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RESULTS OF DEMERSAL FISHERIES RESOURCES SURVEY ALONG THE EAST COAST OF INDIA 1959-74

By

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1. INTRODUCTION

The present bulletin, the fifth in the series of the bulletin of the Exploratory Fisheries Project, Bombay, deals with the results of demersal fisheries resources surveys carried out by the Project along the east coast of India during the period from 1959 to 1974. The results of exploratory fishing conducted during 1974-75 and 1975-76 along the west and east coasts of India by the vessels attached to the Project have already been presented in the bulletins No. 2 and 4 respectively. Thus, with the release of the present bulletin, one could get more or less continuous information relating to the east coast fisheries resources surveys especially with regard to the distribution and intensity of sampling, catch composition, relative abundance, seasonal variation in the catch, stock assessment, data required for studies on the economics of trawling etc. for a period of seventeen years i.e. from 1959 to 1976. It is hoped that the information presented will be particularly useful for scientific management and regulation of fisheries development in this region. This bulletin like the former ones in the series (Joseph, 1974; Anon, 1975 & 1976; Joseph et al., 1976) has been released to meet mainly the requirement of the industry and the Government. It may be mentioned in this connection that the views and interpretations expressed in this bulletin are of the authors only and do not necessarily reflect the views of the Government of India.

This bulletin is prepared on the basis of the data gathered by the vessels attached to the Exploratory Fisheries Project bases at Tuticorin, Madras, Visakhapatnam, Paradeep and Calcutta. The

Exploratory Fisheries Project base at Tuticorin was established in 1958 and since then, several vessels were deployed for exploratory fishing from this base using trawls, gill nets and hook and lines. Since the surveys from Tuticorin were restricted to a limited area along the lower east coast, the Government of India decided to commission a base of the Exploratory Fisheries Project at Madras and it was established in 1972. Systematic exploratory fishing along the upper east coast started only with the establishment of the Exploratory Fisheries Project base at Visakhapatnam in 1959. Due to the limited range of operation of the vessels attached to the base, the sizeable area to be surveyed and of the importance and the speed with which the area was to be surveyed in the context of development of fishing along the Orissa-West Bengal coast, the Government of India opened two more bases of the Exploratory Fisheries Project one at Calcutta and the other at Paradeep in 1971 and 1973 respectively. The information collected by the vessels belonging to the Exploratory Fisheries Project bases at Tuticorin, Madras, Visakhapatnam, Paradeep and Calcutta along the lower and upper east coasts of India has been analysed and presented in this bulletin.

Mention may be made here of the efforts by some of the state governments and other agencies in conducting exploratory/ experimental fishing along the east coast. Records show that the then Madras government with the help of a motor launch, Sea Scout conducted some surveys in 1922. During 1927-30, the Madras government with the help of a steam trawler, Lady Goschen conducted some fishing. The first attempt at mechanised fishing along the upper east coast was probably made by the then Bengal government using a steam vessel Golden Crown in 1908. The West Bengal government procured two Danish trawlers

Baruna and Sagarika in 1950 and three more Japanese trawlers viz., Kalyani III, IV and V were added to the fleet in 1955. These vessels fished from Calcutta as their base. Kalyani III, IV and V were taken over by the Exploratory Fisheries Project in 1964 when the West Bengal government wound up their deep sea fishing project. Mention may also be made of the operation of the four 16 m Polish trawlers having 170 B.H.P. from Paradeep by the Orissa government from 1962 onwards. The erstwhile Indo-Norwegian Project centre at Mandapam conducted some fishing operations during 1963 and 1964, particularly purse seining using 36' boats in the Palk Bay. Some exploratory trawling in the deeper waters of Gulf of Mannar was also done by the Project using Cochin based vessels during 1969-70. Unfortunately, the results of operation of most of these vessels, remain unpublished.

It is to be emphasised that very little published work on the resources position along the east coast is available. The distribution pattern of the major exploited marine fishery resources of India has been given by Rao (1969). Naumov (1961), Poliakov (1961) and Borisov (1962), have in their reports to Government of India given detailed accounts of the exploratory and experimental fishing conducted by the vessels of the Exploratory Fisheries Project base, Visakhapatnam during 1960. Sekharan (1973), James (1973), Krishnamoorthy (1973), Rai and Mahadevan Pillai (1973), Shariff (1961) and West (1973) have also given some useful information about the demersal fisheries resources along the east coast. Except a few, most of these papers deal with biological aspects of demersal fisheries occurring in the area of investigation. Apart from these, there are a few unpublished reports on the trawl fishery surveys off Tuticorin, Paradeep and Calcutta released annually by the respective bases of the Exploratory Fisheries Project.

The authors wish to take this opportunity to express their sincere thanks to Sri S.P. Balasubramanian, Joint Secretary (Fisheries), to Prof. P.C.George, Joint Commissioner(Fisheries), Ministry of Agriculture and Irrigation (Department of Agriculture), Government of India for the keen interest, they have evinced in the preparation of this bulletin. Our thanks are also due to Sarvashri A. Rajkumar and Y. B. Goudar for the assistance they have rendered in the processing of the data and in the preparation of text figures.

2. AREA OF STUDY

The scope and limitation of the data collected by the exploratory fishing vessels attached to the different bases of this Organization and the methodology adopted in the presentation of data have already been discussed by Joseph (1974) and the same procedure has been followed in the preparation of the current bulletin also.

The results of survey conducted by the Organization between the lat. 8° N to 22° N and long. 78° E and 90° E are presented in this bulletin. For convenience of discussion, the entire east coast has been divided into two sections viz., lower and upper regions, the lower region covers 8° N to 16° N and lat. 78° E and 82° E while the upper region extends from 16° N to 22° N and lat. 82° E to 90° E. In this context, it may be mentioned that the results of surveys carried out between lat. 77° E and 78° E have already been discussed (Joseph et al., 1976) and hence, this area has not been brought within the purview of this bulletin. The area of survey showing different depth contours is presented in Figs. 1 and 2. The entire coast line of West Bengal, Orissa, Andhra Pradesh and the east coast of Tamil Nadu falls within the area of study. The total length of the coast in the area under observation is about 2600 km, of which about 680 km are in the state of West Bengal and Orissa, 970 km in the state of Andhra Pradesh and 950 km in the state of Tamil Nadu.

It is seen that the continental shelf in the area under study is relatively narrow and varies from a maximum width of about 80 km off Point Calimere along the lower east coast and about 180 km

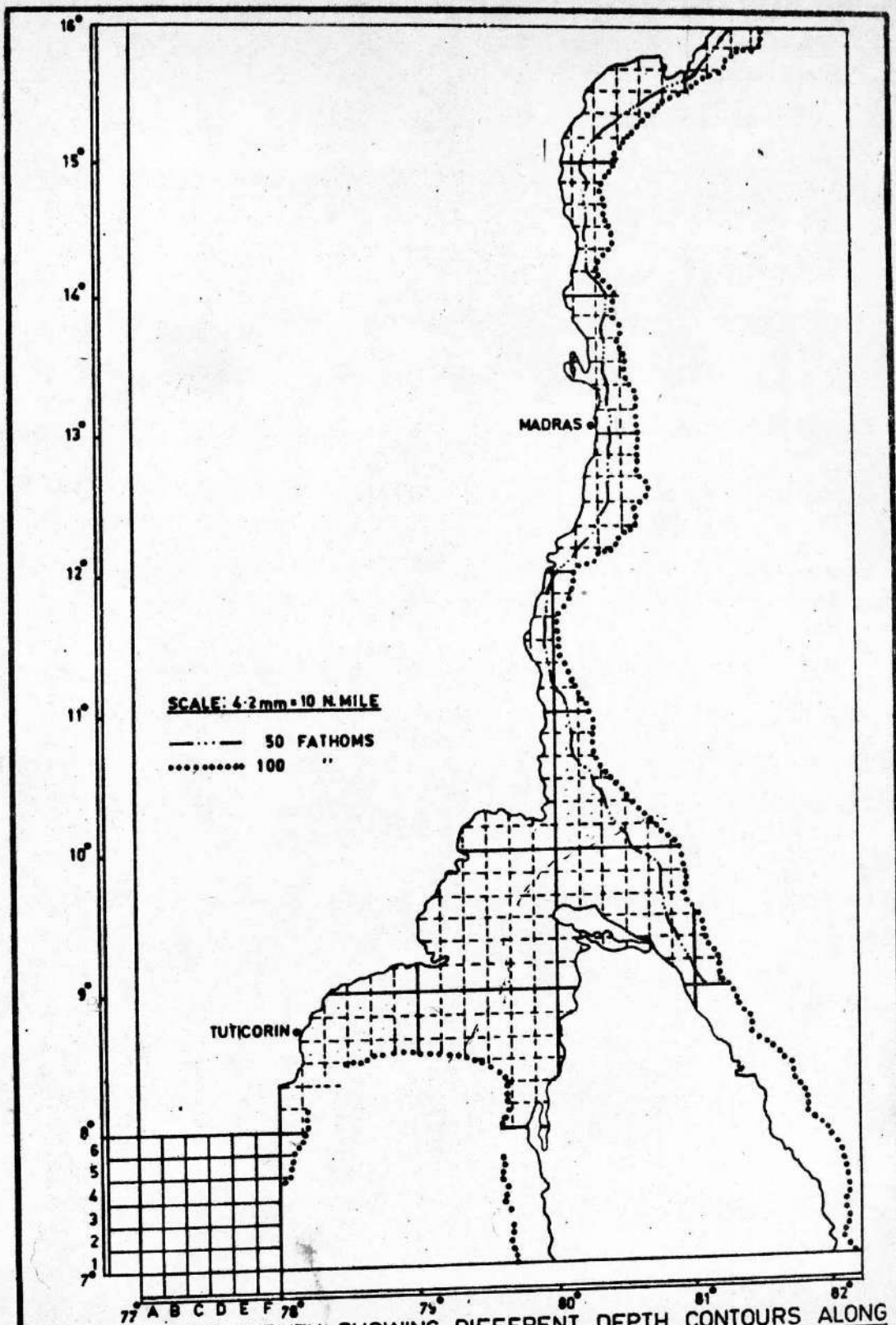


FIG. 1. AREA OF SURVEY SHOWING DIFFERENT DEPTH CONTOURS ALONG THE LOWER EAST COAST.

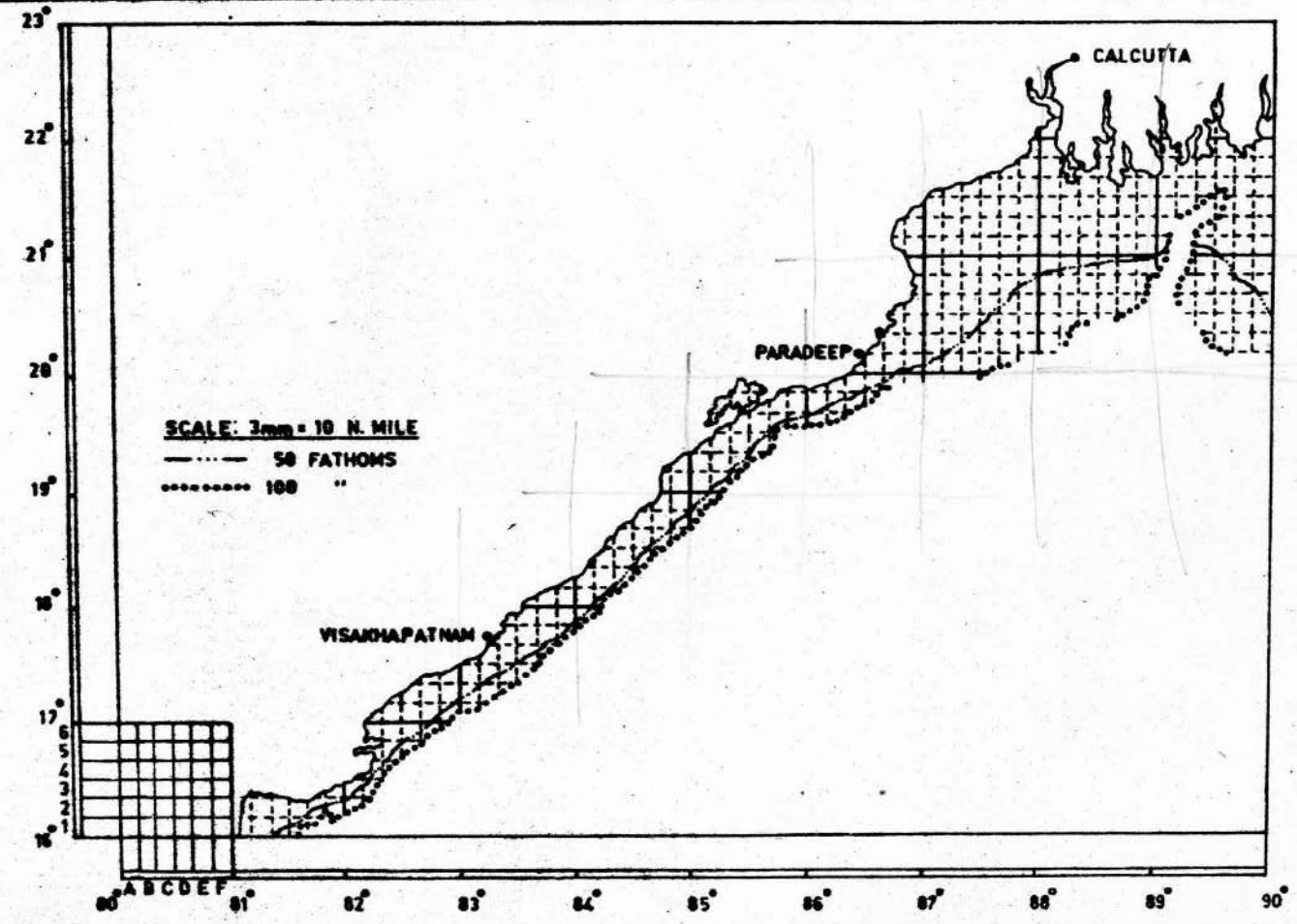


FIG.2. AREA OF SURVEY SHOWING DIFFERENT DEPTH CONTOURS ALONG THE UPPER EAST COAST.

a little north of Balasore along the upper east coast. The average width may be placed at about 40 km. Reference may be made of the fact that the continental shelf on the north west coast of India is the widest, compared to that in any other part of the Indian sub-continent. Studies on the circulation of the waters in the Arabian Sea and the Bay of Bengal has revealed, that they are much influenced by the pattern of winds associated with the two monsoons. On the east coast between February and July the surface drift has a north-easterly direction with an occasional easterly component. This changes to south-westerly in the northern part of the coast and southerly in the southern part about September-December. In January, a weak westerly drift is also observed (Panikkar and Jayaraman, 1966). The average values of salinity range between 30‰ and 34‰ in the Bay of Bengal. The fluctuations in the surface temperature in the Bay of Bengal is between 27° C and 29° C. With regard to the vertical distribution of temperature, it may, generally, be stated that in the Bay of Bengal the thermocline level is usually below 50 - 55 m and at times going down to 100 - 125 m level. Further, the shelf waters in this region are mostly isothermal. It is also of interest to note that although upwelling is reported as a seasonal phenomenon on the east coast, nutrients in high concentrations are absent in the surface waters (Panikkar and Jayaraman, 1966).

3. VESSELS EMPLOYED

3.1. Lower east coast

Table I shows the major specifications such as length, breadth, horse power, gross tonnage, etc. of the vessels operated in the lower east coast during the period under study. It may be seen that 12 vessels with horse power ranging between 42 - 300 H.P. were employed in this region during the period of survey. Based on the power of engine, which is the main factor determining the fishing capability of trawlers, these vessels have been grouped under five classes as detailed below for analysis and reporting of data.

Class	Horse Power	Name of vessels
I	42	Sagar Kumari, Sagar Sundari, Sardinella, Meenakshi and Meena Lochani
II	153	Jheenga
III	200	Meena Prayas, Meena Niryantak, Meena Sitara and Meena Gaveshak
IV	262	Meena Bharati
V	300	Kalyani V

It may be seen that five smaller vessels and four 17.5 m trawlers were available in the Class I and Class III category respectively. In the remaining three classes only one vessel each was available. All these vessels were operated from the Project bases at Tuticorin and Madras.

Sl. No.	Name of vessel	Year built	Place built	Length B.P. (m)	Beam (m)	Depth amid-ship (m)	Hull mate-rial	Make of engine	B.H.P.	G.R.T.	Crew strength
1.	Meena Lochani	1954	Japan	13.7	3.5	1.2	Wood	Yanmar 4 LDG	42	9.9	6
2.	Meenakshi	1954	Japan	10.1	3.5	1.2	Wood	Yanmar 3 LDG	42	9.9	6
3.	Sardinella	1954	Japan	10.1	3.5	1.2	Wood	Yanmar 3 LDG	42	9.9	6
4.	Sagar Sundari	1954	Japan	10.1	3.5	1.2	Wood	Yanmar 3 LDG	42	9.9	6
5.	Sagar Kumari	1954	Japan	10.5	3.2	1.2	Wood	Yanmar 3 LDG	42	9.9	6
6.	Jheenga	1958	Holland	16.5	5.4	2.9	Steel	Caterpillar D.342	153	48.6	7
7.	Meena Prayas	1969	India	16.3	5.20	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
8.	Meena Niryantak	1970	India	16.3	5.20	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
9.	Meena Sitara	1970	India	16.3	5.20	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
10.	Meena Gaveshak	1970	India	16.3	5.20	3.20	Steel	Kirloskar M.A.N.	200	56.8	10
11.	Meena Bharati	1965	India	20.9	5.8	3.4	Steel	M.A.N.	262	69.1	12
12.	Kalyani V	1955	Japan	27.8	5.4	2.8	Steel	Hayashikane	300	123.2	14

TABLE I Major specifications of the vessels employed for exploratory fishing along the lower east coast

Out of these 12 vessels, Sagar Kumari, Sagar Sundari and Sardinella obtained under T.C.M. Aid during the fifties were wooden vessels and all of them were since then decommissioned. These vessels operated mainly from the Tuticorin base. The vessel Jheenga is, probably, the first imported steel shrimp trawler into this country while the vessels viz. Meena Prayas, Meena Niryantak, Meena Gaveshak and Meena Sitara are indigenously constructed 17.5 m stern trawlers. Two 17.5 m trawlers each were based at Tuticorin and Madras base for exploratory survey in the region. The vessels Meena Bharati and Kalyani V are typical side trawlers with cruise stern and were used for stern trawling by making necessary rigging. Built in 1965 Meena Bharati is, probably, the first indigenously built large steel trawler of the country.

The period of operation, number of fishing days, fishing hours expended etc. in the lower east coast are detailed in Table II. During the period of study some of these vessels were also utilised for gill netting, tuna long lining etc. However, the period of operation indicated in the table denotes only the period when the vessels were utilised for demersal trawling.

Name of vessel	Period of operation		No. of days	Hours fished
	From	To		
Small vessels	1959	1968	2018	6890
Jheenga	1967	1973	606	2317
17.5 m trawlers	1970	1974	1449	4894
Meena Bharati	1967	1970	395	1602
Kalyani V	1964	-	34	152

TABLE II Period of operation of different classes of vessels and the fishing effort expended by them along the lower east coast

It may be seen from the table that the smaller vessels and Jheenga operated during the periods from 1959 to 1968 (about nine years) and from 1967 to 1973 (about six years) respectively with Tuticorin as base, while Meena Bharati operated only for about three years with Tuticorin and Madras as bases. The 17.5 m vessels started fishing operation only from 1970 onwards from the bases at Madras and Tuticorin. Kalyani V fished only for a short period i.e. for about one year.

3.2. Upper east coast

Table III furnishes the details of vessels operated in the upper east coast during the period under study. It shows that 13 vessels were operated in this region during the period of study. These vessels as classified on the basis of horse power into six groups are shown below:

Class	Horse power	Name of vessels
I	42 - 56	Sagar Kumari and Sea Horse
II	165	Champa
III	200	Meena Jawahar, Meena Shodhak, Meena Tarangini, Meena Saudagar, Meena Grahi and Meena Prasarak
IV	215	Gudjon
V	240	Ashok and Pratap
VI	578	Matsyavigyani

Sagar Kumari and Sea Horse, having 42 H.P. and 56 H.P. respectively were operated from the Visakhapatnam base. In the third category, six 17.5 m trawlers were available. Of these four vessels viz., Meena Jawahar, Meena Shodhak, Meena Grahi and Meena Prasarak alone have operated on systematic basis. The remaining two 17.5 m trawlers have operated from Calcutta only for short durations. In the Class V type, two vessels viz., Ashok and Pratap were available while in the remaining three classes i.e. II, IV and VI one vessel each was available.

Sl. No.	Name of vessel	Year built	Place built	Length B.P. (m)	Beam (m)	Depth amid-ship (m)	Hull mate-rial	Make of engine	B.H.P.	G.R.T.	Crew strength
1.	Sagar Kumari	1954	Japan	10.5	3.2	1.2	Wood	Yanmar 3 LDG	42	9.9	6
2.	Sea Horse	1954	Japan	10.97	3.50	1.83	Wood	Yanmar 4 LDG	56	12.8	6
3.	Champa	1949	U.K.	15.0	4.9	5.32	Wood	G.M.	165	36.5	7
4.	Meena Jawahar	1970	India	16.3	5.20	3.00	Steel	Kirloskar M.A.N.	200	56.8	10
5.	Meena Shodhak	1970	India	16.3	5.20	3.00	Steel	Kirloskar M.A.N.	200	56.8	10
6.	Meena Tarangini	1971	India	16.3	5.20	3.00	Steel	Kirloskar M.A.N.	200	56.8	10
7.	Meena Saudagar	1971	India	16.3	5.20	3.00	Steel	Kirloskar M.A.N.	200	56.8	10
8.	Meena Grahi	1971	India	16.3	5.20	3.00	Steel	Kirloskar M.A.N.	200	56.8	10
9.	Meena Prasarak	1971	India	16.3	5.20	3.00	Steel	Kirloskar M.A.N.	200	56.8	10
10.	Gudjon	1954	Norway	15.5	5.2	2.8	Wood	Caterpillar	215	44.6	8
11.	Ashok	1949	Holland	25.40	6.30	2.97	Steel	B & W	240	91.7	12
12.	Pratap	1949	Holland	25.40	6.30	2.97	Steel	B & W	240	91.7	12
13.	Matsyavigyani	1969	G.D.R.	31.80	7.80	7.40	Steel	New Schwema Sohenen	578	182.6	14

TABLE III Major specifications of the vessels employed for exploratory fishing along the upper east coast

The vessel Sea Horse was a seiner while Sagar Kumari was a gill netter. Ashok and Pratap were typical side trawlers with a whaleback, aft super structure and a cruise stern while Champa was a gill netter with cruise stern. Gudjon was a typical Pacific coast purse seiner with forward superstructure. These vessels were used for stern trawling after necessary alterations. The vessel Matsyavigyani based at Calcutta is a typical stern trawler with transom stern and was operated along the Orissa and West Bengal coast.

Table IV illustrates the duration of operation by the different classes of vessels during the period under investigation. It may be seen that the vessel Ashok carried out operation for about 10 years and expended about 7050 hours of fishing effort while Pratap fished for about 306 days during 1961-63 covering 1721 hours of actual fishing. The vessel Champa which operated for about 11 years expended about 6800 hours whereas small vessels, Sagar Kumari and Sea Horse fished for about five years expending about 4200 hours. The vessel Matsyavigyani commenced regular fishing from Calcutta only during 1973 while the 17.5 m indigenously constructed trawlers commenced regular trawling from Paradeep and Visakhapatnam during 1973-74.

Name of vessel	Period of operation From	To	No. of days fished	Hours fished
Small vessels	1960	1965	961	4235
Champa	1961	1972	1628	6774
17.5 m trawlers	1971	1974	781	3066
Gudjon	1960	1962	175	506
Ashok	1960	1970	1353	7048
Pratap	1961	1963	306	1721
Matsyavigyani	1973	1974	95	208

TABLE IV Period of operation of different classes of vessels and the fishing effort expended by them along the upper east coast

4. TYPES OF TRAWLS OPERATED

Different sizes and types of shrimp and fish trawls were operated by the vessels during the period of investigation (Table V). Most of the 17.5 m trawlers which form the main stay of the fishing fleet of this Organization were operating 28 m shrimp trawls and 24 m fish trawls. Matsyavigyani operated 35 m and 45 m fish trawls while Meena Bharati operated 30 m fish trawl. The vessels Ashok and Pratap fished with 18 m and 24 m fish trawls. It has been indicated earlier that a separate bulletin is proposed to be published on the different designs of trawl gear experimented by the Project (Joseph, 1974). However, the fact that a number of designs of existing fish trawls and oval otter doors were introduced by the team of F.A.O. experts attached to the Visakhapatnam base during 1959-60 deserves special mention (Goliokov op. cit.). A series of fish trawls ranging in size from 12 m to 30 m with suitable oval otter doors were introduced during this time. These trawls are popularly known as Russian trawls and have found to be very effective for ground fish survey and have become the trawl gear in vogue for survey purposes by the Project since then.

Sl. No.	Type of trawl	Head rope length (m)	Foot rope length (m)	Mesh size maximum and minimum (bar length mm)	Weight and size of otter board
1.	15 m shrimp trawl	15.0	20.0	25 - 18	70 kg. Rectangular
2.	12 m Fish trawl	12.0	17.6	60 - 25	70 kg. 0.7 sq. m area Oval with single slit
3.	16 m Fish trawl	16.0	18.5	60 - 25	150 kg. 1.6 sq. m area Oval with single slit
4.	20 m Fish trawl	20.0	27.5	60 - 25	150 kg. 1.6 sq. m area Oval with single slit
5.	24 m Fish trawl	24.0	32.0	70 - 25	180 kg. 2.0 sq. m area Oval with two slits
6.	28 m Shrimp trawl	28.0	32.5	25 - 18	180 kg. 2.0 sq. m area Oval with two slits
7.	42.5 m Shrimp trawl	42.5	46.9	25 - 18	180 kg. 2.0 sq. m area Oval with two slits
8.	30 m Fish trawl	30.0	38.0	70 - 40	240 kg. 2.0 sq. m area Oval with two slits
9.	35 m Fish trawl	35.0	42.0	70 - 40	240 kg. 2.0 sq. m area Oval with two slits
10.	45 m Fish trawl	45.0	58.0	70 - 50	300 kg. 2.5 sq. m area Oval with three slits

TABLE V Major specifications of the important types of trawls operated along the east coast

5. DISTRIBUTION AND INTENSITY OF SAMPLING

5.1. Sampling distribution by area along the lower east coast

As already discussed elsewhere the area of survey lies approximately between 8° N to 16° N i.e. the east coast of Tamil Nadu. The results of survey conducted in areas lying between latitude 77° E and 78° E which form part of the coast of Tamil Nadu have already been discussed (Joseph et al., 1976). Therefore, in the present study the area between latitude 78° E and 82° E alone is taken into consideration. In the lower east coast, shelf area is available in 15 divisions. The divisions are demarcated on the basis of one degree latitude and one degree longitude which is further divided into sub-areas at the interval of 10 minutes latitude and 10 minutes longitude. The sampling effort expended in this area by all vessels and a selected few vessels are plotted on the maps which illustrates the distribution of sampling in different areas. This would help to indicate the heavily/partially surveyed areas and also the areas which remain to be surveyed in this region along the shelf.

