GOVT. OF INDIA

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DEMERSAL FISHERIES RESOURCES OFF THE NORTH WEST COAST OF INDIA

By

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FOREWORD

The major scope for increasing the production of fish, both quantitatively and qualitatively, so vital for raising the country's nutritional levels and earning much needed foreign exchange, has ultimately to be from deep sea fishing. Deep sea fishing has to be scientifically based and the approach has to have the twin objective of raising the optimum level of exploitation of available resources and also sustaining this optimum level. This requires an extensive and intensive study of the marine resources on a continuing basis. The areas have to be delineated according to the fishing intensity, assessment of the various biological species made and optimum levels of fishing in the various intensity stratum decided on these and other factors to ensure a planned development and sustained exploitation of the resources.

The importance of the Deep Sea Fishing Organisation is obvious in the context of the above type of tasks assigned to it. Having its nucleus in the establishment of Deep Sea Fishing Station, Bombay in 1946, it has over the plan periods progressively developed into its present structure comprising 11 off-shore Fishing Stations along both the coasts and having a fleet of 25 steel trawlers in active operation. This expansion of the organisation has been desirable to enable it to carry out its exploratory and experimental fishing with a view to assessing the fishing intensity both in time and space and to make available specieswise biological details etc.

The organisation seems to have collected a huge wealth of information over the last three decades but somehow it has not been possible for it to process and publish these data so far. Dissemination of the available information with

the organisation is likely to ensure its optimum utilization, stimulate interest in furthering the research and be of invaluable use to those engaged in deep sea fishing or interested in entering the field. An attempt has been made to analyse and serialise the important available information in 4 or 5 bulletins. This is a step in right direction.

The present issue, the first of the series covering results of exploratory and experimental fishing along the North West Coast comprising Maharashtra and Gujarat, contains details of the qualitative and quantitative variations in the fishery resources on the basis of depth, distance, season and area on the one hand and size of the fishing boats, the type of gear and methods employed on the other. Similar details are expected to be given in the subsequent issues covering the other coastal geographical zones.

I hope, the present as well as the future issues will be found useful by various units in Fishing industry and others.

NEW DELHI
dated 14th Oct. 1974

S.P.BALASUBRAMANIAN
JOINT SECRETARY (FISHERIES)
MINISTRY OF AGRICULTURE AND
IRRIGATION(DEPARTMENT OF
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DEMERSAL FISHERIES RESOURCES OFF THE NORTH WEST COAST OF INDIA

K. M. JOSEPH

Exploratory Fisheries Project of Govt. of India

INTRODUCTION

A study of the history of industrial fishing in India indicates that interest in the introduction of modern techniques of fishing such as bottom trawling began to be evinced by some of the then maritime states towards the beginning of this century. Chidambaram (1953) has given an historical account of the various attempts made at the introduction of trawling in Indian waters prior to the Second World War. Of these, the first attempt was that by S.T. Premier in the year 1900 in the waters off Bombay. The trials made by S. T. William Carrick in 1921-22 and S.T. Madras in 1923 too deserve mention as their operations were also confined to areas off the then Bombay state. While the results of operation of S.T. Premier and S.T. Madras remain unpublished, the results of operation of S.T. William Carrick is available in the report of Hefford (1949).

Nevertheless, organised exploratory trawl fishing in Indian waters began only with the establishment of the Deep Sea Fishing Station, Bombay. The Deep Sea Fishing Station, Bombay, was established as a Pilot Project by the Government of India as part of its post-war developmental programmes in October 1946. Exploratory fishing was only one of the several objectives of the Station during the early years of its existence. An extract of the Government of India notification dealing with the objectives of the Station is furnished in Appendix-I. Consequent of this and due to a host of other reasons such as the different types of vessels, gear and methods it had to

experiment with, the emphasis given on training etc., the fishing programme of the Station during the early years of its existence cannot be said to have been planned and executed to satisfy the scientific requirements of exploratory fishing. A major part of the fishing activities during the early years could at best be called only as experimental fishing. Although no clear distinction appears to have been made between exploratory and experimental fishing during the early part of its existence, the fishing activities of the Station have given invaluable information about the species composition of trawl catches along the north west coast of India and the suitability of different types of fishing craft, gear and methods for their exploitation.

Exploratory fishing is the study of the seasonal distribution and abundance of the different species of fish inhabiting in a given area using a fishing gear of known efficiency. Experimental fishing on the other hand, aims at the study of the efficiency of a fishing gear for the exploitation of the fish inhabiting in a given area. It may be seen that conduct of exploratory fishing envisages some prior knowledge about the efficiency of the fishing gear to be employed while conduct of experimental fishing envisages some prior knowledge about the behaviour of the fish in the area where the gear is to be experimented. Both the investigations are thus overlapping to some extent. But the distinction becomes more and more clear cut as the investigations in a particular area proceed farther.

The purpose of this bulletin is to present the results of exploratory otter trawling conducted by the Deep Sea Fishing Station, Bombay along the Gujarat and Maharashtra waters, since its inception

requisite for a value analysis of the data presented. It should also be remembered that the organisation had to work under several constraints, particularly, lack of sophisticated exploratory fishing vessels and of requisite expertise for scientific programming and periodical evaluation of results during the initial years of its existence.

I take this opportunity to express my sincere thanks to Mr. S.P.Balasubramanian, Joint Secretary (Fisheries), Ministry of Agriculture & Irrigation, Department of Agriculture, Government of India, for the keen interest he has evinced in the preparation of this bulletin. My sincere thanks are also due to Prof. P.C. George, Joint Commissioner (Fisheries), Ministry of Agriculture & Irrigation, Department of Agriculture, Government of India, for going through the manuscript and for his valuable suggestions. I also wish to record my appreciation and thanks to M/s. M.K. Ravindran Nair, Antony Joseph and B.R. Dubey for the assistance they have rendered in the processing of the data and in the preparation of the charts.

The views and interpretations expressed in this bulletin are of the author only and do not necessarily reflect the views of the Government of India.

VESSELS EMPLOYED

A large number of vessels which differ in design, type, size, power, etc., have been employed for exploratory trawling along the north west coast since 1948. The salient features of these vessels are furnished in table-I. It may be mentioned that the first vessel commissioned for the survey viz., S.T. MEENA was a steam powered mine sweeper converted into a trawler. All others were motor vessels built as fishing vessels. On the basis of horse power, one of the most important factor

upto 1973. The data thus cover a period of about 27 years. The results of the exploratory fishing carried out employing other types of fishing gear and methods, the details of the different types of fishing gear experimented etc., are proposed to be published separately.

A report on the working of the first trawler commissioned by the Station, viz., S.T. Meena was published in 1954. Jayaraman et al (1959) have given a preliminary picture about the trends of some of the demersal fisheries occurring along the north west coast based on the results of operation of two vessels of the Station during the period from 1949 to 1955. Rao (1969) has also furnished some information on the various demersal fisheries occurring in the area based on the results obtained by the vessels operated by the Station during the period 1963-67. While the above mentioned reports and the purely biological papers on individual species published by several other scientists give a general picture about the different demersal fisheries occurring in the area, they do not seem to satisfy the requirements of the fishing industry which are rather specific and precise.

Assessment of fisheries resources potential and the proper documentation of it, form the basis of establishing an information retrieval system from which the industry and the government can draw the requisite data for making investment decisions, resources management policies, etc. Special care has therefore been taken to see that the presentation and interpretation of the data contained in the bulletin, meet these requirements of the industry and the government to a large extent. In this endeavour and during the course of the critical evaluation of the data, a certain amount of self criticism was found unavoidable. This should be taken in the correct perspective and as a pre-

which determines the catch per unit of effort, these vessels are grouped into nine classes as detailed below for purposes of analysis and reporting of data in this bulletin. Of these Meera, Sagarpravasi, Sagarkumari, Bumili, Ashok, Pratap, S.T. Meena and Kalyani-III have already been decommissioned.

Class	H.P.	Name of vessels
I.	42-56	Meera, Sagarpravasi, Sagarkumari
II.	165	Bumili
III.	150	Jheenga
IV.	200	Meena Khojini, Meena Udyog and Meena Prayas
V.	215	Bangada
VI.	240	Ashok and Pratap
VII.	262	Meena Bharathi
VIII.	300	Kalyani-III, IV and V
IX.	475	Meena

Out of these 16 vessels, Ashok, Pratap, Meenabharathi and the three Kalyanis are typical side-trawlers. However, these vessels were being used mostly for stern trawling, by improvising the deck rigging. Meera and Bumili were gill netters converted for trawling while Bangada was a tuna clipper converted for trawling. These three vessels were used for trawling only for short periods. Jheenga, Meenakhojini, etc., are typical stern trawlers with transom stern.

Sl. No.	Name of vessel	Year built	Place built	Length B.P. m.	Beam m.	Depth amidship m.	Hull material	Make of engine	B.H.P.	G.R.T.	Crew strength
1.	Meera	1954	Japan	10.3	3.3	1.2	Wood	Yanmar	42	9.9	6
2.	Sagarkumari	1954	Japan	10.5	3.3	1.2	Wood	Yanmar	42	11.2	6
3.	Sagarpravasi	1954	Japan	10.9	3.5	1.5	Wood	Yanmar	56	12.8	6
4.	Bumili	1949	U.K.	14.3	4.9	1.6	Wood	G.M.	165	34.5	7
5.	Jheenga	1958	Holland	15.6	5.4	2.4	Steel	Caterpillar D342	153	48.6	7
6.	Meenakhojini	1969	India	16.3	5.2	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
7.	Meenaprayas	1969	India	16.3	5.2	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
8.	Meena Sangrahak	1970	India	16.3	5.2	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
9.	Meena Udyog	1970	India	16.3	5.2	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
10.	Meenautpadak	1971	India	16.3	5.2	3.0	Steel	Kirloskar M.A.N.	200	56.8	10
11.	Bangada	1954	Norway	15.6	5.2	2.8	Wood	Caterpillar D364	215	44.6	8
12.	Ashok	1949	Holland	25.4	6.3	2.9	Steel	B&W	240	91.7	12
13.	Pratap	1949	Holland	25.4	6.3	2.9	Steel	B&W	240	91.7	12
14.	Meenabharathi	1965	India	20.9	5.9	3.4	Steel	M.A.N.	262	69.1	12
15.	Kalyani-III	1955	Japan	27.8	5.4	2.8	Steel	Hayashikane	300	123.2	14
16.	Kalyani-IV	1955	Japan	27.8	5.4	2.8	Steel	Hayashikane	300	123.2	14
17.	Kalyani- V	1955	Japan	27.8	5.4	2.8	Steel	Hayashikane	300	123.2	14
18.	S.T. Meena	N.A.	U.K.	46.6	8.5	N.A.	Steel	Steam engine	475	462.6	32

Table. I. Major specifications of the vessels employed for exploratory fishing.

Since these vessels have also been deployed for operation on other areas based at Cochin, Vizag, etc., it is necessary to detail their period of operation in the North-west zone. Table-II gives the period of operation, the number of days and hours operated by these vessels in the North-west zone based at Bombay, Veraval and Kandla. The Veraval Station was established in 1959 and closed down in 1965 while the Kandla Station was established in 1971. From the table, it may be seen that Jheenga conducted fishing for about 8 years in the area. Ashok and Pratap have also fished for an almost equal period. The data of Kalyani group of vessels relates only to a period of about four years. Meenabharathi fished for about 5 years at two intervals of time. Bumili and the small boats fished for about 10 years, although they were not conducting trawling exclusively.

Vessel	Period operated From	To	No.of days fished	No.of hours of trawling
Meena	1948	1949	143	1582
Ashok & Pratap	1949	1955	1152	13723
Bangada	1959	1960	138	493
Jheenga	1959	1967	1368	5358
Kalyani (III,IV & V)	1964	1970	555	4329
Small boats	1962	1967	841	7376
Bumili	1962	1965	418	1740
Meena Bharathi	1965 & 1971	1967 & 1973	487	1917
17.5 m vessels	1972	1973	109	705

Table.II. Period of operation of different vessels and the fishing effort expended by them by trawling.

TYPES OF TRAWLS OPERATED

As already mentioned elsewhere in the paper a variety of types and sizes of trawls were operated during the period prior to 1959. Since 1959, however, the main stay of the trawl gear has been two-seam Russian type fish trawls of different sizes. The major specifications of these trawls operated by the different vessels are furnished in table-III. Since a separate bulletin is proposed to be published on the different designs of trawl gear experimented, a detailed discussion on this aspect is not attempted in this bulletin.

Type of trawl	Head rope length	Foot rope length	Mesh size maximum and minimum (stretched) mm.	Weight and size of otter-board
12 m two-seam Fish trawl	12	17.6	60 to 30	50 kg. 0.7 sq.m. Oval, single slit
16 m two-seam Fish trawl	16	18.5	70 to 30	150 kg. 1.6 sq.m. Oval, single slit
20 m two-seam Fish trawl	20	27.5	60 to 30	150 kg. 1.6 sq.m. Oval, single slit
24 m two-seam Fish trawl	24	32	70 to 37	200 kg. 2.0 sq.m. Oval, two slits
30 m two-seam Fish trawl	30	38	70 to 37	240 kg. 2.0 sq.m. Oval, three slits

Table.III. Major specifications of the important types of trawls operated.

SCOPE AND LIMITATIONS OF THE DATA

This bulletin deals with only the data related to the exploratory otter trawling conducted in the area. While the data from the year 1959 upto 1973 are more or less complete and continuous, it may be noted that the data related to the period prior to 1959 are to some extent incomplete. This is mainly because of the fact that prior to 1959, there was no systematic procedure or prescribed proforma for collection of fishing data. The proforma now in vogue, in which the Skippers are required to record data in respect of each haul, was introduced only during 1959. Hence for data prior to 1959 i.e. from 1948 to 1959, the author had to depend on the log books of the various vessels and in this attempt he met with difficulties in sorting out comparable information.

Firstly since no standard pattern was prescribed for recording data in the log books, Skippers seemed to have recorded data as they felt to be the best form. In the second place, areas are not properly indicated and wherever they are indicated it is based on a system different from what is adopted now. This has limited the scope of utilisation of data prior to 1959 for purposes of analysing the distribution and intensity of sampling by area and depth, and co-related factors. Thirdly, the volume of catch is given either in terms of number of baskets. It has also not been possible to trace all the log books in the case of some of the vessels.

An attempt has however been made to utilise all the relevant and reliable data prior to the period 1959 in this study to the extent possible.

PRESENTATION OF DATA

It is generally believed that the character of reporting of data collected during exploratory fishing should be contingent upon the user. This bulletin, as mentioned elsewhere in the paper, is primarily meant for the industry and government as an aid in planing sea fisheries exploitation and management. The information that is generally required for these purposes are (1) areas of observation and the distribution of the sampling intensity in these areas (2) general characteristics of the fisheries occurring in the area (3) the relative abundance of the fish resources in general and of commercially important species in particular, with reference to area, depth and time, and (4) estimates of standing stocks and potential yields from them.

Normally exploratory surveys are conducted with a specific type of vessel. In this case, however, as already mentioned elsewhere, a variety of types and sizes of vessels have been employed. Consequently, the type and size of the trawls operated by them differ. It has therefore become necessary to treat the data of each vessel separately. The data of each vessel has been stratified on the basis of area, depth and time. The catch per unit of effort in terms of total catch and of commercially important species are then studied with reference to each of these variables. The reliability of the data have also been discussed with special reference to sampling intensity.

A unit area for purposes of this analysis is taken as the area lying between 1° lat. and 1° long. The extent of this geographical division is 3600 sq. nautical miles or about 12000 sq. km. The area under observation is divided into several such

DISTRIBUTION AND INTENSITY OF SAMPLING

The reliability of the results of exploratory fishing depends, to a great extent, on the distribution and intensity of sampling. Data on the distribution and intensity of sampling by area, depth and time are therefore essential pre-requisites for judging the accuracy, reliability and value of the results obtained. If the investigation has been carried out with two or more vessels of varying horse power, it is also necessary to study the sampling intensity in respect of each vessel.

The sampling intensity is generally indicated either in terms of number of hauls or in terms of actual fishing effort or both. Since the duration of the trawl hauls very often vary and since it is difficult to adhere rigidly to a particular duration due to obvious reasons, number of hauls may not give an accurate estimate of the sampling intensity. The actual time spent in fishing, is considered to be by far the most reliable index of sampling intensity. The distribution and intensity of sampling in the area under study, is therefore indicated in terms of the actual hours of trawling conducted by different vessels.

Sampling distribution by area

As already discussed elsewhere in the paper the area of investigation lies approximately between the lat. 15° N and 23° N. This area is divided into 27 divisions and each of this division is further divided into 36 squares of equal size. The unit area for purpose of studying the sampling distribution is thus a square or sub-division which measures approximately 343 sq. km or 100 sq. nautical miles.

It has also been mentioned already that this system of demarcation of area has come into existence only in 1959 and that

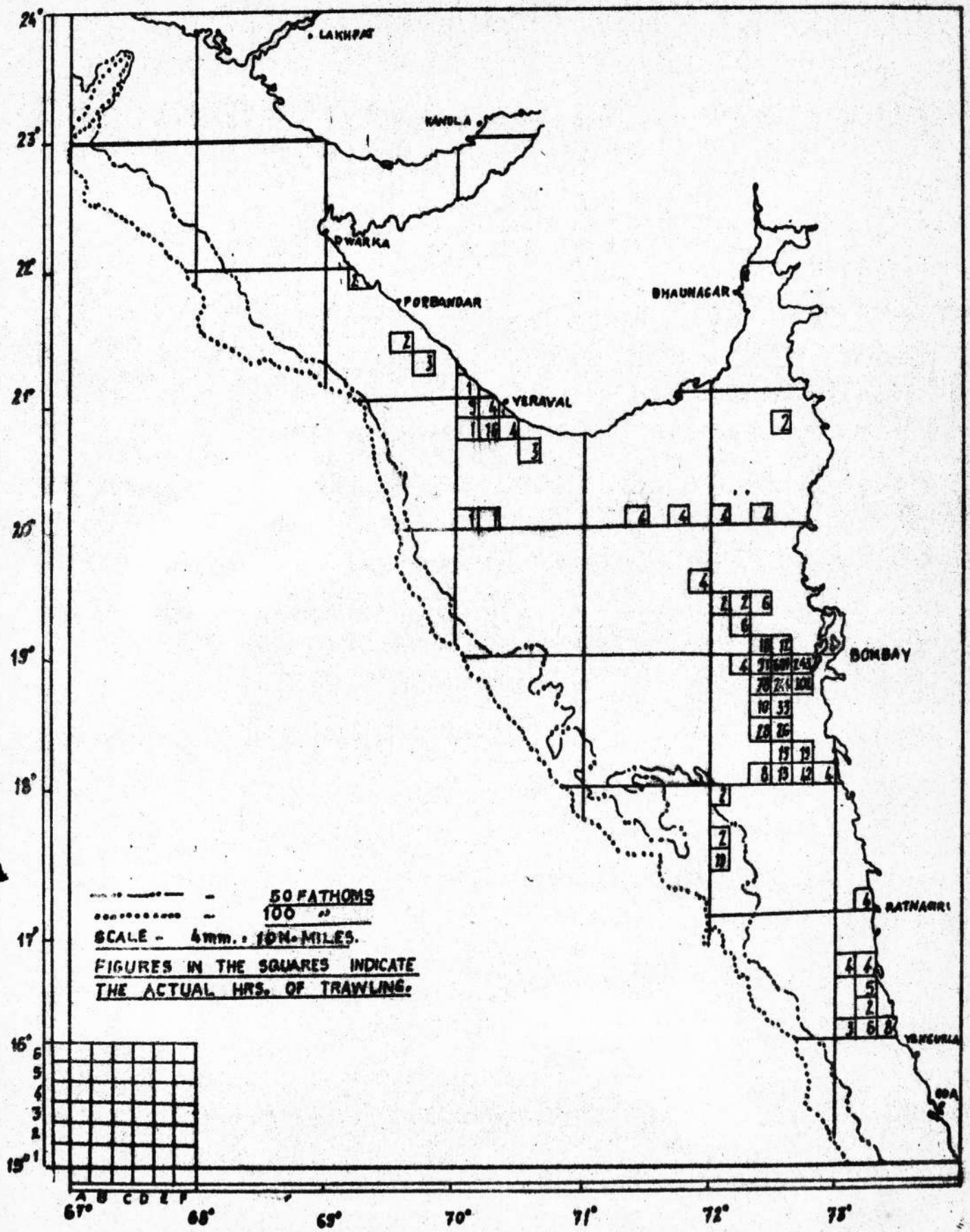

FIG.3 DISTRIBUTION AND INTENSITY OF SAMPLING BY BUMLI.

