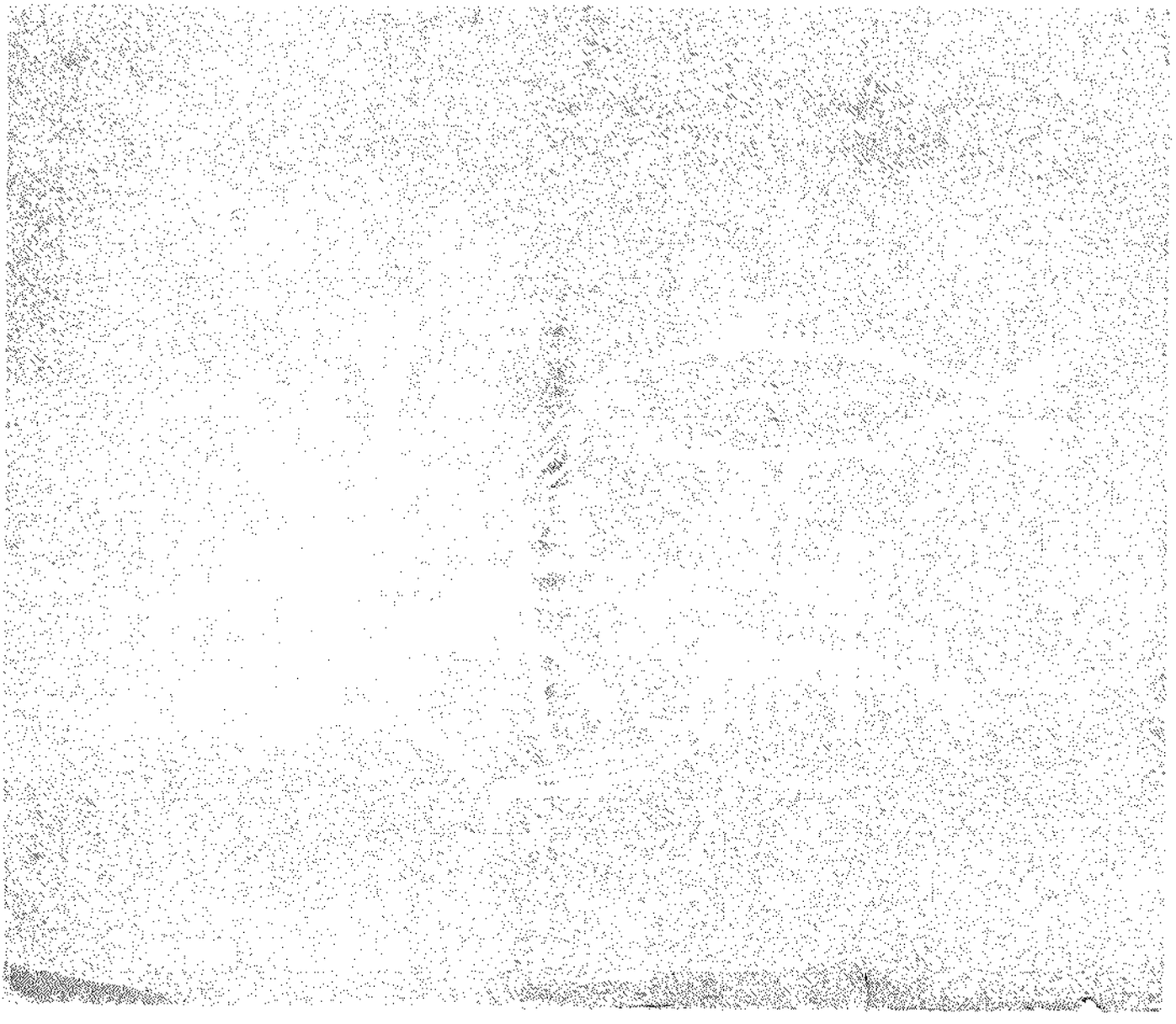
PROCEEDINGS OF THE SYMPOSIUM

ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

ICAR



PROCEEDINGS OF THE SYMPOSIUM
ON
LIVING RESOURCES OF THE SEAS AROUND INDIA

SPECIAL PUBLICATION
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN-11
1973

SHRIMP RESOURCES ON THE CONTINENTAL SHELF AS REVEALED BY TRAWLER LANDINGS FROM OFFSHORE WATERS OF INDIA

K. VIRABHADRA RAO* AND K. DORAIRAJ

Central Marine Fisheries Research Institute, Mandapam Camp

ABSTRACT

An account of the region-wise shrimp landings by the trawlers operating from Bombay, Karwar, Mangalore, Cannanore, Cochin, Mandapam, Tuticorin, Visakhapatnam and Calcutta bases is given. The catch per hour of shrimp returns by the trawlers is taken as the basis for determining the area-wise and regional abundance. Productive areas which have fairly constantly given high catch rates in different regions have been charted. In the west coast the catch rates have been found to increase north to south, from Kutch to Cochin. Productive areas occur on the continental shelf in the Gulf of Cambay, off Bombay, Ratnagiri, Vengurla-Dabhol, Karwar, Mangalore, Cannanore, Cochin and Alleppey. On the east coast the shrimp catches are comparatively less. However some productive prawn grounds have been located off Tuticorin, Mandapam, Kakinada and Visakhapatnam. In West Bengal also fairly productive grounds have been recorded from the Eastern Channel, off Debi-Prachi rivers and the Western Channel. The seasonal and depth-wise abundance of shrimp species in different regions has been investigated.

