OBSERVATIONS ON THE TRAWL-FISHERIES OF THE BOMBAY AND SAURASHTRA WATERS, 1949-50 to 1954-55

By R. Jayaraman, G. Seshappa, K. H. Mohamed and S. V. Bapat

(*Offshore Fisheries Research Unit of the Central Marine Fisheries Research Station, Bombay*)

CONTENTS

I. INTRODUCTION

A HISTORICAL account of trawling experiments made in Indian waters before the Second World War is given by Chidambaram (1953). Of these, the Bombay waters were covered by S. T. *Premier* in the year 1900, S. T. *William Carrick* in 1921-22 and S. T. *Madras* in 1923. The results of working of S. T. *William Carrick* are available in the excellent report of Hefford (1949) while those of S. T. *Premier* and S. T. *Madras* have not been published. The outcome of these initial trials was not encouraging and it was felt that trawling might not prove economically successful in the areas worked. A

reliable picture was, however, obtained of the different species of fishes occurring in these waters during different seasons of a single year.

With the establishment of a pilot Deep Sea Fishing Station at Bombay by the Government of India in 1946, fishing experiments were renewed with considerable vigour. To start with, a trawler S. T. *Meena* and later on two cutters M. T. *Ashok* and M. T. *Pratap* were able to do some survey operations. The efforts of *Meena*, however, again proved a little discouraging though considerable scientific information was collected through these operations (CMFRS, 1954 and Kristensen, 1953). *Meena* was decommissioned in June 1949; the cutters *Ashok* and *Pratap* taking over subsequently. These vessels continued otter-trawling operations in the waters off Bombay and Saurashtra coasts and a Japanese trawler *Taiyo Maru No.* 17 joined the trawling fleet in November 1951. *Taiyo Maru No.* 17 concentrated on operations on a commercial scale, while the Government vessels continued to work on the basis of a pilot plan. The commercial venture proved a considerable success. Encouraged by this, two other trawlers of the West Coast Fisheries, Cochin, M. T. *Kanya Kumari* and M. T. *Sagar Kumari* also began operating in these waters, though owing to technical difficulties, they had to withdraw after some time. During the year 1953–54, the pilot Deep Sea Fishing Station tried a different fishing method using the trawlers together as one unit. This method, known as *bull trawling*, is one in which the Japanese are considered to be experts and the operation was carried out under their technical supervision.

In view of the intensification of the trawling operations, the necessity arose for the Government to keep track, not only of the fish stocks available in the different fishing grounds at different seasons of the year but also of the trends of possible changes from year to year in order that the fishery wealth may be fully assessed and the interest of the consumer and the industry alike safeguarded by such protective measures as may become necessary as a result of continued scientific research. The present paper gives a detailed analysis of the results of these recent operations up-to-date so that a complete picture of the main categories of the trawl-fisheries in our fishing grounds may be available for future reference. An attempt is also made in this paper to understand, in addition to the catch per unit of effort in the different regions, certain other features of the fishery as were evident from a close analysis of the catch data.

In assessing the fishery productivity of the various grounds from the results of operations, which have been either purely commercial in character, or, if exploratory, a not-rigorously planned one, one is confronted with

considerable difficulties in arriving at any definite conclusion. In a commercial enterprise, the fishing captain is likely to touch only those grounds which, in his opinion, or from his experience are likely to yield a large quantity of fish. The other areas will remain either untouched or very cursorily examined during the season and it will not, therefore, be possible to obtain any estimate of the productivity of those areas. There will thus be a great deal of unevenness of sampling of these grounds. Notwithstanding the limitations resulting from uneven sampling the present series of analysis do provide a fairly reliable picture of the trends of the different fisheries in the different regions from season to season and year to year. The information presented here, although essentially preliminary in character is nevertheless highly valuable.

II. Methods of Fishing by the Different Vessels and the Mode of Collection and Analysis of Data

The gear used by S. T. *Meena* was a Peter-Carey type of otter-trawl. The cutters, *Ashok* and *Pratap*, used midget-sized otter-trawls of the Hoover type till the end of the fishing season of 1952-53. Subsequently the bull-trawl was used and the two boats worked together as one unit in the operation. The Japanese trawler, *Taiyo Maru No.* 17 and the Cochin trawlers, *Kanyakumari* and *Sagara-kumari* were using Vigneron-Dahl type of otter-trawls. The detailed data of the last two vessels have, however, not been available to the authors so far.

Table I gives a comparative picture of the capacity of the cutters and *Taiyo Maru* No. 17 and also the dimensions of the gear employed by them; the bull-trawl is described separately in Table I.

Bull-trawl.—The bull-trawl is a two-boat trawl of Spanish origin largely used at present in Japan and Philippines and is essentially similar to the North Sea Pareja Trawl (Hickling, 1946 b) and the South American Paranzella (Rounsefell and Everhart, 1953). The Brazilian two-boat trawl (Conner, 1948) and the Danish Floating Trawl (Krason, 1949) are somewhat different, being designed to fish at surface and midwater. Bull-trawl was used in Indian waters by the cutters, *Ashok* and *Pratap* during the fishing season of 1953-54. In Bull-trawling, the net is dragged by the two vessels which keep a certain distance apart so as to spread the two wings of the net properly. Shooting and hauling are done by each of the boats alternately. The essential difference between this and the otter-trawl lies firstly in the absence of the otter boards, secondly in the enormous size of the net itself and thirdly to the presence of very long hunt ropes. The net used by cutters had the following dimensions.

Length of head rope	..	191·5′.
Length of foot rope	..	205·0′.
Size of cod-end mesh	..	2·5″.

TABLE I

	Boat Cutters (*Ashok* and *Pratap*)	*Taiyo Maru No.* 17
Length	83'-4"	126'-0"
Beam	20'-8"	24'-0"
Draft	8'-8"	11'-4"
Gross Tonnage	135·0 tons	277·3 tons
Horse power	240	550
Trawling speed	2·5–3·0 knots	3·0–3·5 knots

	Gear Hoover Midget trawl	V. D. trawl
Length of Head rope	64'	122'
Length of Foot rope	80'	162'
Length of Hunt rope	Nil (40 ft. legs on either side of wings)	55–65 fathoms
Size of cod-end mesh	3"	2·5"

Collection and analysis of data.—The collection of data was mainly done during the voyages themselves. The skippers of all the vessels were instructed to maintain a detailed log of the catches haul to haul, along with other environmental data such as depth, location of haul, nature of bottom, etc., in a standard form. The correctness of the entries was assured by periodical checking-up of the procedure by scientist observers who were actually on board during many of the voyages. The fish catches were examined by these observers both during the voyages and also at the time of landing of catches. All the authors of this paper have worked as observers by turns. The raw data were later processed in the laboratory and final tables of catch per hour according to areas, regions and depths derived. Considerable biological information was also collected on the various fisheries, but the same has been excluded from the scope of the present paper.

In assessing the weights of the fish landings, two methods had to be followed. In the case of the cutters, the actual weights of the different categories

caught during the entire voyage were available at the time of marketing of the catches. The trawlers' logs had recorded the haul-to-haul catches in terms of numbers and size categories of the different varieties of fishes. The landings by hauls and areas had to be derived by a process of 'breakdown' of the voyage totals of the weights of the different categories. This was done on the basis of average weights of the different size categories of fishes which were obtained by actual weighing of random specimens. In the case of *Taiyo Maru No.* 17, a different method has been followed. An advantage in this method has been that the trawler was using cases of known cubic capacity for packing the fish in the hold and the number of cases of each size category of each variety of fish was entered in the logs for every haul taken. According to the size of the case used in each voyage an average weight has been assessed per case of fish and this figure used in the calculation involved in each voyage. It was found that a fair degree of accuracy was obtained by using this method. Cases filled with different size categories and varieties of fish were weighed and we were satisfied with the dependability of the above method. In the case of large fishes such as sharks which could not be packed in cases, an approximate guessed weight has been used in the reckonings.

III. AREA OF OPERATION

As shown in Fig. 1, the whole fishable region in the Arabian Sea has been divided into several rectangular areas and numbered, the latitudes and longitudes being used to demarcate these areas. Each of these areas has a total extent of 600 square miles. Practically all the fishing has been done between Bombay and the Gulf of Cutch except for a few hauls in the south of Bombay (all vessels) and north of Cutch (*Taiyo Maru No.* 17). The areas fished by the different vessels fall into the following regions:

I.	Bombay Region	48, 43, 38, 32, 31, 30.
II.	Cambay Region	26, 25, 24, 20, 19, 18, 17, 11, 10.
III.	Veraval Region	4, 3, 2.
IV.	Porbundar Region	A, B, D, E, H.
V.	Dwarka Region	K, L, M, N.

For assessing the fishery productivity of the trawling grounds, these regions are of greater importance than the individual areas which are, however, necessary for a complete understanding of the fishery trends. Until the season of 1952–53, the cutters have been concentrating mostly in regions I and II. Subsequently however, practically all the vessels did the major part of their fishing in region V, which has emerged as one of the best fishing grounds of the Indian coast. The nature of the sea-bottom in all these grounds is muddy as mentioned by Hefford, (1949).
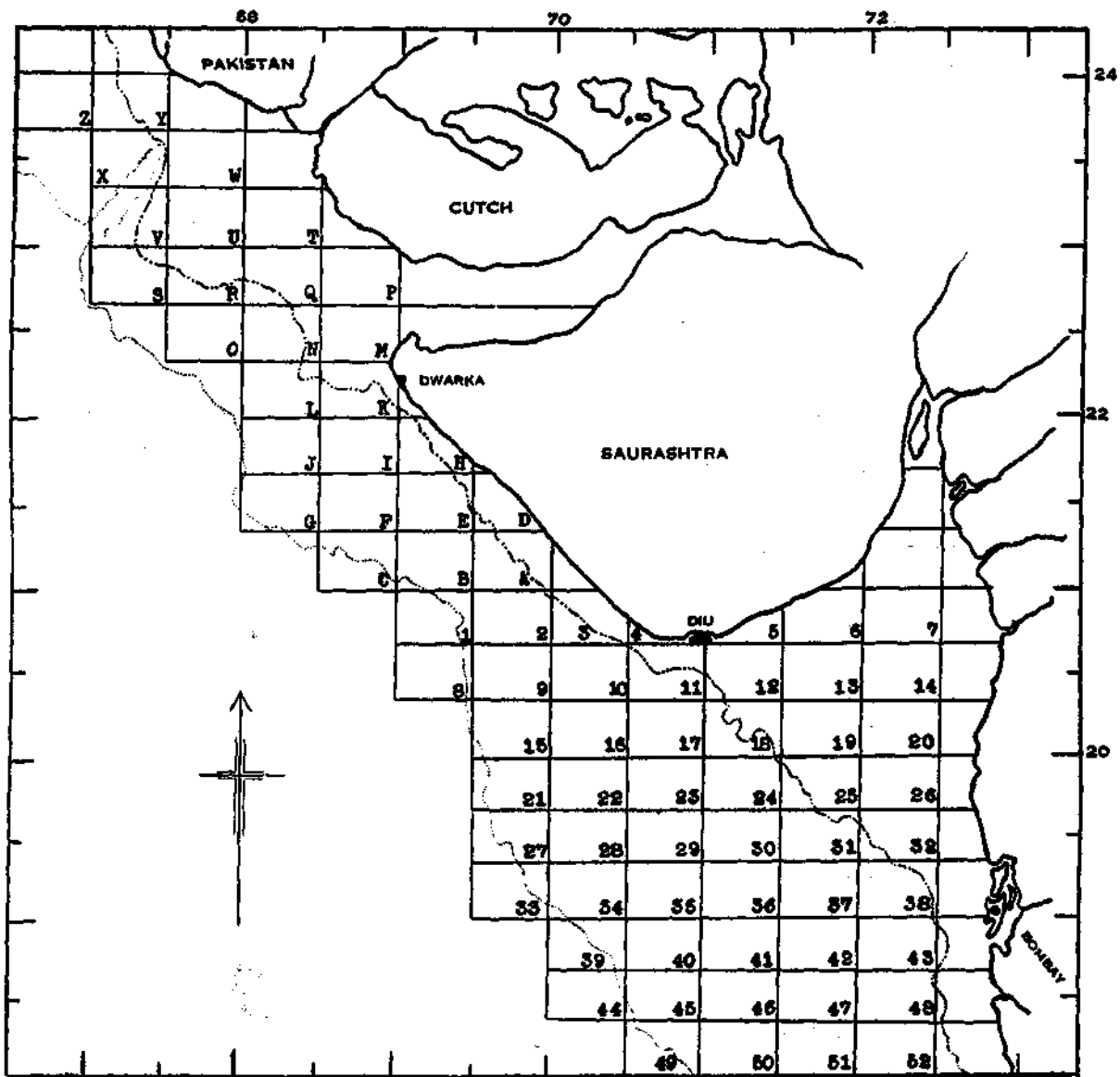
Fig. 1. Map of the Offshore Fishing grounds of the Bombay and Saurashtra coasts showing the different areas.

IV. Fishing Efforts and Total Yields

A brief account of the operations and results of trawling by S. T. *Meena* has been published already (CMFRS, 1954). This trawler was in commission for a total period of 18 months, from January 1948 and took in all 888 hauls. Out of these, only 12 hauls yielded more than 500 lb. of fish per

hour of trawling. Practically all the hauls were taken in regions I and II. Of the different areas, 11, 18, 19 and 24 (region II) yielded more than 200 lb. of fish per hour (leaving out a few other areas where only a few occasional hauls were taken). The total quantity caught by *Meena* for the whole period was 3,57,724 lb. for a trawling time 2,143 hours and 199·9 days absence from port. The average catch per hour was 171·5 lb.

The following table shows the total fishing effort and catches of the cutters, *Ashok* and *Pratap* for the years 1949–50 to 1952–53 (otter-trawling), 1953–54 and 1954–55 (bull-trawling), and *Taiyo Maru No.* 17 (1951–52 to 1953–54).

TABLE II

Years	No. of days out of port	Total fishing effort (hours)	Total catch (lb.)	Catch per hour (lb.) per boat
I. Cutters* (*Ashok and Pratap*), otter-trawling				
1949–50	242	3,196·3	4,00,896	125·4
1950–51	279	4,532·3	4,24,857	94·0
1951–52	249	4,155·7	4,73,760	114·0
1952–53	309	4,754·5	4,39,656	92·4
II. Cutters (*Ashok* and *Pratap*), bull-trawling				
1953–54	104	704·9	8,06,400	1,143·9
1954–55	77	300·0	4,68,730	1,562·4
III. *Taiyo Maru No.* 17, otter-trawling				
1951–52	219	2,760·0	21,54,600	782·1
1952–53	230	3,895·3	20,11,740	516·5
1953–54	251	3,859·2	21,21,760	548·5

* Figures represent totals of the two vessels *Ashok* and *Pratap*.

It is clear from this table that the yield of *Taiyo Maru* No. 17 per hour of trawling was much more than that of the cutters during their first 4 years of work, (the latter having worked, however, mainly in a different area). The

yield of the cutters with bull-trawling, on the other hand, showed a phenomenal increase not only as compared with their performance in previous years but also as compared with that of *Taiyo Maru No.* 17 which was doing otter-trawling more or less in the same grounds as the bull-trawlers. In comparing the productivity of the different regions and years, fishing efforts of less than 10 hours duration per month are to be considered as insufficient and are hence marked with asterisks, in the tables. During the otter-trawling operations of the years 1949–50 to 1952–53 by the cutters, effort was concentrated mainly in regions I and II (Table III *a*). In region III, fishing was done in 1949–50 only in October, in 1950–51 only in January and June, while in 1952–53 only 4·5 hours of fishing was done and that was in May. A slightly longer fishing was done in this region in 1951–52, namely, from January to May. In regions IV and V practically no fishing was done in 1949–50 and 1950–51, and of these two, region V was better fished in the years 1951–52 and 1952–53. But even here fishing was restricted to the period, February to May taking the two years together. Table III *b* shows that bull-trawling has been concentrated during both the years in regions IV and V, more so in the latter. In the other regions effort has been rather scattered and during most of the months, the monthly total effort has been less than 10 hours. Nevertheless, the effort in some of the months has been enough to give a reliable picture of the respective regions in those months. In region IV a better effort was put in during January to March in 1954–55 than in 1953–54. In region V, the effort has been more sustained in all the months during 1953–54 than in 1954–55. During both the years, however, the overall bull-trawling activity was restricted to only a part of the fishing season, namely, December to May while in the previous years, the activity had extended practically to the whole season. The histograms in Fig. 2 show the total trawling time of *Taiyo Maru No.* 17 during different months of the period 1951–52 to 1953–54 in the various regions. It is found that in all the 3 years, the maximum effort has been put in region V, region II coming next during the years 1952–53 and 1953–54. During several months in regions I, III and IV, the effort has been less than 10 hours. In general, it is seen that effort in regions I to III is more in the earlier part of the season and towards the end of the season than in the middle.

V. Abundance of the Chief Categories of Fishes in the Different Fishing Grounds

An essential part of any modern fishery research programme is the assessment of the catch per unit of fishing effort in the different fishing grounds

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TABLE III *a*

Showing the Fishing Effort (*Trawling hours*) *of the cutters* Ashok *and* Pratap *in various regions during different months* (1949–50 *to* 1952–53; *otter-trawling*)

Regions	Years	Months											
		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
I. Bombay	1949–50	91·0	..	56·5	57·4	40·0	114·2	426·4	117·2	119·1	180·8	..	..
	1950–51	..	108·1	50·1	29·0	62·3	89·3	98·0	28·0	91·0	..	..	..
	1951–52	..	..	32·9	59·2	214·2	118·2	430·3	259·8	52·8	..	..	..
	1952–53	..	170·7	22·9	94·9	222·8	70·4	289·8	95·6	90·0	123·5	..	..
II. Cambay	1949–50	61·0	130·8	340·8	356·5	223·2	157·8	..	320·8	297·0	62·2	..	..
	1950–51	..	362·7	532·2	550·2	475·2	464·4	474·1	276·0	609·0	144·3	..	..
	1951–52	..	..	460·4	604·1	318·4	296·1	272·0	221·7	91·5	190·2	..	..
	1952–53	..	375·8	537·6	526·8	141·6	302·5	484·7	341·6	330·5	49·6	..	..
III. Veraval	1949–50	..	35·3	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	24·3	..	..	..	..	24·0	..	..
	1951–52	..	..	..	..	46·5	9·5*	28·6	..	14·9	..	..	..
	1952–53	..	..	..	..	..	..	..	..	4·5*	..	..	..
IV. Porbundar	1949–50	..	7·7*	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	101·8	..	6·2*	..	18·5	..	..	..
	1952–53	..	..	..	..	..	..	..	..	39·3	..	..	..
V. Dwarka	1949–50	..	..	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	..	..	45·0	140·0	..	..	..	..
	1952–53	..	..	..	..	..	127·4	..	97·0	215·3	..	..	..

TABLE III *b*

Showing the Fishing Effort (*Trawling hours*) *of the cutters* Ashok *and* Pratap
in the various regions during different months (1953–54 *and* 1954–55;
bull-trawling)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Bombay ..	1953–54	7·8*	14·3	1·2*	37·9	..	33·9
	1954–55	..	1·5*	..	..	..	..
II. Cambay ··	1953–54	3·3*	18·9	..	5·4*	..	14·7
	1954–55	..	26·0	1·4*	4·4*	3·2*	3·0*
III. Veraval ..	1953–54	1·5*	13·8	..	5·0*	..	12·5
	1954–55	..	12·4	..	11·0	15·9	1·5*
IV. Porbundar	1953–54	..	6·7*	..	9·7	21·4	13·2
	1954–55	..	11·8	65·6	32·6	30·8	..
V. Dwarka ..	1953–54	52·8	91·9	103·4	95·4	80·2	60·0
	1954–55	..	31·1	29·4	13·5	4·9*	..

and the following up of the changes in the same from season to season and
year to year. The catch per unit effort is a measure of the available stocks
in the sea and it is this parameter which gives the most important clue for
developing a suitable conservation and management policy for any fishery
(Ricker, 1940 and Rounsefell and Everhart, 1953). It is this same criterion
(and not the total catch) that is valid in comparing the performance of differ-
ent vessels also (Hickling, 1946 *b*). In view of the fact that trawling opera-
tions have been in progress for a few years in the fishing grounds referred
to in this paper it would be useful to follow the trends of productivity in
the different regions as seen by the catch rates of the different trawlers. The
trawling operations during the 6 years from 1949–50 to 1954–55 have been
grouped into three categories mentioned under Section II. They are: (i)
Otter-trawling by the Cutters, using midget-sized Hoover trawl, between the
years, 1949–50 and 1952–53; (ii) Otter-trawling by *Taiyo Maru No.* 17
using V. D. trawl between the years, 1951–52 and 1953–54; and (iii) Bull
trawling by the Cutters during 1953–54 and 1954–55. Tables V to IX show
the catch-per-hour data relating to all the trawlers and all the years. Figs.
8 to 13 show the relative abundance of the different categories of fishes in
the different regions during the years 1951–52 to 1953–54.
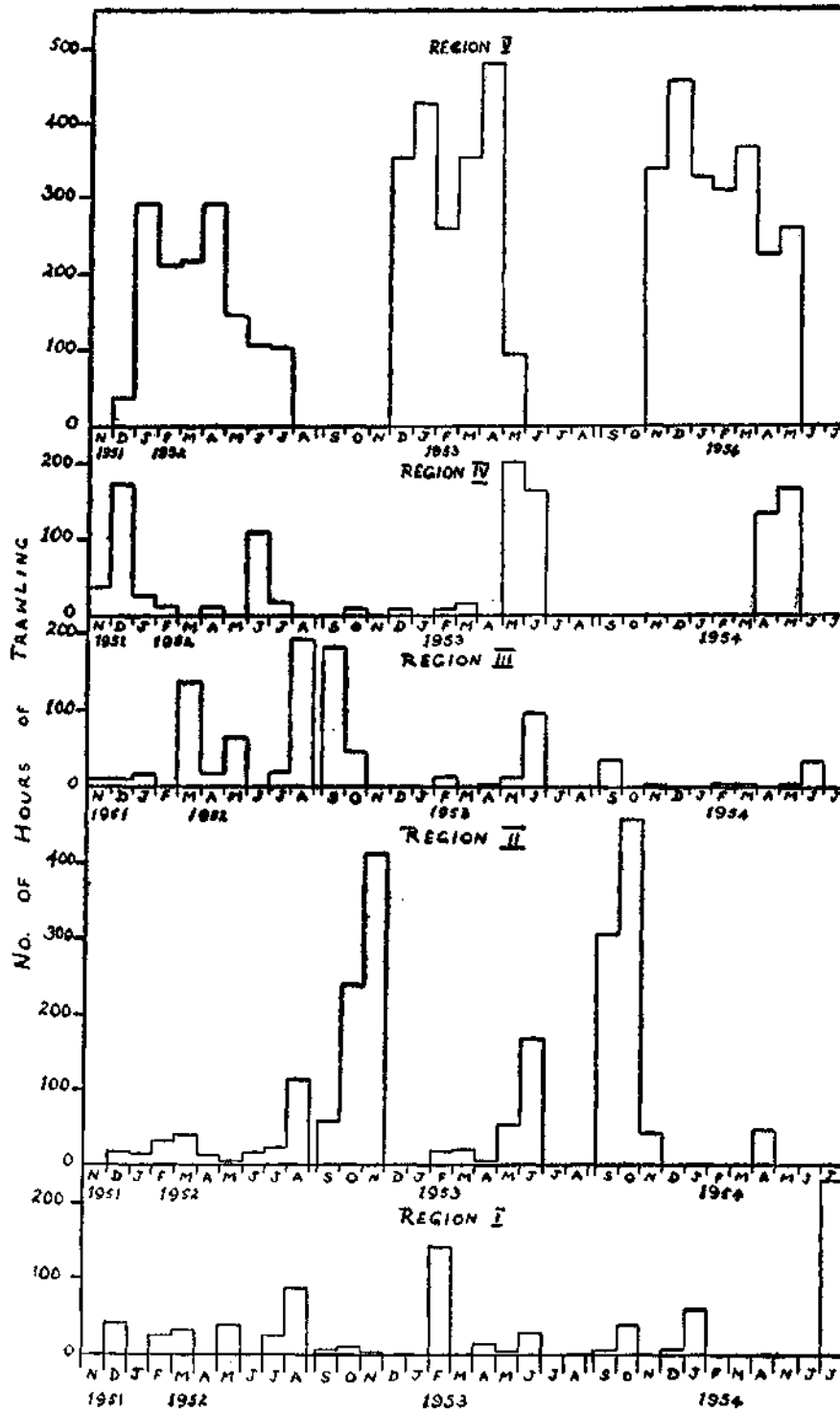
FIG. 2. Monthly totals of fishing effort of *Taiyo Maru No. 17* in the various regions during the years 1951-52 to 1953-54.

FIG. 3. Percentage composition of the monthly catches taken by *Taiyo Maru No.* 17 during the years 1951–52 to 1953–54—REGION I.

Fig. 4. Percentage composition of the monthly catches taken by *Taiyo Maru No.* 17 during the years 1951-52 to 1953-54—REGION II.