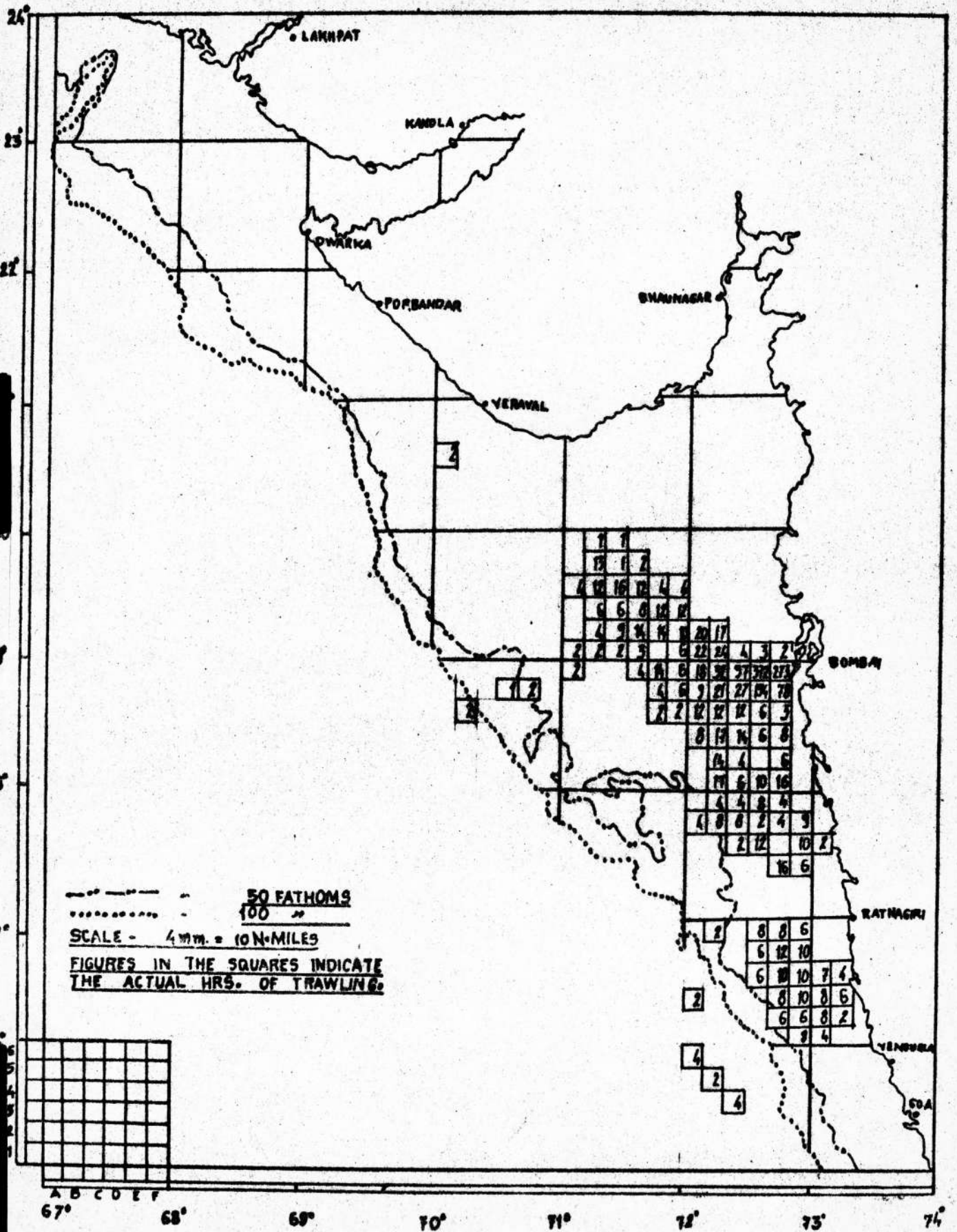

FIG. 5 DISTRIBUTION AND INTENSITY OF SAMPLING BY MEENA BHARATHI.

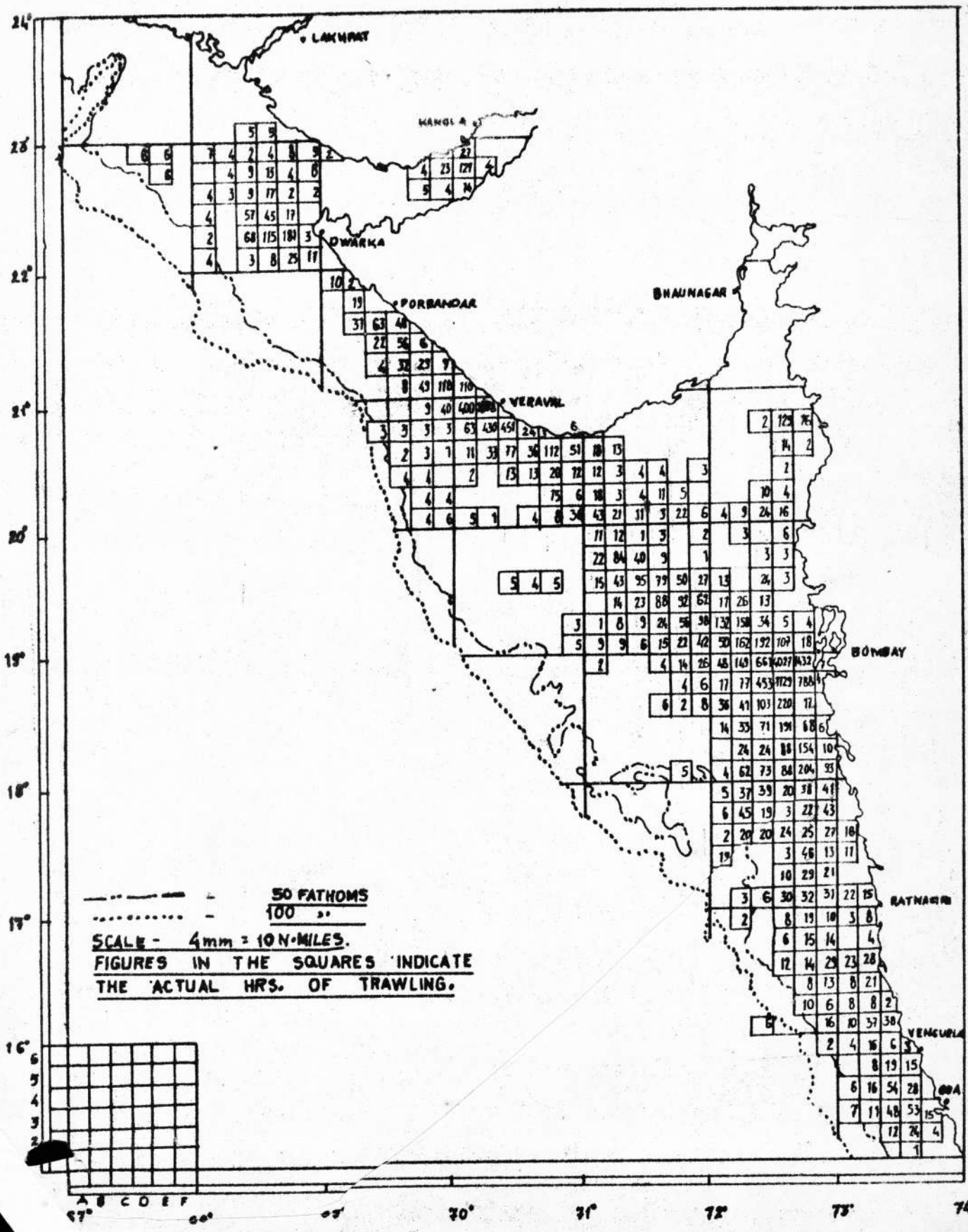

FIG. 7 DISTRIBUTION AND INTENSITY OF SAMPLING BY ALL VESSELS.

(table contd...)

Sl.No.	Scientific name	Common English name	Local name
21.	Eleutheronema spp.	Indian Salmon	Rawas
22.	Scomberomorus spp.	Seer fish	Suramai
23.	Chirocentrus spp.	Silver bar	Karli
24.	Drepane spp.	Moon fish	Chandi
25.	Penaeus spp.	Prawn	Kolambi
26.	Metapenaeus spp.	Prawn	Jeenga
27.	Sepia spp.	Cuttle fish	Makul

Table.IX : List of commercially important species of fish occurring in the trawl catches off Bombay and Gujarat.

Catch composition by area

Fig. VIII illustrates the seven most important species and their percentage in the total catch from six regions viz., Goa, Ratnagiri, Bombay, Veraval, Porbandar and Dwaraka. The geographical boundaries of these regions are furnished in appendix-II. From the figure it may be seen that "Dhoma" forms 25 to 50 per cent of the total catch in all the regions except Dwaraka. Elasmobranchs account for 10 to 25 per cent of the total catch in all the regions. The occurrence of all other species except cat fish is less than 10 per cent. Cat fish accounts for about 25 per cent of the catch in Ratnagiri area while its percentage is less than 10 in all other regions. The percentage of "Ghol" and eel appears to increase progressively from Goa to Dwaraka while the percentage of prawn decreases from Goa to Dwaraka. The percentage of perches seem to be more or less the same in all the six regions.

CATCH COMPOSITION

A list of commercially important species of fish occurring in the trawl catches from the area under study is furnished in table-IX. The list indicates the common English names and the local names of the species besides their scientific names.

Sl.No.	Scientific name	Common English name	Local name
1.	Scoliodon spp.	Sharp-nosed shark	Sor Mushi
2.	Carcherhinus spp.	Black finned shark	Kheda
3.	Rhynchobatus spp.	Guitar fish	Ranja
4.	Dasyatis spp.	Sting ray	Pakat
5.	Actinomylaens spp.	Bat Ray	Bolod
6.	Muraenosox spp.	Common eel	Wam
7.	Tachysurus spp.	Cat fish	Shingada
8.	Thrissocles spp.	Anchovy	Kati
9.	Epinephelus spp.	Groupers	Gobra
10.	Lutjanus spp.	Snapper	Tamb
11.	Pomadasys spp.	Grunter	Karkara
12.	Pseudosciaena spp.	Jew fish	Ghol
13.	Johnius spp.	Croaker	Dhoma
14.	Otolithoides spp.	Dori	Koth
15.	Trichiurus spp.	Ribbon fish	Wagti
16.	Caranx spp.	Horse mackerel	Kala bangada
17.	Pampus argenteus	Silver pomfret	Saranga
18.	Pampus Chinensis	White pomfret	Kalwad
19.	Parastromateus nigher	Black pomfret	Halwa
20.	Polynemus spp.	Monk fish	Dara

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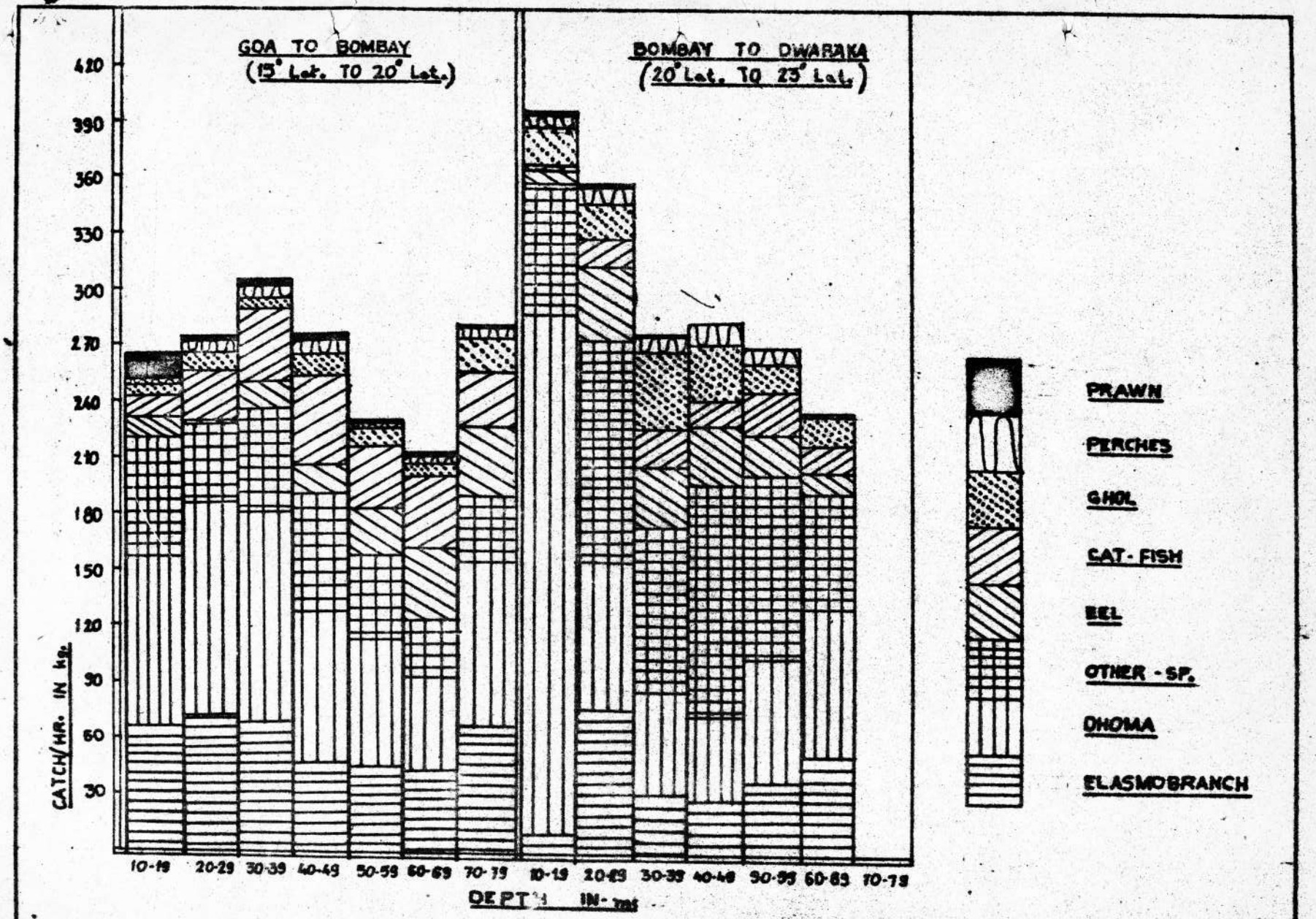


FIG- 22 CATCH/HOUR OF TRAWLING FOR DIFFERENT SPECIES OBTAINED BY KALYANI - III, IV AND V BY REGION AND DEPTH

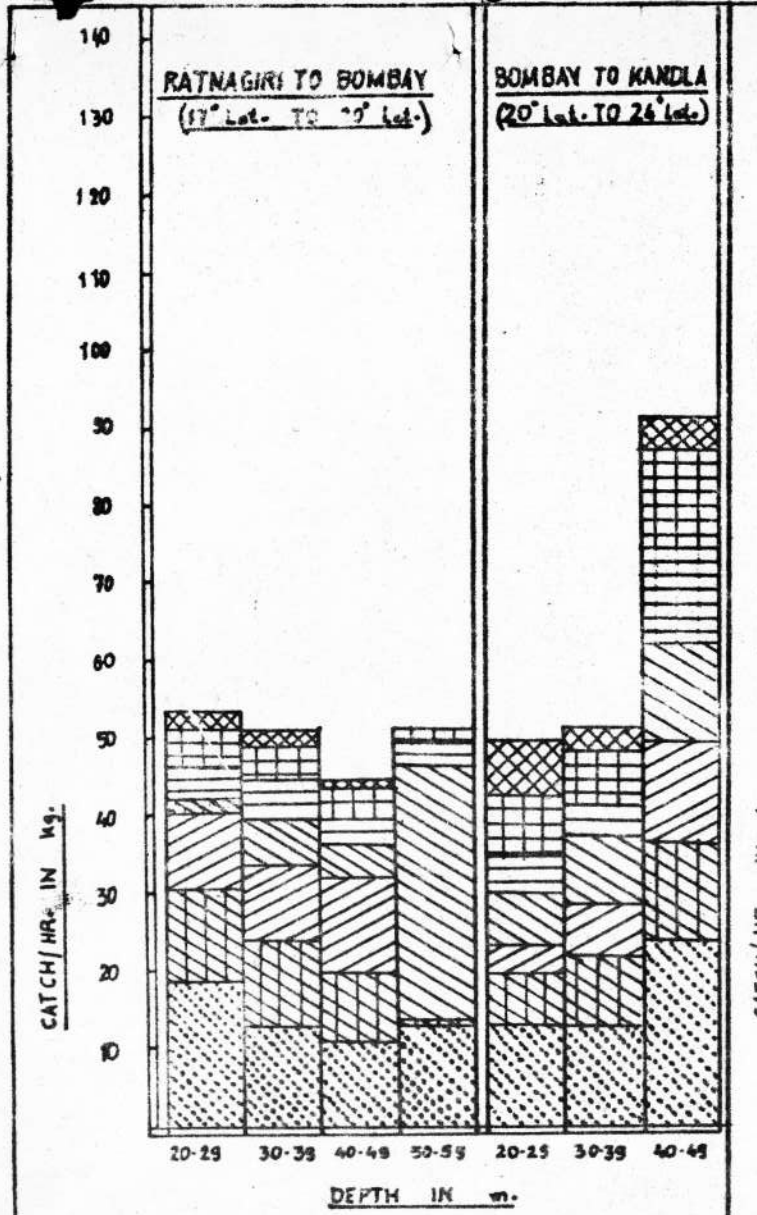


FIG. 24 CATCH/HOUR OF TRAWLING FOR DIFFERENT SPECIES OBTAINED BY ASHOK AND PRATAP BY REGION AND DEPTH.

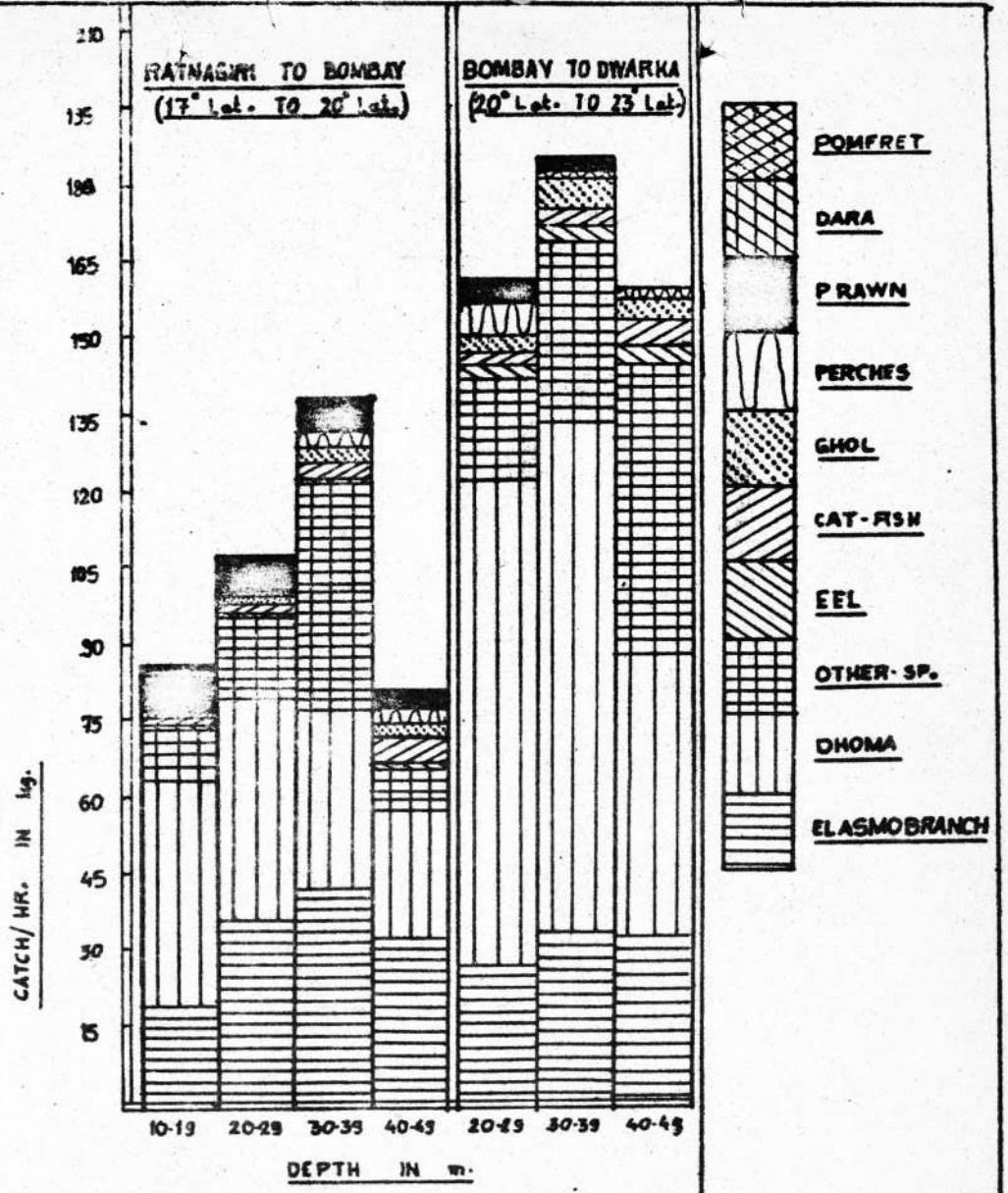


FIG. 25 CATCH/HOUR OF TRAWLING FOR DIFFERENT SPECIES OBTAINED BY SMALL VESSELS BY REGION AND DEPTH.

Fig. IX furnishes the percentage composition of the above mentioned seven groups in the five intensively surveyed areas viz., 18-72, 19-71, 20-70, 20-71 and 19-72. From the figure it may be seen that in the area 18-72, one of the most extensively surveyed areas, "Dhoma" and elasmobranchs are the most dominant groups which account for about 63 per cent. The occurrence of eel in 19-71 is remarkably high. The high percentage of "Ghol" in 20-71 is also note-worthy. The percentage composition of "Dhoma", eel, elasmobranchs and cat fish appear to be rather even in area 19-72. Perch forms only about two percentage in all these areas.

Catch composition by depth and area

Table X gives the percentage of the seven most important species by depth in the six regions. From the table it emerges that there is a remarkable change in the percentage of the seven species under reference from depth to depth and from region to region. The occurrence of "Dhoma" seems to be highest within 40 m depth. In the case of Prawn there is a progressive decrease in its percentage from shallow to deeper waters and also from Goa to Dwaraka. The percentage of elasmobranchs also appear to decrease from shallow to deeper waters in all regions. Its highest occurrence is in 0-39 m depth in all except Porbandar region. The percentage of cat fish increases with depth, the peak percentage being in the depth belt 40-59 m. The highest percentage of "Ghol" and eel is also obtained from the depth range 40-59 m. In the case of prawns the highest percentage is taken from within 19 m depth.