INTRODUCTION

AMONG the shrimp producing countries of the world, India ranks very high. In 1961–66 the world shrimp catch ranged from 474·0 to 595·0 thousand metric tons with an annual average of 545·67 thousand metric tons. The first six major shrimp producing countries and their annual average landings for the six year period are United States of America (88·18), India (81·78), Japan (75·41), Mexico (68·13), Thailand (28·32) and Pakistan (21·98 thousand metric tons). In 1962 and 1964 India's shrimp production was the highest (Table I).

With the availability of improved facilities for freezing, canning and other types of processing, there has developed in this country within the past ten years a growing export trade in shrimp and shrimp products which annually earn a considerable amount of foreign exchange. 15,964 metric tons of shrimp and shrimp products were exported from India, valued at Rs. 171,052,857 in the year 1967–68. The demand for shrimp is so great from the internal and external markets, that there is the necessity for stepping up production in the known grounds to the optimal level of fishing and locating as yet unknown grounds.

The production trends in the shrimp in different states give an indication of the regional location of shrimp grounds in the inshore and offshore waters. Marine prawn landings averaged annually to 77,461 metric tons forming 10·6% of the total fish and 97·14% of the total crustaceans for the eight year period of 1958–65 (Mohamed, 1967). In the same period, the lowest catch was 62,768 metric tons in 1961 and the highest was 94,895 metric tons in 1964. Prawn landings formed 95·41% to 98·78% in the total crustacean landings and 7·73% to 12·92% in the total marine fish landings.

The average annual landings of marine prawns for the period 1958–65 in the state-wise distribution are the highest for Maharashtra, being 40,605 metric tons forming 52·73% of the shrimp

* Present Address: National Institute of Oceanography, Miramar, Panaji, Goa.

TABLE I

Landing of prawns (marine) 1961–66 in thousand metric tons
(Source: *FAO Year Book of Fishery Statistics*—1966)*

Countries	1961	1962	1963	1964	1965	1966	Average
U.S.A. (Atlantic) ..	69·6	76·3	99·4	89·5	101·4	92·9	88·18
India ..	62·8	83·2	81·6	94·9	77·3	90·9	81·78
Japan ..	73·5	79·3	86·7	77·8	66·5	68·7	75·41
Mexico ..	72·3	70·6	72·0	69·0	59·1	65·8	68·13
Thailand ..	16·5	20·1	23·3	29·5	35·2	45·3	28·32
Pakistan ..	19·5	19·1	18·4	25·7	27·0	22·2	21·98
Other countries ..	159·8	179·4	167·6	176·6	198·5	209·2	181·85
World production ..	474·0	528·0	549·0	563·0	565·0	595·0	545·67

* Excluding *Crangon* and pandalids.

production of India. Kerala ranks second with 20,445 metric tons forming 26·55% and Gujarat third with 6,983 metric tons forming 9·07%. The annual average production in metric tons for the rest of the states for the period in the order of abundance is Andhra 3,426 (4·45%), Madras 2,625 (3·41%), West Bengal and Orissa 1,843 (2·39%), Mysore 950 (1·23%), Goa 123 (0·16%) and Andaman Is. (Mohamed, 1967). These production figures are for marine shrimp only landed from the inshore and offshore regions and they do not include shrimps obtained from backwaters, lakes and inland waters for which we have no adequate data. However, for a few regions, it is roughly estimated that the annual production of shrimps in metric tons as from Hooghly estuary is 900, Mahanadi estuary 100, Chilka lake 1,100, Godavari estuary 1,100, Pulicat lake 1,000 and Kerala backwaters 10,000 (Pantulu, 1965).

In the last two decades, the operations of large, medium and small trawlers of the Central and State Government organisations, the Indo-Norwegian Project and the commercial concerns have revealed good prawn grounds on the continental shelf of the coasts of India. Although most of the operations were carried out with trawls suitable for netting miscellaneous varieties of fishes, prawn catches obtained incidentally have given a fairly reliable picture of the distribution of the shrimp grounds. In the following account regional abundance of shrimp is given on the basis of trawling operations carried out on the east and west coasts of India. The results are dealt below under four different divisions, *viz.*, (1) North-Western Division (Kutch to Goa), (2) South-Western Division (Karwar to Cape Comorin), (3) South-Eastern Division (Cape Comorin to Krishnapatnam) and (4) North-Eastern Division (Masulipatnam to Diamond Harbour).

SHRIMP LANDINGS IN THE NORTH-WESTERN DIVISION

This division includes areas on the continental shelf between latitudes 24° N to 15° N and longitudes 66° E to 74° E. Six regions are recognised, *viz.*, Kutch, Dwarka, Porbundar, Veraval, Cambay and Bombay (Rao *et al.*, 1966). The bull-trawling operations of the New India Fisheries vessels (*Arnala* cum *Paj* and *Satpati* cum *Pilotan* 250 H.P. each) in this division from 1956 to 1963 have furnished some information. In 1956 and 1963 there was no fishing by these vessels in some

of the months. In the rest of the period, taking all regions into consideration, it is seen that the catch and the catch rates were the highest in 1962 and the lowest catch and the catch rate were in 1959 and 1958 respectively. Regarding the regional abundance, it is seen from Table II and Fig. 1 that the catch and the catch rate for shrimps were the highest from Cambay region, but the percentage proportion of prawns in the region ranked next to that of Bombay. The catch per hour returns have been observed to be in the decreasing order in the rest of the regions, *i.e.*, Bombay, Veraval, Porbundar, Kutch and Dwarka. The maximum monthly catch per hour returns from each region has shown a north to southward increase from Kutch (18·23 kg/hr) to Bombay (200 kg/hr).

