

## EXPLORATORY TRAWLING OFF GOA BY THE GOVERNMENT OF INDIA FISHING VESSELS

K. VIRABHADRA RAO AND K. DORAIRAJ

*Central Marine Fisheries Research Institute; Regional Centre, Mandapam Camp*

### ABSTRACT

The fish catch data of the Government of India vessels *M. T. Kalyani IV* and *M. T. Kalyani V* trawling off Goa during November - December 1967 and March - April 1968 have been analysed and the area and depth-wise distribution of the fishes is presented in the paper, along with an estimate of potential yield by employing the "sweep method".

Altogether 25 sub-areas under major areas 15-73 and 16-73, between lat. 15°N and 16°30'N were fished. For a fishing effort of 347.58 hours, 175, 446 kg of fish were netted at a catch rate of 504.76 kg/hr. Most of the sub-areas have given an average over 350 kg/hr up to a maximum of 821.67 kg/hr. Sub-areas 15-73/2E, 3D, 4A, 4C, 4E, 6C, 6D, 16-73/1B, 2B and 3B are considered very productive in the region.

About 80% of the catches was constituted by small sciaenids (52.79%), catfishes (14.91%) and elasmobranchs (12.55%). Quality fishes *Lactarius* and pomfrets constituted 7.82% and 1.69% respectively and prawns formed 1.43% of the catches.

The bulk of the catches (55%) came from 21-40 m depth zone. The catch/hour returns were very high in 31-40 m. A second peak at 61-70 m for total fish was also noticed.

The potential sustainable annual yield for the shelf area between 15°N and 16°30'N has been estimated at 28,535 tonnes which indicates a good scope for an increase in the fishing effort.

### INTRODUCTION

Exploratory fishing carried out by the Government of India fishing vessels during 1967-68 off Goa region has revealed certain very productive trawling grounds, yielding very high catch returns of total fish per trawling hour with a fair proportion of some of the quality fishes, like pomfrets and *Lactarius*. In an earlier paper it has been briefly indicated that the catch rates increase gradually southwards between 18° N latitude zone off Bombay and 15° N latitude zone off Goa (Rao *et al.*, 1968). The present paper gives an account of the area-wise abundance and depth-wise distribution pattern of the different fish groups, with estimates of their potential yields for the region. Purse seining off Goa in recent years has been found to be very successful in the exploitation of the mackerel shoals which abound in the neritic-pelagic complex. The present paper throws light on the rich, but as yet not fully exploited, demersal fishery resources of the region.

## EXPLORATORY FISHING VESSELS, GEARS AND OPERATIONAL DETAILS

The Government of India vessels *M. T. Kalyani IV* and *M. T. Kalyani V* of the Bombay base were temporarily shifted to Panaji for exploratory surveys which lasted from the middle of November to the end of the first week of December 1967 and from about the middle of March to the middle of April 1968. The vessels have each a tonnage of 123.24, length of 27.82 m, beam of 5.43 m and draft of 2.82 m. They have the same horse-power of 300 and used 28 m to 55 m (mostly 30 and 35 m) otter trawls.

The region covered was under two major areas, viz. 15-73 and 16-73, falling between latitudes 15° N and 16°30' N and between longitudes 73° E and 74° E (Fig.1). A total of 21 voyages were made expending 347.58 hours for a catch of 175,446 kg of fish, caught in 193 hauls at a catch rate of 504.76 kg/trawling hour, the catch per haul being 909.04 kg, catch per day of fishing 2,973.66 kg and catch per day of absence from port 2,403.37 kg. The sale proceeds amounted to Rs. 60,950.25 for 59 days of actual fishing operations. Vessel-wise and month-wise catch particulars are shown in Fig. 1. Both vessels being of the same specifications, the catch data were pooled together and analysed for determining the area-wise abundance of total and individual fish groups, taking the catch per trawling hour as a unit of fishing operations (Ricker, 1940; Gulland, 1964, 1968).

## AREA-WISE ABUNDANCE OF FISHES

Twenty one sub-areas under 15-73 and 4 sub-areas under 16-73 have been fished. The amount of effort expended in each of the sub-areas varied much (Table 1). The more intensively fished areas were 15-73/3C, 3D and 4C where the effort spent varied from 46.00 hours to 52.25 hours. In sub-areas 15-73/2D, 3E, 4B, 4D, 4E, 5C, 5D, 6B and 16-73/1B the fishing effort ranged from 10.00 hours to 28.33 hours. In the remaining sub-areas the fishing effort spent in each did not exceed 7.50 hours.