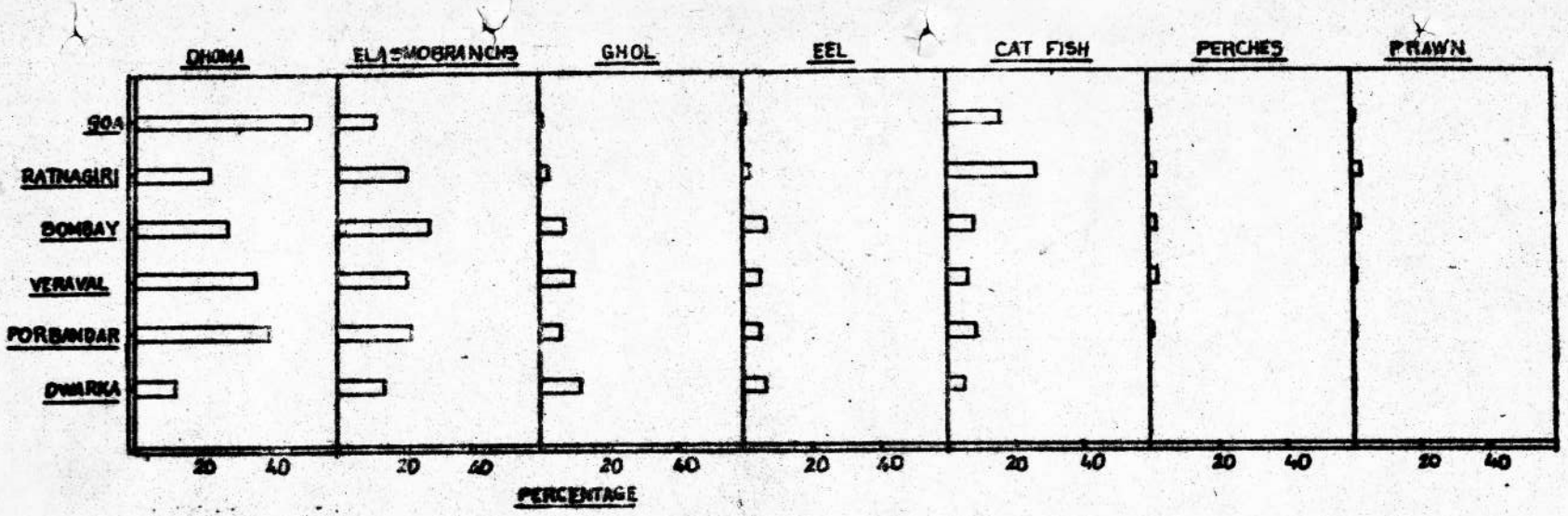


FIG-8 THE SEVEN MOST IMPORTANT GROUPS / SPECIES AND THEIR PERCENTAGE OF THE TOTAL CATCH BY REGIONS.

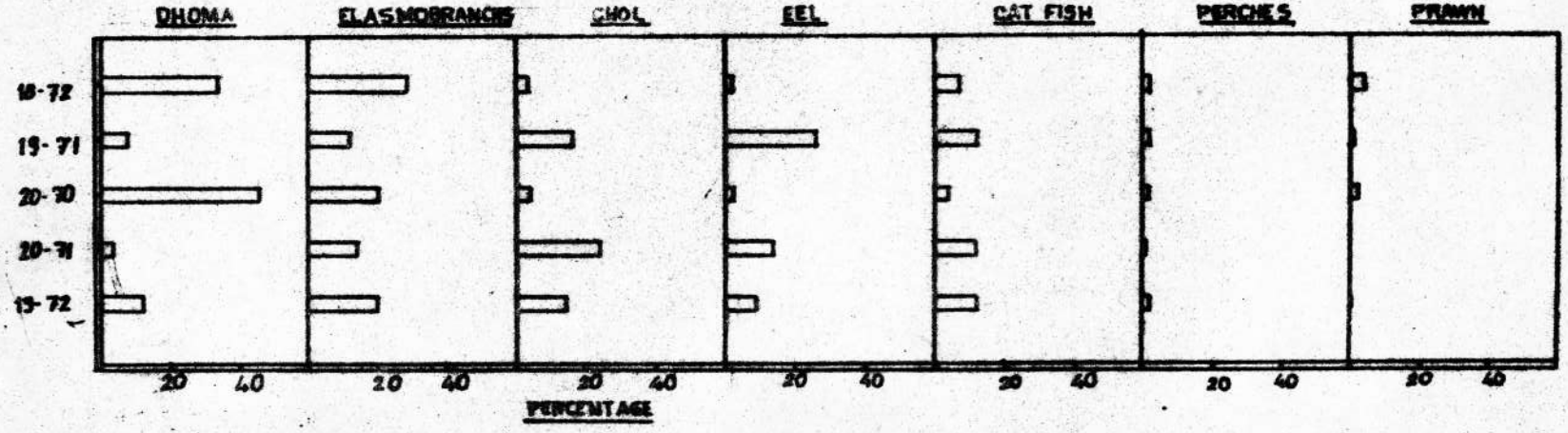
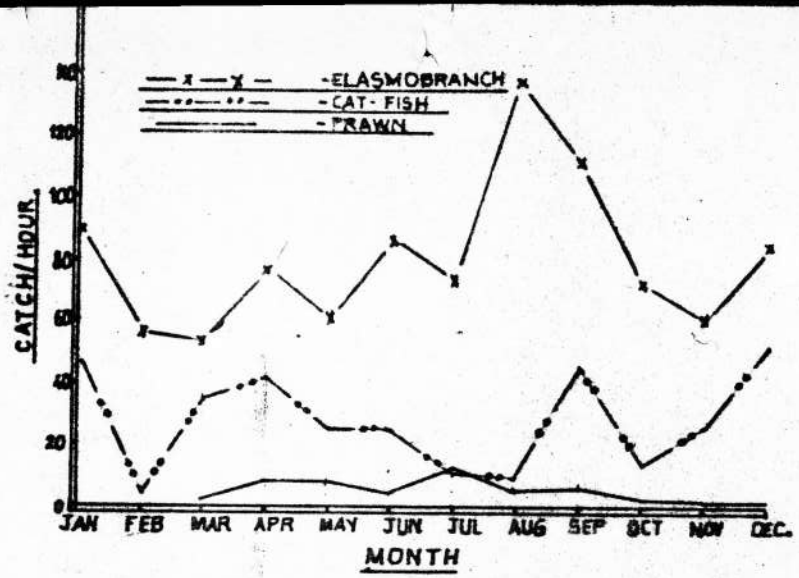


FIG-9 THE SEVEN MOST IMPORTANT GROUPS / SPECIES AND THEIR PERCENTAGE OF THE TOTAL CATCH IN THE FIVE INTENSIVELY SURVEYED AREAS.



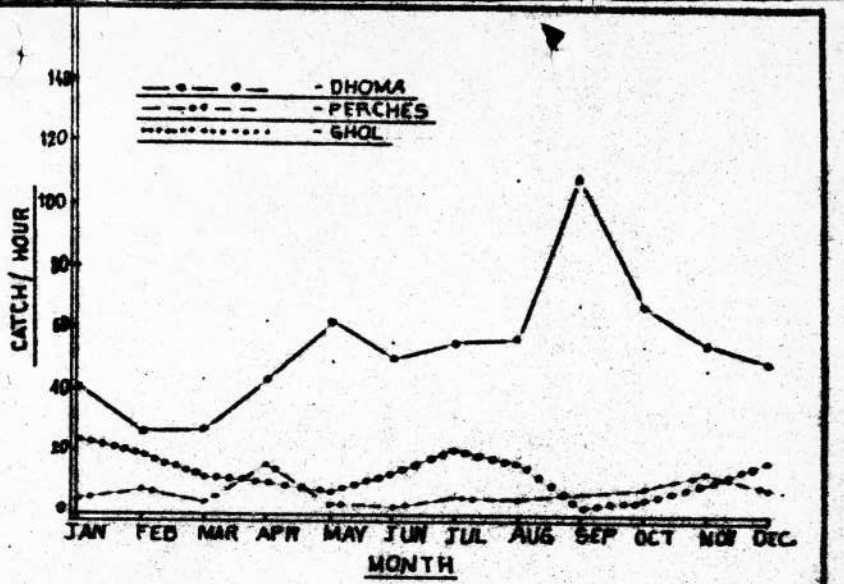
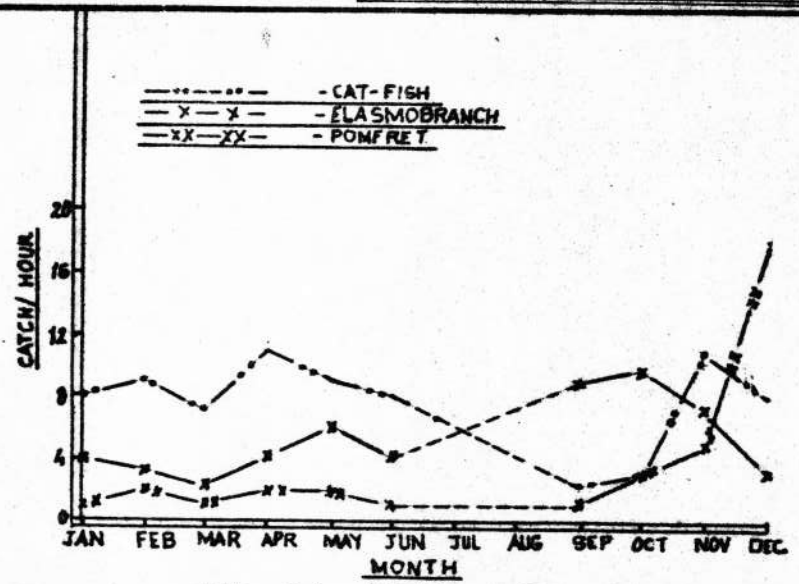


FIG. 33 - MONTH - WISE CATCH PER UNIT EFFORT OF SIX IMPORTANT SPECIES OBTAINED BY MEENA - BHARATHI.



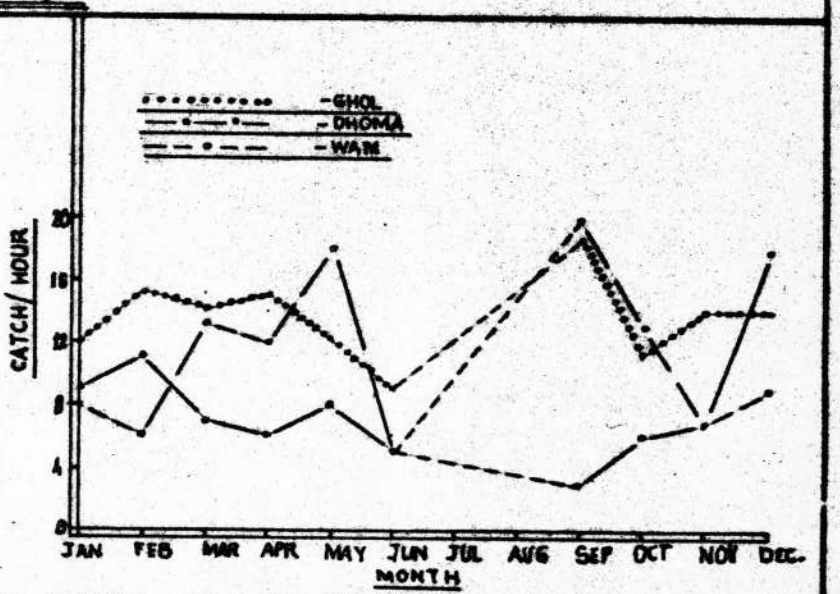


FIG. 34 - MONTH - WISE CATCH PER UNIT EFFORT OF SIX IMPORTANT SPECIES OBTAINED BY ASHOKA AND PRATAP.

	DEPTH RANGE IN METRES				DEPTH RANGE IN METRES			
	0-19	20-39	40-59	60-79	0-19	20-39	40-59	60-79
	GOA				RATNAGIRI			
DHOMA	61	53	40	56	20	32	18	10
ELASMOBRANCHS	21	11	8	10	26	25	16	14
CAT FISH	3	14	27	16	12	14	34	44
GHOL	5	1	1	3	1	2	2	2
EEL	5	0	0	0	0	3	0	0
PERCHES	0	1	1	2	4	2	5	3
PRAWNS	1	2	1	1	9	5	1	0
	BOMBAY				VERAVAL			
DHOMA	42	26	18	19	15	41	23	32
ELASMOBRANCHS	26	30	16	21	34	18	19	23
CAT FISH	3	9	16	11	0	5	8	5
GHOL	3	9	11	5	0	8	11	6
EEL	1	3	12	18	5	5	7	4
PERCHES	2	2	3	3	0	1	1	1
PRAWNS	7	3	1	0	0	1	0	0
	PORBANDAR				DWARKA			
DHOMA	70	40	37	0	3	11	13	0
ELASMOBRANCHS	3	20	22	0	73	14	12	0
CAT FISH	1	10	6	0	3	6	6	0
GHOL	7	8	3	0	0	13	12	0
EEL	2	5	3	0	2	12	12	0
PERCHES	1	1	2	0	0	5	5	0
PRAWNS	0	1	1	0	0	0	0	0

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

Thus with the existing data in the case of Gujarat it is possible to make estimates of standing stock for about 56,000 sq.kms of the shelf area out of about 79,000 sq.km. area, coming within the 40 fm depth. In the case of Maharashtra-Goa region it is possible to make similar assessment covering the entire 50,000 sq.km within the 40 fm depth. As far as Maharashtra-Goa is concerned, it is also possible to make a preliminary assessment of the standing stock of the area within 40-50 fm depth.

Division	Depth range in fm. 0-25 Area (sq.km)	0-25 Standing stock m.t	25-40 Area (sq.km)	25-40 Standing stock m.t.	Total Area (Sq. km)	Total Standing stock m.t.
1. 22-67	1,030	4,150	687	2,768	1,717	6,918
2. 22-68	7,897	49,119	2,747	11,554	10,644	60,673
3. 22-69	5,837	1,985	-	-	5,837	1,985
4. 22-70	2,232	2,678	-	-	2,232	2,678
5. 21-69	3,777	18,440	3,090	12,133	6,867	30,573
6. 21-70	601	5,829	-	-	601	5,829
7. 20-69	172	835	1,717	5,959	1,889	6,794
8. 20-70	2,404	16,924	2,404	9,227	4,808	26,151
9. 20-71	10,129	32,919	687	2,364	10,816	35,283
10. 20-72	10,644	46,620	-	-	10,644	46,620
Sub-total Gujarat:	44,723	1,79,499	11,332	44,005	56,055	2,23,504
11. 19-71	3,028	10,553	5,023	16,029	8,051	26,582
12. 19-72	8,927	43,207	1,030	4,120	9,957	47,327
13. 18-71	-	-	858	3,394	858	3,394
14. 18-72	5,494	29,448	4,807	27,304	10,301	56,752
15. 17-72	2,747	13,570	3,434	12,637	6,181	26,207
16. 17-73	2,575	13,751	-	-	2,575	13,751
17. 16-72	-	-	2,060	7,663	2,060	7,663
18. 16-73	2,919	15,821	1,545	4,419	4,464	20,240
19. 15-73	3,434	25,401	2,404	15,202	5,838	40,603
Sub-total Maharashtra-Goa	29,124	1,51,751	21,161	90,768	50,285	2,42,519
GRAND TOTAL:	73,847	3,31,250	32,493	1,34,773	1,06,340	4,66,023

Table.XIII. Standing stock estimates for areas surveyed upto 40 fm depth.

using suitable shrimp trawls in order to establish the relative abundance and the bathymetrical distribution limits of penaeid prawns.

(3) It is rather difficult to make a scientific evaluation of the relative efficiency of the different vessels operated in the area because of the difference in the age of these vessels, the variation in the period of their operation, etc. Nevertheless the data on the catch per effort of different vessels indicate that a vessel of the Jheenga type with about 200 H.P. is likely to be adequate for exploitation of the grounds upto 25 fm depth. This type of vessel can be based at Kandla, Porbandar, Veraval, Bombay, Ratnagiri and Goa with the existing harbour facilities. For exploitation of the grounds lying between the depth 25-50 fm an ice carrying vessel with refrigerated hold, and having over all length of 20-25 m. with 300 to 400 B.H.P. is likely to prove adequate. For areas beyond 50 fm depth vessels of 30 m and above length with 600 to 800 H.P. having suitable freezing arrangements on board may be required. Taking into consideration of the area under the different depth zones, it may be said that the requirement may be more for the small and medium size trawlers than for the large sized ones.

(4) If the results of the intensively surveyed Bombay region can be regarded as a fair indication of the bathymetrical distribution of the resources, it may be said, that there is no remarkable change in the relative abundance of the resources from shallow waters to depth upto 40 fm. in the area. From what little information we have about the resources in the 40-50 fm depth zone, which forms a sizable portion of the shelf area of the Maharashtra state, it may also be said that there is no significant

By far the most reliable and widely used index of relative abundance in the case of trawl fishery investigations is the catch per hour of trawling. This index can also be used to study the relative efficiency of different fishing methods, gear and vessels.

Relative abundance by area

The average catch/hour of trawling obtained by the nine classes of vessels from the various geographical divisions are furnished in fig.X. This figure is designed in such a way as to give a graphic picture of the vessels which have surveyed each area and the catch /hour of trawling obtained by them from each. From the figure it emerges that only two geographical divisions viz., 18-72 and 19-72 were surveyed by all the nine classes of vessels. Area 20-70 was surveyed by seven groups of vessels. While area 17-72 was surveyed by eight groups, areas 17-73, 19-71 and 20-71 were surveyed by only six groups of vessels. All the remaining areas except three or four, had also been fished by more than three groups of vessels.

From among the 25 divisions surveyed, eight divisions viz. 17-73, 18-72, 19-71, 19-72, 20-70, 20-71, 21-69 and 21-70 can be regarded as intensively surveyed taking into consideration of the combined fishing effort expended in them. A comparative study of the catch /hour of trawling obtained from these eight areas by various vessels, will reveal that in the order of relative abundance, these areas can be placed as 21-70, 21-69, 20-70, 17-73, 18-72, 19-71, 19-72 and 20-71.

Fig.X also illustrates how the catch/hour of trawling changes from vessel to vessel in the same area. This aspect has been discussed elsehwere while dealing with the relative efficiency of different types of vessels.

difference between the relative abundance of the resources of this zone and the 25-40 fm depth zone. The Kalyani class of vessels have obtained an average catch of about 300 kgs from both the depth zones.

(5) The latent demersal fishery potential of Maharashtra from the depth zone 25-50 fm may be in the order of 120,000 m.t. In the case of Gujarat it is very likely that the latent resources in this depth zone will be less than that is estimated for Maharashtra.

(6) As compared to the other parts of the Indian coast, the demersal fishery resources of the North west coast of India comprises relatively less number of species. Elasmobranchs and "Dhoma" alone account for about 50 percent of catch while elasmobranchs, "Dhoma", "Ghol", cat fish, "dara", perches and prawns together account for nearly 75 percent of the catch from the area.

(7) The demersal fisheries resources of the area can sustain the operation of a fairly large number of medium and large sized trawlers. The rate of return from a Bombay based 23 m trawler is estimated at about 16 percent.

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"Dhoma" accounts for the highest percentage of the catch in 0-19 m depth zone in Goa, Bombay and Porbandar regions while elasmobranchs account for the highest percentage in Ratnagiri, Veraval and Dwaraka areas in this depth zone. "Dhoma" also forms the highest percentage in 20-39 m depth zone in Goa, Ratnagiri, Veraval and Porbandar whereas elasmobranchs form the highest percentage in Bombay and Dwaraka areas. The most dominant species in the 40-59 m depth zone is cat fish in the case of Ratnagiri, while it is "Dhoma" in the case of all other areas. Elasmobranchs form the highest percentage in the 60-79 m depth zone in Bombay while it is cat fish in Ratnagiri and Dhoma in Goa and Veraval.

RELATIVE ABUNDANCE

One of the most important objectives of exploratory fishing is assessment of the relative abundance of resources. Relative abundance is often expressed in terms of the aggregate catch and also of the dominant species or groups. While relative abundance in terms of total catch gives an index of the general productivity of fish in a given area, the relative abundance in respect of dominant species establishes their relative importance to the aggregate catch in that area.

Abundance indices can be worked out for a whole area under investigation or for its geographical and bathymetrical divisions. For a clear understanding of the distribution pattern and abundance of the resources it is essential that relative abundance is studied from the point of view of area, depth and time. If investigations have been carried out using two or more unidentical vessels, it also becomes necessary to study relative abundance in terms of each such vessels.

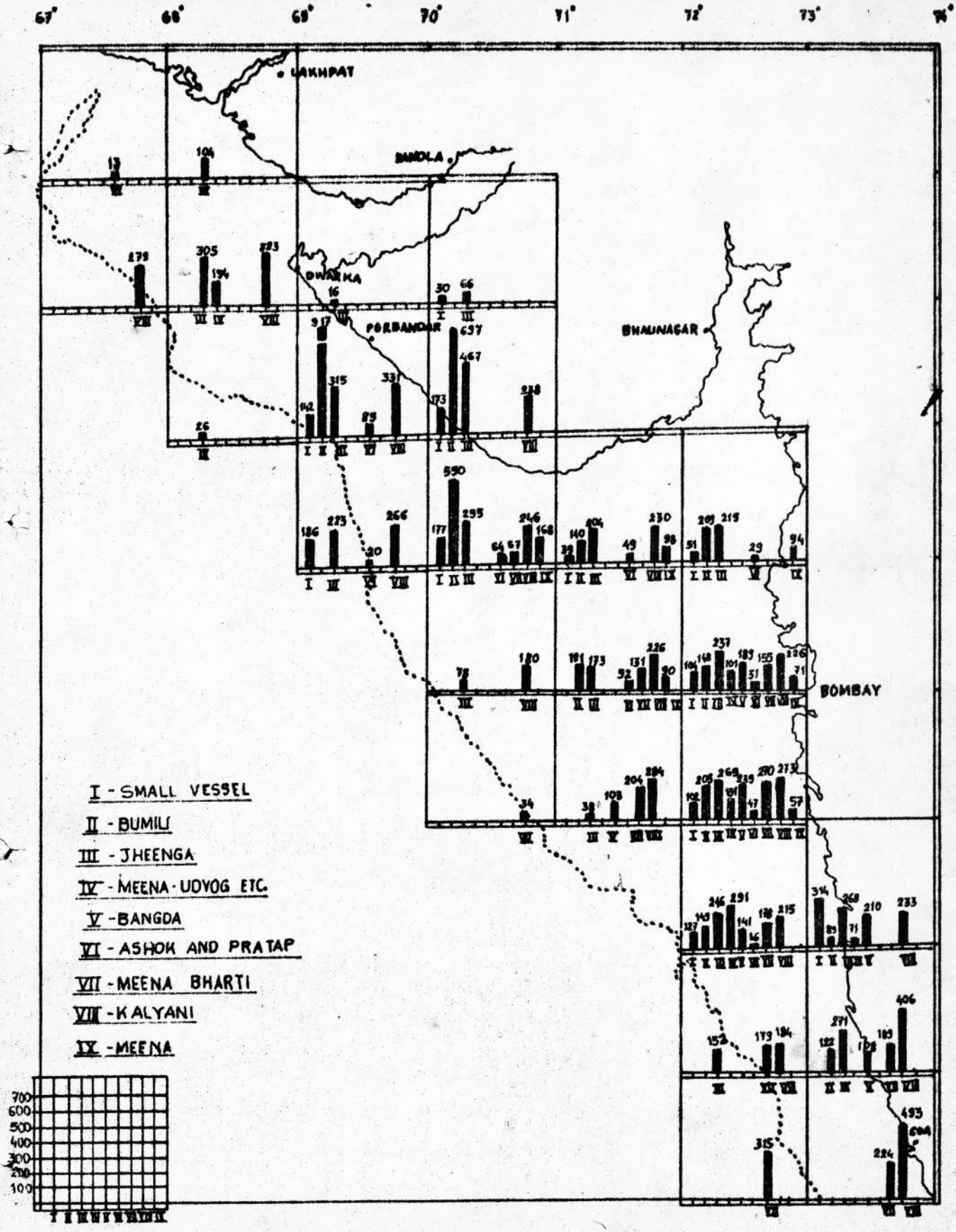


FIG.-10 CATCH/HOUR OF TRAWLING OF DIFFERENT VESSELS IN kg. BY AREA

Fig.XI to XV illustrate the catch per hour trawling in respect of the seven dominant groups obtained by the small vessels, Bumili, Jheenga, Meenabharathi and Kalyanis from the various geographical divisions which they surveyed. The figures give a graphic picture of the relative importance of the seven dominant groups viz., "Dhoma", elasmobranchs, cat fish, "Ghol", eel, perches and prawn to the aggregate catch from the relevant geographical divisions. Generally speaking "Dhoma", elasmobranchs and cat fish account for the bulk of the aggregate catch from most of the areas. Areas north of Bombay particularly 19-70, 19-71, 21-70, 22-67 and 22-68 are remarkable for the high catch/hour of trawling in respect of quality fish such as eel, "Ghol" and perches. Areas 17-73, 18-71 and 18-72 are note-worthy for the high catch rate of prawns.

