·9	26·4
pr.	1964	n.f.	n.f.	n.f.	n.f.	n.f.	0·0	0·0	n.f.	n.f.	1·2	n.f.	30·1
	1961-65 (Average)	16·5	5·0	0·0	0·8	0·0	0·0	0·2	0·0	n.f.	0·4	1·1	15·1
msf.	1964	n.f.	n.f.	n.f.	n.f.	n.f.	56·7	0·0	n.f.	n.f.	64·0	n.f.	89·3
	1961-65 (Average)	58·0	21·4	17·1	58·7	42·9	56·7	51·2	09·4	n.f.	57·0	41·5	64·0
mbf.	1964	n.f.	n.f.	n.f.	n.f.	n.f.	2·1	0·0	n.f.	n.f.	0·0	n.f.	0·5
	1961-65 (Average)	10·5	1·0	0·3	1·2	0·0	2·1	1·3	1·1	n.f.	0·2	1·4	0·3
All fishes	1964	n.f.	n.f.	n.f.	n.f.	n.f.	74·8	0·0	n.f.	n.f.	78·9	n.f.	186·2
	1961-65 (Average)	120·5	55·3	19·3	74·8	51·5	74·8	71·9	94·2	n.f.	84·9	55·8	115·8

The differences mentioned above are to be expected because (1) *Champa* and *Sea Horse* did stern trawling and *Ashok* and *Pratap*, side trawling, (2) the latter vessels used larger cod-end mesh (35–40 mm) than the former (30 mm) and (3) sampling of the 18° 10′ zone by *Sea Horse* had been poor. On the other hand, the data of all vessels are in substantial agreement in regard to the periods of high abundance of fishes in the 17° 40′ zone.

Zones of high relative abundance of the different categories of fishes in different months.—The monthly data of *Ashok* and *Pratap* for the five years, 1961–1965, show that in certain months, if not during the major part of the year, two zones of high c.p.h. may be found. They may be regarded as the locations of two major concentrations of fishes. The northern concentration is always found either in the 19° 10′ or 19° 40′ zone, but the location of the southern one is not so stable and may change between the 17° 10′ and 18° 40 zones. It may also be noted that the best monthly c.p.h. of "all fishes", sharks and skates, miscellaneous small fishes and miscellaneous big fishes are found in the 19° 10′–19° 40′ zones (Figs. 7–9).

If, however, minor variations in the c.p.h. between zones are ignored, only the northern concentration remains in certain months, which indicates a progressive south to north incerease in the relative abundance of the different categories of fishes. This may be illustrated by the data of 1964 for "all fishes" given below (*see* also Figs. 7–9). A regular south to north increase is seen in the c.p.h. in February, March, July, October and December; it is perhaps so in November also, since in the 18°40′ zone the catch rate is better than in the 17° 40′ zone, and the difference in c.p.h. in the 18° 10′ and 18°40′ zones is not considerable.

TABLE XIV

Monthly c.p.h. of "all fishes" in different zones in 1964

(n.f. = No fishing)

Zones	Monthly c.p.h.											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
17° 10′ ..	n.f.	n.f.	68·0	n.f.	n.f.	45·9	n.f.	n.f.	69·8	n.f.	n.f.	n.f.
17° 40′ ..	n.f.	45·4	83·6	118·9	151·8	169·2	160·4	136·1	120·9	84·9	44·0	23·3
18° 10′ ..	n.f.	90·9	203·7	152·0	68·9	155·2	n.f.	80·5	59·6	206·0	130·0	82·2
18° 40′ ..	n.f.	91·7	n.f.	110·2	96·4	81·8	207·3	n.f.	152·9	210·7	105·5	n.f.
19° 10′ ..	n.f.	98·1	n.f.	33·4	289·6	427·5	352·6	n.f.	533·9	357·5	185·5	245·0
19° 40′ ..	n.f.	229·5	n.f.	75·0	n.f.	435·3	n.f.	n.f.	337·1	292·7	n.f.	149·3

The data of the various categories of fishes from 1961 to 1965 were also examined from this point of view. The categories of fishes and the months in which a south to north increase in the relative abundance was seen are shown in Table XV.

TABLE XV

The categories of fishes whose c.p.h. showed a south to north increase and the periods of the same (17° 10′ – 19° 40′ *zones*)

Year	Sharks and skates	Miscellaneous small fishes	Miscellaneous big fishes	All fishes	Remarks
1961 ..	March and September–November	November	March, October, November	October–December	No fishing in January, February, June and July
1962 ..	January, February, November, December	February, April, October, December	February, April, October	January, October–December	..
1963 ..	March, September, December	February–April, November–December	February, March, October	January–March, October–December	..
1964 ..	July, October, November	February, April, July, November, December	June–July, October–December	February, March, July, October–December	No fishing in January
1965 ..	April	January, March	March	..	No fishing in June–November

Note.—In June and August–September, the northern grounds were not adequately fished, so whether or not the south to north increase in c.p.h. occurs during those months cannot be stated.

Summing up, it may be mentioned that generally in October–March and July, a regular south to north increase is noted in the c.p.h. of sharks and skates, miscellaneous small fishes, miscellaneous big fishes and "all fishes". The trend in August is not clear as enough zones were not fished in that month. In September a south to north increase is noted in the c.p.h. of certain categories of fishes in some years. It is also significant that a reverse trend (*i.e.*, a north to south increase in c.p.h.) is not seen in respect of any category of fish in any month. This again shows that the level of abundance of fishes is always high in the 19° 10′–19° 40′ zones (off Gopalpur and Chilka Lake), as stated earlier.

In demonstrating the occurrence of three peaks in the c.p.h. of fishes in each zone, the depth ranges were not considered. Obviously the demonstrated peaks have no significance unless it be shown that they occur in most of the depth ranges, when the latter are considered individually. This is discussed below.

Relative Abundance of Demersal Fishes in Different Depth-Ranges

The monthly c.p.h. ranges in different depth intervals of the zones fished for 6 months or more per year by *Ashok* and *Pratap* from 1962–65 are plotted in Figs. 10–13. The (arithmetic) averages of the corresponding months in respect of each depth-range of each zone are plotted in Figs. 14–16. In regard to *Champa* and *Sea Horse* the average c.p.h. of the corresponding months of the years 1962–65 in each depth-range are given in Table XVI and XVII.

(*A*) *Ashok and Pratap*

Figures 10–13 show that, as a rule, three peaks occur in the monthly c.p.h. of the different categories of fishes and also of "all fishes" in the depth ranges fished for 6 months or more per year. That the depth-ranges in the 17° 10′, 19° 10′ and 19° 40′ zones do not show all the peaks is of course explained by inadequacy of sampling in time. But the four-year averages (of monthly c.p.h.) of the corresponding months (Figs. 14–16) show that in the different depth-ranges of those zones also, three peaks probably occur in a year in the c.p.h. of the various categories of fishes. The periods of peaks especially in the grounds <50 m deep correspond, to a large extent, with what are mentioned for each zone as a whole.

(*B*) *Champa and Sea Horse*

The monthly data of these vessels for individual years as well as the averages for the four years generally show the incidence of three peaks per year in the c.p.h. of the various categories of fishes and of "all fishes" in different depth ranges of the 17° 40′ and 18° 10′ zones.

The Depth Ranges of the Best Monthly C.P.H.

(*A*) *Ashok and Pratap*

The depth ranges of the best c.p.h. among those fished every month by *Ashok* and *Pratap* may be seen from Figs. 10–16. They are joined by lines to indicate roughly the changes in the depth of best concentrations of fishes with time. Strictly speaking, the data cannot of course be interpreted to show the inshore-offshore movements of fish groups, since even the depth ranges fished were not constant from month to month. Nevertheless the figures indicate alternating periods of high fish abundance in the shallow and deeper regions and are significant to that extent. For purposes of this study, the grounds < 50 m in depth are referred to as shallow or inshore and > 50 m in depth as deeper or offshore. They correspond to the sublittoral and eulittoral regions of the benthic division (Sverdrup *et al.*, 1961, p. 273). As before only the 17° 10′–19° 40′ zones are taken into account.

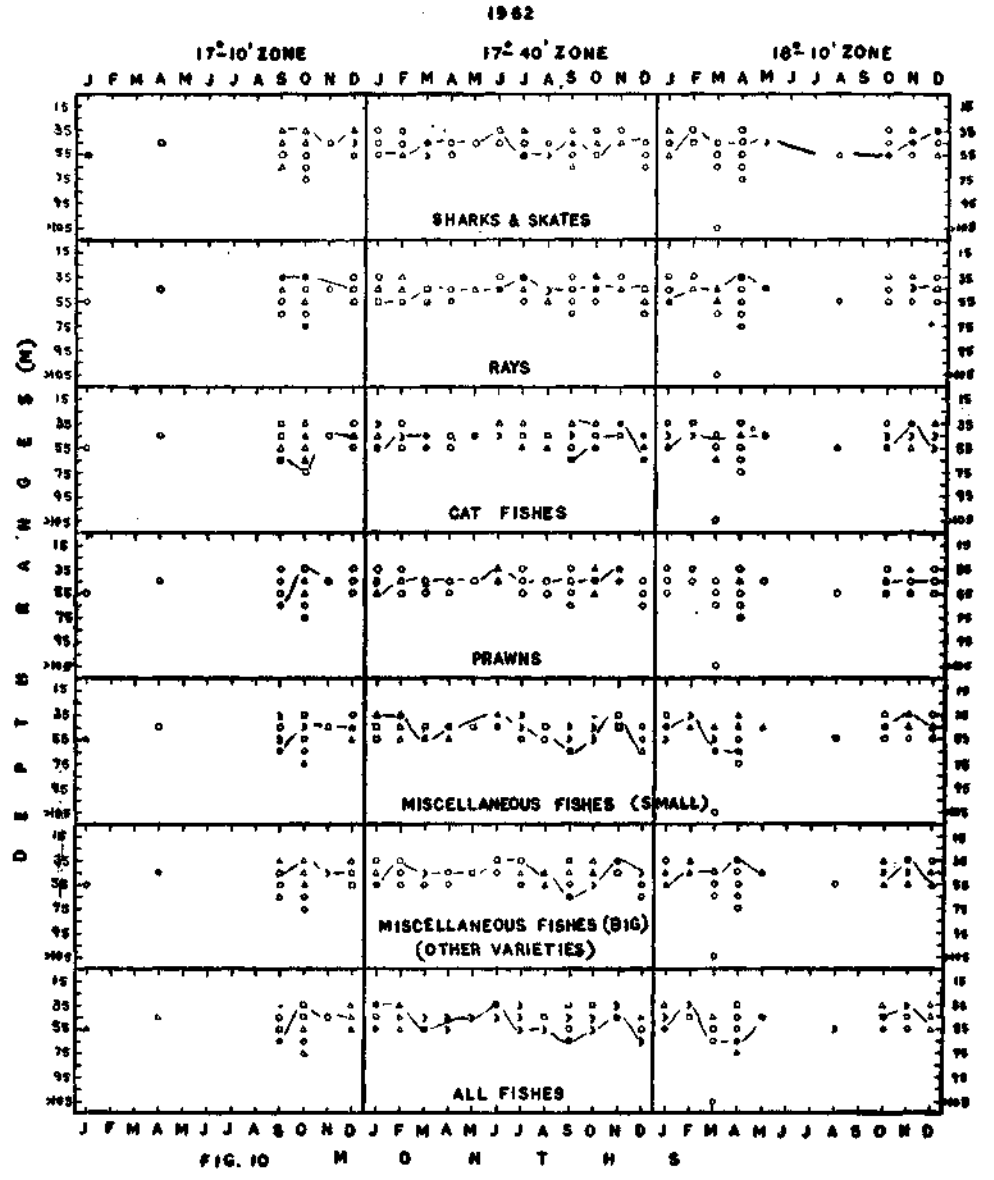

FIG. 10. The monthly catch per hour (kg.) in the 10 m. depth-range of the zones fished for 6 months or more by *Ashok* and *Pratap* in 1962. (The depth-ranges of the best c.p.h. among those fished in the different months are joined by line. For legend *see* Fig. 14).