Fig. 5. Percentage composition of the monthly catches taken by *Taiyo Maru No.* 17 during the years 1951-52 to 1953-54—REGION III.
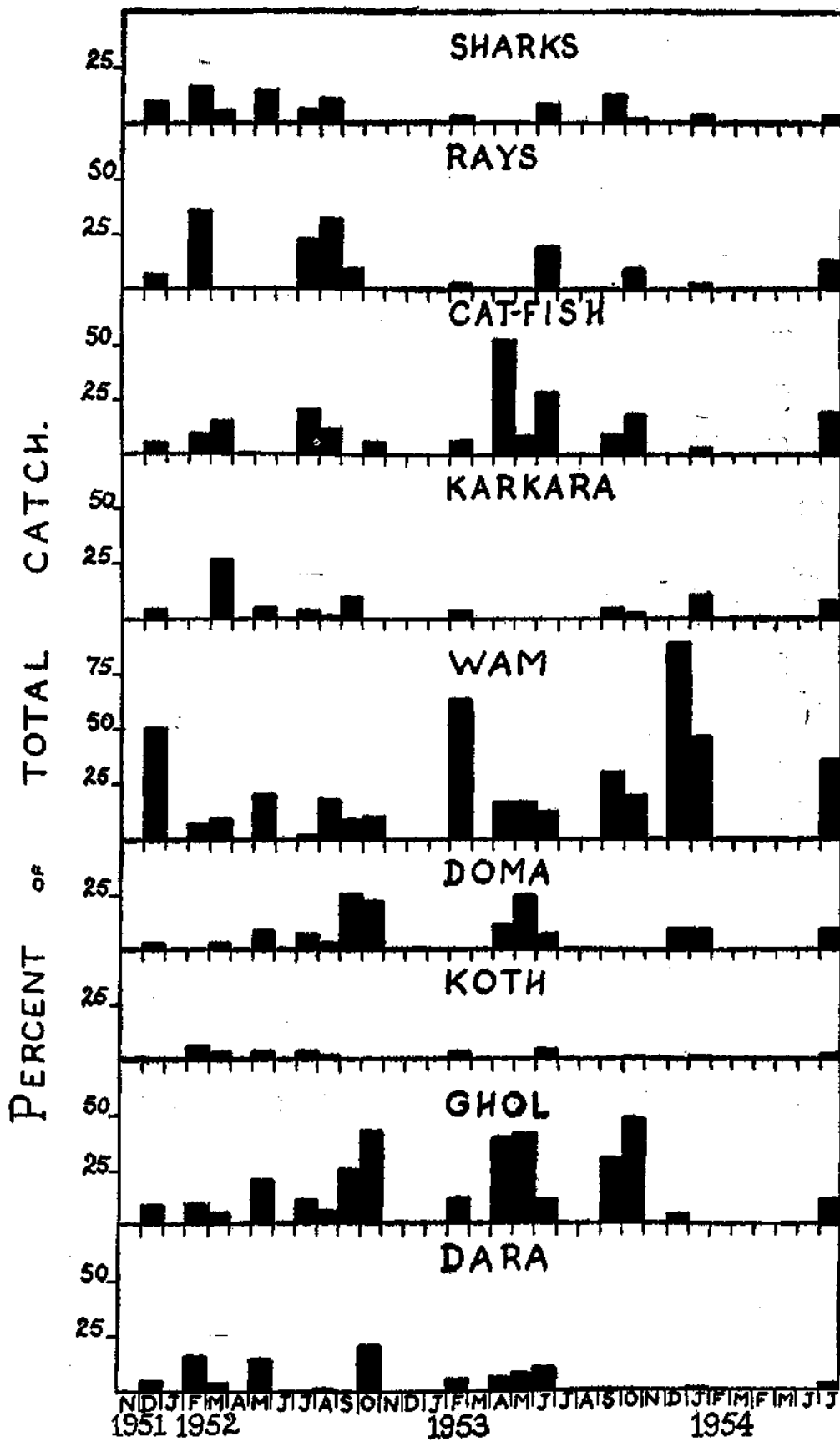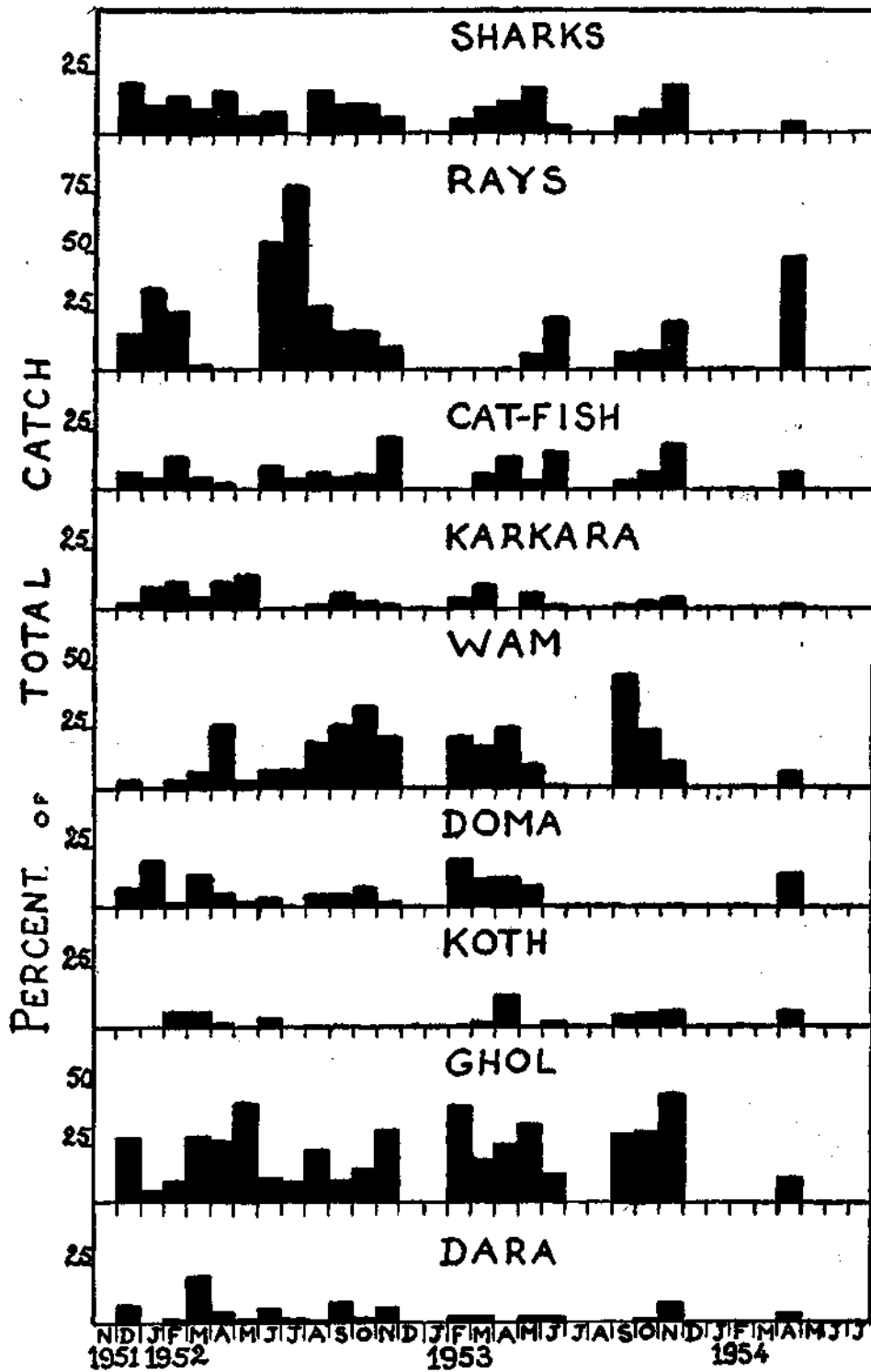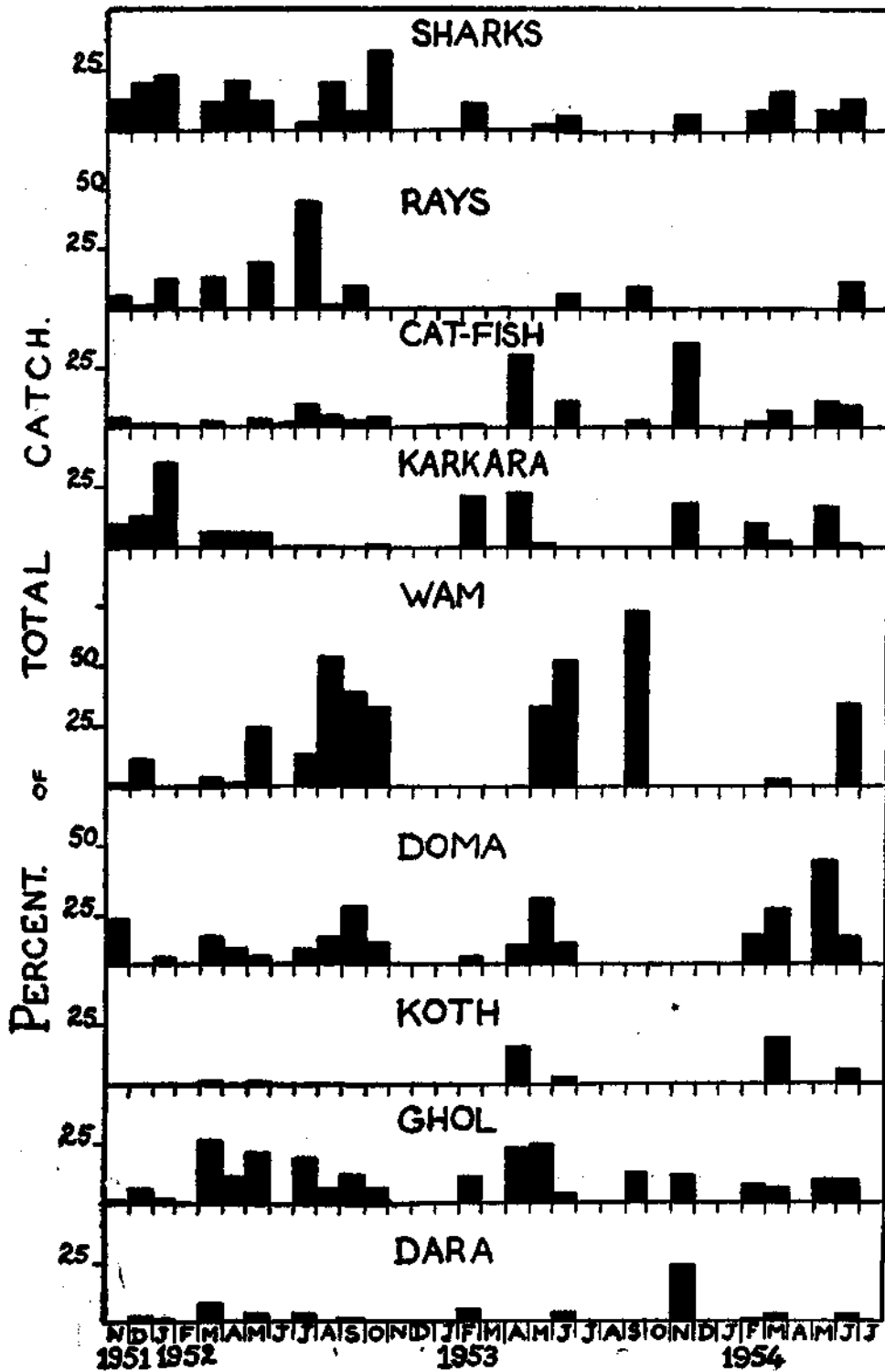
Fig. 6. Percentage composition of the monthly catches taken by *Taiyo Maru No. 17* during the years 1951-52 to 1953-54—Region IV.
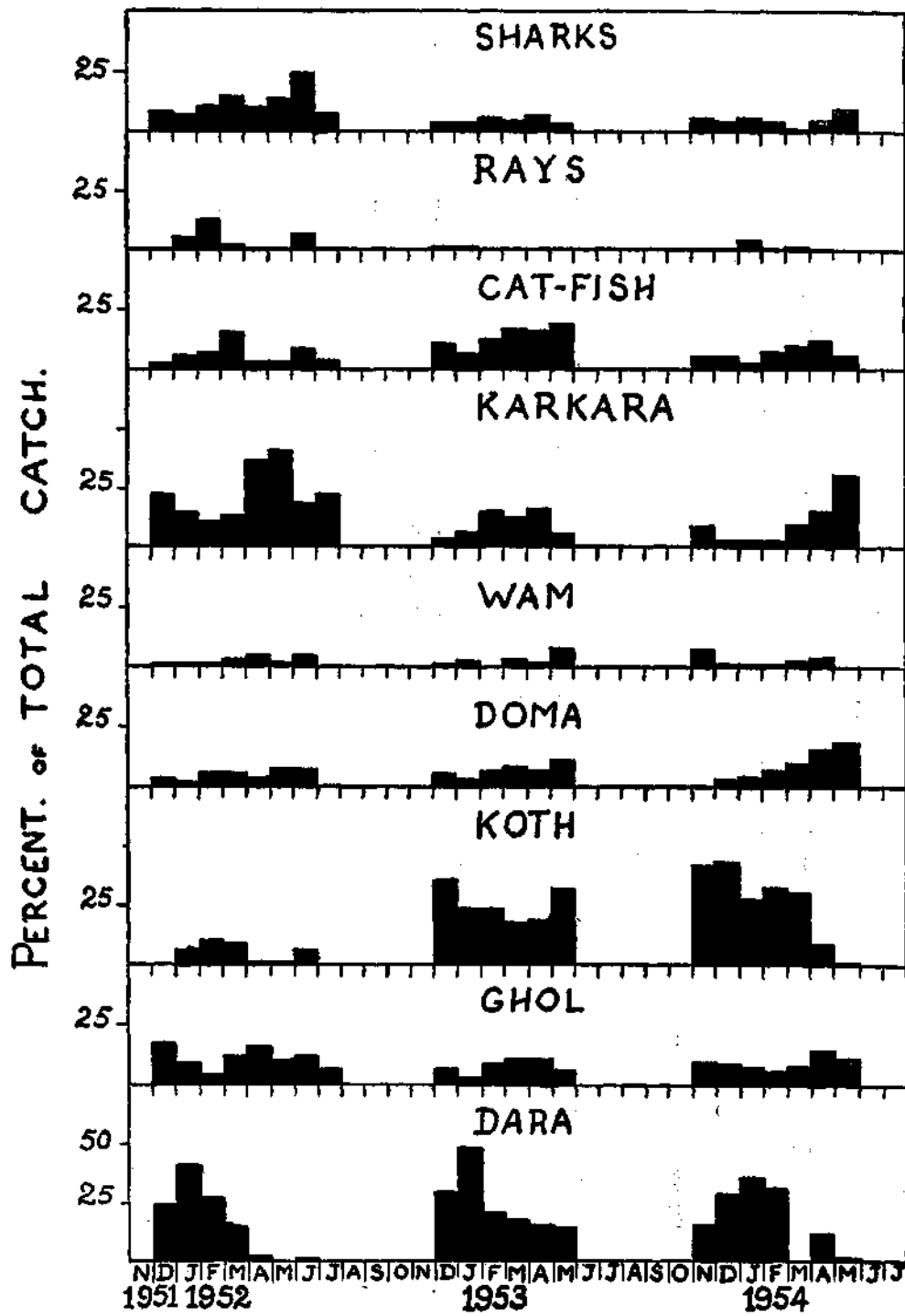
Fig. 7.   Percentage composition of the monthly catches taken by *Taiyo Maru No.* 17 during the years 1951–52 to 1953–54—REGION V.

TABLE IV a

Showing the catch in lb. of All Fish *per trawling hour by the cutters from various regions during different months* (1949–50 *to* 1952–53; *otter-trawling*)

Regions	Years	Months											
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
I. Bombay	1949–50	93·1	..	295·5	107·5	138·7	107·7	98·2	46·6	89·6	79·6	..	..
	1950–51	..	47·6	128·4	49·2	43·4	81·3	35·0	79·2	55·7	..	..	..
	1951–52	..	..	45·6	151·8	112·9	70·5	145·5	95·0	31·0	..	..	..
	1952–53	..	70·1	34·6	60·7	71·3	55·1	95·3	76·0	134·7	63·2	..	..
II. Cambay	1949–50	88·9	203·0	169·9	166·6	112·8	151·2	..	87·1	106·8	56·9	..	..
	1950–51	..	71·6	125·8	125·4	121·2	103·4	68·4	76·4	86·1	79·5	..	..
	1951–52	..	..	153·6	142·1	100·7	101·8	92·6	94·1	81·6	70·6	..	..
	1952–53	..	85·0	70·9	76·0	46·5	146·2	116·1	92·6	96·1	82·5	..	..
III. Veraval	1949–50	..	185·0	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	44·7	..	..	..	..	105·2	..	..
	1951–52	..	..	..	..	64·8	75·0*	61·8	..	22·9	..	..	..
	1952–53	..	..	..	..	..	..	..	..	24·9*	..	..	..
IV. Porbundar	1949–50	..	25·5*	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	103·0	..	9·5*	..	34·3	..	..	..
	1952–53	..	..	..	..	..	..	..	..	80·6	..	..	..
V. Dwarka	1949–50	..	..	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	..	..	288·8	153·7	..	..	..	..
	1952–53	..	..	..	..	..	131·0	..	177·0	113·3	..	..	..

TABLE IV *b*

Showing the catch in lb. of All Fish *per trawling hour by cutters from various regions during different months* (1953-54 *and* 1954-55; *bull-trawling*)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Bombay	1953-54	836·8*	309·4	1,137·1*	695·4	..	535·6
	1954-55	..	80·7*	..	..	..	..
II. Cambay	1953-54	655·8*	225·1	..	311·4*	..	320·1
	1954-55	..	1,359·2	545·7*	312·5*	2,478·8	1,120·0*
III. Veraval	1953-54	785·3*	663·8	..	1,213·0*	..	568·2
	1954-55	..	1,388·4	..	1,423·3	1,280·2	2,246·7*
IV. Porbandar	1953-54	..	1,651·1*	..	896·6*	1,009·2	605·4
	1954-55	..	742·0	1,776·0	1,561·6	1,084·8	..
V. Dwarka ..	1953-54	958·8	1,335·1	1,332·4	1,695·5	1,241·8	1,526·5
	1954-55	..	1,327·1	3,059·2	1,314·4	914·3*	..

The study of the catch rate trends of the cutters *Ashok* and *Pratap* during the years 1949-50 to 1952-53 indicates that the yield was rather low throughout by this method of fishing; the mean annual catch of 'all fish' ranging from 92·4–125·4 lb. per hour of fishing in all the regions considered together. In regions I and II where the bulk of the trawling was done, the ranges are 60·6–113·2 and 92·2–134·2 lb. respectively per hour. The highest catch rate of 186·8 lb. per hour was obtained from region V in 1951-52. Operations in region V by these boats for the entire period was rather limited, but still there were sufficient indications that these grounds were richer than the others. While certain trends can be made out regarding the regional, seasonal and year-to-year changes in the different fisheries of the above four years from the tables, a detailed discussion of the same is considered unnecessary for the present purpose in view of the fact that firstly, the yields have been rather low throughout and secondly, the mode of fishing has changed in the subsequent years making the earlier figures not comparable with the later ones. The chief annual trends noticeable may, however, be mentioned here. The *dara* figures show that the best yields have been obtained from region II in the first two years, the lowest and the highest rates being 22·3 and 33·2 lb. per hour respectively, while

TABLE V *a*

Showing the catch in lb. of Dara *per trawling hour by the cutters from various regions during different months* (1949–50 *to* 1952–53; *otter-trawling*)

Regions	Years	Months											
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
I. Bombay ..	1949–50	0	..	44·3	40·8	47·0	22·7	19·7	9·4	12·8	11·6	..	..
	1950–51	..	7·4	19·3	20·1	7·3	24·0	14·6	8·0	5·8	..	..	..
	1951–52	..	..	0	27·2	12·9	15·4	4·3	1·0	0·9	..	..	..
	1952–53	..	0·1	0	5·8	5·1	2·8	9·2	6·5	10·3	8·6	..	..
II. Cambay ..	1949–50	12·7	29·1	36·9	65·8	46·1	33·1	..	16·0	10·4	4·9	..	..
	1950–51	..	12·0	34·7	32·1	22·5	26·2	15·7	15·0	16·3	14·6	..	..
	1951–52	..	..	8·0	47·6	29·2	13·7	10·8	10·4	7·9	21·8	..	..
	1952–53	..	6·2	6·8	9·4	8·5	10·2	11·5	5·8	15·9	11·8	..	..
III. Veraval ..	1949–50	..	28·8	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	1·2	..	..	..	..	19·3	..	..
	1951–52	..	..	..	..	1·9	3*	1·6	..	0	..	..	..
	1952–53	..	..	..	..	..	..	..	..	6·7*	..	..	..
IV. Porbundar ..	1949–50	..	0*	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	1·4	..	0*	..	0	..	..	..
	1952–53	..	..	..	..	..	..	..	..	0	..	..	..
V. Dwarka ..	1949–50	..	..	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	..	..	158·2	34·2	..	..	..	..
	1952–53	..	..	..	..	..	34·8	..	59·9	48·6	..	..	-

TABLE V *b*

Showing the catch in lb. of Dara *per trawling hour from various regions during different months* (1953–54 *and* 1954–55; *bull-trawling*)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Pombay	1953-54	47·0*	9·4	0*	11·1	..	2·0
	1954-55	..	0*	..	..	..	..
II. Cambay	1953-54	4·2*	13·5	..	14·8*	..	11·0
	1954-55	..	3·2	0*	9·3*	16·3*	28·0*
III. Veraval	1953-54	0*	0	..	0*	..	1·8
	1954-55	..	0·8	..	8·3	3·3	246·7*
IV. Porbundar	1953-54	..	1·5*	..	0$	2·8	8·4
	1954-55	..	0	1·2	15·7	5·9	..
V. Dwarka	1953-54	398·3	706·8	755·1	214·2	243·6	67·4
	1954-55	..	338·1	1,371·1	233·4	455·9*	..

in the last two years, region V (which has not been worked in the first 2 years) has been found to be the richest, yielding between 47·0 and 64·4 lb. per hour. The yields of region II are lower. *Ghol* occurred in varying quantities in all the regions. In regions I and II the catch rates were higher in 1949–50 and 1951–52 than in 1950–51 and 1952–53. The figures for perches show very poor yields throughout, the highest figure for all the 4 years being 32·4 lb. per hour (region I, 1950–51). In the case of *wam* also, the catch rates have been rather low, the overall catch per hour being below 20 lb. except in 1951–52 when 59·4 lb. per hour was obtained in region I. The first two years were poorer than the next two. Despite the low catches of the different categories mentioned above, the seasonal trends of different fisheries in the regions exploited in these years are found to be more or less similar to those revealed in the subsequent years by the operation of the other trawlers.

" All fish "

Taiyo Maru No. 17—*Otter-trawling* (1951–52 to 1953–54).—A good picture of the catch trends, seasonal as well as regional, is presented by the data of *Taiyo Maru No.* 17 for the 3 years of her operation in Indian waters.

TABLE VI a

Showing the catch in lb. of Ghol *per trawling hour by cutters from various regions during different months* (1949-50 *to* 1952-53; *otter-trawling*)

Regions	Years	Months											
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
I. Bombay	1949–50	37·7	..	77·8	20·0	38·5	33·9	38·0	16·9	24·9	16·5	..	..
	1950–51	..	8·8	25·0	3·3	13·4	19·4	4·3	27·8	14·1	..	..	..
	1951–52	..	..	4·7	19·7	21·3	25·4	35·7	20·9	8·8	..	..	..
	1952–53	..	6·6	8·0	17·5	23·8	21·1	28·1	11·6	12·4	3·6	..	..
II. Cambay	1949–50	34·4	39·1	42·3	41·9	26·9	49·3	..	24·3	26·7	5·1	..	..
	1950–51	..	21·1	29·4	27·6	56·9	40·0	28·1	25·8	19·8	25·3	..	..
	1951–52	..	..	43·1	28·8	30·3	42·2	42·8	39·1	32·8	37·1	..	..
	1952–53	..	10·3	13·2	15·8	7·4	48·1	36·0	19·0	12·2	5·3	..	..
III. Veraval	1949–50	..	8·3	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	6·9	..	..	..	..	32·7	..	..
	1951–52	..	..	..	..	13·9	4·0*	27·4	..	1·1	..	..	..
	1952–53	..	..	..	..	..	..	..	..	0*	..	..	..
IV. Porbundar	1949–50	..	0	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	35·7	..	0*	..	0·9	..	..	..
	1952–53	..	..	..	..	..	..	..	..	26·0	..	..	..
V. Dwarka	1949–50	..	..	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	..	..	42·2	44·9	..	..	..	..
	1952–53	..	..	..	..	..	29·9	..	31·4	13·3	..	..	..

TABLE VI *b*

Showing the catch in lb. of Ghol *per trawling hour from various regions during different months* (1953–54 *and* 1954–55; *bull-trawling*)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Bombay	1953–54	109·0*	42·9	0*	55·4	..	23·0
	1954–55	..	0*	..	..	..	..
II. Cambay	1953–54	47·3*	7·0	..	46·0*	..	65·6
	1954–55	..	29·1	100·0*	144·3*	508·8*	102·7*
III. Veraval	1953–54	0*	72·2	..	104·6*	..	116·2
	1954–55	..	144·6	..	244·0	176·7	21·3*
IV. Porbundar	1953–54	..	169·4*	..	149·5*	280·4	80·6
	1954–55	..	59·5	111·0	227·9	130·1	..
V. Dwarka	1953–54	56·8	44·3	51·3	201·0	208·6	143·5
	1954–55	..	57·8	93·9	158·5	48·9*	..

The data from region I obtained in all the 3 years show that its overall productivity is somewhat less than that of the other regions as revealed by the relatively lower catch rates. The yields, in general, are much higher than in the case of the otter-trawling operations by the cutters. The mean annual ranges of values for catch per hour are (in lb.) 254·4–305·6 for region I, 395·9–563·9 for region II, 490·8–840·0 for region III, 485·1–794·7 for region IV and 590·8–883·3 lb. for region V. On a detailed examination of the values for all the 3 years in all the five regions, it is observed that the highest yields per unit of effort have been obtained in 1951–52 from all the regions and the lowest in the year following, namely 1952–53, from the first four regions, the values for 1953–54 falling in between. In the case of region V, however, the lowest catch per hour has been obtained in the third year; the figure for 1952–53 although higher, not appreciably differing from that for 1953–54.

A comparative picture of the catch rates of all fish by *Taiyo Maru No.* 17 in the different regions is shown in Fig. 8. The mean monthly ranges of the yields show certain interesting features. In region I, in most of the months, the catch per hour falls within the 200–300 lb. range; the extreme

TABLE VII a

Showing the catch in lb. of Wam (Eel) per trawling hour by cutters from various regions during different months (1949–50 to 1952–53; otter-trawling)

Regions	Years	Months											
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
I. Bombay	1949–50	41·9	..	0	27·3	4·2	5·8	6·1	4·7	6·3	2·8	..	..
	1950–51	..	6·6	5·9	4·3	3·2	9·9	4·8	29·6	13·0	..	..	..
	1951–52	..	..	10·9	18·5	58·8	7·3	89·6	58·3	12·5	..	..	..
	1952–53	..	9·0	11·7	14·9	22·1	15·9	34·9	11·6	10·2	6·6	..	..
II. Cambay	1949–50	16·6	49·2	12·9	13·6	1·5	3·6	..	7·8	14·5	1·2	..	..
	1950–51	..	3·6	4·9	13·0	3·3	3·6	5·4	16·6	18·8	6·4	..	..
	1951–52	..	..	35·8	11·5	6·8	9·8	13·8	11·8	11·3	1·7	..	..
	1952–53	..	41·9	23·8	24·2	7·6	4·5	5·5	4·0	5·4	5·5	..	..
III. Veraval	1949–50	..	14·5	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	0	..	..	..	..	7·2	..	..
	1951–52	..	..	..	..	5·7	0*	7·4	..	6·4	..	..	..
	1952–53	..	..	..	..	..	..	..	..	0*	..	..	..
IV. Porbandar	1949–50	..	0*	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	2·1	..	0*	..	2·1	..	..	..
	1952–53	..	..	..	..	..	..	..	..	1·2	..	..	..
V. Dwarka	1949–50	..	..	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	..	..	5·5	1·1	..	..	..	..
	1952–53	..	..	..	..	..	4·8	..	3·5	3·3	..	..	..

values, however, being 105·1 and 432·7 lb. per hour. The variations in region II are, on the other hand, much wider, the range being 143·8–934·7 lb. per hour. There is one instance where a yield of 1,766·7 lb. per hour has been obtained, but in this case the total effort was less than 10 hours. In most of the months, the average yield per hour of operation is more than 300 lb. in this region. In region III, the effort has been more sustained in the first two years, the average catch per hour of trawling ranging between 256·0 and 1,253·3 lb. The catch per hour in this region as well as in region II is much higher in the beginning of the season and towards the end of the season than in the middle. The results from region IV are comparable to those of region III, the catch rates varying between 293·3 and 1,357·4 lb. when the fishing effort was of sufficient magnitude. Owing to the rather scattered survey of this region no regular trends could be indicated. In the first year there have been good yields from November to January and also in June. In the second year, the fishing was only in March, May and June while in the last year this region has been visited only in May and June. The catch per hour in May of 1953–54 season was nearly double of that in 1952–53 season. On the other hand in the month of June in both the years the catch rates were identical.

TABLE VII *b*

Showing the catch in lb. of Wam *(Eel) per trawling hour by cutters from various regions during different months* (1953–54 *and* 1954–55; *bull-trawling*)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Bombay	1953-54	448·6*	95·2	1,032·3*	416·5	..	40·8
	1954-55	..	0*	..	..	..	..
II. Cambay	1953-54	290·3*	68·5	..	94·8*	..	92·3
	1954-55	·.·	65·8	28·6*	10·0*	387·5*	326·7*
III. Veraval	1953-54	30·0*	21·0	..	146·0*	..	130·0
	1954-55	..	40·9	..	55·0	67·9	326·7*
IV. Porbundar	1953-54	..	71·8*	..	30·7*	87·3	84·4
	1954-55	..	19·9	85·9	41·8	160·3	..
V. Dwarka	1953-54	16·4	16·6	18·1	95·4	128·7	59·5
	1954-55	..	20·6	46·5	51·3	53·1*	..