Relative abundance by area and depth

For purposes of this study, the total area of investigation has been divided into six regions by grouping the geographical sub-divisions as in appendix-II. Bathymetrically these regions have been stratified into seven depth zones viz., 0-19 m, 20-29 m, 30-39 m, 40-49 m, 50-59 m, 60-69 m and 70-79 m, for purposes of this analysis.

Figs. XVII to XXI furnish the catch/hour of trawling obtained respectively by the small vessels, Bumili, Kalyanis, Jheenga, Meenabharathi and Ashok and Pratap by region and depth. In the case of small vessels, it may be seen that they have fished only upto about 50 m depth. From all regions the highest average catch rate was obtained by them from 20 to 39 m. depth range. In the case of Bumili the highest catch rate was obtained from 20-39 m depth zone from Veraval and Porbander regions.

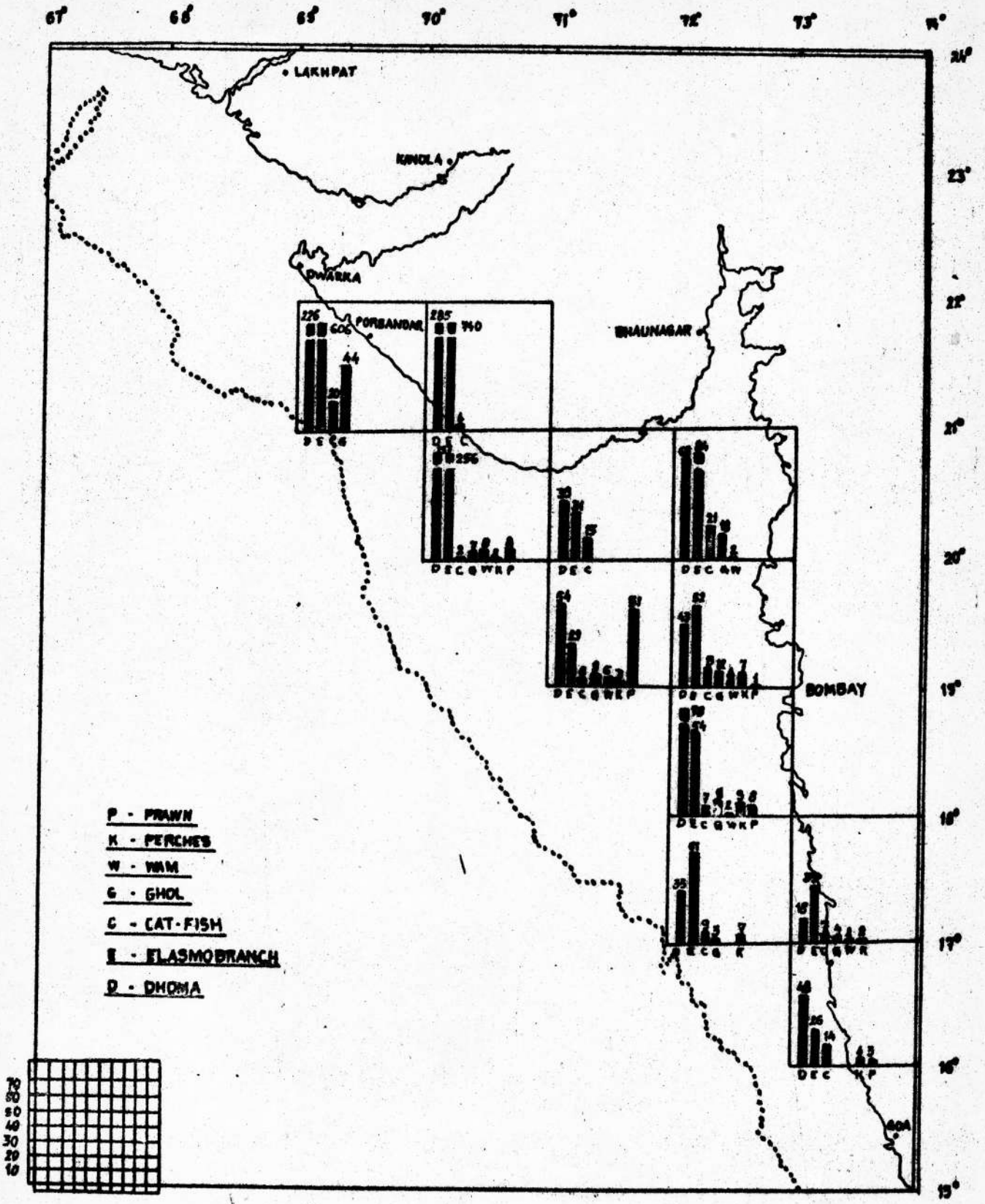


FIG. 12 CATCH/HOUR OF TRAWLING OF BUMILI FOR THE SEVEN IMPORTANT GROUPS.

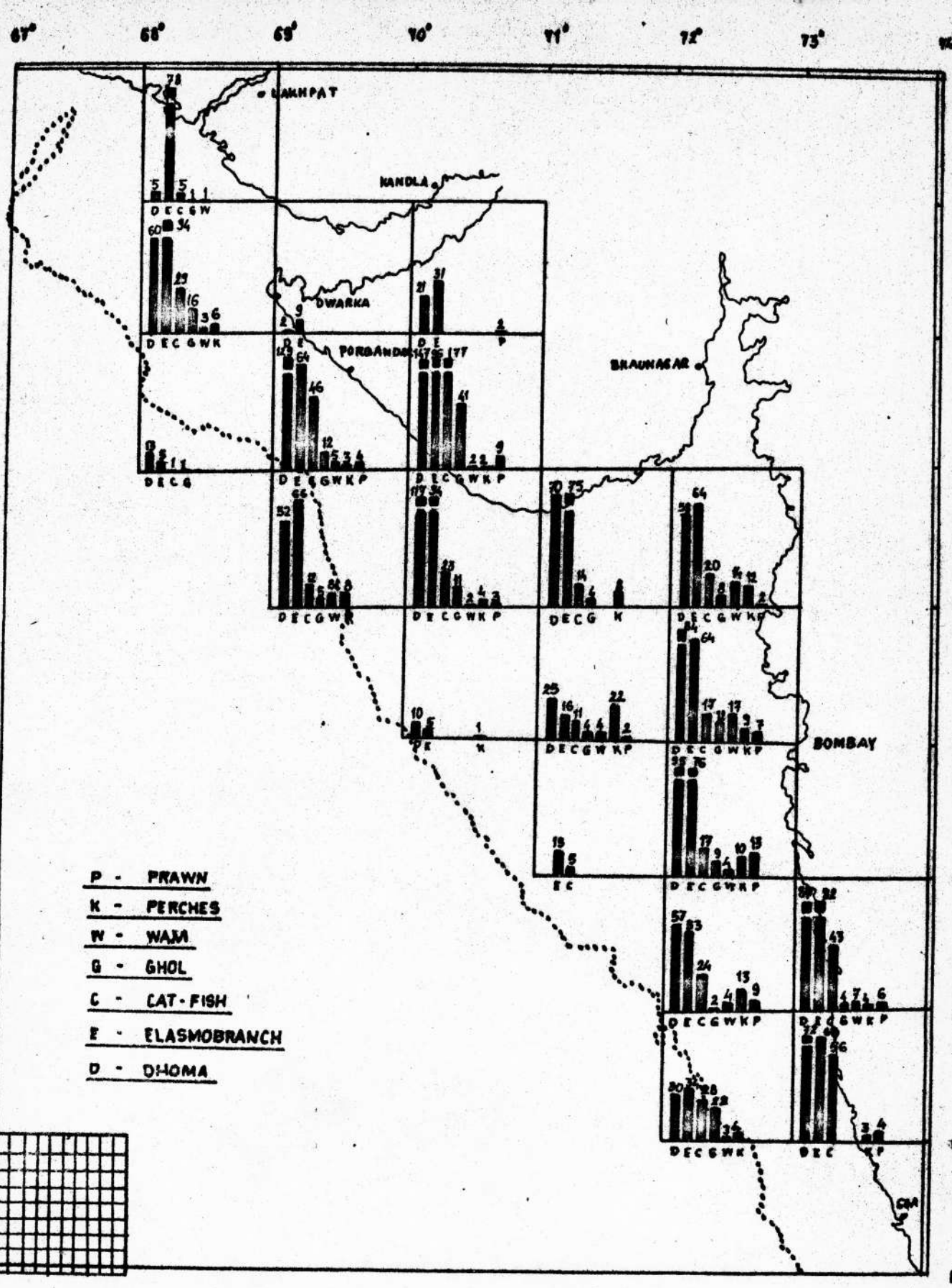


FIG-13 CATCH/HOUR TRAWLING OF JHEENGA FOR THE SEVEN IMPORTANT GROUPS.

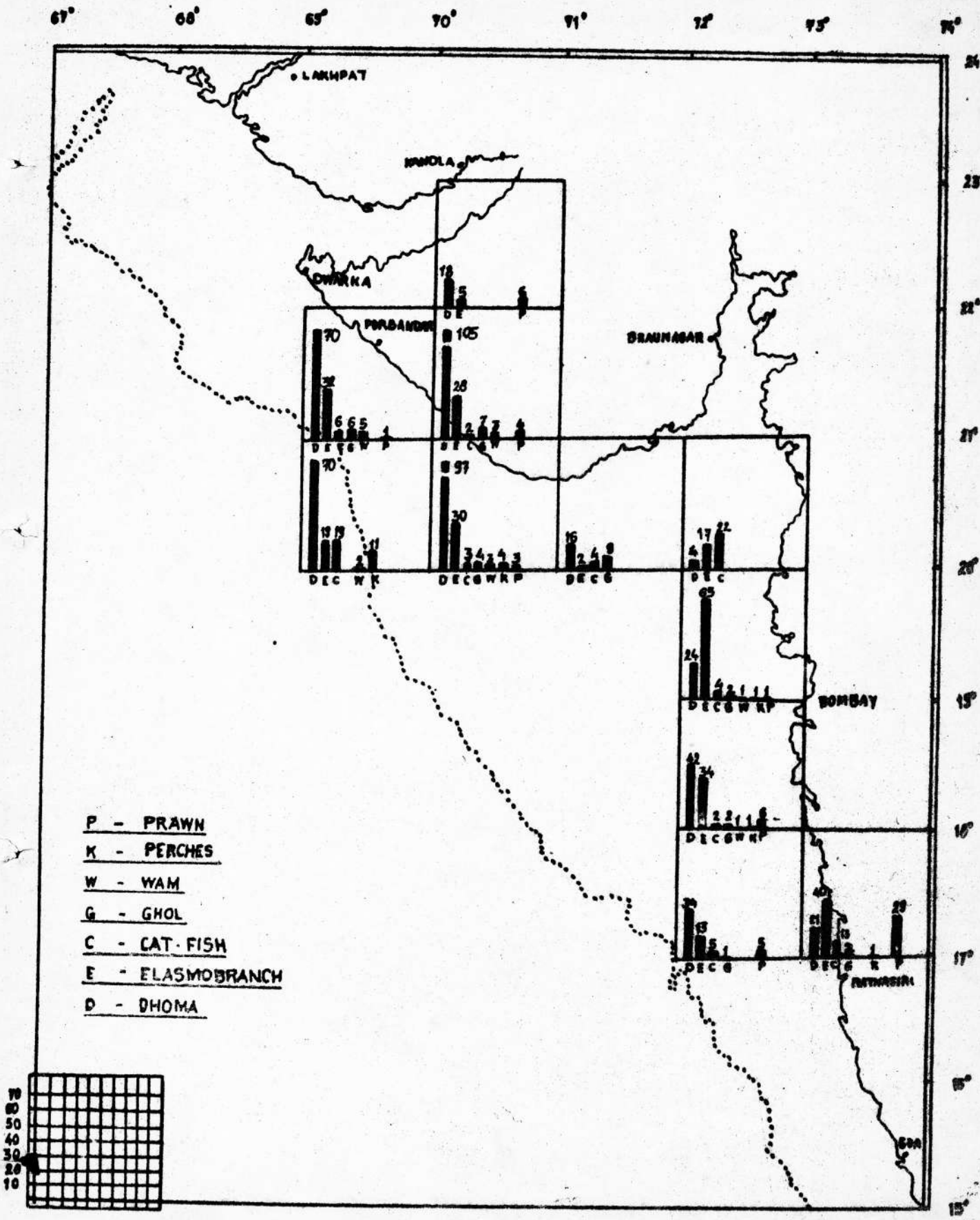


FIG. 11 CATCH/HOUR OF TRAWLING OF THE SMALL VESSELS FOR THE SEVEN IMPORTANT GROUPS.

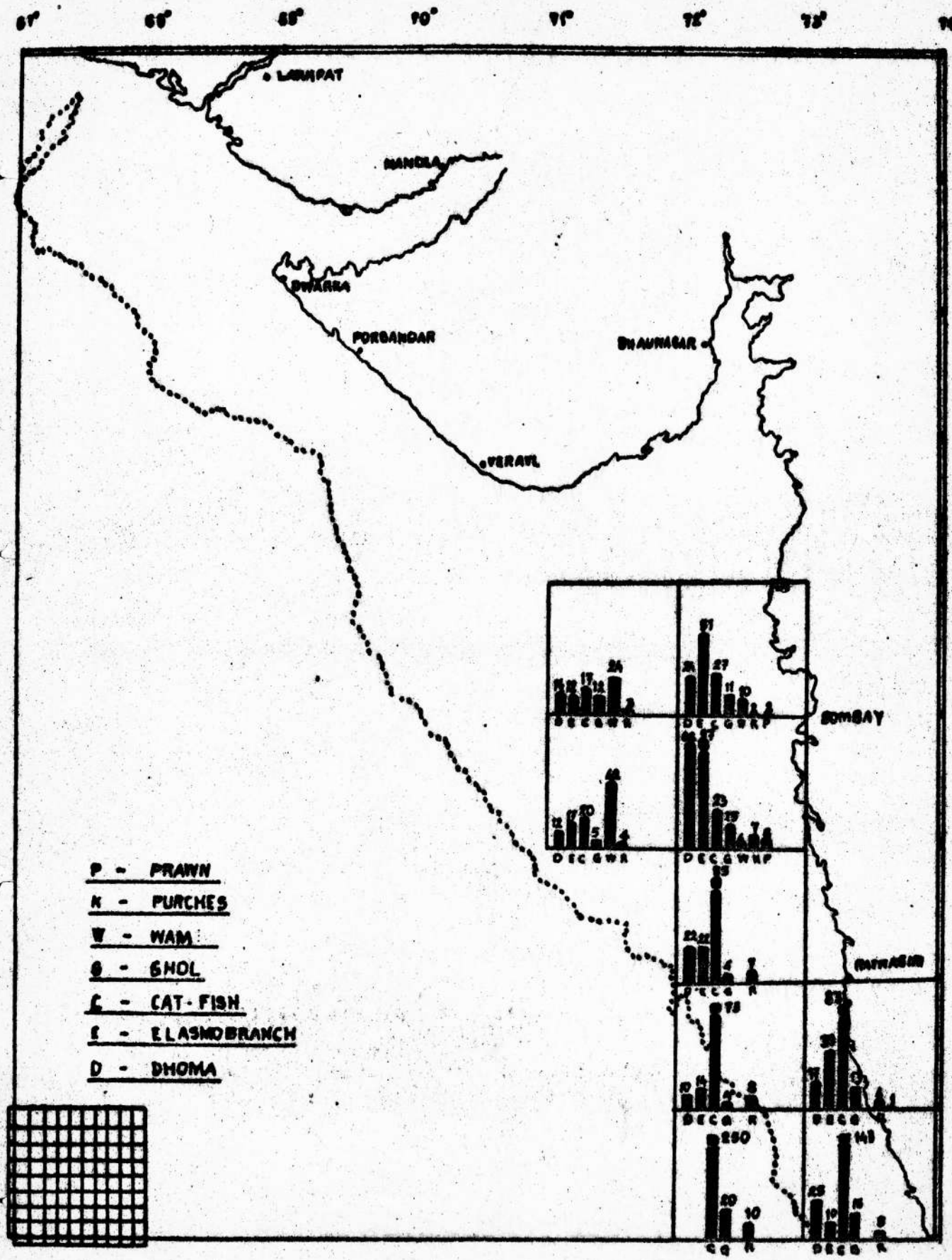


FIG. 14 CATCH/ HOUR TRAWLING OF MEENA BHARATI FOR THE SEVEN IMPORTANT GROUPS.

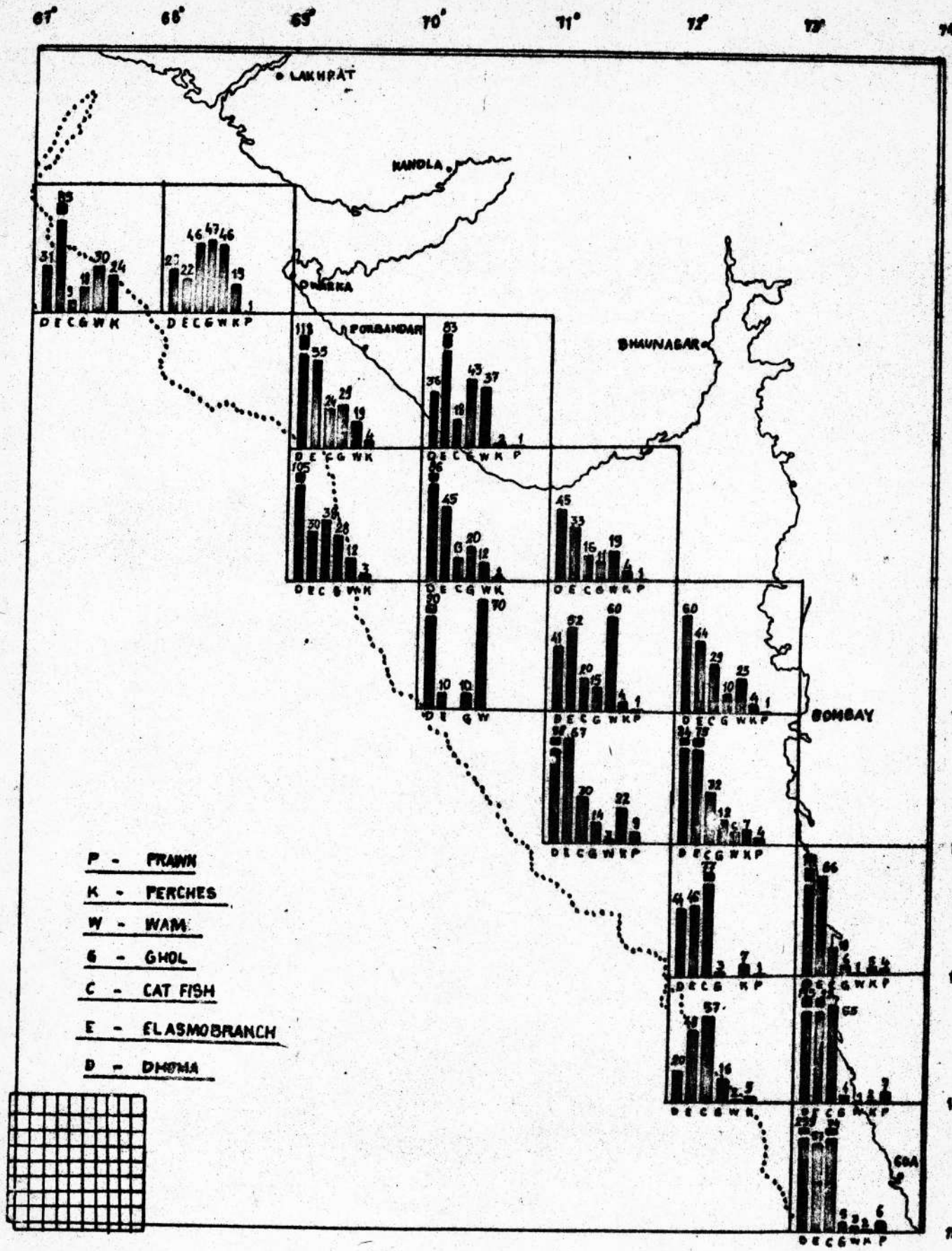


FIG- 15 CATCH/HOUR TRAWLING OF KALYANI III, IV AND V FOR THE SEVEN IMPORTANT GROUPS.