TABLE II

Annual average of prawn landings by the New India Fisheries Company's vessels for 1957–62 (after Rao *et al.*, 1966)

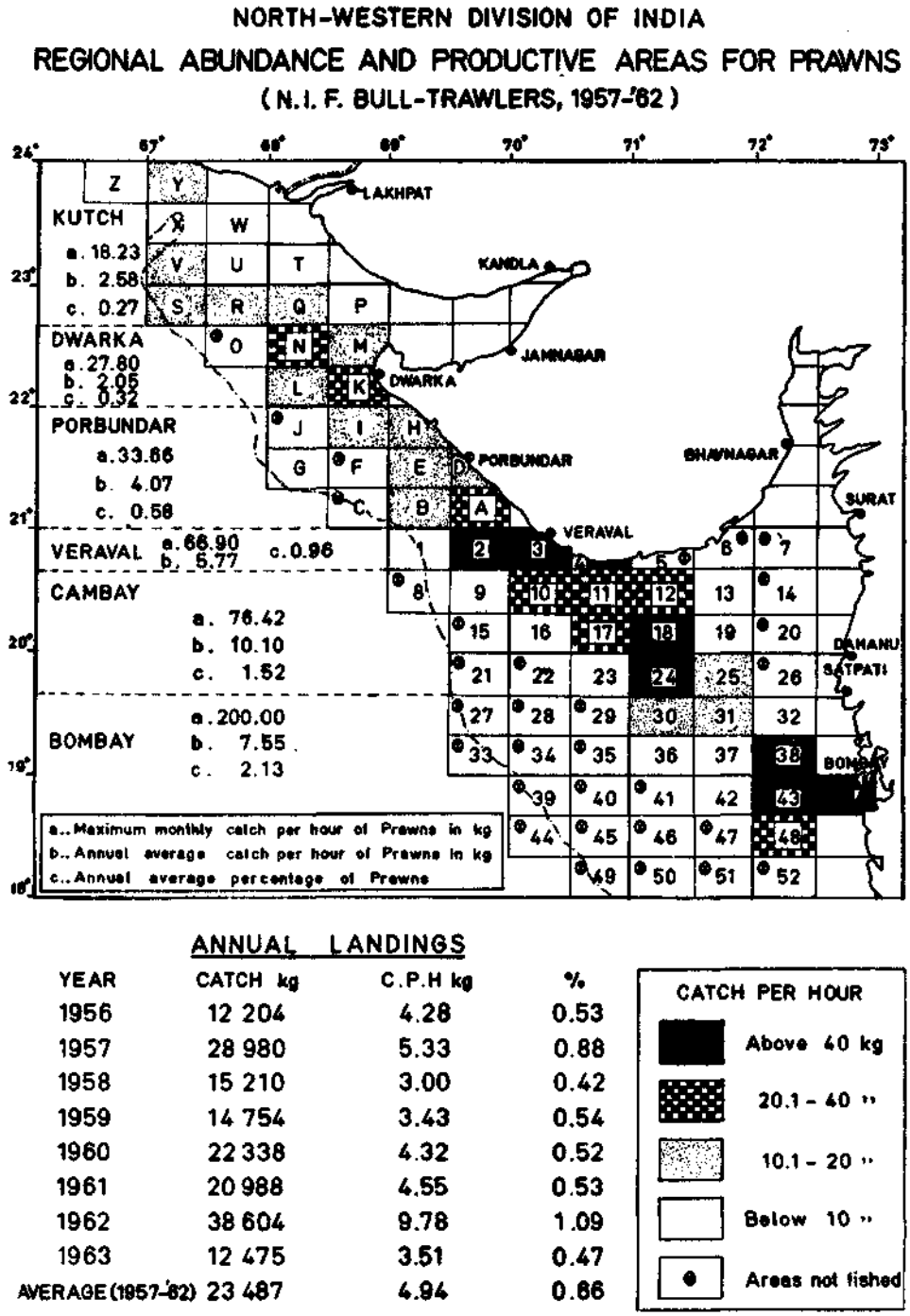
Region	Catch in kg	Region	Catch in kg
Kutch ..	3,707	Veraval ..	2,685
Dwarka ..	1,321	Cambay ..	11,078
Porbundar ..	4,351	Bombay ..	336

The productive areas shown in Fig. 1 are based on the maximum monthly catch rates obtained. The areas are 600 square nautical miles each. Areas 2, 3, 4, 18, 24, 38, 43 and 43 A are considered highly productive as they have given over 40 kg/hr; N, K, A, 10, 11, 12, 17 and 48 are moderately rich giving between 20·1 and 40 kg/hr; Y, V, S, R, Q, M, L, I, H, E, D, B, 25, 30 and 31 are fair giving between 10·1 and 20 kg/hr and the rest of the areas which have given less than 10 kg/hr are considered poor.

Kagwade (1967) working upon the data of New India Fisheries vessels for the eight year period has obtained very similar results.