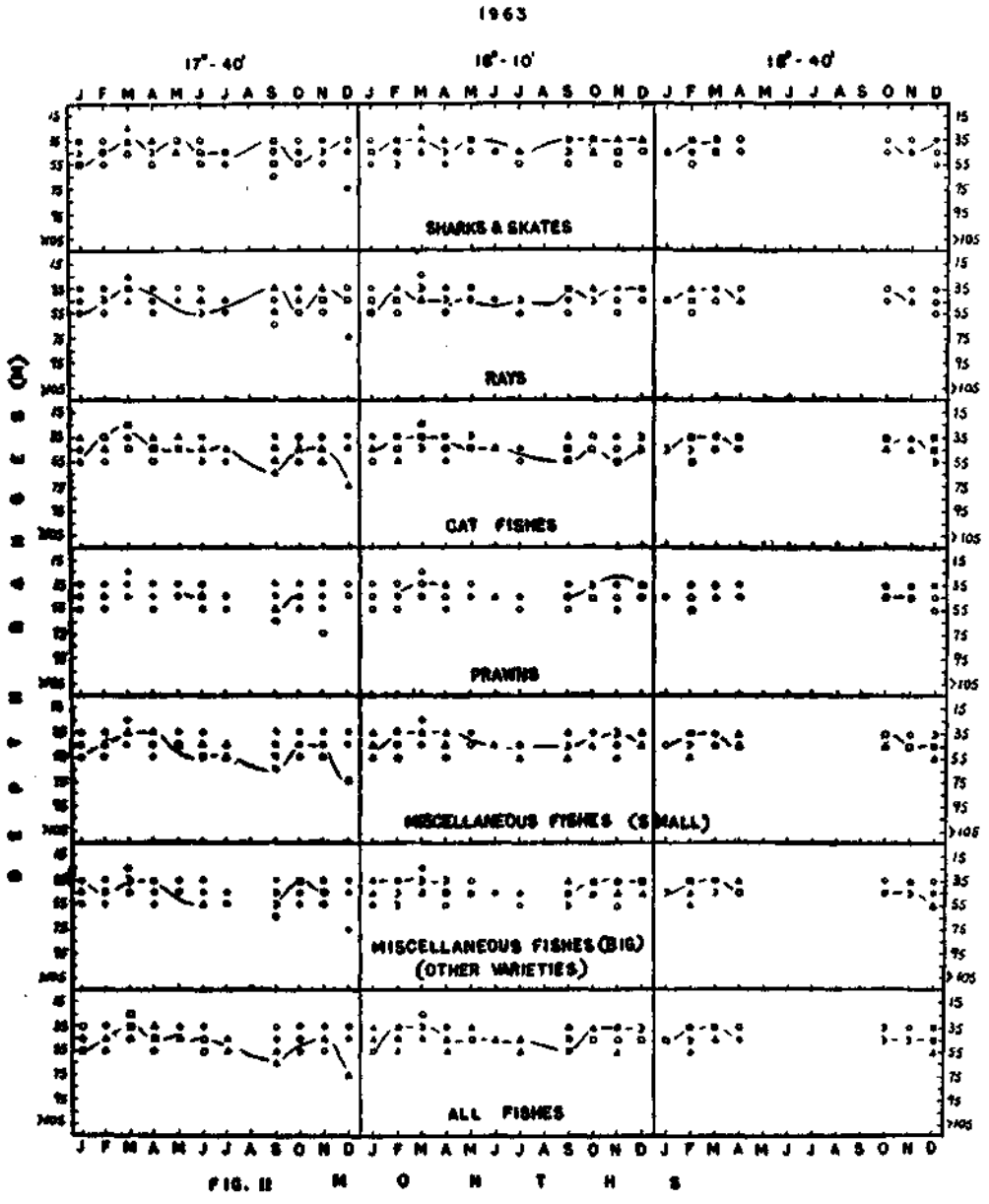

FIG. 11. The monthly catch per hour (kg.) in the 10 m. depth-ranges of the zones fished for 6 months or more by *Ashok* and *Pratap* in 1963.

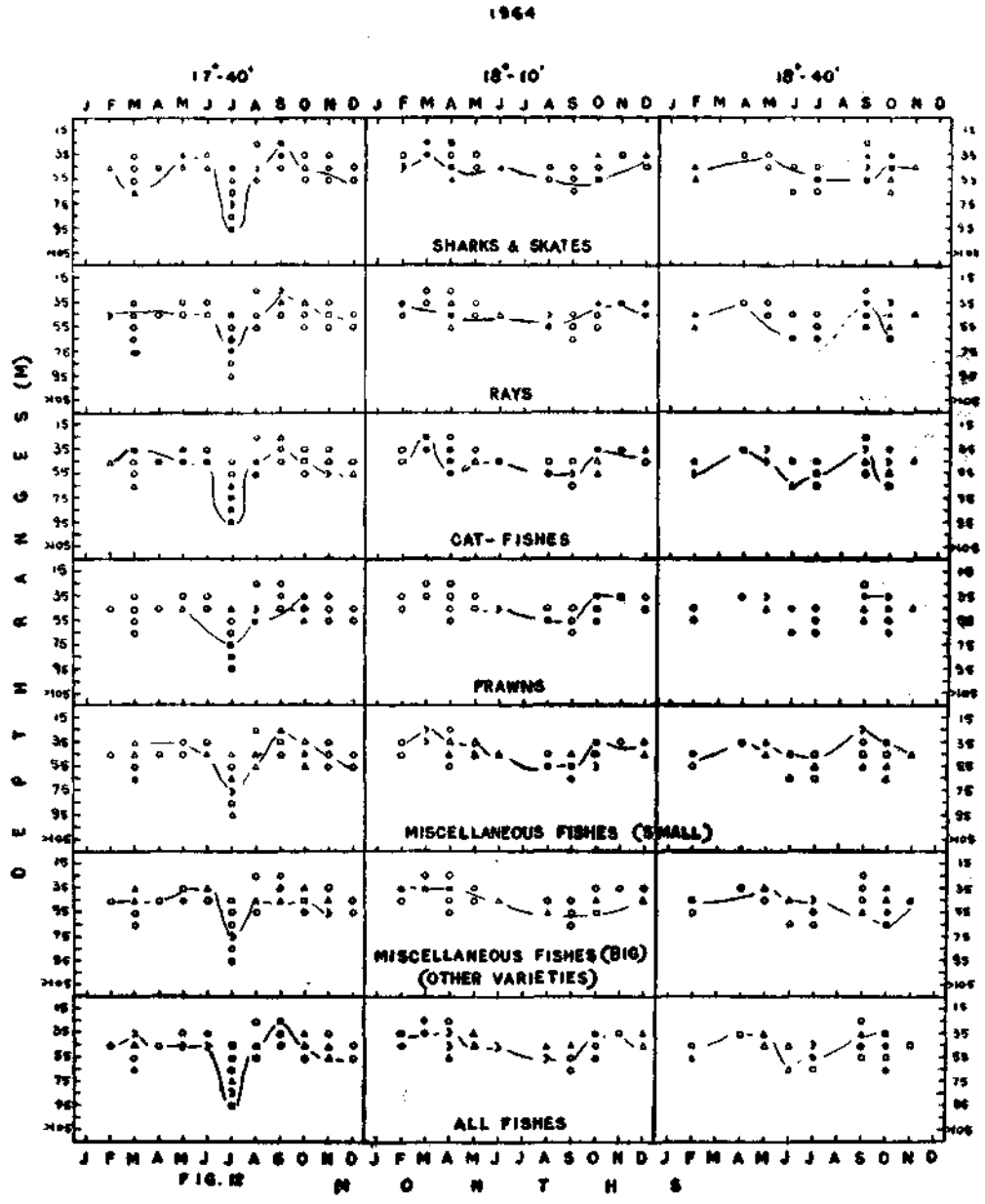

FIG. 12. The monthly catch per hour (kg.) in the 10 m. depth ranges of the 17° 40′ and 27° 40′ zone which were fished for 6 months or more each by *Ashok* in 1964.

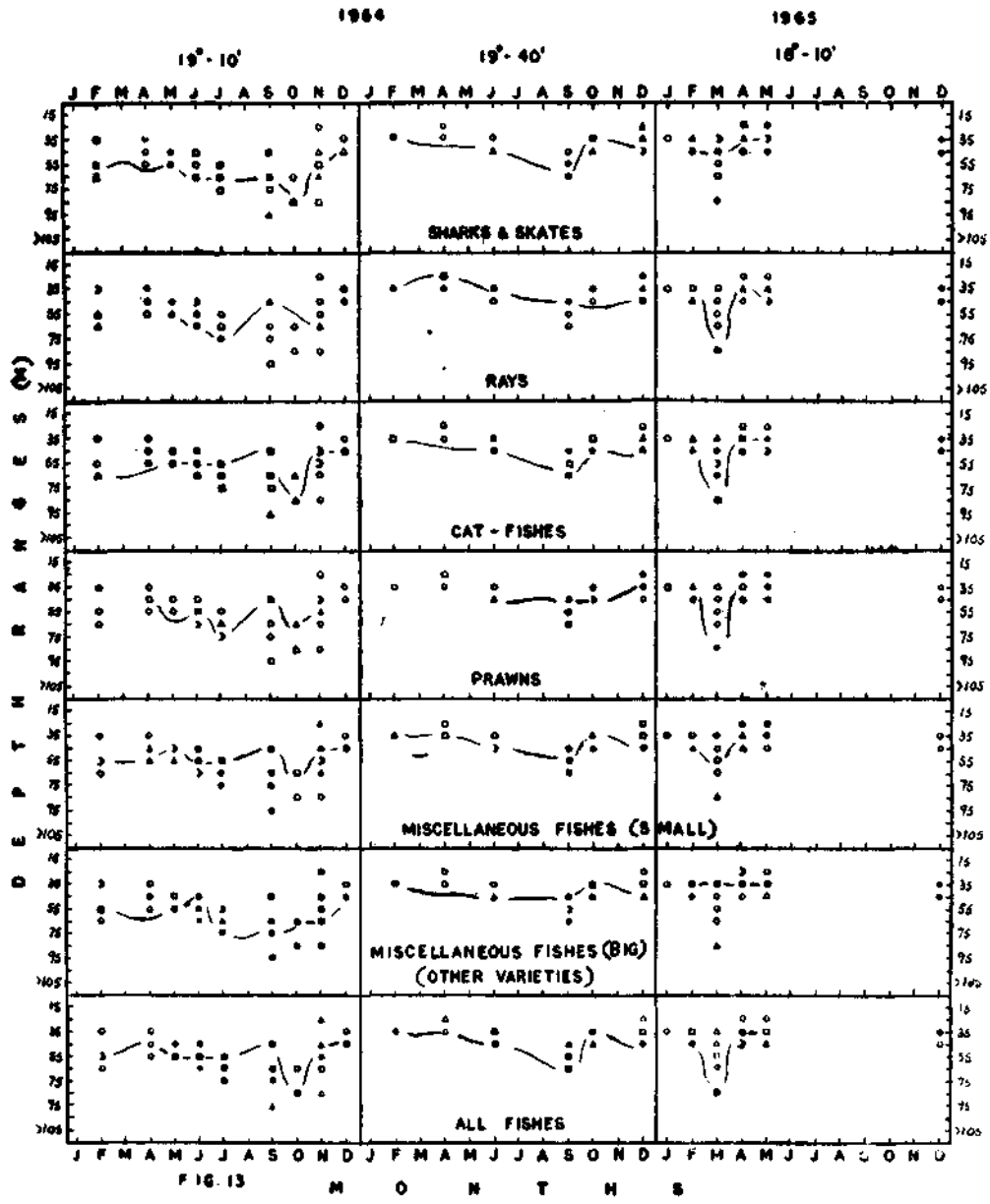

FIG. 13

FIG. 13. The monthly catch per hour (kg.) in the 10 m. depth-ranges of the 19° 10′ and 19° 40′ zones in 1964 and of the 18° 10′ zone in 1965 recorded by *Ashok* (Each of the zones was fished for 6 months or more in the years referred to.