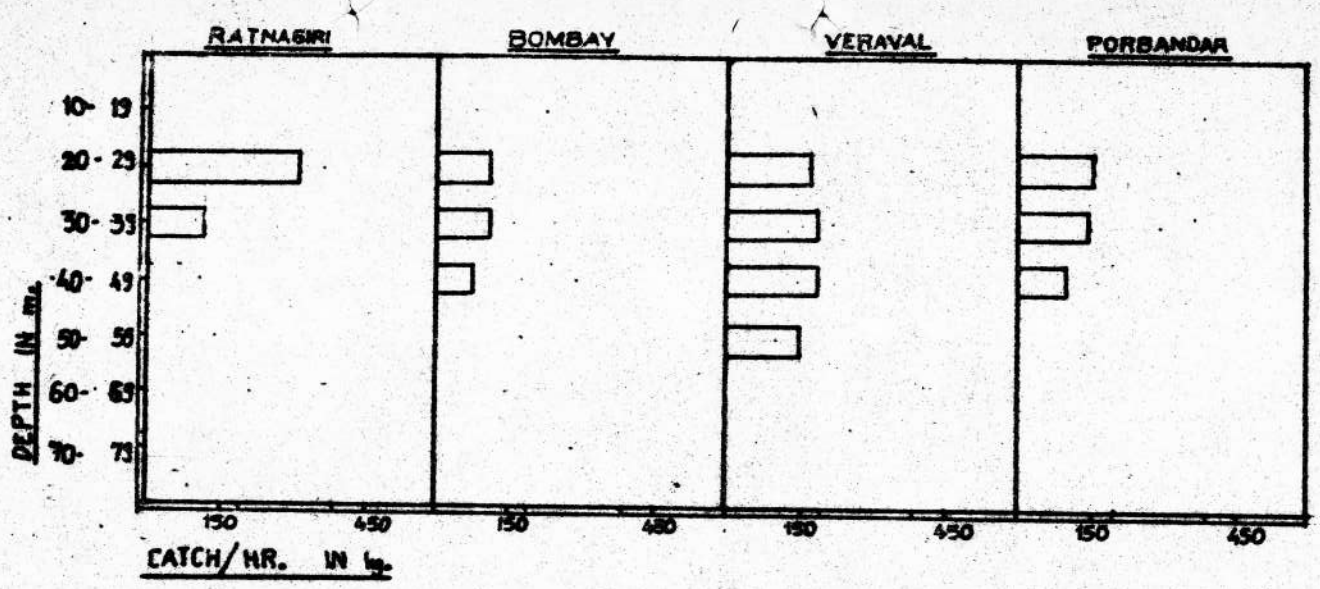


FIG.- 16 CATCH/HOUR OF TRAWLING OF SMALL VESSELS BY REGION AND DEPTH.

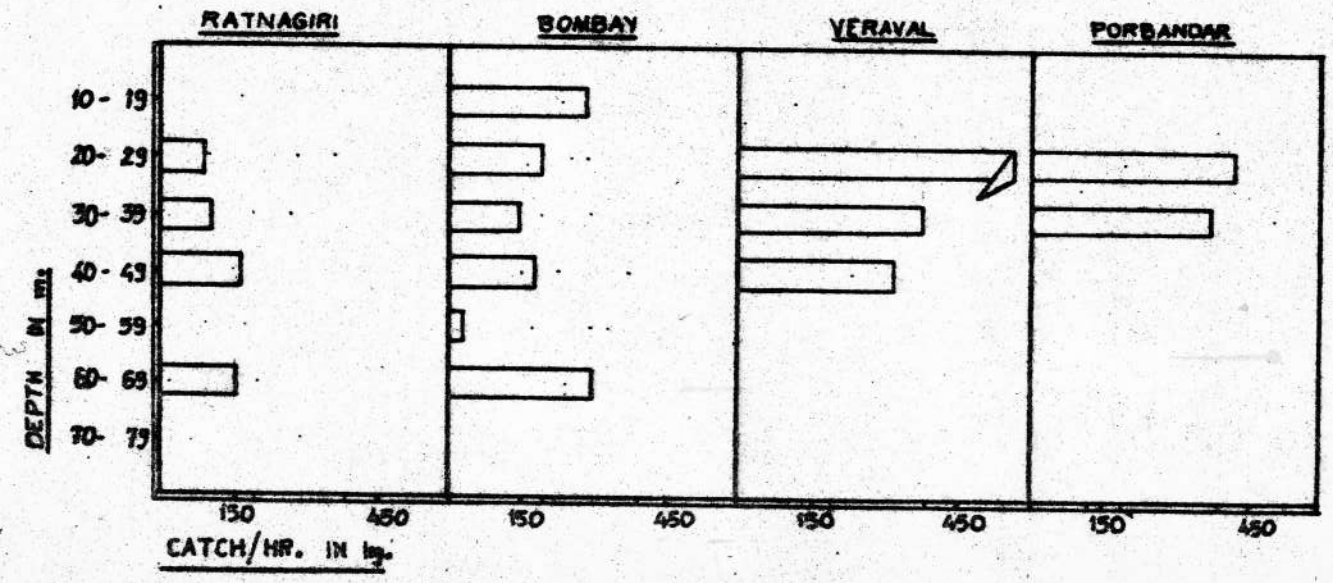


FIG.- 17 CATCH/ HOUR OF TRAWLING OF BUMIL BY REGION AND DEPTH.

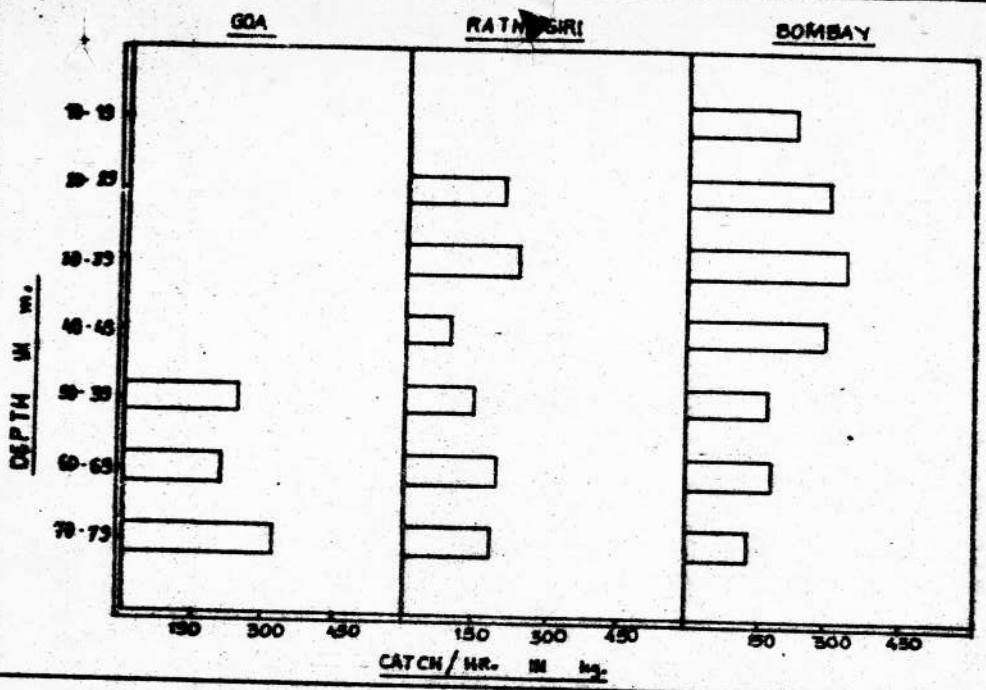


FIG. 20 CATCH/HOUR OF MEENA-BHARATHI IN kg. BY REGION AND DEPTH.

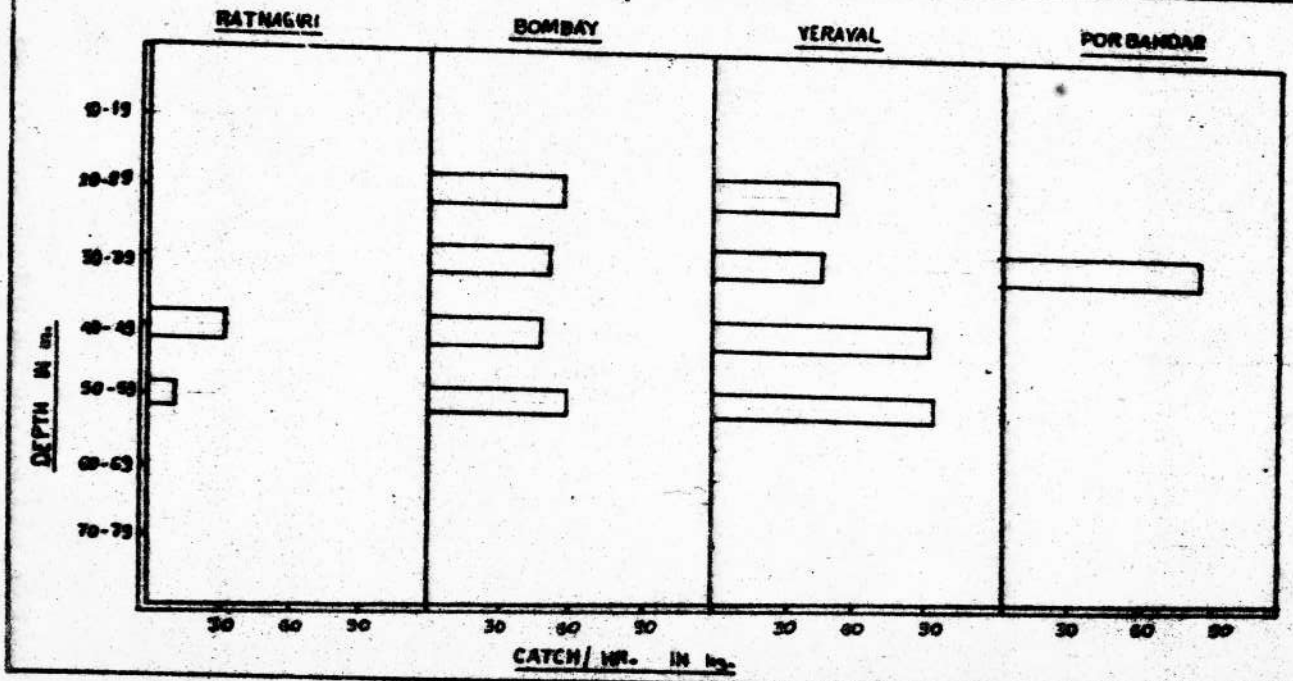


FIG. 21 CATCH/HOUR OF ASHOK AND PRATAP IN kg. BY REGION AND DEPTH.

From fig. XVIII it may be seen that Kalyanis obtained the highest average catch rate from 20-29 m depth zone from Goa, and from 30-39 m zone from Ratnagiri. The highest average catch/hour of trawling obtained by Kalyanis from Bombay, Veraval, Porbandar and Dwaraka were respectively from depth zones 40-49 m, 20-29 m, 40-49 m and 10-19 m. The difference in the average catch/hour of trawling between zones is not very significant as far as Bombay, Veraval, Porbandar and Dwaraka are concerned. From fig.XIX it may be seen that the highest catch rate was obtained by Jheenga is from 20-29 m depth zone from Veraval as in the case of Kalyanis. In the case of Porbandar and Dwaraka, the highest catch rate was from 30-39 m depth zone.

A close scrutiny of the figures XVII, XIX and XI, would reveal that depth zones 30-39, 40-49 and 50-59 are probably the best productive zones along the Saurashtra coast. Ashok and Pratap which have extensively surveyed these areas, obtained the highest catch rate from these depth zones. It appears that in Bombay region comprising area 18-72, in which nearly 35 per cent of the total fishing effort was expended, the demersal fishery resources are rather evenly distributed in all the depth zones surveyed. There is no significant variation in the catch rate from the different depth zones.

Figs. XXII to XXV indicate the catch/hour of trawling of the seven dominant species obtained by selected groups of vessels from different depth zones separately for areas north of Bombay and south of Bombay. In order to facilitate an understanding of the data with ease and clarity, the number of regions have been reduced from six to two for purposes of this analysis. From fig.XXII and XXIII, it may be seen, that "Dhoma" accounts for the highest catch rate among the seven groups from almost all depth zones in either regions. The abundance of "Dhoma" is relatively high upto 40 m depth. There is no

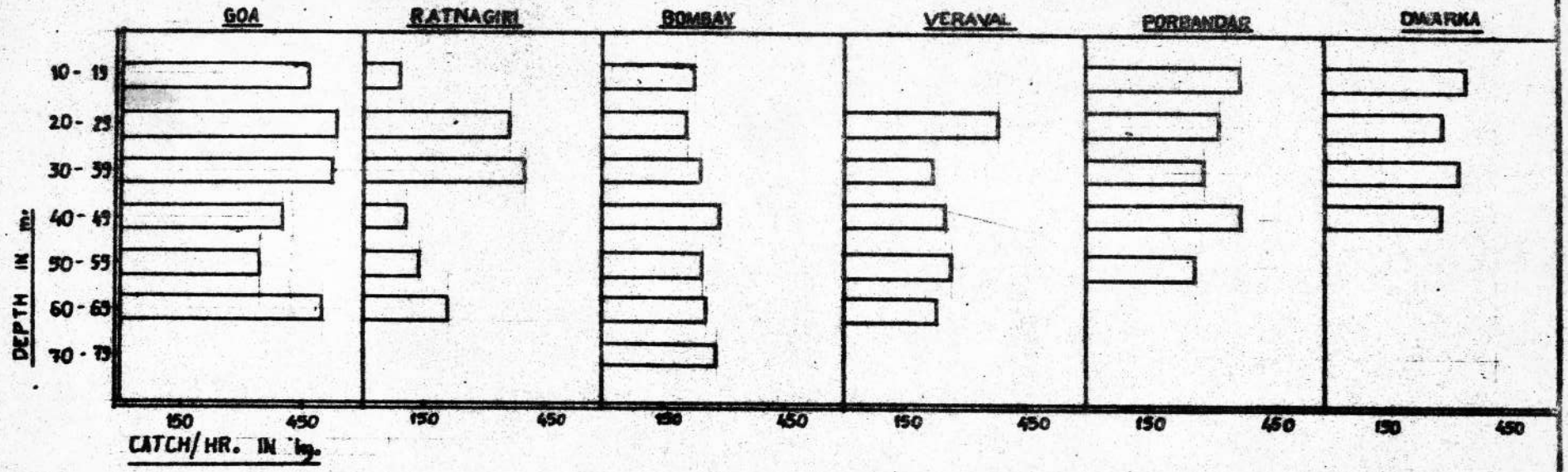


FIG.- 16 CATCH/HOUR OF TRAWLING OF KALYANI III, IV AND V BY REGION AND DEPTH

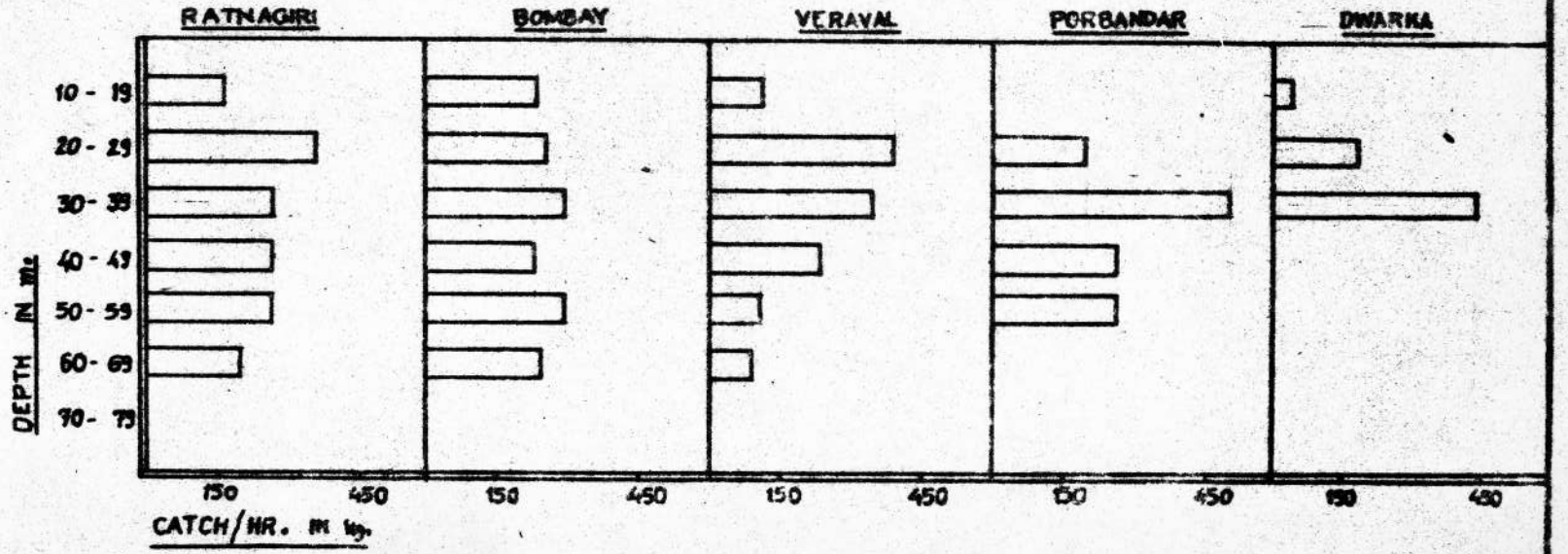


FIG. 19 CATCH/HOUR OF TRAWLING OF M.F.V. JHEENGA BY REGION AND DEPTH

geographical divisions and each of which is identifiable by the corelated latitude and longitude. For instance the area lying between the lat. 16°N and long. 72°N is identified as area 16-72. Each division is further divided into 36 squares of 100 sq. nautical miles for purposes of sampling. Each of this square or sub-division is identifiable by prefixing alphabets and numerals on a systematic basis as 16-72/1A, 2A, etc.

Prior to 1959 a slightly different method was employed for this purpose. The area lying between 1° lat. and 1° long. was sub-divided into six equal squares, each of which measuring about 600 sq. nautical miles. These squares were identified serially as 1, 2, 3 etc., from sea to shore and from South to North. The presentation of the data in this bulletin is on the basis of the method of demarcation of areas now in vogue. Consequently it has not been possible to present sampling intensity prior to 1959 in the charts contained in this bulletin. However this information is given in tabular forms.

AREA OF STUDY

The bulletin covers the results of survey conducted by the organisation between the lat. 15° N and 23° N and long. 67° E and 74° E. The entire coastal line of Gujarat, Maharashtra and part of the coastal line of the Union territory of Goa, Daman and Diu falls within the area of study. The total length of the coastal line of the area under observation is about 2300 km. Of this about 1600 km are in the State of Gujarat, about 600 km in the state of Maharashtra and the remaining in the Union territory of Goa.

It deserves mention that the continental shelf in the area under study is the widest as compared to that in any other

part of the Indian sub-continent. The maximum width of the shelf which is about 340 km occurs north of Bombay. The minimum width of the shelf in the area is about 90 km. It is also remarkable that the total area of the continental shelf in the area under observation, which works out to approximately 225000 sq. km., is about 60 percent of the total continental shelf area of the country. Although Gujarat has a more lengthy coastal line than Maharashtra, the area of its shelf is only almost equal to that of Maharashtra. The break up figures of shelf area for the two states are approximately 109000 sq. km. and 107000 sq. km. respectively, for Gujarat and Maharashtra.

From the point of view of oceanography also the area under observation possesses many unique characteristics. The most important of these is, as already stated, the remarkable wide shelf. It is also noteworthy that the Gulf of Cambey and the Gulf of Kutch, two of the four important gulfs in the Arabian Sea occur in the area under study. Of these, the Gulf of Cambey, into which the river Narmada discharges, appears to have relatively high rate of primary production. It also deserves mention that the powerful Somalia current going northwards of East Africa in a clockwise direction grazes the Saurashtra coast during the South west monsoon. During the North east monsoon the offshore wind off the Kathiawar peninsula results in upwelling in the Gulf of Cambey. Oceanographers believe that these circulation patterns play an important role in the relatively high primary production encountered in the area (Panikkar 1969).

The area of study is shown in fig. I. The figure also indicates the stratification of the area into divisions and sub-divisions on the basis of longitude and latitude and on the basis of depth.