Very nearly half the total catch was landed from sub-areas 15-73/3D, 4C and 3C, which gave average catch rates of 558.79 kg/hr, 527.43kg/hr and 459.35 kg/hr respectively. The highest area-wise catch rate was 821.67 kg/hr from sub-area 15-73/6D, which was fished only for 3 hours. Sub-areas 15-73/2D, 2E, 3A, 4A, 5C, 5D, 6B, 6C, 16-73/1B, 1C and 2B have also registered high catch rates over 500 kg/hr. A graded pattern of average catch rates in different areas fished during the period is shown in Fig. 1. 15-73/1C and 1D, where the effort spent was less than 2 hours landing nil catches due to the net being heavily damaged, have not been shown in the figure. It may be clearly seen from Fig. 1 and Table 1 that, excepting 15-73/1C, 1D, 2C, 3B and 16-73/3B, each of the other areas fished has given on the average over 350 kg/hr up to a maximum of 821.67 kg/hr showing thereby that the region as a whole is highly productive for demersal fishes. It may be mentioned here that the catch per hour returns shown in Fig. 1 are based on the averages worked out for the total number of hours fished under each

# EXPLORATORY TRAWLING OFF GOA

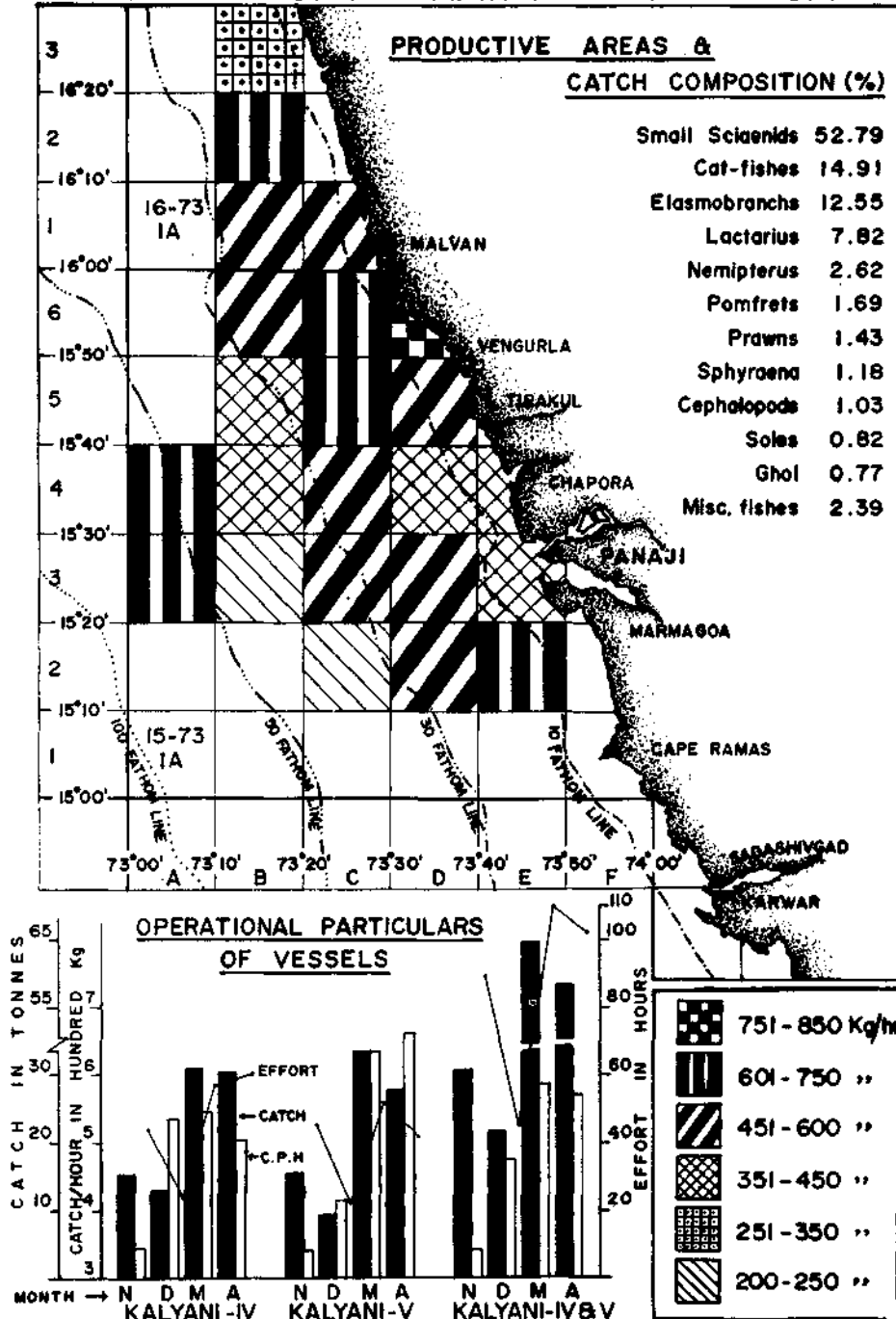


FIG. 1. Productive areas, catch composition and monthly fish landings by the Government of India vessels operated off Goa.