The larger vessels, *viz.*, *M.F.V. Jheenga* (153 H.P.), *M.F.V. Meenabharathi* (260 H.P.) and *M.T. Kalyani's* III to V (300 H.P. each) of the Government of India Deep Sea Fishing Station were also fishing in this division using otter trawls. The latitude zone-wise abundance of shrimps for the five year period 1963–67 has been assessed and the results are shown in Fig. 2. From 22° N latitude zone to 18° N latitude zone there is an increase in the maximum monthly catch rates, annual average catch rates and the percentage proportion of shrimp. South of 18° N latitude zone, there is a fall in the catch rates of shrimp in 17°, 16° and 15° N latitude zones. Of the 3 last zones, 16° N latitude zone is a shade better than the other two zones. Subareas 16–73/4B; 17–72/6F; 18–72/1C, 1D, 1E, 3D, 4D, 5B, 5C, 5D, 5E, 6C, 6D, 6E; 19–71/3F; 19–72/1C, 1D, 1E, 3A and 20–70/1D are very productive having given over 20 kg/hr: 15–73/2D, 3D; 16–73/1B; 17–72/1B, 1E; 18–72/1F, 4E, 6B; 19–72/2A; 20–69/4F; 20–70/4C, 5C and 6A are good with 10·1 to 20 kg/hr and 15–73/4E; 16–72/4D; 17–72/1F, 5E; 18–72/1B, 3B, 3E, 6A; 19–71/3C, 3D, 6B; 19–72/1B; 20–69/3E; 20–70/2F, 3E and 21–69/2E are fair giving 5·1 to 10 kg/hr. The rest of the areas fished have given below 5 kg/hr.

It may be seen that the zonal or regional catch rates obtained by the bull-trawlers are higher than those of the otter trawlers. In bull-trawling the catch per hour returns are for a pair of vessels and in otter trawling they are for a single vessel. It is well known that the catch per hour returns of bull-trawling are always higher than those of otter trawling (Jayaraman *et al.*, 1959 and Rao *et al.*, 1968).



ANNUAL LANDINGS

YEAR	CATCH kg	C.P.H kg	%
1956	12 204	4.28	0.53
1957	28 980	5.33	0.88
1958	15 210	3.00	0.42
1959	14 754	3.43	0.54
1960	22 338	4.32	0.52
1961	20 988	4.55	0.53
1962	38 604	9.78	1.09
1963	12 475	3.51	0.47
AVERAGE (1957-'62)	23 487	4.94	0.66

FIG. 1. Shrimp landings in the North-Western Division of India fished by the commercial bull-trawlers for the period 1956–63. Figure also shows productive areas for shrimps in regions from Kutch to Bombay.

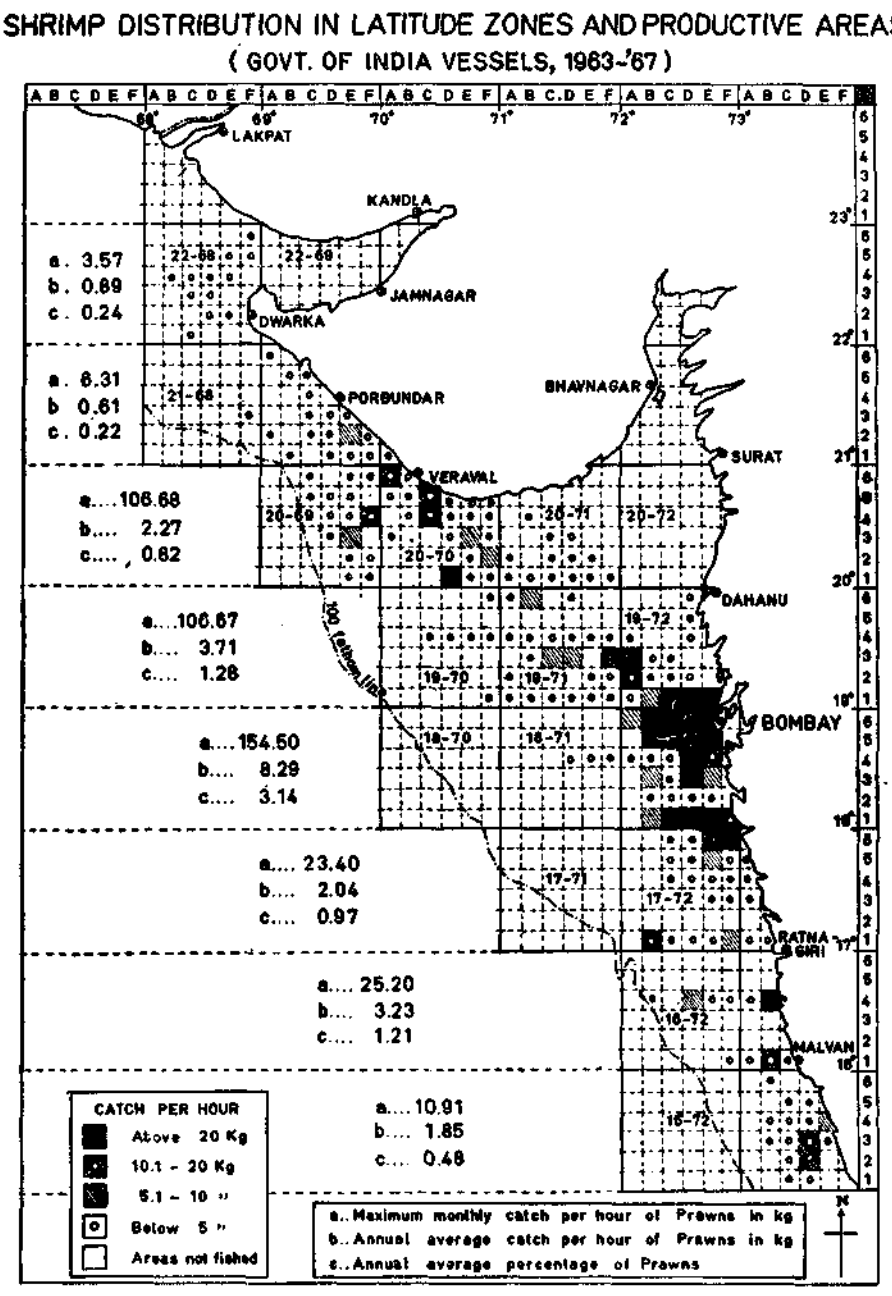


FIG. 2. Latitude zone-wise and area-wise abundance of prawns fished by the Government of India vessels of Bombay base for the period 1963–67.