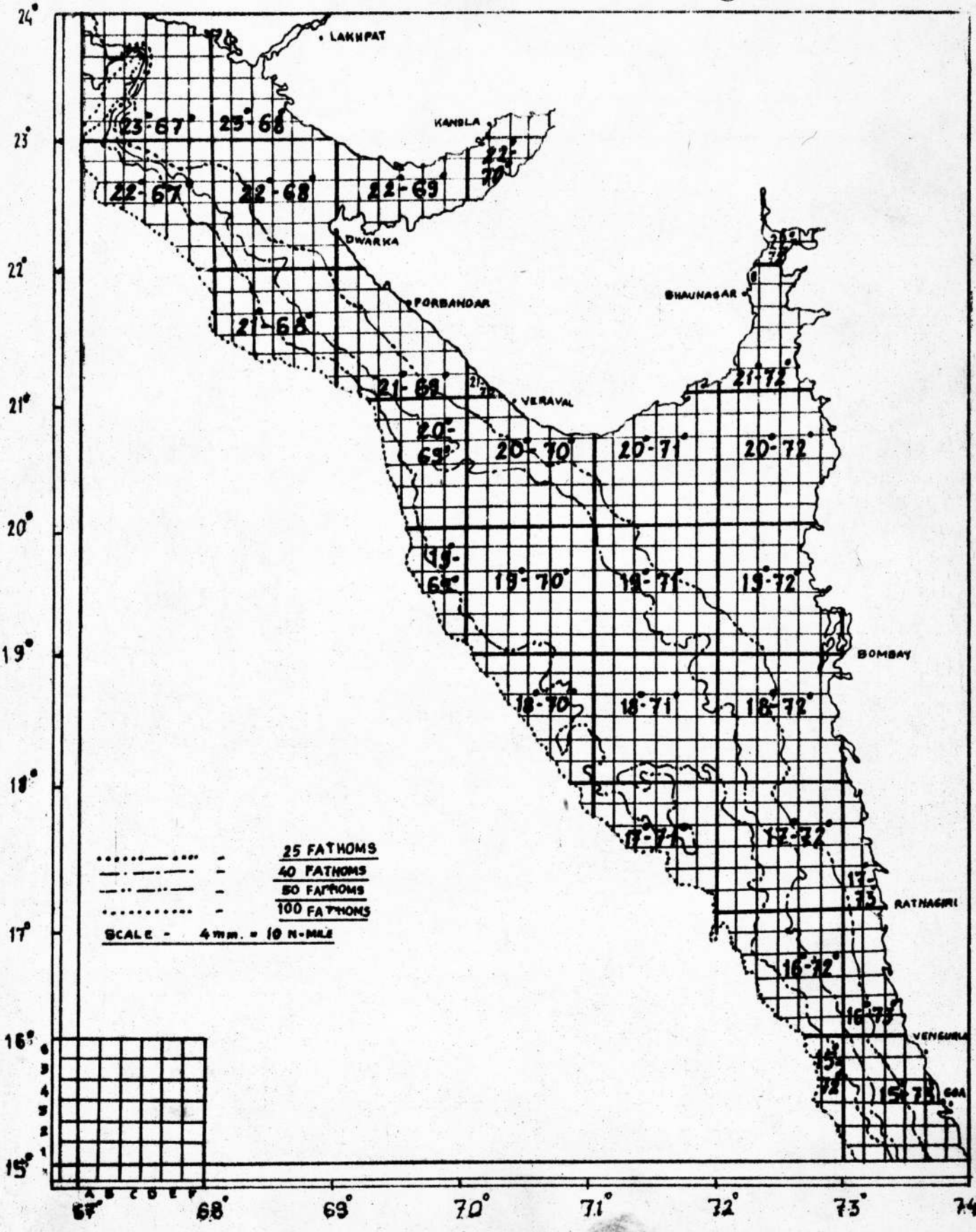
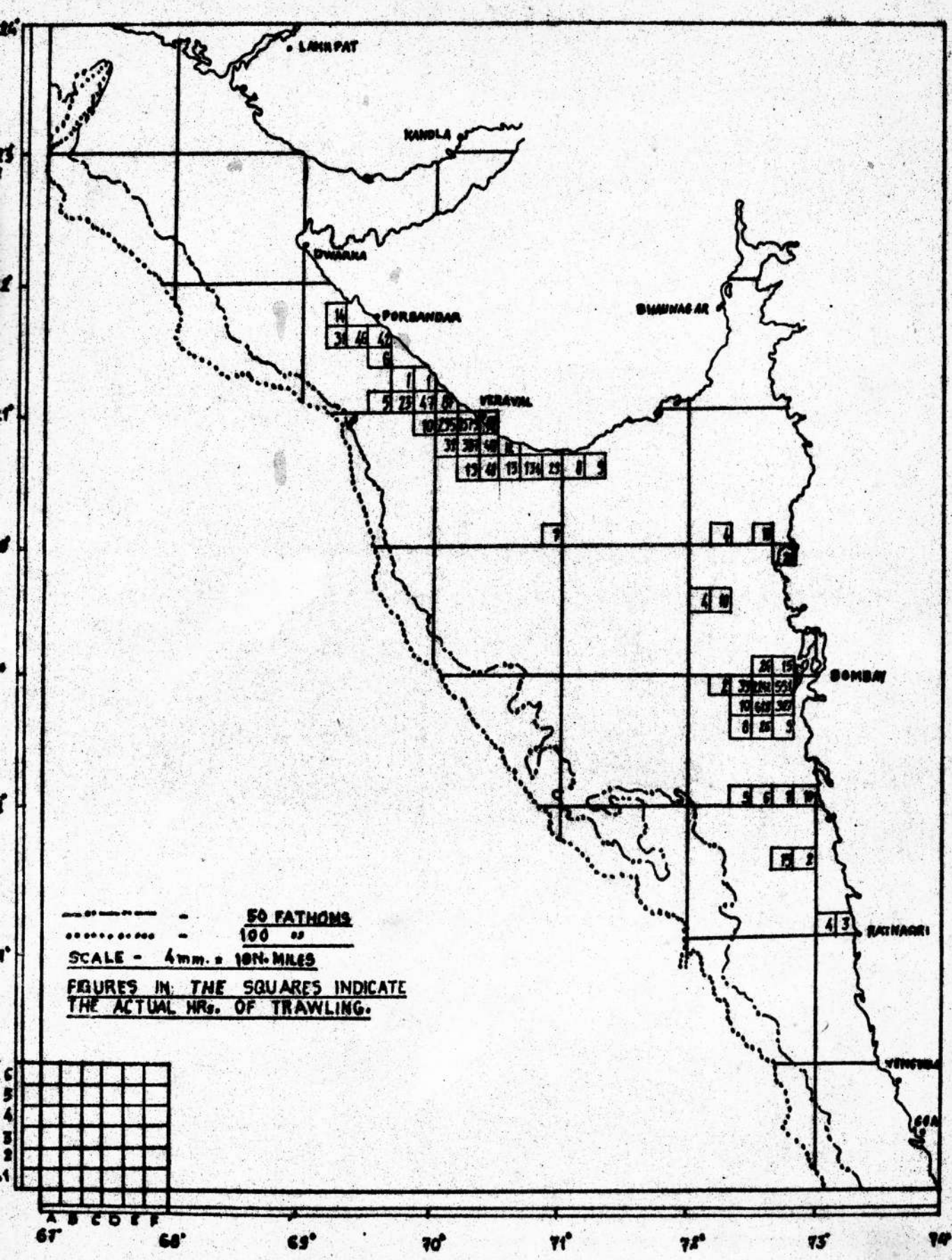


FIG- 1 AREA OF SURVEY SHOWING DIFFERENT DEPTH CONTOURS.

the system of demarcation of area existed prior to this period was slightly different. Figs. II to VII show the sampling distribution of various groups of vessels which conducted survey since 1959, while table IV gives the division-wise effort expended by the various vessels prior to 1959.

From fig. II which depicts the sampling distribution of small vessels, it may be seen that the distribution of the sampling effort is confined mainly to two areas viz., 18-72 off Bombay and 20-70 off Veraval. In the case of Bumili also (fig. III), it may be seen, that the sampling distribution is confined mainly to area 18-72. From fig. IV, it will be seen, that the sampling distribution of Jheenga is more spread than in the case of the small vessels and Bumili, although the sampling intensity in this case too tends to be concentrated into the areas 18-72 and 20-70. As regards Meenabharathi (fig. V) it is seen that the distribution of fishing effort is confined almost exclusively to area 18-72, 19-71, 19-72, 17-72 and 16-72. The distribution of the sampling intensity is more in 18-72 than in other areas. As far as Kalyani III, IV & V are concerned (fig.VI) it may be seen that the distribution of the sampling is more widely and evenly spread than that of any other groups of vessels.

Fig. VII indicates the distribution of the combined fishing effort of all the vessels since 1959. From the figure, it may be seen that the vessels have fished in about 25 out of the 27 divisions. Out of these 25 areas, it may be seen, that the sampling intensity is relatively more in 11 areas viz., 15-73, 16-72, 16-73, 17-72, 18-72, 19-71, 19-72, 20-70, 20-71, 21-69 and 22-68 as compared to others. The figure gives a very clear understanding about the distribution of the sampling intensity in the area under study and helps to pin point squares which lack in adequate sampling.



IG. 2 DISTRIBUTION AND INTENSITY OF SAMPLING BY SMALL VESSELS.

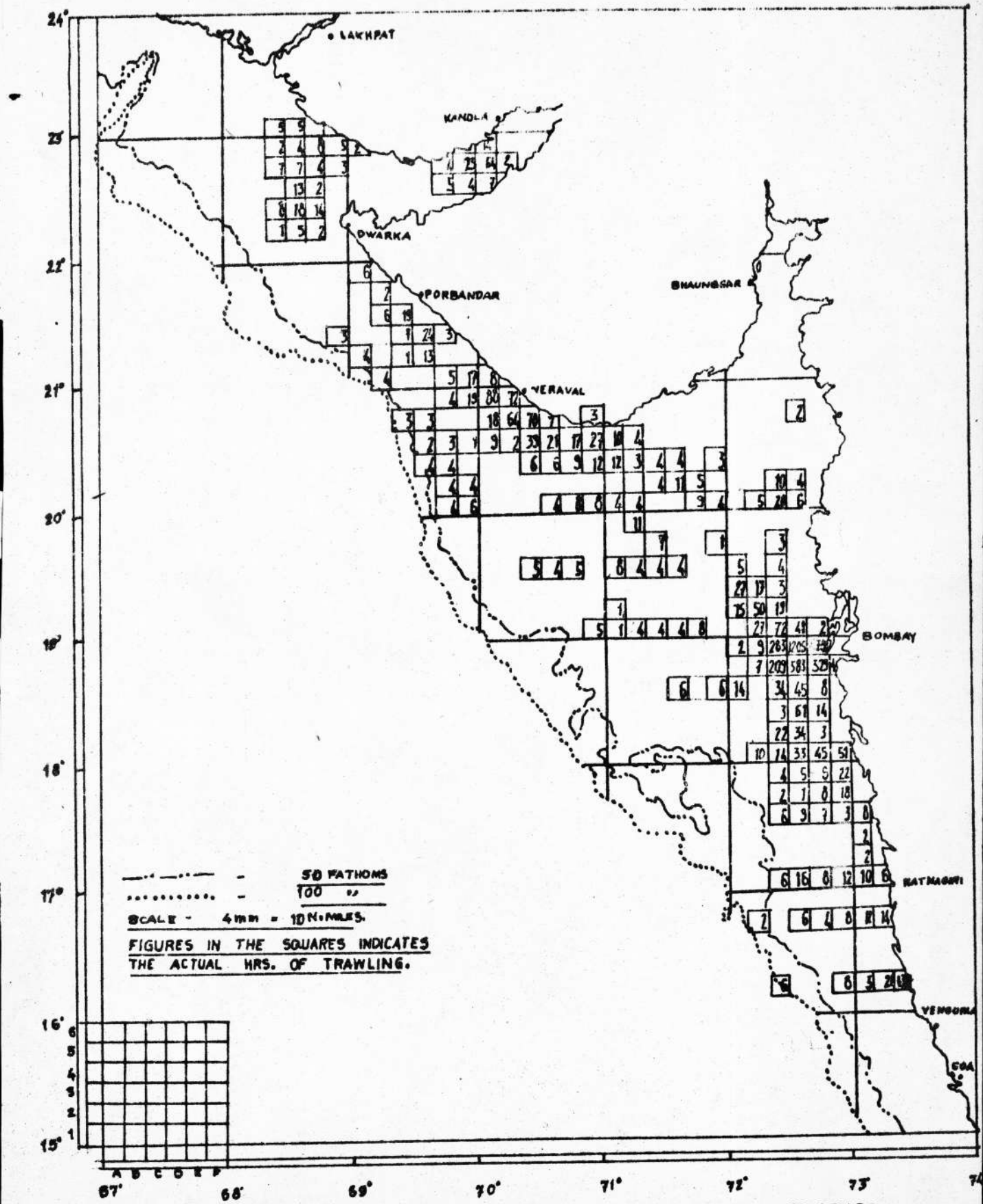


FIG. 4 DISTRIBUTION AND INTENSITY OF SAMPLING BY JHEENGA.

Area	Fishing effort in hours		
	Ashok & Pratap.	S.T.Meena	Total
17-72	71	-	71
18-72	562	349	911
19-71	6446	231	6677
19-72	2180	427	2607
20-69	4	0	4
20-70	1219	48	1267
20-71	3033	511	3544
20-72	139	16	155
21-69	61	0	61
23-67	8	0	8
22-68	0	0	0
Total:	13723	1582	15305

Table.IV: Distribution of Fishing effort expended by Ashok, Pratap and Meena - 1948-55 by otter trawling.

From table IV, which furnishes the fishing effort expended by the vessels Ashok, Pratap and Meena during the period 1948-55 in the area under observation, it may be seen that the operation of these vessels were more or less confined to areas between the lat. 18° N and 20° N. Four divisions viz. 19-71, 19-72, 20-70 and 20-71 were rather heavily fished by these vessels. It may be noted that these four areas also figure in the list of the eleven areas surveyed intensively since 1959.

Distribution of Sampling effort by depth

Table-V gives the distribution of the combined fishing effort of all the vessels from 1948 to 1973 by area and by depth intervals. From the table, it may be seen that the total fishing effort expended by all the vessels by otter trawling in the area under investigation is about 37,000 hours. The table also indicates the combined fishing effort of all the vessels in each of the five depth zones viz., 0-19, 20-39, 40-59, 60-79 and 80-99 m. About two-third or about 24700 hours of the total fishing effort was expended in the stratum 20-39 m. The depth strata 40-59 m and 0-19 m come next in the order of intensity of survey. The effort expended in stratum 60-79 m as far as

areas north of lat. 20° are concerned and in the stratum 80-99 m. are rather significant.

Division	Depth in m. 0-19	20-39	40-59	60-79	80-99	Total
	Effort in hrs.					
15-72	-	-	-	2	-	2
15-73	26	208	85	23	-	342
16-72	2	4	12	158	14	190
16-73	11	150	39	17	-	217
17-72	12	305	253	205	18	793
17-73	58	89	8	-	-	155
18-70	-	-	-	-	5	5
18-71	-	5	12	52	10	79
18-72	2,286	9,104	1,504	211	19	13,124
19-70	-	-	15	8	3	26
19-71	3	2,951	4,284	403	48	7,689
19-72	81	3,021	575	43	-	3,720
20-69	-	8	89	4	-	101
20-70	5	4,221	924	68	-	5,218
20-71	-	3,451	290	3	-	3,744
20-72	-	223	-	-	-	223
21-68	-	14	-	-	-	14
21-69	20	395	183	-	-	598
21-70	-	133	-	-	-	133
22-67	-	9	12	-	-	21
22-68	17	356	318	-	-	691
22-69	2	33	1	-	-	36
22-70	78	7	-	-	-	85
23-67	-	7	-	-	-	7
23-68	10	-	-	-	-	10
Total:-	2,611	24,694	8,604	1,197	177	37,223

Table: V. Combined fishing effort of all vessels by area and depth.

Table-VI indicates the divisions in which 100 or more hours of actual fishing effort was expended. From table-VI it may be seen that five areas, viz., 18-72, 19-71, 20-70, 20-71 and 19-72 have accounted for nearly 80 per cent of the total fishing effort. The area 18-72 alone accounts for about 35 per cent of the total fishing effort. The fishing effort in all these five areas exceeds 3,700 hours. Table-VI also indicates the remaining 10 areas, out of the 27 divisions, which were surveyed by more than 100 hours of actual fishing. The table also shows the extent of survey conducted in the different depth strata. Nearly 80 per cent of the total fishing effort was spent in the depth zones 20-39 m and 40-59 m.

On the basis of this study of the distribution and intensity of sampling by area and depth, it may be mentioned, that it is possible to demarcate areas which have been adequately surveyed, from those which have been partially surveyed and scarcely surveyed. On the same analogy, it is also possible to identify the depth strata which have been adequately surveyed, partially surveyed and scarcely surveyed.

Division	No. of sub-divisions surveyed / Total No. of sub-divisions	Depth range in m. 0-19	20-39	40-59	60-79	Total
		Hours of fishing				
18-72	35/35	2,286	9,104	1,504	211	13,105
19-71	33/36	3	2,951	4,284	403	7,641
20-70	28/32	5	4,221	924	68	5,218
20-71	18/30	-	3,451	290	3	3,744
19-72	20/26	81	3,021	575	43	3,720
	Total:	2,375	22,748	7,577	728	33,428
17-72	30/36	12	305	253	205	775
22-68	31/36	17	356	318	-	691
21-69	16/26	20	395	183	-	598
15-73	20/29	26	208	85	23	342
20-72	12/30	-	223	-	-	223
16-73	11/12	11	150	39	17	217
16-72	11/36	2	4	12	158	176
17-73	4/9	58	89	8	-	155
21-70	1/1	-	133	-	-	133
20-69	15/36	-	8	89	4	101
	Total:	146	1,871	987	407	3,411
Grand	Total:	2,521	24,619	8,564	1,135	36,839

Table.VI: The 15 intensively surveyed areas and the fishing effort expended in them by depth.

Distribution of sampling by area and time

Table-VII gives the distribution of sampling by time in each of the 25 divisions surveyed while table-VIII gives the same information in respect of the 15 intensively surveyed areas. From table VII, it may be noted that all except seven divisions viz., 15-72, 18-70, 21-68, 22-67, 22-69, 23-67 and 23-68 were surveyed during two or more seasons although the fishing expended in them vary considerably. It may also be seen from table-VIII that all the 15 divisions which were surveyed by more than 100 hours were fished during four or more years. Needless to say that this distribution of sampling effort into a time span of over four years has increased the reliability of the results obtained from these areas, to a great extent.

Area	Year																Total
	1948-1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	
	Fishing effort in hours																
15-72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
15-73	-	-	-	-	-	-	-	-	-	138	194	-	-	-	6	4	342
16-72	-	-	-	-	-	-	16	16	-	-	-	-	40	-	-	118	190
16-73	-	3	10	5	11	-	56	30	-	11	52	-	-	-	12	27	217
17-72	71	7	36	10	25	66	48	46	-	-	25	84	173	12	76	114	793
17-73	-	28	9	-	28	46	8	12	-	-	13	10	-	-	1	-	155
18-70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5
18-71	-	-	3	-	-	-	11	-	-	-	20	5	-	9	9	22	79
18-72	911	786	598	423	1,401	1,044	1,572	1,227	2,333	1,168	514	350	160	128	293	216	13,124
19-70	-	-	-	-	-	-	23	-	-	-	-	3	-	-	-	-	26
19-71	6,677	-	19	-	-	-	46	38	-	-	55	421	252	14	68	99	7,689
19-72	2,607	12	15	88	234	10	43	145	3	69	26	153	149	65	80	21	3,720
20-69	4	-	6	17	2	8	38	13	-	-	2	11	-	-	-	-	101
20-70	1,467	147	171	70	524	683	802	1,006	206	11	17	86	26	-	2	-	5,218
20-71	3,544	-	-	-	40	43	20	38	-	-	-	59	-	-	-	-	3,744
20-72	155	-	-	-	44	2	22	-	-	-	-	-	-	-	-	-	223
21-68	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	14

(contd...)

(table contd...)

Area	Year																Total
	1948-1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	
	Fishing effort in hours																
21-69	61	21	53	25	29	66	125	91	-	-	29	98	-	-	-	-	598
21-70	-	-	4	5	-	14	58	22	-	-	2	28	-	-	-	-	133
22-67	-	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	21
22-68	-	7	-	61	18	31	-	31	-	-	-	470	-	-	55	18	691
22-69	-	-	-	-	36	-	-	-	-	-	-	-	-	-	-	-	36
22-70	-	31	-	7	47	-	-	-	-	-	-	-	-	-	-	-	85
23-67	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
23-68	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	10
TOTAL:	15,504	1,042	924	711	2,449	2,013	2,902	2,715	2,542	1,418	949	1,778	800	228	602	646	37,223

Table-VII: Distribution of sampling effort by area and time.

AREA	Year 1948-1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	TOTAL
	Fishing effort in hours																
18-72	911	786	598	423	1,401	1,044	1,572	1,227	2,333	1,168	514	350	160	128	293	216	13,124
19-71	6,677	-	19	-	-	-	46	38	-	-	55	421	252	14	68	99	7,689
20-70	1,467	147	171	70	524	683	802	1,006	206	11	17	86	26	-	2	-	5,218
20-71	3,544	-	-	-	40	43	20	38	-	-	-	59	-	-	-	-	3,744
19-72	2,607	12	15	88	234	10	43	145	3	69	26	153	149	65	80	21	3,720
Total:	15,206	945	803	581	2,199	1,780	2,483	2,454	2,542	1,248	612	1,069	587	207	443	336	33,495
17-72	71	7	36	10	25	66	48	46	-	-	25	84	173	12	76	114	793
22-68	-	7	-	61	18	31	-	31	-	-	-	470	-	-	55	18	691
21-69	61	21	53	25	29	66	125	91	-	-	29	98	-	-	-	-	598
15-73	-	-	-	-	-	-	-	-	-	138	194	-	-	-	6	4	342
20-72	155	-	-	-	44	2	22	-	-	-	-	-	-	-	-	-	223
16-73	-	3	10	5	11	-	56	30	-	11	52	-	-	-	12	27	217
16-72	-	-	-	-	-	-	16	16	-	-	-	-	40	-	-	118	190
17-73	-	28	9	-	28	46	8	12	-	-	13	10	-	-	1	-	155
21-70	-	-	4	5	-	14	58	22	-	-	2	28	-	-	-	-	133
20-69	4	-	6	17	2	8	38	13	-	-	2	11	-	-	-	-	101
Total:	291	66	118	123	157	233	371	261	-	149	317	701	213	12	150	281	3,443
Grand Total:	15,497	1,011	921	704	2,356	2,013	2,854	2,715	2,542	1,397	929	1,770	800	219	593	617	36,938

Table-VIII: Distribution of sampling effort by time in the 15 intensively surveyed areas.

significant variation in the abundance of it between the two regions. In the case of elasmobranchs the abundance seems to be relatively high in the depth zones 20-29 and 30-39 m.

The abundance of eel appears to be highest in the 60-69 and 70-79 m depth zones in the southern region while it is highest in the 30-39 and 40-49 m depth zones in the northern region. Cat fish catch rate is relatively high in the 30-49 m depth belt in the south zone. The highest catch rate of "Ghol" was from 30-49 m depth belt in the north zone.

Fig. XXIV is significant in that it shows very high catch rates of quality fishes such as "Ghol", "Dara", eel and pomfret. It is also remarkable that there is no "Dhoma" in the catches of these vessels i.e. Ashok and Pratap. The data of these vessels relate to the p eriod 1949-54. The absence of "Dhoma" is due to two reasons. Firstly the vessels were only taking quality fishes in those days. Secondly they were operating relatively large-meshed fish trawls. These also would explain the reasons for the relatively low catch/hour of trawling obtained by these vessels.