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TABLE VIII a

Showing the catch in lb. of Perches per trawling hour by cutters from various regions during different months (1949-50 to 1952-53; otter-trawling)

Regions	Years	Months											
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
I. Bombay	1949–50	0	..	1·7	10·2	0	1·0	3·0	0·4	0·7	0·3	..	..
	1950–51	..	7·6	32·4	0·9	1·4	0·3	0·1	0	0·5	..	..	..
	1951–52	..	..	2·1	7·6	3·1	0·5	2·9	2·7	1·9	..	..	..
	1952–53	..	5·7	2·8	2·7	1·1	1·5	0·2	1·1	0	0·2	..	..
II. Cambay	1949–50	0	18·8	17·3	7·8	0·4	0·7	..	0·7	1·3	0	..	..
	1950–51	..	6·1	10·8	16·2	0·7	0·6	0·3	0·1	0·6	1·0	..	..
	1951–52	..	..	13·8	7·8	0·5	0·2	0·6	0·5	3·0	0	..	..
	1952–53	..	2·6	4·0	8·0	1·6	0	0	0·2	0	0·1	..	.
III. Veraval	1949–50	..	19·0	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	0·7	..	..	..	..	0	..	..
	1951–52	..	..	..	..	4·4	0·4*	0·7*	..	1·2	..	..	..
	1952–53	..	..	..	..	..	..	..	..	0*	..	..	..
IV. Porbundar	1949–50	..	0*	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951–52	..	..	..	..	11·4	..	0*	..	1·0	..	..	..
	1952–53	..	..	..	..	..	..	..	..	3·0	..	..	..
V. Dwarka	1949–50	..	..	..	..	..	..	..	..	..	..	..	..
	1950–51	..	..	..	..	..	..	..	..	..	..	..	..
	1951 52	..	..	..	..	..	..	16·7	6·6	..	..	..	..
	1952–53	..	..	..	..	..	29·6	..	16·4	7·5	..	..	..

TABLE VIII *b*

Showing the catch in lb. of Perches *per trawling hour by cutters from various regions during different months* (1953–54 *and* 1954–55; *bull-trawling*)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Bombay	1953–54	122·7	42·4	26·5	21·7	..	46·3
	1954–55	..	0	..	..	..	..
II. Cambay	1953–54	87·6	5·4	..	15·7	..	10·0
	1954–55	..	199·3 (128·8)	11·4 (11·4)	1·6 (1·6)	50·1 (31·3)	18·7 (0)
III. Veraval	1953–54	285·3	202·6	..	98·6	..	39·8
	1954–55	..	71·0 (65·6)	..	111·5 (89·7)	246·7 (236·6)	18·7 (0)
IV. Porbundar	1953–54	..	84·7	..	222·5	287·2	40·3
	1954–55	..	127·8 (27·5)	393·9 (318·8)	227·4 (185·7)	143·5 (125·6)	..
V. Dwarka	1953–54	207·0	131·5	158·7	206·8	343·8	302·3
	1954–55	..	203·7 (194·8)	95·4 (94·5)	86·6 (86·6)	30·6 (30·6)	..

Figures in brackets indicate the catch rates for *Karkara.*

The sustained operations in region V by this vessel in all the 3 years have brought out certain very interesting trends. In 1951–52, the range of values was 444·7 to 1,295·7 lb. per hour. In 5 out of 8 months, the operations have resulted in a very high yield of more than 900 lb. per hour, a very high figure for otter-trawling in Indian waters. In 1952–53 season, in January and February the catch was more than 600 lb. per hour and in other months lower than this figure. The lowest figure, however, is 437·4 lb. per hour and this was in May. In 1953–54, the monthly average yield is, in general, between 500 and 600 lb. per hour in all the months, except November when a value of 854·6 lb. per hour has been obtained which is the highest for this season.

Bull-trawling by the cutters during 1953–54 *and* 1954–55.—The bull-trawling operations have yielded very high figures for catch per unit of effort and often the values are more than double those of *Taiyo Maru No. 17.* As shown in Table II, the overall catch per hour from all the regions during

1953–54 was 1,143·9 lb., whereas in the next year 1954–55, it has risen to 1,562·4 lb. per hour. The regional trends in the figures for catch rates between these 2 years show that in most of the regions the average values in the second year are nearly double or slightly less than double of those in the previous year. The maximum difference is seen in region II, where the 1954–55 value is nearly 4 times the figure for 1953–54.

TABLE IX

Showing the catch in lb. of Koth *per trawling hour by the cutters* Ashok *and* Pratap *from the various regions during different months* (1953–54 *and* 1954–55; *bull-trawling*)

Regions	Years	Months					
		Dec.	Jan.	Feb.	March	April	May
I. Bombay	1953–54	0	22·6	39·5	0·6	..	7·1
	1954–55	..	0	..	'..	..	..
II. Cambay	1953–54	0	11·6	0	18·1	..	14·7
	1954–55	..	0	0	27·9	2·8	0
III. Veraval	1953–54	0	0	..	0	..	0
	1954·55	..	0	..	0	0	0
IV. Porbandar	1953–54	..	0	..	0	15·1	29·2
	1954–55	..	0	0	0	7·4	..
V. Dwarka	1953·54	126·5	124·3	85·8	35·0	34·4	1·4
	1954–55	..	103·2	822·0	288·5	65·7*	..

A detailed analysis of the region-wise variations in the 2 years shows the following trends. In region I, the range of catch per hour values is 309·4 to 695·4 lb. in 1953–54. Although values as high as 1137·1 lb. per hour have been obtained, they refer to considerably small fishing effort often 1–2 hauls of 1·5 hours duration each—and hence not of much significance. In 1954–55, the bull-trawling has been done to a very negligible extent in this region. In region II again very high catch rates are evident from the table all referring to low fishing effort. The highest rate obtained in this region was 1,359·2 lb. per hour in 1954–55 with appreciable fishing effort. In 1953–54, on the other hand, the average yields fluctuated between 225·1 and 320·1 lb. per hour. 655·8 lb. per hour was the highest figure in this year (but in a month when the fishing effort was of less than
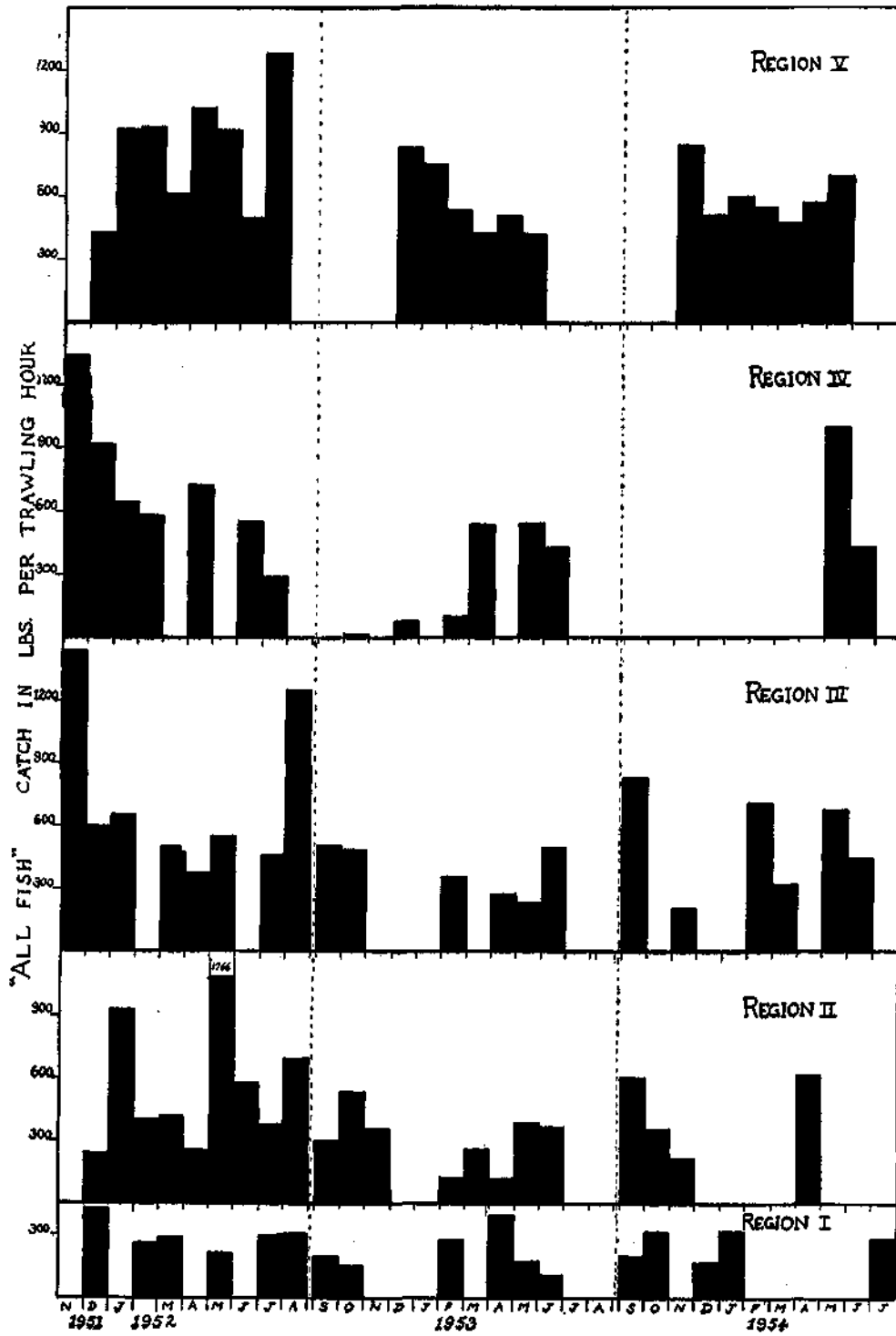
Fig. 8. Histogram showing the catches per hour of ALL FISH, in the various regions during the years 1951–52 to 1953–54 (*Taiyo Maru No.* 17).

10 hours duration). Region III which was not sufficiently intensively worked during the year 1953–54, had a range of 568·2 to 1,213·0 lb. per hour; here again the highest value refers to low effort. In 1954–55, this region has been worked to a greater extent obtaining yields ranging from 1,280·2 to 1,423·3 lb. per hour. A value of 2,246·7 lb. per hour has been recorded with a fishing effort of less than 10 hours duration. Region IV has been better worked in the second year by the bull-trawlers. The average catch rates in the different months varied between 742·0 and 1,776·0 lb. per hour. In the first year of operation in region V, the average monthly catch rate was more than 1,200 lb. per hour except in the month of December; the mean monthly range being 958·8 to 1,695·9 lb. per hour, the lowest having been obtained in December. In the next year, i.e., 1954–55, fishing of sufficient magnitude has been carried out only in 3 months, January, February and March. Fishing effort in April was not appreciable. The catch per hour of fishing varied from 1,314·4 to 3,059·2 lb. The highest yield was in February and the value was the maximum recorded so far for trawling in Indian waters.

From the detailed examination of the catch rate trends for ' all fish ' of the bull-trawlers, it is clearly seen that from a rich region like region V, the bull-trawling operations have obtained the highest yield per unit of effort, which speaks of the efficiency of this gear for working in these waters. The catch rates of ' all fish ' in the individual areas of the different regions as revealed from the data of the *cutters* for the years 1953–54 and 1954–55 are shown in Charts I and II.

Dara

Taiyo Maru No. 17 (1951–52 *to* 1953–54).—Figure 9 shows the catch rates of *dara* by *Taiyo Maru No.* 17 in all the five regions during the years 1951–52 to 1953–54. Regions I and II proved, in general, to be of low productivity with the mean annual values of catch per hour ranging between 4·8 and 22·5 lb. This is a state of affairs also revealed by the data of the cutters during the period. But within this range the yield was slightly better in the first 2 years than in the third year. In regions III and IV the catch rates were very low, often reaching zero and the highest mean annual value for the entire period being 14·2 lb. per hour. On the other hand, in region V, where the bulk of the operations has been carried out the yields are very high.

In region I, during 1951–52, the best and second best catches were obtained in February and May, the values being 38·6 and 32·0 lb. respectively per hour. July and August proved to be off-season. In 1952–53,

the highest catch recorded for this region was in October (33·3 lb. per hour), the lowest being in June (11·0 lb. per hour). No samples were taken in July and August. During 1953–54, the total effort was very low and *dara* catches were also poor. In region II during the first year, the highest catch
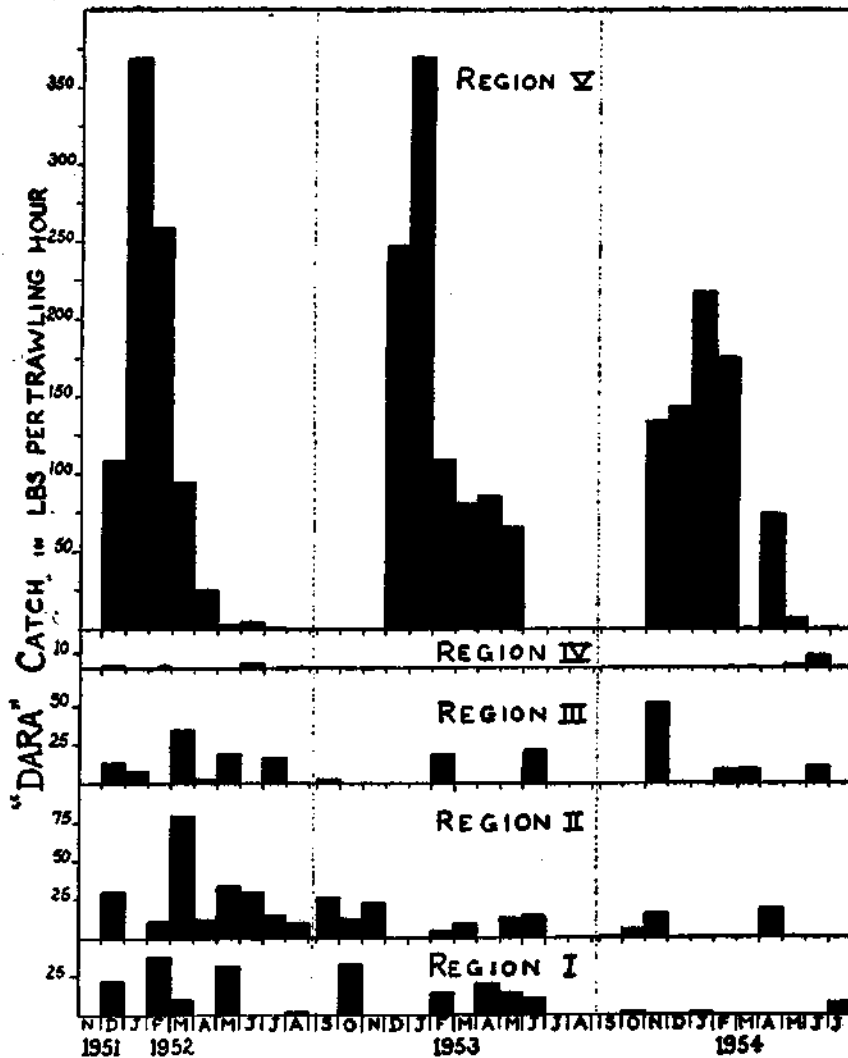

Fig. 9. Histogram showing the catches per hour, of *Dara* in the various regions during the years 1951–52 to 1953–54 (*Taiyo Maru No.* 17).

rate was in March (790 lb.), but the rate was low, in general, in other months, February, April, July and August giving very low yields and January showing no catches at all. In the second year, the highest catch rate was only

23·6 lb. and was in September, the November value coming very close (23·2 lb.). The sampling was poor in the third year. In regions III and IV, the effort has been more uneven than in the first two regions, the seasonal pattern being thus not revealed by the data. The catch rates, however, were much better in region III than in region IV. In the latter, zero values are very frequent, while in the former the range of values went up to 34·6 lb. per hour in the first year, 21·4 lb. in the second year and 51·1 lb. in the third year. In region V during 1951–52 good yields have been obtained from December to March, the values ranging from 94·0 lb. in March to 368·8 lb. per hour in January. In the second year, 1952–53, the *dara* catches have been high throughout from December to May, but particularly good during December, January and February. The highest rate this year was again in January (369·2 lb. per hour) while the lowest was in May (66·1 lb. per hour). In the third year, fishing was done in November also in this region and catches were good, in general, up to April, but particularly so up to February; the maximum yield was in January, 217·1 lb. per hour, while the May catch rate was as low as 6·9 lb. per hour. It may be said, in general, that good yields for *dara* can be obtained from this region for nearly 6 months in the year. As no sampling has been done from June to November (except June, July in 1951–52 and November in 1953–54), no definite picture is available of the distribution of *dara* in these months. But a distinct downward trend in the values is seen after April in all the three years, the March and April values also being invariably lower than those of the previous months. It is most likely, therefore, during the hot months and the monsoon months the fish withdraws from the grounds exploited, perhaps to deeper waters.

The mean annual catch rate, which was 139·7 lb. in the first year increased to 173·7 lb. in the second year but suffered a rather severe decline to 110·4 lb. per hour in the third year. The productivity of the different areas in respect of *dara* as indicated by the catch rates of the bull-trawlers, *Ashok* and *Pratap* during the years 1953–54 and 1954–55, is shown in Charts III and IV.

Ghol

1951–52 to 1953–54—*Taiyo Maru No. 17*—Fig. 10 shows the catch rates of *ghol* by *Taiyo Maru No. 17*. The range of variation for values, showing yield rates from region I is 13·1 to 149·7 lb. per hour. The best yields were in October and April. The yields in December, February and May may be considered to be moderate while the lowest values have been obtained in September, January and June. For this region the mean annua
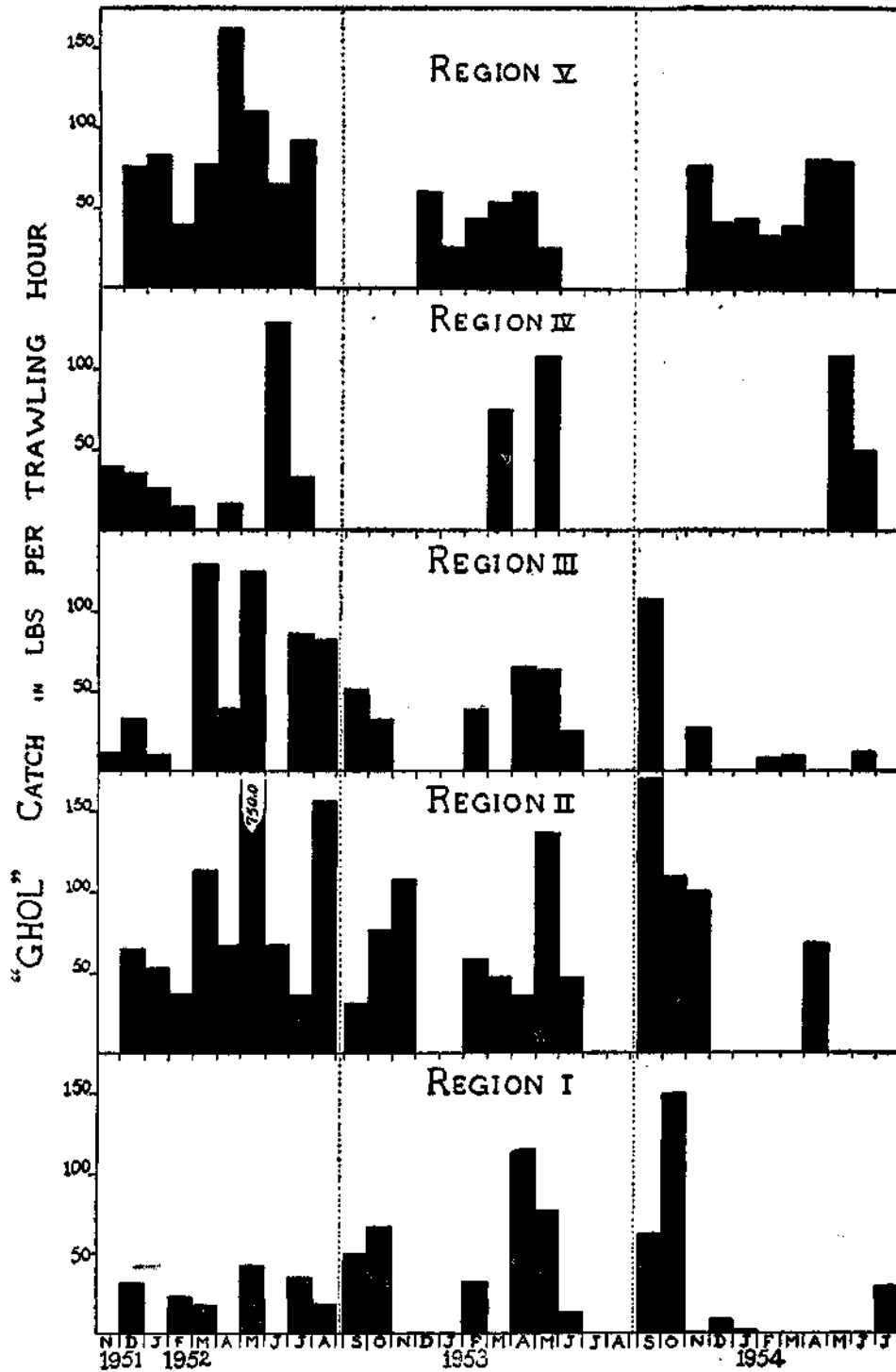
FIG. 10. Histogram showing the catches per hour, of *Ghol* in the various regions during the years 1951–52 to 1953–54 (*Taiyo Maru No.* 17).

catch per hour was 26·4, 38·8 and 38·0 lb. respectively during the 3 years. In region II, the average catch rates are higher than in region I the lowest and highest being 35·0 and 171·0 lb. per hour. There is one instance when 750 lb. per hour of *ghol* have been obtained (May, 1952) but this represents, the yield from low fishing effort and is due to a stray rich haul. The highest catch per unit of effort was obtained in September 1953; the next best was in August 1952 (157·0 lb.). The overall catch rate figures for the 3 years are 112·8, 79·7 and 128·1 lb. respectively. From region III, the yields have been good being comparable to those from region II. The effort has been sustained only in the first year and March and May appear to be the best months yielding respectively 129·5 and 124·8 lb. per hour. July and August come fairly close with catch rates of 86·0 and 83·5 lb. Lower yields have been obtained in January. In the subsequent years there is a fall in the catch rates in this region. The mean monthly range was 38·0 to 81·7 lb. per hour and yields above 60 lb. per hour have been obtained from April to June. The yearly catch per hour for this region ranged from 50·9 to 127·2 lb. per hour. The corresponding range for region IV was 24·2 to 85·2 lb., the latter being obtained in the third year. The yield of *ghol* from region IV in all the 3 years may be considered to be good with the limited fishing that has been done. The catch rate figures for May and June in 1952-53 and 1953-54 are almost identical (105·0 and 107·0 lb. respectively). In region V, the yearly average catch rates were 94·5, 47·2 and 53·5 lb. per hour respectively. The average monthly yield in the first year fluctuated between 65·7 and 164·0 lb. per hour with the exception of the value for February which was only 39·9 lb. per hour. In the second year, a much lower yield of *ghol* was observed, the average values ranging from 26·0 to 59·9 lb. per hour. The catch rates are best in December and April and lowest in January and May. The range of values for the third year was 33·2 to 80·4 lb. per hour. In the months of November, April and May, yields of more than 70 lb. per hour have been obtained, the highest figure of 80·4 lb. being in April. In this year the leanest months were February and March.

Bull-trawling by cutters during 1953-54 *and* 1954-55.—Considering the overall catch rates of the bull-trawlers from the various regions, it may be seen that the values obtained from regions III and IV are of very high order of magnitude; whereas in regions I and II they are relatively low. In general, the catch per hour of *ghol* from regions III to V is more than 100 lb. per hour in most of the months. Values above 200 lb. per hour have been obtained in March from regions III, IV and V and in April from regions IV and V. The highest yield was 280·4 lb. per hour from region IV and

that was in April of 1953–54 season. Charts V and VI show the abundance of *ghol* in the individual areas of the various regions as indicated by catch rates.
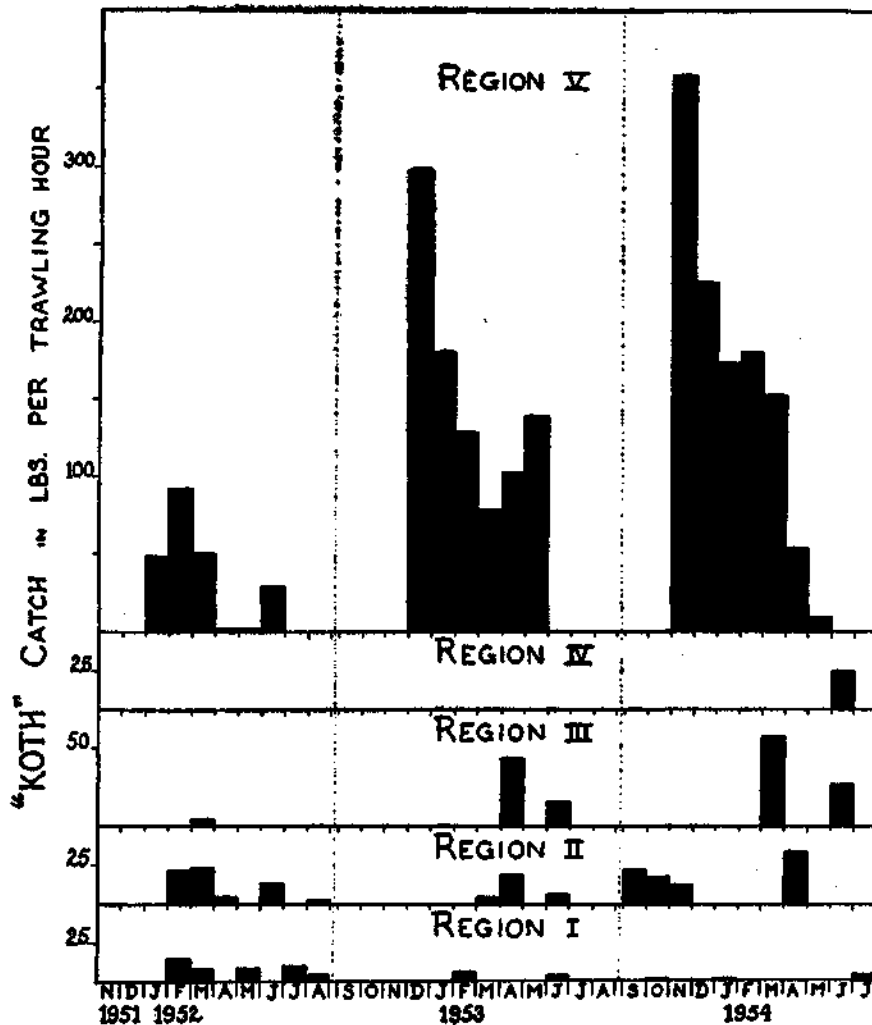

FIG. 11. Histogram showing the catches per hour, of *Koikara*, in the various regions during the years 1951–52 to 1953–54 (*Taiyo Maru No.* 17).

Koth

A reliable picture of the abundance of this group from the various regions in the different seasons is obtained from an examination of the figures for catch per hour of *Taiyo Maru No.* 17 as the cutters have not been recording this category properly except in 1954–55. Looking into the overall yields

in the 3 years, 1951–52 to 1953–54, the only catch rates which are of appreciable magnitude are those obtained from region V. Before considering these figures, it would be worthwhile to have an idea of the order of values from regions I to IV. The highest overall yield is from region III with a value of 19·8 lb. per hour. The values are more often below 10 lb. per hour in these four regions. In region V, on the other hand, the catch rates are very high comparable to those of *dara*. While, in the first year the annual mean catch per hour is only 34·9 lb. in the other 2 years they are 155·4 and 177·9 lb. respectively. In examining the detailed monthly distribution, region II, although generally poor in respect of *koth*, has shown relative catch yields of more than 15 lb. per hour in some months. The maximum value for the first year was in March and the same was in April in the next two years.

In region V, the best yields are restricted from January to March in the first year, the rates being very low in the other months except for a slight recovery in June. In the succeeding years, the catch rates have been very good in all the months except in May of 1953–54 season. The ranges for monthly figures are 77·1 to 298·6 lb. per hour in 1952–53, and 52·8 to 360·4 lb. per hour in 1953–54 leaving out in the latter case, the May figure of 8·3 lb. per hour. While December and January may be considered to be the months of best yields in 1952–53, in the next year, the best season extends from November to March, the highest figure for catch rate being 360·4 lb. per hour in November of 1953–54. It may be seen from these figures that the period of maximum yields tends to precede that for *dara*.