Fig. 3 to 5 show the sampling distribution of various groups of vessels i.e. 17.5 m trawlers, Jheenga and Meena Bharati which conducted surveys in the lower east coast since 1959. It may be seen that the 17.5 m trawlers (Fig. 3) operated from Madras covered a wider area and they conducted survey in areas between Cuddalore in the south and Nagapatnam in the north i.e. between 11° 20' N and 15° 40' N. They surveyed the divisions 11-79, 11-80, 12-80, 13-80, 14-80 and 15-80 whereas the areas of survey by the 17.5 m trawlers operated from Tuticorin base was mainly confined only to one division viz., 8-78. In the case of Jheenga and Meena Bharati (Figs. 4 & 5)

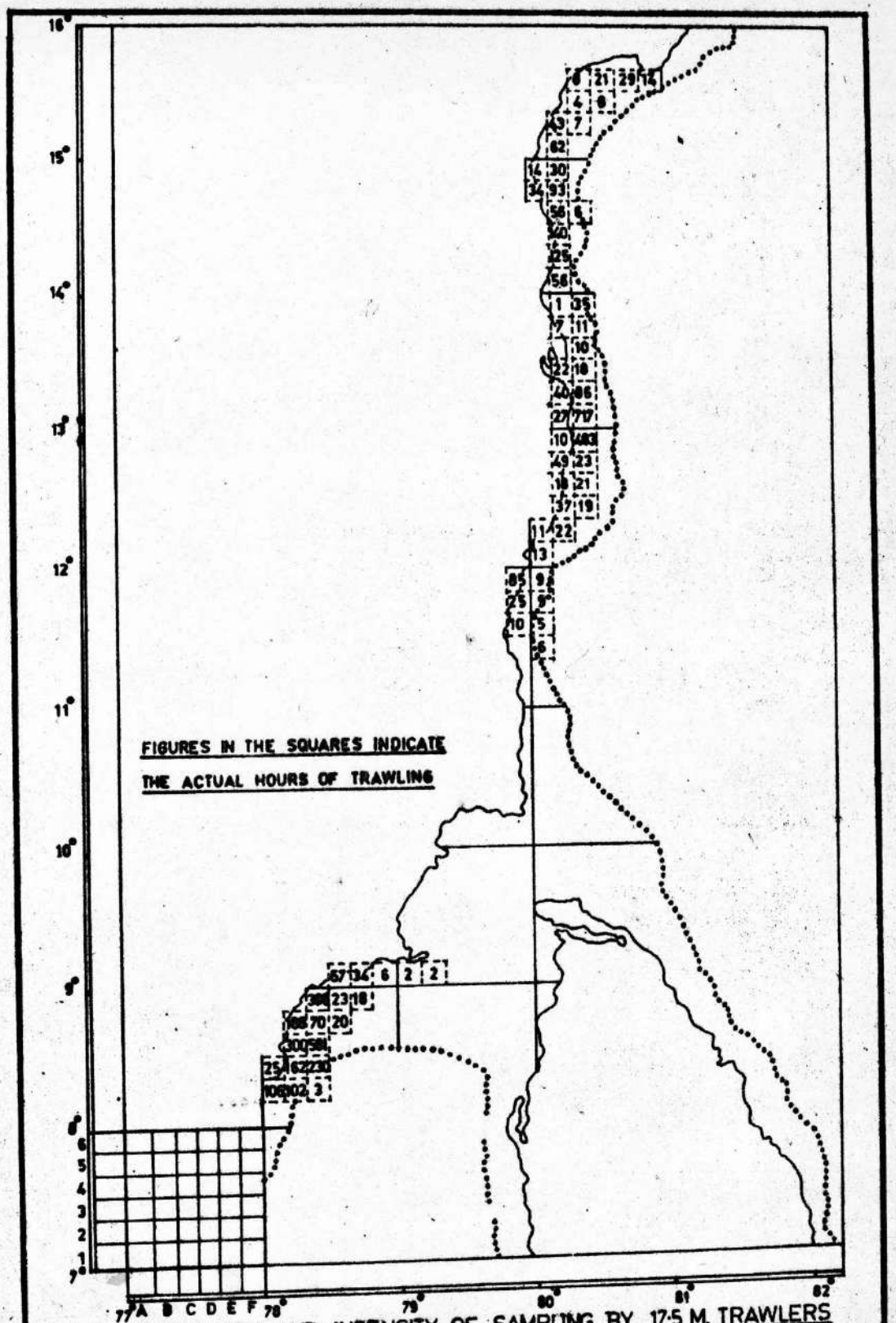


FIG. 3. DISTRIBUTION AND INTENSITY OF SAMPLING BY 17·5 M. TRAWLERS ALONG THE LOWER EAST COAST.

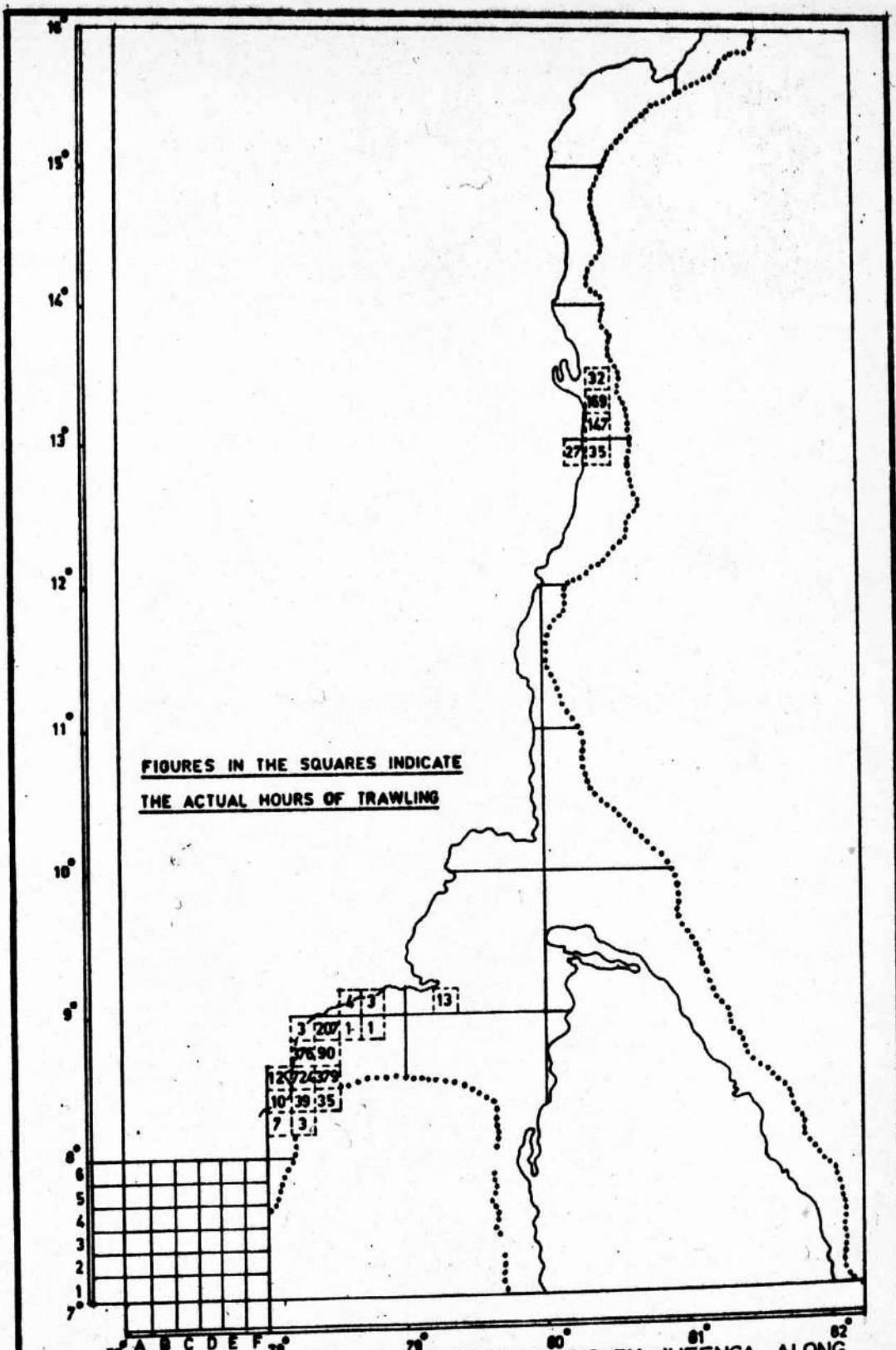


FIG. 4. DISTRIBUTION AND INTENSITY OF SAMPLING BY JHEENGA ALONG THE LOWER EAST COAST.

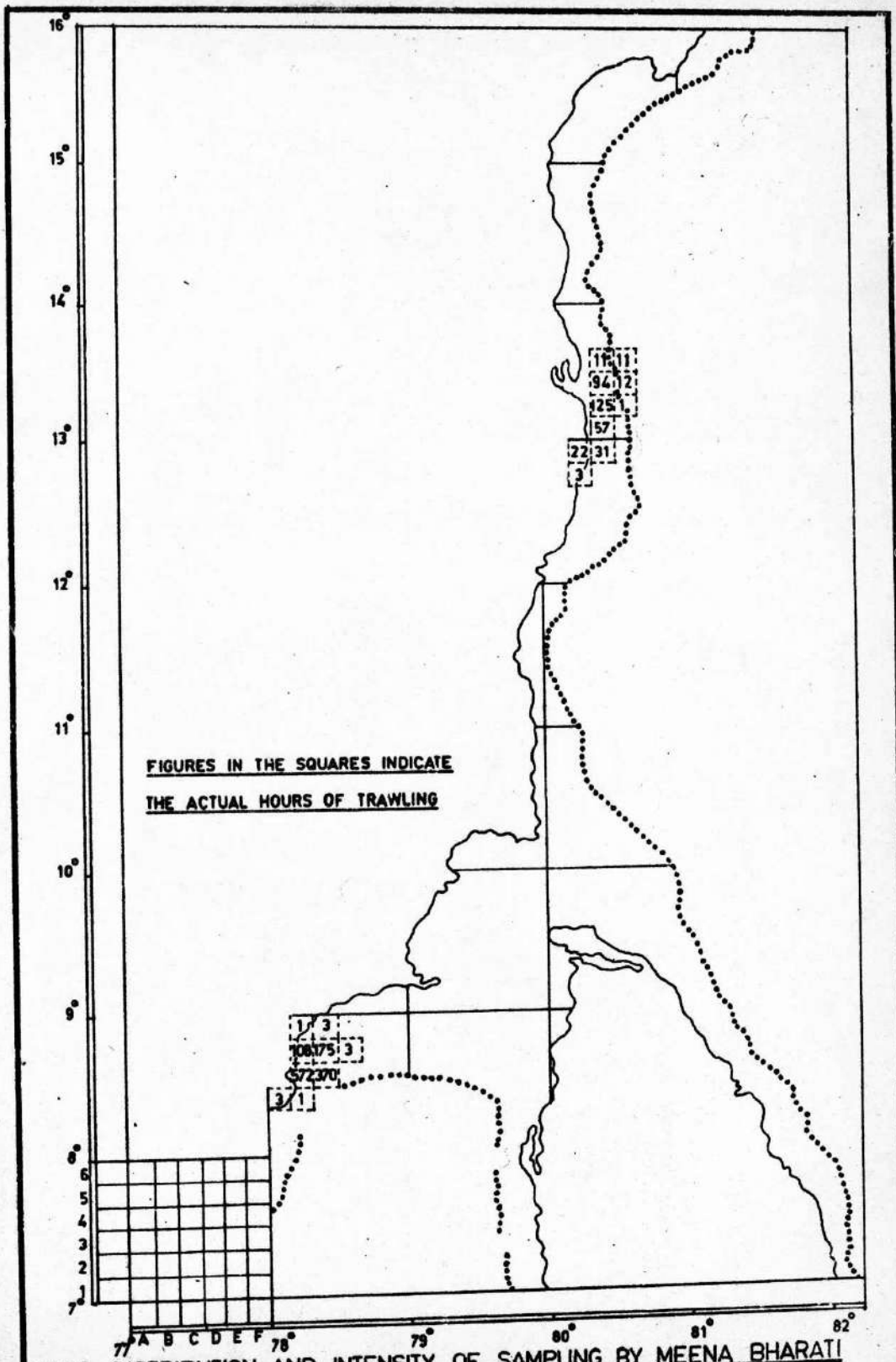


FIG. 5. DISTRIBUTION AND INTENSITY OF SAMPLING BY MEENA BHARATI ALONG THE LOWER EAST COAST.

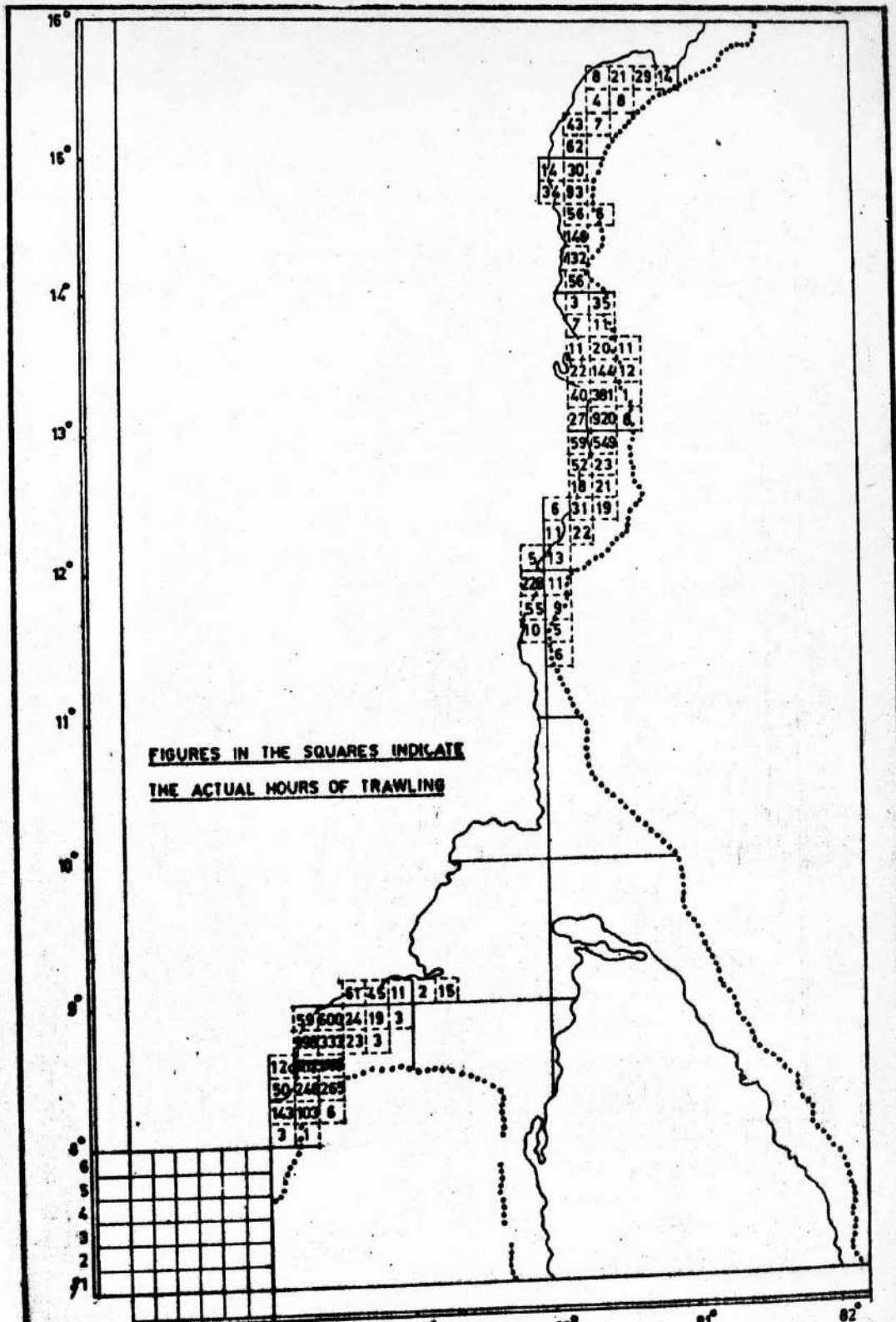


FIG. 6. DISTRIBUTION AND INTENSITY OF SAMPLING BY ALL VESSELS IN THE LOWER EAST COAST.

the survey was mainly confined to two divisions viz., 8-78 off Tuticorin and 13-80 off Madras. In the same way, Kalyani and smaller vessels also concentrated their attention mainly to area 8-78 off Tuticorin.

Fig. 6 shows the distribution and intensity of sampling by all vessels in the lower east coast. It may be seen from the figure that out of the 10 divisions surveyed by the vessels of the Project during the period of study, the area 8-78 was intensively surveyed by spending an effort of about 12,000 hours of actual fishing or about 77% of the total fishing effort expended in this region. About 1600 hours or about 10% of the total fishing effort was expended in area 13-80 while in area 12-80 about 5% or about 800 hours of fishing effort was spent. Thus one could see that on the lower east coast there is only one area viz., 8-78 off Tuticorin which is heavily explored. The area 13-80 off Madras where the fishing effort expended has exceeded 1000 hours can also be regarded as fairly surveyed for purpose of investigation. Amongst the different sub-areas it may be emphasized that the areas 4B, 4C and 5B of 8-78 and 1C and 2C of 13-80 are heavily explored ones. All the remaining areas need further exploratory work. It may also be mentioned that the divisions 15-81, 10-79, 10-80, 9-80 and 8-79 are yet to be surveyed by the Project vessels. Needless to say that these areas require special attention while planning future survey programme.

5.2. Sampling distribution by area and depth along lower east coast

For the purpose of studying the depth-wise distribution of sampling, the shelf area covered by the vessels is stratified into 20 m depth intervals. The shelf area upto 100 m appears to have been surveyed during the period under investigation. But the fishing effort expended in areas between 60-100 m appears to be rather inadequate (Table VI). It can be stated that the shelf area upto 40 m depth was fairly surveyed from Tuticorin and upto 60 m from Madras. The fishing effort expended in different depth zones viz., 0-19 m, 20-39 m, 40-59 m, 60-79 m and 80-99 m of various areas along this

region are shown in Table VI. From the table it may be seen that about 52% or about 8300 hours of fishing effort was spent in 20-39 m depth belt of this region. Further, it is observed that the depth belts 0-19 m and 20-39 m of area 8-78 are the heavily explored zones. The fishing effort put in 20-39 m depth belt of area 13-80 has exceeded 1000 hours while the fishing effort spent in depth belt 40-59 m of areas 13-80 and 12-80 was found to be above 500 hours.

5.4. Sampling distribution by area along the upper east coast

The area under investigation lies between lat. 16° N and 23° N and between long. 81° E and 90° E and the areas are demarcated on the same principles as in the case of lower east coast. This area is divided into 16 divisions and each of this division is further divided into 36 squares of equal area as explained in the earlier bulletins. Figs. 7 to 12 shows the distribution and intensity of sampling in respect of different classes of vessels operated and Fig. 13 summarises the total fishing effort expended by all vessels in different sub-divisions during the period of survey.

On a detailed examination of the figures presented, it is seen that small vessels have restricted their fishing operations to areas 17-82, 17-83, 20-86 and 20-87 (Fig. 7). With regard to Champa, though the period of operation was from 1961-72 the activity was mainly confined to 17-83 (Fig. 8). The same area seems to have been covered by Gudjon also (Fig.10). With the addition of 17.5 m trawlers to the fishing fleet of the Project, the area of coverage was extended and more areas i.e. 16-82, 18-83, 18-84, 20-86 and 20-88 were also surveyed (Fig. 9).

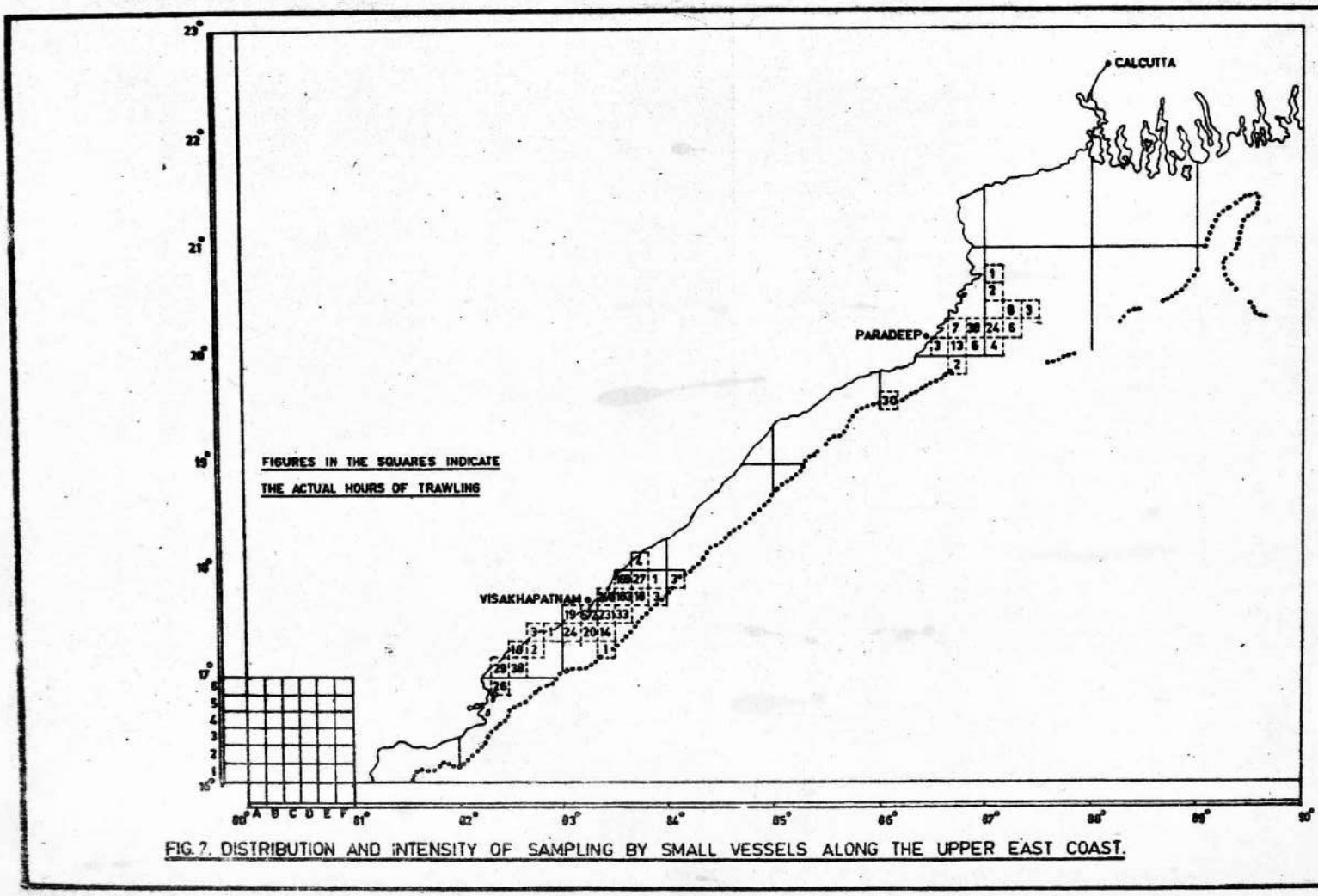


FIG. 7. DISTRIBUTION AND INTENSITY OF SAMPLING BY SMALL VESSELS ALONG THE UPPER EAST COAST.

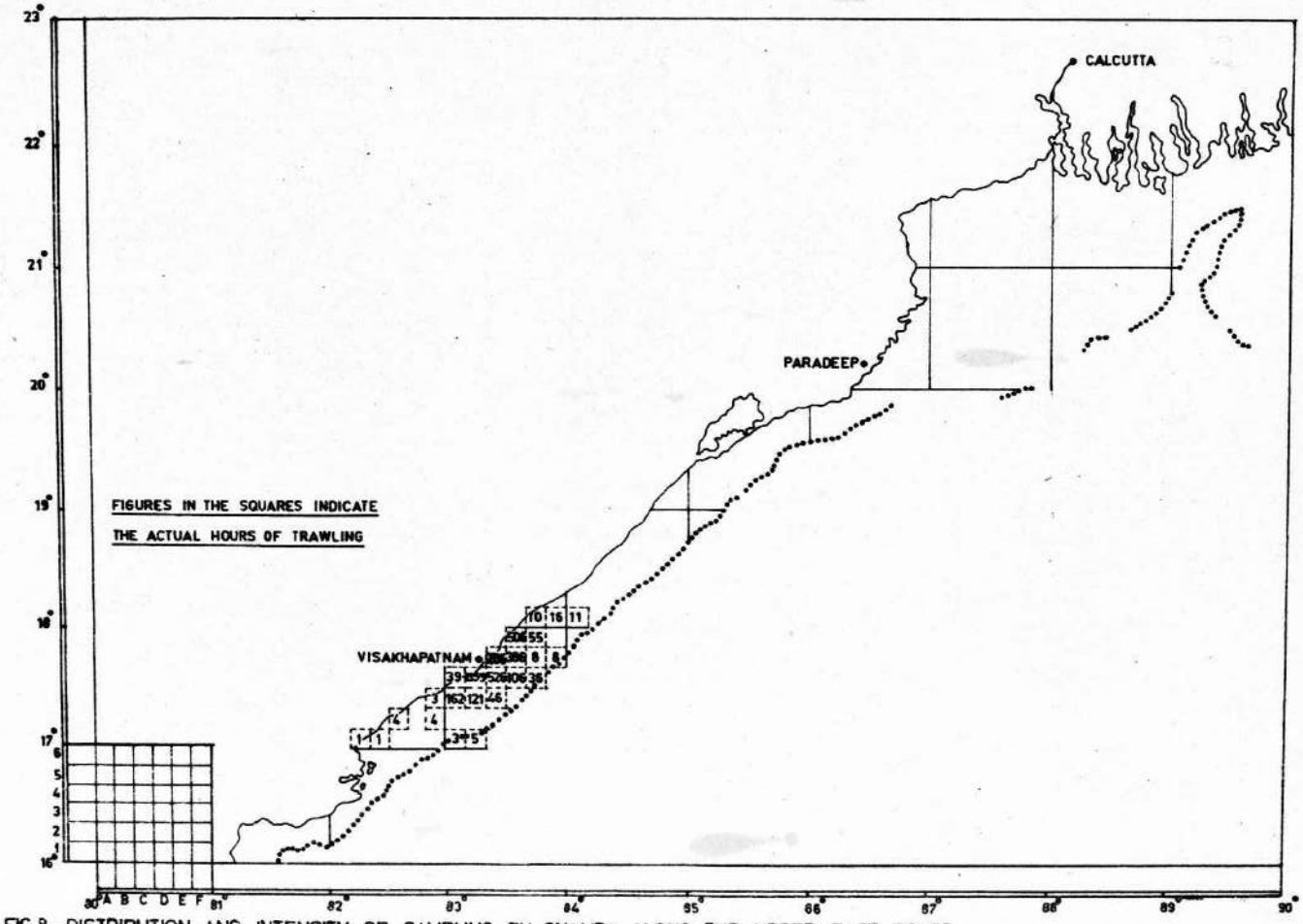


FIG.8. DISTRIBUTION AND INTENSITY OF SAMPLING BY CHAMPA ALONG THE UPPER EAST COAST.