From Fig.XXIV it will be seen that the highest catch rate of eel was obtained from 50-59 m depth zone from south of Bombay while the highest catch rate of "Ghol" was obtained from 40-49 m depth zone from the areas north of Bombay. The highest catch rate of these vessels are also from 40-49 m depth zone from the north zone.

SEASONAL VARIATION IN THE CATCH

Out of the nine classes of vessels which took part in the investigation none had surveyed all the six regions on a round the year basis. Six groups, viz., small vessels, Bumili, Jheenga, Meena-bharathi, Kalyanis and Ashok and Pratap have surveyed the Bombay region more or less during all the 12 months of the year while only the small vessels and Ashok and Pratap have surveyed Veraval region.

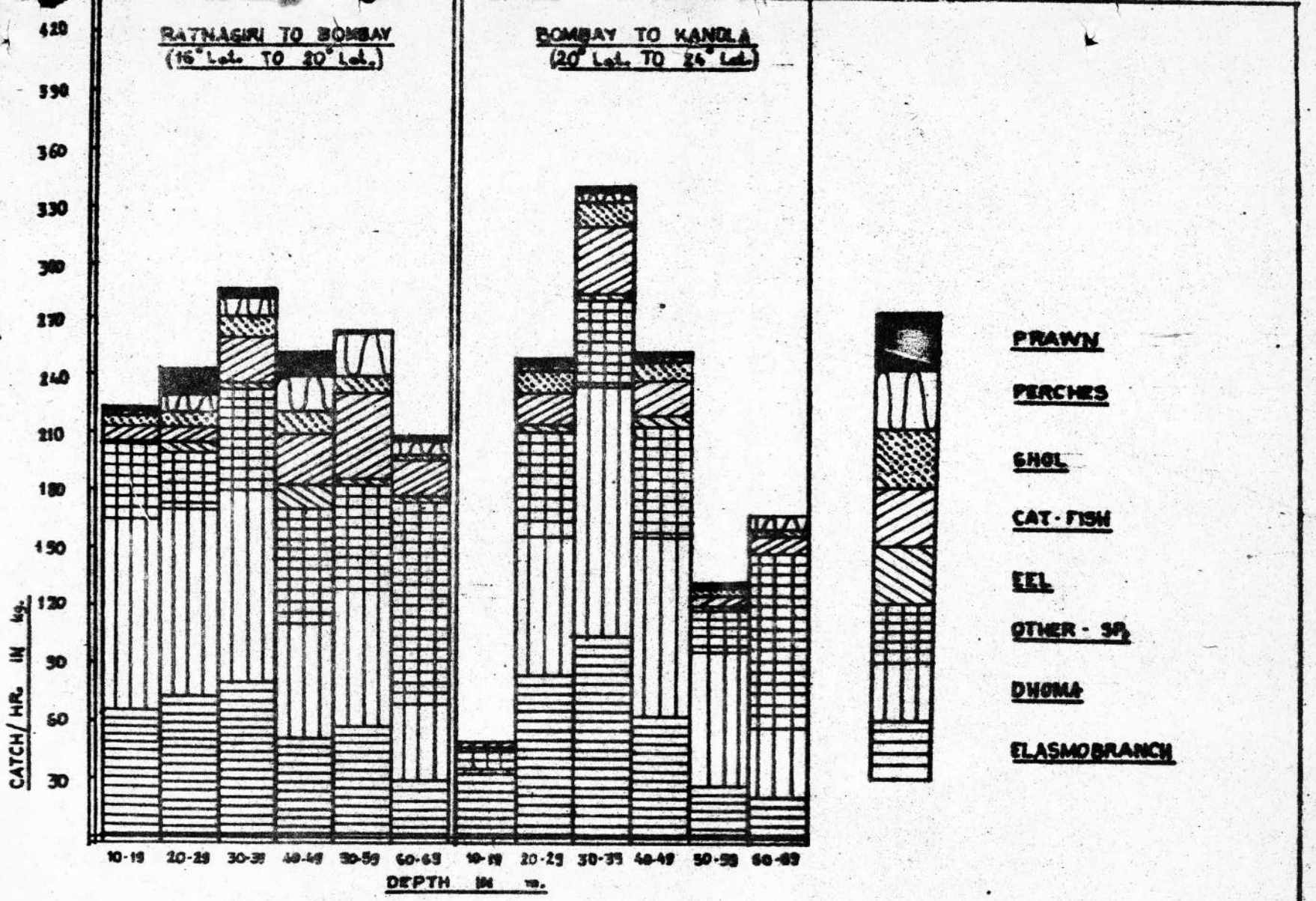
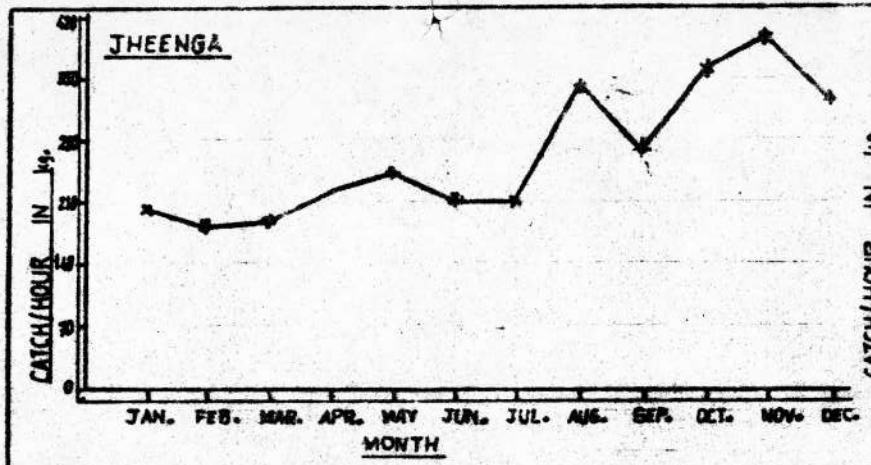


FIG. 23 CATCH/HOUR OF TRAWLING FOR DIFFERENT SPECIES OBTAINED BY M. F.V. JHEENGA BY REGION AND DEPTH



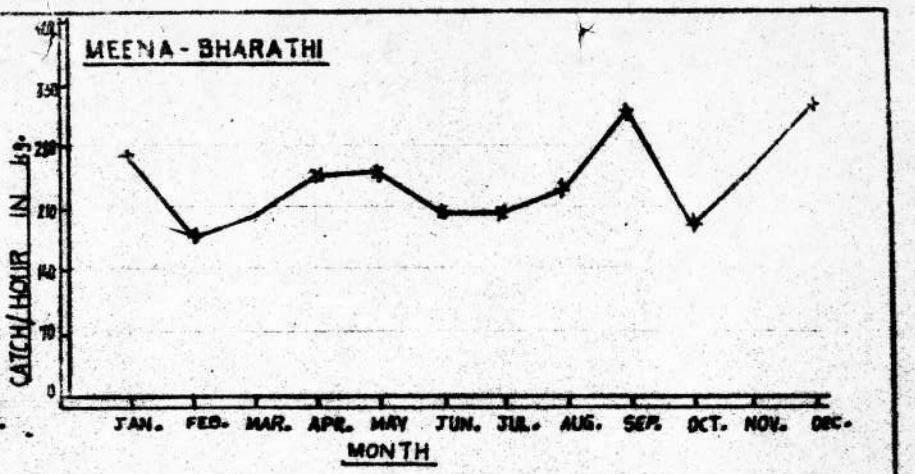
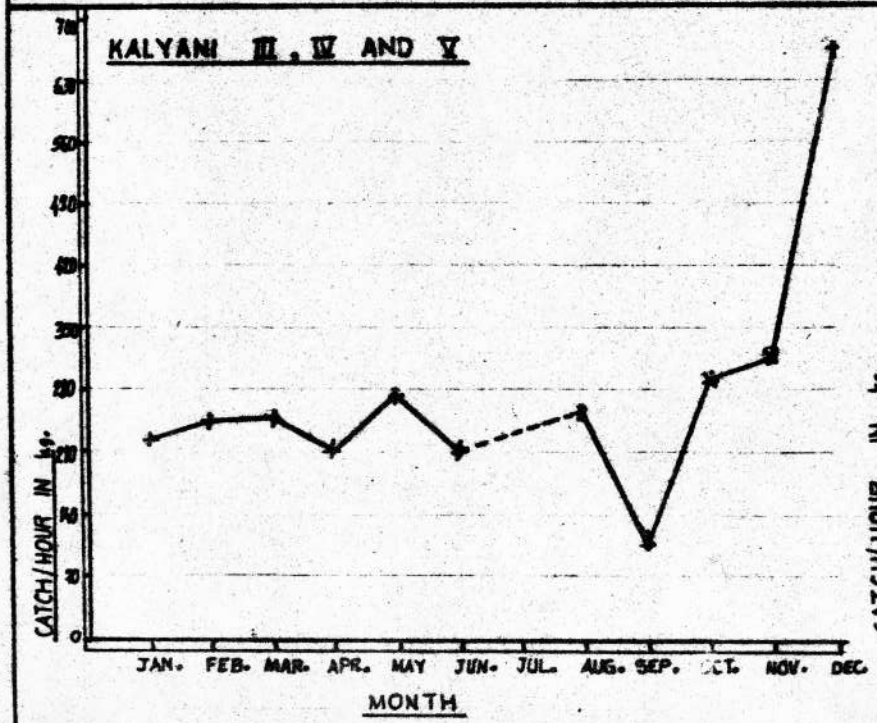


FIG-26 MONTH-WISE CATCH/HOUR OF TRAWLING OF M.F.V. JHEENGA AND MEENA-BHARATHI FROM BOMBAY REGION.



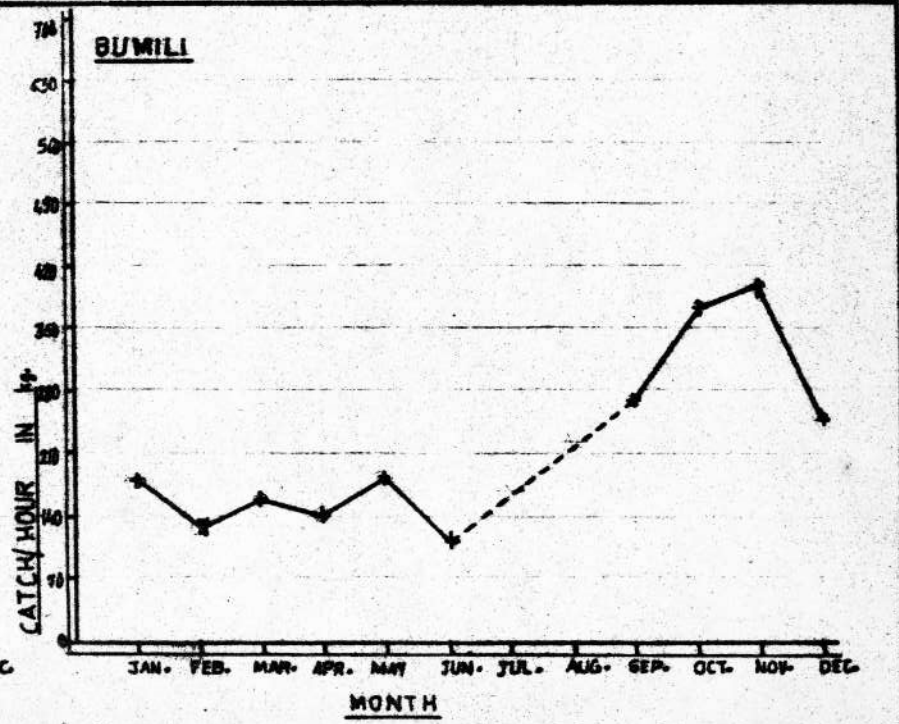


FIG-27 MONTH-WISE CATCH/HOUR OF TRAWLING OF KALYANI III, IV AND V; AND BUMILI FROM BOMBAY REGION.

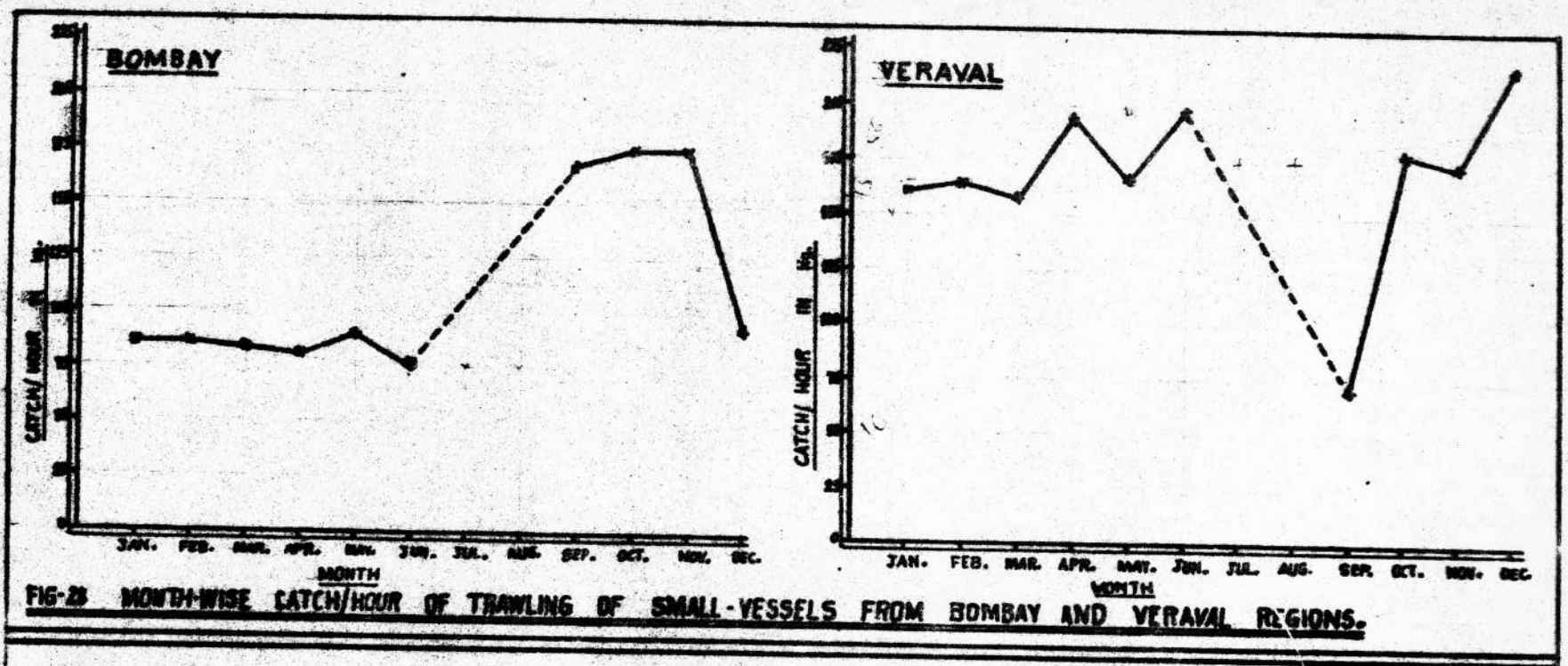


FIG-28 MONTH-WISE CATCH/HOUR OF TRAWLING OF SMALL-VESSELS FROM BOMBAY AND VERAVAL REGIONS.

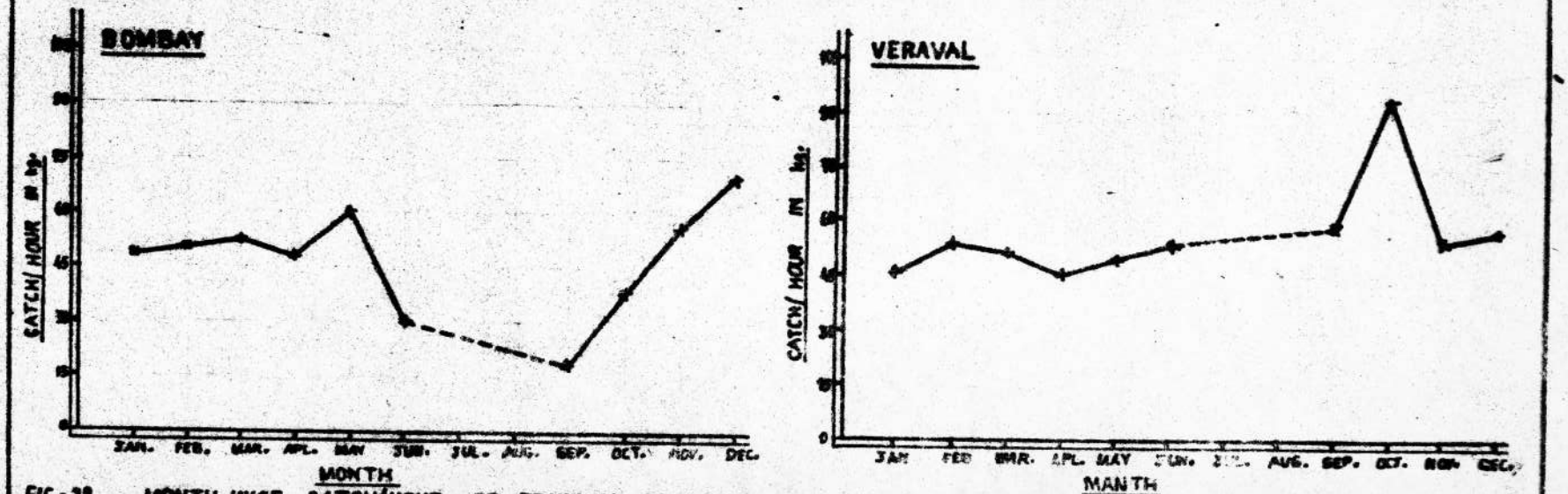


FIG-29 MONTH-WISE CATCH/HOUR OF TRAWLING OF ASHOK AND PRATAP FROM BOMBAY AND VERAVAL REGIONS.

Figs. XXVI to XXIX illustrate the monthly variation in the catch/hour of trawling in respect of Bombay and Veraval regions. The months of September, October, November and December appear to be the best productive months in the case of both Bombay and Veraval regions. March, April and May form the next highest productive months. The least productive month seems to be February barring, perhaps the monsoon months from June to August.

Fig. XXX illustrates the annual variation in the catch/hour of trawling of Jheenga during the years 1959 to 1967 in the case of Bombay and Veraval regions. Barring the year 1965 there is no significant fluctuation in the catch rate as far as Bombay region is concerned. The seemingly significant fluctuation in the case of Veraval region may probably be due to the intermittent nature of operation of the vessel from Veraval.

Figs. XXXI to XXXIV indicate the monthly variation in the catch rates of some important species viz. "Dhoma", "Wam", cat fish, "Ghol", elasmobranchs, perch, pomfret and prawn as evidenced by data gathered by a selected few vessels. From the figures it may be seen that the highest catch/hour of trawling in respect of "Dhoma" was obtained during the period from September to November. In the case of cat fish the peak months appear to be November and December. As regards "Ghol" there appears to be two peak periods viz., August-September and February-March.

The best season for elasmobranchs appear to be the period between August and October. In the case of pomfret the peak season seems to be November-December. Regarding penaeid prawns it may be said that relatively high catch rates were obtained during the post monsoon months of September and October. As far as "Wam"(eel) is concerned there appears to be two peak months viz., March and December.

STANDING STOCK

An attempt has been made to determine the standing stock of demersal fish available in the continental shelf area under study. For this purpose, on the basis of the depth contour marking on Admiraly Charts, the continental shelf has been stratified into four depth zones, viz., 0-25 fm, 25-40 fm, 40-50 fm and 50-100 fm. The area of the shelf coming under each of these depth zones in respect of each division is furnished in Table-XI.

Division	Depth in fathoms				TOTAL
	0-25	25-40	40-50	50-100	
	AREA IN SQUARE K.M.				
23-67	8,240	687	687	1,374	10,988
23-68	5,150	-	-	-	5,150
23-70	687	-	-	-	687
22-67	1,030	687	1,030	5,494	8,241
22-68	7,897	2,747	858	687	12,189
22-69	5,837	-	-	-	5,837
22-70	2,232	-	-	-	2,232
21-68	75	2,060	2,404	4,218	8,757
21-69	3,777	3,090	1,202	343	8,412
21-70	601	-	-	-	601
21-72	5,494	-	-	-	5,494
22-72	687	-	-	-	687
20-69	172	1,717	4,121	1,372	7,382
20-70	2,404	2,404	5,836	-	10,644
20-71	10,129	687	-	-	10,816
20-72	10,644	-	-	-	10,644
Total of Gujarat	65,056	14,079	16,138	13,488	1,08,761

(table contd..)