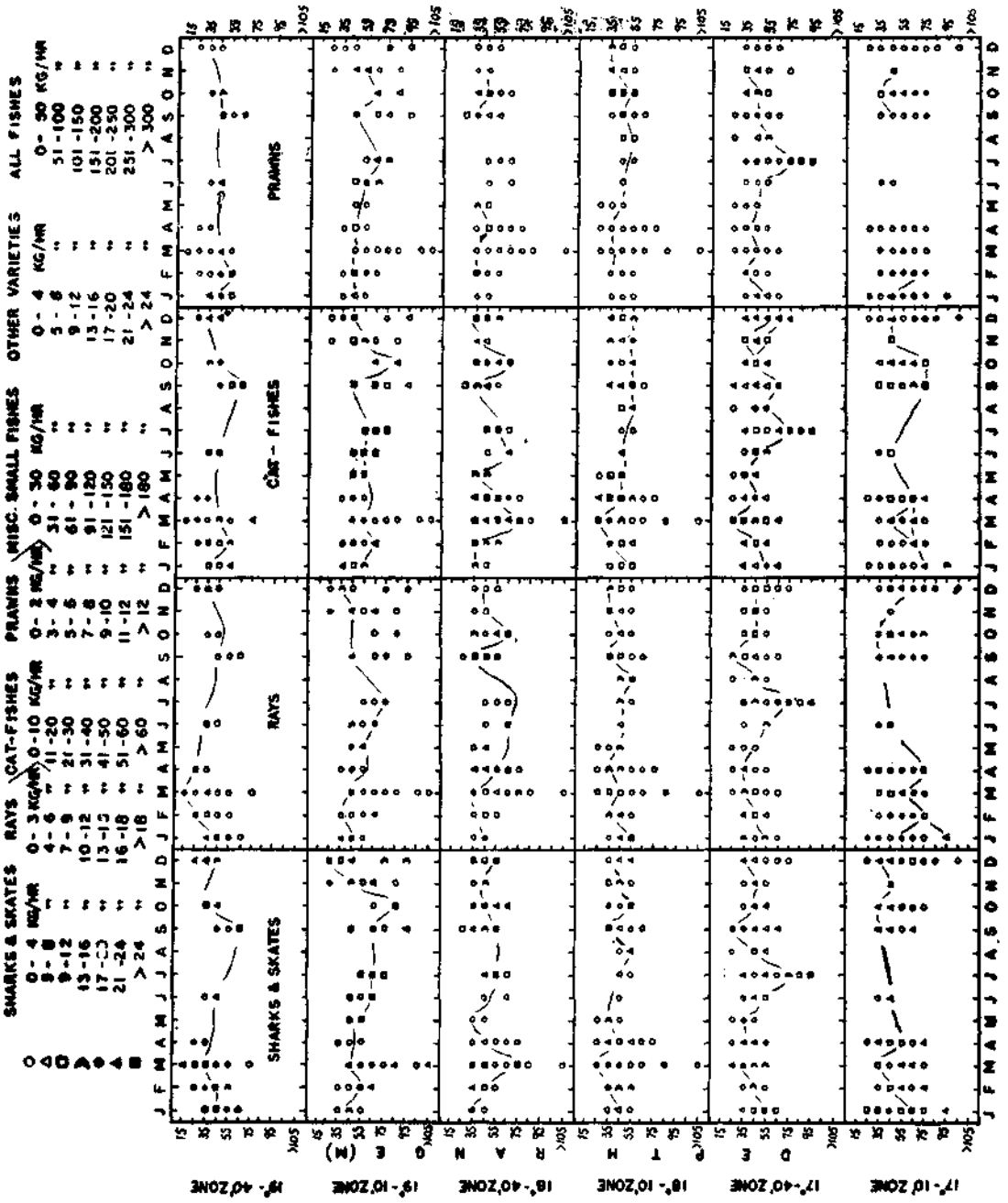

FIG. 14. The arithmetic averages of the c.p.h. of the corresponding months of 1962–65 record from 10 m. depth ranges of the 17°10'–19°40' zones by *Ashok* and *Pratap* (The lines join the depth ranges of the best average monthly c.p.h.).

On an "all fish" basis, the inshore grounds of the various zones generally give higher yield rates than the offshore grounds during at least two periods per year: April-June and October-December. July-September is the main period when the yield rate may be higher in the offshore grounds.

For sharks and skates the concentrations are generally better inshore than offshore during at least two periods per year: February-May and October-December. In July-September, the catch rates are generally higher in offshore grounds than in inshore grounds.

Rays generally attain higher level of abundance in the inshore region compared to the offshore region twice a year in the various zones: February-June and September-December. On the other hand, June-August is the main period of peak abundance in the offshore region.

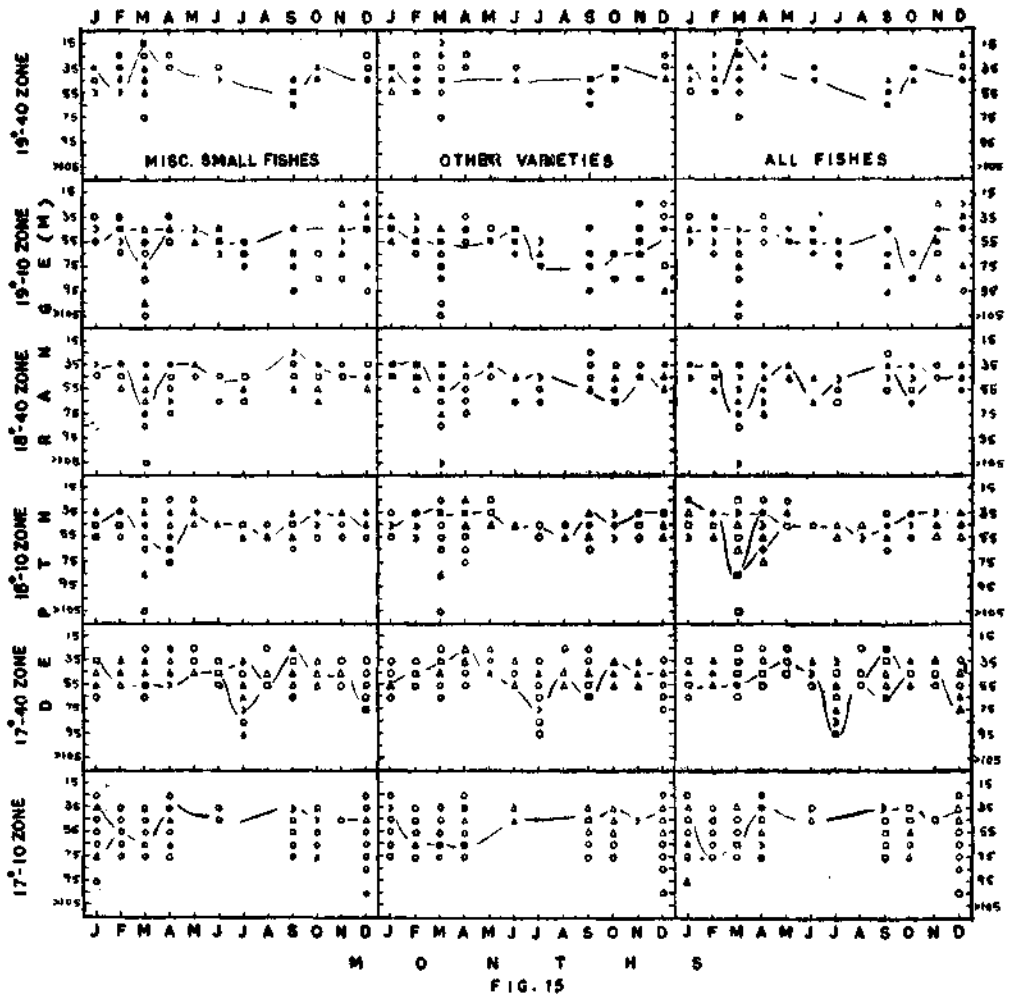

FIG. 15

FIG. 15. The arithmetic averages of the c.p.h. of the corresponding months of 1962–65 recorded from 10 m depth ranges of the 17° 10′–19°–40′ zones by *Ashok* and *Pratap* (The lines join the depth-ranges of the best average monthly c.p.h.).

Generally, February-April and October-December are the main periods when the relative abundance of cat-fishes is higher in the inshore grounds than in the offshore grounds, and July-September when it is higher in the offshore grounds.

The abundance of prawns is comparatively higher in the inshore grounds than in the offshore grounds generally during two periods per year: March-June and October-December. July-September is the main period of higher abundance in offshore grounds.

For miscellaneous small fishes the two periods of high abundance in the inshore regions of the various zones are April-June and October-January.

For miscellaneous big fishes (other varieties) the catch rates generally are better inshore than offshore in the various zones during March-June and October-January. The reverse trend is observed in July-September.

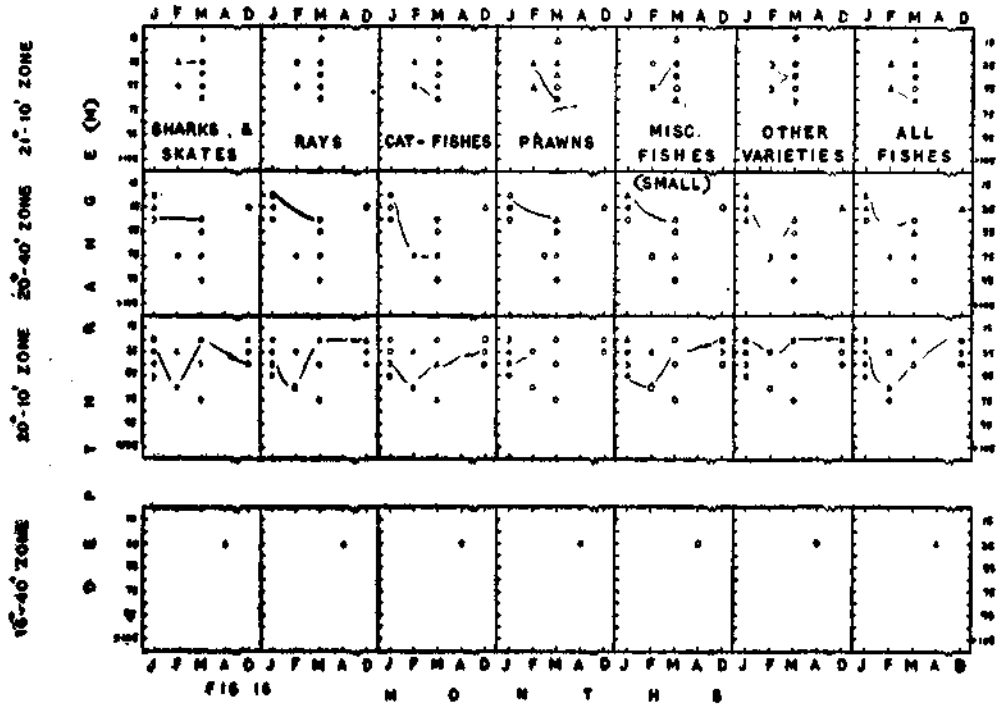

FIG. 16. The arithmetic averages of the c.p.h. of the corresponding months of 1962-65 recorded 10 ni from depth-ranges of the zones 16° 40′ and 20° 10′-21° 10′.