Prawn landings at Bombay base by the Government of India vessels for the year 1966 give a fair picture of their major area-wise and seasonal abundance in the region. The vessels fished 29,982 kg of prawns forming 6·01% of the total marine fish catch, the annual catch rate being 12·86 kg/hr of trawling. The split up figures for each quarter are indicated in Table III.

TABLE III

Prawn landings by the Government of India vessels, Bombay base, 1966

	1st quarter	2nd quarter	3rd quarter	4th quarter
Major areas fished ..	18–72, 19–72	18–72, 19–72	17–72, 17–73, 18–72	17–72
Prawn catch kg ..	4,600	17,759	21,036	5,587
Percentage ..	4·22	14·07	3·84	2·64
Catch rate kg ..	5·99	29·21	10·52	7·33

Some of the hauls from Bombay region have been good for prawns with very high catch rates; in Table IV particulars of all hauls with over 200 kg in each fished by *M.F.V. Jheenga* in 1966 are given.

TABLE IV

Particulars of hauls by M.F.V. 'Jheenga' (153 H.P.) with more than 200 kg of prawns in 1966

Area	Date	Duration of haul in hrs	Prawn catch (C.P.H.) in kg	% of Prawns in total catch
18–72/6E	31–3–1966	1·50	500 (333·33)	70·13
,,	,,	1·50	501 (334·00)	68·07
,,	,,	1·00	200 (200·00)	63·29
,,	,,	1·25	230 (184·00)	42·44
,,	1– 4–1966	1·50	350 (233·33)	56·36
,,	,,	1·50	400 (266·67)	54·35
18–72/6D	,,	1·50	437 (291·33)	50·06
,,	11– 4–1966	2·00	300 (150·00)	51·72
18–72/6E	,,	1·50	241 (160·67)	53·92
,,	12– 4–1966	2·00	300 (150·00)	47·92
,,	,,	2·00	335 (167·50)	47·99
,,	15– 4–1966	1·50	200 (133·33)	44·74
,,	16– 4–1966	1·50	200 (133·33)	46·95
,,	,,	1·50	208 (138·67)	51·23
18–72/6D	26– 4–1966	1·50	225 (150·00)	27·95
18–72/5D	1–11–1966	1·50	235 (156·67)	25·82
18–72/6C	12–12–1966	1·50	280 (186·67)	34·57

The prawn fishery off Ratnagiri has come into prominence in the past nine years. In November 1959, a single haul of shore seine landed about 25 metric tons of prawns although in a few days the catches dwindled considerably. Since then, the region has been explored and exploited

regularly for prawns. The grounds lie between Harnai in the north to Vengurla in the south in the inshore areas of Ratnagiri District, about 20 miles in width along the coast. The number of trawlers has increased in this region from 3 in 1961 to 27 in 1964. In a survey conducted with the help of 12 trawlers of the Fisheries Department of Maharashtra State from October 1963 to March 1964, a prawn catch of about 304 metric tons was obtained forming about 45% of the total catch. Prawn catch was found to be better in Ratnagiri (23·6%) than in Malvan (14·13%) (Ranade *et al.*, 1965).

Off Dabhol (17° 35′ N) and Vengurla (15° 50′ N) in depths from 16–22 metres, two of the larger vessels, *viz.*, *Akashi Maru's* No. 23 and 25 and the smaller vessels the *Sudhas* I–VI of the New India Fisheries Company, Bombay, during January–March 1967 landed about 145 metric tons of shrimp. The overall catch rate for prawns in the quarter for the bigger vessels was 67·38 kg/hr and for the smaller vessels 77·90 kg/hr. Not only the catch rates but also the percentage proportion of prawns were higher for the smaller vessels (81·68%) as compared with those obtained by the bigger vessels (44·38%). During the year as a whole covering the areas north and south of Bombay, the New India Fisheries vessels fished 237,246 kg of prawns which formed 22·2% at a catch rate of 48·95 kg/hr. The southern grounds have proved to be extremely productive as in the first quarter of the following year (1968) the smaller vessels had obtained 190 metric tons of prawns forming 59·38% of the total catch at 93·31 kg/hr.

In the North-Western Division, the common prawn species landed by the trawlers are *Metapenaeus affinis* (Milne Edw.), *M. monoceros* (Fabr.), *M. brevicornis* (Milne Edw.), *Penaeus indicus* (Milne Edw.), *Parapenaeopsis stylifera* (Milne Edw.) and *P. hardwickii* (Miers). The less common ones are *Metapenaeus kutchensis* George *et al.* from Kutch, *Solenocera indicus* Nataraj, *Palaemon tenuipes* Henderson, *Penaeus penicillatus* Alcock, *P. monodon* Fabricius and *Hippolysmata ensirostris* Kemp from Bombay and *Penaeus merguiensis* de Man off Goa.

Shrimp Landings in South-Western Division

The best of the shrimp fishing grounds of India are located in the southern part of this division. The particulars of prawn landings by the offshore fishing vessels operating from different bases in recent years are furnished below.