Division	Depth in fathoms 0-25	25-40	40-50	50-100	TOTAL
	AREA IN SQUARE K.M.				
19-69	-	-	1,030	2,747	3,777
19-70	-	-	11,330	945	12,275
19-71	3,028	5,023	4,310	-	12,361
19-72	8,927	1,030	-	-	9,957
18-70	-	-	2,232	4,807	7,039
18-71	-	858	10,819	684	12,361
18-72	5,494	4,807	1,373	-	11,674
17-71	-	-	1,717	5,494	7,211
17-72	2,747	3,434	2,746	3,434	12,361
17-73	2,575	-	-	-	2,575
16-72	-	2,060	3,090	3,434	8,584
16-73	2,919	1,545	-	-	4,464
15-72	-	-	258	1,459	1,717
15-73	3,434	2,404	2,060	1,716	9,614
Total of Maharashtra-Goa	29,124	21,161	40,965	24,720	1,15,970
GRAND TOTAL:	94,180	35,240	57,103	38,208	2,24,731

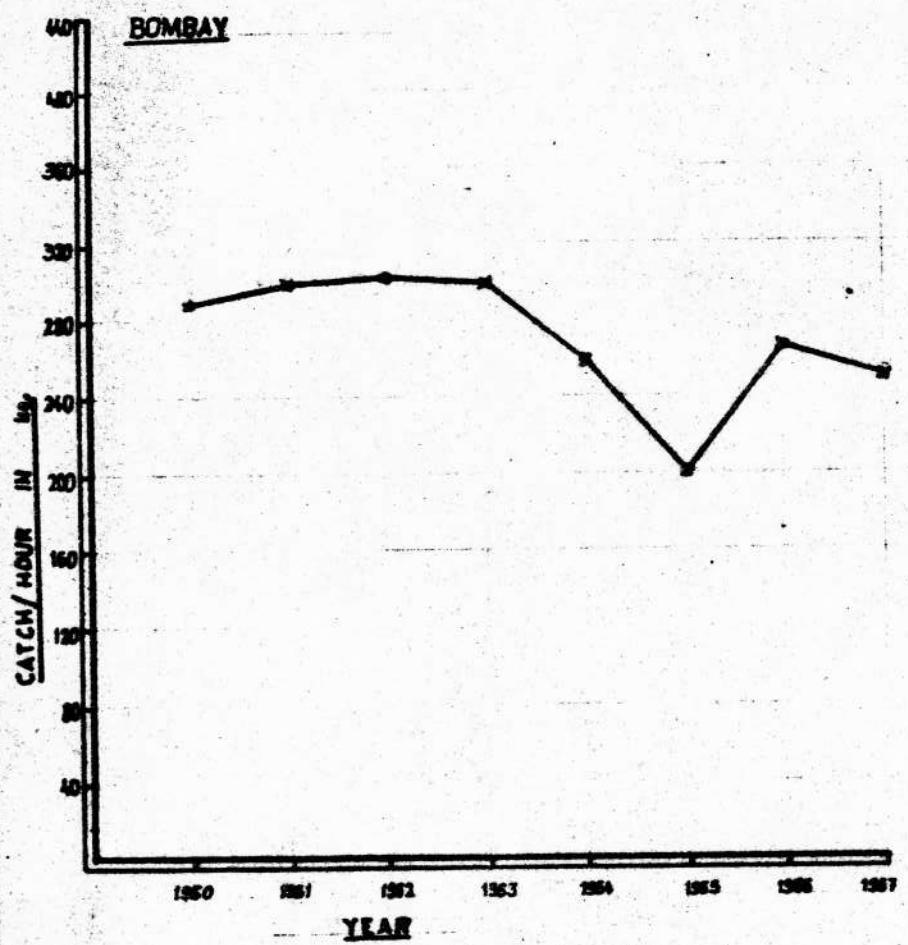
Table.XI: Extent of Continental Shelf area in different bathymetrical and geographical divisions.

From table-XI it may be seen that the line of demarcation of the shelf between the Maharashtra and Gujarat states is placed at lat. 20° N. On the basis of this demarcation it will be seen that the total continental shelf area of Gujarat State is about 1,09,000 sq.kms. Out of this about 65,000 sq.kms. or about 60 percent of the area is within the 0-25 fm depth zone. The total extent of the continental shelf of the

Maharashtra state is about 1,07,000 sq.km. while that of Goa is about 9000 sq.km. About 40 percent of the shelf area of Maharashtra is within the depth zone of 40-50 fm . It may thus be seen that in the case of Gujarat State a major portion of its shelf area is within the 0-25 fm depth zone while in the case of Maharashtra State a substantial portion of its shelf area is within the 40-50 fm depth zone. The distribution of the area under the different depth zones are as follows:-

	Area in square kilometres				
	0-25 fm	25-40 fm	40-50 fm	50-100 fm	Total
Gujarat State (Lat. 23° N and 20° N)	65056	14079	16138	13488	1,08,761
Maharashtra-Goa (Lat. 19° N and 16° N)	29124	21161	40965	24720	1,15,970
T o t a l :	94180	35240	57103	38208	2,24,731

An analysis of the data pertaining to the intensity and distribution of sampling furnished in table XII and in figs. II to VII will show that the sampling intensity is probably adequate for the purpose of standing stock assessment in the depth zones 0-25 fm and 25-40 fm covering all the divisions except 23-68, 23-67, 21-72 and 22-72. It may also be seen that the intensity of survey in the depth zone 40-50 fm as far as the Maharashtra State is concerned can be regarded as fairly adequate for a preliminary assessment of standing stock. In the case of Gujarat state hardly any survey has been done in this depth zone. As far as the depth zone 50-100 fm is concerned no survey has been done in either regions.



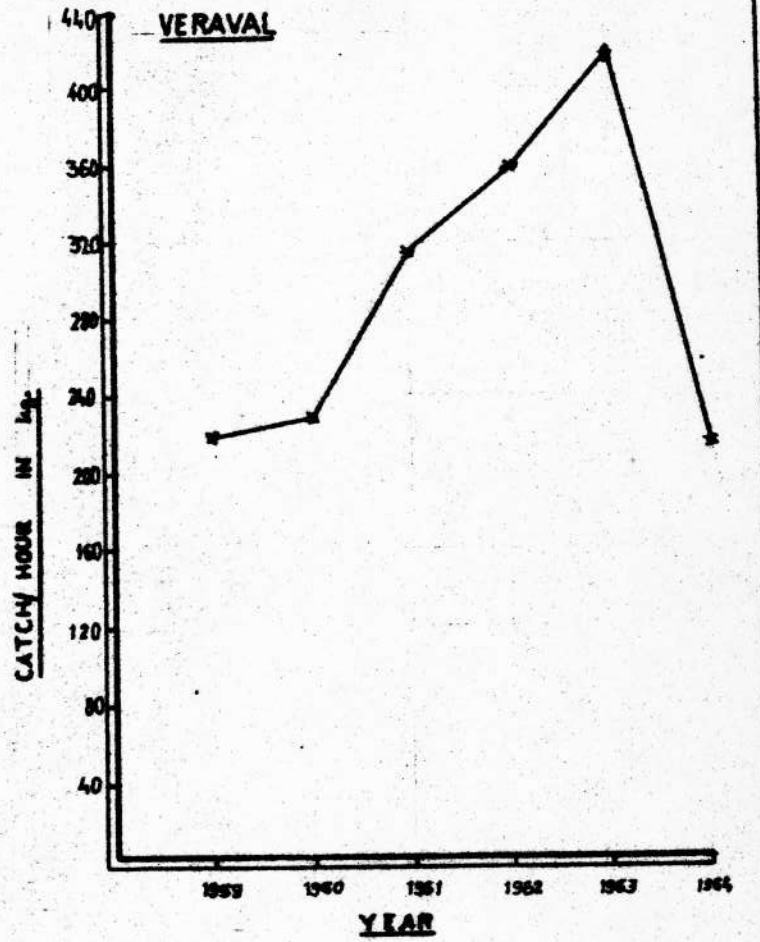


FIG-30 YEAR-WISE CATCH/ HOUR OF TRAWLING OF M.F.V. JHEENGA FROM BOMBAY AND VERAVAL ORIGION.

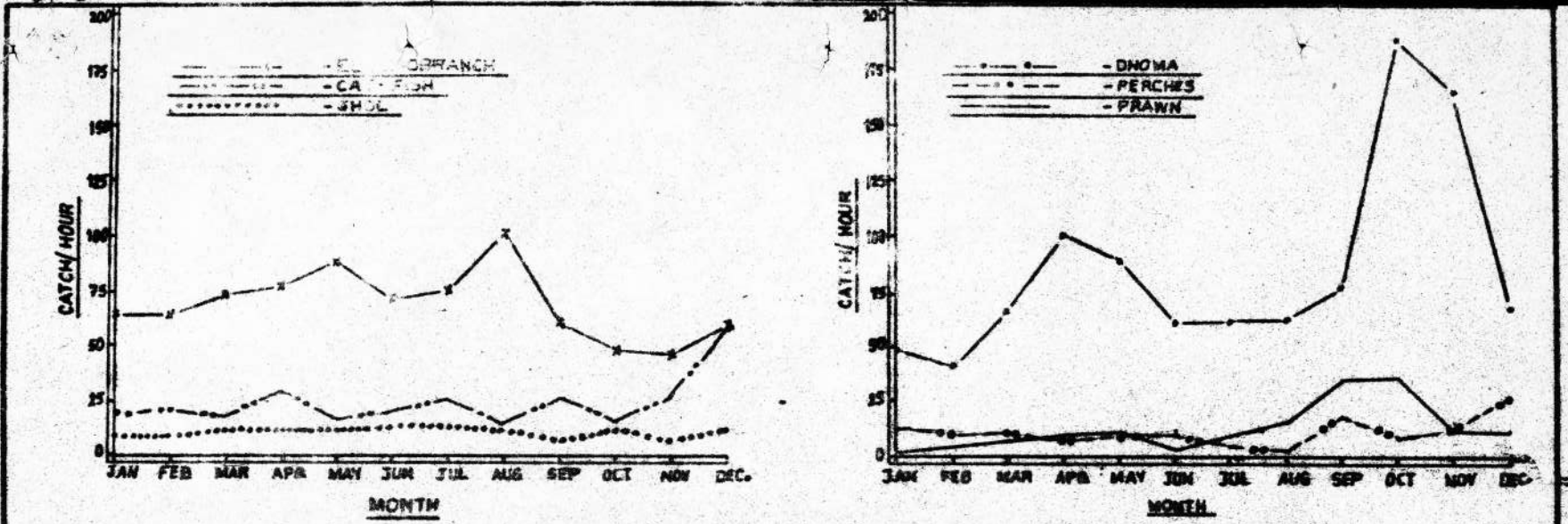


FIG. 31- MONTH-WISE CATCH PER UNIT EFFORT OF SIX IMPORTANT SPECIES OBTAINED BY JHEENGA.

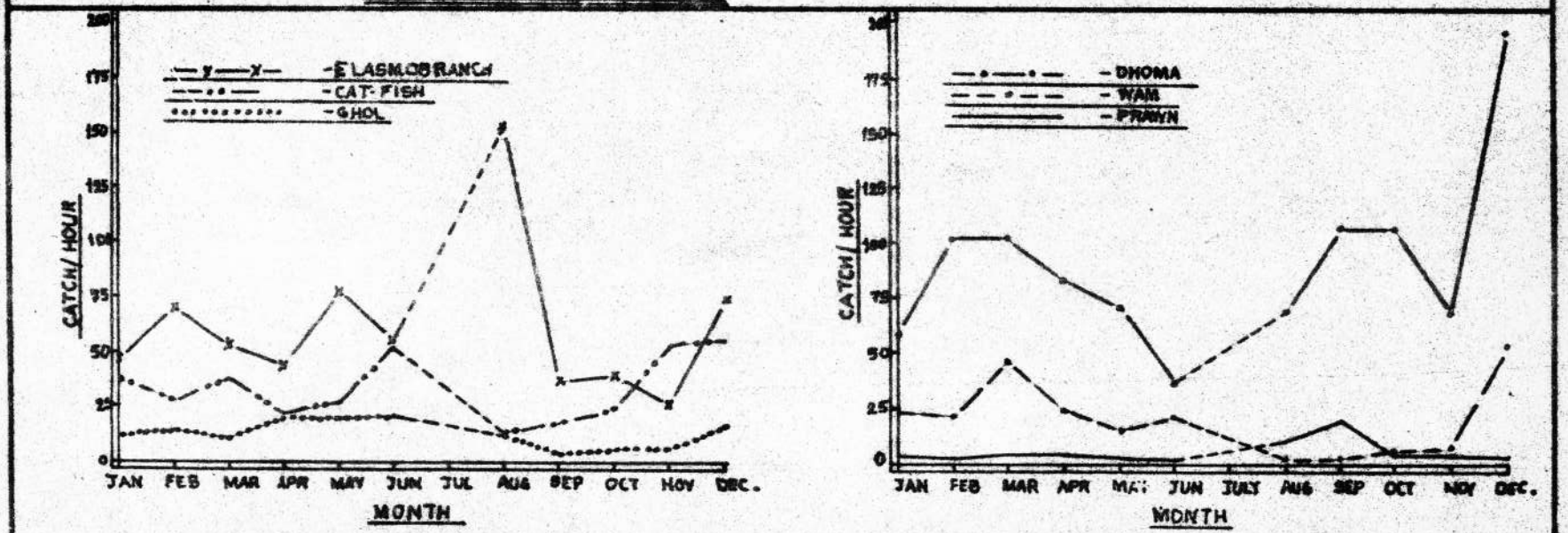


FIG. 32- MONTH-WISE CATCH PER UNIT EFFORT OF SIX IMPORTANT SPECIES OBTAINED BY KALYANI - III, IV AND V.

Division	Depth in Fathoms 0-25	25-40	40-50	Total
	Actual hours of trawling			
15-72	-	-	2	2
15-73	288	54	-	342
16-72	6	130	54	190
16-73	187	30	-	217
17-72	402	373	18	793
17-73	146	9	-	155
18-70	-	-	5	5
18-71	20	49	10	79
18-72	12507	599	18	13124
19-70	15	8	3	26
19-71	6514	1086	89	7689
19-72	3583	137	-	3720
20-69	87	14	-	101
20-70	4995	223	-	5218
20-71	3698	46	-	3744
20-72	223	-	-	223
21-68	14	-	-	14
21-69	541	57	-	598
21-70	133	-	-	133
22-67	21	-	-	21
22-68	683	8	-	691
22-69	36	-	-	36
22-70	85	-	-	85
23-67	7	-	-	7
23-68	10	-	-	10
Total:	34,201	2,823	199	37,223

Table.XII. Distribution of actual fishing effort in various depth zones.

The estimates of standing stock have been made mainly on the basis of the results of operation of the vessels, Jheenga, Meenabharathi and the three Kalyanis. While Jheenga and Meenabharathi have operated a 24 m fish trawl, Kalyani has operated a 30 m fish trawl. The area of coverage of these nets per hour of trawling at an average trawling speed of 2 knots have been worked out to 0.050 and 0.0683 sq.kms. respectively for the 24 m. and 30 m. net. Table-XIII gives the standing stock estimates for depth zones 0-25 fm and 25-40 fm separately for each divisions while table-XIV furnishes the preliminary standing stock assessment for the depth zone 40-50 fm covering the Maharashtra-Goa zone. A summary of the findings is furnished below:

	0-25 fm		25-40 fm		Total	
	Area in sq.kms	Standing stock in m.t.	Area in sq.kms	Standing stock in m.t.	Area in sq.kms	Standing stock in m.t
Gujarat State (22°N to 20°N)	44,723	1,79,499	11,332	44,005	56,055	2,23,504
Maharashtra-Goa (Lat.19°N to 15°N)	29,124	1,51,751	21,161	90,768	50,285	2,42,519
T O T A L:	73,847	3,31,250	32,493	1,34,773	1,06,340	4,66,023

It may be seen that the total standing stock of demersal fish upto 40 fm depth for the 56,000 sq.kms of area surveyed in the case of Gujarat is about 2,23,000 m.t. as against 2,42,000 m.t. in the case of about 50,000 sq.kms of area surveyed in the Maharashtra-Goa zone. From table-XIV it may also be seen that the preliminary assessment of the standing stock of demersal fish for the 40-50 fm depth zone in the case of Maharashtra is about 1,53,000 m.t. Thus the total standing stock of demersal fish for the Maharashtra-Goa zone upto 50 fm depth is nearly 0.4 million m.t.

In the case of Gujarat the standing stock of demersal fish per sq.km. works out to 3.99 m.t. as against 4.82 in the case of Maharashtra as far as the areas upto 40 fm depth is concerned.

The average for the entire area works out to 4.38 m.t. per sq.km. as against about 6.4 m.t. worked out for the Gulf of Thailand(Isarankura 1971).

Sub-division	Area sq.km.	Standing stock in m.t.
19-69	1,030	2,726
19-70	11,330	29,991
19-71	4,310	16,099
18-70	2,232	1,518
18-71	10,819	55,686
18-72	1,373	7,653
17-71	1,717	8,838
17-72	2,746	8,952
16-72	3,090	11,680
15-72	258	1,625
15-73	2,060	9,188
	40,965	1,53,956

Table-XIV. Standing stock estimate for 40-50 fm depth zone for Maharashtra and Goa area

Potential yield

The maximum sustainable yield from virgin and partially exploited demersal fisheries resources is generally computed at about 50 percent of the standing stock estimated. On this basis the potential yield of demersal fish from the region has been worked out separately for Gujarat and Maharashtra as shown below:

	Potential yield in 000 m.t			
	0-25 fm	25-40 fm	40-50 fm	Total
Gujarat	89	22	Not computed	111
Maharashtra-Goa	75	45	76	198
Grand Total:	164	67	76	309

The present level of exploitation of the demersal fisheries resources in the two states, estimated at about 40 percent of the average marine fish landing during 1972 and 73, would work out to about 33,000 m.t and 86,000 m.t. respectively for Gujarat and Maharashtra. From this it is evident that the present level of exploitation of the demersal fishery resources of Gujarat is less than one third of its estimated potential yield from the shelf area upto 40 fm depth. In the case of Maharashtra the present level exploitation seems to be less than 50 percent of the estimated potential yield of demersal fish from areas upto 50 fm depth.

ECONOMICS OF TRAWLING

From the data available, it may be seen, that the economics of operation of large sized trawlers to be operated in the area has to be based mainly on fish catch. The largest trawler operated in the region during exploratory fishing is Kalyani which has a break horse power of 300. This vessel during 1968-69, as already discussed elsewhere, operated extensively in the area and obtained an average catch of about 300 kgs. per hour of trawling. The vessel was operating fish trawls and the prawn content of the catch was only a little over one percent. It may also be noted, in this context, that the vessel was about 15 years old in 1969. In the light of the above observations it is reasonable to assume that a 23 m. stern trawler with about 350 B.H.P. can obtain an average catch of about 400 kgs. of fish and prawns per hour of trawling from the area. The vessel may have to operate shrimp trawls during October to December in the area between Goa and Bombay and during the remaining period, fish trawls in other areas. Under these circumstances, 10 percent of the aggregate catch of the vessel is likely to be prawn.

It is assumed that a vesselof this size will be operating for about 200 days in a year with an average daily actual fishing effort

of about 12 hours. The estimated landing and its break-up of different varieties of fish and prawn are furnished below:-

	Percentage	Estimated catch in m.t.
Large and medium Prawns ..	5	50
Small prawns ..	5	50
Quality fish ..	30	300
Others ..	60	600
T o t a l ..	100	1000

The approximate cost of operation of a Bombay based 23 m. vessel and the estimated earnings from it per annum are furnished below. The cost of the vessel is placed at Rs.25 lakhs.

	Rs. in 000	
Expenses		
Interest on capital @ 15% ..	375	
Depreciation @ 10% ..	250	
Insurance @ 2% ..	50	
Fuel and lubricant ..	220	
Maintenance ..	80	
Salary, incentive, etc. to the crew ..	150	
Ice, refrigerant, etc. ..	60	
Gear replacement ..	50	
Overheads ..	50	
Other expenses ..	50	
		1335
Revenue		
50 tons of large and medium prawn ..	400	
50 tons of small prawn ..	150	
300 tons of quality fish ..	900	
600 tons of low-quality fish ..	300	
		1750
Profit per vessel		415

CONCLUSIONS

(1) An attempt is made to give a clear picture of the present status of the exploratory demersal fisheries survey along the North west coast of India. Out of about 37,000 hours of actual fishing conducted in the area during the exploratory trawling, a little over 90 percent of the effort was expended in areas within 25 fm depth. Taking into consideration of the extent of the various geographical sub-divisions within the depth zone 0-25 fm and the fishing effort expended in them, it may be said, that this depth zone from Vengurla to Dwaraka i.e. from the lat. 16° N to 22° N has been surveyed fairly adequate. The geographical divisions lying between the lat. 22° N and 24° N i.e. Dwaraka-Kandla area and the areas south of lat. 16° N appear to be deficient in fishing effort to provide a clear picture.

The depth zone 25-40 fm lying between the lat. 16° N and 22° N i.e. from Vengurla to Dwaraka can also be regarded as partially surveyed. Only a fringe of the areas beyond 40 fm depth has so far been surveyed.

It is also interesting to note that the bulk of the total fishing effort was expended in areas closer to the bases of operation of the vessels, viz., Bombay and Veraval. This might have been partly due to limitations in the endurance of the vessels and partly due to lack of proper scheduling of fishing programme.

(2) A study of the trawl gear employed for the exploratory survey shows that mostly fish trawls were operated. Because of this, it is doubtful whether the volume of penaeid prawn taken during the exploratory fishing as detailed in this bulletin reflects the actual percentage of it in the demersal fish resources of the area investigated. It is, therefore desirable to conduct a special shrimp survey in the area

15) Joseph, K.M. 1971 - Crustacean Fisheries of the West coast of India. IOFC/DEV/71/21. F.A.O. of the U.N., Rome

16) Okonski S. and Sadowski S. 1959 - The headline, the foot rope and their influence on the vertical opening of the mouth of the trawl. Modern fishing gear of the world. Fishing News(Books) Ltd. England.

17) Panikkar, N.K. 1969 - Fishery resources of the Indian Ocean. Bull. of National Institute of Sciences, India. No.38 Part.II. 813-821.

18) Rao, K.V. 1969 - Distribution of pattern of the Major Exploited Marine Fishery resources of India. Bull. Cent. Mar. Fish. Res. Inst. No.6

APPENDIX. I.

Extract from Order No.F.3-39/51-FY. dt.21.12.1951 of Govt.of India, Ministry of Food & Agriculture, Department of Agriculture, New Delhi.

Resolution:

With a view to give a fillip to fisheries research and help develop the marine fishing industry in the country, the Central Government set up in 1946 a Pilot Deep Sea Fishing Station at Bombay, with the following OBJECTIVES:-

i) to carry out exploratory work in respect of:

a) the charting of fishing grounds;

b) the determination of the best fishing seasons;

c) the examination of the types of fish available;

d) the preservation and storage of fish at the Cold Storage Plant and Ice factory at Sassoon Docks;

e) the assessment of the suitability of different types of fishing vessels; and

f) the assessment of the suitability of different types of fishing gear and equipment, especially nets.

ii) to train personnel fishing operations on modern lines; and

iii) to test the commercial possibilities of deep sea fishing and make available the requisite data and information to those concerned, so as to help and guide the expansion of the fishing industry.

x x x x x x x x x x

Region	Division
Goa	15-72 & 15-73
Ratnagiri	16-72, 16-73, 17-72 & 17-73
Bombay	18-70, 18-71, 18-72, 19-71 & 19-72
Veraval	20-69, 20-70, 20-71 & 20-72
Porbandar	21-68, 21-69 & 21-70
Dwaraka	22-67, 22-68, 22-69 & 22-70

Appendix. II. Sub-divisions coming under various regions.