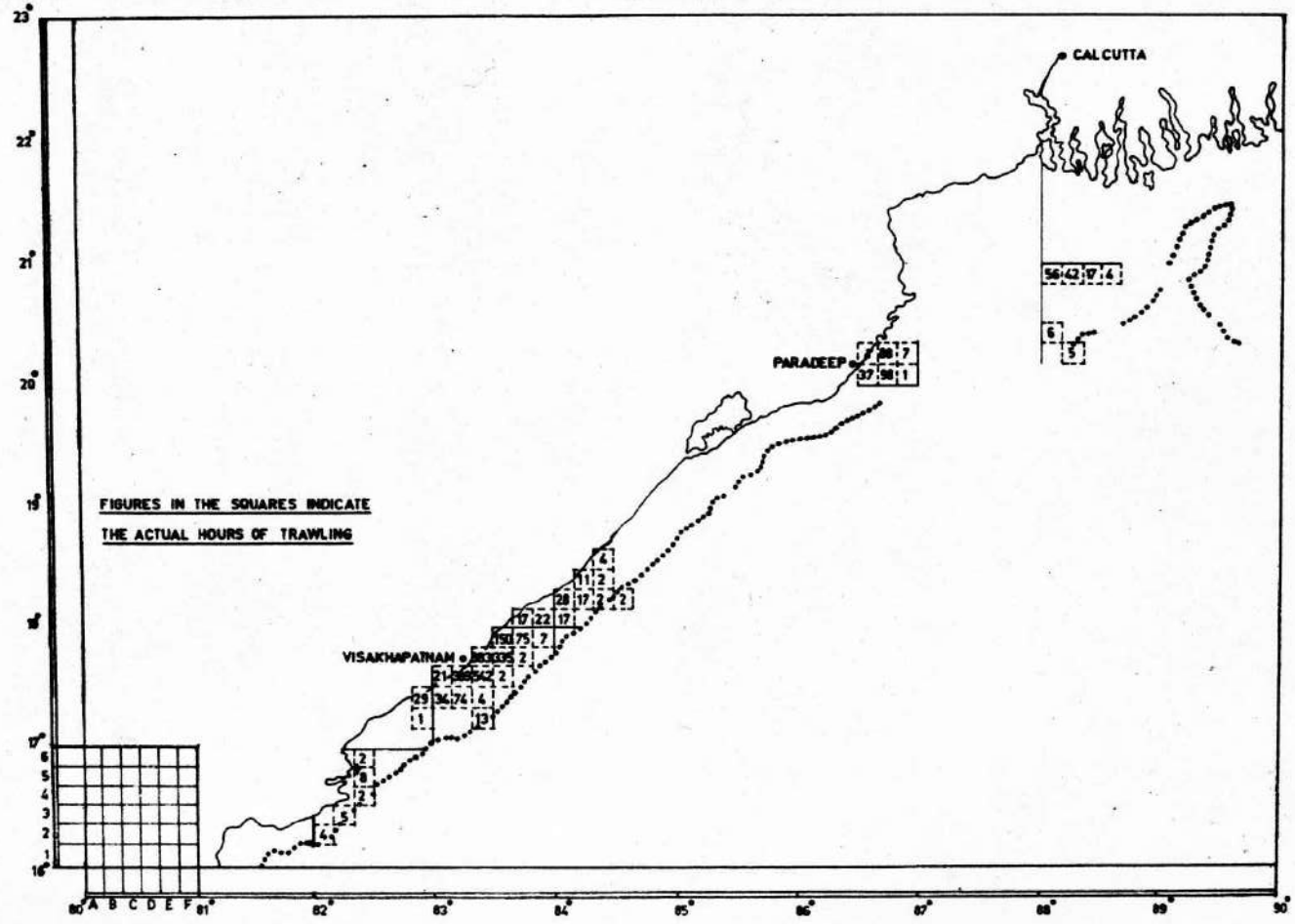


FIG. 9. DISTRIBUTION AND INTENSITY OF SAMPLING BY 17·5 M. TRAWLERS ALONG THE UPPER EAST COAST.

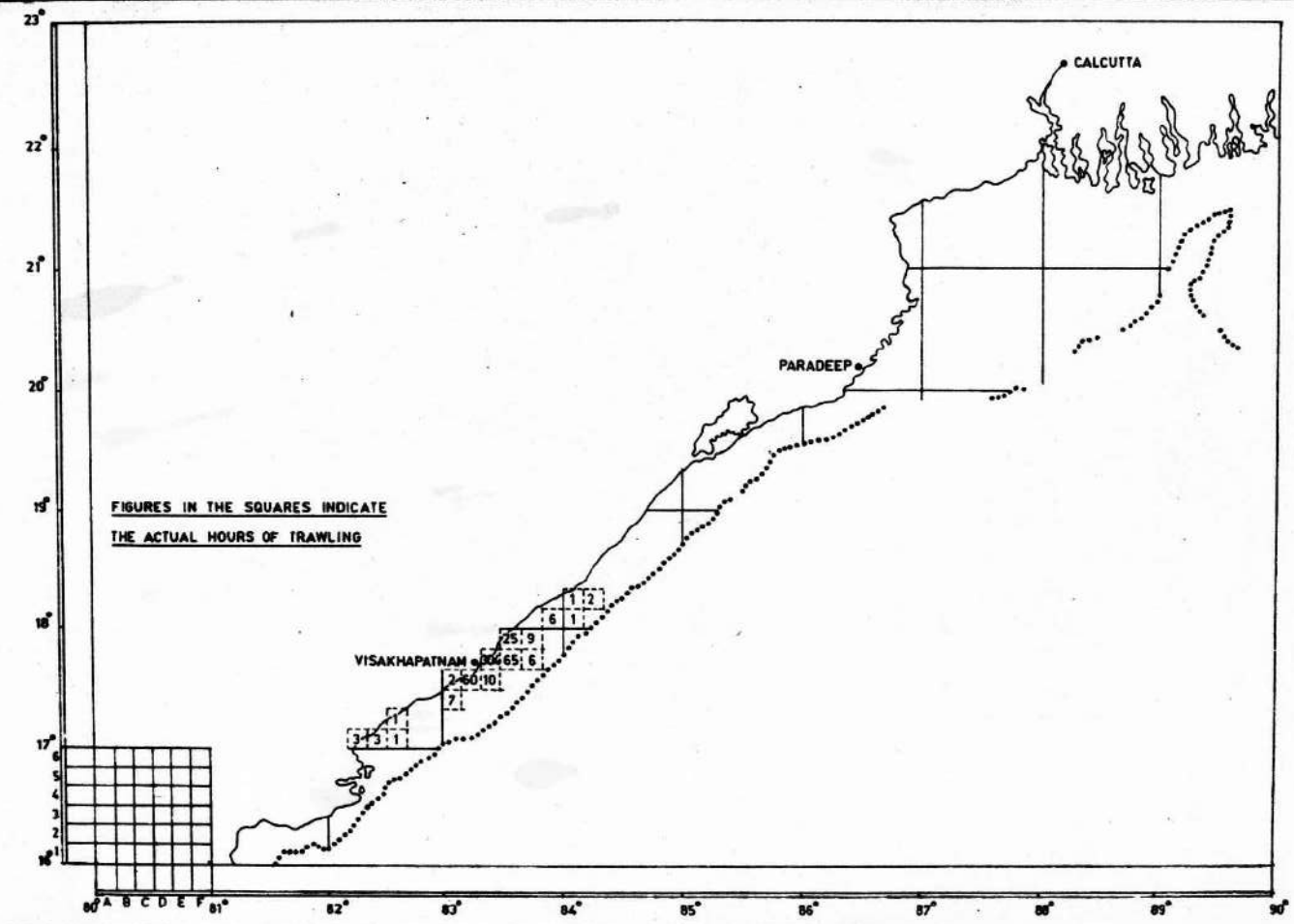


FIG.10. DISTRIBUTION AND INTENSITY OF SAMPLING BY GUDJON ALONG THE UPPER EAST COAST.

Depth range (metres) / Area	0-19	20-39	40-59	60-79	80-99	Total
8-78	5743	6368	35	11	1	12158
9-78	88	29	-	-	-	117
9-79	10	7	-	-	-	17
11-79	206	66	21	-	-	293
11-80	-	28	3	-	-	31
12-79	5	-	-	-	-	5
12-80	-	263	561	-	-	824
13-80	-	1052	582	13	-	1647
14-80	88	348	108	4	19	567
15-80	57	109	30	-	-	196
Total:	6197	8270	1340	28	20	15855

Table VI Combined fishing effort of all vessels by area and depth along the lower east coast

A better exploratory coverage seems to have been done by Ashok during 1960 to 1970 and Iratap during 1961-63 which covered the areas 16-82, 17-82, 17-83, 18-83, 18-84, 19-84, 19-85, 19-86, 20-86, 20-87 and 20-88 (Fig. 11). Matsyavigyani supplemented the coverage restricting her activity to 20-88, 20-86 and 19-86 (Fig.12). While studying the intensity of sampling by all vessels as depicted in Fig. 13, it is evident that the area 17-83 was intensively surveyed expending about 19000 hours or about 82% of the total fishing effort expending in this region. About 1200 hours or about 5% of total fishing effort was expended in area 18-84 whereas about 4% in area 17-82 and about 2% in areas 20-86 and 20-88. It may be mentioned that out of 16 divisions area 17-83 is the only one which is heavily surveyed. Area 18-84 where fishing effort of about 1000 hours were expended can be regarded as fairly surveyed. All the remaining areas needs further attention in future years. The areas 21-87 and 16-81 are yet to be surveyed and these areas require closer attention during future programming of survey.

5.4. Sampling distribution by area and depth along the upper east coast

Table VII gives the distribution of combined fishing effort of all the vessels from 1969-74, by area and by depth intervals. It is seen that the total fishing effort expended by all the vessels is about 24000 hours. About 14000 hours of the total effort was expended in the depth belt 40-59 m, the depth strata 20-39 m and 60-79 m came next in the order of intensity of survey. On a comparison with Table VI relating to lower east coast, it is seen that in the intensity of survey, the depth belts follows the order 20-39 m, 0-19 m and 40-59 m. The effort spent, in the depth strata from 60-109 m on the upper east coast appears to have been on a higher side as compared to that on the lower east coast, probably because of basing of larger vessels along the upper east coast.

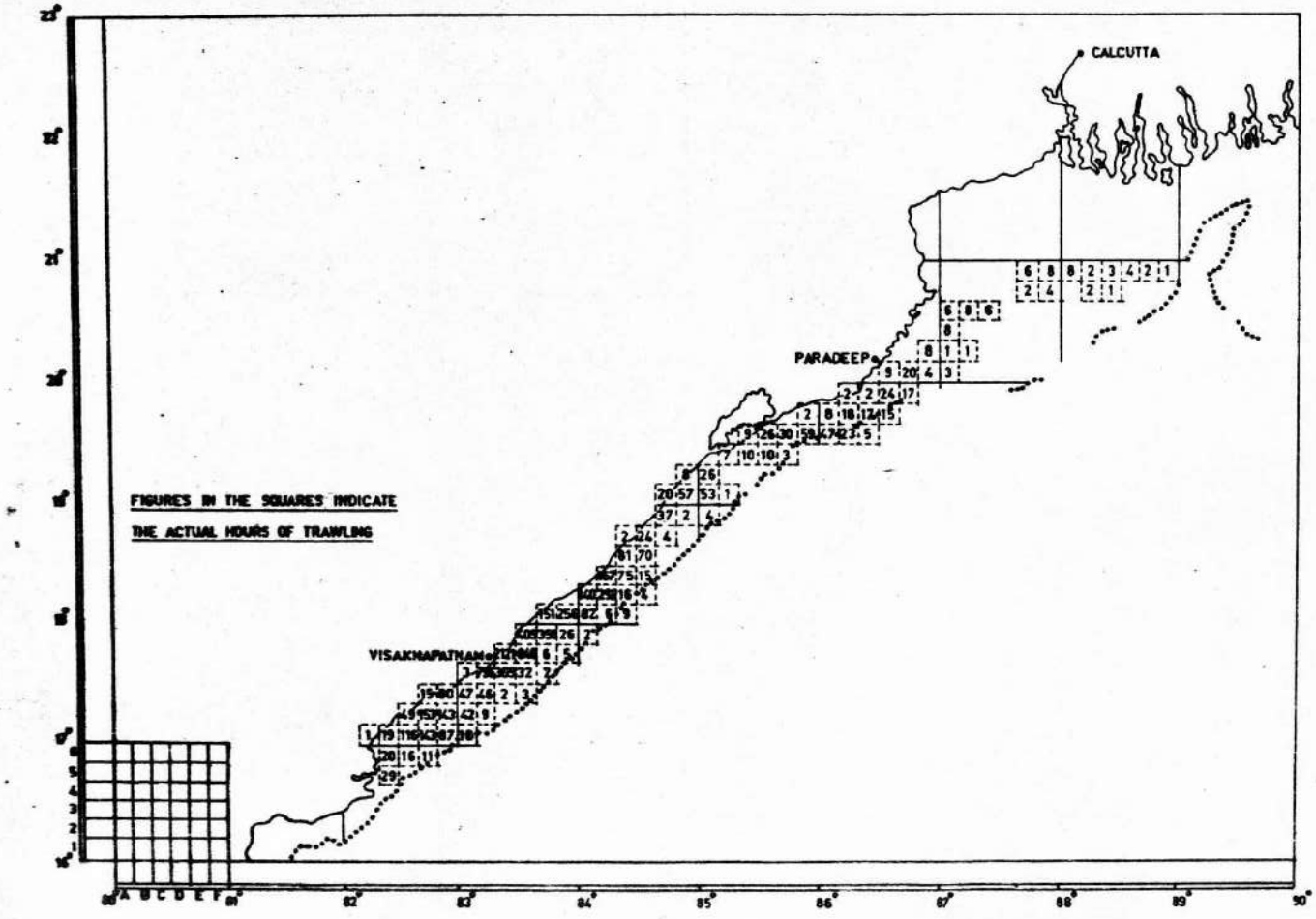


FIG.11. DISTRIBUTION AND INTENSITY OF SAMPLING BY ASHOK AND PRATAP ALONG THE UPPER EAST COAST.

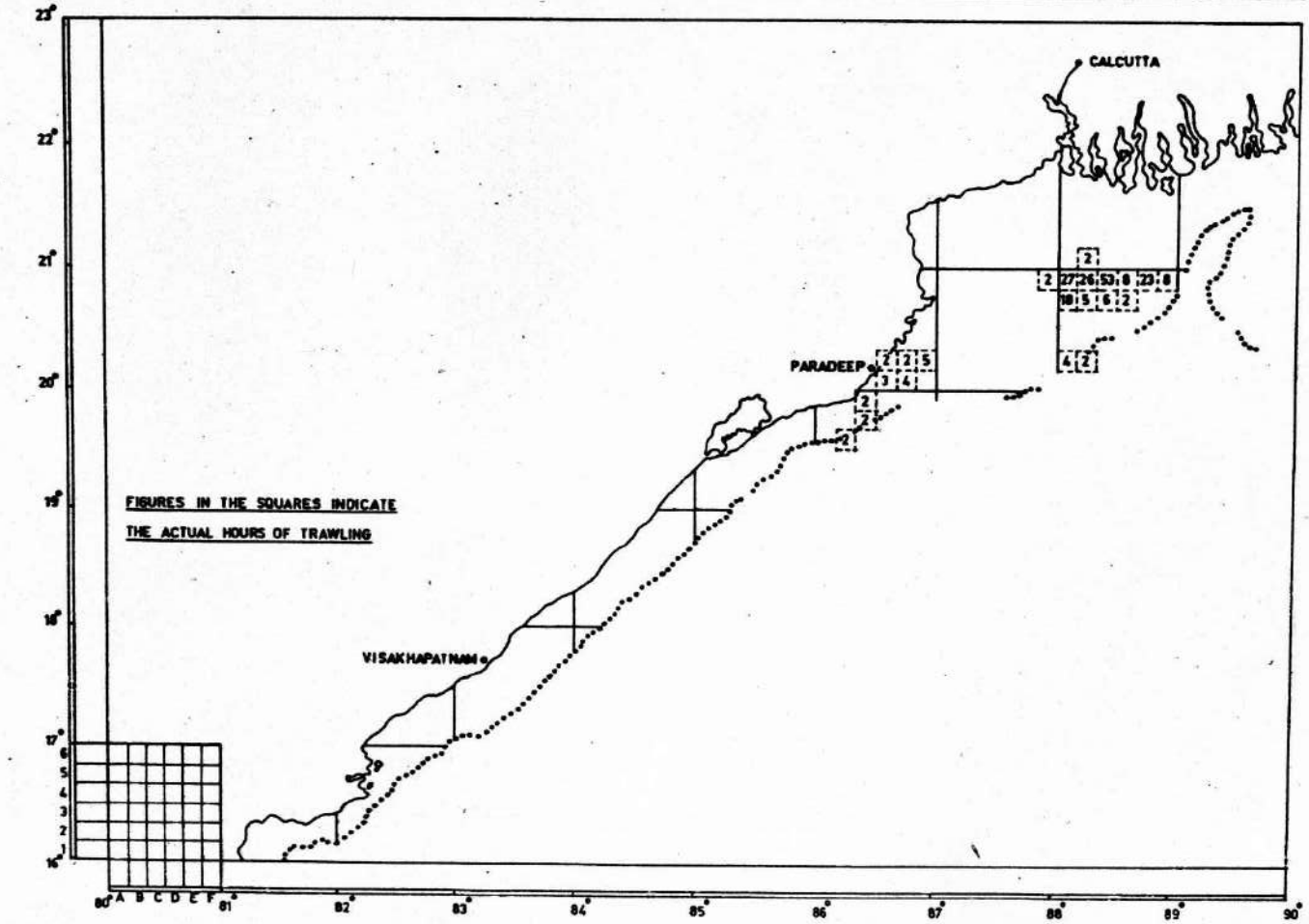


FIG.12. DISTRIBUTION AND INTENSITY OF SAMPLING BY MATSYAVIGYANI ALONG THE UPPER EAST COAST.

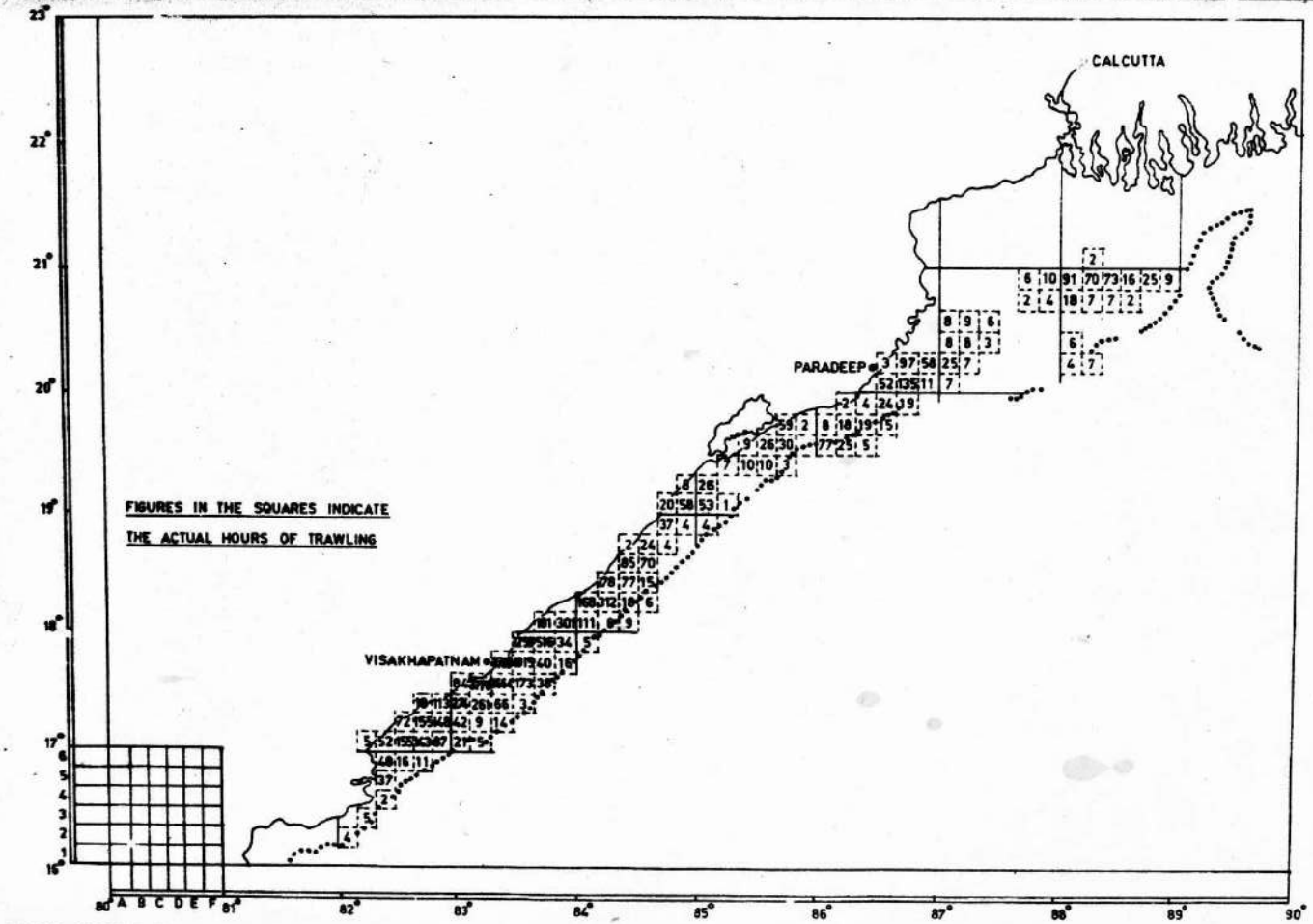


FIG.13. DISTRIBUTION AND INTENSITY OF SAMPLING BY ALL VESSELS ALONG THE UPPER EAST COAST.

5.5. Distribution of sampling by area and time

Tables VIII and IX give the yearly distribution of sampling respectively in the 10 divisions along the lower east coast and 14 divisions along the upper east coast since 1959. It is seen from the tables that the areas 8-78 along the lower east coast and 17-83 of upper east coast were sampled more or less continuously through out the period of study. Areas 17-82, 18-83, and 18-84 were surveyed between 8-9 years while areas 9-78, 11-79, 11-80, 12-80, 13-80, 16-82, 19-84, 19-85, 19-86, 20-86, 20-87 and 20-88 were sampled between 4-6 years. In the rest of the areas the survey was restricted to less than three years. It has earlier been pointed out that the distribution of sampling effort into a time span of over four years would increase the reliability of the results.

The actual fishing effort expended was less than 100 hours in areas 9-79, 11-80, 12-79, 17-84, 18-85, 19-84 and 21-88. The fishing effort spent in areas 9-78, 11-79, 15-80, 16-82, 18-83, 19-85, 19-86, 20-86, 20-87 and 20-88 ranged between 100-500 hours, while that spent in areas 12-80, 14-80 and 17-82 varied between 500 to 1000 hours. The effort expended in areas 13-80 and 18-84 is much more than 1000 hours while that spent in 17-83 and 8-78 were about 19,000 hours and 12,000 hours respectively.