Karwar (Between latitudes 14° N to 15° N and longitudes 73° 30′ E to 74° 30′ E)

Exploratory fishing by the medium vessels of the Indo-Norwegian Project [*INP*–167 (24 H.P, *Karwar* 1 (90 H.P.), *M*1/*M*4 (48 H.P.)] was commenced in September 1963. In the years 1963–64, 1964–65 and 1965–66 the vessels landed 11·13, 3·29 (data for one vessel not available) and 1·48 metric tons of prawns forming 6·66%, 2·0% and 1·13% of the total catches respectively. The major areas 14–73 and 14–74 have yielded fairly good catches of shrimps, the latter being slightly better. 14–73/5F, 6F; 14–74/5A and 6A have been found to give good yields. The catch rates ranged from 8 to 62 kg/hr for the vessel *Karwar*–1, 5 to 92 kg/hr for *M*1/*M*4 and 5 to 18 kg/hr for *LNP*–167. As shown in Fig. 3 the maximum monthly catch rates of prawns obtained in the region for the period 1963–67 is 225 kg/hr.

The common prawn species landed by trawlers in Karwar are *Metapenaeus affinis*, *M. debsoni* (Miers), *Parapenaeopsis stylifera* and *Penaeus merguiensis*.

Mangalore (Between latitudes 12° 10′ N to 14° N and longitudes 73° 30′ E to 75° E)

The Government of India exploratory fishing vessels [*M.F.V. Tarpon* (42 H.P.), *M.V. Samudra* (42 H.P.) and *M.V. Sagarvihari* (42 H.P.)] and a large number of mechanised boats of the Directorate of Fisheries of Mysore State have operated from this base providing information on the existence of rich prawn grounds in this region. The catch particulars are furnished in Table V.

TABLE V

Prawn landings by the Government of India vessels and mechanised boats of Mangalore base, 1963–64 to 1966–67

Year	Government of India vessels			Mechanised boats	
	Catch kg	C.P.H. kg	%	Catch kg	%
1963–64	12,659	31·72	14·74	540,888·5	16·93
1964–65	6,493	10·34	10·40	582,877·0	18·18
1965–66	7,478	18·97	18·03	1,135,948·0	28·87
1966–67	..	..	..	1,007,996·0	25·03
1967–68	..	..	..	996,231·0	26·05

The Government of India vessels operated off Mangalore, Malpe and Coondapore. Some of the subareas in the two major areas, *viz.*, 12–74 and 13–74 have proved to be very productive. In 1963–66 in some of the months from subareas 12–74/3E, 4E, 4F, 5D, 5E, 6E; 13–74/1D, 1E and 3D the catch rates for prawns were over 50 kg/hr up to 360 kg/hr. The catch rates (monthly maximum and annual average) and the percentage proportion of prawns in the total catches have been observed to be very much higher in this region than in Karwar (Fig. 3).

The mechanised boats of the Fisheries Directorate operating in the inshore grounds at Mangalore and Malpe have landed quantities of prawns forming a big proportion in the total landings (Table V). The prawn percentage in the total catch was higher at Mangalore (35%) than at Malpe (3·6%).

The common prawn species landed by trawlers in this region are *Metapenaeus affinis, M. dobsoni, Parapenaeopsis stylifera* and *Penaeus indicus.*

Cannanore (Between latitudes 11° 20′ N to 12° 10′ N and longitudes 74° 30′ E to 75° 40′ E)

The vessels of the Indo-Norwegian Project [*Ashtamudi, Norind* (48 H.P.) and *M1/M4*] explored the inshore region up to 20 fathoms. The operations were commenced in 1963. In 1963–64, 66·16 metric tons of shrimps were obtained which formed 49·72% in the total catch; in the following year 18·107 metric tons of prawn catch was obtained forming 19·66% of the total fish. In the subsequent years the landings by the Indo-Norwegian Project's vessels were still poorer. In the four year period the catch rates had shown a very much downward trend from 151·3 kg/hr in 1963 to 53·5 kg/hr in 1964, 16·3 kg/hr in 1965 and 27·7 kg/hr in 1966. Areas 11–75/5B, 5C, 6A, 6B and 12–75/1A had given monthly catch rates ranging from 25 to 73 kg/hr.

The mechanised boats operating in the region in 1966–67 have obtained a fairly high estimated catch of 130·483 metric tons of prawns forming 32·85% of all fish; the yields were still better in 1967–68, being 896·984 metric tons forming 67·31% of all fish.

The common prawn species landed by trawlers in Cannanore were *Metapenaeus affinis, M. dobsoni, Parapenaeopsis stylifera* and *Penaeus indicus.*

Cochin (Between latitudes 7° 30′ N to 11° 20′ N and *longitudes 74° 50′ E to 78° E)*

This region is well known for shrimp grounds which are comparable to the world's best grounds in Mexico and the United States of America. Shrimp fishing with indigenous non-mechanised craft and gear in the inshore region and the backwaters is an ancient occupation in