During the second year of bull-trawling, 1954–55, the cutters have recorded *koth* in various size categories and from an examination of these, it is seen that average catch rate between January and March, the only months of appreciable degree of fishing, ranged between 108·2 and 822·0 lb. per hour. As seen in the case of *dara*, the highest value for catch per hour was in February (822·0 lb. per hour). Here again, all this average was due to a single huge haul. From the observations made above, it may be seen that the pattern of distribution of *koth* is almost identical with that of *dara* (with the same regional and seasonal abundance).

Wam

Taiyo Maru No. 17 (1951–52 *to* 1953–54).—The catch rate trends of *Taiyo Maru No.* 17 during its 3 years operation give a good picture of the distribution of *wam*; region V stands out as the poorest region in respect of this fish. While the annual range of catch rates for this region is 13·2 to 22·9 lb. per hour, in the first four regions the value fluctuates between
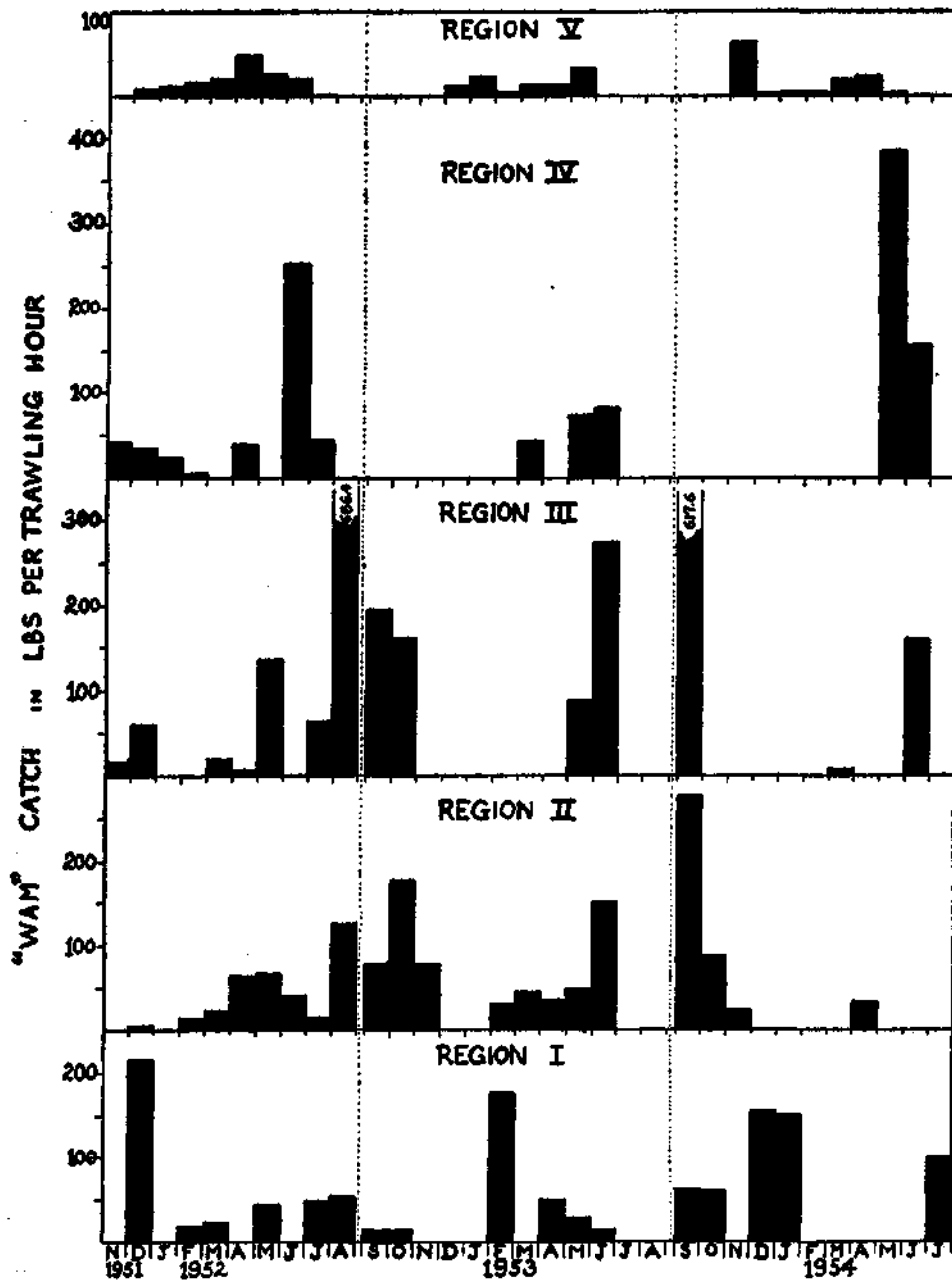
Fig. 12. Histogram showing the catches per hour, of *Wam*, in the various regions during the years 1951–52 to 1953–54 (*Taiyo Maru No.* 17).

66·0 and 315·7 lb. per hour. The best is region III with a range of 199·4 to 315·7 lb. per hour. In general, the months of best catch rates are June to October, the maximum monthly values of catch per hour have been obtained in region III. In the first year, a figure of 686·4 lb. per hour has been obtained in August, while 617·6 lb. per hour has been obtained in September in the third year (1953–54 season), both being from region III. In the second year also, the season's highest catch rate has been from this region only and that was in June although the value was only 273·1 lb. per hour.

Cutters: *bull-trawling.*—In the first year, the highest overall average catch per hour has been obtained from region I, the value being 248·0 lb. per hour. In the second year the catch per hour value of 105·6 lb. has been obtained from region II, being the highest for the season. In both the years, the lowest overall yield is from region V. The monthly catch rates show wide fluctuations. In region I in December the catch per hour was 448·6 lb. when the effort was less than 10 hours. In January, the value was 95·2 lb. and increased subsequently up to March, when the rate of 416·5 lb. per hour has been obtained; this latter is the maximum rate for the months when the effort was above 10 hours per month. In May, the value has fallen down to 40·8 lb. per hour. In February 1954 a single haul in this region yielded a catch of 1,032·3 lb. per hour. During 1955 only one haul was made, which was in January, the catch figure being zero. In region II, the months when fishing effort was appreciable in 1953–54, were January and May, when the catch rates were 68·9 and 92·3 lb. respectively. In 1954–55, the fishing effort was low in 4 months out of 5. In January of this year when the effort was high, the yield was 65·8 lb. per hour. The highest and next best yields of this region were in April and May 1955 (387·5 and 326·7 lb. per hour), but the effort in each case was only about 3 hours. In region III, in the first year, January had the lowest and May the highest yields (considering months when the effort was significant), the latter value being 130·0 lb. per hour. In the second year when the effort was significant in 3 out of 4 months the average catch per hour ranged between 40·9 and 67·9 lb. In region IV, over 80·0 lb. per hour have been obtained in April and May in the first year. In the second season, out of 4 months of fishing, there was an alternation of low and high values for catch per hour; January and March had lower values than February and April. The lowest figure of 19·9 lb. per hour was obtained in January and the highest (160·3 lb. per hour) was recorded in April. In region V, during 1953–54, catch rates were high during March to May, the highest being in April (128·7 lb.); in the months, December to February the catch was below 20 lb. per hour. During the year 1954–55, the value increased from

20·6 lb. in January to 51·3 lb. in May, which was the highest for the season. Charts VII and VIII show the density of *wam* populations in the individual areas of the different regions fished by the cutters during the years 1953–54 and 1954–55.
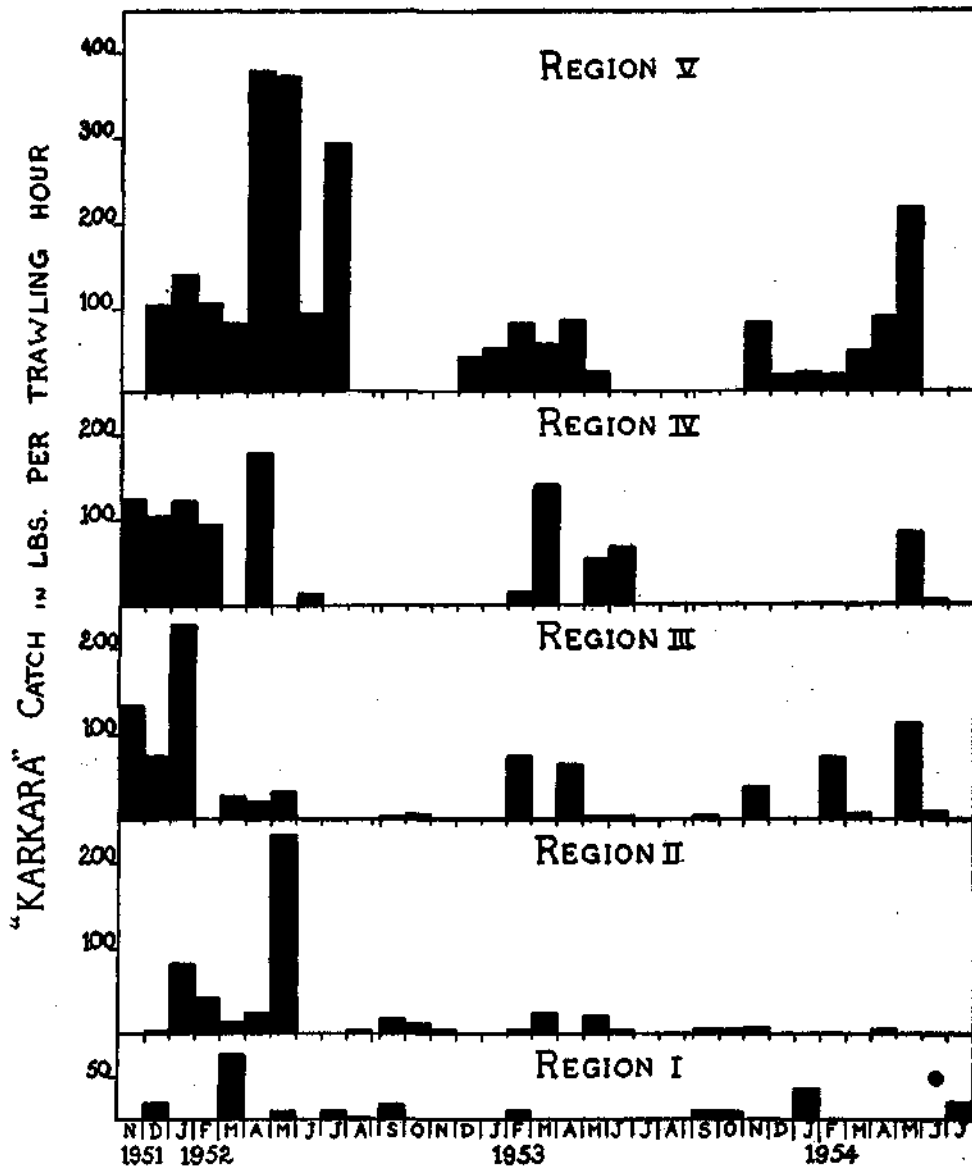

Fig. 13. Histogram showing the catches per hour, of *Karkara* in the various regions during the years 1951–52 to 1953–54 (*Taiyo Maru No.* 17).

Karkara

Data relating to catch per unit of effort of *karkara* are available for the entire period of working of *Taiyo Maru No.* 17. It may be seen that *kar-kara* forms one of the major fisheries in a few regions during the later part of the fishing season. Region I has shown the highest catch rate of 76·5 lb. per hour for *karkara* in the month of March in the year 1951–52. The next best value for this region was 48·0 lb. per hour and that was in the third year in the month of January. In a number of months, the operations have yielded no *karkara* at all. In region II, the yields are somewhat better than region I but still remaining at low levels. Although a value of 233·3 lb. per hour has been recorded, this was with a low fishing effort. The highest figure obtained when fishing effort was of sufficient magnitude was 81·0 lb. per hour in 1951–52 in January. In the second year the maximum value has fallen down to 24·8 lb. per hour while in the third year the corresponding figure was only 7·0 lb. per hour. In this last year, however, there was no fishing in this region between the months, December to March. Region III has yielded somewhat better results than the first two. Fairly appreciable catch rates have been obtained from January to March in the first year —the highest, of course, was in January with a value of 228·3 lb. of *karkara* per hour. In the next year out of 6 months of fishing in this region, four months have yielded catch rate figures of less than 5 lb. per hour. Only in February and April the yields are good, being 76·0 and 65·0 lb. per hour respectively. In the third year, the maximum value was 111·3 lb. per hour in May: the next best was in February. In region IV in the first year, fishing has resulted in yields of more than 100 lb. of *karkara* per hour in November, December and January. In the second year, March, May and June may be considered to be good months, the highest value being in March (140·8 lb. per hour). In the third year, as is already known, the fishing was only in May and June and only in the former there is a good yield of this fish— 85·9 lb. per hour. The June figure is only 3·4 lb. per hour. In region V except in March and June when the catch rates have been, respectively, 80·6 and 93·8 lb. per hour, in all the other months the values are more than 100 lb. per hour. April and May have shown the highest yields, being 377·4 and 373·7 lb. per hour respectively. The catch rate for July is almost close to these values being 291·1 lb. per hour. In the second year, the range is somewhat low, 25·3 to 85·8 lb. per hour, the lowest being in December. From January to April, the catch rates are above 50 lb. per hour, the highest being in February and April (the values in these 2 months are nearly the same, being 81·8 and 85·8 lb.).

In the third year, a high catch rate of 81·6 lb. per hour has been obtained in November, followed by a sudden drop to 17·2 lb. per hour in December. The increase is seen from March onward and the highest value of 216·6 lb. has been seen in May. For the year 1954–55 the picture of the abundance of the *karkara* fishery is available from the bull-trawling figures of the cutters. In this year, regions III, IV and V have yielded good results, with overall annual catch rates of 136·3, 221·3 and 128·7 lb. per hour respectively. In region III, the trend is one of increasing catch rates from January to March—65·6 to 236·6 lb. per hour. In region IV from 27·5 lb. per hour in January the yield increased to 318·8 lb. per hour in February after which there is a decrease, the figure in April being 125·6 lb. per hour. The catch rates in region V show a progressive decrease from January (194·8 lb. per hour) to March (86·6 lb. per hour). The April value is 30·6 lb. per hour but the fishing effort is low.

VI. Depth-wise Variations in the Distribution of the Main Categories of Fishes

In Tables X to XIV are given data relating to the variations in catch per hour at various depth ranges in region V in respect of the important fishes. The data are all compiled from the results of the working of *Taiyo Maru No. 17* from 1951–52 to 1953–54. The depths fished ranged between 20 and 60 meters. This range of depth has been subdivided into smaller depth ranges of 5 meters each and the results in each of these 5 meter ranges have been examined in detail.* As could be expected, fishing effort has not been quite consistent in all the depth ranges. Only in region V, appreciable amounts of fishing effort have been put in, in most of the depth ranges, in the months when this region has been visited. Hence the depth-wise distribution is considered in detail in this region only. In the first 2 years the major part of fishing has been up to 45 meters only, in the Dwarka region. Only in the third year and that, too, in the closing months of the season, deeper

*No.	Depth range (in meters)
1	21–25
2	26–30
3	31–35
4	36–40
5	41–45
6	46–50
7	51–55
8	56–60

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Showing the catch-per-hour of the chief categories of

Months		DARA					
	2	3	4	5	6	7	8
	26–30	31–35	36–40	41–45	46–50	51–55	56–60
December 1951	..	10·6	9·4	..	43·6	..	..
February 1952	30·0*	52·5	0*	..	..	..	..
March 1952	..	5·0*	14·2	..	..	..	..
May 1952	..	16·7	44·4	..	8·3*	..	..
July 1952	..	..	..	0*	0*	0*	..
August 1952	..	..	0*	0	4·0	0*	..
September 1952	..	..	0*	..	..	..	..
October 1952	..	37·5*	..	..	..	..	..
November 1952	..	0*	..	..	..	..	..
February 1953	..	42·1*	42·5	9·5*	12·5	2·8	35·1*
April 1953	..	..	16·7*	22·0	l..l	..	..
May 1953	..	../	..	14·9*	..	..	..
June 1953	..	..	..	7·7*	12·2	..	..
September 1953	..	../	0*	..i	..	..	..
October 1953	..	7·1*	..	l..	..	..	..
December 1953	..	0*	..	0*	..l	..	0*
January 1954	..	..	0	3·2	0	..	0*
July 1954	..	..	..	10·9	7·4	1·3	..

Months		KOTH				WAM	
	5	6	7	8	2	3	4
	41–45	46–50	51–55	56–60	26–30	31–35	36–40
December 1951	..	0	..	..	..	396·0	71·3
February 1952	..	..	..	..	15·0*	22·5	0*
March 1952	..	..	..	..	..	25·0*	19·8
May 1952	..	8·3*	..	..	..	45·8	41·7
July 1952	0*	22·2*	8·3*	..	..	..	..
August 1952	2·8	4·8	0	..	..	..	50·0*
September 1952	..	..	..	..	..	..	16·7*
October 1952	..	..	..	..	..	16·7*	..
November 1952	..	..	..	..	..	0*	..
February 1953	0*	3·3	3·8	7·1*	..	0*	22·7
April 1953	0	..	..	..	..	..	33·3*
May 1953	0*	..	..	..	..	..	..
June 1953	7·7	3·1	..	..	..	..	61·3*
September 1953	..	..	..	..	..	..	..
October 1953	..	..	..	..	72·5	7·1*	..
December 1953	0	■..	..	0*	..	88·2*	..
January 1954	3·2*	0	..	0*	..	..	141·8
July 1954	3·9	2·5	8·9	..	..	..	..

X

fishes at different depth-ranges in region I

GHOL							KOTH		
2	3	4	5	6	7	8	2	3	4
26-30	31-35	36-40	41-45	46-50	51-55	56-60	26-30	31-35	36-40
..	30·0	33·8	..	24·0	..	..	..	0	0
22·5*	30·0	0*	..	..	..	..	7·5*	15·0	30·0*
..	0*	23·3	..	..	..	..	..	0	11·9
..	29·1	52·8	..	41·7*	..	..	..	8·3	8·3
..	..	..	11·1*	33·3*	75·0*	..	..	..	..
..	..	0*	36·1	13·5	33·3*	..	..	..	16·7
..	..	10·0	..	..	..	..	..	..	0*
..	95·8*	..	..	..	..	..	..	8·3*	..
..	0*	..	..	..	..	..	..	0*	..
..	14·0*	68·0	28·4	28·3	31·2	42·1	..	28·1*	28·4
..	..	166·7*	99·0	..	..	..	..	..	0*
..	..	..	74·3	..	..	..	..	..	..
..	..	..	15·4	12·2	..	..	..	..	..
..	..	43·8	..	..	..	..	..	..	0*
98·2	14·3*	..	..	..	..	..	1·6	0*	..
..	0*	..	..	..	..	..	..	0*	..
..	..	0	4·7	4·7	..	0*	..	..	0
..	..	..	23·7	36·1	39·4	..	..	..	..

WAM				KARKARA						
5	6	7	8	2	3	4	5	6	7	8
41-45	46-50	51-55	56-60	26-30	31-35	36-40	41-45	46-50	51-55	56-60
..	147·0	..	..	..	30·0	0	..	24·0	..	..
..	..	..	..	0*	0	0*	..	..	..	..
..	..	..	..	..	85·0*	73·3	..	..	..	..
..	41·7*	..	..	..	20·9	5·6	..	0*	..	..
55·6*	44·4*	41·7*	..	..	..	..	0*	5·6*	33·3*	..
44·4	54·8	16·7*	..	..	..	0*	5·6	1·6	16·7*	..
..	..	..	..	..	..	16·7*	..	..	..	..
..	..	..	..	..	0*	..	..	..	..	..
..	..	..	..	..	0*	..	..	..	..	..
207·9*	174·0	258·9	91·3*	..	0*	0	4·7*	10·0	15·1	0*
35·0	..	..	..	..	..	0*	0	..	..	..
29·7*	..	..	..	..	..	..	0*	..	..	..
15·4*	12·2	..	..	..	..	..	0*	0	..	..
..	..	..	..	..	..	8·8*	..	..	..	..
..	..	..	..	11·3	0*	..	..	..	..	..
220·5*	..	..	..	..	0*	..	0*	..	..	..
144·9	182·3	..	141·0*	..	..	3·5	25·2	70·1	..	68·5*
106·3	195·1	94·0	..	..	..	..	19·8	20·5	19·1	..

TABLE

Showing the catch-per-hour of the chief categories of

Months		1	2	3	4	5	6	7	8
		21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
December	1951	..	..	..	30·0	..	..	..	..
January	1952	..	..	..	0*	0*	..	..	..
February	1952	..	..	21·0	0*	0*	..	..	..
March	1952	..	..	15·8*	29·1	160·0*	100·0	..	..
April	1952	..	..	7·5*	..	33·3*	0*	..	..
May	1952	..	..	..	..	..	33·3*	..	..
June	1952	..	..	..	..	16·7*	38·9*	..	..
July	1952	..	..	..	..	..	13·3	16·7*	..
August	1952	..	..	..	..	..	9·3	8·3*	..
September	1952	..	..	8·3*	24·1	0	..	..	..
October	1952	24·3	7·6	6·2	16·7*	..	..	..	..
November	1952	..	5·5*	21·2	11·9	..	..	..	..
February	1953	..	..	..	0*	..	14·1*	..	14·1*
March	1953	..	..	..	5·7*	7·4*	0*	..	..
April	1953	..	..	..	..	0*	..	..	..
May	1953	..	..	..	9·1*	14·0	0*	..	..
June	1953	..	..	..	..	7·5	14·5	46·1*	15·7*
September	1953	..	..	..	0·4	0	1·1	..	..
October	1953	..	..	7·2	4·0	0*	..	..	..
November	1953	..	58*	18·7	..	..	..	..	..
April	1954	..	11·6	..	..	20·6	0*	..	..

Months		KOTH				WAM			
		5	6	7	8	1	2	3	4
		41-45	46-50	51-55	56-60	21-25	26-30	31-35	36-40
December	1951	..	..	..	..	..	..	..	5·0
January	1952	0*	..	..	..	..	..	..	0*
February	1952	7·5*	..	..	..	..	..	15·0	15·0*
March	1952	15·0*	29·1	..	..	..	..	30·0*	25·0
April	1952	16·7*	0*	..	..	..	..	75·0*	..
May	1952	..	0*	..	..	..	..	..	..
June	1952	0*	22·2	..	..	..	..	..	..
July	1952	..	0	0*	..	..	..	..	..
August	1952	..	2·0	8·3*	..	..	..	..	..
September	1952	0	..	..	..	..	..	66·7*	76·6
October	1952	..	..	..	..	99·9	117·7	115·4	33·4*
November	1952	..	..	..	..	..	83·3*	78·1	171·4
February	1953	..	0*	..	0*	..	..	..	24·6
March	1953	7·3*	0*	..	..	..	..	..	37·6*
April	1953	18·3*	..	..	..	..	..	..	..
May	1953	0	0*	..	..	..	..	..	45·6*
June	1953	13·2	4·7	45·1*	0*	..	..	..	..
September	1953	6·9	2·1	..	..	..	..	..	225·2
October	1953	21·2*	..	..	..	..	29·4*	42·2	109·9
November	1953	..	..	..	..	..	0	46·7	..
April	1954	34·4	14·7*	..	..	..	..	..	..

XI

fishes at different depth-ranges in region II

GHOL								KOTH			
1	2	3	4	5	6	7	8	1	2	3	4
21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	21-25	26-30	31-35	36-40
··	··	··	65·0	··	··	··	··	··	··	··	0
··	··	··	67·5*	42·6*	··	··	··	··	··	··	0*
··	··	69·0	3·0*	0*	··	··	··	··	··	33·0	10·0
··	··	32·5*	129·1	118·3*	137·5	··	··	··	··	15·8*	25·0
··	··	0*	··	50·0*	66·7*	··	··	··	··	0*	··
··	··	··	··	··	0*	··	··	··	··	··	··
··	··	··	··	66·7*	66·7*	··	··	··	··	··	··
··	··	··	··	··	50·0	0*	··	··	··	··	··
··	··	··	··	··	164·2	25·0*	··	··	··	··	··
··	··	11·7*	23·4	20·8	··	··	··	··	··	0*	0
60·0	65·2	95·8	200·0*	··	··	··	··	31·3	10·6	5·4	0*
··	180·5*	160·0	222·5	··	··	··	··	··	2·8*	4·4	0
··	··	··	63·3	··	56·3*	··	42·3*	··	··	··	0
··	··	··	26·2*	63·4*	65·0*	··	··	··	··	··	0*
··	··	··	··	36·7*	··	··	··	··	··	··	··
··	··	··	54·7*	141·2	145·9*	··	··	··	··	··	0*
··	··	··	··	43·2	33·7	30·7*	15·7*	··	··	··	··
··	··	··	99·6	22·3	49·4	··	··	··	··	··	39·2*
··	235·2*	56·9	45·8	0*	··	··	··	··	73·5*	9·9	21·1
··	65·1	67·7	··	··	··	··	··	··	20·9	4·7	··
··	··	··	··	66·4	88·2*	··	··	··	··	··	··

WAM				KARKARA							
5	6	7	8	1	2	3	4	5	6	7	8
41-45	46-50	51-55	56-60	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60
0*	··	··	··	··	··	··	2·5	··	··	··	··
7·5*	··	··	··	··	··	··	180·0*	15·0*	··	··	··
20·6*	16·7	··	··	··	··	6·0	50·0*	120·0*	··	··	··
183·3*	66·7*	··	··	··	··	22·5*	0	50·6*	4·2	··	··
··	0*	··	··	··	··	0	··	50·0*	50·0*	··	··
91·7*	5·6*	··	··	··	··	··	··	··	233·3*	··	··
··	30·0	8·3*	··	··	··	··	··	0*	0*	··	··
··	135·3	33·3*	··	··	··	··	··	··	0	0*	··
25·0	··	··	··	··	··	0*	16·7	16·7	3·9	6*	··
··	··	··	··	2·0	2·0	35·7	0*	··	··	··	··
··	··	··	··	··	11·1*	4·2	4·1	··	··	··	··
··	42·3*	··	42·3*	··	··	··	7·0	··	0*	··	0*
39·4*	86·7*	··	··	··	··	··	57·0*	··	0*	··	··
36·7*	··	··	··	··	··	··	0*	··	··	··	··
50·3	80·2*	··	··	··	··	··	9·1*	15·4	73·0*	··	··
178·4	152·8	0	0*	··	··	··	··	7·5	1·4	0*	0*
216·5	534·9	··	··	··	··	··	1·6	12·0	4·3	··	··
63·5*	··	··	··	··	44·1*	5·5	6·6	35·3*	··	··	··
··	··	··	··	··	11·6	2·3	··	··	··	··	··
34·4	14·7*	··	··	··	··	··	··	0	0*	··	··

TABLE

Showing the catch-per-hour of the chief categories of

Months		DARA						
		1	2	3	4	5	6	7
		21–25	26–30	31–35	36–40	41–45	46–50	51–55
November	1951 ..	..	..	..	..	0*	0*	..
December	1951 ..	..	..	15·0*	7·7*	15·0*	..	..
January	1952 ..	..	..	..	0	..	..	..
March	1952 ..	.	15·0*	12·5	35·2	50·5	15·0*	..
April	1952 ..	..	..	..	0	15·0	..	..
May	1952 ..	..	..	..	33·3	16·7	27·8*	..
July	1952 ..	..	..	..	..	0*	25·0	..
August	1952 ..	..	..	..	..	0*	0	..
September	1952 ..	..	..	0*	2·6	2·8	0*	..
October	1952 ..	0	0*	0*	0	..	..	..
February	1953 ..	..	..	..	19·0	..	..	..
April	1953 ..	..	..	..	0*	..	..	..
May	1953 ..	..	..	..	0*	0*	..	..
June	1953 ..	..	..	..	..	8·5	27·0	17·2
September	1953 ..	..	..	..	0*	0*	0	..
November	1953 ..	..	..	..	0*	..	..	..
February	1954 ..	..	..	..	7·3*	..	..	..
March	1954 ..	..	..	..	0*	12·5*	..	..
May	1954 ..	..	..	..	..	0*	..	..
June	1954 ..	..	..	..	36·8*	14·7*	18·0	..