TABLE I. Area-wise catch particulars of exploratory fishing off Goa

Area	Effort in hr	Total catch in kg	Catch/hour in kg	Maximum catch/hr in kg
15-73/1C	0.25	Nil	—	—
" /1D	1.25	Nil	—	—
" /2C	7.50	1,590	212.00	300.00
" /2D	13.00	7,227	555.92	1097.00
" /2E	4.00	2,830	707.50	787.50
" /3A	6.50	4,240	652.31	712.50
" /3B	6.00	1,350	225.00	500.00
" /3C	46.00	21,130	459.35	1392.50
" /3D	52.25	29,197	558.79	952.50
" /3E	14.50	5,562	383.58	687.50
" /4A	6.50	3,920	603.08	1207.50
" /4B	16.00	5,741	358.81	666.67
" /4C	51.50	27,163	527.43	885.00
" /4D	28.33	10,913	385.21	730.00
" /4E	10.25	4,341	423.51	856.00
" /5B	6.00	2,550	425.00	480.00
" /5C	19.50	13,795	707.43	1115.00
" /5D	14.75	7,412	502.51	793.33
" /6B	14.50	8,265	570.00	1035.00
" /6C	6.00	4,365	727.50	862.50
" /6D	3.00	2,465	821.67	1203.33
16-73/1B	10.00	5,905	590.50	940.00
" /1C	4.00	2,175	543.75	630.00
" /2B	4.00	2,645	661.25	1022.50
" /3B	2.00	665	332.50	332.50

sub-area. In some of the individual hauls from sub-areas 15-73/2D, 3C, 4A, 5C, 6B, 6D and 16-73/2B, the catch per hour returns were over 1000 kg/hr, the maximum being 1392.50 kg/hr from 15-73/3C (fished for two hours on 26th March 1968 by M.T. *Kalyani V*). The catch composition of all the areas together is given in Fig. 1.

The area-wise abundance of different categories of fishes in a graded pattern based upon the average catch per hour returns is shown in Fig. 2 and 3. The average area-wise catch per hour returns for small sciaenids did not exceed 526.67 kg/hr, very productive sub-areas being 15-73/2E, 3A, 4A, 5C, 5D, 6C, 6D, 16-73/1B and 1C which gave over 300 kg/hr. Cat-fish catch rates were high, between 101 and 147 kg/hr, from sub-areas 15-73/2D, 2E, 3C, 6B and 16-73/1B. Elasmobranchs have been best obtained from 16-73/1B with an average catch rate of 452.50 kg/hr. *Lactarius* has been found in fair concentrations in almost all the sub-areas fished, but in the sub-areas 15-73/2D, 2E, 3C, 3D, 3E, 4C, 4E, 5C, 6C and 16-73/1C the catch rates were particularly high varying between 32 and 73.75 kg/hr. In respect of pomfret, very good catch rates, ranging between 14 and 33 kg/hr, have been registered by the sub-areas 15-73/3E, 4D and 4E. This being a high quality fish the distribution

has special significance. It may be seen from the figure that it occurred in fair quantities from other sub-areas also. Prawns appeared to be evenly distributed in most of the sub-areas, but by far the higher catch rates of 31 kg/hr and 18 kg/hr came from sub-areas 15-73/4A and 6C respectively. As regards other fish groups it may be stated that the highest catch rate for *Nemipterus* came from 16-73/1B (46.00 kg/hr) for *Sphyræna* 15-73/2C (40.00 kg/hr), for cephalopods 15-73/4B (14.69 kg/hr), for soles 15-73/4A (20.77 kg/hr), for *ghoi* 15-73/6B (12.07 kg/hr) and for miscellaneous fishes 16-73/3B (55.00 kg/hr).

In respect of some of the quality fishes, in individual hauls, very high catch rates have been obtained from certain areas and these deserve special mention here. For *Lactorius* in sub-areas 15-73/2D, 2E, 3C, 3D, 4C, 4E, 5C, 6B and 6C, the catch rates in individual hauls ranged from 110 to 225 kg/hr, the highest being obtained from 15-73/4C. In a similar manner for pomfret individual haul catch rates were over 50 kg/hr up to 140 kg/hr from sub-areas 15-73/3C, 3E, 4B, 4C, 4D and 4E, the highest catch rate being from 4E, and for prawns between 40 and 100 kg/hr from sub-areas 15-73/3D, 4A, 4B, 4C and 6C, the highest being from 4A. A few quality fishes occurring among the miscellaneous fishes have shown rather a peculiar distribution pattern. Although they were represented only in small proportion in the overall catches, some of the species occurred in fair concentrations in certain restricted sub-areas. Thus for *Polydactylus indicus* a fair catch rate of 7.5 kg/hr was obtained from only one sub-area, viz. 15-73/6B; for seer fishes sub-areas 15-73/3C, 5B and 4B gave catch rate from 20 kg/hr to 27.5 kg/hr; similarly high catch rates of 20 kg/hr to 40 kg/hr for *karkara* (*Pomadasys hasta*) were from sub-areas 15-73/3C, 3D, 4C, 4D and 5C and 20 kg/hr to 40 kg/hr for *Lutjanus* sp. from 15-73/2D and 4B. In conclusion it may be said that for either the total fish, miscellaneous fishes or any one of the major categories of fishes, the highest average catch rate was registered by sub-areas 15-73/2E, 3D, 4A, 4C, 4E, 6C, 6D, 16-73/1B, 2B and 3B, these areas being hence considered more productive than the others in the region fished.