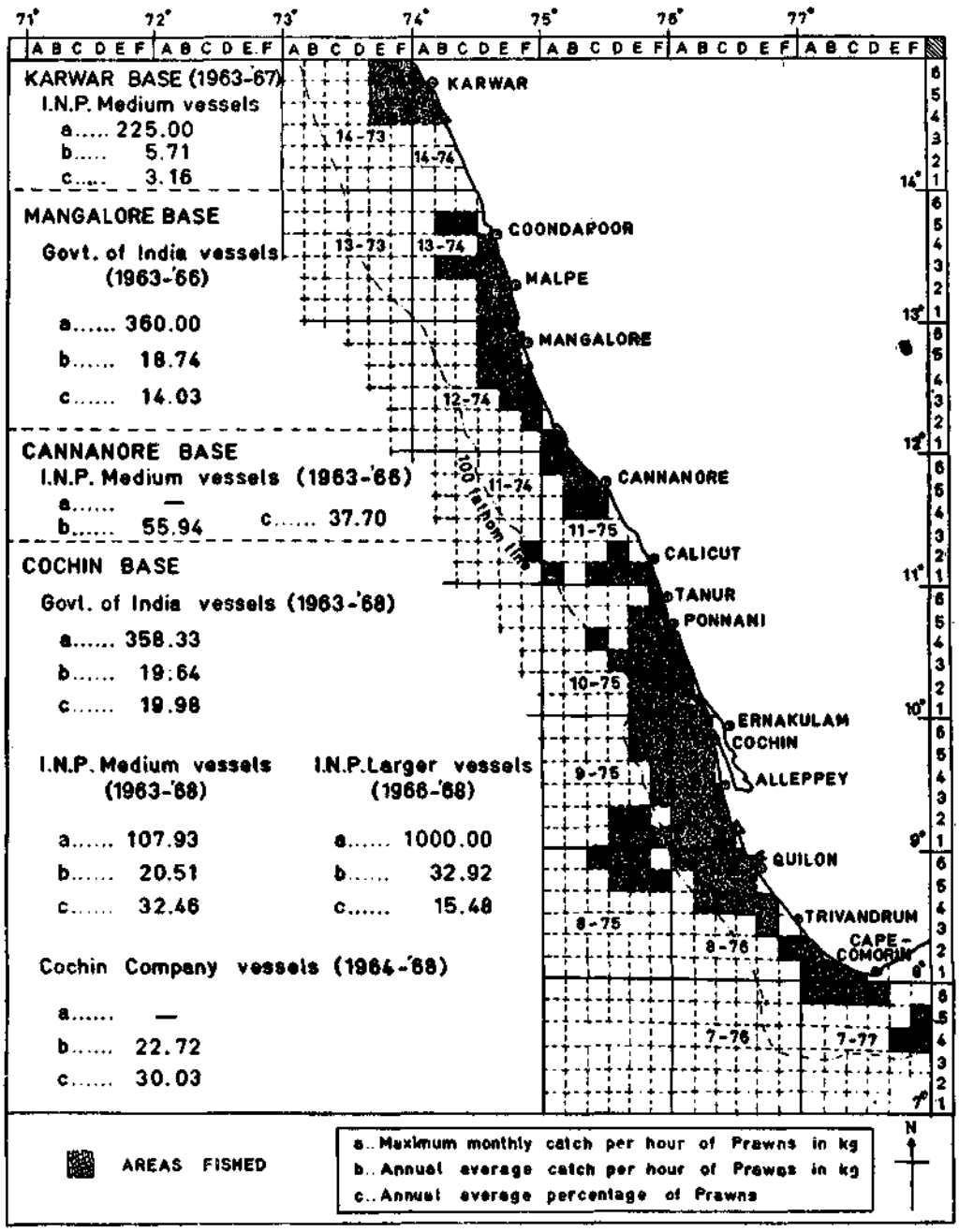


FIG. 3. Regional abundance of prawns in trawling grounds of the South-western Division of India from Karwar to Cape Comorin.

Kerala, but the introduction of mechanised craft and particularly fishing with trawlers is more recent. In 1956 *Ashok* and *Pratap* (240 H.P. each) commenced trawling (bull-trawling) in the region, followed in the subsequent years by a number of other trawlers belonging to the Government of India, Offshore Fishing Station. Large and medium trawlers of the Indo-Norwegian Project and several commercial concerns, besides a number of smaller mechanised craft of the fisheries co-operatives and processing concerns are now regularly operating from this base for shrimp fishing.

Bull-trawling operation by *Ashok* and *Pratap* in 1956–59 period, in grounds between Cannanore and Wadge Bank, have resulted in rather low yields of prawns which constituted about 1·3% of the total fish catches. In Table VI are given the catch particulars of the prawns by some of the trawlers in recent years. A downward trend is seen in the catch rates of the prawns obtained by the Government of India vessels for all the years from 1963–64 to 1967–68. The Indo-Norwegian Project's medium vessels also showed a downward trend in the catch rates, but only upto 1965–66 and then an increase. As compared with these results, the catch rates of prawns by the Cochin Company vessels were more or less steady in the entire period, the reason being that these vessels were seeking to find productive grounds only for fishing.

TABLE VI

Landings of prawns in Cochin by some trawlers, 1963–64 to 1967–68

	1963–64	1964–65	1965–66	1966–67	1967–68
Government of India vessels					
Catch kg ..	44,160	27,508	18,587	40,626·5	12,947·5
Catch/hour kg ..	47·01	19·61	15·80	16·50	9·65
Percentage ..	37·01	17·16	14·13	20·57	11·65
INP medium vessels					
Catch kg ..	20,323	3,546	3,901	25,730	103,334
Catch/hour kg ..	23·49	17·04	13·96	14·28	23·00
Percentage ..	20·68	14·21	13·17	25·59	44·96
INP larger vessels					
Catch kg ..	..	..	..	19,992	41,526·5
Catch/hour kg ..	..	..	..	30·75	34·07
Percentage ..	..	..	..	27·38	12·80
Cochin Company's vessels					
Catch kg. ..	..	14,112*	55,168	88,856·5	59,207
Catch/hour kg ..	..	18·38	20·69	24·83	23·12
Percentage ..	..	9·16	27·90	36·62	45·67

* 3 months fishing only.

In areas explored by the Government of India vessels for the period 1963–66, the following graded pattern of catch rates was observed. In 9–75/5 F and 9–76/5 B the catch rates were over 40 kg/hr; in 9–76/2B, 4B, 6A, 6B; 10–75/1E, 5F; 10–76/1A and 11–75/1D the catch rates were between 21 and 40 kg/hr; in 9–75/6F; 9–76/1A, 1C, 4A, 5A; 10–75/1F, 4E; 10–76/1B, 4A; 11–75/1E

and 1F the catch rates were between 10 and 20 kg/hr and in 8–76/4D, 4E; 9–75/6E; 9–76/1B; 10–75/2F, 3E, 3F, 4E, 5E, 6F; 10–76/2A and 11–75/1C they were below 10 kg/hr.