Depth range (Metres) / Area	0-19	20-39	40-59	60-79	80-99	100-119	Total
16-82	-	83	35	5	-	-	123
17-82	-	234	546	163	5	-	948
17-83	52	6567	11956	677	33	7	19292
17-84	-	-	3	2	-	-	5
18-83	-	285	197	-	-	-	482
18-84	7	489	649	35	1	13	1194
18-85	-	-	-	-	4	-	4
19-84	-	16	69	1	-	-	86
19-85	3	99	100	34	17	-	253
19-86	10	155	116	4	-	-	285
20-86	72	281	1	-	-	-	354
20-87	11	75	97	-	-	-	183
20-88	83	199	56	9	-	-	347
21-88	2	-	-	-	-	-	2
Total:	240	8483	13825	930	60	20	23558

TABLE VII Combined fishing effort of all vessels by area and depth along the upper east coast

Area/ Year	8-78	9-78	9-79	11-79	11-80	12-79	12-80	13-80	14-80	15-80	TOTAL
	(Fishing effort in hours)										
1959	84	-	-	-	-	-	-	-	-	-	84
1960	1225	-	-	-	-	-	-	-	-	-	1225
1961	1141	-	-	-	-	-	-	-	-	-	1141
1962	1203	-	-	-	-	-	-	-	-	-	1203
1963	600	-	-	171	2	5	-	-	-	-	778
1964	496	-	-	-	-	-	-	-	-	-	496
1965	491	11	-	-	-	-	-	-	-	-	502
1966	706	-	-	-	-	-	-	-	-	-	706
1967	1402	-	-	-	-	-	-	-	-	-	1402
1968	1428	-	-	-	-	-	-	-	-	-	1428
1969	-	-	-	-	-	-	117	685	-	-	802
1970	466	-	-	-	-	-	-	1	-	-	467
1971	430	-	-	-	-	-	-	-	-	-	430
1972	1203	39	-	-	-	-	58	28	-	-	1328
1973	686	28	17	76	9	-	470	223	161	112	1782
1974	597	39	-	46	20	-	179	710	406	84	2081
Total:	12158	117	17	293	31	5	824	1647	567	196	15855

TABLE VIII Distribution of sampling by area and time by the Project vessels from 1959 to 1974 along the lower east coast

Area/ Year	16-82	17-82	17-83	17-84	18-83	18-84	18-85	19-84	19-85	19-86	20-86	20-87	20-88	21-88	TOTAL
	(Fishing effort in hours)														
1960	-	13	1260	-	3	68	-	-	17	103	8	100	-	-	1572
1961	28	115	2081	-	35	122	-	1	7	25	60	27	-	-	2501
1962	-	382	2774	-	117	146	4	9	89	84	11	5	-	-	3621
1963	-	322	2102	-	148	527	-	6	6	-	-	-	-	-	3111
1964	-	44	1195	-	90	155	-	65	116	23	8	6	-	-	1702
1965	26	44	1328	5	15	68	-	5	18	44	22	43	35	-	1653
1966	52	12	1493	-	35	30	-	-	-	-	-	-	-	-	1622
1967	-	-	1091	-	-	-	-	-	-	-	-	-	-	-	1091
1968	-	-	1028	-	-	-	-	-	-	-	-	-	-	-	1028
1969	-	-	909	-	-	-	-	-	-	-	-	-	-	-	909
1970	-	-	907	-	-	-	-	-	-	-	-	-	-	-	907
1971	-	-	372	-	-	-	-	-	-	-	-	-	-	-	372
1972	-	3	480	-	-	41	-	-	-	-	-	-	128	-	652
1973	17	-	850	-	-	-	-	-	-	-	-	-	74	-	941
1974	-	13	1422	-	39	37	-	-	-	6	245	2	110	2	1876
TOTAL:	123	948	19292	5	482	1194	4	86	253	285	354	183	347	2	23558

TABLE IX Distribution of sampling by area and time by the Project vessels from 1960 to 1974 along the upper east coast

5.6. Sampling intensity along the east coast as a whole

Taking into account of the survey conducted upto March 1976 as detailed in bulletin No.4 it may be concluded that the following areas can be stated as heavily explored:

8-78 off Tuticorin and 17-83 off Visakhapatnam;

Areas 13-80, 17-82, 18-84, 20-86 and 20-88 where the fishing effort expended was about 1000 hours can be regarded as fairly surveyed. The partially surveyed areas were 9-78, 12-80, 14-80, 18-83 and 18-84. The rest of the areas remained either unexplored or too inadequately explored. It may be emphasised that while formulating future exploratory fishing programmes these areas are to be considered for intensive survey work.

6. CATCH COMPOSITION

6.1. Catch composition by area

Fig. 14 shows the seven most important species and their percentages in the total catch from four regions viz., Tuticorin, Madras, Visakhapatnam and Paradeep/Calcutta. The geographical boundaries of these regions are given below:

Regions	Divisions
Tuticorin	8-78, 9-78 and 9-79
Madras	11-79, 11-80, 12-80, 13-80, 14-80 and 15-80
Visakhapatnam	16-82, 17-82, 17-83, 17-84, 18-83, 18-84 and 18-85
Paradeep/Calcutta	19-84, 19-85, 19-86, 20-86, 20-87, 20-88 and 21-88

It is seen that Tuticorin and Madras exhibited almost identical species composition in the catch. The three groups in the order of abundance were elasmobranchs (20.2%), perches (14.6%) and sciaenids (8.6%) at Tuticorin whereas at Madras the three groups which had the highest percentages were leiognathids (12.3%), elasmobranchs(8.4%) and perches (6.6%). On the upper east coast, percentage of elasmobranchs

in the total catch at Visakhapatnam and Paradee /Calcutta varied between 12.4% to 15.9%. Cat fish accounted for 22.7% at Visakhapatnam whereas at Paradeep/Calcutta it formed only about 13%. Prawn accounted for about 3% at Visakhapatnam and showed an upward trend at Paradeep/Calcutta. It may be recalled that the percentage of prawn was significantly high off Paradeep during 1975-76 (Anon 1976). The percentage-composition of miscellaneous fish ranged between 40% to 55% in the total catch and they are not indicated in the figures presented.

Fig. 15 furnishes the percentage composition of the seven categories in the six intensively surveyed areas i.e. 8-78, 12-80, 13-80, 17-82, 17-83, and 18-84. From the figures it is seen that in the heavily explored area viz., 8-78 along the lower east coast the species composition in the total catch in the order of abundance were elasmobranchs, perch, sciaenids, leiognathids and prawn, whereas in area 17-83 along the upper east coast the dominant groups were cat fish, elasmobranchs and prawn. In areas 17-82, 17-83 and 18-84, cat fish dominated (15.5% to 29.5%) along with elasmobranchs forming the next important category (12.0% to 15.6%) whereas in areas 8-78, 12-80 and 13-80, leiognathids and sciaenids were found to be abundant. The percentage composition of perches and sciaenids appears to have been on a higher side along the lower east coast while comparing with that on the upper east coast.

6.2. Catch composition by depth and area

Table X gives the percentages in the total catch of all the important categories by region and depth. It is evident from the table that there is a remarkable change in the percentages of important groups under reference from depth to depth and from region to region.

The percentage of elasmobranchs in the total catch was high in 40-59 m at Tuticorin, 60-79 m at Madras and 80-99 m at Visakhapatnam and Paradeep/Calcutta. Cat fish, though caught in fairly

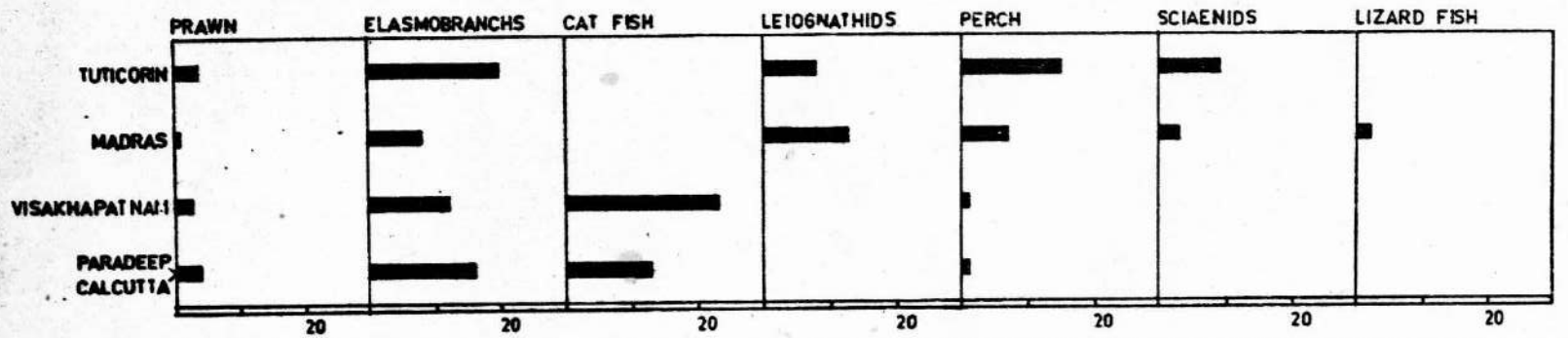


FIG.14. THE SEVEN MOST IMPORTANT VARIETIES AND THEIR PERCENTAGE OF THE TOTAL CATCH BY REGION.

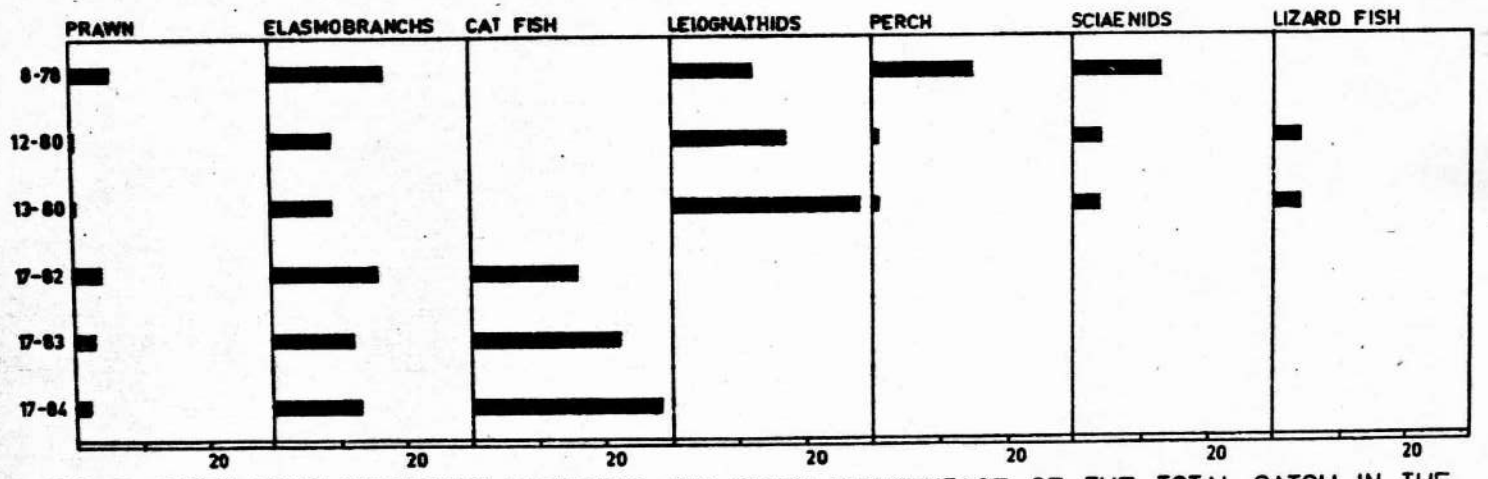


FIG.15. THE SEVEN MOST IMPORTANT VARIETIES AND THEIR PERCENTAGE OF THE TOTAL CATCH IN THE SIX INTENSIVELY SURVEYED AREAS.

good quantities from 0-19 m belt at Tuticorin showed an upward trend in abundance in the 40-79 m at Visakhapatnam and Paradeep/Calcutta, the highest percentage recorded being from 60-79 m belt. The highest percentage of 'other quality fishes' was obtained from the depth zone 80-99 m at Visakhapatnam and Paradeep/Calcutta while they were netted in large quantities from areas below 39 m depth from Tuticorin and Madras regions.

The bulk of pomfret, 'dhoma', 'karkara' and perches was caught from areas below 39 m depth from all the regions. With regard to miscellaneous fish the percentage was more or less high at all the depth zones though the highest was recorded from 60-79 m depth zone at Tuticorin and Madras and 100-119 m at Visakhapatnam whereas at Paradeep/Calcutta it was netted more or less in a uniform manner upto 79 m with a decrease in the later depth ranges. In the case of prawn the highest percentage was noticed from within 19 m depth at Tuticorin and Paradeep/Calcutta though the depth belt 20-59 m was found to be good at Visakhapatnam.

From the available data it is seen that along the lower east coast viz., Tuticorin and Madras, the occurrence of prawn, in relatively good quantities were noticed in depth belts 0-19 m, perches and other quality fishes in 0-39 m, elasmobranchs in 40-79 m and leiognathids in 20-59 m whereas along the upper east coast prawn was available in good quantities in 20-59 m at Visakhapatnam and in 0-39 m at Paradeep/Calcutta, elasmobranchs in 80-99 m at Visakhapatnam and in 100-119 m at Paradeep/Calcutta. Cat fish was abundant in 60-79 m depth belt at Visakhapatnam as well as at Paradeep/Calcutta.

Depth range (m) / Species	0-19	20-39	40-59	60-79	0-19	20-39	40-59	60-79
	TUTICORIN				MADRAS			
Elasmobranchs	17	23	27	-	9	8	8	23
Prawn	8	0	2	-	5	-	-	-
Cat fish	2	1	-	-	-	-	-	-
Karkara	2	2	3	-	-	-	-	-
Dara	1	1	2	-	-	-	-	-
Perch	11	19	8	-	6	9	3	-
Sciaenids	9	8	19	-	2	2	5	-
Clupeids	2	1	4	-	-	-	-	-
Leiognathids	7	8	11	-	2	11	15	-
Other quality fish	14	7	8	-	18	20	15	16
Miscellaneous fish	27	30	16	100	58	50	50	61

	0-19	20-39	40-59	60-79	80-99	100-119	0-19	20-39	40-59	60-79	80-90
	VISAKHAPATNAM						PARADEEP AND CALCUTTA				
Elasmobranchs	32	13	12	17	26	5	18	17	12	13	43
Prawn	-	3	3	2	2	3	7	4	3	3	-
Cat fish	2	23	22	25	17	10	4	9	21	25	7
Perch	-	-	-	-	-	-	-	1	-	-	-
Pomfrets	-	-	-	-	-	-	3	1	-	-	-
Dhoma	-	-	-	-	-	-	14	7	-	-	-
Other quality fish	5	8	6	6	13	1	1	11	11	9	20
Miscellaneous fish	61	53	57	50	42	81	53	50	53	50	30

Table X The important species/groups and their percentage of the total catch by region and depth.

7. RELATIVE ABUNDANCE

It has been well established that the most reliable index of relative abundance in the case of trawl fishery investigations is the catch per hour of trawling. As such, the trends of productivity in the different regions as seen by the catch rates by different types of trawlers has been made and are presented.

7.1. Relative abundance by area

The average catch/hour of trawling obtained by different classes of vessels from the various geographical divisions along the lower and upper east coasts are presented in Fig. 16 and 18 respectively. These clearly illustrate that the catch per hour of trawling varies widely from vessel to vessel in the same area.

7.1.1. Lower east coast

Out of 10 divisions surveyed only one area 8-78 was surveyed by all the five classes of vessels. Area 13-80 was covered by 4 classes of vessels whereas areas 9-78 and 12-80 were surveyed by three classes of vessels. Areas 9-79, 11-79, 11-80 and 14-80 were surveyed by only two classes of vessels and the rest of the areas by only one class (Fig. 16). The catch/hour recorded by small vessels varied from 44-117 kg/hour, the highest being from 8-78. Jheenga, the second category had a slightly wider coverage compared to the first type, the highest value viz., 199 kg/hour was recorded from 8-78, the range being 48-199 kg/hour. In the case of 17.5 m trawlers the catch rates were comparatively high in most of the squares fished: 8-78 (120 kg/hour), 9-78 (73 kg/hour), 9-79 (254 kg/hour), 11-79 (126 kg/hour), 11-80 (121 kg/hour), 12-80(126 kg/hour), 13-80 (87 kg/hour), 14-80 (187 kg/hour) and 15-80 (193 kg/hour). The catch rates recorded off Madras and off

Tuticorin ranged between 87-193 and 73-254 kg/hour respectively. Reference may be made here on the observations made by the 17.5 m trawlers along the lower east coast during 1975-76 (Anon 1976). A comparative study has indicated that the areas off Tuticorin appears to have yielded relatively poor catch rates. With regard to Meena Bharati , the highest catch per hour was from area, 13-80 with 376 kg/hour whereas Kalyani obtained a catch rate of 125 kg/hour from area 14-80.

The catch per hour of trawling of 17.5 m trawlers for the important groups by area along the lower east coast is given in Fig. 17. The catches from this zone comprises mainly elasmobranchs, sciaenids, leiognathids and perches. The catch rate of prawn obtained by 17.5 m trawlers was negligible in almost all areas surveyed. Similar trend was also noticed during 1975-76 (Anon-1976) except in areas 9-78 where the catch/hour of prawn was about 6 kg/hour. In the case of leiognathids, area 13-80 recorded the highest catch rate, while area 12-80 stood next in the order of abundance. The catch rate of perches ranged from 2-49 kg/hour while that of sciaenids varied from 3-8 kg/hour. It is interesting to note that the occurrences of cat fish in this zone was rather insignificant compared to others.

7.1.2. Upper east coast -

From Fig. 18 it can be seen that out of 14 divisions surveyed only three divisions viz., 17-82, 17-83 and 18-83 were surveyed by all the five classes of vessels, areas 18-84 and 20-86 by four classes of vessels, areas 16-82, 19-86 and 20-87 by three classes of vessels and the remaining by one or two classes of vessels during the period of investigation.

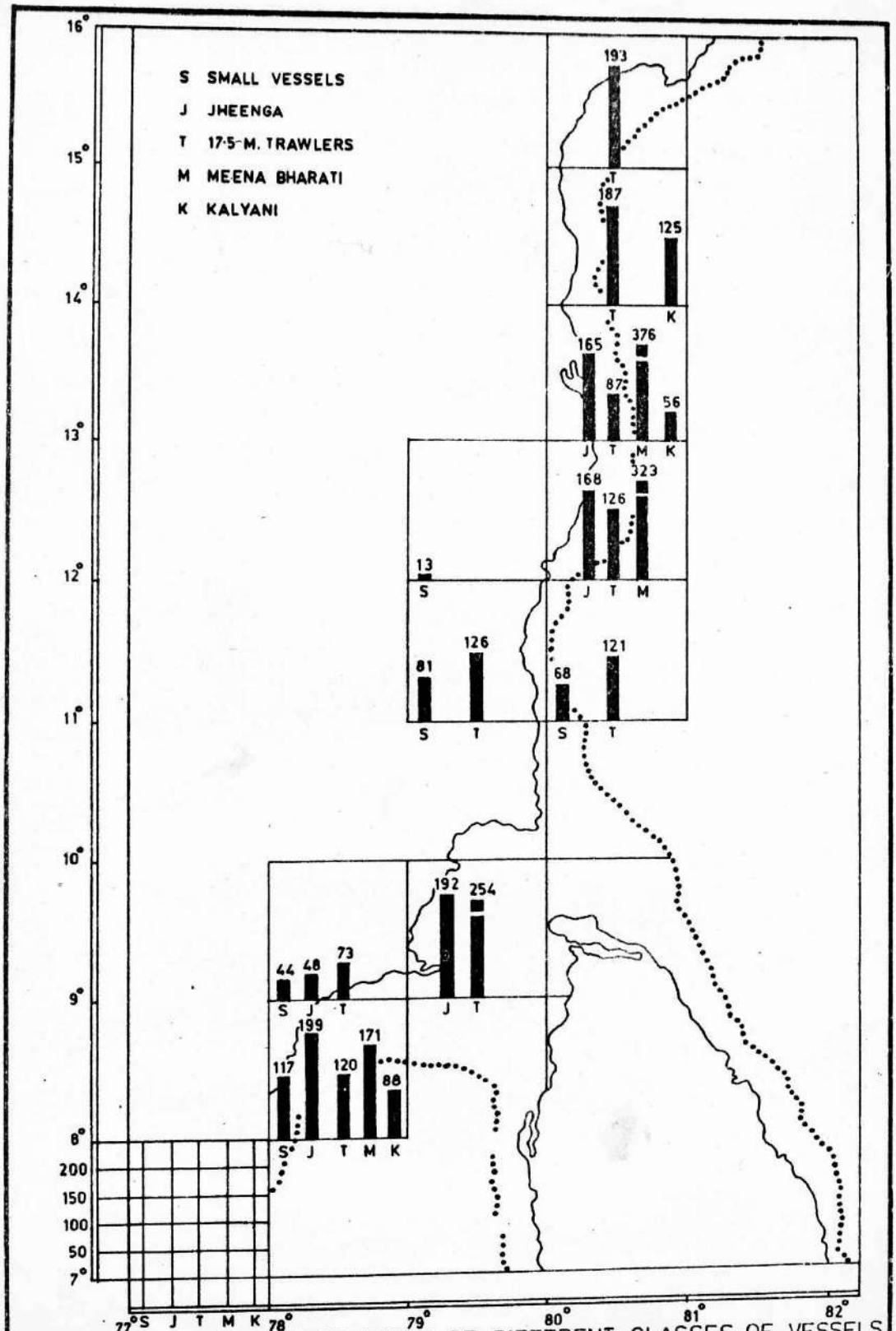


FIG. 16. CATCH/HOUR OF TRAWLING OF DIFFERENT CLASSES OF VESSELS BY AREA ALONG THE LOWER EAST COAST.

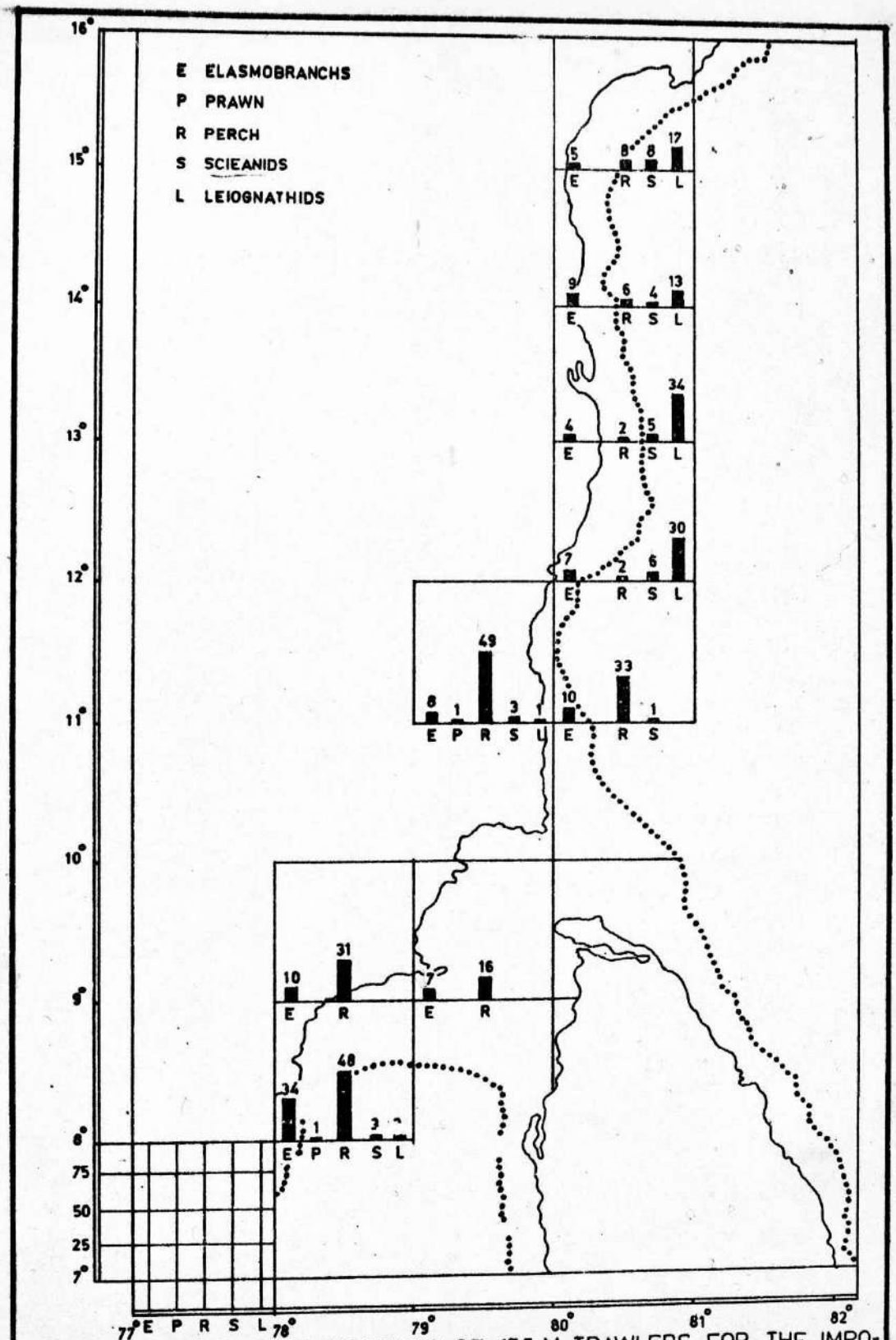


FIG.17. CATCH/HOUR OF TRAWLING OF 17·5 M. TRAWLERS FOR THE IMPORTANT GROUPS BY AREA ALONG THE LOWER EAST COAST.

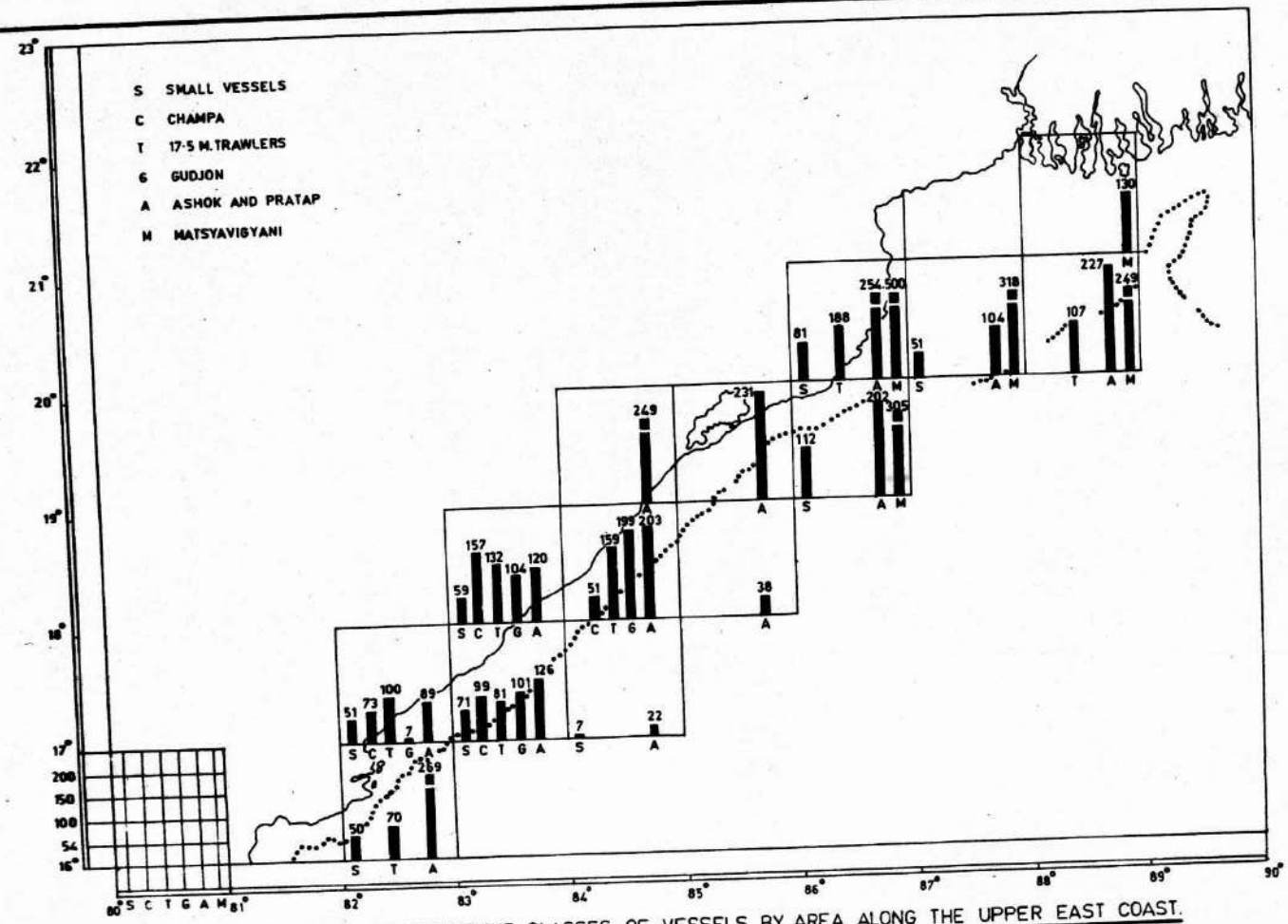


FIG. 18. CATCH/HOUR OF TRAWLING OF DIFFERENT CLASSES OF VESSELS BY AREA ALONG THE UPPER EAST COAST.