(*B*) *Champa and Sea Horse* (TABLES XVI AND XVII)

The periods of abundance of the different categories of fishes in the inshore and offshore areas of the 17° 40′ and 18° 10′ zones as shown by the data of these vessels are generally comparable to those indicated by *Ashok* and *Pratap*. But certain important differences found from a study of the annual data are referred to here.

In the 17° 40′ zone, towards the close of the year, the shift of the best c.p.h. of ''all fishes to offshore grounds takes place earlier (in November) than indicated by the data of *Ashok* and

TABLE XVI

The average monthly catch per hour (kg.) recorded from different depth-ranges during 1962-65 *by m.v.* Champa
(These are the arithmetic averages of the c.p.h. of the corresponding months of 1962-65)
n.f. = No fishing

Depth range	A. 17° 40′ Zone											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
i. Sharks and Skates												
10–19 ..	n.f.	n.f.	7·9	3·8	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	3·6	n.f.
20–29 ..	2·2	7·6	4·8	10·3	2·5	0·8	3·9	9·9	6·8	2·4	5·2	7·1
30–39 ..	3·2	4·6	7·5	12·0	3·9	5·3	8·1	6·8	1·5	6·4	9·4	4·6
40–49 ..	8·9	3·3	5·8	5·9	7·0	3·8	4·9	2·4	10·3	7·3	9·2	77·6
50–59 ..	4·3	5·6	4·7	12·8	7·3	2·4	4·6	8·0	4·0	3·9	5·6	4·9
60–69 ..	6·0	15·3	1·7	6·2	1·4	3·0	5·4	10·0	12·2	12·0	7·8	1·7
70–79 ..	4·4	7·3	0·5	4·3	5·0	n.f.	2·0	n.f.	15·1	n.f.	n.f.	5·7
80–89 ..	n.f.	n.f.	5·2	50·0	n.f.	n.f.	n.f.	n.f.	3·3	n.f.	n.f.	n.f.
90–99 ..	n.f.	n.f.	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
100–09 ..	n.f.	n.f.	n.f	n.f.	n.f	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	12·0
ii. Rays												
10–19 ..	n.f.	n.f.	16·8	9·6	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	18·3	n.f.
20–29 ..	0·0	12·8	5·4	17·2	7·9	10·5	8·0	6·0	2·4	1·4	1·8	0·0
30–39 ..	8·5	16·9	4·0	4·5	8·1	5·3	6·3	6·0	1·1	13·3	5·6	7·5
40–49 ..	8·8	12·7	2·5	4·7	2·8	4·3	2·1	2·2	3·0	5·2	3·2	24·1
50–59 ..	8·5	4·5	7·3	4·9	2·3	3·6	3·2	4·0	13·5	1·9	0·8	3·8
60–69 ..	2·5	3·1	10·8	0·0	2·7	2·0	11·0	7·7	1·5	0·1	1·3	10·9
70–79 ..	0·0	0·0	2·8	4·8	3·0	n.f.	0·0	n.f.	10·6	n.f.	n.f.	14·3
80–89 ..	n.f.	n.f.	4·8	5·0	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.
90–99 ..	n.f.	n.f.	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
100–09 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	2·0
iii. Cat-fishes												
10–19 ..	n.f.	n.f.	0·0	22·4	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	5·7	n.f.
20–29 ..	0·0	30·5	14·3	31·2	51·1	5·5	1·0	1·2	0·9	10·8	6·0	0·9
30–39 ..	5·6	11·3	11·6	26·5	123·5	12·6	1·7	2·7	2·9	8·5	8·2	12·7
40–49 ..	8·0	20·6	28·9	16·5	35·5	19·4	4·2	6·2	5·7	9·8	17·9	6·4
50–59 ..	12·6	13·8	31·5	13·6	18·4	27·1	8·8	5·2	22·1	11·1	35·1	8·0
60–69 ..	12·7	21·2	10·5	1·6	36·5	71·0	31·8	6·8	59·7	72·9	15·8	6·4
70–79 ..	20·0	30·9	4·4	0·0	1·0	n.f.	18·0	n.f.	0·9	n.f.	n.f.	45·5
80–89 ..	n.f.	n.f	16·0	0·0	n.f.	n.f.	n.f.	n.f.	2·0	n.f.	n.f	n.f.
90–99 ..	n.f	n.f	0·0	n.f.	n.f	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
100–09 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	8·0
iv. Prawns												
10–19 ..	n.f.	n.f.	10·2	8·9	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	2·6	n.f.
20–29 ..	0·0	5·7	5·6	4·9	1·2	2·8	3·2	n.f.	8·4	5·4	0·5	0·0
30–39 ..	3·8	0·6	1·3	4·4	14·8	5·9	2·4	0·5	7·8	10·0	7·0	0·0
40–49 ..	12·4	0·6	0·6	1·7	1·0	4·3	1·8	1·4	3·1	12·6	8·2	1·6
50–59 ..	1·8	0·1	0·8	1·9	0·1	13·5	2·9	3·8	8·4	4·8	2·3	1·9
60–69 ..	0·0	0·0	0·0	3·3	0·5	50·0	8·1	0·4	6·5	12·3	0·9	0·0
70–79 ..	0·0	0·0	0·6	0·0	1·0	n.f.	0·3	n.f.	1·1	n.f.	n.f.	3·2
80–89 ..	n.f.	n.f.	1·6	0·0	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.
90–99 ..	n.f.	n.f.	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
100–09 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0

TABLE XVI—*Comtd.*

Depth range	Jan.	Feb.	Mar.	April	May	Juue	July	Aug.	Sept	Oct.	Nov.	Dec.
					v. Misc. Small Fishes							
10–19 ..	n.f.	n.f.	89·8	76·5	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	32·0	n.f.
20–29 ..	133·3	15·0	139·5	141·0	89·5	47·2	36·5	32·9	60·0	63·1	34·8	22·0
30–39 ..	124·6	46·4	97·5	133·2	108·0	53·8	52·8	74·8	108·1	45·1	70·2	22·9
40–49 ..	47·0	50·7	85·2	117·4	59·0	29·8	32·6	48·8	48·9	50·5	75·2	22·4
50–59 ..	35·5	28·8	37·4	110·2	44·1	50·6	33·8	27·2	52·7	41·3	46·6	25·4
60–69 ..	81·0	24·0	23·1	175·0	59·1	66·0	67·6	49·0	62·3	54·6	34·3	17·2
70–79 ..	240·0	18·2	22·8	53·3	75·0	n.f.	35·7	n.f.	36·9	n.f.	n.f.	30·8
80–89 ..	n.f.	n.f.	28·6	6·0	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.
90–99 ..	n.f.	n.f.	30·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	11·1
100–09 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	10·0
					vi. Misc. Big Fishes							
10–19 ..	n.f.	n.f.	1·0	12·2	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	2·5	n.f.
20–29 ..	0·0	0·4	3·8	28·7	1·8	7·0	6·2	2·6	2·3	1·3	0·5	0·3
30–39 ..	5·5	10·9	13·2	5·7	8·4	3·5	10·1	1·2	0·7	2·8	3·1	2·3
40–49 ..	5·1	6·6	8·5	6·3	6·1	3·5	2·1	1·3	1·4	3·3	4·2	1·5
50–59 ..	4·8	2·9	4·0	1·6	6·4	2·8	2·0	2·0	2·0	2·4	4·6	1·7
60–69 ..	3·0	5·4	0·4	5·0	4·1	5·0	4·9	2·0	6·9	5·9	7·7	0·7
70–79 ..	9·6	6·5	2·0	4·3	2·5	n.f.	1·5	n.f.	0·3	n.f.	n.f.	0·7
80–89 ..	n.f.	n.f	1·2	1·5	n.f.	n.f.	n.f.	n.f.	0·7	n.f.	n.f.	n.f.
90–99 ..	n.f.	n.f.	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
100–09 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
					vii. All Fishes							
10–19 ..	n.f.	n.f.	125·7	133·4	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	64·7	n.f.
20–29 ..	135·5	72·0	173·4	233·3	154·0	73·8	58·8	52·6	80·8	84·4	48·8	30·3
30–39 ..	151·2	90·7	135·1	186·3	266·6	86·4	81·4	92·0	122·1	86·1	103·5	50·0
40–49 ..	90·2	94·5	131·5	152·5	111·4	65·1	47·7	62·3	72·4	88·7	117·9	133·6
50–59 ..	67·5	55·7	75·7	145·0	78·6	100·0	55·3	50·2	102·7	65·4	95·0	45·7
60–69 ..	105·2	69·0	46·5	191·1	104·3	197·0	128·8	75·9	149·1	157·8	67·8	36·9
70–79 ..	270·0	62·9	33·1	66·8	87·5	n.f.	57·5	n.f.	64·9	n.f.	n.f.	100·2
80–89 ..	n.f.	n.f.	57·4	62·5	n.f.	n.f.	n.f.	n.f.	6·0	n.f.	n.f.	n.f.
90–99 ..	n.f.	n.f.	41·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	11·1
100–09 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	32·0

TABLE XVI—*Contd.*

B. 18°10′ zone

Depth range	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
						i. Sharks and Skates						
10–19 ..	n.f.	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	0·5	0·7	0·1	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	5·0
30–39 ..	5·8	4·6	14·3	0·6	1·0	6·1	n.f.	19·0	n.f.	13·0	5·9	4·9
40–49 ..	7·2	3·3	13·0	1·6	0·4	14·5	38·4	5·6	n.f.	6·3	12·9	14·3
50–59 ..	40·8	1·7	9·0	3·9	n.f.	0·0	1·7	2·9	n.f.	3·0	13·5	1·5
60–69 ..	n.f.	n.f.	6·7	n.f.	n.f.	n.f.	n.f.	5·6	n.f.	4·0	n.f.	n.f.
70–79 ..	n.f.	n.f.	5·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
						ii. Rays						
10–19 ..	n.f.	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	0·8	1·4	1·2	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
30–39 ..	1·4	11·8	7·9	5·0	11·3	7·9	n.f.	10·0	n.f.	26·7	10·3	22·9
40–49 ..	11·5	2·4	7·5	0·8	6·4	15·3	12·8	11·5	n.f.	8·7	10·6	0·3
50–59 ..	15·2	0·0	33·3	6·2	n.f.	3·1	0·0	6·9	n.f.	1·8	0·0	4·9
60–69 ..	n.f.	n.f.	0·0	n.f	n.f.	n.f.	n.f.	10·9	n.f.	0·0	n.f.	n.f.
70–79 ..	n.f.	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
						iii. Cat-fishes						
10–19 ..	n.f.	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	1·0	20·4	13·3	n.f.	n.f.	n.f.	n.f	n.f.	n.f.	n.f.	3·5
30–39 ..	3·9	7·6	36·0	4·9	10·7	6·6	n.f.	25·0	n.f.	9·7	5·0	2·6
40–49 ..	6·9	9·6	62·1	12·0	1·1	51·9	6·0	4·0	n.f.	5·5	7·8	7·0
50–59 ..	49·2	0·6	218·3	25·4	n.f.	26·4	0·0	27·5	n.f.	11·3	13·4	3·7
60–69 ..	n.f.	n.f.	834·7	n.f	n.f.	n.f.	n.f.	25·3	n.f.	3·5	n.f.	n.f.
70–79 ..	n.f.	n.f.	76·0	0·0	n.f.	n.f.	n.f.	n.f	n.f.	n.f.	n.f.	n.f.
						iv. Prawns						
10–19 ..	n.f.	n.f.	0·0	0·2	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	0·0	0·5	13·1	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
30–39 ..	0·3	0·0	0·0	5·2	2·3	0·7	n.f.	2·5	n.f.	13·1	5·8	1·4
40–49 ..	9·8	0·2	0·4	1·3	0·5	5·6	4·4	1·1	n.f.	25·4	5·0	0·0
50–59 ..	2·2	0·3	0·0	0·0	n.f.	4·8	0·0	1·7	n.f.	9·9	3·1	3·4
60–69 ..	n.f.	n.f.	0·0	n.f.	n.f.	n.f.	n.f.	4·5	n.f.	0·0	n.f.	n.f.
70–79 ..	n.f.	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.