#### DEPTH-WISE DISTRIBUTION OF FISHES

In the present operations, the depths covered were from 10 to 68 meters. These have been grouped under depth ranges of 10 meters each, as shown in Table 2 and Fig. 4. It may be seen that the fishing effort has not been equally distributed in all the different depth zones. However, it may be stated that fairly adequate sampling has been done in depth zones between 11m and 70 m. The bulk of the catches came from 21-30 m and 31-40 m depth zones which amounted to over 55% of the total fish landed from all the depth zones. The catch per haul returns and the catch per hour returns were also high in these two zones, 31-40 m zone being better than 21-30 m zone and also all other zones. The amount of catch is dependent on the amount of fishing effort spent, but it cannot show the relative productivity of the zone fished. This is evident from the low catch of 7.91% only realised from 61-70 m depth zone although the catch per haul return (1,067.6 kg) and catch per hour return (533.85 kg) have been extremely high and comparable with those obtained in 21-30

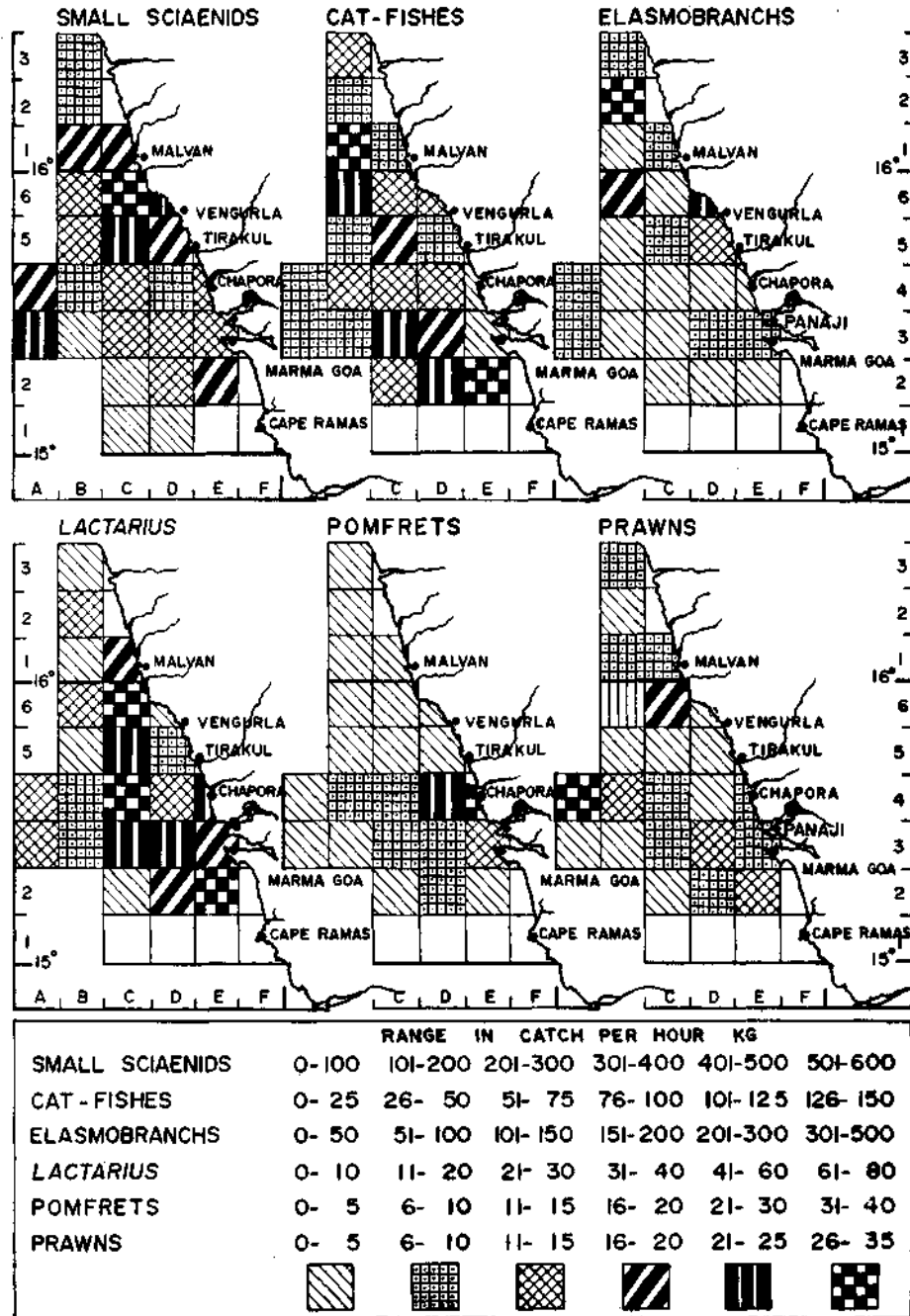


FIG. 2. Productive areas for small sciaenids, cat-fishes, elasmobranchs, *Lactarius*, pomfrets and prawns as revealed by exploratory trawling off Goa.