With regard to small vessels, eight divisions were surveyed and it is seen that the catch per hour varied from 7 to 112 kg/hour, the highest rate recorded from area 19-86. The next highest rates were 81 kg/hour from 20-86 and 71 kg/hour from 17-83. The species-wise catch/hour of trawling by these vessels from the different areas are given in Fig. 19. Miscellaneous fish formed the bulk of landings, the catch/hour varying from 32-92 kg/hour.

Champa operated only in 4 divisions. The catch per hour varied from 51 to 157 kg/hour and the highest catch rate was from area 18-83.

The 17.5 m trawlers, have covered seven divisions and the catch per hour varied from 70-188 kg/hour the highest value being recorded from 20-86. From 18-84, 159 kg/hour was recorded. Elasmobranchs, cat fish and perches were the dominant groups in most of the areas surveyed, besides prawn, eel, pomfrets, sciaenids and other quality fishes. The catch rates of miscellaneous species ranged between 28-89 kg/hour (Fig. 20). Prawn, though recorded from areas off Visakhapatnam, was more predominant in areas off Paradeep particularly in area 20-86 where the catch rate was 24 kg/hour. Reference may be made here about the results of exploratory fishing conducted during 1975-76 (Anon, 1976) wherein it was indicated that the areas 20-86 and 19-86 recorded the highest catch/hour of prawn viz. 20 kg and 7 kg respectively in the case of 17.5 m trawlers. High catch rates of cat fish and perches were recorded from areas 18-84 and 18-83 while elasmobranchs showed a high catch rate of 55 kg/hour from 20-88 (Fig. 20). Generally speaking elasmobranchs was the dominant group in the catches from Orissa-West Bengal coast.

In the case of Gudjon, the fishing activity was restricted only to four divisions and the highest catch rate was recorded from area 18-84 with 199 kg/hour. Ashok and Pratap surveyed 13 divisions, the catch rate ranging from 38 - 269 kg/hour, the highest having recorded from 16-82. The catch/hour of cat fish varied from 14-70 kg/hour, elasmobranchs 8-38 kg/hour, other quality fish 10-125 kg/hour and miscellaneous fish 1-160 kg/hour. The highest catch per hour in respect of quality and miscellaneous fish were recorded from 16-82 and 20-86 respectively (Fig. 21).

The catch per hour of Matsyavigyani in the areas of investigation ranged from 130-500 kg/hour, the highest rate was recorded from 20-86 and the next highest (305 kg) from 19-86. She surveyed altogether five divisions viz. 21-88, 20-88, 20-87, 20-86, 19-86.

7.2. Relative abundance by area and depth

For the purpose of studying bathymetrical distribution of resources, the shelf area was stratified into eight depth zones of 10 m depth intervals viz., 0-9 m, 10-19 m, 20-29 m, 30-39 m, 40-49 m, 50-59 m, 60-69 m and 70-79 m. The sampling intensity in areas beyond 80 m depth is too inadequate for a resources evaluation and hence these areas are not included for discussion in this section.

7.2.1. Lower east coast

Figs. 22 and 23 furnish the catch/hour of trawling obtained respectively by Jheenga and 17.5 m trawlers along the lower east coast by region and depth. In the case of Jheenga, it may be seen that the survey was done upto 70 m in area 13-80, 50 m in 12-80, 40 m in 8-78 and 20 m in areas 9-79 and 9-78. The highest catch rate (236 kg/hour) was obtained from 20-29 m depth zone off Tuticorin from area 8-78. In the Madras region out of the two areas surveyed,

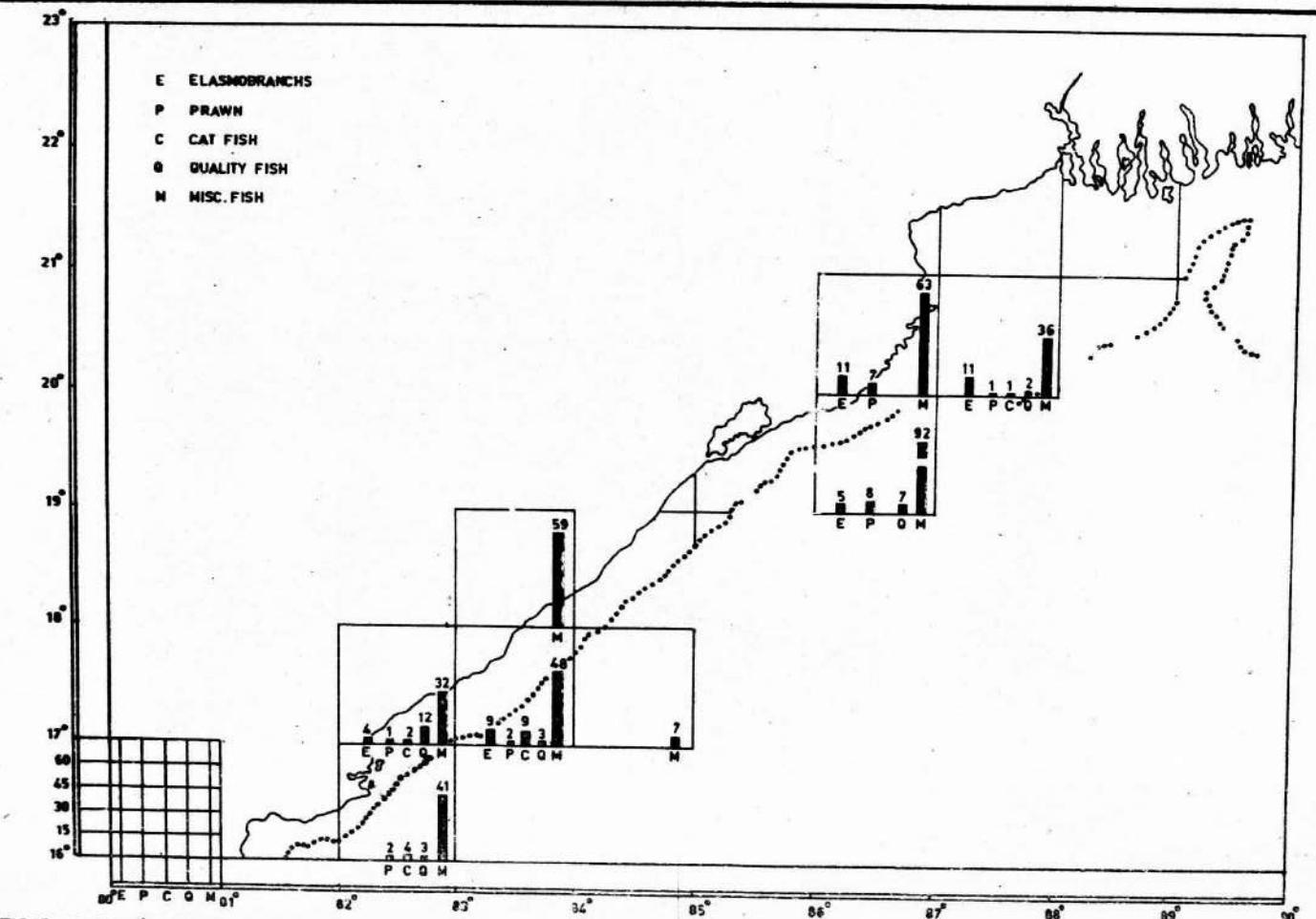


FIG.19. CATCH/HOUR OF TRAWLING OF SMALL VESSELS FOR THE IMPORTANT GROUPS BY AREA ALONG THE UPPER EAST COAST.

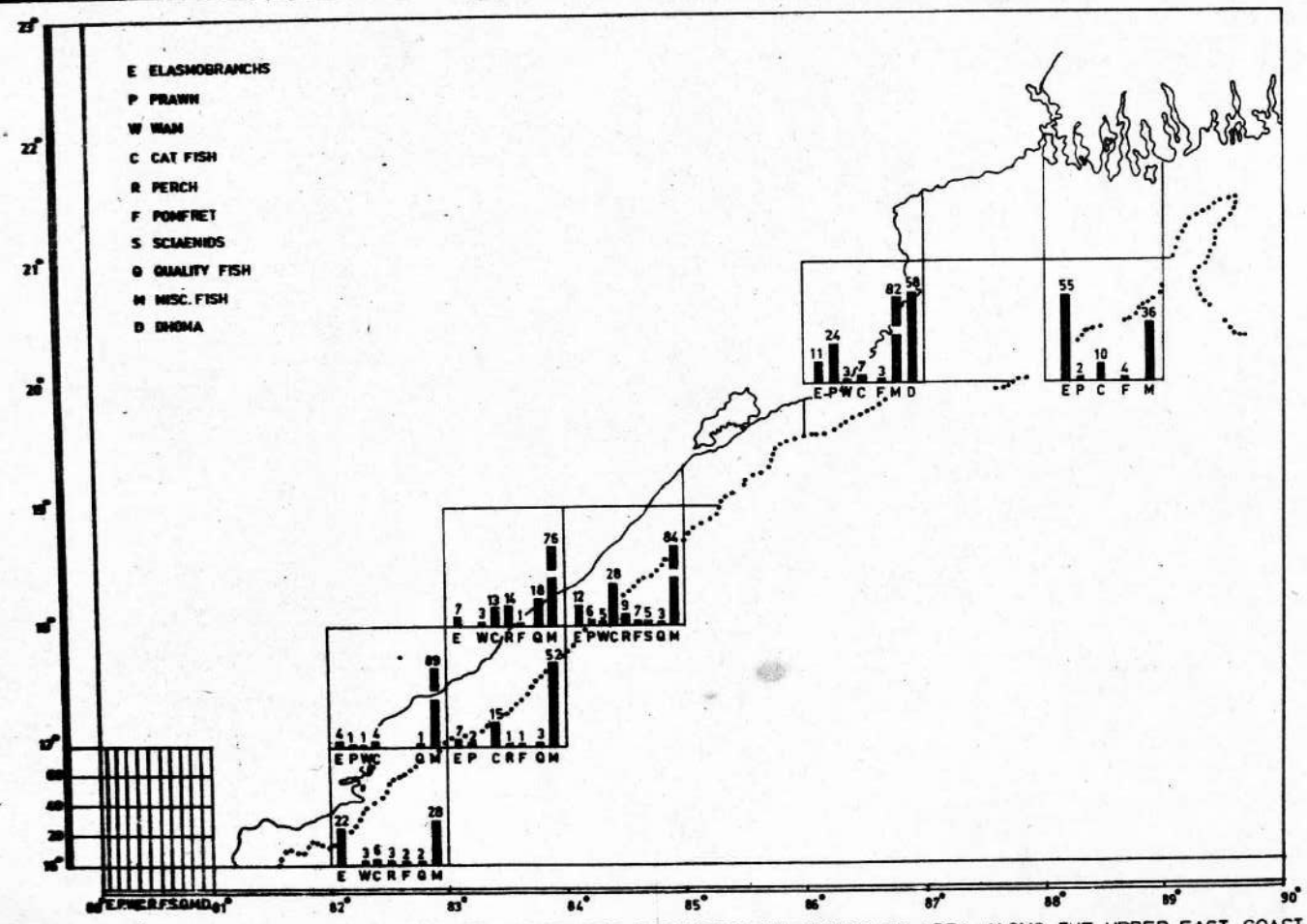


FIG. 20. CATCH/HOUR OF TRAWLING OF 17·5 M. TRAWLERS FOR THE IMPORTANT GROUPS BY AREA ALONG THE UPPER EAST COAST.

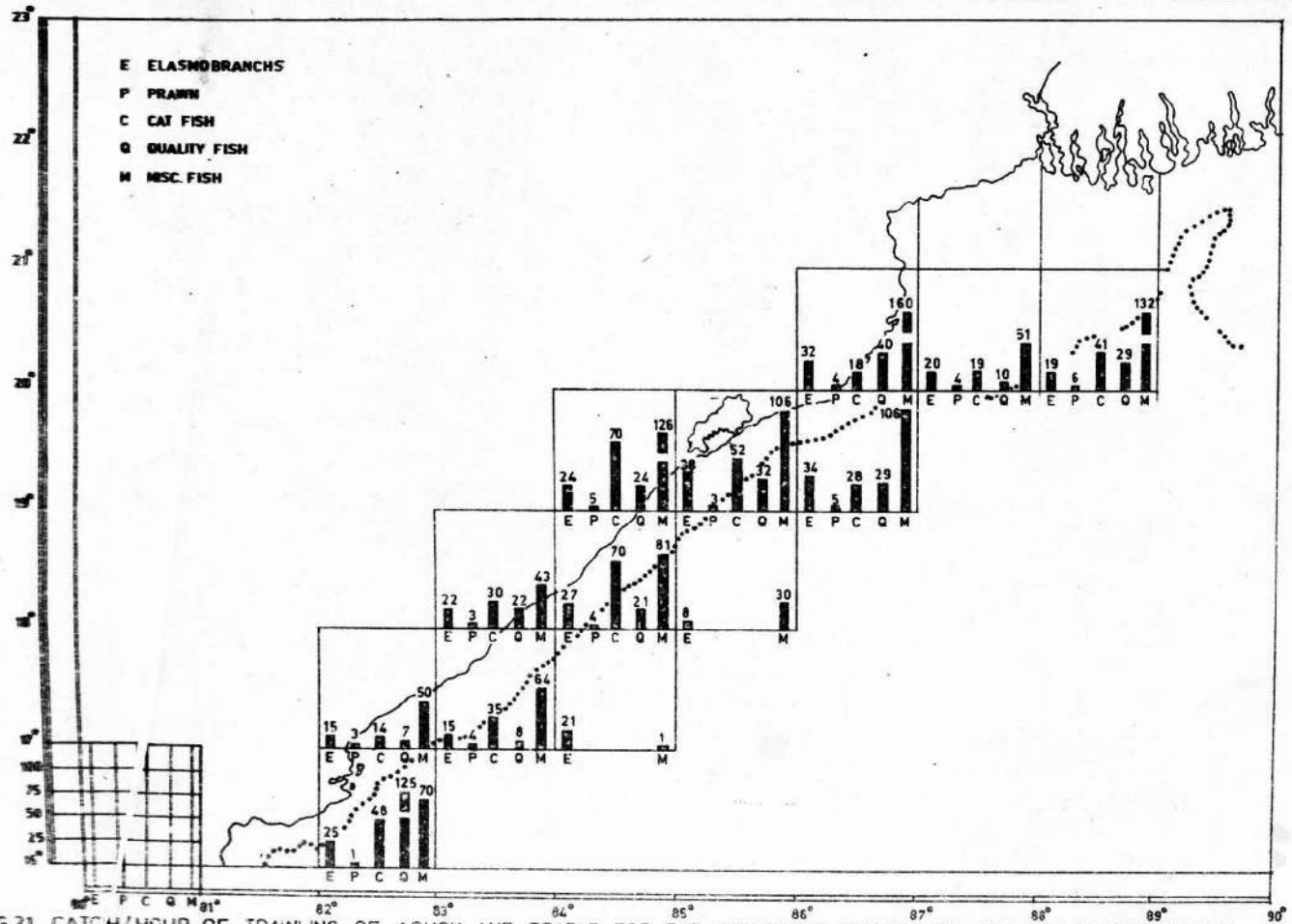


FIG 21. CATCH/HOUR OF TRAWLING OF ASHOK AND PRATAP FOR THE IMPORTANT GROUPS BY AREA ALONG THE UPPER EAST COAST.

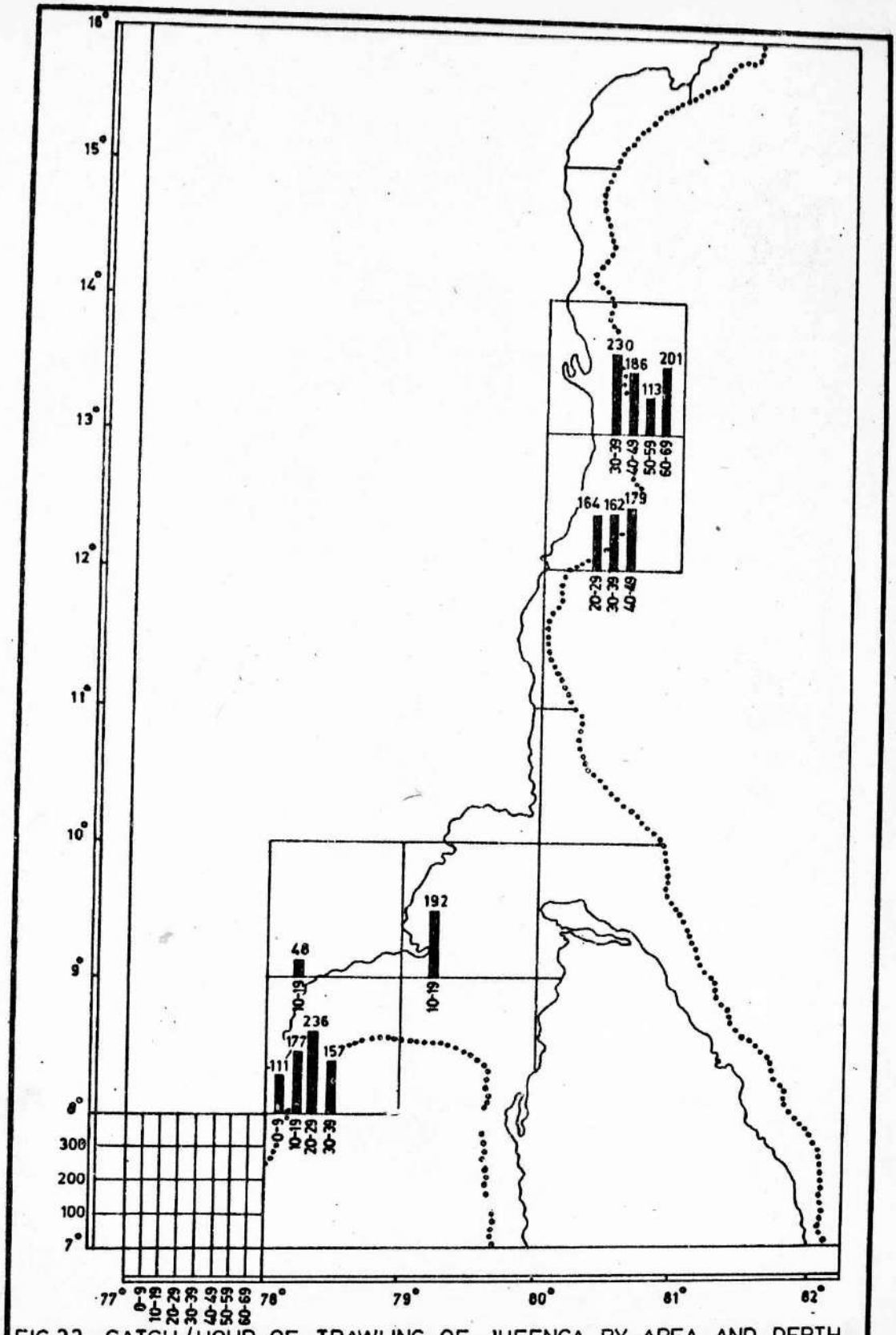


FIG. 22. CATCH / HOUR OF TRAWLING OF JHEENGA BY AREA AND DEPTH ALONG THE LOWER EAST COAST.

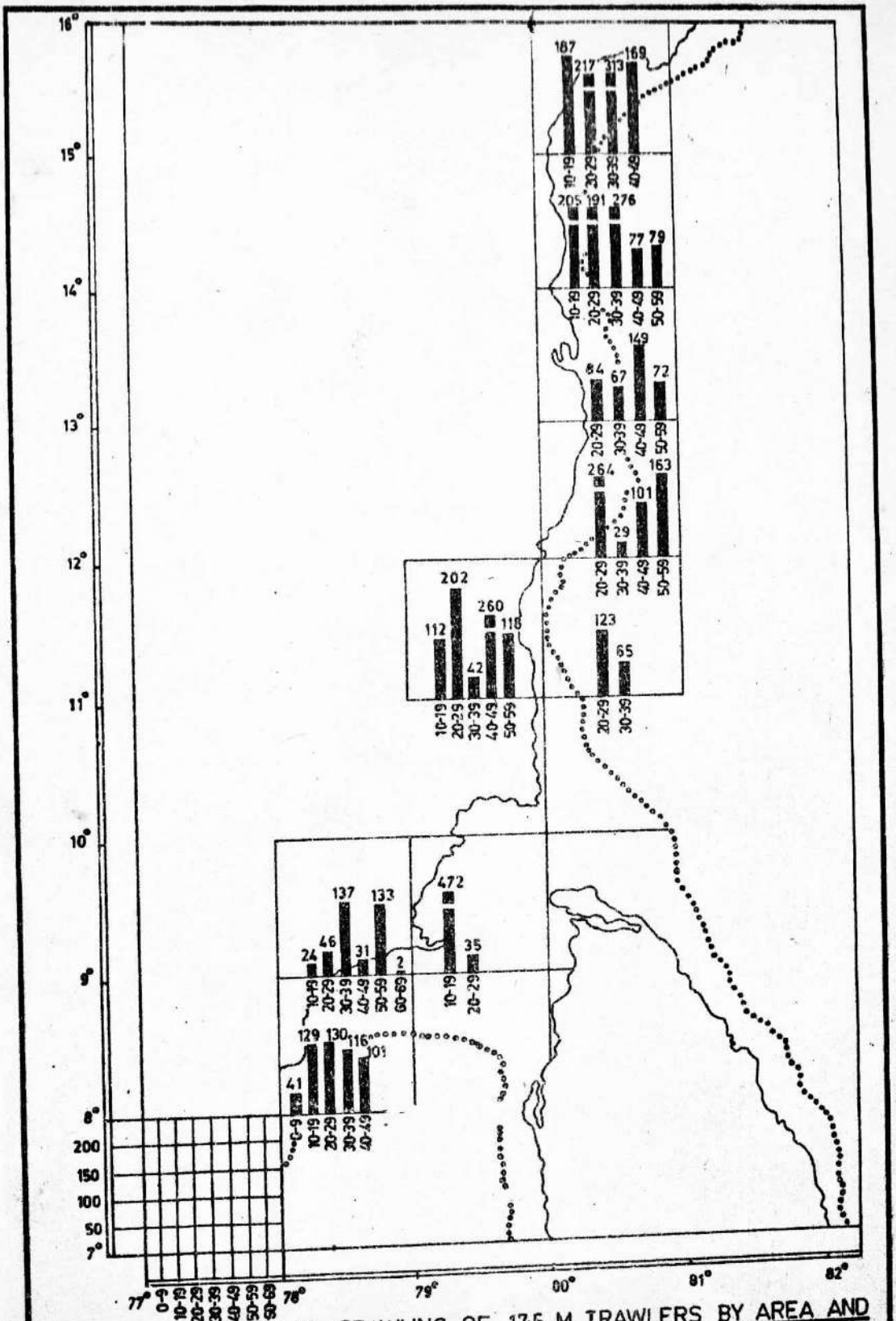


FIG.23. CATCH/HOUR OF TRAWLING OF 17·5 M. TRAWLERS BY AREA AND DEPTH ALONG THE LOWER EAST COAST.

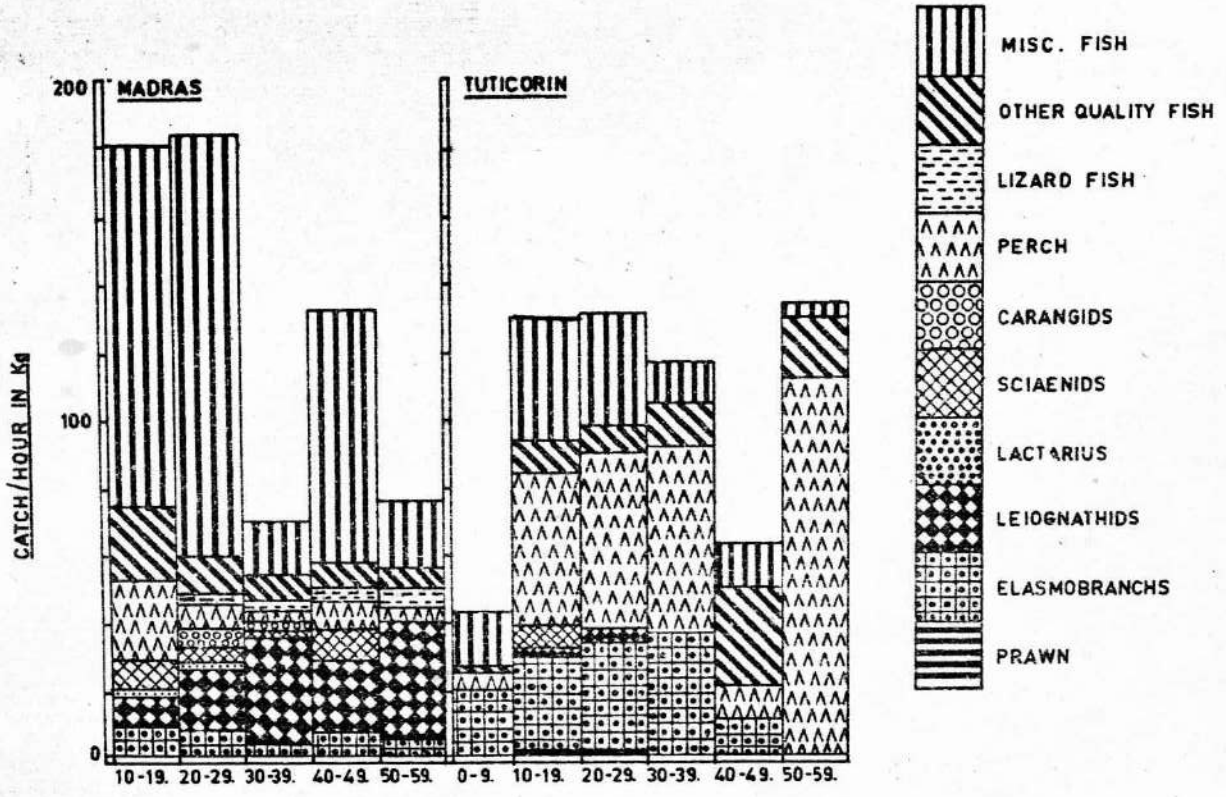


FIG. 24. CATCH/HOUR OF TRAWLING OF DIFFERENT SPECIES OBTAINED BY 17·5 M. TRAWLERS BY REGION AND DEPTH ALONG THE LOWER EAST COAST.