Months		KOTH			WAM			
		5	6	7	1	2	3	4
		41–45	46–50	51–55	21–25	26–30	31–35	36–40
November	1951 ..	0*	0*	..	..	..	..	..
December	1951 ..	0*	..	..	..	..	0*	30·0*
January	1952 ..	..	..	..	..	..	..	0
March	1952 ..	4·1	0*	..	..	30·0*	10·0	16·7
April	1952 ..	0*	..	..	..	..	..	7·5
May	1952 ..	2·9	5·5	..	..	..	..	216·7
July	1952 ..	0*	0	..	..	..	..	..
August	1952 ..	0*	0·3	..	..	..	..	..
September	1952 ..	0	0*	..	..	..	200·0*	132·1
October	1952 ..	..	..	..	37·7	33·3*	50·0*	21·4
February	1953 ..	..	..	..	..	..	..	0
April	1953 ..	..	..	..	..	..	..	0*
May	1953 ..	0*	..	..	..	..	..	74·3*
June	1953 ..	6·4	7·2	17·2	..	..	..	..
September	1953 ..	0*	0	..	..	..	..	274·6*
November	1953 ..	..	..	..	..	..	..	0*
February	1954 ..	..	..	..	..	..	..	0*
March	1954 ..	0*	..	..	..	..	..	0*
May	1954 ..	0*	..	..	..	..	..	..
June	1954 ..	29·4*	25·2	..	..	..	..	29·4*

XII

fishes at different depth-ranges in region III

GHOL						KOTH			
1	2	3	4	5	6	1	2	3	4
21-25	26-30	31-35	36-40	41-45	46-50	21-25	26-30	31-35	36-40
..	..	..	..	0*	16·7*	..	..	..	..
..	..	0*	52·7*	45·0*	..	..	0*	0*	0*
..	..	..	10·9	..	..	..	..	0	0
..	90·0*	122·5	163·5	163·8	66·8*	..	0*	0	6·3
..	..	..	41·3	30·0*	..	..	..	..	0
..	..	..	83·3	127·5	122·2*	..	..	..	16·7
..	..	..	..	58·3	100·0	..	..	..	..
..	..	..	..	122·2*	83·1	..	..	..	..
..	..	61·1*	41·9	36·1	133·3*	..	..	0*	0
75·0	0*	11·7*	5·7	..	..	30·0	0*	0*	0
..	..	..	38·0	..	..	..	..	..	0
..	..	..	85·0*	..	..	..	..	..	43·3*
..	..	..	59·4*	59·4*	..	..	..	..	0*
..	..	..	34·3	70·2	68·6	..	..	..	..
..	..	..	308·9	60·0	61·8	..	..	..	0*
..	..	..	0*	..	..	..	..	..	25·6
..	..	..	50·8*	..	..	..	..	..	0*
..	..	..	25·0*	12·5*	..	..	..	..	0*
..	..	..	..	57·2*	..	..	..	..	..
..	..	..	58·8*	73·5*	32·4*	..	..	..	51·5*

WAM			KARKARA						
5	6	7	1	2	3	4	5	6	7
41-45	46-50	51-55	21-25	26-30	31-35	36-40	41-45	46-50	51-55
0*	25·0	..	..	..	..	..	0*	200·0*	..
150·0*	..	..	..	..	135·0*	15·0*	75·0*	..	..
..	..	..	..	..	..	216·0	..	..	..
28·6	30·0*	..	..	0*	10·0	16·7	54·5	112·5*	..
0*	..	..	..	..	..	22·5	15·0*	..	..
138·2	83·3*	..	..	..	..	33·3	12·9	144·4*	..
41·7*	75·0	..	..	..	..	..	0*	0	..
1050·0*	668·0	..	..	..	..	..	0*	1·3	..
300·6	616·7*	..	..	..	0*	2·6	3·7	0*	..
..	..	..	0	0*	0*	19·0	..	..	..
..	..	..	..	..	..	53·9	..	..	..
..	..	..	..	..	..	21·7*	..	..	..
44·6*	..	..	..	..	..	0*	7·4*	..	..
216·3	309·6	17·2	..	..	..	..	4·3	1·8	0
317·1*	734·9	..	..	..	..	0*	0*	4·3	..
..	..	..	..	..	..	38·4*	..	..	..
..	..	..	..	..	..	72·5*	..	..	..
0*	..	..	..	..	..	0*	12·5*	..	..
0*	..	..	..	..	..	..	85·8*	..	..
0*	46·7	..	..	..	..	0*	0*	14·4	..

TABLE

Showing the catch-per-hour of the chief categories of

Months	DARA						
	2	3	4	5	6	7	8
	26-30	31-35	36-40	41-45	46-50	51-55	56-60
November 1951	..	..	0	0	..	..	..
December 1951	0*	3·8*	0	1·6	6·0	..	0*
January 1952	..	..	0*	0	0*	..	..
February 1952	..	..	0*	0*	..	..	..
April 1952	..	..	0*	0*	..	..	..
June 1952	..	..	..	30	0*	..	..
July 1952	..	..	..	..	0*	0*	..
October 1952	..	0*	..	..	..	..	..
December 1952	..	..	0*	..	..	..	..
February 1953	..	..	0*	..	..	..	..
March 1953	..	..	0*	0*	..	..	..
May 1953	..	..	0	0	..	..	..
June 1953	..	..	0	0	0	..	..
May 1954	..	..	5·1	0	..	..	..
June 1954	..	..	..	6·9	6·2	0*	..

Months	KOTH			WAM			
	6	7	8	2	3	4	5
	46-50	51-55	56-60	26-30	31-35	36-40	41-45
November 1951	..	..	..	..	..	36·1	46·7
December 1951	0	..	0*	66·7*	30·0*	34·5	36·1
January 1952	0*	..	..	..	..	45·0*	9·0
February 1952	..	..	..	..	..	7·5*	0*
April 1952	..	..	..	..	..	0*	58·3
June 1952	0*	..	..	..	..	..	263·6
July 1952	0*	0*	..	..	..	..	..
October 1952	..	..	..	..	0*	..	..
December 1952	..	..	..	..	..	0*	..
February 1953	..	..	..	..	..	0*	..
March 1953	..	..	..	..	..	57·7*	0*
May 1953	..	..	..	..	..	76·3	67·0
June 1953	0	..	..	..	..	41·3	76·2
May 1954	..	..	..	..	..	38·4	381·8
June 1954	27·1	0*	..	..	..	..	258·1

XIII

fishes at different depth-ranges in region IV

GHOL							KOTH			
2	3	4	5	6	7	8	2	3	4	5
26-30	31-35	36-40	41-45	46-50	51-55	56-60	26-30	31-35	36-40	41-45
..	..	25·0	53·3	..	..	..	..	..	0	0
25·0*	15·0*	27·2	52·8	12·0	..	0*	0*	0*	0	0
..	..	15·0*	36·0	0*	..	..	..	..	0*	0
..	..	22·5*	0*	..	..	..	..	..	0*	0*
..	..	16·7*	16·7*	..	..	..	..	..	0*	0*
..	..	..	139·4	16·7*	..	..	..	..	..	0
..	..	..	..	33·3*	33·3*	..	..	..	..	..
..	0*	..	..	..	..	..	..	0*	..	..
..	..	0*	..	..	..	..	..	..	0*	..
..	..	0*	..	..	..	..	..	..	0*	..
..	..	101·1*	0*	..	..	..	..	..	0*	0*
..	..	81·6	109·6	..	..	..	..	..	0	0
..	..	30·0	69·0	54·5	..	..	..	..	0	0
..	..	134·4	95·0	..	..	..	..	..	0	0
..	..	..	70·4	35·0	42·9*	..	..	..	..	24·8

WAM			KARKARA						
6	7	8	2	3	4	5	6	7	8
46-50	51-55	56-60	26-30	31-35	36-40	41-45	46-50	51-55	56-60
..	..	..	..	..	180·6	60·0	..	..	..
18·0	..	15·0*	150·0*	450·0*	92·8	87·8	27·0	..	15·0*
45·0*	..	..	..	..	45·0*	144·0	180·0	..	..
..	..	..	..	..	82·5*	120·0*	..	..	..
..	..	..	..	..	150·0*	191·7*	..	..	..
166·7*	..	..	..	..	..	146·5	0*	..	..
50·0*	41·7*	..	..	0*	..	..	0*	0*	..
..	..	..	..	..	0*	..	..	..	..
..	..	..	..	..	15·0*	..	..	..	..
..	..	..	..	..	130·0*	173·3*	..	..	..
..	..	..	..	..	19·9	57·5	..	..	..
92·6	..	..	..	..	18·8	104·4	9·5	..	..
..	..	..	..	..	62·7	91·3	..	..	..
131·6	0*	..	..	..	..	5·5	2·3	0*	..

TABLE

Showing the catch-per-hour of the chief categories of

Months		DARA						
		1	2	3	4	5	6	7
		21-25	26-30	31-35	36-40	41-45	46-50	51-55
December	1951	..	..	0*	167·5	60·0	..	..
January	1952	345·2	446·9	42·9	202·9	181·7	..	..
February	1952	420·8	258·5	264·1	102·5	..	..	..
March	1952	125·0	107·7	86·0	64·3	5ï·6*	33·3	..
April	1952	0*	75·0	56·3	4·8	23·7	8·3	..
May	1952	..	..	0*	2·9	1·9	8·3*	0*
June	1952	..	..	..	8·3	1·8	..	..
July	1952	..	..	..	0	1·2	0*	..
December	1952	293·9	216·1	217·2	178·5*	..	..	..
January	1953	47·1	390·5	225·1	125·6	151·5*	..	..
February	1953	172·0	152·3	97·2	46·5	0*	48·2*	..
March	1953	109·6*	112·1	77·8	65·8	64·0	47·0*	..
April	1953	140·3	123·4	75·8	56·1	74·0	0*	..
May	1953	..	54·7	..	63·6	67·4	..	..
November	1953	..	161·7	108·2	67·6	..	..	..
December	1953	136·7	126·9	107·4	1579·2*	..	..	..
January	1954	..	78·1	213·9	255·6	211·4	..	..
February	1954	82·7	182·9	172·0	187·0	118·5	..	..
March	1954	79·5	63·0	80·9	57·8	14·1*	..	..
April	1954	..	18·9	42·0	52·5	80·4	86·1	..
May	1954	..	..	..	14·3*	22·8	2·1	0

Months		KOTH			WAM			
		5	6	7	1	2	3	4
		41-45	46-50	51-55	21-25	26-30	31-35	36-40
December	1951	0	..	..	..	..	0*	7·5
January	1952	0	..	..	7·1	11·1	9·8	15·8
February	1952	..	..	..	16·7	14·8	17·0	25·6
March	1952	16·7*	50·0*	..	15·0	14·1	27·2	22·6
April	1952	1·0	8·3	..	60·0*	37·5*	28·3	29·2
May	1952	1·3	0*	0*	..	..	23·3*	23·5
June	1952	38·6	..	..	..	..	..	22·9
July	1952	0·6	0*	..	..	..	..	0
December	1952	..	..	..	6·5	13·0	12·4	10·5*
January	1953	30·3*	..	..	16·8	13·9	8·0	9·2
February	1953	0*	0*	..	4·0	5·9	3·3	12·2
March	1953	46·0	47·0*	..	0*	9·5	13·6	13·2
April	1953	104·2	0*	..	7·4	6·3	7·6	21·2
May	1953	147·7	..	..	..	0	..	18·2
November	1953	..	..	..	..	42·1	49·8	173·4
December	1953	..	..	..	0	3·0	4·9	21·2*
January	1954	169·3	..	..	..	2·4	2·2	1·2
February	1954	89·6	..	..	0	2·9	0·5	6·1
March	1954	112·8*	..	..	18·7	8·4	10·7	28·2
April	1954	55·8	35·4	..	..	4·7	16·5	25·3
May	1954	23·6	4·2	0	..	..	..	28·6*

XIV

fishes at different depth-ranges in region V

	GHOL							KOTH			
1	2	3	4	5	6	7		1	2	3	4
21-25	26-30	31-35	36-40	41-45	46-50	51-55		21-25	26-30	31-35	36-40
..	..	15·0*	96·3	63·0	..	..		..	..	0*	0
52·4	67·8	69·1	144·9	85·7	..	..		83·3	86·1	23·0	13·3
33·3	19·9	43·2	6·4	..	..	..		491·7	65·6	78·3	12·5
46·7	62·5	95·2	73·8	155·6*	133·3*	..		36·7	76·0	32·9	31·0
105·0*	225·0	1?9·2	128·6	191·0	104·1	..		0*	7·5*	7·5	1·4
..	..	66·7*	100·0	124·7	83·3*	166·7*		..	..	0*	5·8
..	..	..	58·3	71·9	..	..		..	..	..	16·7
..	..	..	228·3	76·3	0*	..		..	..	..	0
38·8	56·3	72·7	52·5*	..	..	..		213·2	265·8	389·2	173·2*
26·9	24·6	27·5	33·7	15·2*	..	..		225·6	188·8	138·0	36·8
21·2	34·1	51·1	80·8	15·8*	48·2*	..		2?2·0	177·7	85·6	1·2
15·7*	32·8	55·2	58·9	77·6	62·6*	..		266·1*	93·9	83·1	70·4
28·8	50·0	47·3	70·4	93·1	50·0*	..		171·6	153·7	69·0	51·9
..	0	..	12·1	31·1	..	..		..	36·5	..	121·2
..	51·7	68·8	94·4	..	..	..		..	405·9	363·7	179·3
9·4	34·0	49·4*	..	..	..	..		334·8	220·7	209·6	232·7*
..	12·2	24·1	38·3	29·3	..	..		..	63·4	1?0·5	233·7
18·0	?0·5	31·8	38·9	40·5	..	..		183·3	276·6	143·6	145·4
9·4	?0·9	32·2	43·7	49·4*	..	..		935·0	155·4	151·8	103·3
..	23·6	59·0	57·6	94·1	99·1	..		..	103·7	85·0	37·4
..	..	..	85·8*	45·5	88·4	91·2		..	..	..	14·3*

WAM				KARKARA						
5	6	7		1	2	3	4	5	6	7
41-45	46-50	51-55		21-25	26-30	31-35	36-40	41-45	46-50	51-55
9·0	..	..		..	..	240·0*	125·6	13·2	..	..
20·0	..	..		8·6	62·1	169·7	2?0·3	111·0	..	..
..	..	..		16·7	50·2	134·7	179·4	..	..	..
33·3*	33·3*	..		26·7	31·4	92·3	184·5	122·2*	0*	..
32·6	45·8	..		?0·0*	45·0*	294·2	40?·4	4?8·3	283·3	..
25·9	66·7*	66·7*		..	..	16·7*	365·7	431·5	16·7*	33·3*
18·4	..	..		..	..	..	65·6	117·5	..	..
1·2	0*	..		..	..	..	195·0	331·2	120·0*	..
..	..	..		11·3	24·9	55·3	99·8*	..	..	..
0*	..	..		7·7	48·2	83·1	177·8	166 7*	..	..
15·8*	16·1*	..		2·6	15·9	85·6	313·3	181·1*	48·2*	..
26·3	31·3*	..		0*	14·5	?0·2	21·8	59·0	31·3*	..
14·8	50·0*	..		10·0	17·5	57·8	16?·4	82·6	166·7*	..
38·9	..	..		..	18·2	..	6·1	31·1	..	..
..	..	..		..	50·0	90·5	164·5	..	..	..
..	..	..		9·4	11·9	26·9	49·4*	..	..	..
7·3	..	..		..	34·2	14·6	20·4	?0·2	..	..
28·9	..	..		0	4·0	15·4	29·4	57·8	..	..
35·3*	..	..		4·7	10·4	26·4	93·4	0*	..	..
24·4	28·3	..		..	18·9	160·5	65·7	101·4	69·6	..
22·0	22·3	38·9		..	..	..	42·9*	137·4	225·9	281·4

waters have been visited. The 51–55 meter range has been fished only in May 1954. The main features of the depth-wise distribution of the important groups of fishes are given below.

Dara

During the period December to April which is the season of best yields of *dara*, there is a tendency for a greater concentration of this fish in shallower waters—roughly up to 36 meters. This is more so in the earlier months of the season. During December 1951, only the depth ranges 3–5 were fished and of these, range 4 was the best for *dara* with an yield of 167·5 lb. per hour of fishing. In January 1952, fishing was done in all ranges from 1–5 and while the highest yield was in depth range 2 (being 446·9 lb. per hour) depth range 1 had the next best yield. The catches in ranges 4 and 5 were also good. But range 3 showed a low yield (42·9 lb. per hour). In February and March, the highest catches were in depth range 1 (420·8 and 125·0 lb. per hour respectively), there being a gradual decrease towards deeper waters. The catch rate of *dara* in the different depths which is already low in March shows a distinct decline in April when the few catches that are made, are in the slightly deeper waters. More or less similar trends are seen during the season, December 1952 to April 1953. But in December 1952 as against December 1951 fishing was done in shallower waters also and the best catch was in depth range 1 (293·9 lb. per hour). In January and February 1953, the highest yields are in depth ranges 2 and 1 respectively. The ranges 1 and 2 are again the best in March and April, the yeilds decreasing in deeper waters, in general. During the *dara* season of 1953–54 (in this year fishing was done in November also in the Dwarka region), while the shallower waters again appeared important, there were some instances of extremely good catches in the deeper zones. Thus in December 1953, a catch of 1,579·2 lb. per hour was obtained in depth range 4 from a single haul. Similarly in January and February depth range 4 was more important than the other ranges. March showed a slightly different distribution, while in April, it was again the deeper zones which appeared relatively rich. During the other months of the year (namely, off season period), it is seen, in general, that the few catches that were obtained are from the deeper waters. But, in view of the effort being not appreciable in the different depth ranges, it is not possible to obtain a reliable picture of the actual distribution in these months.

A close study of the table makes it fairly obvious that the *dara* fishery during the years 1951–52 and 1952–53 was particularly good in the relatively shallow depth ranges of 1–3. With the close of the usual *dara* season in

both the years, the tendency is seen (and it seems clear from the indirect evidence available from inshore fisheries) for the species to withdraw to deeper waters. As discussed later, temperature variations seem to have some control over the abundance of *dara* in the different regions. Not only is this fishery particularly characteristic of the colder region, but also is it restricted to the colder months. During the year 1953–54 the water temperatures, even during the normal *dara* season, were found to be considerably higher than in the corresponding periods of the previous years. It seems highly probable that the partial reversal of the depth distribution trends of the *dara* catches in 1953–54 was a direct consequence of the high temperature values. The withdrawal of the species into deeper waters in the warmer months of the year, which appears to be a normal behaviour for the fishery may also be partly determined by the temperature factor, while there may be other factors also contributing to the general seasonal pattern of the fishery.

Ghol

In the case of *ghol* while good catches are obtained practically in all the depth ranges throughout the year there is a tendency for the highest catches to occur in the rather deeper regions within the ranges exploited. The depth ranges 4 and 5 are the ones where best catch rates have been recorded in most of the months. In December 1951 and January 1952, also, the best yield was from depth range 4–96·3 and 144·9 lb. per hour. In February, the catches were, in general, poor, depth range III, yielding 43·2 lb. per hour, being the highest figure for this month. From March onwards the catches were good, the lowest catch per hour for the period, March to July 1952, being 46·7 lb. in depth range 1 in March and the highest 228·3 lb. depth range 4 in July. During the later months of the above period only the deeper waters were fished sufficiently and the catches were good, particularly in depth ranges 4 and 5. In December 1952 depth range 1 was the poorest for *ghol* (38·8 lb. per hour) while depth range 3 was the richest (72·7 lb. per hour). In January 1953, the catch of *ghol* was low in all the depth ranges the maximum being 33·7 lb. per hour in depth range 4. Better catches were obtained during the period February to April, the depth range 4 yielding the highest catch per hour in February and depth range 5 in the other 2 months. May 1953 was a poor month for the *ghol* fishery in region V. In November and December 1953 and January 1954 the highest catch rates were again in depth range 4, though the yield was in general poor in these months and also in February 1954. The highest catch rates were in depth ranges between 5 and 7 in the succeeding months. While in the

other regions, the fishing effort has not been as sustained as in region V, a general examination of the tables indicates that the *ghol* fishery tends to be better in the relatively deeper waters (ranges 4-6). It is seen, however, that in the deepest region covered in the present investigations very poor or no *ghol* catches were obtained. It appears, therefore, that the optimum depth range for *ghol* is between 35 and 45 meters.

Koth

Inasmuch as the season of *koth* coincides with that of *dara*, the preference of this fish also seems to be for shallow waters as *dara*. It can easily be seen that in the peak season, there is a great deal of concentration of this in shallower waters and the distribution pattern of *koth* is practically identical with that of *dara*. It may be stated that the highest catch rates for this fish are obtained mostly in depth ranges 1 and 2 between November and March. By May, the fishery seems to be practically at an end although a complete decline is seen in April itself in the first year. The values for catch rates at different depths are in general of a higher order in 1952-53 and 1953-54 than in the first year. The only instance when a very high catch rate has been obtained in the first year was in the month of January in 21-25 meters. In the second year, the highest value has been obtained in 31-35 meter range in the month of December. The catch rates are, however, quite good up to April in most of the depth ranges. In December in all the three depth ranges where sufficient amount of fishing effort has been expended the catch rates are above 200 lb. per hour. There is a slight lowering in January and February but in both these months, the catch rate is above 200 lb. per hour in 21-25 meter range and near about 180 lb. per hour in 26-30 meter range. It is clear from the table that in the second year high values have been obtained quite consistently up to 35 meters. It is interesting to note that in May of this year, a high yield of 147·7 lb. per hour has been obtained in 41-45 meters. In 1953-54, the month of March has yielded the highest catch rate of 935·0 lb. per hour in 21-25 meters. The distribution pattern for this year shows good values for catch per hour up to 40 meters depth and sometimes (*e.g.*, January, February and April) up to 45 meters. The lower figures in April show the commencement of decline in the fishery for the season. As has been shown earlier (in 1952-53 season—month of May), when the fishery extends to the later months of the season, this fish seems to occur in deeper waters.

Wam

In the case of *wam* a good picture of the depth-wise distribution can be obtained from a close study of the data from regions I to III where this

fish occurs in great abundance. Unfortunately, as stated earlier, since the fishing effort in the different depth ranges in these regions has not been very consistent it is not possible to work out any pattern of depth-wise distribution for this fish from the data relating to these regions. Hence an attempt is made to determine the trend of catch rates in different depth ranges in Dwarka region and to find out how far the trends reflect the distribution in the other regions. It may be seen from the Table XIV that with fishing effort of sufficient magnitude, higher catch rates have been obtained in deeper waters whenever depths beyond 40 meters have been worked. As, in this region, the deepest range worked was 41–45 meters, it is observed that high yields, have been in general, between 36 and 45 meters. In those months when the fishing has been beyond 40 meters, the best yields have been either from 46–50 or 51–55 meter ranges. This could be clearly seen in April of 1951–52 season and in April and May 1953–54 season. It may be seen that during seasons when the fish is in great abundance, more fish is caught in waters between 41 and 50 meters, than in the shallower regions. No information is, however, available of the state of affairs beyond 50–55 meters as very little trawling has been done in such deep waters by this boat.

Karkara

As has already been observed, Dwarka region is very rich in this fishery and an idea of the abundance of this fish in various depth ranges can be got from an examination of catch rate trends for this region. It is observed in waters below 30 meters, the catch rates for this fish are low. The yields, in general, are good beyond 36 meters in all the months. The months of good fishery for *Karkara* are April and May in the first year, January, February, March and April in the second year and again April and May in the third year and in these months very high catch rates have been obtained in all the depths from 36 to 55 meters. In April of 1951–52 season, the range of catch rates between 31 and 50 meters is 283·3 to 418·3 lb. per hour. Values above 400 lb. per hour have been obtained in 36–40 and 41–45 meter ranges while in 31–35 and 46–50 meters, the catch rates are 294·2 and 283·3 lb. per hour respectively. In May in the same year the best catch rate was 431·5 lb. in 41–45 meter range, the value in 36–40 metre range being only slightly lower. From January to March, the best yields are from 36–40 meters, although the figures are not as high as in April and May. In the second year, the maximum catch rate was 313·3 lb. in 36–40 meters in the month of February, the next best was in January in the same depth. In the third year, besides April and May, November also appears to have yielded fairly good catch of *Karkara*, the mean values in the three depth ranges lying between 50·0 and 164·5 lb. per hour, the highest figure having been obtained

from 36–40 meters. The distribution in April of this year has been good from 31-50 meters but the best is in the 31–35 meter range (160·5 lb. per hour). The 41–45 meter range has yielded a catch rate of 101·4 lb. per hour. In May this year, the only time when 51–55 meter range has been worked, the maximum yield was from this depth, the catch from 46–50 meters coming very close.

In concluding this section on the distribution by depth of the important groups of fishes, it may be stated that the data are more or less in conformity with the observations made by Hefford (1949). The bulk of the yields is near about the 20 fathom line, with *dara* and *koth* showing relatively greater abundance on the landward side of this line, while *ghol, wam* and *karkara* occur in quantities a little to the seaward side of this line.

VII. Abundance of the Fisheries in Relation to Light and Tide Factors

It is a matter of common belief that tidal periods—the spring and neap tides—caused by the variations in the moon's phases have a great influence on the nature and extent of the inshore fisheries in different regions. It is also well known that during the neap tide periods, the inshore fishing activity is highly reduced at various parts along the coast, the effort required being considered not worthwhile in view of the poor catches expected. The fishing community in Bombay appeared to have long held the view that the fish go offshore, to deeper waters, during the neap tide periods and come inshore again during the spring tide phase. The present offshore data provided us an opportunity to check up how far this common belief can be borne out by actual facts. In the case of the East Anglian autumn herring fishery, Savage and Hodgson (*see* Hickling, 1946 *a*) found that there was a relation between the phases of the moon and the catches of the herrings, " such that the best landings tended to occur at full moon ", and also the success of herring season as a whole depended on the date of the full moon. However, they could not find any regular relation between the moon's phases and the seasonal course of the drift-net fisheries for herring at North Shields and Grimsby. Hickling (1946 *a*), examining the catch data and the lunar phases in detail with reference to the Milford drift-net and trawl herring fisheries, found no sign of lunar periodicity in the winter drift-net fishery, nd also in the summer trawl herring fishery there was no regular and contant tendency for the catches to improve at full moon. He concludes thus: " There is no evidence that the catches in any one season fluctuate with the moon's phases, but it is found that, in seasons when the moon was full in the last 14 days of September, the result of the trawl herring fishery has

almost always been poor". Rounsefell and Everhart (1953), suggest that the lunar cycle influences the size of fish catches in the sea considerably.

Figures 14 and 15 show the catch in lb. per hour of fishing during the spring and neap tide periods during different months of the year 1953–54, by *Taiyo Maru No.* 17 and the bull-trawlers, *Ashok* and *Pratap*, in region V. In the same figures are also shown the average catches per hour during day and night separately in order to examine the possible differences associated with the light factor (day and night). The spring and neap periods as considered in this chapter are periods of about 7 or 8 days centred about the corresponding phase of the moon, with adjustments made in the number of days in order to keep the moon's phase central. Hickling (1946 *a*) has also followed the same method for the demarcation of the lunar phases.