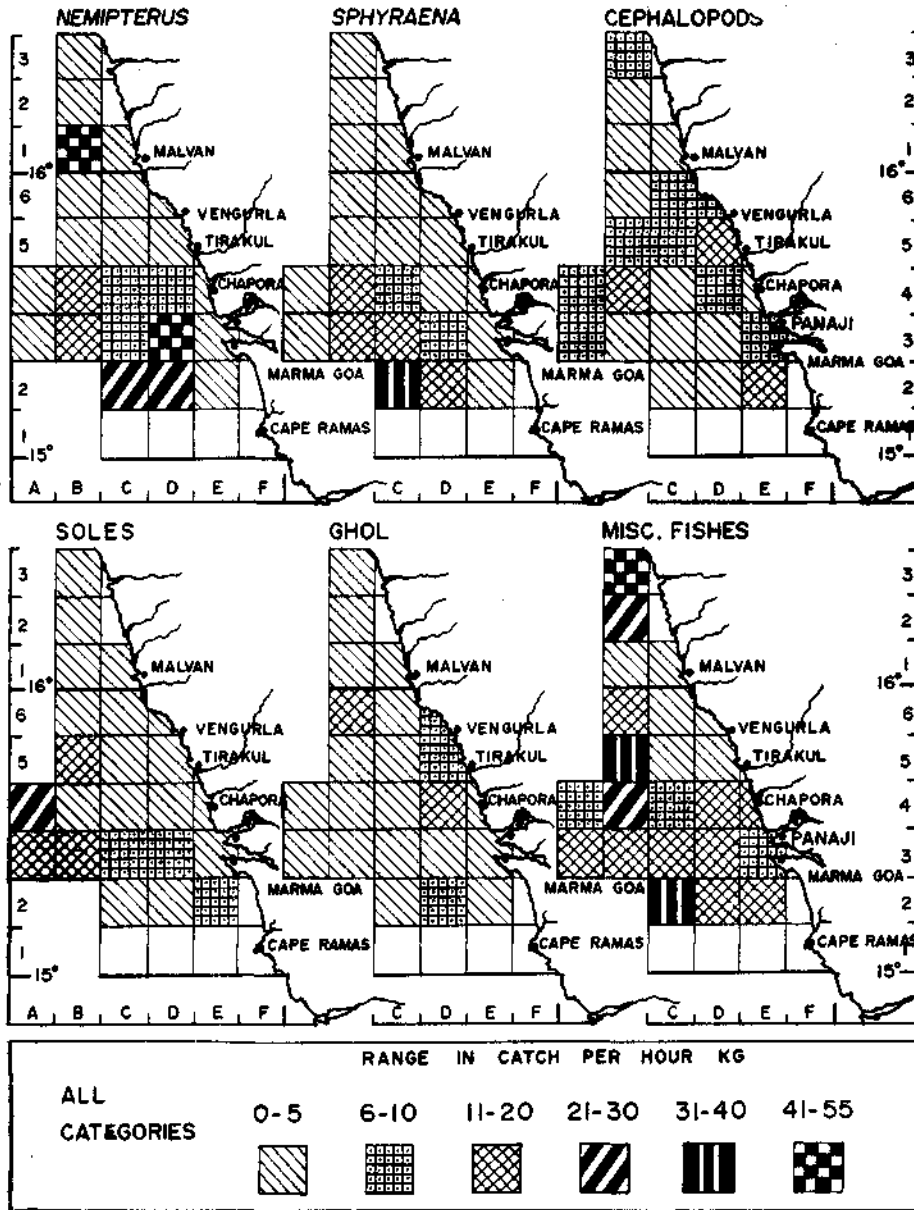


FIG. 3. Productive areas for *Nemipterus*, *Sphyræna*, cephalopods, soles, *ghol* and miscellaneous fishes as revealed by exploratory trawling off Goa.