30-39 m depth zone in 13-80 recorded the maximum catch rate viz., 230 kg/hour which is the next highest catch rate observed along the lower east coast by this vessel. Further it was noticed that the 20-39 m depth zone yielded comparatively high catch rates in all the areas fished. With regard to 17.5 m trawlers (Fig. 23) it is observed that the survey has been done only upto 60 m in most of the areas of investigation. The highest catch per hour viz., 313 kg/hour was obtained from the 30-39 m depth zone from area 15-80, the next highest catch rate of 276 kg/hour was also obtained from the same depth zone in 14-80. In the adjoining two areas viz., 13-80 and 12-80, the highest average catch rates were recorded from 40-49 m and 20-29 m depth belts respectively.

Fig. 24 indicates the catch/hour of trawling of different species obtained by 17.5 m trawlers from different depth zones separately for two regions i.e. Madras and Tuticorin along the lower east coast. It can be seen from the figure that from Tuticorin region perches and elasmobranchs dominated whereas from Madras region sciaenids and leiognathids were abundant. The highest catch rate of perch from Tuticorin region was observed in 50-59 m depth belt. It is interesting to note that at the same depth zone in Madras region leiognathids was predominant. In the case of elasmobranchs the abundance seems to be more or less uniform at all depth zones in Madras region whereas 20-39 m zone in Tuticorin region registered the highest catch rate. Prawn in Tuticorin region showed its presence only in 10-29 m belt with a catch rate of 1 kg/hour whereas from Madras region it was almost negligible in all depth belts. The abundance of quality fish was noticed in 10-19 m in Madras region but the same showed the highest catch rate in 40-49 m depth off Tuticorin. The catch per hour of sciaenids appeared to be the highest in 40-49 m zone at Madras but the same was insignificant in the catches from Tuticorin.

7.2.2. Upper east coast

From Fig. 25 it may be seen that small vessels obtained the highest catch rate (122 kg/hour) from 30-39 m off Paradeep from area 19-86 and the next highest rate was recorded from 10-19 m off Visakhapatnam from area 17-83. With regard to 17.5 m trawlers relatively high catch rates were recorded upto 39 m off Paradeep as well as off Visakhapatnam. In areas off Visakhapatnam, the depth zone 20-29 m recorded the highest catch rate (167 kg/hour). From area 18-84 off Kalingapatnam the highest catch rate viz., 187 kg/hour was obtained from depth zone 30-39 m (Fig. 26). The depth belt 10-19 m of area 20-86 registered the highest catch rate of 250 kg/hour. Ashok and Pratap which have extensively surveyed these areas obtained the highest catch rates, from depths beyond 30 m (Fig. 27). The table shown below illustrates the maximum values of catch rates obtained by these vessels by areas and depth during the period of investigation.

Area	Maximum depth range (m) surveyed	Highest value of catch/hour (kg)	Depth range at which occurred (m)
16-82	60-69	317	30-39
17-82	80-89	112	50-59
17-83	100-109	172	70-79
18-83	50-59	124	30-39
18-84	90-99	231	40-49
19-84	50-59	426	50-59
19-85	90-99	287	50-59
19-86	60-69	304	60-69
20-86	30-39	262	30-39
20-87	50-59	120	40-49
20-88	70-79	390	60-69

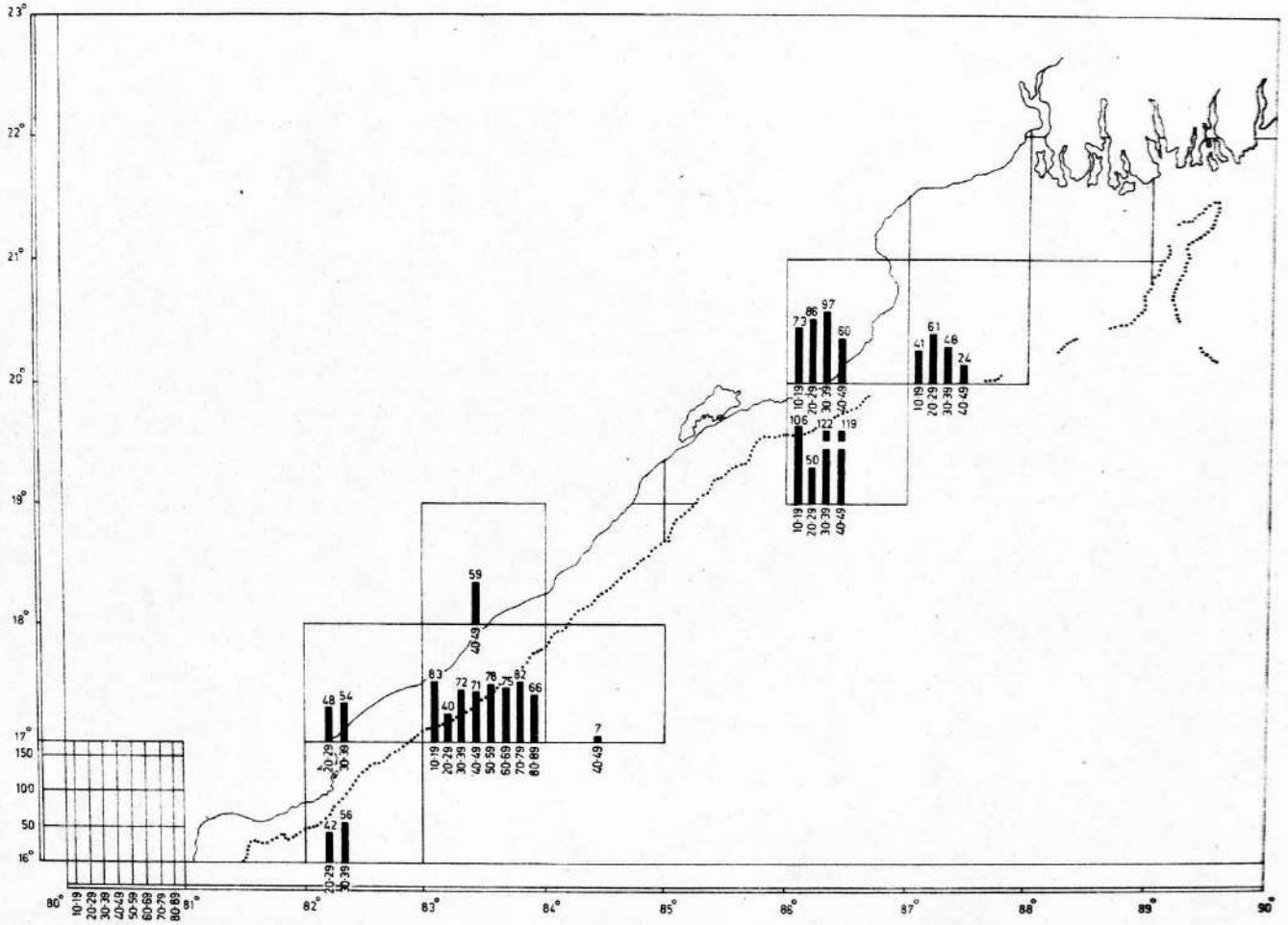


FIG. 25. CATCH/HOUR OF TRAWLING OF SMALL VESSELS BY AREA AND DEPTH ALONG THE UPPER EAST COAST.

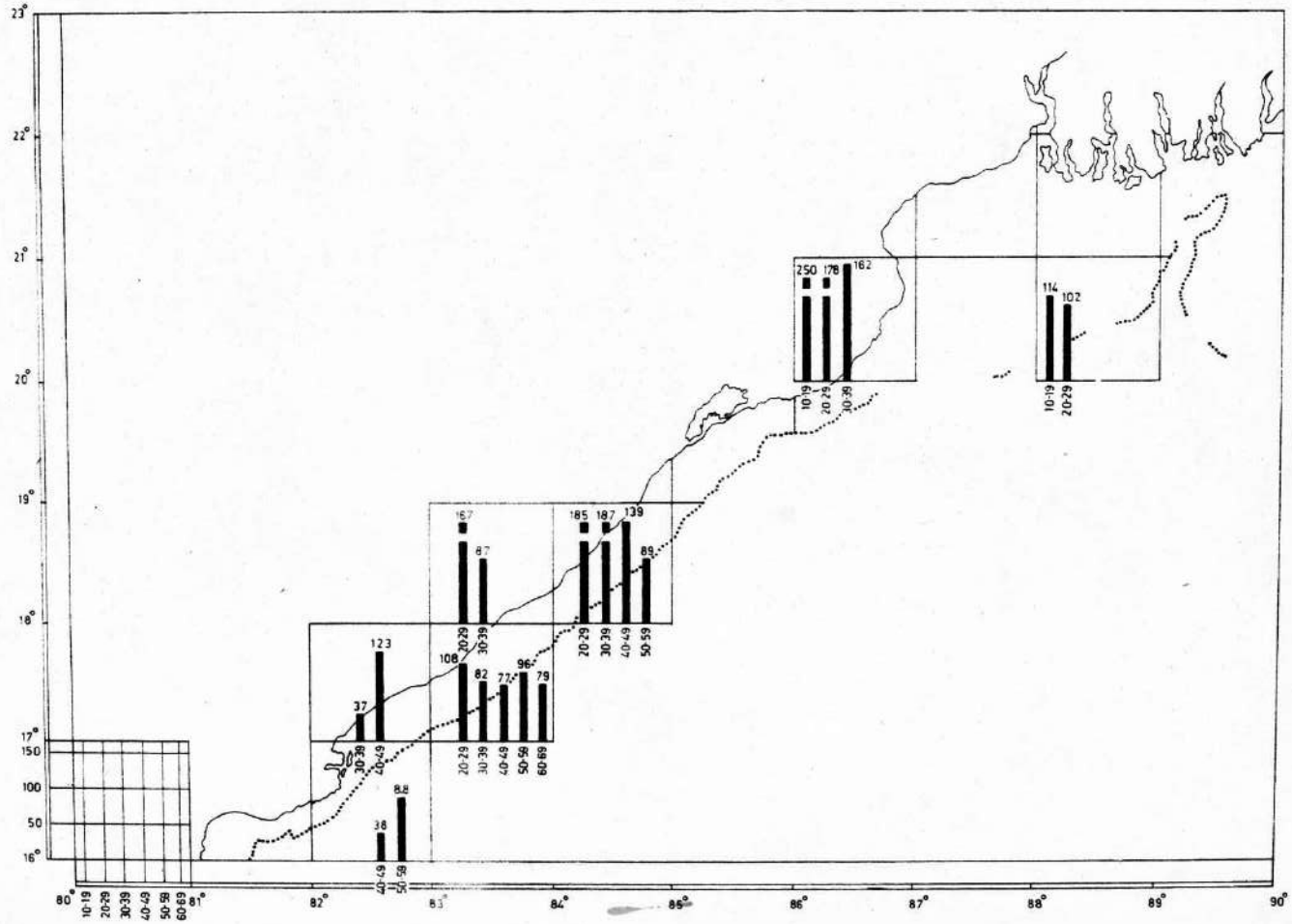


FIG. 26. CATCH/HOUR OF TRAWLING OF 17.5 M. TRAWLERS BY AREA AND DEPTH ALONG THE UPPER EAST COAST.

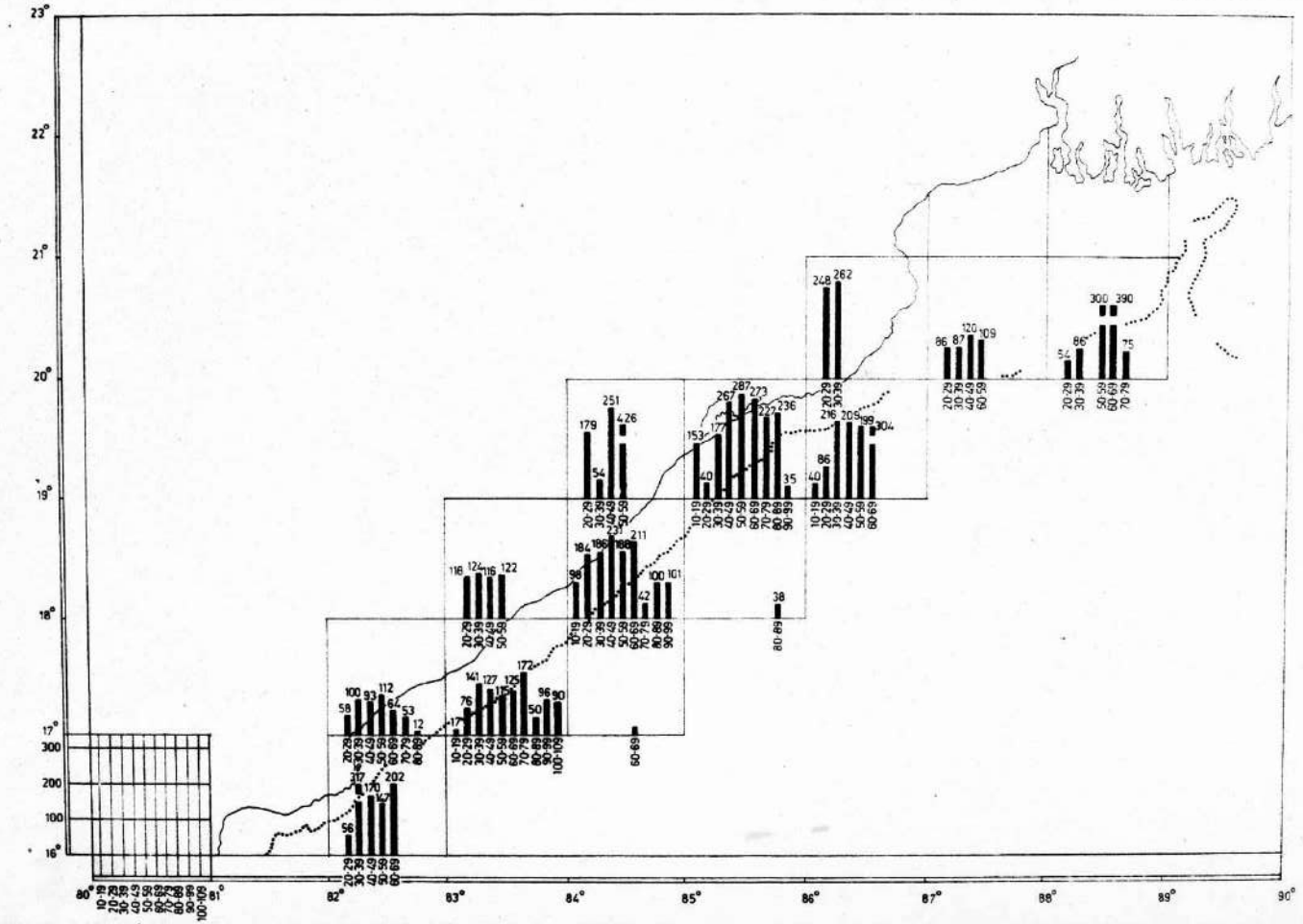


FIG. 27. CATCH/HOUR OF TRAWLING OF ASHOK AND PRATAP BY AREA AND DEPTH ALONG THE UPPER EAST COAST.

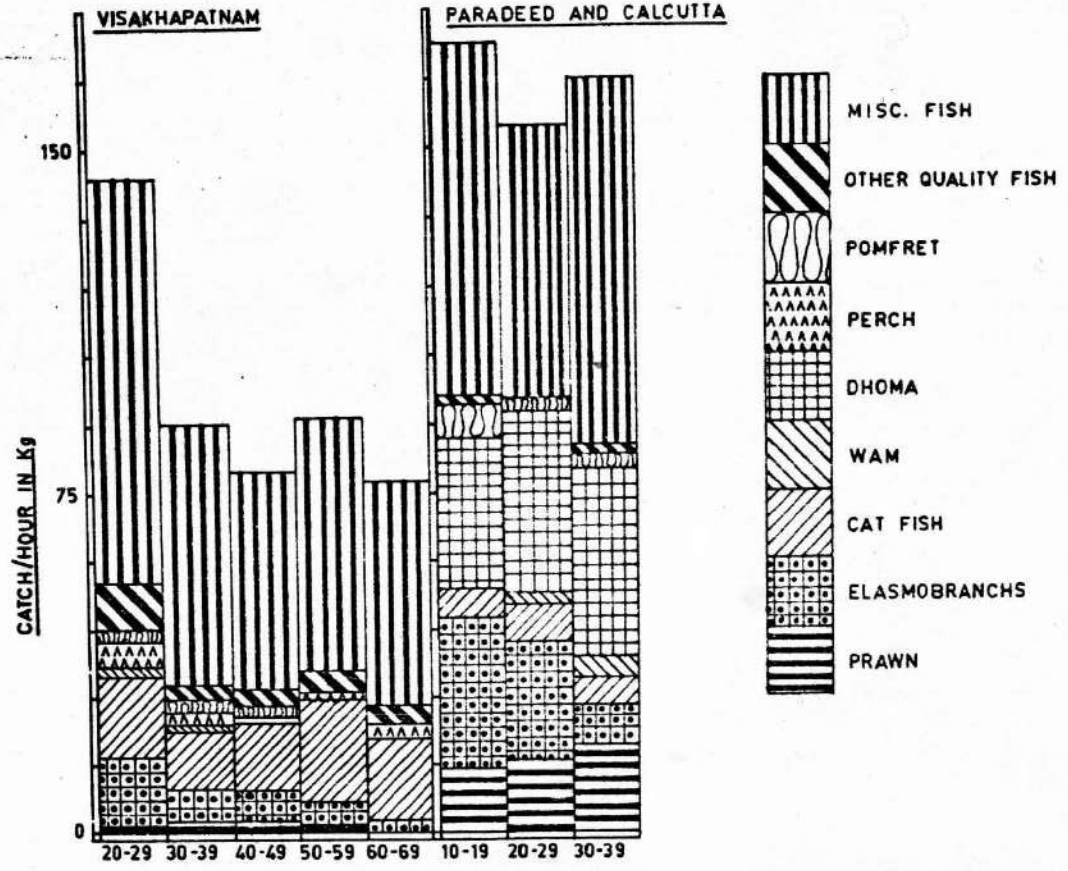


FIG.28. CATCH/HOUR OF TRAWLING FOR DIFFERENT SPECIES OBTAINED BY 17·5 M. TRAWLERS BY REGION AND DEPTH ALONG THE UPPER EAST COAST.

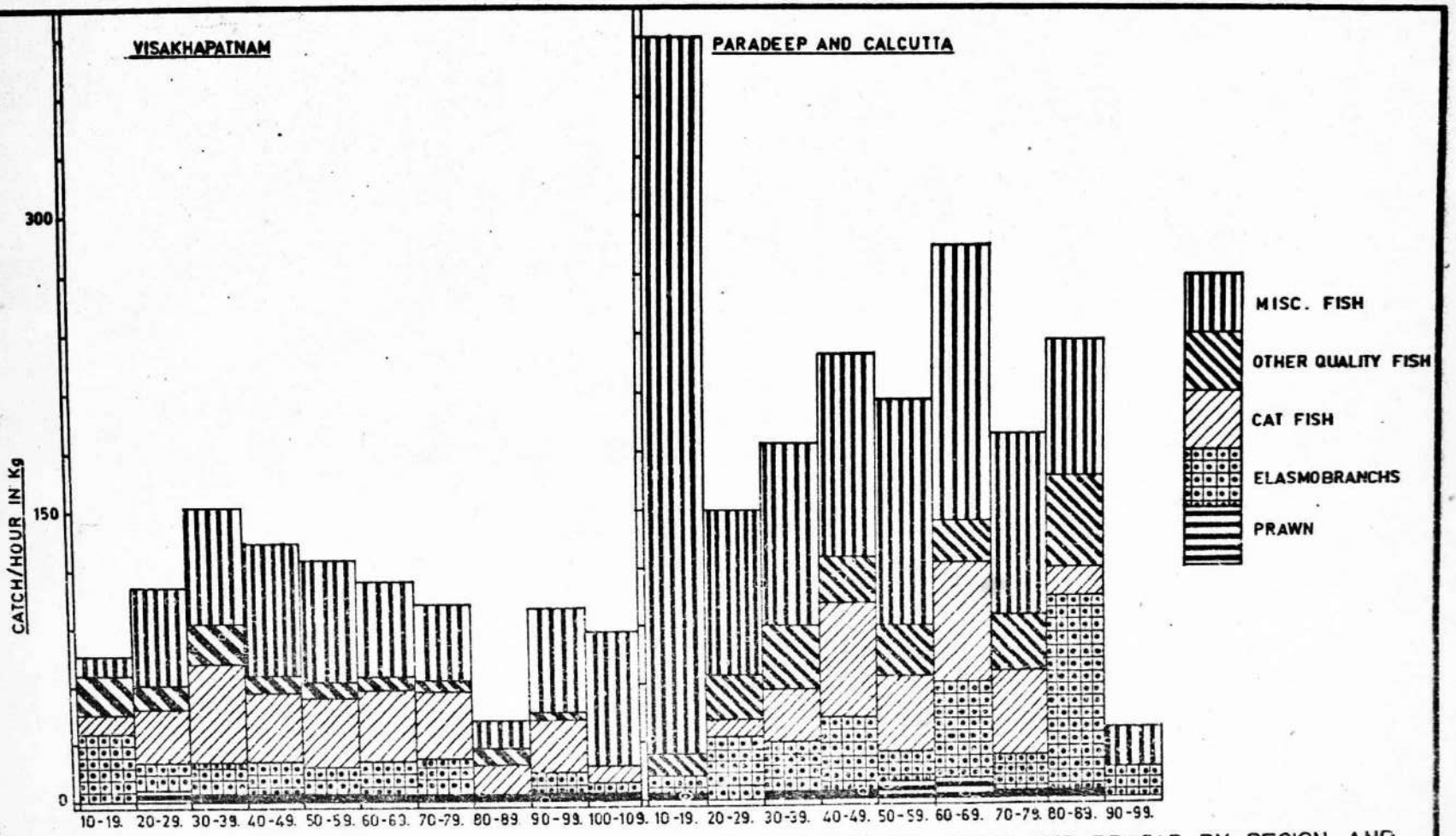


FIG.29. CATCH/HOUR OF TRAWLING FOR DIFFERENT SPECIES OBTAINED BY ASHOK AND PRATAP BY REGION AND DEPTH ALONG THE UPPER EAST COAST.

A close scrutiny of Fig. 27 revealed that the highest catch rate (426 kg/hour) was obtained from 50-59 m depth zone from 19-84, the next highest being 390 kg/hour from 20-88 (off Calcutta) from 60-69 m depth.

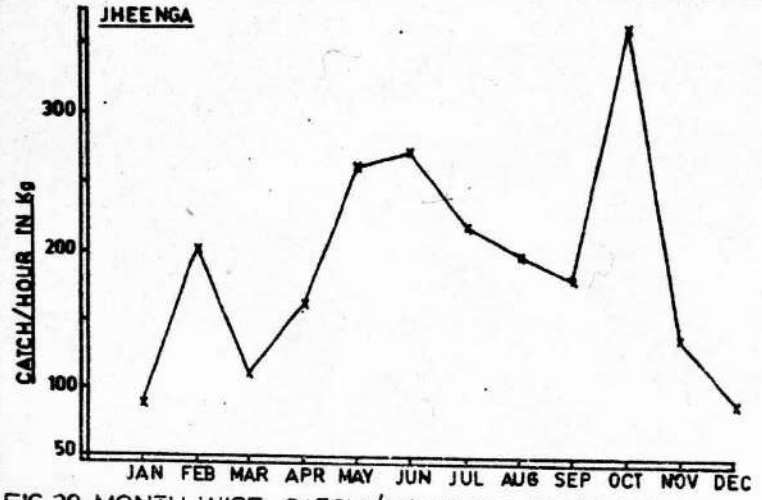
The catch per hour of trawling for different species obtained by 17.5 m trawlers and Ashok and Pratap by region and depth are shown in Fig. 28 and 29. On a close scrutiny of the figures it is seen that the catch per hour of prawn recorded from Paradeep/Calcutta by 17.5 m trawlers showed an upward trend from 10-19 m to 30-39 m depth, the maximum rate being from 30-39 m. In the case of Ashok and Pratap a similar trend was noticed, the maximum catch rate obtained being from 60-69 m depth belt. Cat fish dominated in the catch at Visakhapatnam as compared to Paradeep/Calcutta. It is interesting to note that the catch rates of cat fish by Ashok and Pratap from Paradeep/Calcutta were comparatively higher, the maximum being 62 kg/hour from 60-69 m. The maximum catch rate of quality fish recorded by Ashok and Pratap from Paradeep/Calcutta was 48 kg/hour from 80-89 m depth zone whereas from areas off Visakhapatnam, the same ranged between 1-20 kg/hour. On the other hand, the catch rate for this species was not high at both the regions by 17.5 m trawlers. 'Dhoma' was caught only by 17.5 m trawlers from the maximum catch rate viz., 41 kg/hour being recorded from 30-39 m depth zone. Similarly 'wam' from 30-39 m depth belt showed a catch rate of 5 kg/hour.

8. SEASONAL VARIATION IN THE CATCH

8.1. Lower east coast

Figs. 30 and 31 illustrate the monthly variation in the catch/hour of trawling of small vessels, Jheenga, 17.5 m trawlers and Meena Bharati. It is seen from Fig. 30 that the trend of peak landings based on catch rates were more or less the same for small vessels and Jheenga, the primary peak month being October and the secondary peak in May-June. On the other hand 17.5 m trawlers and Meena Bharati showed a slightly different trend, the primary peak period for Meena Bharati was May and for 17.5 m trawlers July. The months of September to November recorded good catch rates in the case of Meena Bharati , whereas for 17.5 m trawlers the secondary peak season was noticed in the month of September.