Considering the monthly average catch rates for the spring and neap periods (without taking into account the day and night differences) it may be seen that with regard to 'all fish', the values for months other than January, are higher during the neap tide period (range, 542 to 936 lb. per hour) than during the corresponding spring tide period (447 to 793 lb. per hour). In the month of January, there is a complete reversal of this trend, the catch rate for spring (633 lb.) being higher than that for neap (507 lb.). *Dara* shows a trend similar to 'all fish'. Except in May when the catch rate itself is very low (8·6 lb. per hour in spring and zero in neap), and in January when there is a reversal as in the case of ' all fish ', the yield in neap tide period is higher than that in spring in all the months. The difference between spring and neap values is most marked in November (258·6 lb. per hour in neap and 82·4 lb. per hour in spring). In the case of *ghol*, the neap values are higher than the spring values only in November and May. The difference is maximum in May, when the catch rate for neap tide period is nearly double that for the spring tide (137 lb. and 66 lb. per hour respectively). The trend is just the opposite in December and January, especially so in the former (the values for spring and neap in December being 50·7 and 25·2 lb.). From February to April the catch rates in the two tidal periods are nearly equal. The values for *koth* show that, between November and January, the catch rates for neap tide (208·3 to 411·3 lb.) are higher than those for the spring tides (157·9 to 351·2 lb.). The reverse trend is seen in February and April, the difference not being so marked in the latter month. The catch rates for *koth* for the two periods in March are identical, being 150 lb. per hour. With regard to *wam*, as the yields are themselves low in region V, the pattern of variations during the two tidal periods is not very marked. The only months when the catch rates are appreciable

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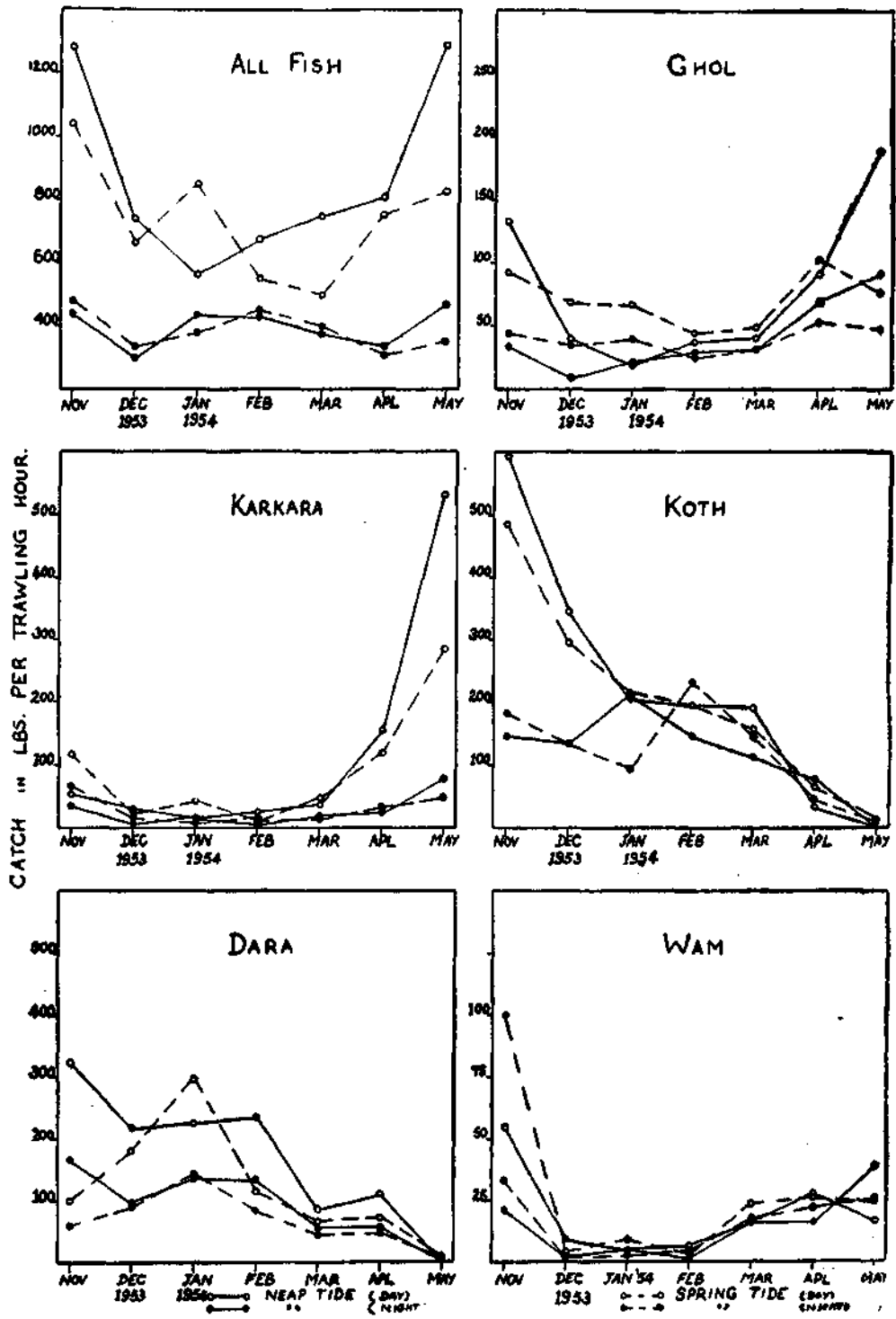
Fig. 14. Monthly day and night catch rates for the spring and neap tide periods during the year 1953-54 (*Taiyo Maru No. 17*).
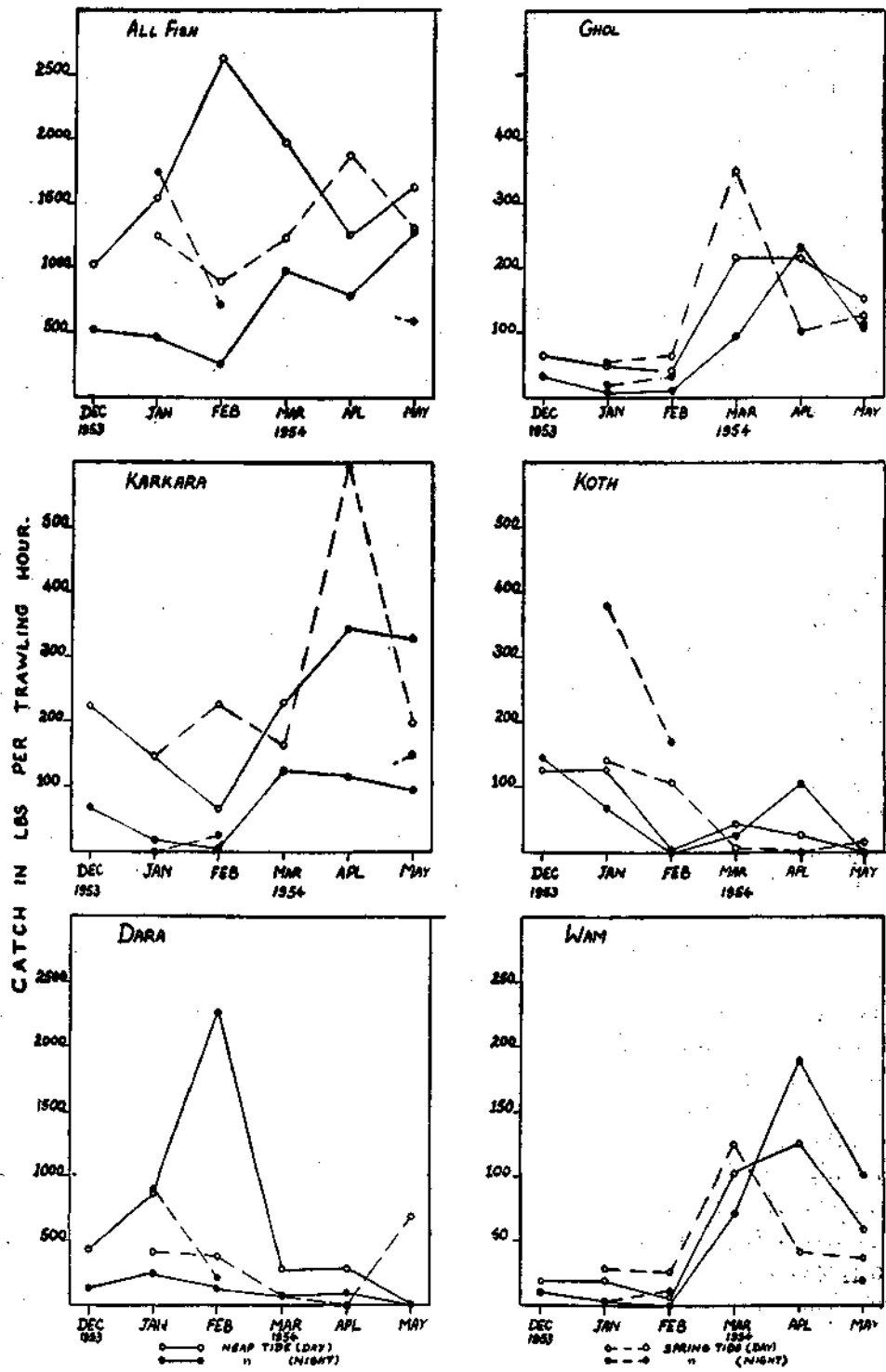
Fig. 15. Monthly day and night catch rates for the spring and neap tide periods during the year 1953-54 (*Ashok* and *Pratap*, bull-trawling).

are November, March, April and May. While in April and May, the values are practically identical in spring and neap tides, in November and March the spring catch rates are higher than the neap values; the spring-neap difference is most marked in November (70·2 lb. in spring and 40·5 lb. in neap). The best season for *karkara* as seen from the catch rates is between March and May and during these months higher yields of this fish have been obtained in the neap tide. In November and January the spring tide values are higher, while in December there is little difference between the catch rates in the two tidal periods. Fig. 14 shows the monthly day and night catch rates (separately for the spring and neap periods) of ' all fish ', *dara, ghol, koth, wam* and *karkara* from the data of *Taiyo Maru No.* 17 for region V during 1953–54. It is seen, in general, that the night catches are of a lower order of magnitude than the day catches.

In regard to day catches, it may be seen that the variations shown by ' all fish ', *dara* and *ghol* are similar to the trends described above. But the differences between the catch rates for spring and neap are more marked in the day catch figures. In the case of *koth*, the neap day catch rates are higher than the corresponding spring tide figures in November, December and March. During January and February the day time catch rates are nearly the same both for spring and neap tides. In April a reverse trend is seen. The day values of *wam* for the months of November, March and May are lower during the neap tide period than during the spring tide periods. In April the values are about the same for both the periods. In other months, the neap catches are higher than those of the spring, although the catch rates themselves are less than 10 lb. per hour. The day catches of *karkara*, during the peak season for this fish (April and May), are higher in the neaps; the highest value (531 lb. per hour) has been obtained in May in the day time during neap tide. The differences between spring and neap tide catch rates during night operations are not so marked as in the day catches. In a number of instances it has been seen that neap tide night figures are either slightly lower than spring night figures or very nearly equal. Thus the *Taiyo Maru No.* 17 data appear to prove, in general, that the yields from trawling are better during neap tides than during spring tides and that the day catches are better than night catches. Fig. 15 shows the monthly average catch rates of the different categories of fish during day and night periods and for the spring and neap tides separately for the bull-trawlers, *Ashok* and *Pratap* for the year 1953–54 in the same region as in the case of *Taiyo Maru No.* 17. Unlike the latter vessel, the bull-trawlers used to suspend operations during the night time, barring a haul or two after sunset. Thus, while a large number of hauls were available to represent the day

values, the night values are here represented only by the few hauls mentioned; the typical midnight hauls being altogether absent. Similarly, the spring tide period also happened to be rather poorly represented compared to the neap tides; the large majority of the bull-trawler fishing falling in the neap tide phase. Perhaps because of this and also because of the different mode and speed of fishing, the trends of values seen in the above figures are somewhat different from the trends seen in the case of *Taiyo Maru No.* 17. Still it appears, in general, true that the neap catches are higher than the spring catches while the day catches are better than the night catches. This is quite well brought out in the figures representing ' all fish ' and *dara*. But there are instances in the case of the other fishes where there has been a very high spring value against a rather low neap value as, for example, in the case of *ghol* in March, *koth* in January and *karkara* in April, and also where the night catches have been higher than the day catches as in the case of *koth* in January and April and *wam* in April. Apart from a consideration of the average values presented here, a close perusal of the haul-to-haul values on the basis of day and night and spring and neap differences does leave a clear impression that the general conclusion arrived at, in the case of *Taiyo Maru No.* 17, is to a considerable extent, borne out by the data of the cutters also. But it is most probable that there may be various other factors associated with bull-trawling as such and influencing the catch rate trends of the individual species. Also it is likely that slight differences in the site of fishing even within the same region or area might introduce such variations. It may be mentioned in this connection that Lucas (*see* Hickling, 1946 *a*) found in the case of the North Sea trawl herring fishery that the average catches increased from midnight to a maximum at midday falling again to a minimum at midnight. But Hickling *loc. cit.*, reports that " Skippers are agreed that herring catches are best at night off the smalls, and by day off Kinsale ", in the former place, Hickling actually saw the catches being best at night. The day and night changes in the catch rates have also perhaps something to do with the feeding habits of the individual categories of fishes and the diurnal vertical movements of these food organisms themselves. The data available on this aspect is, however, very meagre at present.

VIII. RELATION OF THE FISHERIES TO WATER TEMPERATURE

Several authors have referred in the past to the importance of water temperature in determining the size of fish catches. Mackenzie (1934) states that haddock distribution in good quantities had a close relationship with the distribution of temperature ranges, the catches being nil in waters

of temperature below 36° F. and best between 45° F. and 50° F. Hunts-man (1933) has stressed the importance of heat and cold in determining the herring season in Passammaquody. He observed that the catch was lowest in the coldest months and highest in the warmest months, indicating that the warmer the water, the greater the catch. Vladykov (1933) found that high temperatures inhibited the young haddock fishery. He also suggested that fisherman would find the temperature data, taken while fishing, would be a useful guide for their fishing activities. But he also said, " the range of favourable temperature would probably vary within certain limits for different regions and grounds but, on the whole, it will be fairly constant and dependable ". While referring to the Bear Island cod and its distri-bution in relation to temperature, Graham (1951) states that best fishing is associated ·with warmer water during the months of May, June, October and November. But he concludes: " It will be seen that, in our experience so far, we have not found the thermometer to be an aid to fishing in the months of January to April nor July to September. Although further appli-cation of the thermometer may be discovered in the future, it seems that the catches for a good part of the year are governed solely by the migrations of the fish." Mackenzie (1934, 1936) says that there is an optimal tem-perature range for cod and that this varies with the season and with the fishing area, although there is a rather wide range tolerated by this fish. Other workers such as, Kawana (1937) and Doudoroff (1938), also refer to the probable influence of temperature on the variations in the abundance of different fisheries. Nakamura (1954) found that the temperature bears an important relationship to the distribution and migration of the tunas. But he concluded that "while water temperatures which limit the possibility of occurrence of these species can become a controlling factor as regards fishing grounds and fishing seasons, in waters where the temperatures are favourable for their occurrence at all times, we can hardly think that tem-perature has a controlling influence on the establishment of fishing seasons and grounds".

The Japanese skipper on *Taiyo Maru No. 17* was found to be con-stantly taking bottom and surface temperatures apparently for his guidance while fishing and it was brought out during discussions with him that this is a prevalent practice of most Japanese fishermen and that it is extremely useful for obtaining good catches of fishes. While Chidambaram (1950) found that there was some correlation between low mean temperatures and good inshore fishery years for oil sardine along the Malabar Coast, no other instance has been known to the present authors of any established corre-lations between water temperature and fishery in the Indian waters. It also

occurred to us that the rather limited temperature variations found in the Indian trawling grounds may result in the temperature factor being much less effective than in temperate waters in space and time. The temperature and the catch data were available for part of the period of the operations of *Taiyo Maru No. 17* in Indian waters and these data were, therefore, examined to see any possible correlations between temperature and catches in the different fishing grounds.

The monthly mean temperature values of the bottom water of the different fishing grounds (regions I to V) for the periods when both catch and temperature values were available are shown in Table XV. The temperatures are plotted against the corresponding catch rates in respect of the chief categories of fishes in Fig. 16 to show out possible relationships between temperature and catch rate. Unfortunately, there is no continuity in the temperature data available. The lowest monthly value recorded was 22° C. (region V, January 1953) while the highest is 28·5° C. (region I, June 1953), the range of variations being thus only 6·5° C. It will also be seen that, in general, the lower temperature values are characteristic of region V, while the higher temperature values are characteristic of regions I and II, the transition being more or less gradual. The difference between the extreme regions is slightly more in the winter months, December and January, than in the summer months of May and June. The range of variation of the temperature values was a bit more during the year 1953 than during 1952.

An examination of the catch figures with the temperature values seems to indicate the following: *Dara* and *koth* are characteristic fisheries of region V and their occurrence in large quantities is restricted to the months of low bottom temperature. Though both these do occur in the other regions, it seems very clear that as big fisheries they are distinctive of region V rather than any other region. The graphs shown in Fig. 16 refer to region V only. In the figure showing 'all fish,' catches, it is found that in both 1952 and 1953, there are two peaks in the catch rate curve, though in the second year the second peak is rather low. But in both the years, the first peak is correlated with low temperature while the second seems to go with high temperature. A further examination of the catch data shows that the 'all fish' totals during the first part of the season are dominated by *dara* in the first year and *dara* and *koth* in the second year while in second part, *ghol* and *karkara* reduce the importance of these two although *koth* continues to dominate the second portion in the second year. It is seen from the figure that *dara* fishery is closely correlated with low temperature, the best catch being obtained when temperatures were below 24° C.; the *koth* fishery, on the other hand,

TABLE XV

Showing the monthly mean values of bottom temperatures in the different trawling grounds

Regions		1951	1952							1953									
		Dec.	Jan.	Feb.	March	April	May	June	Dec.	Jan.	Feb.	March	April	May	June	Sept.	Oct.	Nov.	Dec.
I	No. of observations	19	..	12	7	..	13	..	..	..	43	..	4	1	6	2	11	..	..
	Mean Temp. °C.	26·4	..	25·0	25·6	..	27·2	..	..	..	25·7	..	27·1	27·0	28·5	27·7	28·0	..	..
II	No. of observations	5	..	3	53	1	..	4	..	..	6	..	1	16	42	88	..	12	..
	Mean Temp. °C.	25·8	..	24·5	24·9	25·9	..	25·5	..	..	24·2	..	26·8	26·9	27·9	27·9	..	26·6	..
III	No. of observations	3	9	..	11	5	21	..	..	..	5	..	1	3	28	11	..	1	..
	Mean Temp. °C.	25·3	24·1	..	24·5	25·0	25·8	..	..	..	23·8	..	26·9	26·9	28·0	28·1	..	27·3	..
IV	No. of observations	33	14	3	..	4	..	31	..	..	1	4	..	57	40	..	..	..	..
	Mean Temp. °C.	25·6	24·4	23·7	..	25·8	..	26·4	..	..	23·5	25·5	..	27·1	27·1	..	..	..	..
V	No. of observations	12	99	71	70	97	48	38	56	131	72	91	144	28	..	..	..	30	10	
	Mean Temp. °C.	24·2	22·8	22·7	24·2	25·4	25·8	26·1	22·4	22·0	23·0	24·8	25·7	27·5	..	..	..	27·0	25·6
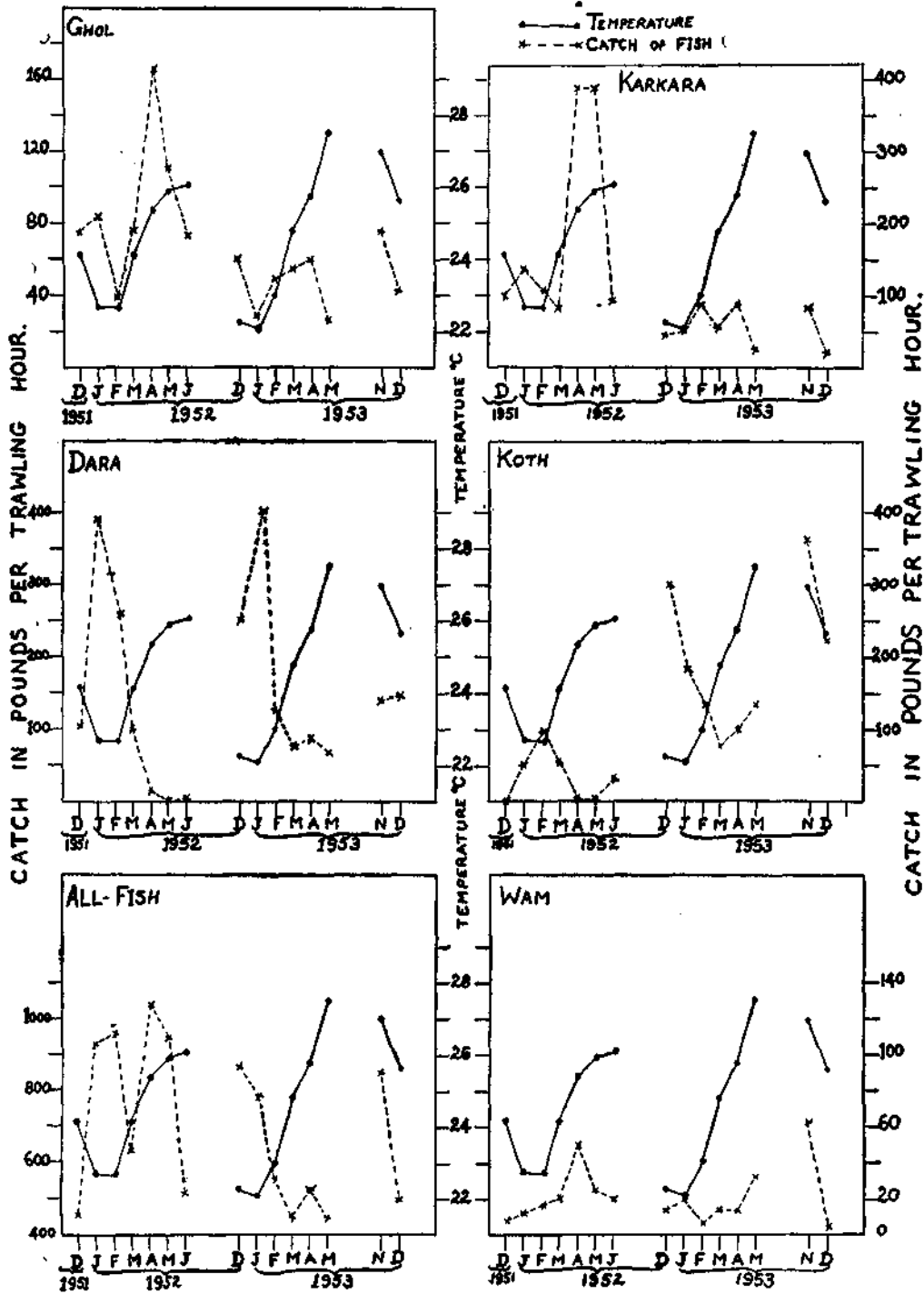
Fig. 16. Graphs showing the monthly mean values of bottom temperature and catch per hour of the different categories of fishes in the Dwarka region during the years 1951-52 to 1953-54 (*Taiyo Maru No.* 17).

shows a less perfect correlation but may be said to be, in general, similar. However, both the *dara* and *koth* figures for November and December, 1953 do not fall in line with this trend. It may be mentioned that in November and December, 1953, the temperatures are higher than 24° C. and it may be seen that the catch rates for *dara* have not reached such high values in these months as in the previous years. In the case of *koth*, on the other hand, the catch rate has actually been the highest in this period (when the bottom temperature was 27° C.); the trend of catch in April and May 1953 is also in line with the rise in temperature values instead of being inverse. *Wam*, *karkara* and *ghol* are less abundant in the colder months; *wam* being more characteristic of regions I to III rather than of region V. The catch rates for *wam* and *karkara* also appear to indicate a kind of reciprocal relationship, high quantities of one being obtained when the other occurs in low quantities and *vice versa*. It is known from experience that the *wam* fishery normally extends from June to October when the temperature is high (27·5–28·5° C.). *Karkara*, while best at high temperature does occur in fairly good quantities at lower temperatures also. The predominance of *dara* and *koth* fishery in region V and of the *wam* fishery in regions I to III may be possibly associated, among other factors, with the temperature range also, which is low in region V and higher in regions I to III. The Table XV also shows that region IV has rather higher temperature values than region V, particularly during the non-summer months. It is extremely interesting that *dara* and *koth* fishery should be practically absent from this region which is adjacent to region V and, if temperature should be responsible for this exclusion, the upper limiting level appears to be very near 24·0° C. However, it is obvious that this cannot be the only factor and it would be very interesting and useful in future to collect more information on the temperature and other characters of region IV in comparison with those of region V.

Figure 16 also shows the correlations of the *ghol*, *wam* and *karkara* catches with the temperature values for the different months. *Ghol* fishery was better in 1951–52 than in 1952–53, the catches being poor in the latter year even during the months of the high temperature. But on most occasions *ghol* catches were high during the months of high temperature, while there are some instances of good catches during low temperature also; this being particularly so in the first year which was a good year for *ghol*. Even when temperature is likely to be a controlling factor, the correlations between the catches and the temperature values may be presumed to be masked to some extent by the magnitude of the fishery in any particular season. While the data collected at present are naturally insufficient to draw any

conclusions, the general pattern of the fisheries and the temperature distri-
bution do indicate the existence of possible correlations between fisheries
of the different fishing grounds and the temperature variations of the same.
The presence of a general seasonal pattern in the fisheries is quite well known
and, among other factors, which contribute to the appearance of such sea-
sonal patterns, temperature changes must be considered very important, if
not critical. The present data have shown different though graded patterns
of temperature distribution among the different regions, and correlated with
these are the differences in the trends of the fisheries also. It seems quite
possible that there are certain definite optimum temperatures limiting the
abundance of the different groups even within the limited range found in
our waters. Here is a problem of great practical importance which needs
further detailed and careful investigation.

IX. GENERAL REMARKS

A few points which have emerged as a result of examination of the data
for the past 6 years are presented below. The annual total landings by
all the trawlers put together from the different regions during the year 1949-50
to 1954-55 are shown in Table XVI. The landings upto 1951-52 have
been mainly from regions I and II and they have been taken only by the
cutters, *Ashok* and *Pratap*. An increase in the landings have been noticed,
in general, during 1951-52 in most of the regions in view of the fact that
Taiyo Maru No. 17 has also joined the fishing fleet. In subsequent years
while regions I and II were visited during the earlier months as well as towards
the close of the season, all the trawlers concentrated on region V during the
rest of the season. In the year 1953-54, when the cutters changed over
to bull-trawling and *Taiyo Maru* also continued her operations, the
overall landings increased considerably, particularly from region V. In
1954-55, the figures of landings are low for all the regions. This should
not however be confused for any decline in the fishery because this was due
firstly to the withdrawal of *Taiyo Maru No. 17* from the fishing fleet and to
the restriction of the fishing activity of the bull-trawlers to a rather short period.
Considering the quantities of fish landed alone, it is seen that the Dwarka
region has yielded the best catch in 1953-54, this being true not only for
the total fish but also for each of the different categories listed in the table.