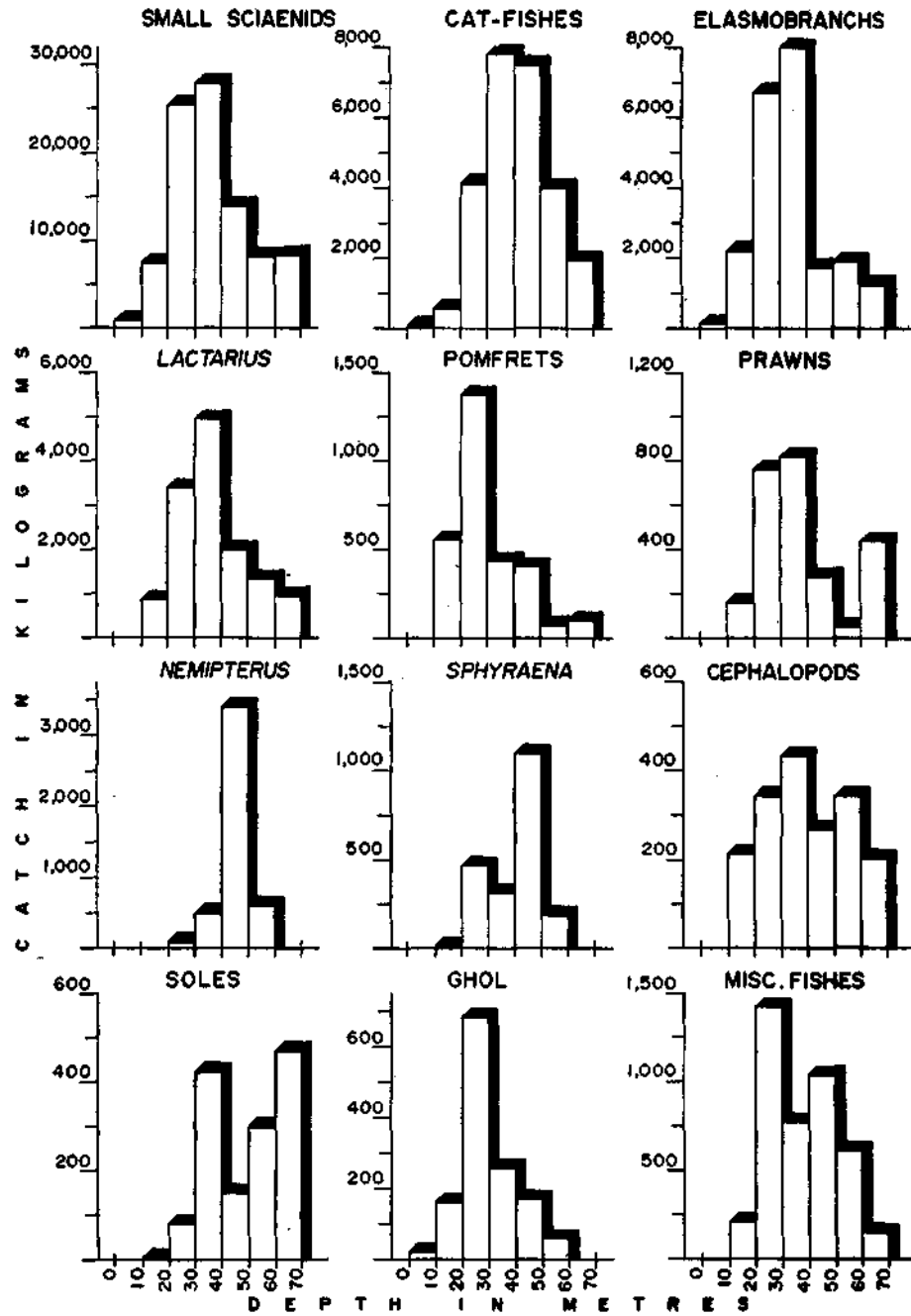


FIG. 4. Distribution pattern of categories of fishes in different depth zones in exploratory trawling operations off Goa.



and 31-40 m depth zones. If we take 50 m depth as a limit for shallower waters, the higher concentrations were found to occur both in the shallower waters and the deeper waters. The relative abundance of the fishes judged by the catch per hour returns showed a bimodal distribution with modes in 21-40 m and 61-70 m depth zones. It may also be noted from the table that fairly high catch rates of total fish of over 400 kg/hr have been registered for all the depth zones covered, indicating that the region as a whole is productive in all its depth zones.

TABLE 2. *Depth-wise distribution of total fishes landed off Goa by exploratory trawlers*

Depth in meters	No. of hauls	Fishing effort in hours	Total catch in kg	Catch/haul in kg	Catch/hour in kg	Percentage of catch
1—10	2	3.00	1,245	622.50	415.00	0.71
11—20	18	30.25	12,521	695.61	413.92	7.14
21—30	50	88.08	45,060	901.20	511.58	25.68
31—40	48	86.50	52,684	1,097.58	609.06	30.03
41—50	41	70.50	32,170	784.63	456.31	18.34
51—60	21	43.25	17,886	851.71	413.55	10.19
61—70	13	26.00	13,880	1,067.69	533.85	7.91

In regard to depth-wise distribution of different categories of fishes it has been found that the small sciaenids occurred fairly high in all shallower depth zones up to 40 meters and also in deeper waters of 61-70 meters. Cat-fish abundance was less in shallow depth zone up to 30 meters and relatively more in depth beyond 30 meters. *Lactarius* catch rates were fairly high in zones beyond 11 meters, but their best concentration was in 31-40 meter depths. For elasmobranchs too 31-40 m zone was the best, but very high catch rates were registered in most other depth zones also. For *Nemipterus* a remarkably high concentration was found in 41-50 m depth zone. Pomfrets were more in depths from 11 to 30 m than in other zones. Prawns, like the total fish, showed a bimodal distribution, one in 21-40 m zone and another in 61-70 m zone. Like *Nemipterus*, *Sphyræna* has been found to occur in good concentration in 41-50 m zone. Cephalopods appeared in good abundance both in the shallower and deeper waters. Soles were found best in 61-70 m, *ghol* in 21-30 m and miscellaneous fishes in 41-60 m depths.

#### ESTIMATES OF THE POTENTIAL YIELD

By employing the "sweep method" in exploratory trawling, the estimates for the total demersal fishery resources and the potential sustainable yield have been calculated for the continental shelf area of 15,798 sq. km between 15° N and 16°30' N latitudes off Goa. The width of the mouth of the otter trawls varied from 28 m to 55 m. The operational results of each trawl are shown separately in Table 3.