Fig. 32 gives the year-wise catch per hour of trawling of small vessels and Jheenga. For the small vessels, the information are available from 1959 to 1968 and for Jheenga from 1967 to 1973, the highest catch rates recorded by small vessels and Jheenga were in 1966 (234 kg/hour) and in 1971 (339 kg/hour) respectively. During the initial years of operation i.e. from 1959 to 1961 for smaller vessels and from 1967-68 for Jheenga, the catch rates recorded were comparatively poor, probably due to the intermittant nature of operation of the vessels. Meena Bharati operated only for a short time during 1967, 1968, 1969 and 1970 with Tuticorin/Madras as bases, and the catch rates recorded during these years respectively were 220, 139, 262 and 421 kg/hour.



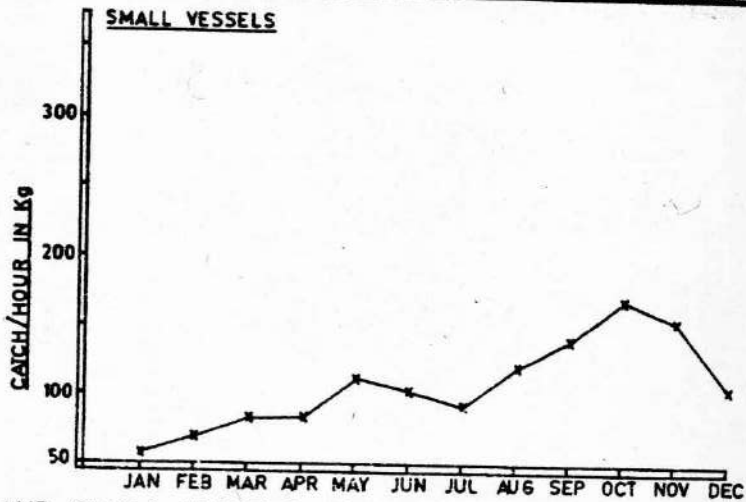
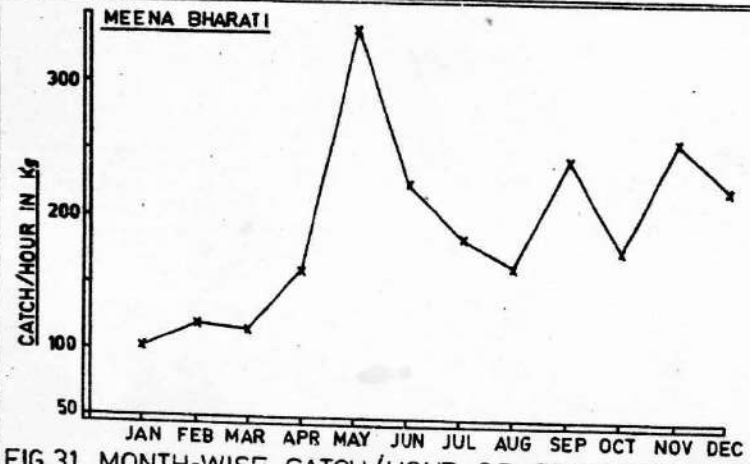


FIG.30. MONTH-WISE CATCH/HOUR OF TRAWLING OF JHEENGA AND SMALL VESSELS FROM THE LOWER EAST COAST.



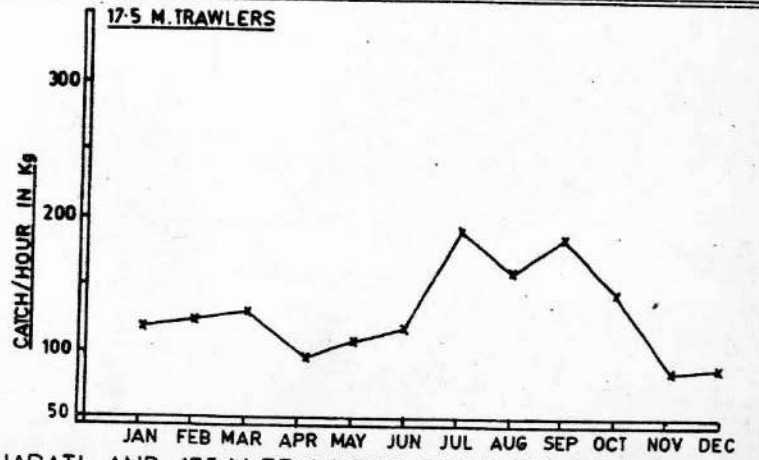


FIG.31. MONTH-WISE CATCH/HOUR OF TRAWLING OF MEENA BHARATI AND 17·5 M. TRAWLERS FROM THE LOWER EAST COAST.

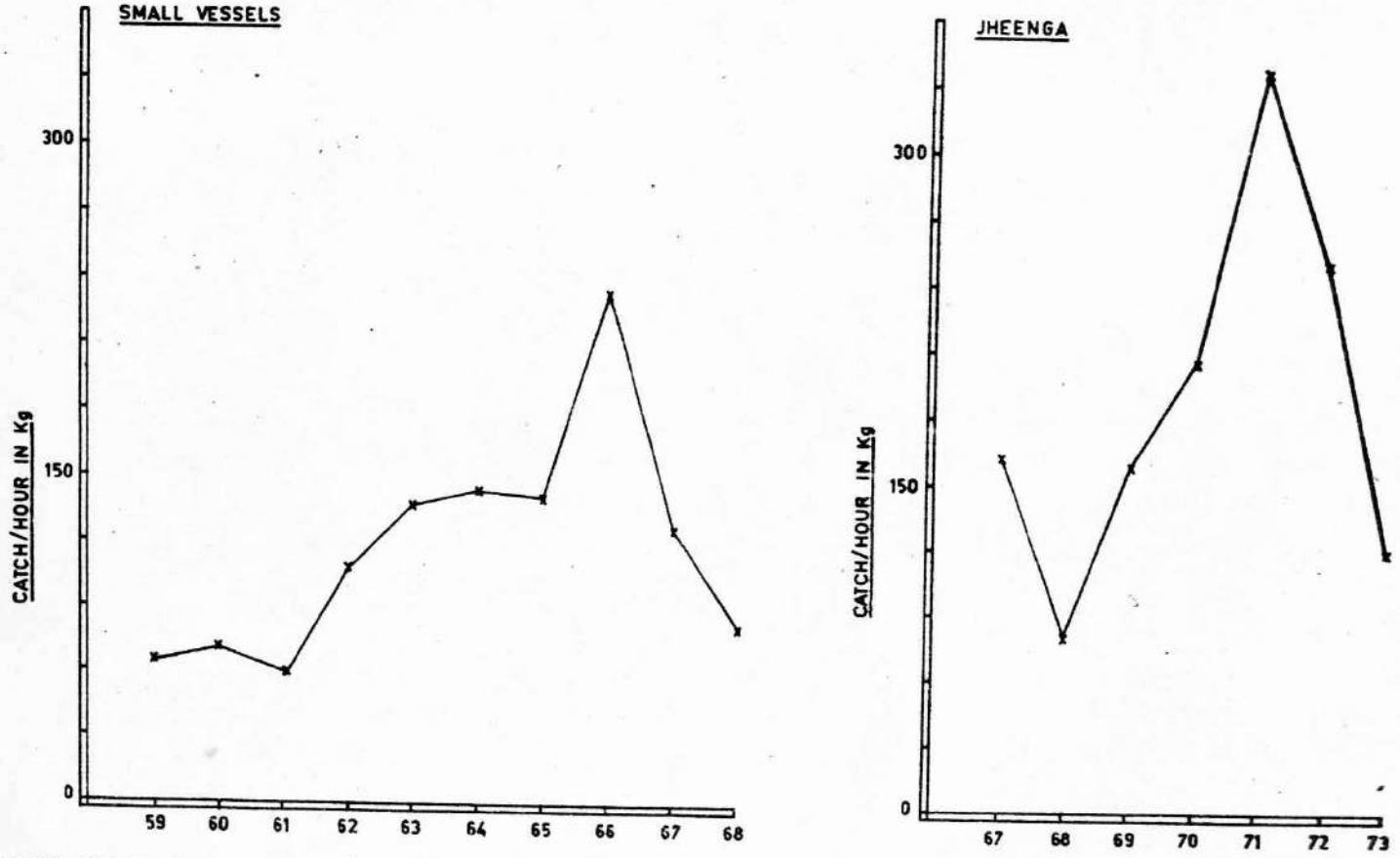
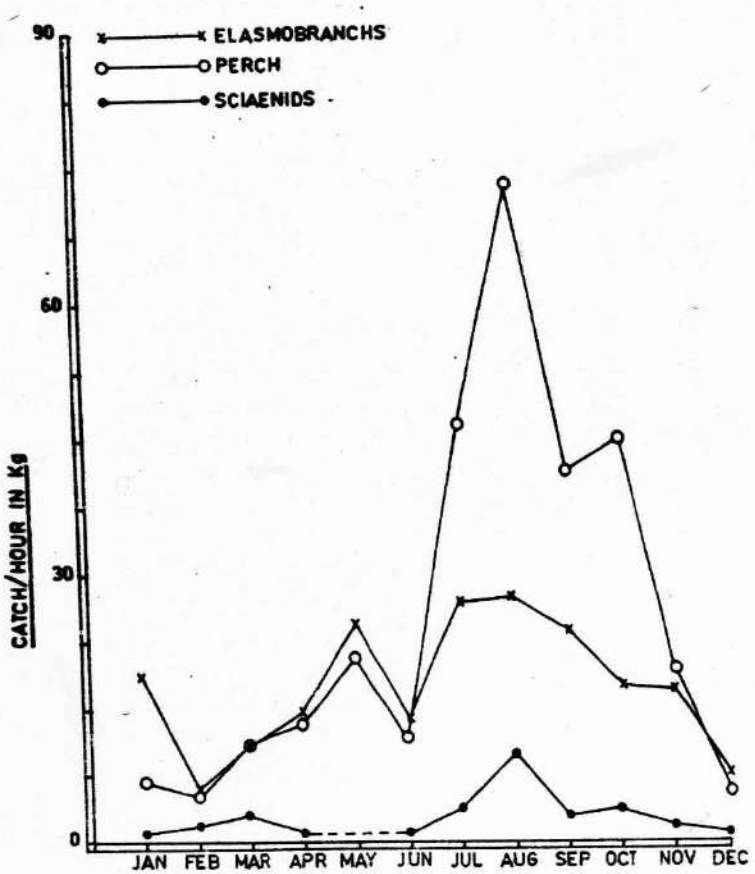


FIG. 32. YEAR-WISE CATCH/HOUR OF TRAWLING OF SMALL VESSELS AND JHEENGA FROM THE LOWER EAST COAST.



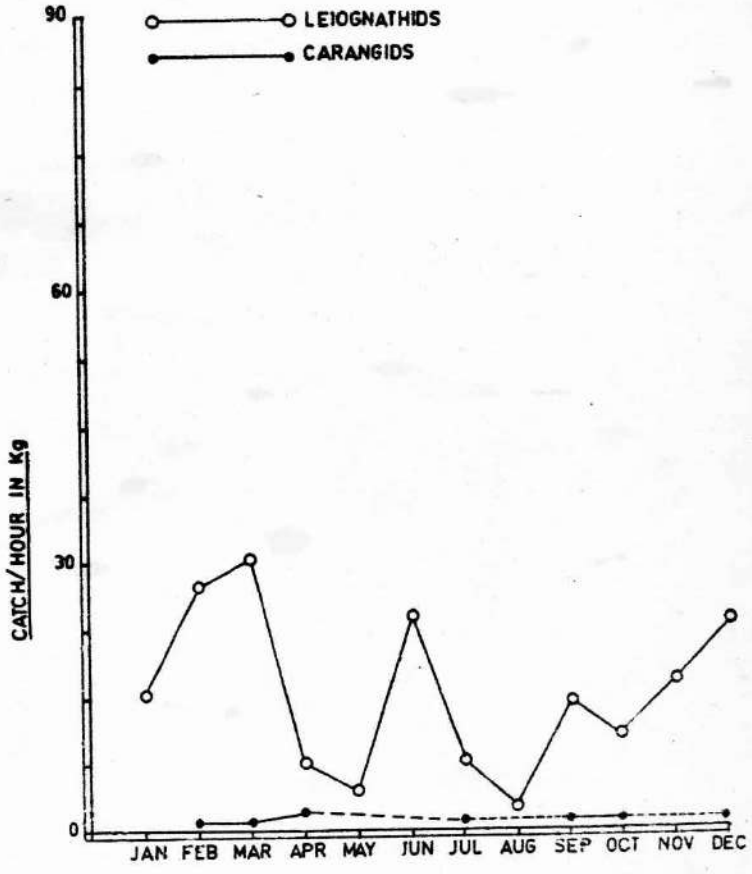
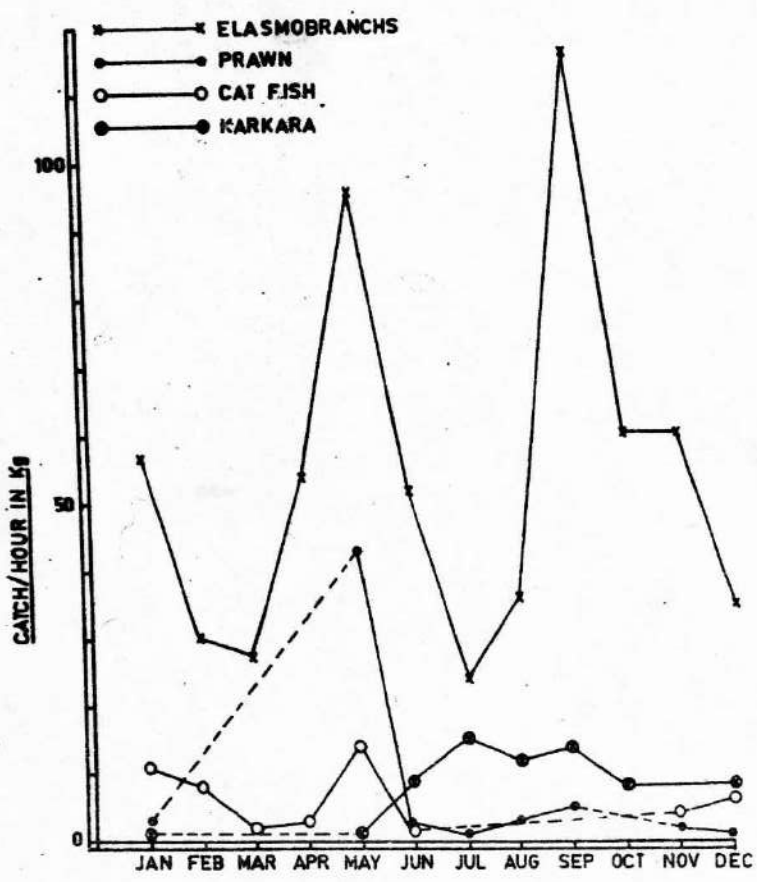


FIG.33. MONTH-WISE CATCH/HOUR OF TRAWLING OF IMPORTANT VARIETIES OBTAINED BY 17·5 M. TRAWLERS ALONG THE LOWER EAST COAST.



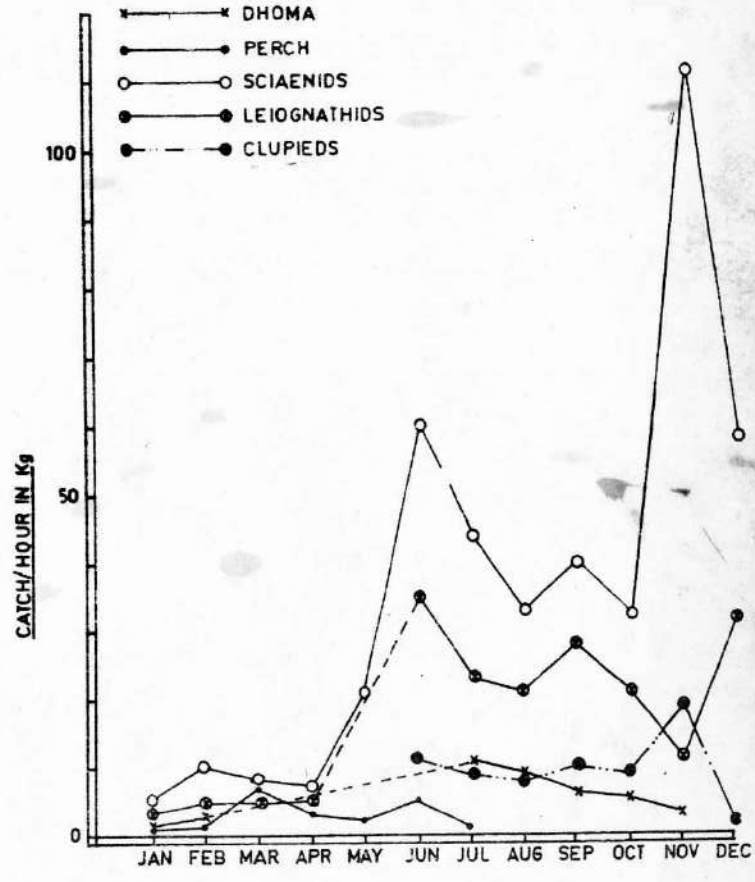


FIG. 34. MONTH-WISE CATCH/HOUR OF TRAWLING OF IMPORTANT VARIETIES OBTAINED BY MEENA BHARATI ALONG THE LOWER EAST COAST.

The operation of 17.5 m trawlers were from 1970 to 1974, the catch rates recorded respectively were 79, 147, 172, 153, and 115 kg/hour. Figs. 33 and 34 indicate the monthly variation in the catch rates of some important species viz., elasmobranchs, perch, sciaenids, leiognathids, carangids, cat fish and prawn as evidenced by data gathered by a selected few classes of vessels. It can be seen from the figures that in the case of prawn comparatively high rates of catch were obtained by Meena Bharati during May and September. Elasmobranchs registered high catch rates from Tuticorin during May and July to September. Perches recorded relatively high catch rates from Tuticorin during May and August to October whereas from Madras the catch rates were poor, the maximum rates recorded being in March and June. The 17.5 m trawlers obtained high catch rates of sciaenids during March and August, while Meena Bharati recorded high values for these species in June, September and November. Leiognathids yielded relatively high catch rates during the period June - December for both the classes of vessels from Madras region.

8.2. Upper east coast

Figs. 35 and 36 show the monthly variation in the catch rates of different classes of vessels. From the whole area under investigation, it may be seen that two peak seasons of productivity viz., June - December and March - April are discernable. It is seen that Ashok and Pratap, 17.5 m trawlers and Champa showed more or less similar pattern of catch rates. The year-wise catch

per hour of trawling of Champa and Ashok and Pratap are illustrated in Fig. 37, wherein it is seen that the highest catch rate was recorded during 1961 for both the types of vessels with 175 kg/hour and 224 kg/hour respectively. For Champa another high catch rate of 160 kg/hour was observed in 1962 whereas for Ashok and Pratap the values recorded were rather high during 1964 with 176 kg/hour. Matsyavigyani operated only for two years i.e. during 1973 and 1974 and the catch rates recorded were 234 and 274 kg/hour respectively. The catch rates recorded by small vessels during 1960-65 ranged between 43 kg/hour and 122 kg/hour, the highest being 122 kg/hour for the year 1961.

The monthly variation in the catch rates of important groups like cat fish, elasmobranchs and prawn obtained by Ashok and Pratap and 17.5 m trawlers are indicated in Fig. 38 and 39. It is interesting to see the distribution pattern of prawn in time along the upper east coast. The highest peak was observed in October and the next highest in July. Reference may be made here on the observations made by 17.5 m trawlers, during 1975-76 (Anon 1976) wherein it was pointed out that in areas off Paradeep, prawn recorded high catch rates during October - December, the highest rate of 60 kg/hour having been recorded during the month of November. Heavy catches were also recorded from areas off Visakhapatnam during July - October. The periods June - July and September - October appeared to be good season for elasmobranchs, while the periods June - July and September to November for cat fish. 'Dhoma' was abundant during February, September and December.

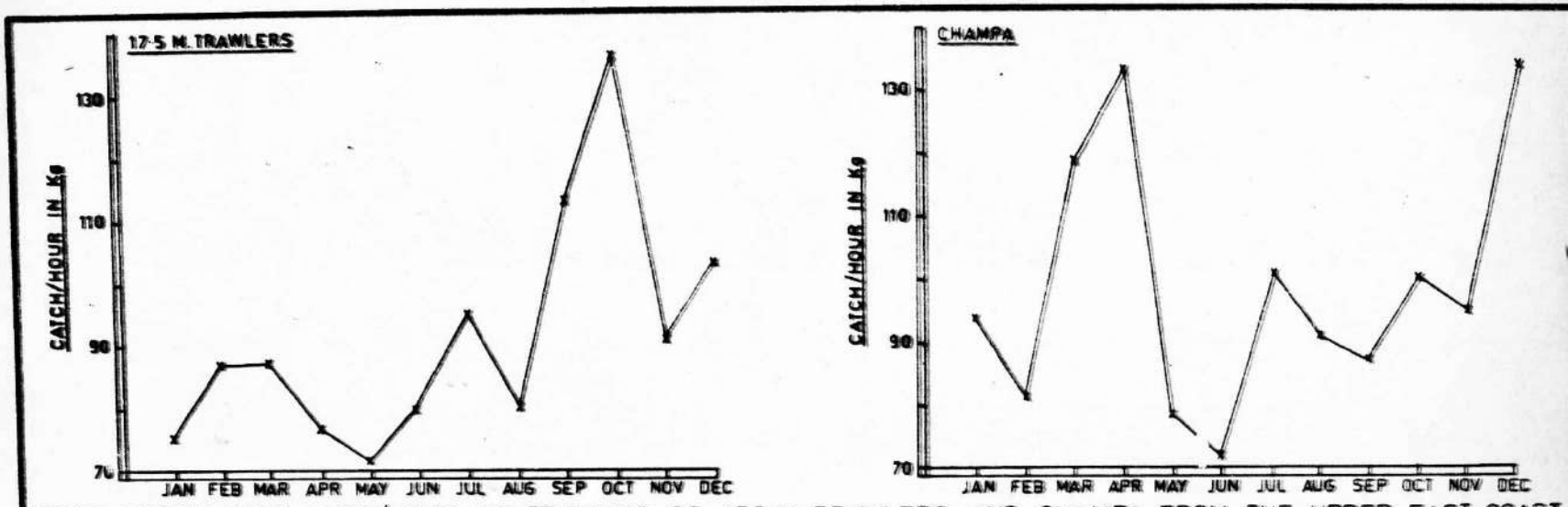


FIG. 35. MONTH-WISE CATCH/HOUR OF TRAWLING OF 17·5 M. TRAWLERS AND CHAMPA FROM THE UPPER EAST COAST.

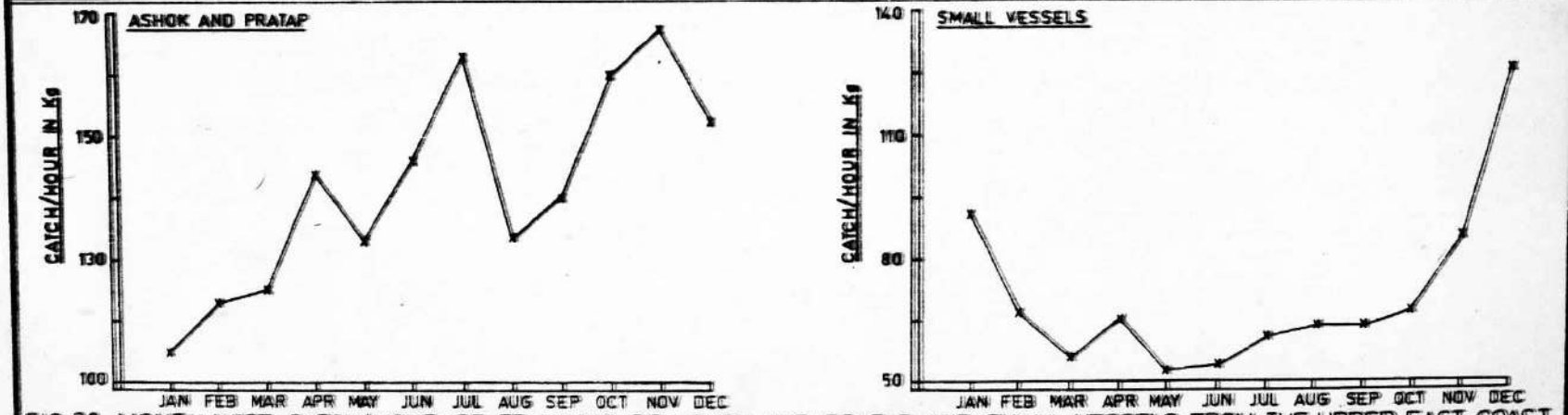
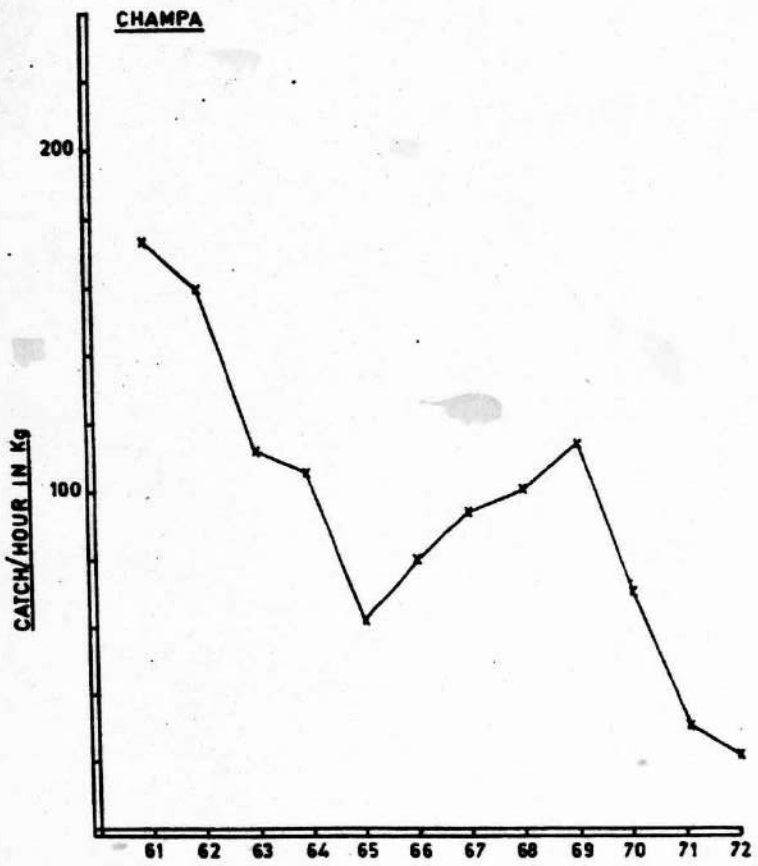


FIG. 36. MONTH-WISE CATCH/HOUR OF TRAWLING OF ASHOK AND PRATAP AND SMALL VESSELS FROM THE UPPER EAST COAST.