In regions III and IV, considerable annual fluctuations in the landing
figures are to be expected in view of the irregular trends in the distribution
of effort in those regions. In 1951-52, the highest landings have been
recorded for all fish and several of the individual categories. Certain
interesting landing trends are seen from regions I and II. In region I, the

maximum landings of 'all fish' was in 1951–52, while in region II it was in 1952–53. All of the individual groups except *dara* showed their highest landings in the latter year, this being again due to the joint effort of the cutters and *Taiyo Maru No.* 17. The *dara* landings have shown a declining

TABLE XVI

Showing the total quantities of fish taken out of the different fishing grounds during the years 1949–50 to 1954–55

Years	All Fish lb.	DARA	GHOL	KOTH	WAM	Perches	Cat-fish	Elasmobranchs
1	2	3	4	5	6	7	8	9
I. BOMBAY REGION								
1949–50	1,21,481	22,413	38,519	..	10,612	2,168	28,567	15,295
1950–51	33,655	7,147	7,345	..	4,699	2,679	6,458	3,124
1951–52	2,05,313	11,825	36,495	1,515	86,495	8,350·	12,782	29,059
1952–53	1,43,069	9,824	28,300	1,260	48,175	3,459	29,256	13,135
1953–54	1,57,545	3,036	17,388	1,833	59,627	12,227	18,735	21,428
1954–55	121	0	0	0	0	0	46	75
II. CAMBAY REGION								
1949–50	2,61,576	64,662	66,409	..	24,484	11,963	54,100	30,656
1950–51	3,85,346	86,957	1,20,334	..	33,785	18,127	95,765	32,864
1951–52	4,34,327	61,727	1,19,457	2,010	53,583	17,603	45,263	98,492
1952–53	6,65,301	45,410	1,39,555	7,995	1,53,895	23,528	1,48 292	1,09,762
1953–54	4,00,447	4,629	1,11 086	8 527	1,31,499	9,031	21,214	54,773
1954–55	48,775	261	3,466	132	4,012	5,421	1,985	8,606
III. VERAVAL REGION								
1949–50	6,105	1,016	292	..	511	672	77	2,619
1950–51	3,608	493	953	..	173	18	718	980
1951–52	3,91,342	6,673	59,889	930	1,45,401	15,140	16,125	91,475
1952–53	1,74,767	2,850	18,140	1,170	70,965	2,5ε0	9,785	16,351
1953–54	82,559	723	9,313	1,300	32,171	5,073	3,622	10,686
1954–55	56,497	515	7,319	..	3,217	6,085	11,135	5,497
IV. PORBUNDAR REGION								
1949–50	196	0	0	0	0	0	0	0
1950–51				no fishing				
1951–52	3,04,426	672	12,588	··	36,218	33,734	11,138	57,950
1952–53	1,88,347	..	32,208	..	26,064	29,279	12,725	18,785
1953–54	2,55,836	1,631	31,801	4,757	80,311	22,615	21,578	25,255
1954–55	2,09,920	1,748	18,834	229	12,188	39,186	21,328	28,940
V. DWARKA REGION								
1951–52	12,69,878	2,06,819	1,40,237	48,800	32,391	2,99,055	83,819	1,81,112
1952–53	12,50,392	3,61,335	1,03,310	2,04,760	27,507	1,30,617	1,53,588	74,087
1953–54	20,31,773	4,60,208	1,78,856	4,39,26	71,498	2,53,247	1,55,527	1,66,140
1954–55	1,53,417	56,112	6,988	31,754	2,961	10,459	11,782	8,920

tendency during the later years of the period under review, in these two regions. While the figures of fish landings from different regions are an indication of the fishing effort combined with the availability of the fishes in the respective regions, a better measure of the fishable stocks in the grounds during the fishing season is provided by the catch-per-hour data. The shifting in the density from area to area in the various months and also the changes in the abundance as revealed in the Charts I to X will give a useful picture of the intra-regional trends of the different categories.

Considering the 'all fish' totals for the different years, the figures for the cutters during the first 4 years, were of a lower order due to the low efficiency of the gear. Within these low values, the fluctuations are more in region I than in region II. While *Taiyo Maru No.* 17 yielded high catch rates in both these regions in 1951–52, the rates were lower during the next 2 years. This is partly due to the fact that during the first year this trawler was retaining all the catches without regard to commercial value, while subsequently the uncommercial varieties were thrown out in variable quantities. A similar trend can be seen in the 'all fish' values for the other regions also. Similarly there is a slight fall in the catch rate figures of the cutters also between 1949–50 and 1950–51. This fall must be mainly due to the fact that the fishing grounds in question were being exploited practically for the first time and as Rounsefell and Everhart (1953, p. 73) say, such a decline must perhaps be expected when a virgin fishery with a climax population is exploited. A similar factor may also be operative in the case of *Taiyo Maru No.* 17 in 1951–52 because, that was the first time such an efficient gear was used in addition to the fact that the Dwarka region was first attacked during that year only.

While the catch rates for *dara* in regions I and II after the year 1951–52 show a slight decline, this is not to be considered as significant, because the effort of the trawlers in these regions was not evenly distributed in all the areas of the region during these years. Fewer hauls have been taken in the shallower waters which were apparently favoured by *dara*. But the main point is that the maximum catch rate obtained in these regions in any of the six years under review has been only a small fraction of the mean catch rate for the same fish from region V. An interesting feature of the *dara* fishery of regions I and II as pointed out by Mohamed (1955) is that the inshore *dara* fishery along the Bombay coast consists mainly of the largest size groups (size group V, 83–97 cm.); this group is entirely absent in region V, where, however, the first four groups are all represented, the juveniles and immatures dominating the catches. Mohamed (1955) has suggested

a possibility of some kind of movement between the Dwarka region and Cambay region. He has also observed spent individuals more frequently in the shallower waters of regions I and II. Probably, spawning in the case of *dara* takes place in the shallow inshore waters and the young ones perhaps migrate to offshore waters for further growth. In view of the high concentrations of juveniles in the Dwarka region it is quite possible that this region constitutes a big nursery ground for the *dara* fishery of this coast. Apart from the consideration as to whether any or all of the inshore *dara* fisheries currently exploited along this coast may be directly derived as a result of recruitment from the above grounds, the question arises as to how far it would be rational to continue exploiting the juvenile fishery without restriction indefinitely. This question becomes all the more important when we consider the fact that the exploitation of the inshore *dara* fishery along the Bombay coast has increased at a very rapid pace during the past 3 years, consequent on the introduction of powered craft. These powered vessels which numbered only 23 in 1951–52 rose to 90 in 1952–53 and 256 in 1953–54 (Bombay Fisheries Administration Reports 1951–52, 1952–53 and 1953–54). The landings of *dara* amounted to 4,06,862 lb. by these vessels in 1951–52; in 1952–53, the total was 10,65,398 lb. while in 1953–54 it was 18,58,098 lb. The landings in 1953–54 would actually be much more than these figures in view of the fact that 114 out of 256 of the powered vessels did not supply the catch statistics during this year. The quantities of *dara* brought by carrier launches also deserve attention in this connection. In 1949–50, 41 launches brought a total 2,38,441 lb., the average per launch being 5,816 lb. In 1951–52, 20 launches brought 95,300 lb., the average being 4,765 lb. In 1952–53, 18 launches brought 74,784 lb. which works out to 4,155 lb. per boat. In 1953–54, 17 launches brought 20,500 lb. yielding an average of 1,206 lb. per launch. The Bombay fisheries Administration Reports for 1952–53 and 1953–54 give the catch rate figures for sailing vessels and power crafts. It is seen from these that the catch rate of *dara* per sailing vessel has declined from 462 numbers in 1952–53 to 124 numbers in 1953–54; the decline is also seen though to a less marked extent in the case of powered vessels also from 1,900 numbers per vessel in 1952–53 to 1,409 numbers per vessel in 1953–54. Along with the *dara*, it has also been noticed that the *koth* fishery of region V is also predominantly a juvenile fishery. Nothing can be said definitely regarding the rationalisation of these fisheries until the life-history and biology of the species are fully known. A close watch on the fishery trends of these grounds, however, appears to be very essential particularly because during all these years the trawlers have been concentrating their activity mostly along the 20 fathom contour

line—the extreme limits of fishing being 15 and 30 fathoms, there being more scope for, but actually less of, fishing activity in the deeper waters.

Regarding *ghol* and *wam*, while some fluctuations are noticed, there are no clear pointers either towards a noted decline or any undue exploitation of juveniles in any of the grounds.

A glance at the table will indicate that the catfishes and Elasmobranchs form a good proportion of the catches particularly in regions I and II. Among the Elasmobranchs the rays have been predominant in region II and these and the catfishes are commercially of a poor quality. As already mentioned, the actual quantities caught of these varieties and also of small fishes such as *doma* and other miscellaneous categories were much more than the retained catch, the quantities retained being dependent upon the availability or otherwise of the better quality fishes during the voyages concerned. The previous trawling attempts in this region have also brought out the dominance of these uneconomical varieties (Sorley, 1948; Hefford, 1949). While at present, these categories of fishes are not proving commercially attractive their importance will be increased if a market is created for them as raw material for fish-meal and other by-products. Apart from the fact that variable quantities of the uneconomical varieties were thrown out by the *Taiyo Maru No.* 17 during her voyages, there are other factors which introduce some differences in the percentages of the different categories as between the cutters and the *Taiyo Maru No.* 17 even while fishing in the same grounds and during the same period. These are connected with the variations in the size and type of gear and speed of trawling (Margetts, 1951; Hickling, 1931). It has thus been found that among the bull trawler catches from region V during 1953–54, there was a slightly higher percentage of the commercially valuable fish than in the case of *Taiyo Maru No.* 17 in spite of the fact that the figures of the latter do not include the discarded poor quality fish. Tables XVII *a* and *b* make this clear. How exactly such differences are introduced in the capturing capacity of the two nets is a matter for separate investigation.

A close study of the charts showing the catch-per-hour data of *Taiyo Maru No.* 17 and bull-trawlers from the individual areas in comparison with the fishing effort data shows that there are a number of areas where there appear to be potentialities of good catches but the effort has not been sustained, this being a consideration apart from the fact that, in general, the deeper waters are yet to be fully explored. In the Dwarka region alone, it is the areas K and M which have been exploited most, although it would appear from the data available that areas L and N which include slightly

deeper regions have also good potentialities. In regions III and IV which have, in general, been trawled only occasionally, there is an indication that good catches can be obtained by further exploration. Area A, for instance, gave a catch-per-hour of 1,357 lb. in November 1951 in the case of *Taiyo Maru No.* 17. Area 2, yielded a catch per hour of 2,133 lb. in the same month. Fairly good catches are similarly shown frequently in areas E, D, and 3. In region II, areas 24, 25, 26, 11 and 10 seem to be similarly promising, areas 11 and 10 particularly so.

TABLE XVII *a*

Showing the comparative statement of the landings of Taiyo Maru No. 17
(277·3 tons; *otter-trawling*) *and the cutters* Ashok *and* Pratap
(135 plus 135 *tons; bull-trawling*) *from the*
Dwarka Offshore Fishing grounds

(Areas K, L, M and N)

Months and Year	Actual fishing time		Total catch (in lb.)		Catch per hour		Percentage of good fish*	
	Taiyo Maru No. 17	*Ashok and Pratap*	*Taiyo Maru No.* 17	*Ashok and Pratap*	*Taiyo Maru No.* 17	*Ashok and Pratap*	*Taiyo Maru No.* 17	*Ashok and Pratap*
	Hrs. Min.	Hrs. Min.	lb.	lb.	lb	lb.		
December 1953 ..	456 45	52 49	2,34,100	50,643	512·5	958·8	75·86	84·18
January 1954 ..	324 35	91 55	1,95,000	1,22,720	600·8	1,335·1	80·12	80·80
February 1954 ..	308 40	103 24	1,71,700	1,37,771	556·3	1,332·4	77·05	83·19
March 1954 ..	369 45	95 21	1,81,450	1,61,666	490·7	1,695·5	67·05	45·12
April 1954 ..	226 20	80 12	1,29,550	99,589	572·4	1,241·8	57·40	79·48
May 1954 ..	260 05	60 02	1,82,250	91,634	700·7	1,526·5	51·17	44·31

* *Good Fish*—please see Table No. XVII *b*.

A comparison of the present results with the previous trawling experiments in the other parts of the Indian coast and also in Pakistan waters (*see* Qureshi and Burney, 1952; West Bengal Government, 1951; Gopinath, 1954; Hornell, 1915, 1916; Sundara Raj, 1931 and 1933) has shown that the following are the contributory factors for the commercial success of the recent trawling operations in the Bombay and Saurashtra waters.

1. During all the previous trawling attempts, not only was the catch rate found to be very low, but also the composition of the catches has been

TABLE XVII b

Percentage composition of the different categories of Good Fish *in the landings of* Taiyo Maru No. 17 *and the cutters* Ashok *and* Pratap

Month and Year	Trawlers	Pomfret	RAWAS	DARA	GHOL	KOTH	WAM?	Perches (KARKARA AND TAM)
December 1953 ..	*Taiyo Maru No.* 17	1·11	0·40	28·12	8·13	44·09	0·75	3·46
	Ashok and Pratap	0·28	..	41·54	5·92	13·19	1·71	21·54
January 1954 ..	*Taiyo Maru No.* 17	2·17	0·76	36·12	7·39	28·75	0·85	4·08
	Ashok and Pratap	3·41	0·75	52·94	3·32	9·31	1·24	9·83
February 1954 ..	*Taiyo Maru No.* 17	2·71	0·15	31·60	5·98	32·47	0·79	3·35
	Ashok and Pratap	2·92	0·04	56·67	3·85	6·44	1·36	11·91
March 1954 ..	*Taiyo Maru No.* 17	1·29	0·22	12·87	7·74	30·99	3·91	10·03
	Ashok and Pratap	0·30	0·28	12·68	11·90	2·07	5·68	12·24
April 1954 ..	*Taiyo Maru No.* 17	0·09	0·43	12·89	14·09	9·25	4·14	15·71
	Ashok and Pratap	1·89	0·36	19·61	16·80	2·77	10·36	27·69
May 1954 ..	*Taiyo Maru No.* 17	0·04	..	1·00	11·56	1·20	3·73	33·64
	Ashok and Pratap	6·55	0·26	4·41	9·35	0·09	3·87	19·78

such that a large percentage was constituted by rather small and often un-commercial categories. In the trawling operations now under discussion, though during the first 2 years, the overall catch rates were found to be low, subsequently, not only have the rates been high, but also they have been sustained; this is particularly true of the Dwarka region, the catch composition also being such in this region that a very large percentage is constituted by first quality fishes. In the other regions also the percentage of good quality fish has not been found to be as discouraging as during previous trawling experiments.

2. The better yield noticed in the present experiments has been made possible, firstly by the introduction of a more efficient gear than ever before and secondly, by a wider range and a longer duration of the exploration involved. During all the previous efforts, the cost involved in the initial experiments has been so heavy that the initial failures resulted in the termination of the trawling experiments. It has now been found that in Indian waters, the V-D type trawl operated by *Taiyo Maru No. 17* was a better gear than the Hoover and Peter-Carey trawls used earlier and that the bull-trawl is even more efficient than the V-D trawl. It has long been known that the Vigneron-Dahl gear catches more fish than otter-trawl (Russell, 1942 and Hickling, 1931). Hickling (1946 *a* and *b*) has shown that (i) the fishing capacity of a steam-trawler bears a simple and direct relation to its gross tonnage; (ii) Diesel engine-trawlers have a higher fishing capacity than steam-trawlers; (iii) when two small otter-trawlers are used together for bull-trawling (Pareja net), the catch-per-hour of these is much higher than that of a large (Castle-type) otter-trawler; and (iv) the greater the density of fish in the grounds, the greater will be the superiority of a large trawler over a small one. Among these findings lies the explanation for the good results obtained by *Taiyo Maru No. 17* (V-D otter-trawling) and *Ashck* and *Pratap* (bull-trawling).

3. Among the grounds visited, the Dwarka region stands as a category by itself and while it was touched by *William Carrick* on a few occasions during her voyages, the existence of this bank as a rich fishery ground has been discovered for the first time during these recent experiments. A comparison of the catch figures of this region with those of some of the other parts of the world (Anon, 1936) indicates that the Dwarka Offshore Fishing grounds compare favourably with some of the richest grounds of the world.

X. SUMMARY

1. Detailed analyses of the results of the trawling operations in the Bombay and Saurashtra waters during the 6 years, 1949-50 to 1954-55, are presented and

discussed. Besides the total landings and catch rate data relating to the chief categories of fishes, their distribution in relation to depth and also their abundance in relation to the temperature, light and tide factors are discussed.

2. Five main trawling grounds, are recognized, namely the Bombay region, the Cambay region, the Veraval region, the Porbundar region and the Dwarka region, each consisting of a number of smaller rectangular areas which are fixed on the basis of latitude and longitude. From the year 1951–52 onwards, trawling was done more in the Dwarka region than in the other regions. During the earlier years there was a greater concentration of fishing activity in the Bombay and Cambay waters.

3. The landings in the earlier years were rather low as the Government cutters were the only vessels doing trawling. During the later years the landings increased enormously partly due to the entry of other vessels into the fleet and partly owing to the conversion of the Government cutters into bull-trawlers.

4. The monthly catch rate trends of the chief categories of fishes are charted in detail for the different areas. Of the fishing regions, the Dwarka region has proved to be the richest and has provided, in general, the best landings as well as total catch rates. This region has also been the best for *dara* and *koth* fisheries. *Wam* fishery has been the best in the Cambay and the Veraval regions. *Ghol* occurs in considerable but varying quantities in all the regions but *karkara* has been seen to occur mainly in the Porbundar and the Dwarka regions.

5. The study of the depth-wise distribution has shown that the bulk of the yields is nearabout the 20 fathom line with the *dara* and the *koth* showing relatively greater abundance on the landward side of this line while the *ghol*, the *wam* and the *karkara* occur in quantities a little to the seaward side of this line.

6. It may be said that, in general, the yields of day trawling are better than those of night trawling and also that the catches tend to be better during the neap tide periods than during the spring tides. Slight differences in trends are noticeable between *Taiyo Maru No.* 17 data and the data of the bull-trawlers and it is suggested that these are due to differences in the gear and speed of trawling.

7. An examination of the catch rate and the temperature data of the different regions has shown that there are different, though graded, patterns of temperature distribution among the different regions and that, correlated with these there are differences in the trends of the fisheries also. It seems possible that there are certain definite optimum temperatures limiting the abundance of the different fishes even within the limited temperature range found in our waters.

8. The *dara* and the *koth* fisheries of the Dwarka region are essentially juvenile fisheries. The possible effect of their exploitation on the inshore fisheries is to be investigated.

9. Catfishes and Elasmobranchs form a good proportion of the catches in the Bombay and the Cambay regions.

10. The introduction of a more efficient gear than ever before, in the form of the Vigneron-Dahl trawl and the bull-trawl and also more sustained efforts than at any time previously, are responsible for the remarkable success of the recent trawling operations. While the V–D trawl has been known to yield very good catches as compared to the otter-trawl, the *Ashok* and *Pratap*, while doing bull-trawling were able to catch on an average as much as 2½ times as the *Taiyo Maru* while fishing in the same grounds in the same season.

11. The existence of the Dwarka region as a rich fishery ground has been discovered for the first time during the operations reviewed in this paper. A comparison of the catch figures for this region with those of some of the other parts of the world shows that it compares favourably with some of the richest grounds elsewhere.

XI. Acknowledgements

Charts.—The Charts I–X on the following pages represent mean monthly values (in lb.) of the catch of fish per hour of trawling during bull-trawling by M. T. *Ashok* and M. T. *Pratap* in the years 1953–55.

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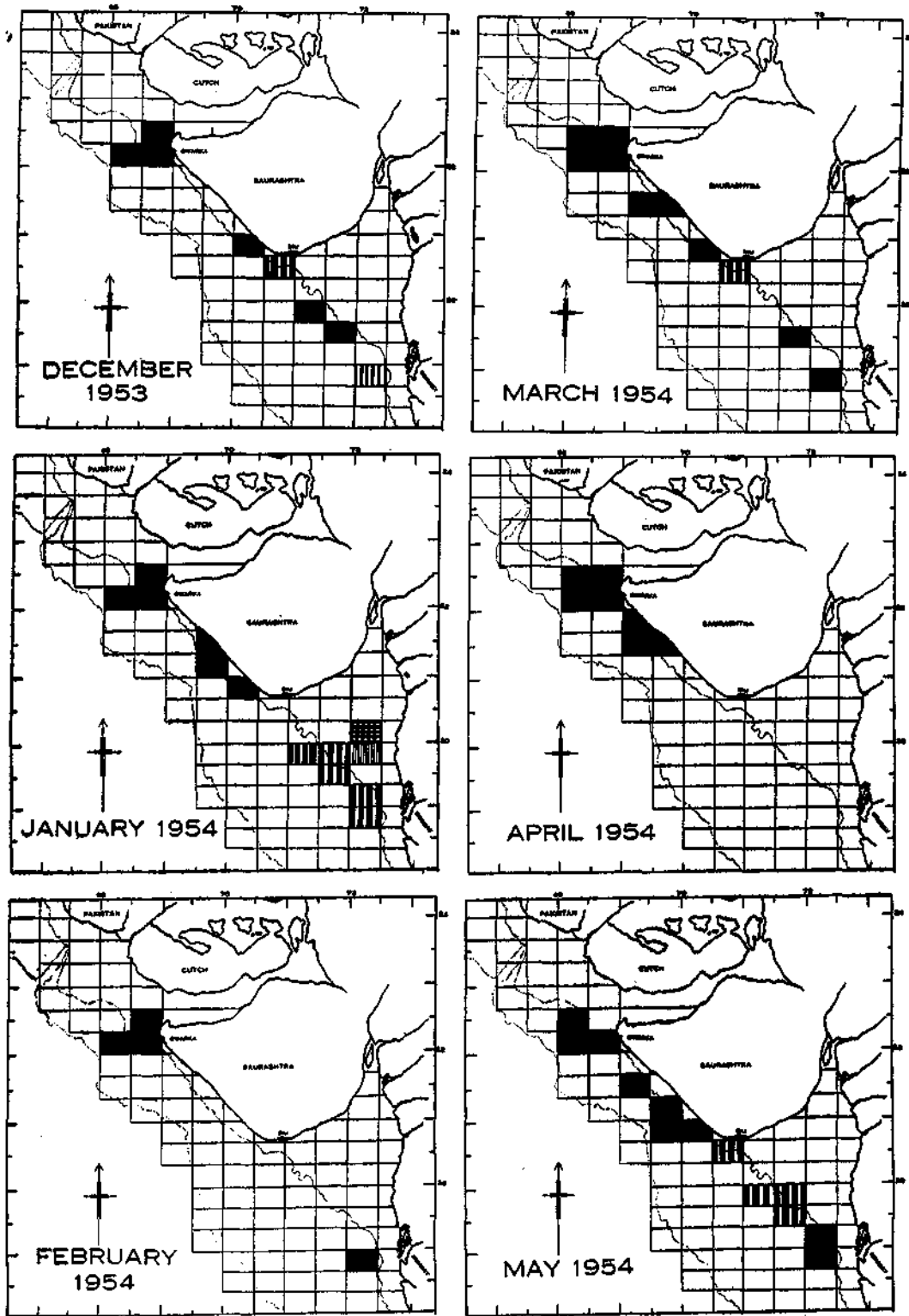
CHART I. Catch per hour during 1953-54—ALL FISH
(For key to shading, *see* Chart II)

KEY TO SHADING

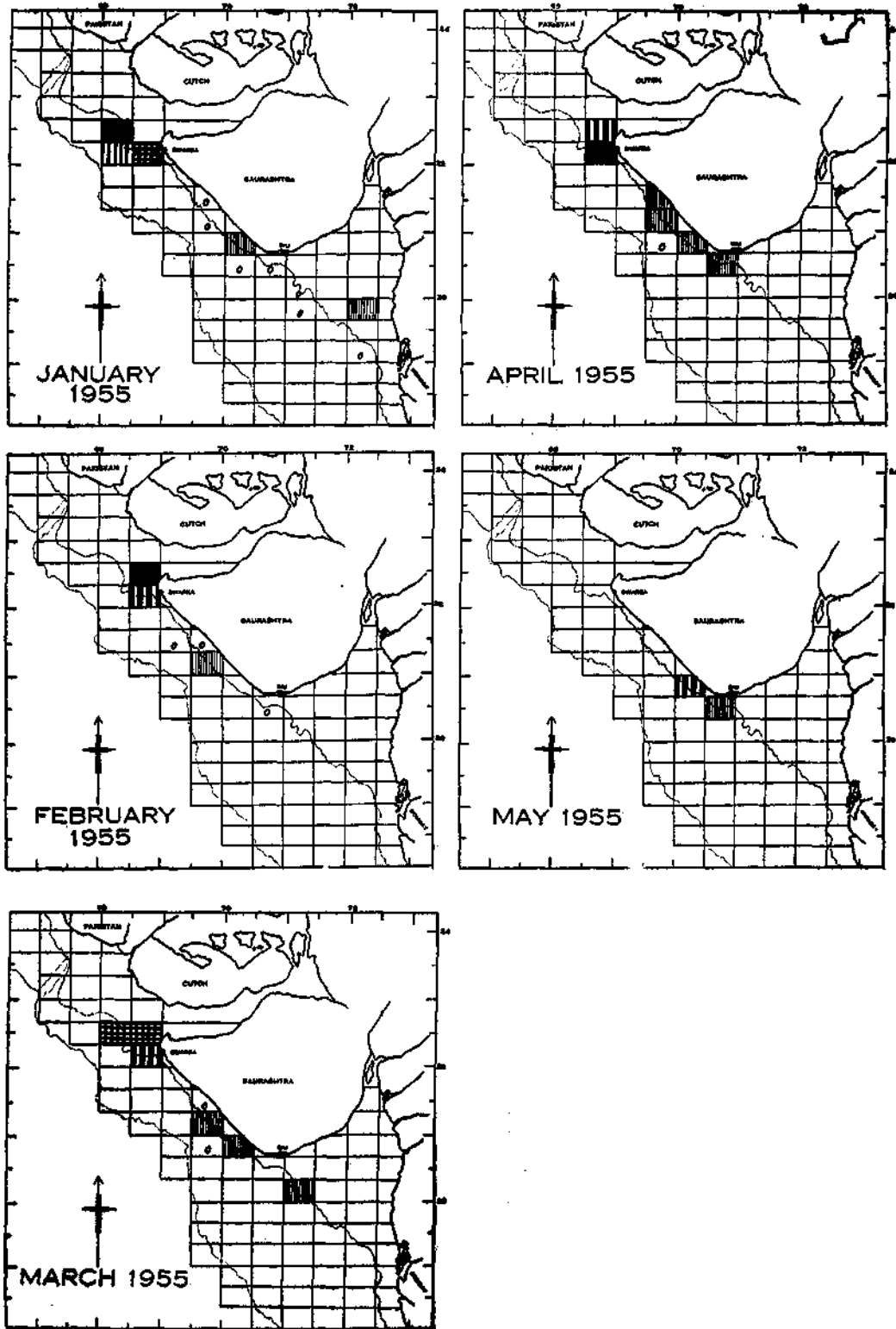|	
■	ABOVE 1000 LB.
	501 TO 1000 LB.
	201 TO 500 LB.
	101 TO 200 LB.
	51 TO 100 LB.
	1 TO 50 LB
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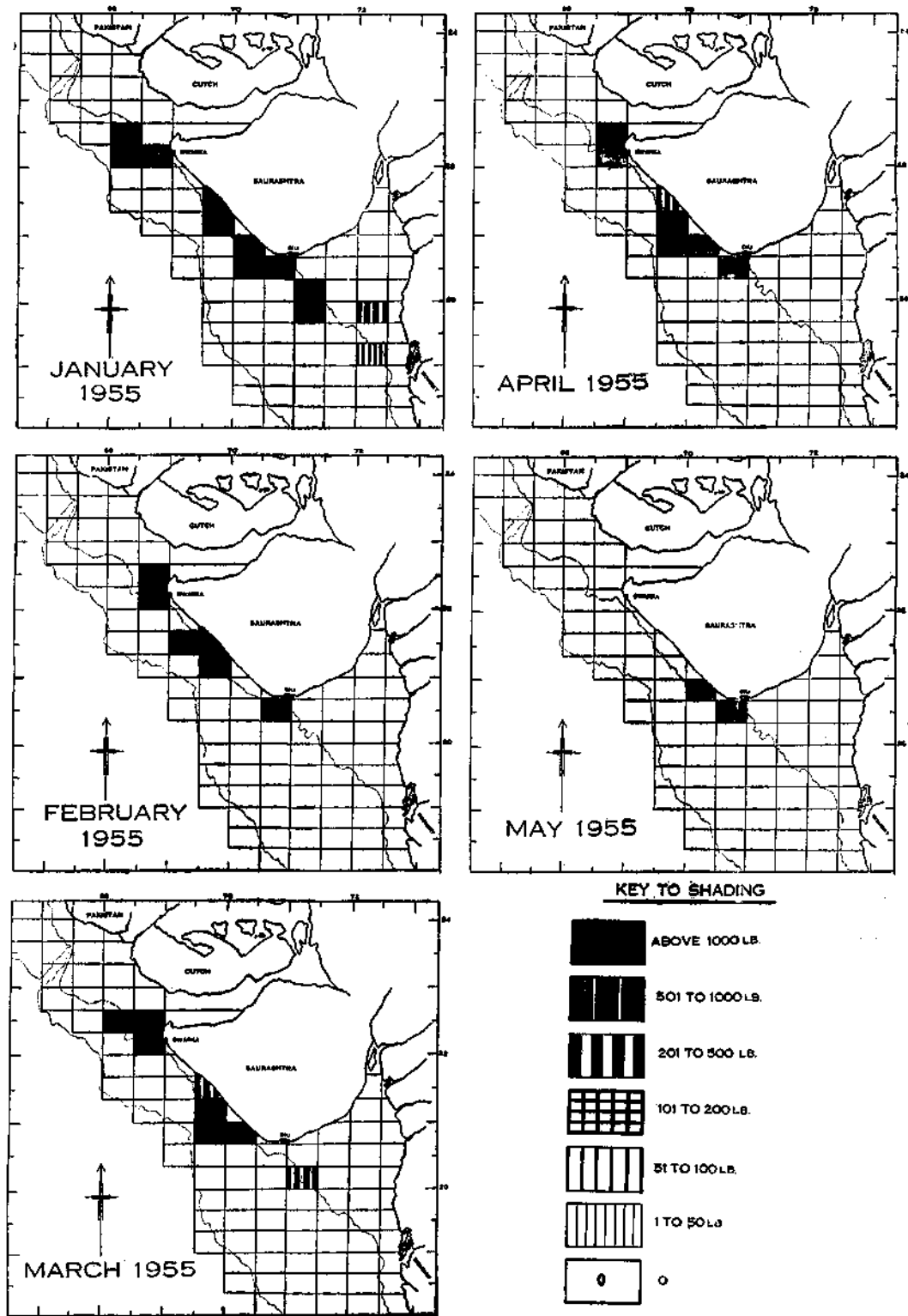
CHART II. Catch per hour during 1955—ALL FISH
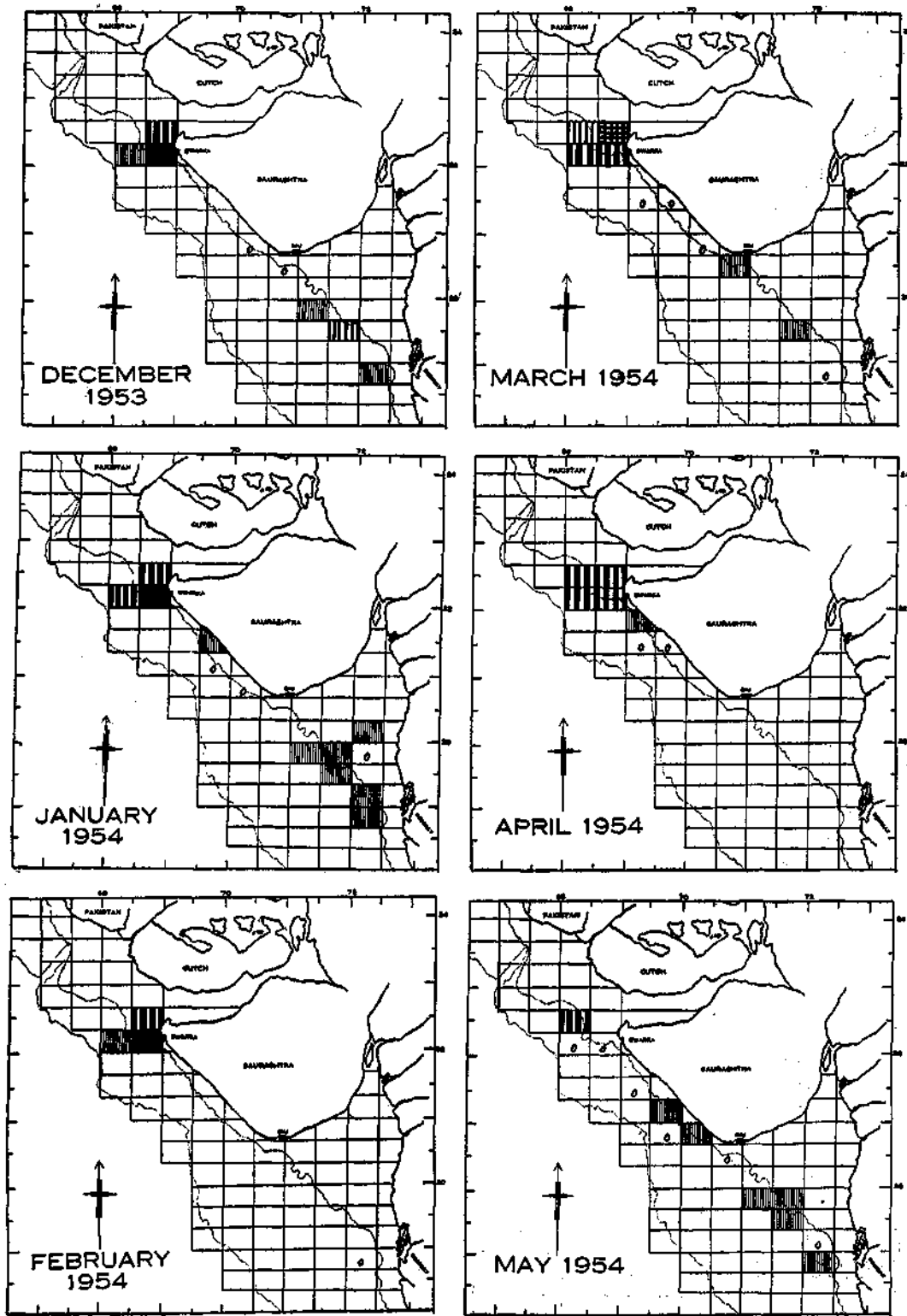
CHART III. Catch per hour during 1953-54—DARA
(For key to shading, *see* Chart II)