TABLE XVI—*Contd.*

Depth range	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					v. Misc. Small Fishes							
10–19 ..	n.f.	n.f.	0·0	86·3	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	18·0	68·3	44·6	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	111·3
30–39 ..	45·2	68·3	90·1	130·4	68·0	26·3	n.f.	103·5	n.f.	106·6	181·2	62·5
40–49 ..	64·1	47·0	115·4	102·5	87·2	60·7	28·0	63·4	n.f.	126·5	72·7	24·7
50–59 ..	82·5	19·5	52·0	84·6	n.f.	41·1	83·3	63·1	n.f.	87·8	169·6	20·2
60–69 ..	n.f.	n.f.	84·4	n.f.	n.f	n.f.	n.f.	63·3	n.f.	50·0	n.f.	n.f.
70–79 ..	n.f.	n.f.	90·0	24·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f
					vi. Misc. Big Fishes							
10–19 ..	n.f.	n.f.	0·0	2·5	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	0·0	0·7	2·2	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0·0
30–39 ..	1·3	2·7	7·7	1·2	0·0	1·7	n.f.	0·0	n.f.	0·7	1·8	0·6
40–49 ..	8·5	4·1	14·9	1·5	1·2	2·6	4·4	0·8	n.f.	4·4	6·1	0·3
50–59 ..	10·3	0·0	6·3	1·6	n.f.	2·4	2·7	0·9	n.f.	4·1	6·5	1·4
60–69 ..	n.f.	n.f.	8·4	n.f.	n.f.	n.f.	n.f.	5·4	n.f.	0·0	n.f.	n.f.
70–79 ..	n.f.	n.f.	10·0	0·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
					vii. All Fishes							
10–19 ..	n.f.	n.f.	0·0	89·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	20·3	92·0	74·9	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	111·3
30–39 ..	57·9	95·0	156·0	147·3	83·3	49·1	n.f.	160·0	n.f.	169·8	209·0	94·9
40–49 ..	108·0	99·9	213·3	119·7	96·8	150·6	94·0	86·4	n.f.	176·8	104·9	46·6
50–59 ..	200·7	22·1	319·0	121·7	n.f.	80·2	87·7	102·8	n.f.	117·9	206·1	35·1
60–69 ..	n.f.	n.f.	934·2	n.f.	n.f.	n.f.	n.f.	115·0	n.f.	57·5	n.f.	n.f.
70–79 ..	n.f.	n.f.	181·0	24·0	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.

From the 80–89 and 90–99 m. depth-ranges respectively of the 18° 10′ Zone, the following averages were recorded in March: 0·0 and 7·5 kg. for sharks and skates; 5·0 and 8·5 kg. for rays; 0·0 and 27·5 kg. for cat-fishes; 0·0 and 0·0 kg. for prawns; 10·0 and 28·0 kg. for misc. small fishes; 0·0 and 2·0 kg. for misc. big fishes and 15·0 and 73·5 kg. for "all fishes".

Pratap (December-January). Moreover in April-May in this zone, *Champa* and *Sea Horse*, unlike *Ashok* and *Pratap* recorded the best c.p.h. of sharks and skates, prawn and miscellaneous big fishes from offshore grounds; in March-April the best c.p.h. of rays was obtained from offshore grounds by the former but from inshore grounds by the latter vessels. A shift of the best c.p.h. of rays to the deeper grounds in October in the 18° 10′ zone is indicated by the data of the former but not by the latter vessels. In this zone in April, the concentration of miscellaneous big fishes is better in offshore grounds than in inshore grounds as indicated by the data of *Champa* and

TABLE XVII

The average monthly catch per hour (kg.) recorded by m.v. Sea Horse from different depth ranges of the 17° 40′ *and* 18° 10′ *Zones during* 1962–65 (*Details as in Table* XVI)

A. 17°40′ zone

Depth range	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
i. Sharks and Skates												
10–19 ..	n.f.	n.f.	17·2	6·7	0·0	n.f.	n.f.	n.f.	0·0	n.f.	0·0	n.f.
20–29 ..	5·8	10·9	5·3	0·9	1·7	0·0	2·3	n.f.	0·0	0·9	2·6	0·8
30–39 ..	5·6	4·0	2·6	1·4	3·8	15·9	3·0	5·9	18·0	9·6	2·9	3·9
40–49 ..	4·2	4·1	3·7	5·7	4·1	5·7	4·3	3·3	5·2	2·5	3·1	4·8
50–59 ..	3·4	3·2	3·7	2·5	1·5	0·0	10·2	3·5	4·3	9·5	4·2	14·5
60–69 ..	6·7	5·2	15·2	0·3	1·0	0·9	0·0	4·2	5·7	1·7	n.f.	n.f.
70–79 ..	1·2	0·6	4·3	n.f.	n.f.	n.f.	n.f.	n.f.	4·0	n.f.	n.f.	n.f.
ii. Rays												
10–19 ..	n.f.	n.f.	16·5	4·7	8·5	n.f.	n.f.	n.f.	10·0	n.f.	0·0	n.f.
20–29 ..	3·8	0·3	8·7	1·6	9·4	11·6	11·7	n.f.	7·1	2·4	4·4	18·1
30–39 ..	16·8	5·0	3·8	3·9	4·8	4·4	13·8	14·3	10·2	8·6	2·3	9·0
40–49 ..	2·8	5·9	3·6	0·3	4·5	9·3	6·1	3·9	10·2	5·6	1·5	1·7
50–59 ..	1·3	4·1	4·7	1·7	3·3	0·0	1·3	0·5	18·3	7·1	4·5	4·7
60–69 ..	0·8	3·6	7·9	0·6	1·6	0·0	100·0	0·0	1·4	66·6	n.f.	n.f.
70–79 ..	0·0	0·0	15·8	n.f.	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.
iii. Cat-fishes												
10–19 ..	n.f.	n.f.	0·0	133·3	0·0	n.f.	n.f.	n.f.	0·0	n.f.	0·0	n.f.
20–29 ..	13·5	2·1	0·3	7·3	4·4	3·5	2·4	n.f.	3·7	11·3	1·5	7·7
30–39 ..	181·5	4·0	6·4	13·6	25·5	35·1	2·5	4·5	6·7	3·0	2·7	7·8
40–49 ..	5·4	4·4	3·9	5·2	21·7	38·6	8·4	7·0	4·4	5·1	6·2	7·8
50–59 ..	4·7	5·1	6·8	18·2	14·2	0·0	37·6	15·7	7·8	5·5	9·2	9·3
60–69 ..	12·1	9·2	23·5	27·2	9·9	6·7	8·4	42·5	15·9	21·7	n.f.	n.f.
70–79 ..	1·8	12·6	6·1	n.f.	n.f.	n.f.	n.f.	n.f.	15·0	n.f.	n.f.	n.f.
iv. Prawns												
10–19 ..	n.f.	n.f.	17·6	2·0	0·0	n.f.	n.f.	n.f.	0·0	n.f.	0·0	n.f.
20–29 ..	1·0	1·5	3·6	0·7	0·7	0·0	1·9	n.f.	0·0	1·8	5·3	0·9
30–39 ..	1·7	0·9	5·7	2·2	1·2	1·4	0·5	0·0	0·8	0·0	5·0	2·3
40–49 ..	1·0	1·0	0·8	1·3	0·8	1·2	2·7	1·3	2·0	3·2	1·6	3·6
50–59 ..	1·9	1·0	0·7	0·6	1·8	0·0	2·5	0·0	0·7	2·6	4·2	0·0
60–69 ..	1·6	0·5	0·1	0·0	0·0	0·0	0·0	0·0	0·0	0·0	n.f.	n.f.
70–79 ..	0·0	0·0	0·1	n.f.	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.

TABLE XVII—*Contd.*

Depth range	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					v. Misc. Small Fishes							
10–19 ..	n.f.	n.f.	59·0	20·0	13·0	n.f.	n.f.	n.f.	75·0	n.f.	38·0	n.f.
20–29 ..	98·6	28·4	54·7	26·9	24·2	38·7	52·1	n.f.	26·9	71·1	22·7	24·6
30–39 ..	66·3	39·1	33·8	47·1	58·9	61·1	49·9	71·6	48·7	15·6	22·4	27·1
40–49 ..	45·2	46·3	36·0	40·1	30·9	26·4	54·7	25·7	46·8	37·6	29·0	30·1
50–59 ..	37·1	36·9	19·7	18·9	26·3	0·0	37·6	49·5	33·2	39·6	45·7	34·4
60–69 ..	63·0	20·2	57·9	3·8	8·8	11·1	14·0	52·2	52·0	47·0	n.f.	n.f.
70–79 ..	22·4	4·0	41·4	n.f.	n.f.	n.f.	n.f.	n.f.	72·0	n.f.	n.f.	n.f.
					vi. Misc. Big Fishes							
10–19 ..	n.f.	n.f.	0·0	0·0	0·0	n.f.	n.f.	n.f.	0·0	n.f.	0·0	n.f.
20–29 ..	2·4	0·4	1·0	0·3	0·7	0·0	3·6	n.f.	0·0	2·7	0·6	0·2
30–39 ..	3·1	2·6	1·1	3·9	1·3	0·4	1·6	0·3	0·2	2·3	0·7	2·3
40–49 ..	1·2	1·9	2·4	3·2	1·9	0·9	1·0	1·2	0·5	2·1	1·3	1·4
50–59 ..	2·6	1·0	0·1	0·4	0·8	0·0	1·6	1·1	0·0	4·6	3·4	2·1
60–69 ..	31·0	1·4	0·0	0·0	1·9	0·6	0·0	5·6	0·0	2·0	n.f.	n.f.
70–79 ..	0·0	3·4	1·9	n.f.	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.
					vii. All Fishes							
10–19 ..	n.f.	n.f.	110·3	166·7	22·2	n.f.	n.f.	n.f.	85·0	n.f.	43·0	n.f.
20–29 ..	121·2	43·6	73·6	37·6	41·1	53·8	74·0	n.f.	37·7	90·2	37·1	52·3
30–39 ..	275·1	55·7	53·4	72·1	95·2	118·3	71·3	96·6	84·6	39·1	36·0	52·4
40–49 ..	59·9	63·6	50·4	55·9	63·6	82·1	77·2	42·4	69·1	56·1	42·7	49·4
50–59 ..	51·2	51·4	35·5	42·2	47·9	0·0	90·8	70·3	64·3	68·9	71·2	65·0
60–69 ..	115·1	40·0	84·0	31·9	22·1	19·3	122·4	104·5	76·0	139·0	n.f.	n.f.
70–79 ..	25·3	20·6	69·4	n.f.	n.f.	n.f.	n.f.	n.f.	91·0	n.f.	n.f.	n.f.

The following averages (kg.) were also recorded in March in 80–89 and 90–99 m respectively: 1·9 and 5·0 for sharks and skates; 3·1 and 3·0 for rays; 14·9 and 1·0 for cat-fishes; 2·8 and 0·0 for prawns; 55·4 and 20·0 for miscellaneous small fishes; 4·8 and 4·0 for miscellaneous big fishes and 82·8 and 33·0 for "all fishes".

Sea Horse. In respect of cat-fishes, the data of *Champa* and *Sea Horse* show that in both zones, higher catch rates may be obtained from the deeper grounds than from shallow grounds in November-March.

The data of all the vessels agree in indicating an important feature: that the offshore shift of the best c.p.h. of "all fishes" and miscellaneous small fishes in February-March takes place only in some years and is not as regular or as pronounced as that in July-September.