It may be seen that 70.58% of the fishing effort has been spent by using the 30 m and 35 m trawls. These two trawls have covered almost all the sub-areas. Not only were the widths of the mouths of these two trawls almost the same, but also their catching efficiency has been found to be consistent. For the purpose of calculation of the area swept, the average width of the mouth of these trawls, which comes to 32.5 m, has been taken. The 30 m trawl sweeps an area of 0.166786 sq. km at a trawling speed of 3 knots and the 35 m trawl at same speed covers 0.194584 sq. km, the average of these two being 0.180685 sq. km. The trawling speed in most hauls was 3 knots and in a few cases 2.8 knots but this slight difference was ignored. On the basis of 543.94 kg of fish for an area of 0.180685 sq. km, the total fish catch has been estimated (Table 4) for the entire area

TABLE 3. *Gear-wise landings off Goa by the exploratory trawlers*

Trawl size	Satisfactory fishing effort in hours	Total catch in kg	Catch per hour in kg	Loss of fishing effort due to damage of net etc.
28 meter	4.00	1,935	483.75	—
30 meter	170.08	85,847	504.74	7.00
35 meter	75.25	47,597	632.52	1.75
38 meter	31.50	9,557	303.40	3.00
45 meter	13.00	8,160	627.69	—
55 meter	42.00	22,350	532.14	—

TABLE 4. *Estimates of potential fishery yields off Goa*

1. Total area between 15°00' N and 16°30' N latitudes	15,798 sq. km
2. Total effort expended in exploratory surveys using 30 m and 35 m trawls	254.08 hours
3. Total catch by the above trawls	133,444 kg
4. Average catch per hour based on total effort	525.20 kg/hr
5. Fishing effort lost due to damage or loss of net	8.75 hours
6. Total fishing effort for successful hauls	245.33 hr
7. Average catch per hour of trawling based on successful hauls	543.94 kg /hr
8. Average width of mouth of 30 m and 35 m trawls	32.5 m
9. Estimated area covered by trawl with average mouth-width of 32.5 m for one hour at speed of 3 knots	0.180685 sq. km
10. Estimated demersal fishery resource calculated at 543.94 kg/hr for the entire area	47,558,813 kg
11. Estimated potential sustainable yield at 60% level of the estimated resource	28,535,288 kg
12. Estimated demersal fish resource	
(a) per sq. km	3,010.43 kg
(b) per hectare	30.10 kg

of 15,798 sq. km. This has amounted to 47,558.813 tonnes and of this, at 60% level, 28,535 tonnes of fish have been considered a reasonable estimate for potential sustainable annual yield for the region as a whole. The density distribution of fish per sq. km was estimated at 3010.43 kg and per hectare 30.10 kg. Based on the percentage composition of the total landings obtained in the exploratory fishing operations, the category-wise estimates of the potential sustainable yields have been arrived at, as shown in Table 5. Apart from the small sciaenids which form the bulk of the landings this region is bound to prove very good for categories of quality fish, like *Lactarius*, pomfrets and prawns in commercial fishing operations.

TABLE 5. *Estimates of potential yield of fish categories off Goa*

S. No.	Name of fish	Estimated resources in tonnes	Potential sustainable yield in tonnes
1.	Small sciaenids	25,106	15,064
2.	Cat-fishes	7,091	4,254
3.	Elasmobranchs	5,969	3,581
4.	<i>Lactarius lactarius</i>	3,719	2,231
5.	<i>Nemipterus sp.</i>	1,246	748
6.	Pomfrets	804	482
7.	Prawns	680	408
8.	<i>Sphyræna sp.</i>	561	337
9.	Cephalopods	490	294
10.	Other misc. fishes	1,893	1,136
Total		47,559	28,535

#### GENERAL CONSIDERATIONS

For a region, the fishery potential of which is hitherto little known, any fruitful results obtained by systematic exploration will be of much value, particularly in the present moment when major developmental schemes are contemplated, aiming at a substantial increase in food production. The region off Goa dealt with here has excellent harbour facilities for the fishing craft to bring the catches into the very heart of the important townships, viz. Panaji and Marmagoa, and offers immense scope for the exploitation of the pelagic as well as the demersal fishery resources. Although the present paper deals with the trawler landings, it may not be out of place to point out here that the recent purse seine operations by one of the Government of India vessels proved beyond any doubt that the mackerel and sardine catches could be enormous in favourable fishing seasons, if carefully exploited. M.V. *Meenakhajini*, purse seining in the major area 15-73 during November 1969-February 1970, netted mackerel in appreciable quantities with monthly catch rates varying from 1,345.18 kg/hr to 9,729.33 kg/hr, the sub-areas yielding these high

catch rates being 15-73/3E and 4E. From the sub-area 15-73/3D in a single haul, a quantity of 1,320 kg of sardines also has been obtained for a fishing effort of less than one hour (CMFRI, offshore catch data, November '69 to February '70).

In the region-wise abundance of fish distribution in Bombay to Kutch through Cambay, Veraval, Porbundar and Dwarka, as revealed by commercial bull-trawling operations, a south-to-northward increase has been noticed (Rao *et al.*, 1966; Rao, 1967). The exploratory surveys carried out during 1963-67 by the Government of India vessels of Bombay base have also pointed out a significant pattern of distribution in fish abundance in one degree latitude zones (Rao *et al.*, 1968). An increase in catch rates from 18° N latitude zone off Bombay to 22° N latitude zone off Dwarka was clearly evident and in a similar manner an increase in catch rates from 18° N latitude zone to 15° N latitude zone off Goa. In the region under the present report, i.e. 15° N latitude to 16° 30' N latitude off Goa, in all zones of 10' intervals of latitude the catches have been high with no marked differences in the yield rates, showing that the shelf as a whole is productive. Another remarkable fact observed was that the fish concentrations have been fairly high in all depth zones up to 70 meters.