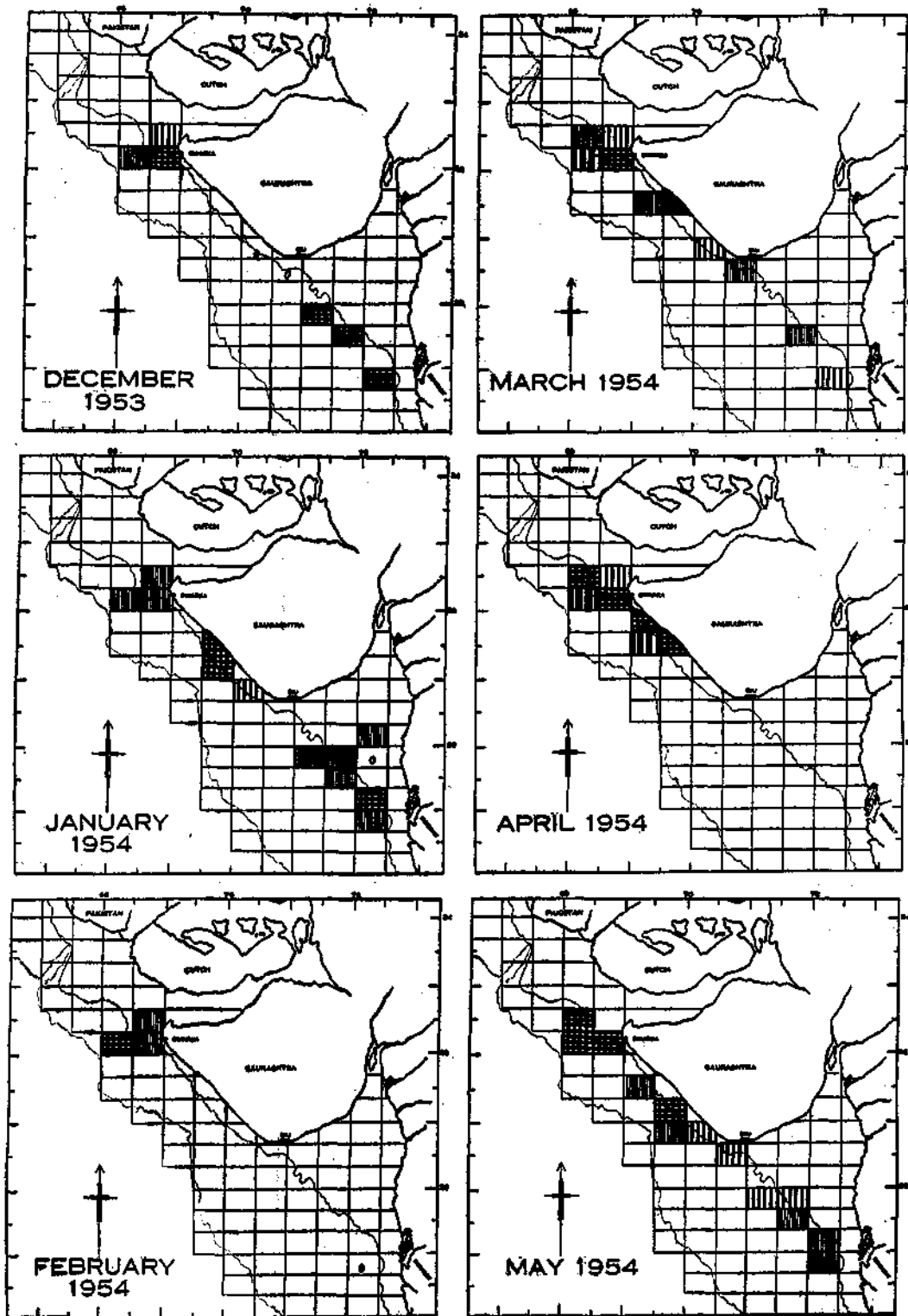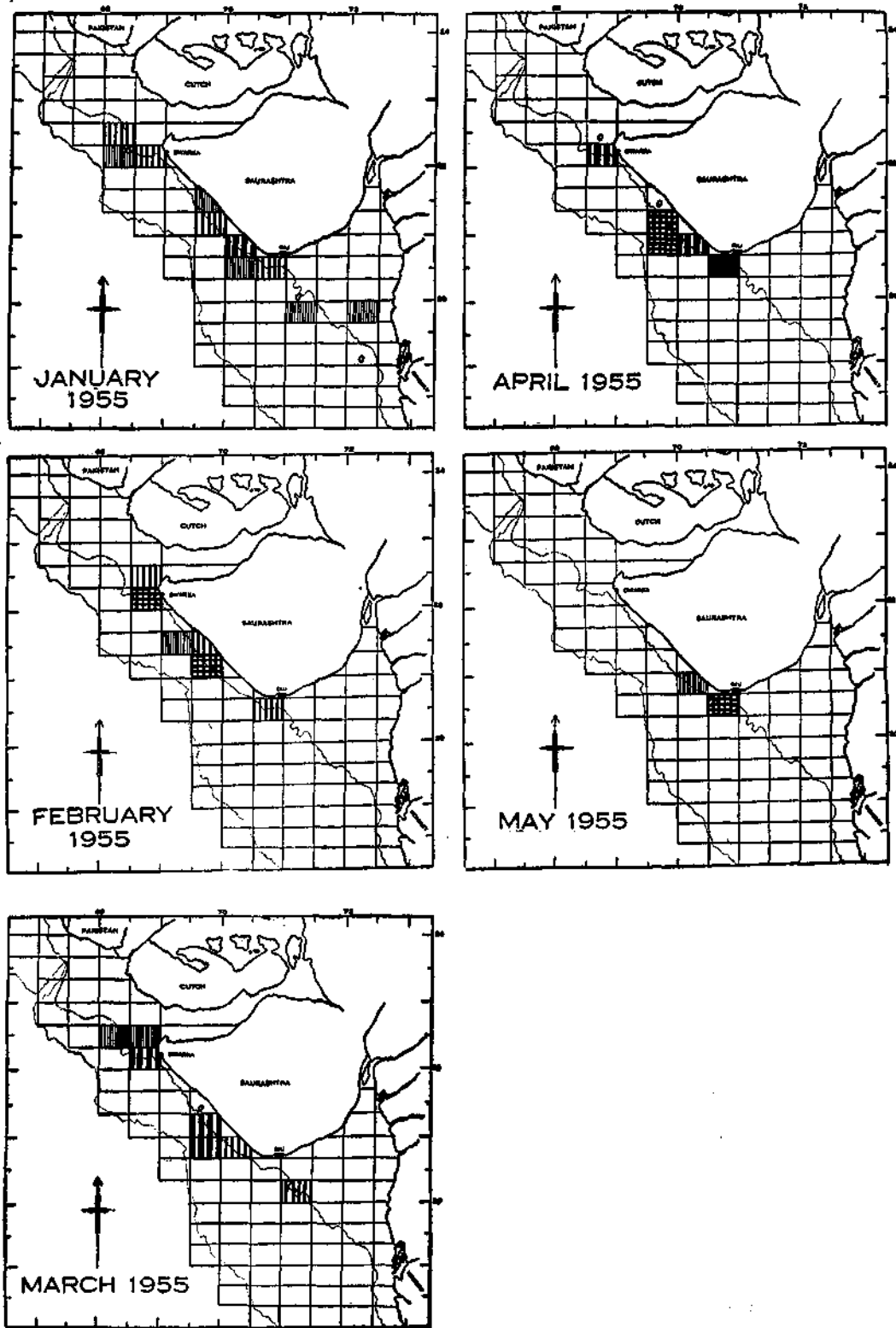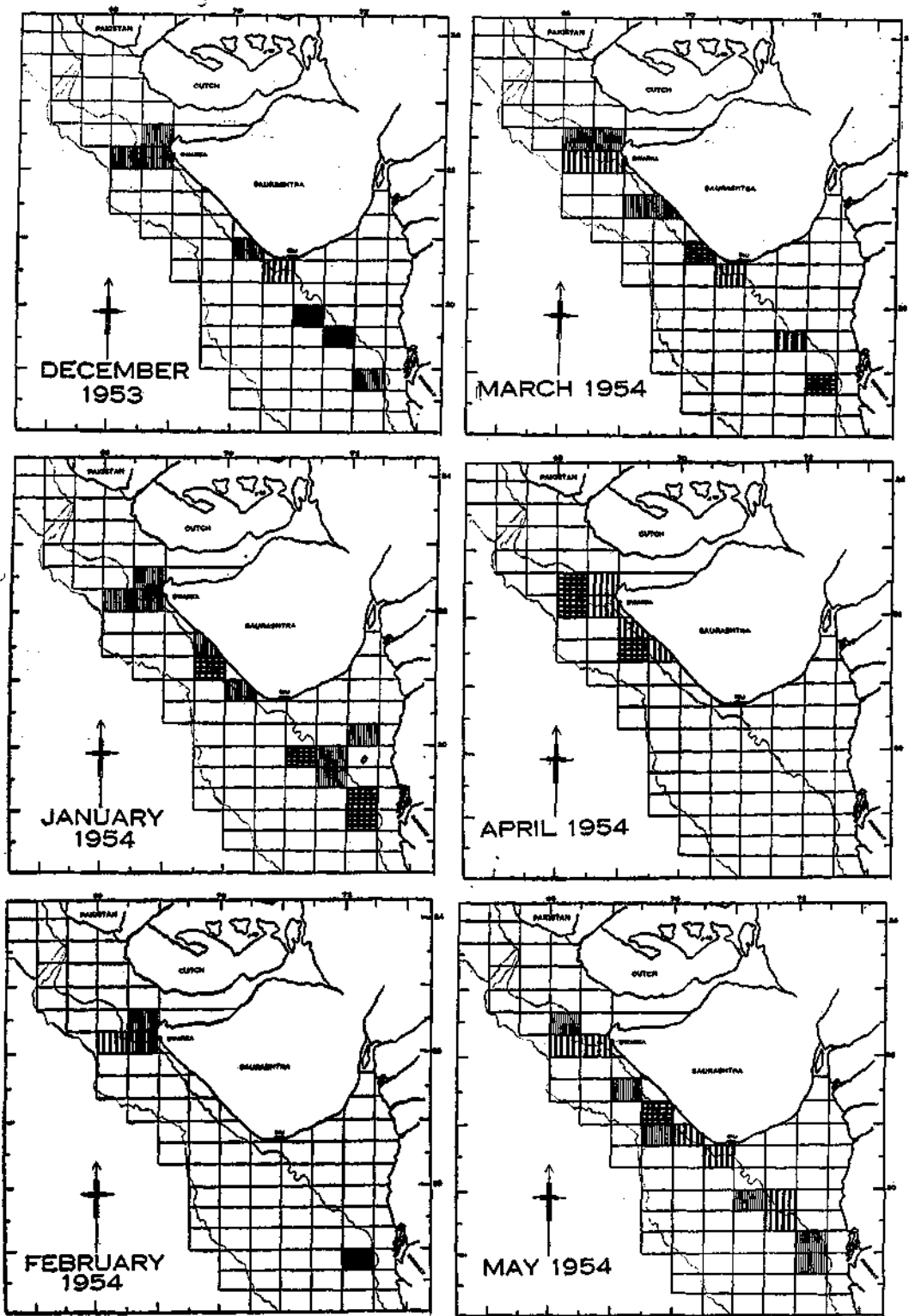CHART IV.   Catch per hour during 1955—DARA
(For key to shading, see Chart II)

CHART V. Catch per hour during 1953-54—GHOL
(For key to shading, *see* Chart II)

CHART VI. Catch per hour during 1955—GHOL
(For key to shading, see Chart II)

Chart VII. Catch per hour during 1953-54—WAM
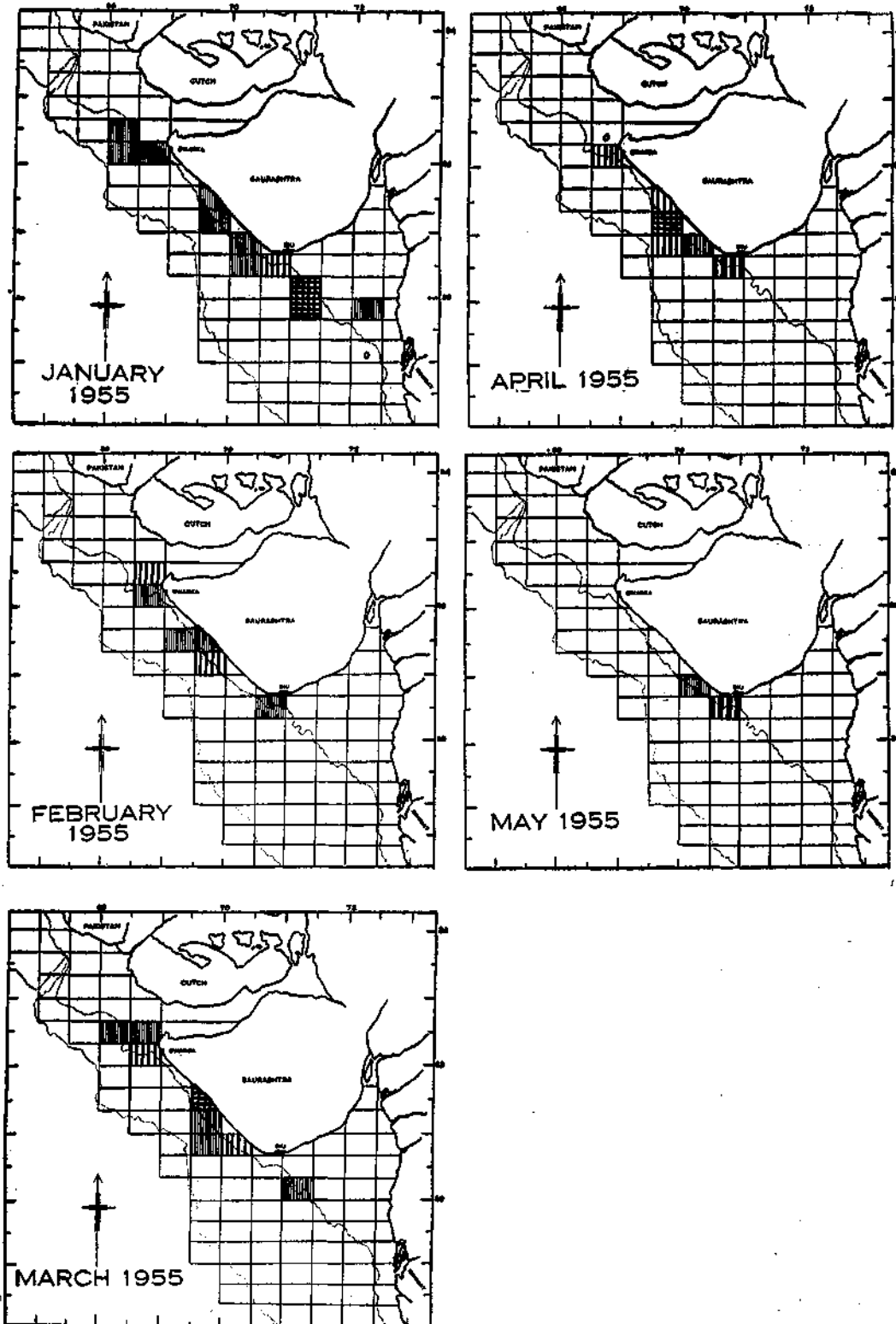(for key to shading, *see* Chart II)

Chart VIII. Catch per hour during 1955—WAM
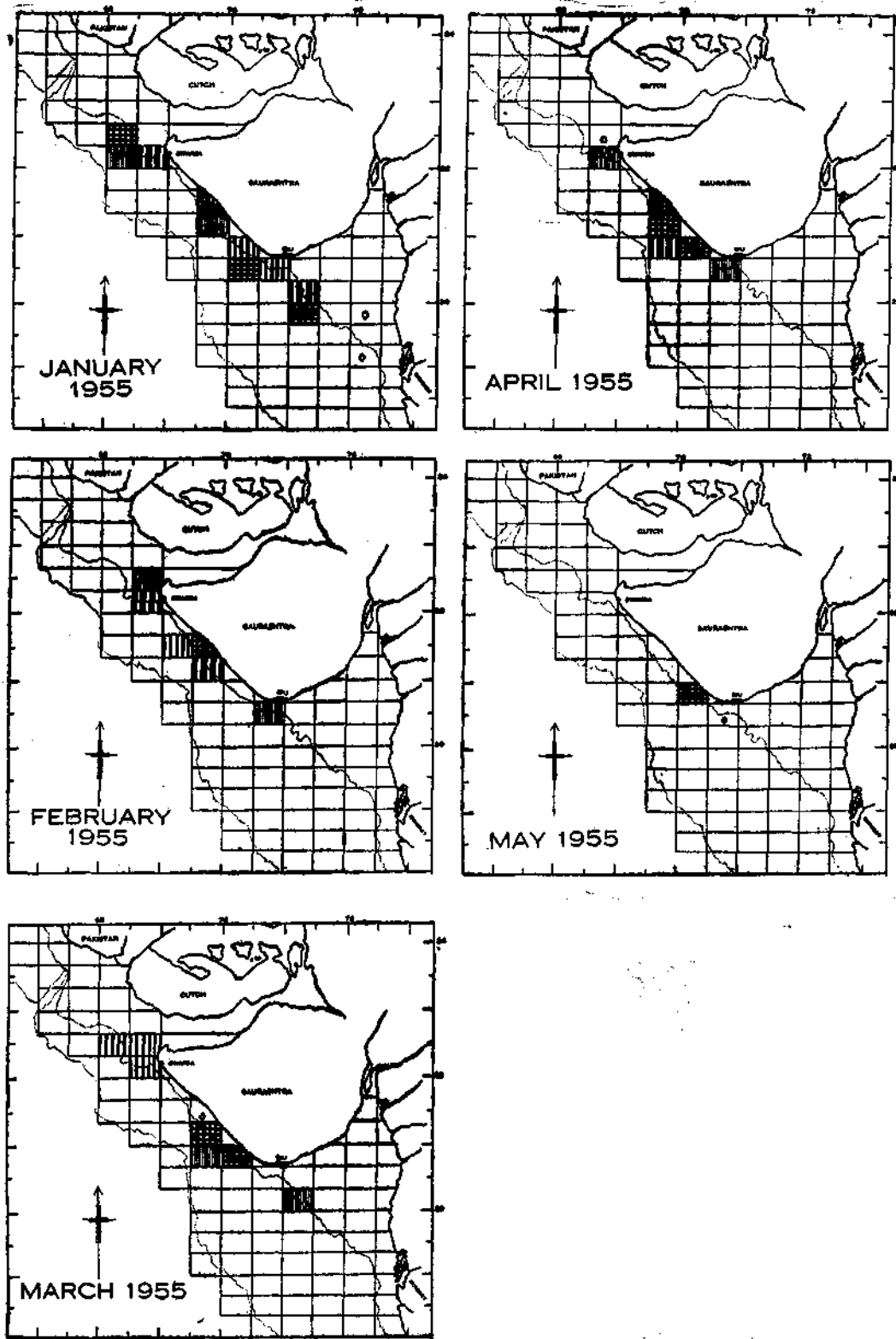(For key to shading, see Chart II)

CHART IX. Catch per hour during 1953-54—KARKARA
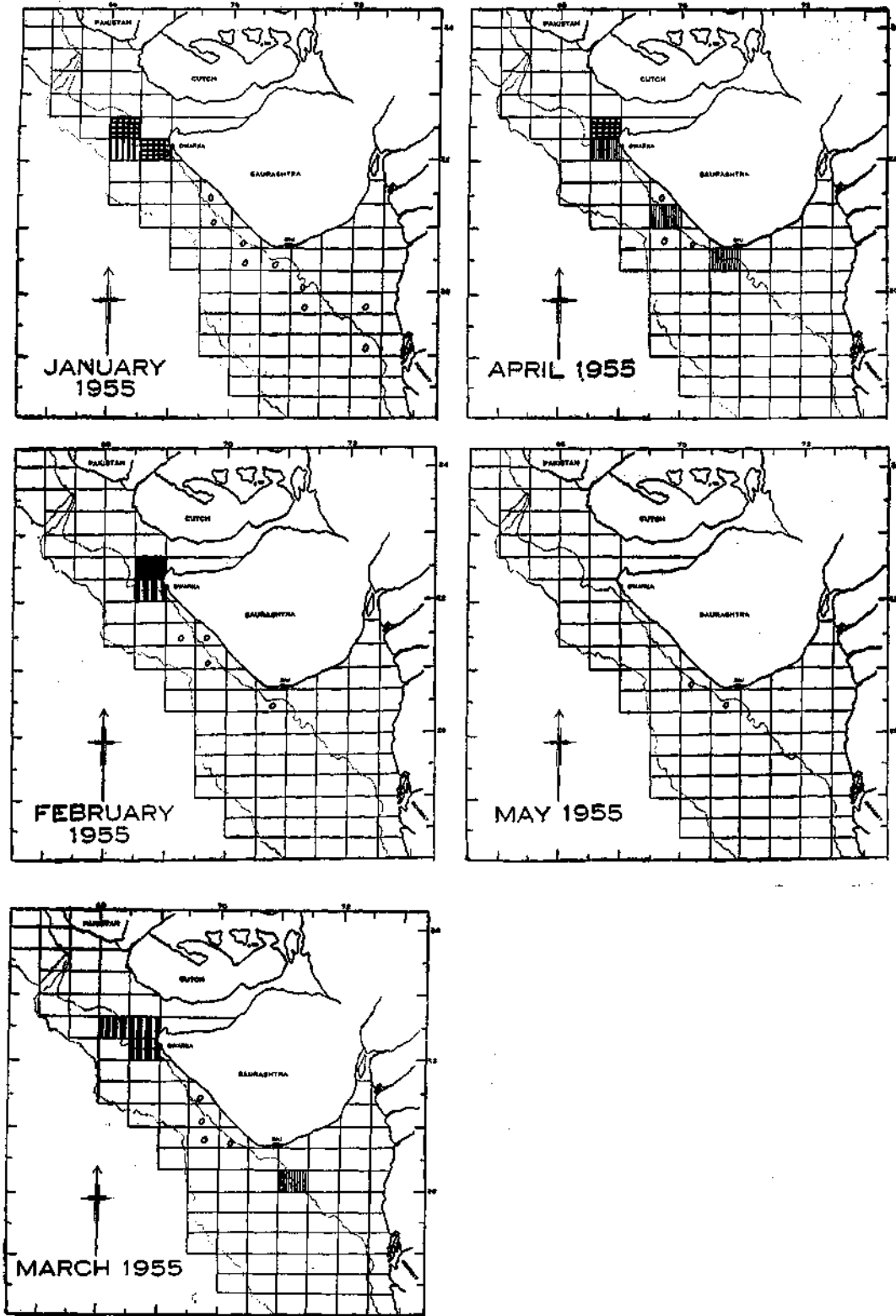(For key to shading, *see* Chart II)

CHART X. Catch per hour during 1955—KOTH
(For key shading, *see* Chart II)