TABLE XVII—*Contd.*

B. 18° 10′ zone

Depth range	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
i. Sharks and Skates												
10–19 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	n.f.	0·0	0·3	0·0	n.f.	0·7	n.f.	n.f.	0·0	n.f.	0·0
30–39 ..	n.f.	2·6	0·0	0·0	0·0	n.f.	0·0	0·0	n.f.	0·0	0·0	5·0
40–49 ..	1·5	3·0	0·0	0·2	2·3	3·8	1·2	6·9	n.f.	1·9	2·8	16·0
50–59 ..	n.f.	4·4	n.f.	0·0	n.f.	n.f.	4·1	5·4	n.f.	3·0	1·3	6·7
60–69 ..	n.f.	2·0	0·6	n.f.	n.f.	n.f.	n.f.	2·0	n.f.	n.f.	n.f.	n.f.
ii. Rays												
10–19 ..	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.
20–29 ..	n.f.	n.f.	0·0	1·4	0·0	n.f.	7·0	n.f.	n.f.	0·0	n.f.	0·0
30–39 ..	n.f.	8·3	1·7	0·0	0·0	n.f.	40·0	0·0	n.f.	0·0	0·0	4·0
40–49 ..	1·5	1·7	0·0	2·7	3·4	2·6	8·5	30·0	n.f.	1·4	0·0	7·5
50–59 ..	n.f.	17·0	n.f.	3·8	n.f.	n.f.	0·7	3·5	n.f.	16·8	0·0	3·1
60–69 ..	n.f.	20·0	0·0	n.f.	n.f.	n.f.	n.f.	19·9	n.f.	n.f.	n.f.	n.f.
iii. Cat-fishes												
20–29 ..	n.f.	n.f.	0·0	0·0	0·0	n.f.	0·0	n.f.	n.f.	3·0	n.f.	0·0
30–39 ..	n.f.	5·8	0·0	10·7	12·1	n.f.	0·0	0·0	n.f	5·2	10·0	23·3
40–49 ..	32·5	2·5	0·0	20·7	8·5	9·6	4·5	0·0	n.f.	12·1	8·5	121·0
50–59 ..	n.f.	1·6	n.f.	15·0	n.f.	n.f.	60·4	38·7	n.f.	3·0	11·6	20·4
60–69 ..	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	65·4	n.f.	n.f.	n.f.	n.f.
iv. Prawns												
20–29 ..	n.f.	n.f.	0·0	0·0	0·0	n.f.	1·0	n.f.	n.f.	0·0	n.f.	0·0
30–39 ..	n.f.	6·3	0·0	0·5	0·0	n.f.	0·0	0·0	n.f.	0·0	0·0	20·0
40–49 ..	16·5	0·0	0·0	1·2	0·0	0·0	0·0	0·0	n.f.	1·3	2·1	74·0
50–59 ..	n.f.	3·4	n.f.	0·0	n.f.	n.f	0·0	0·0	n.f.	0·0	2·8	0·0
60–69 ..	n.f.	0·0	0·0	n.f.	n.f.	n.f.	n.f.	0·0	n.f.	n.f.	n.f.	n.f.
v. Misc. Small Fishes												
20–29 ..	n.f.	n.f.	8·8	40·6	7·7	n.f.	66·0	n.f.	n.f.	32·0	n.f.	0·0
30–39 ..	n.f.	18·7	18·8	22·8	68·2	n.f.	66·7	49·4	n.f.	30·4	33·3	67·4
40–49 ..	58·0	23·0	2·4	31·8	31·8	56·7	52·8	32·7	n.f.	70·5	56·4	195·0
50–59 ..	n.f.	57·7	n.f.	4·2	n.f.	n.f.	79·4	65·3	n.f.	60·0	52·8	32·0
60–69 ..	n.f.	43·0	6·2	n.f.	n.f.	n.f.	n.f.	168·5	n.f.	n.f.	n.f.	n.f.

TABLE XVII—*Contd.*

Depth range	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					vi. Misc. Big Fishes							
20–29 ..	n.f.	n.f.	0·0	0·0	0·0	n.f.	0·7	n.f.	n.f.	0·0	n.f.	0·0
30–39 ..	n.f.	0·7	0·0	3·6	0·0	n.f.	1·3	0·0	n.f.	0·0	0·0	0·0
40–49 ..	10·5	0·5	0·0	0·4	0·0	2·1	1·7	1·8	n.f.	0·5	0·5	1·5
50–59 ..	n.f.	1·9	n.f.	1·4	n.f.	n.f.	3·1	2·1	n.f.	0·0	3·2	0·0
60–69 ..	n.f.	0·0	0·3	n.f.	n.f.	n.f.	n.f.	2·7	n.f.	n.f.	n.f.	n.f.
					vii. All Fishes							
20–29 ..	n.f.	n.f.	8·8	42·0	7·7	n.f.	75·4	n.f.	n.f.	35·0	n.f.	0·0
30–39 ..	n.f.	42·4	20·5	235·5	80·3	n.f.	108·0	49·4	n.f	35·6	43·3	119·7
40–49 ..	120·5	30·7	2·4	57·0	45·5	74·8	68·7	71·4	n.f.	87·7	70·3	415·0
50–59 ..	n.f.	86·0	n.f.	24·4	n.f.	n.f.	147·7	115·0	n.f.	82·8	71·7	62·2
60–69 ..	n.f.	65·0	7·1	n.f.	n.f.	n.f.	n.f.	258·5	n.f.	n.f.	n.f.	n.f.

TABLE XVIII

Minimum annual catches expected, if commercial trawling is undertaken by vessels of different sizes in the area

		Estimates made by							
		Borisov (1962)				The present authors			
		Ashok	*Pratap*	*Champa*	*Sea Horse*	*Ashok*	*Pratap*	*Champa*	*Sea Horse*
1	No. of days out of port ..	189	Not stationed		235	189	189	235	235
2	No. of days of fishing ..	105	at		235	105	105	235	235
3	No. of hours of fishing ..	1890	Visakhapatnam		1410	1890	1890	1060	1000
4	Catch per hour (kg.) Range ..	..	during		..	130–205	130–205	63–164	56–94
	Catch per hour (kg.) Average ..	150			57	150	150	118	76
5	Catch per day out of port (kg.) Range ..	..	Borisov's		..	1323–2064	1323–2064	285–740	238–400
	Catch per day out of port (kg.) Average ..	..	period of		..	1497	1497	532	323
6	Annual catch (m.t.) Range ..	280–300	work		80–90	250–390	250–390	67–174	56–94
	Annual catch (m.t.) Average ..	283			80	283	283	125	76

Note.—(1) The total number of working days of *Ashok* per year is regarded as only 270, leaving 95 days per year for laying up the vessel because of bad weather, repairs, etc. In 270 days, *Ashok* can undertake a total of 27 voyages of 10 days' duration each; the time spent in port between voyages is regarded as $27 \times 3 = 81$ days; the time spent for travelling to and from the fishing grounds is put as 56 days (steaming speed: 6 knots; the average radius of the fishing ground from base: 150 miles); the time likely to be spent on trial fishing and searching for fishes is put as 28 days. Thus the time left for fishing per year is put as 105 days or 2520 hours; leaving 25% of this time for shooting and hauling, the actual trawling time per year is estimated as 1890 hours, which multiplied by the catch per hour gives the expected total catch per year.

(2) The number of days when *Champa* and *Sea Horse* are likely to be laid up because of bad weather and repairs is put as 130 per year; the average number of hours of fishing per working day is put as 4·5 for *Champa* and 4·25 for *Sea Horse*.

(3) Nets: as mentioned in Table I (*i.e.*, *Ashok* and *Pratap*: 15 m otter-trawl; *Champa*: 14 m. otter-trawl; *Sea Horse*: 12 m. otter-trawl).

Succession of Fish Faunal Groups in Different Depth-Ranges

The gross classification of the fish fauna adopted here precludes a detailed study of possible fish faunal succession in different depth-ranges according to season. Nevertheless certain broad indications in this regard are available. A level of relative density to the extent of being the most abundant single category (in terms of c.p.h.) has not been observed in the case of sharks and skates, rays, prawns or miscellaneous big fishes in any depth range fished in any month. The other two groups attain that level in different seasons.

The months when cat-fishes or the miscellaneous small fishes usually form the most abundant group in different depths in the landings of *Ashok* and *Pratap* are given below.

Months when cat-fishes are the most abundant group.	Months when miscellaneous small fishes are the most abundant group
17° 10′ Zone	
April, June in 40–49 m, April in 60–69 m, January in 70–79 and 90–99 m	January, April, December in 20–29 m. February, March (sometimes January, and April) and generally September-December in deeper grounds.
17° 40′ Zones	
Generally March-May (sometimes January) and November- December in 30–69 m, July in 60–99 m.	March-May, August, September. in 20–29 m, January, February (sometimes March) and June-October (Sometimes November) in 30–59 m, December in 70–79 m.
18° 10′ Zone	
April-June, (Sometimes March) in 20–49 m, August-December in 50–59 m, March in 80–89 m.	January-March, September - December, in 30–49 m, January, March and July in 40–59 m, April, May in 60–69 m, September, in 40–49 and 60–69 m.
18° 40′ Zone	
February-April, October, December in 30–59 m, January, October in 60–69 m, March in 70–79 and 100 m and above.	September in 20–29 m, June, July, September, November in 30–59 m, March, April in 60–89 m, July in 60–69 m.
19° 10′ Zone	
March (Sometimes January, February), May, June in 30–59 m.	November, December in 20–39 m, January, February, April, September-December in 40–59 m, February, March, June, July September, November, in 60–79 m March, September, December in 80–100 m and above.
19° 40′ Zone	
June in 30–39 m, March in 70–79 m	February-April, December in 10–29 m, January-March, September, October, December in 30–69 m.

Cat-fishes normally do not attain dominance in grounds up to 29 m. In deeper grounds they form the dominant group roughly from March-June and are replaced by the "miscellaneous small fishes" during July-October. Cat-fishes may again be dominant in December or December-January.

In regard to the dominance of the two groups of fishes, the data of *Champa* and *Sea Horse* generally conform to those of *Ashok* and *Pratap*. The main difference is that the December-January dominance of cat-fishes is not indicated by the data of these smaller trawlers.

Regions Requiring Intensive Exploration

Sand Heads Region (20° 40′ *and* 21° 10′ *N Zones*)

Although this region was fished only from December to March, the results indicate that this may rank as potentially one of the richest grounds in the Bay of Bengal for demersal fishes. This may be seen particularly from the following Table, which gives the catch per hour of *Ashok* in March 1965 when it sampled all the zones from 18° 10′ to 21° 10′ N in the course of three specially undertaken voyages.

Zones	Catch per hour of *Ashok* in March 1965						
	Sharks and skates	Rays	Cat-fishes	Prawns	Misc. small fishes	Misc. big fishes	All fishes
18° 40′ ..	17·7	8·5	52·3	0·3	27·2	7·2	113·2
18° 40′ ..	23·2	11·6	87·0	0·1	57·0	14·1	193·0
19° 10′ ..	11·9	18·2	26·4	0·1	32·8	12·8	102·2
19° 40′ ..	21·9	3·6	3·4	0·1	84·2	15·2	128·4
20° 10′ ..	25·7	9·3	13·1	0·0	18·9	21·1	88·1
20° 40′ ..	43·3	4·6	4·0	1·9	32·3	3·9	90·0
21° 10′ ..	38·3	12·9	6·4	6·1	113·8	28·5	206·0
All Zones ..	25·1	9·0	24·1	1·4	61·1	15·6	136·3

Prawns were characteristic components of the catches in the region, 14 out of 18 hauls made there containing 4 kg. or more, the maximum being 70 kg. The percentage of successful hauls as also the c.p.h. for prawns was considerably higher than that recorded in other zones. Out of 18 hauls, sharks were found in 15, sciaenids in 16, white pomfret in 10 and eels in 8 (weight of each eel 6–10 kg.). Large surface schools of sharks were visually spotted in this region (*see* Table IV), and many could be caught on hooks and lines from the vessel. The data suggest that the Sand Heads region may be one of the best grounds in the Bay for sharks. On the other hand, rays and cat-fishes were poorly represented in the hauls. The results indicate the necessity of undertaking a more intensive exploratory trawling with a view to assessing the relative abundance of fishes in this region.