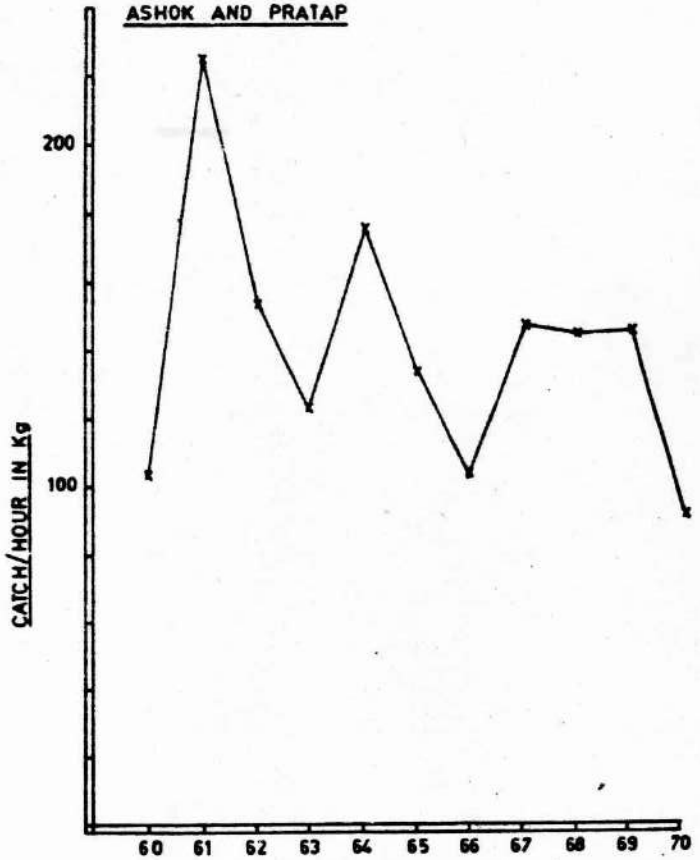


FIG.37. YEAR-WISE CATCH/HOUR OF TRAWLING OF CHAMA AND ASHOK AND PRATAP FROM THE UPPER EAST COAST.

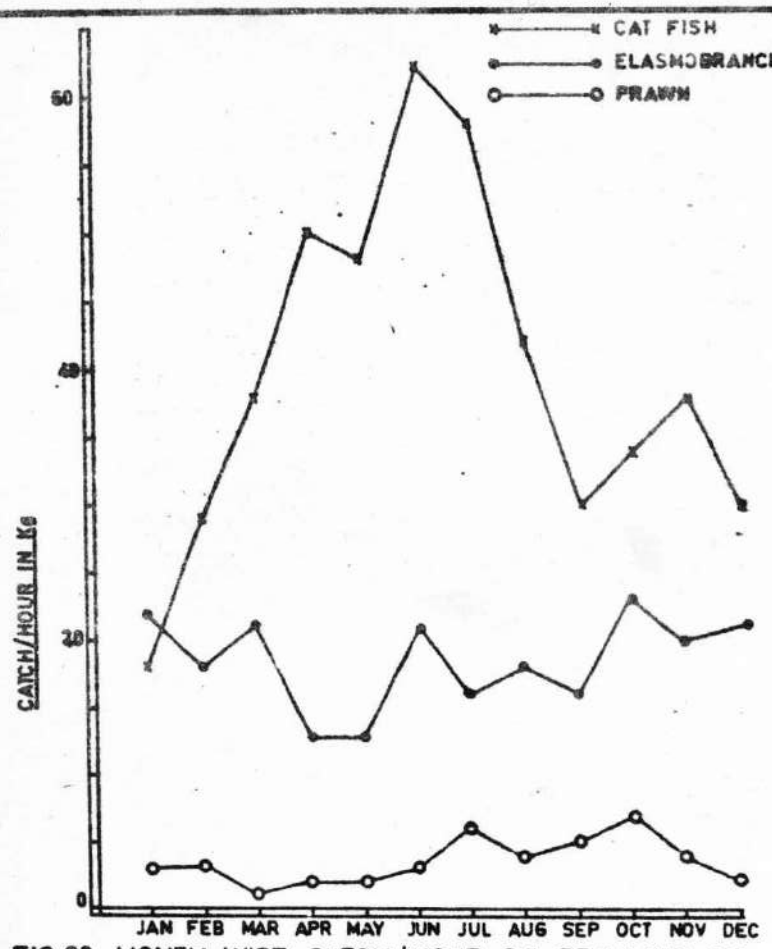


FIG. 38. MONTH-WISE CATCH/HOUR OF TRAWLING OF IMPORTANT VARIETIES OBTAINED BY ASHOK AND PRATAP FROM THE UPPER EAST COAST.

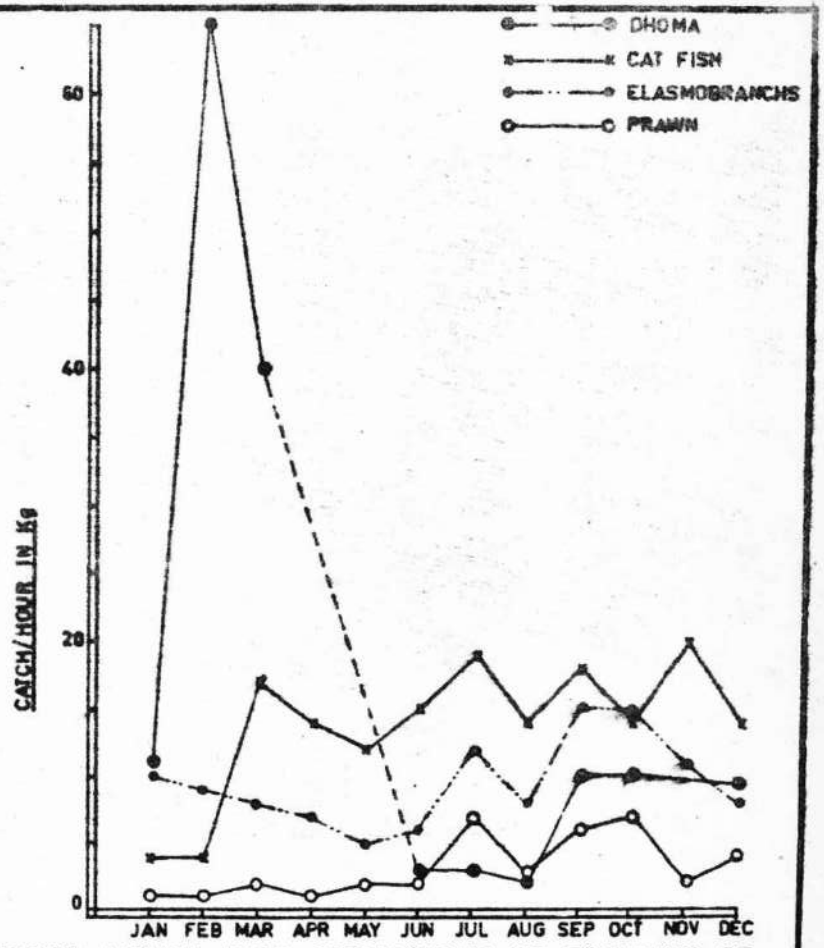


FIG.39. MONTH-WISE CATCH/HOUR OF TRAWLING OF IMPORTANT VARIETIES OBTAINED BY 17·5 M. TRAWLERS FROM THE UPPER EAST COAST.

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Figure 7	Scieaids	Sciaenids

9. STOCK ASSESSMENT

9.1. Standing stock

An attempt has been made to make a rough estimate of the standing stock and the likely potential yield of demersal fisheries resources in the area of investigation between 0-40 fm depth on the basis of the data gathered by the vessels operated by the five Exploratory Fisheries Project bases viz., Tuticorin, Madras, Visakhapatnam, Paradeep and Calcutta from their inception upto 1975-76. In this context it may be recalled that Jones and Banerji (1973), Prasad and Nair (1971) and West (1973) have furnished estimates of potential yield from the east coast of India on the basis of productivity studies, catch and effort etc.

Table XI gives the total continental shelf area along the east coast of India between the lat. 8° N and 21° N and long. 78° E and 88° E reckoned at 100 fm depth. The area has been stratified into 0-40, 40-50 and 50-100 fm for the purpose of this study. The total shelf area upto 40 fm is about 90,000 sq.km as against about 1,12,000 sq. km reckoned at about 100 fm or 180 m.

The methodology adopted for the computation of the standing stock is the same as that employed in the case of north west coast and south west coast (Joseph, 1974; Joseph et al., 1976). For the purpose of calculation of standing stock the catch per hour of 17.5 m trawlers has been taken for almost all areas in respect of the lower east coast. The main type of gear operated by 17.5 m trawlers alorg the lower east coast is 24 m fish trawl, the swept area of this trawl has been worked out to about 0.03914 sq. km at a trawling speed of two knots. In the case of upper east coast also, except for a few divisions along the West Bengal-Orissa coast, the catch per hour of 17.5 m trawlers and Ashok have been taken for the purpose of standing stock assessment. Both these types of vessels have operated 24 m fish trawls. In the case of the other areas the catch per hour of Matsyavigyani has been taken, which operated a 35 m fish trawl during most of her voyages. The swept area of this trawl has been calculated at 0.0642 sq. km at a trawling speed of 2.5 knots.

Sl. No.	Division	Depth in fathoms 0-40	40-50	50-100	Total
1.	8-78	3400	255	170	3825
2.	8-79	450	120	120	690
3.	9-78	1700	-	-	1700
4.	9-79	8500	-	-	8500
5.	9-80	1020	-	-	1020
6.	10-79	4250	-	-	4250
7.	10-80	3060	595	1275	4930
8.	11-79	2142	170	170	2482
9.	11-80	340	140	170	650
10.	12-79	340	-	-	340
11.	12-80	2958	680	680	4318
12.	13-80	2737	255	255	3247
13.	14-80	2023	170	255	2448
14.	15-80	4335	170	170	4675
15.	15-81	850	85	170	1105
	Sub-total: Lower east coast	38,105	2,640	3,435	44,180

(table contd...)

Sl. No.	Division	Depth in fathoms 0-40	40-50	50-100	Total
16.	16-81	2125	85	510	2720
17.	16-82	1530	170	850	2550
18.	17-82	870	170	340	1380
19.	17-83	4420	680	510	5610
20.	17-84	-	255	170	425
21.	18-83	680	-	-	680
22.	18-84	4250	340	340	4930
23.	18-85	-	255	340	595
24.	19-84	510	-	-	510
25.	19-85	3400	340	680	4420
26.	19-86	2040	255	170	2465
27.	20-86	3400	-	-	3400
28.	20-87	7570	1700	3910	13180
29.	20-88	2720	680	3400	6800
30.	21-86	935	-	-	935
31.	21-87	8500	-	-	8500
32.	21-88	8500	-	-	8500
Sub-total: Upper east coast		51,450	4,930	11,220	67,600
Grand Total:		89,555	7,570	14,655	1,11,780

TABLE XI Extent of continental shelf area along the East coast of India

Table XII gives the standing stock estimate in respect of the lower east coast from 0-40 fm depth comprising mainly the Tamil Nadu coast. The table also illustrates the extent of area in each of these divisions, the total fishing effort expended in them etc. In areas where the fishing effort has been adequate for the purpose of standing stock estimate, the average catch per hour obtained from that particular area has been utilised for the study, while in areas where the fishing effort has been inadequate, the average catch per hour obtained from the nearest divisions have been utilised. From the table it may be seen that the extent of area between 0-40 fm depth in the lower east coast is about 37,000 sq.km while the estimated standing stock is about 1,24,000 m.t. The average standing stock per sq. km works out to 3.35 m.t. per sq. km.

Table XIII gives the standing stock estimate in respect of the upper east coast comprising the coast of Andhra Pradesh, Orissa and West Bengal. The same principle as discussed above has been adopted in this case too. Particular mention may be made of the fact that in the case of upper east coast the catch per hour obtained by certain vessels during 1975-76 (Anon. 1976) have also been utilised for the assessment of the standing stock. This became necessary because of the inadequate data available for the Orissa-West Bengal coast. In this context it may be recalled that the vessels attached to Paradeep and Calcutta bases have commenced systematic fishing only during 1974 as discussed elsewhere in this bulletin although the bases were established a little earlier.

Sl. No.	Square	Area sq. km	Fishing effort in hours	Standing stock (m.t.)
1.	8-78	3400	12158	10424
2.	8-79	450	nil	1380
3.	9-78	1700	117	3171
4.	9-79	8500	17	25843
5.	10-79	4250	nil	13682
6.	10-80	3060	nil	9851
7.	11-79	2142	293	6891
8.	11-80	340	31	1051
9.	12-79	340	5	1095
10.	12-80	2958	824	9522
11.	13-80	2737	1647	6084
12.	14-80	2023	567	9665
13.	15-80	4335	196	21376
14.	15-81	850	nil	4192
	Total of Lower east coast:	37,085	15,855	1,24,232

TABLE XII Standing stock estimate along the lower east coast

Sl. No.	Square	Area sq. km	Fishing effort in hours	Standing stock (m.t.)
1.	16-81	2125	nil	3800
2.	16-82	1530	116	2736
3.	17-82	870	880	2223
4.	17-83	4420	19164	14228
5.	18-83	680	482	2293
6.	18-84	4250	1169	17265
7.	19-84	510	85	3245
8.	19-85	3400	226	20066
9.	19-86	2040	285	17936
10.	20-86	3400	354	22586
11.	20-87	7570	183	32426
12.	20-88	2720	347	10550
13.	21-86	935	nil	3626
14.	21-87	8500	nil	32967
15.	21-38	8500	2	32967
Total of Upper east coast:		51,450	23,293	2,18,914

TABLE XIII Standing stock estimate along the upper east coast.

From the table it may be seen that the area between 0-40 fm depth along the upper east coast is about 51,000 sq. km and the standing stock estimate is about 2,19,000 m.t. The average standing stock works out to about 4.26 m.t. per sq. km as against 3.35 m.t. for the lower east coast. The standing stock estimates in respect of the upper and lower east coasts are summarised as follows:

Zone	Area in sq. km	Standing stock in m.t.	Average standing stock/sq. km in m.t.
Lower east coast	37,085	1,24,232	3.35
Upper east coast	51,450	2,18,914	4.26
T o t a l:	88,535	3,43,146	3.88

It may be seen that the total extent of the area between 0-40 fm along the east coast of India is about 90,000 sq. km. The total shelf area reckoned at about 180 m for the entire east coast is about 1,12,000 sq. km. From this it may be seen that the area between 0-40 fm depth accounted for about 80% of the total shelf area along the east coast. It may further be noticed that the total standing stock of the east coast is about 3,43,000 m.t. and the average standing stock per sq. km works out to about 3.88 m.t.

9.2. Potential yield

On the basis of the standing stock estimates as detailed elsewhere the potential yield from the two zones of the east coast within 0-40 fm depth is calculated and furnished

below.

Zone	Potential yield in m.t.	Average potential yield/sq.km in m.t.
Lower east coast	74,539	2.01
Upper east coast	1,31,348	2.55

From the above, it may be seen that the potential yield from the lower east coast is about 75,000 m.t. while that from the upper east coast is about 1,31,000 m.t. The total potential yield of the entire east coast works out to about 2,06,000 m.t. In this context it may be mentioned that this study reveals certain interesting contrasts when compared to the earlier studies made, particularly by Jones and Banerji (1973). Jones and Banerji (1973) have estimated a lower catch rate per hectare for the upper east coast as compared to the lower east coast. The potential yield given by the authors are 15 kg. per hectare for the Andhra-Tamil Nadu coast and 10 kg. per hectare for the Orissa-West Bengal coast. On the basis of these, the authors have computed a total potential yield of 1,43,000 tonnes for the entire shelf area on the east coast reckoned at about 200 m. Prasad and Nair (1971) have also estimated the potential yield from east coast at about 1,43,000 tons on the basis of productivity studies. The present study indicates that the upper east coast is more productive than the lower east coast and the total potential yield from the shelf area is likely to be much more than what the authors have estimated. It is, however, interesting to note that West (1973)

by employing Gulland's conservative density figure of 6.5 tons/sq.mile/ year has estimated a potential yield of about 1,17,000 tons for the upper east coast comprising Orissa and West Bengal.

According to Silas et al (1976) the average demersal fisheries yield from the east coast (average of 13 years i.e. 1962-1974) is about 1,19,000 m.t. Of this the major share viz., about 75,000 m.t. has been taken from the lower east coast(Tamil Nadu). From this, it may be seen that there is considerable scope for increasing the fishing effort along the entire east coast particularly along the upper east coast. While the potential yield within 40 fm depth for the upper east coast is about 1,31,000 m.t. the average annual demersal fish landings from the upper east coast apper to have been around only about 44,000 m.t. This shows that there is possibility of increasing the production from the upper east coast atleast three times for the 40 fm belt. Thus, there appears to be a general agreement among the various authors that there is scope for further development and expansion of the fisheries along the east coast.

A comparative study of the area, standing stock, potential yield from 0-40 fm depth along the four zones comprising both the east and west coast viz., north west coast, south west coast, lower east coast and upper east coast is furnished below.

Zone	Area in sq.km.	Standing stock in m.t.	Potential yield in m.t.	Average/sq.km in m.t. Standing stock	Potential yield
North west coast	1,06,340	4,66,023	2,79,600	4.38	2.63
South west coast	54,781	2,06,814	1,24,087	3.78	2.27
Sub-total: West coast	1,61,121	6,72,837	4,03,687	4.18	2.51
Lower east coast	37,085	1,24,232	74,539	3.35	2.01
Upper east coast	51,450	2,10,914	1,31,348	4.26	2.55
Sub-total: East coast	88,535	3,43,146	2,05,887	3.88	2.33
Grand Total:	2,49,656	10,15983	6,09,574	4.07	2.44

From the above table it may be seen that the potential yield from the four regions are likely to be in the order of 2,80,000, 1,24,000, 75,000 and 1,31,000 m.t. respectively for the north west coast, south west coast, lower east coast and upper east coast. The total potential yield of demersal fisheries from 0-40 fm as per the present authors is about 0.6 million tons which figure appear to be the total estimate for the entire shelf area according to some earlier authors (Mitra 1973; Jones and Banerji, 1973; Prasad and Nair, 1971). The most productive area appears to be the north west coast with 4.38 m.t. per sq.km, the next highest being the upper east coast with 4.26 m.t. per sq.km. The lower east coast appears to register the lowest productivity viz. 3.35 m.t. per sq.km as against 3.78 m.t. per sq.km along the south west coast.

10. ECONOMICS OF TRAWLING

The economics of fishing of demersal fisheries resources along the west coast of India have been discussed earlier by several authors. Joseph(1971) has furnished the basic parameters required to work out the economics of fishing of the deep sea prawn and deep sea lobster along the south west coast of India. The economics of operation of smaller vessels based on the results of 36' vessels viz. Durga and Flying Fish, 17.5 m indigenously constructed steel trawlers on the basis of results obtained by a Cochin based vessel viz. Meena Utpadak and 23 m trawlers on the basis of results obtained from the North west coast of India were also discussed by Joseph(1973 a,b and 1974). In this context the information given by Perumal(1973) on the economics of operation of a 93' and 57' training vessels operated from the south west coast of India is also worth mentioning.

The Cochin based 17.5 m trawler fished for 203 days and landed 196.4 tons of catch during 1972-73, with an average catch/day of little less than a ton and a catch/hour of 215 kg. On the basis of this it was concluded that if the vessel was operated on a commercial basis the vessel could fish about 250 days and land about 430 tons of fish and prawns and that the operation would be economically viable(Joseph 1973). Since all the indigenously constructed 17.5 m vessels are identical and since the gear operated by them are of the same type, the results obtained from different regions are comparable. The economics of operation of demersal fisheries employing 17.5 m trawlers along the east coast can be worked out in the light of the above mentioned studies done at Cochin. An attempt has already been made in this line,

based on the data collected by the 17.5 m trawlers from different regions along the west and east coast of India during 1975-76(Anon. 1976) which may give a general idea about the economic viability of trawl fishing using this type of trawler.

From the studies carried out during 1975-76 it was found out that the average catch rates recorded by 17.5 m trawlers from Paradeep and Madras were 282 kg/hour and 170 kg/hour respectively. The vessel operated from Paradeep conducted 170 days of fishing and landed about 191 tons of fish and prawns with an average catch rate of 1.12 tons/day. The average percentage of prawn, in the catch was about 10%. Through departmental auction the average price obtained per ton of catch was about Rs. 1500/-. It was pointed out that there was enough scope to increase the catch/day to about 3 tons by increasing the average fishing effort/day and days of operation/annum by sending the vessels on long voyages with ice. Thus, the vessel can operate for not less than 200 days and land about 600 tons of catch/annum. From the foregoing it may be seen that commercial fishing even with 17.5 m indigenously constructed trawlers could be profitable from Paradeep. The results of Madras based vessels also indicate commercial trawling possibilities.

11. SUMMARY

An attempt is made to study the demersal fishery resources of the east coast of India between latitudes 8°N and 22°N and longitudes 78°E and 90°E based on the results of survey conducted by the Exploratory Fisheries Project during the period 1959-1974. The total area under investigation is divided into two zones viz., lower east coast and upper east coast for proper documentation and assessment of fisheries resources potential. Twenty four vessels with varying size and horse power were employed for the survey.

A detailed study of sampling distribution along the east coast has revealed that the areas 8-78 off Tuticorin and 17-83 off Visakhapatnam are extensively and intensively explored. Areas 12-80,13-80,17-82 and 18-84 in which the fishing effort expended was about 1000 hours can be regarded as fairly surveyed. The remaining areas are either partially surveyed or unsurveyed.

Elasmobranchs and perches were predominant in the catches from Tuticorin whereas it was leiognathids, elasmobranchs and perches, which were predominant in Madras region. Along the upper east coast elasmobranchs and cat fish were dominant in the catch from both Visakhapatnam and Paradeep/Calcutta. Cat fish recorded the highest percentage viz. 23% of the total catch from areas off Visakhapatnam. Prawn registered about 10% of the total landings from Paradeep/Calcutta regions, 4% from Tuticorin region and 3% from Visakhapatnam. The percentages of perches and sciaenids were significantly high in the lower east coast than the upper east coast.

The percentage of prawn was relatively high in areas within 19 m depth at Tuticorin and Paradeep/Calcutta while that of elasmobranchs was relatively high in 40-59 m at Tuticorin, 60-79 m at Madras and 80-99 m at Paradeep/Calcutta. Cat fish recorded relatively high percentages from 0-19 m depth belt from Tuticorin and 20-79 m at Visakhapatnam and Paradeep/Calcutta. The highest percentage of other quality fishes was observed from 80-99 m depth from Visakhapatnam and Paradeep/Calcutta though they were caught in fairly large quantities from areas below 39 m depth from Tuticorin and Madras.

The relative abundance of demersal fisheries resources along the lower and upper east coast was studied in detail. The small vessels

and Jheenga registered the highest catch rates viz. 117 kg. and 199 kg/ hour respectively from area 8-78 off Tuticorin. The 17.5 m trawlers yielded relatively high catch rates from the northern areas of the lower east coast i.e areas off Madras. In the case of Meena Bharati the highest catch per hour viz., 376 kg was recorded from area 13-80. The catch rates of prawn appear to have been negligible in almost all areas surveyed off Madras. In the case of leiognathids, the areas off Madras recorded the highest catch rates. The catch rates of perches ranged from 0-49 kg/hour and the abundance of this species was relatively high in the southern part of the lower east coast, while that of sciaenids was in the northern part. The occurrence of cat fish in the lower east coast was rather insignificant.

The catch rates of small vessels surveyed along the upper east coast varied from 7 to 112 kg/hour, the highest being from area 19-86. The catch per hour of Champa surveyed along the upper east coast varied from 51 to 157 kg, the highest being from area 18-83. In the case of 17.5 m trawlers, the catch per hour varied from 70 to 188 kg/hour with highest catch rate from area 20-86. The vessels Ashok/Pratap and Matsyavigyani recorded relatively high catch rates from areas 18-84, 16-82 and 20-86 respectively. Prawn and 'dhoma' recorded high catch rates from areas off Paradeep/Calcutta. In the case of cat fish and perch the areas off Visakhapatnam appeared to be more productive.

In general depth zone 10-39 m appeared to be more productive in the areas off Tuticorin while off Madras the most productive zone was found to be 20-59 m depth belt. Based on the catch rate obtained by Ashok and Pratap the depth belt 40-69 m can be regarded as more productive along the upper east coast.

Two peak seasons were noticed along the lower east coast viz., September-November and May-July. Along the upper east coast the best productive season was the period October-December.

The monthly variation in the catch rates of the important groups are presented in detail, illustrating the peak occurrence of different species along the lower and upper east coast by the different vessels.

The average standing stock per sq.km along the lower and upper east coast worked out to 3.35 m.t and 4.26 m.t. respectively, The average for the entire east coast is about 3.88 m.t. The potential yield from the lower east coast and upper east coast has been estimated at about 75,000 m.t and 1,31,000 m.t respectively which gives a total estimate of about 2,06,000 m.t. for the entire east coast. The present study in contrast to earlier belief has shown that the upper east coast is more productive than the lower east coast and the total potential yield from the shelf area is likely to be much more than what has been estimated by earlier workers.

A comparative study of the potential yield of demersal fisheries from 0-40 fm depth along the east and west coast of India has shown that the total yield is likely to be about 0.6 million tons. The most productive region appears to be north west coast with an average estimated standing stock of 4.38 m.t/sq.km., the next best productive area being the upper east coast with an average standing stock of 4.26 m.t/sq.km.

The economics of trawling employing 17.5 m trawlers along the east coast is discussed and it is found that areas of Paradeep portend with considerable scope for commercial trawling.

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