Off Goa the preponderance of quality fishes can be stated to be only fair or moderate, as compared with what is obtained in the catches over the shelf bordering Kutch, Dwarka and adjacent regions which are now well known for big yields of excellent fishes such as *ghol*, *karkara*, *dara*, *koth*, etc. In regard to the abundance of poor quality fishes as *dhoma*, cat-fishes and elasmobranchs, the region off Goa is comparable with any of the northern regions from Bombay to Kutch. However, the importance of this region lies in the fact that the overall catches and catch rates are high, with fair abundance of some quality fishes like *Lactarius*, prawns and pomfrets.

That exploratory surveys furnish the necessary data for the estimation of the potential fishery stocks is well known (Tiews, 1965, 1966; Jones and Banerji, 1968; Silas, 1969). The estimates given in the present paper, of the total demersal fish stocks and the potential yields are only provisional. The area has not been explored all the year round and the deeper regions of the shelf beyond 70 meters have not been fished at all. With more complete data it may be possible at a future day to furnish fuller information. Taking Goa and Mysore regions together, Jones and Banerji (*loc. cit.*) have stated that the results of the experimental trawls had indicated good trawling grounds for demersal fish, at an expected catch of 15 kg per hectare for the entire shelf region. Their estimates for Goa region alone for demersal fish in grounds up to 50 meter depths is 19.3 kg per hectare. The estimate arrived at in the present findings of 30.10 kg per hectare is higher. The difference is due to the fact that in the earlier period, the exploratory survey data were meagre, being confined to the operations of shrimp trawls only in restricted areas.

In 1966, out of a total catch of 24,800 tonnes of fish landed from the Goa region, the quantity of demersal fish landed by all types of craft and gear operated in the region was estimated at 5,500 tonnes (Jones and Banerji, 1968) which formed about 22% in the total landings of pelagic and demersal fishes. Worked out in that proportion, of the total fish catch of 12,460 tonnes and 18,888 tonnes landed during 1967 and 1968 respectively (CMFRI, 1969) the demersal fish catch will be 2,741 tonnes and 4,155 tonnes for the respective years. The annual average of demersal fish landed during the period 1966-1968 works out therefore to 4,132 tonnes. The estimated demersal fish yield at 60% level of the total resources has now been shown to be 28,535 tonnes. It is evident from these figures that the actual level of exploitation at present is only about one seventh of the potential annual estimated yield and there is good scope for immense increase in the fishing effort.

#### ACKNOWLEDGEMENTS

The authors express their sincere thanks to the skippers of the fishing vessels of the Government of India Deep-Sea Fishing Organisation, Bombay, for making available the log data pertaining to the exploratory fishing operations.

#### REFERENCES

- CENTRAL MARINE FISHERIES RESEARCH INSTITUTE. 1969. Marine fish production in India, 1950-1968. *Bull. cent. mar. Fish. Res. Inst.*, No. 13: 144 pp.
- GULLAND, J.A. 1964. Catch per unit effort as a measure of abundance. *Cons. Perm. Intern. Explor. Mer. Rapp. Proces-Verb. Reun.*, 155: 8-14.
- GULLAND, J.A. 1968. The concept of the maximum sustainable yield and fishery management. *FAO, Rome, Fish. Tech. Pap.* 70: 13 pp.
- JONES, S. AND S. K. BANERJI. 1968. A review of the living resources of the Central Indian Ocean. *Symposium on the Living Resources of the Seas around India*, Central Marine Fisheries Research Institute, Mandapam Camp, December, 1968. Abstracts, 2.
- RAO, K. VIRABHADRA. 1967. Exploratory fishing. *Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute*: 25-36.
- RAO, K. VIRABHADRA, K. DORAIRAJ, P. V. KAGWADE AND D. M. PUNWANI. 1968. Results of the exploratory fishing operations of the Government of India vessels at Bombay base for the period 1961-67. *Symposium on Demersal Fisheries, Indo-Pac. Fish. Coun. 13th Session*, Brisbane, Australia, October, 1968. Preprint IPFC/C68/Sym 28: 1-43.
- RAO, K. VIRABHADRA, P. T. MEENAKSHISUNDARAM AND K. DORAIRAJ. 1966. Relative abundance of trawl fishes in the Bombay-Saurashtra waters. *J. mar. biol. Ass. India*, 8: 205-212.
- RICKER, W. E. 1940. Relation of catch per unit effort to abundance and rate of exploitation. *J. Fish. Res. Bd. Canada*, 5 (1): 43-70.

- SILAS, E.G. 1969. Exploratory fishing by R. V. *Varuna*. *Bull. cent. mar. Fish. Res. Inst.*, No. 12: 1-86.
- TIEWS, K. 1965. The development of trawl fisheries in South-east Asian countries as a mean to increase the marine fisheries production. *Proc. International Conference on Tropical Oceanography, High Sea Fisheries, Miami, Nov. 1965*.
- TIEWS, K. 1966. On the possibilities for further development of the South-east Asian fisheries. *Indo-Pac. Fish. Coun. 12th Session document., IPFC/C66/TECH 2*.