Kakinada Region (16° 40′ *and* 17° 10′ N *Zones*)

This region also deserves special study in future, because from the limited data available, it would appear potentially to be one of the good grounds, in the Bay for demersal fishes. When *Sea Horse* fished there in 1961, prawns formed 4% of the catches, which was higher than that recorded by the vessel from other zones except the 20° 10′ zone in that year. Similarly the catch

rates of quality fishes (miscellaneous big fishes) recorded by the vessels from the 16° 40′ and 17° 10′ zones were higher than those recorded from other zones (*see* Tables IX, X and XI).

Expected Minimum Catches in Commercial Trawling

The results of the present study allow the computation of the minimum annual catches that can be expected when commercial trawling is undertaken by vessels of different sizes in the area. The estimates along with the details of calculation are given in Table XVIII (nets as in Table I).

Ashok and Pratap (side-trawling with 15 m otter trawl)

For laying up vessels of this type on account of bad weather and repairs, 95 days per year are provided. The vessels could be out of port for at least 189 days per year; at an average rate of 10 hours of fishing per day out of port they could put in at least 1890 hours of fishing effort, spending the rest of the time on travelling to and from the port, searching for good grounds, and shooting and hauling the net. It may be mentioned that in exploratory work, these vessels trawling only during daytime, had fished at an average of 6 hours per day out of port. Multiplying the fishing time with the observed year-wise c.p.h., *viz.*, 130–205 kg., and the average anual c.p.h. from 1961 to 1965, *viz.*, 150 kg., respectively (*see* Table V), the annual possible catch is estimated as variable from 250 to 390 m tons, with the average at 283 m tons.

Champa (stern-trawling with 14 m otter trawl).—The period of lying at port for a vessel of this type is put as 130 days per year. The average fishing rate is put as 4·5 hours per working day. The observed annual c.p.h. varied from 63–164 kg, the average being 118 kg, which when multiplied by the expected fishing time (1060 hours) gave the expected annual catch as 67–174 tons and the average as 125 tons.

Sea Horse (stern-trawling with 12 m otter trawl).—The minimum possible annual catch is computed as variable from 56–94 tons, with the average at 76 tons.

That the estimates of possible annual catches mentioned above are only minima may be seen from an examination of the details of computation. For all vessels, the non-fishing period has been overestimated, and the fishing rate per day of fishing underestimated. Whereas the average fishing rate in our calculation is 4·5 hours per day out of port for *Champa* and 4·25 hours per day out of port for *Sea Horse*, the former had fished at the rate of 5·27 hours per day in 1962 and 4·83 hours per day in 1963, and the latter vessel at the rate of 4·98 hours per day in 1962 and 4·43 hours per day in 1963. The average of 283 m tons for vessels of the *Ashok* class is based on an annual c.p.h. of 150 kg. But the zones north of 17°40′ have given higher yield rates, as may be seen from Figs. 5–8 and Table XI. Concentrating in the 19° 40′ zone, which gave a 5-year average c.p.h. of 214 kg, vessels of the type of *Ashok* should be able to catch up to about 400 m tons per year, at the level of fishing effort envisaged by us.

Discussion

The scheme adopted here since December 1963 of fishing along latitudes at chosen intervals it may be noted, conforms in essentials to the standard sampling procedure in fisheries exploration and oceanography. Fishing done earlier also had partly fulfilledt he requirements of that programme as already shown. Naumov (1961, p. 48) recommended a so-called "transit fishing" scheme for *Ashok*, whereby the vessel, over the period of 9–10 days when it could stay out at sea at a time, was to go from Visakhapatnam to False Point and back, trawling continuously. But an examination of the details of the proposal (trawling speed, 3 knots; total time out at sea during a voyage, 215 hours; distance to False Point, 300 miles) shows that it only gives just enough time for *Ashok* to go up to False Point and back, fishing in a straight line. Obviously Naumov

ignored the necessity of fishing in different depth-ranges (*i.e.*, along east-west lines and of repeating the hauls in the same ground.

Borisov (1962, p.5) and Poliakov (1961, p.9; 1962, pp.7 and 16) have discussed the current in the Bay in relation to trawling; the latter has also referred to the situations when trawling with or against the current would be advisable. According to him, trawling speeds in the Bay of Bengal should be 3·5 knots or more. Although *Ashok* and *Pratap* had fished at a speed of 3·5 knots during certain periods, most of their hauls were made at speeds of 2–3 knots. This variation has of course introduced an element of error in our estimates of the relative abundance of fishes in the grounds, but it is likely to have been small and has been ingnored, especially as it is not always possible to trawl at the same speed.

The sampling gear referred to here were introduced by Poliakov (1961, p. 2; 1962, pp. 3–5) and Borisov (1962, p. 9). According to Poliakov (1961, p. 5), the 15 m otter trawl is used extensively in the trawl fisheries of the U.S.S.R. *Ashok* was fitted with a 15 m otter trawl in March 1960, and *Sea Horse* with a 12 m otter trawl in July 1960, in the place of the Hoover trawl and shrimp trawl they were using before. Later other vessels also were fitted with the improved gear designed for them. Poliakob (1961, p. 10; 1962, Tables VI) and Borisov (1962, pp. 9 and 11) state that the catch rates of the vessels rose 2–3 times after the change of gear. But Naumov (1961) does not appear to have made any correction in his data for the change of the sampling gear; this has naturally vitiated his analysis and conclusions. Shariff (1961, p. 46) referred the catches of *Ashok* to the 15 m trawl and those of *Sea Horse* to the 12 m trawl.

With regard to the nature of the bottom, our observations that the 17° 40′ zone up to 25 m is mainly sandy and that muddy-sandy bottom occurs in all zones beyond that depth are in agreement with those of Mahadevan and Poornachandra Rao (1954, p. 27), Shariff (1961, p. 46), Subba Rao (1964, Fig. 10) and Ganapati and Lakshmana Rao (1962, Table I). Black sand was recorded by Mahadevan and Poornachandra Rao (1954, Table III) in the 19° 40′–21° 10′ zones, in the depth range 19–53 m and by us in the 18° 10′–19° 10′ zones in the depth range 42–60 m. Shariff (1961, Table III) noted shells only in the 19° 10′ zone, the depth range being 80–120 m; in the same zone, we found shells in the depth-range 31–73 m. According to Mahadevan and Poornachandra Rao (1954, p. 27), there is a shell region in the 17° 40′ zone from 55 to 128 m; our data for this zone show that shells may be found from 33 m onwards. These differences could be due, among other things, to the seasonal changes in the bottom elements. Poliakov (1962, p. 21) described the bottom of the region between 18° 30′ and 19° 30′ N. Lat. as mostly rocky. Our results show that rocks occur only in patches in this region, which however are more numerous than in other regions.

The bottom fauna of the area between 16° 50′ and 21° 20′ N Lat. were investigated by Ganapati and Lakshmana Rao (1962, Table I), using a dredge. In almost all samples molluscs were the dominant elements; other groups recorded by them were polychaetes, echinoderms and fishes. These groups have been recorded by us also, as may be seen from Table IV and Fig. 1. The 18° 10′–19° 10′ zones are the main regions of occurrence of corals, as noted by Shariff (1961, p. 46), Naumov (1961, Fig. 5) and by us. The corals referred to by us are only what may be called the "soft" ones (*i.e.*, gorgonids). From our Fig. 1 and Table IV, it may be seen that the area occupied by them is small, compared to other types of bottom, which are suitable for trawls. But that even the coral grounds do not pose serious hazard to bottom trawling is evident from the fact that exploratory trawling was successfully undertaken in them over the years considered here. With increased trawling, the danger to trawls from corals would also diminish.

Making a study of the profile of the continental shelf off the Vishakhapatnam coast, Kukkuteswara Rao and La Fond (1954, p. 84) found that the average width of the shelf (41 km) is less than the world average (67 km), the average inclination of the shelf (0° 15′) steeper than the world average (0° 07′), and the average depth of the main break between the continental shelf

and the slope (205 m) greater than the world average (132 m). According to them, the average depth of the flattest portion of the shelf is 64 m. But at depths ranging from 95–132 m along different traverses, the inclination of the shelf off Visakhapatnam-Bhimilipatnam coast was found by them to increase rapidly. Whether the inclination of the shelf at such depths would affect the efficiency of trawling to any significant extent will have to be examined in future. As already stated, trawling was done mainly up to 80 m during the period of this study, although deeper grounds were also sampled occasionally without apparent loss of efficiency attributable to the bottom contour. Naumov (1961, p. 8) says that he drew 56 bottom profiles in the area between Visakhapatnam and False Point. He also states (p. 8 of his report) that echo-sounder readings were "co-ordinated with the position, course and speed of the trawlers". However the co-ordinates given in his Table II for the trawling stations in squares 27, 29, 70, 72 and 73 and the depths of the trawling stations given in his Table IV for the squares 24, 28, 34, 37/39, 59 and 60, to mention only a few instances, are contradictory to what are given in his Fig. 1.

The correlation of the physical features of the bottom with fish fauna was apparent in our observations especially as far as the abundance of perches on coral grounds was concerned. Prawns were characteristic elements of the catches in the Sand Heads region, which has fine mud and sand on the bottom. The 17° 40′ and 19° 40′ zones, the other regions of high abundance of prawns, also have predominantly muddy-sandy bottom and are practically free of corals and rocks in the depth-ranges investigated. With regard to the occurrence of the other groups of fishes, the limitations of our methods did not admit of any attempt at correlation with the type of substrata.

The data collected show that there is roughly a progressive increase from south to north in the relative abundance of "all fishes" and also of some categories of fishes from October to March and in July in the region between 16° 50′ N and 19° 50′ N, (*i.e.*, the 17° 10′–19° 40′ zones which were fished for 6 months or more each per year); it is reflected in the annual c.p.h. also. If to this region are added the 20°10′ and 21° 10′ zones (which were fished for $<$ 6 months per year each) the trend of south to north increase in annual c.p.h. is again seen. That the 19° 10′ and 19°40′ zones which show high density of demersal fishes at all times of the year are near the mouths of the big northern rivers is significant. That the Chilka Lake opens into the 19° 40′ zone may also be noted. Borisov's (1962, pp. 11 and 25) estimates of the average catch per hour from November 1959 to September 1960 based on the pooled catch data of different types of gear show that the squares around 17° 50′ N and 20° 00′ N, Lat. are poorer than others. (There is a slight difference in the numbers alloted by him and also Poliakov, 1961 and 1962 and by us to the squares north of 19° 20′ N Lat.) While the poor results obtained by him for the squares around 20° 00′ N Lat. may be due, to some extent, to the pooling of data from different types of gear, he has also recognised that his data are not adequate to form definite conclusions. Noumov (1961, Table IX, Fig. 6) has indicated the squares which yielded average c.p.h. of $>$ 100 kg. (for *Ashok* over the period January-April 1960, according to which the best squares are in the 18° 40′, 19° 10 and 20° 10′ zones, partly conforming to our results. But the zone-wise averages cannot be computed from his data. Moreover, in preparing his Table IX and Fig. 6 (of square-wise average c.p.h.) he apparently omitted the hauls which gave a c.p.h. of $<$ 100 kg. (compare his Tables IX and X). His estimates are also based on the catch data of two types of gear, which he did not differentiate, as already mentioned. It may be of interest to add here that in the Bombay-Saurashtra region also, a general south to north increase in the relative abundance of demersal fishes has been found (Jayaraman *et al.*, 1959, p. 79; Virabhadra Rao, 1967, p. 27).

Poliakov (1962, Table XIII) divided the entire area into four zones and gave the catch composition in each zone for the period 1959–62. It shows that the miscellaneous small fishes from the dominant group in all zones, which also conforms to our results.

The seasonal variations in the relative abundance of demersal fishes in the area has not been studied in detail by the previous workers. A brief reference to it was however made by Shariff

(1961, p. 46), who, on the basis of the data of 1960, stated that in the region between 17° 40′ and 18° 30′ N Lat. peak catch rates were recorded in March, August and September, which roughly conforms to what was found in the present study. Poliakov's data (1961, Tables II and IV; 1962; Tables IV, V, VII and VIII) indicate that in the area as a whole in 1959–62, peak catch rates were recorded by various vessels in April-May and August-January. Naumov (1961, p. 34) states that the catch per hour of *Ashok* averaged 100 kg. in November and December 1959, about 150 kg. from February to April 1960 and about 190 kg in June-July, whereas the data given by Borisov (1962, Table II) and Poliakov (1961, Table IV) for the same period show that the c.p.h. of this vessel was < 76 kg. in November 1959, 50 kg. in December 1959, <115 kg. in February-April 1960, < 155 kg. in July 1960, and the vessel was under repair in June 1960.

The present study has shown that for "all fishes" the April-June peak is best in the 17° 40′ zone but not in the four northern zones. There may be two reasons for this difference: (1) The uneven distribution of fishing effort: The 17° 40′ zone, being nearest the base of the vessels was fished for more time than the others. Of the effort of *Ashok* and *Pratap* in 1961–65 about 35% was spent in the 17° 40′ zone; the other nine zones together received 65% of the effort, (2) Hydrological conditions peculiar to the 17°40′ zone and their effect of plankton production. It is believed that upwelling takes place in the zone from February-April (La Fond, 1954, p. 119; Ganapati and Subba Rao, 1957, p. 348; Mojumder, 1967. But how for it extends towards the south and the north is not known. Ganapati and Murthy (1955, p. 91), Ganapati and Subba Rao (1957, p. 348) and Ganapati and Sarma (1958, p. 188) have shown that of the two peaks in plankton production in this zone the one noted in March-April is more important than the other one noted in September-October and attribute this partly to the effects of upwelling. Demersal fish abundance in the zone is highest in April to June. This means a time-lag of 1–2 months between the periods of the maximum plankton production and the highest abundance of dermersal fishes, provided of course the two are related.

If one of the effects of nearshore upwelling may be the movement of demersal fishes away from nearshore waters (Banse, 1959, p. 44), such a moment in terms of the shift of the best c.p.h. to offshore grounds in February-April has not been positively demonstrated by the present data; only in respect of some categories of fishes and in some years was such a shift seen. It may be mentioned here that Jayaraman (1965) and Panikkar and Jayaraman (1966, p. 238) also think that the upwelling observed off Waltair is too weak to exert any influence on a wide scale.

On the other hand a distinct shift to the best c.p.h. of all categories of fishes to the offshore grounds is observed in all zones, during the July-September period, a shift more pronounced and more regularly occurring than that in March-April. The fact the shift occurs throughout the area explored is particularly noteworthy. A possible hydrological explanation is available for this. Prasad (1952, p. 64) found a shallow thermocline on the western side of the Bay of Bengal in August. La Fond (1954, p. 121), Ganapati and Murthy (1955, p. 88) and Mojumder (1967) suggest that there may be upwelling in the Bay during July-August. If the upwelling is the cause, direct or indirect, of the offshore shift of the best c.p.h. in July-September, then it must be regarded as of greater strength and importance than the one believed to take place in March-April.

The percentage of prawns in the catches found during the present study is low, being only 2–3. When considering this, the limitations of the survey have to be taken into account. The gear used was not specifically meant for prawns but was a generalised one, intended to make, as far as possible, representative samples of bottom fish and crustacean fauna, under other trawling conditions. The size of the mesh used was also large enough for the small prawns to escape. The results given here therefore do not necessarily indicate poor abundance of prawn in the area studied. In this connection the depth distribution of prawns would be of interest. Figure 12 shows that *Ashok* recorded a catch rate of 18–24 kg./hr. of prawns from the 70–99 m

depth in July 1964 from the 17° 40′ zone; such high catch rates were only rarely obtained from the shallow regions. The species of prawns were the same as those found in the shallow regions, namely *Penaeus monodon*, *P. indicus* and *Metapenaeus monoceros*. Naumov (1961, Fig. 7) gave a chart, shading only some of the grounds, to indicate what he called the "distribution of commercially valuable prawns". Our study shows that prawns are available throughout the area explored, although relatively more abundant in the 17° 40′ and 18° 10′ zones than in others. Special studies with shrimp trawls will have to be undertaken in future to make assessment of the prawn beds. The regions around Kakinada and Sand Heads appear particularly promising in this connection.

Naumov (1961, p. 33) deals with the question of mixing of fish stocks, even though he had not studied it, as far as may be judged from his report. He states that "even if exchanges of ichthyofauna of this area with neighbouring areas takes place, it is only in its northern and southerns strips and on a very small-scale". He was obviously not aware that the species of catfishes, mackerel, carangids, ribbon-fishes, sciaenids, seer-fishes, sharks and states and many other categories of fishes he had recorded from this area are commercially available on other sections of the east coast and that theoretically no assumption can be made against the possibility of their migrating into or out of this area on a large scale. But then according to him (Naumov, 1961, p. 16), prior to his investigation no data were available on the characteristics of the fishery resources of the Bay of Bengal, which shows of course that the reports on the subject published over a period of half a century prior to his study had escaped his notice (Bulletins and Administrative Reports of the Madras Fisheries Department since 1907; Hornell, 1916; Nayudu, 1920; Moses, 1931; Mojumder, 1939; Devanesan and Chidambaram, 1948; Anon, 1951 *a* and *b*; Panikkar, 1951; Chidambaram, 1953; Annual Reports of the Central Marine Fisheries Research Station from 1952–53 onwards; Krishnamurthi, 1955; Sekharan, 1955; Jones, 1958; to mention only a few). The problem of mixing of fish stocks will have to be studied in future with referrence to the zone-wise variations in their abundance.

Naumov's data of exploratory fishing referred to the period January-July 1960, as stated before. Summing up his results, he (Naumov, 1961, p. 34) first observes, "A general idea was formed about the bottom fishery resources in the area. Subsequent studies will doubtlessly bring about ammendments, which however should not be great". He also opined that a c.p.h. of $>$ 200 kg. from this area for *Ashok* was not possible. But later (p. 49 of this report), his view changes to the one that "the whole area from Visakhapatnam to the Mahanadi River is practically unknown" and that "the whole fishing area has as yet scarcely been studied." Later still (p. 49 of his report) his conclusion is that "the whole area stretching from Visakhapatnam to off Mahanadi River has schools of fish". From what has been mentioned earlier, it will be apparent that during the period referred to by Naumov, the work done was preliminary in nature, having been related specially to the standardisation of gear and fishing techniques.

Our estimates of the potential annual catches, in commercial fishing, of the trawlers of the classes of *Ashok* and *Sea Horse* are in close agreement with those made by Borisov (1962, pp. 15–16. in respect of the averages. But since the latter author had only one year's data of exploratory trawling, he could not estimate the ranges of values of the expected annual catches. With the present data it has been possible to estimate these ranges, but it may be noted that they are based on exploratory fishing done during daytime. For *Ashok* we have used Borisov's estimate of the possible fishing time. It may also be seen that with increased efficiency of utilisation of the vessels, the commercial catches can be increased considerably over what are estimated here, which are only the expected minima. Even at the level of fishing effort envisaged here, a vessel of the *Ashok* class can land up to about 400 tons of fishes a year, as against the expected minimum of 280 tons, if fishing is concentrated in the rich northern grounds. Poliakov (1962, p. 26) expects an annual catch of 1120 tons from this area for a vessel 30–36 m long, with 450–500 HP, fishing for 300 days per year. The present authors have provided for fishing time of only 1890 hours for vessels of the *Ashok* class, 1060 hours for vessels of the *Champa* class, and 1000 hours for vessels of the *Sea Horse* class, per year. Poliakov's estimates of the possible fishing time per year

of these types of vessels are 7%, 22% and 8% respectively higher; a corresponding increase in their annual catches over what are estimated here should then be possible. But as against this, it has to be noted that with increase in the number of trawlers, the relative abundance of fishes would tend to decline, and to some extent offset the advantage expected from an increased efficiency of utilisation of the vessels.

During the period referred to here, grounds > 130 m in depth were not fished. Even within the 130 m line, grounds > 80 m deep could not be sampled adequately. Needless to say, extension and intensification of exploratory work in deeper grounds would throw more light on the seasonal variations in the relative abundance of fishes and their inshore-offshore movements. Similarly, availability of more data on oceanographic conditions in the Bay would help in understanding the anomalies in the distribution and abundance of various groups of fishes in the area.

Summary

Exploratory trawling was undertaken from 1961 to 1965 on the continental shelf along the north-western part of the Bay of Bengal between Lat. 16° 40′ and 21° 00′ N. For purpose of analysis of data, the entire area was divided into 10 half degree Latitude zones designated as follows: 16° 40′, 17° 10′, 17′ 40′, 18° 10′, 18° 40′, 19° 10′, 19° 40′, 20° 10′, 20° 40′ and 21° 10′ Fishing was confined mainly to the zones 17° 10′–19° 40′ and to depths up to 80 m.

The bottom of the area is mainly sandy-muddy and most of it is suitable for trawling. Soft corals (gorgonids) occur in the region between 17° 50′ N and 19° 20′ N Lat., but do not pose serious hazard to trawl nets.

The catch composition in the entire area from 1961 to 1965 was: sharks and skates-7·5%, rays-5·5%, cat-fishes-20·8%, prawns-2·3%, miscellaneous small fishes-56·4% and miscellaneous big fishes -7·5%.

In the region between 16° 50′ and 19° 50′ N Lat., the relative abundance of all fishes taken together and of sharks and skates, miscellaneous small fishes and miscellaneous big fishes increased from south to north from October to March and in July; the annual c.p.h. also indicated the trend. On an annual average, rays were abundant in the region around 18° 10′ N Lat., cat-fishes in the region around 17° 40′ and 18° 40′–19° 10′ N Lat. and prawns in the regions around 17° 40 and 19° 40′ N Lat.

In each zone, three-peak periods are found in the relative abundance of "all fishes" per year which are roughly, January-February, April-June and September-November. The period of the best catch rates is April-June in the 17° 40′ zone but September-November in most other zones. The catch rates of the different categories of fishes also have three peaks in a year, which roughly correspond to those found for "all fishes". The period of the highest catch rate for sharks aod skates is January-March in the 17° 10′ and 17° 40′ zones but October-December in others. For miscellaneous big fishes February-May and August are the best periods in the 17° 40′ and 17° 10 zones respectively, but September-November is the best period in others. The best season for rays is November-December in 18° 10′ zone, but January-April in others. For the other categories of fishes the periods of the highest relative abundance are roughly the same in all zones: September-November for prawns and miscellaneous small fishes and April-June for cat-fishes.

Generally, April-June and October-December are the periods when the shallow regions (< 50 m deep) of the zones gave higher yield rates than the deeper regions (> 50 m deep) and July-September, the main period when the latter regions gave higher catch rates.

Cat-fishes form the dominant group of fishes in grounds > 30 m deep from March to June and are replaced by miscellaneous small fishes as the dominant group during July-October. Cat-fishes may again be dominant in December-January.

It is estimated that operating commercially in the area with Visakhapatnam as the base, a 25 m side-trawler with 15 m trawl should be able to land 250–390 m. tons of fishes, a 14 m stern trawler with 14 m trawl, 67–174 m. tons, and a 13·7 m stern trawler with 12 m trawl, 56–94 m tons per year. The variation in the estimates for the same type of vessel is mainly due to the allowance made forthe expected variation in the annual abundance of demersal fishes in the area. Increasing the efficiency of utilisation of the vessels and concentrating on the rich grounds, the catches can be raised to much higher levels.

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