The research vessels *Kalava* (120 H.P.) and *Varuna* (400 H.P.) and some of the larger exploratory fishing vessels, *viz.*, *Klaus Sunnana* (220 H.P.), *Tuna* and *Velameen* (480 H.P. each) of the Indo-Norwegian Project fishing in the deeper waters beyond the continental shelf have landed prawn species *Aristeus semidentatus* (Bate), *Penaeopsis rectacuta* (Bate), *Metapenaeopsis* spp., *Parapandalus spinipes* Dc Man, *Plesionika martia* (A. M. Edw.), *Heterocarpus gibbosus* (Bate), *H. wood-masoni* Alcock, *Oplophorus gracilorostris* A. M. Edw., etc. the existence of which was hitherto not known. Some of the species were found in dense populations to support fisheries if the grounds are further explored and carefully exploited.

The productive areas fished by the larger INP vessels giving monthly catch rates of over 200 kg/hr of prawns in the period 1967–68 in the region between Alleppey and Quilon are given in Table VII.

TABLE VII

Productive areas giving over 200 kg/hr, fished by INP larger vessels, 1967–68

Area	Vessel	Month	Depth (metres)	Catch/hour (kg)
8–75/5D	*Klaus Sunnana*	December 1967	289	285·00
8–75/5E	*Velameen*	February 1968	348	260·50
8–75/6D	*Velameen*	January 1968	342–353	273·33
8–75/6E	*Velameen*	January 1968	342–346	214·44
9–75/1E	*Klaus Sunnana*	December 1967	320–358	248·57
9–75/1E	*Tuna*	January 1968	351–366	309·64
9–75/1E	*Velameen*	February 1968	348	244·09
9–75/1F	*Tuna*	December 1967	344–366	415·93
9–75/1F	*Tuna*	January 1968	366–369	206·31

The New India Fisheries Company's vessels at Cochin base in the five years period from 1963–64 to 1967–68 have landed 11,442 metric tons of prawns and fish sold at about Rs. 2·82 crores. The annual average landings were 2,288 metric tons.

It may be mentioned here that usually very heavy prawn catches are landed by the mechanised boats at Azhikode fishing centre also. In 1962–63 a prawn catch of 449·4 metric tons was landed at 50·35 kg/hr forming 73·0% of the total; the corresponding figures for 1963–64 being a catch of 159·8 metric tons at 37·97 kg/hr forming 70·73% (Data *C.M.F.R.I. Annual Reports* 1962–63 and 1963–64).

All the areas covered by the powered fishing vessels operating from Cochin base for the period 1963–68 are shown in Fig. 3. The maximum monthly catch rates of prawns for the different groups of vessels are very high. The highest catch rate registered by INP larger vessels is 1,000 kg/hr. The annual average catch rates and the percentage of prawns in total catches are also very high, but they seem to rank next to the corresponding values obtained by vessels which operated from Cannanore base. Cochin is undoubtedly the best region for prawn grounds. In this region the vessels have operated almost all round the year except when the weather was very unfavourable during monsoon, whereas in Cannanore fishing during the years for which the avarages have been estimated

was confined to the seasons in which the prawns were best obtained. Further during 1963 the catch rates at Cannanore were exceptionally high (151·3 kg/hr), although in subsequent years the annual catch rates ranged only between 16·3 kg/hr and 53·5 kg/hr. It is due to these differences that the annual average catch rates and the percentage proportion of prawns are found higher from Cannanore than in Cochin.

The common species supporting marine prawn fishery at present in Cochin region are *Metapenaeus dobsoni*, *M. affinis*, *M. monoceros*, *Penaeus indicus* and *Parapenaeopsis stylifera*. It may be noted that giant prawn *Macrobranchium rosenbergii* (de Man) does not support a fishery in the coastal or offshore waters, although fairly common in backwaters and rivers.

Shrimp Landings in South-Eastern Division

The marine fish catch of the east coast is only about a fifth of the total catch from both the east and west coasts. Prawn landings too are considerably less on the east coast forming only about 10% of the total prawn production of India. However, fairly good prawn grounds are now known to occur in several regions on east coast as revealed by the trawling operations of vessels belonging to different agencies.

Tuticorin

With Tuticorin as the base of operations, the vessels of the offshore fishing station of the Government of India, which was opened in 1959, surveyed trawl fishing grounds (latitudes 8° N to 12° 10′ N and longitudes 77° E to 81° E) in the vicinity of Tuticorin (major areas 8–78, 9–78 and 9–79) and Pondicherry (major areas 11–79, 11–80, 12–79 and 12–80). In the period from 1960–66 good prawn catches were obtained only from the major area 8–78 near Tuticorin. Possibly some good grounds may be near Pondicherry region also but the few operations carried out so far did not reveal any productive areas.

The Government of India fishing vessel *M.V. Sagarsundari* (42 H.P.) during 1966–67 obtained 19,492 kg of prawns at 29·11 kg/hr forming 12·07% and in 1965–66 a catch of 4,670 kg at 8·21 kg/hr forming 5·59% of the total catch. In 1966–67 the subareas 8–78/4B proved to be very good with an annual catch rate of 30·63 kg/hr, followed by 4C with 19·24 kg/hr and 5B with 3·21 kg/hr. In 1965–66 prawn yield rates in the respective areas were 19·12 kg/hr, 6·51 kg/hr and 1·71 kg/hr. Prawns being of good size for export trade and the yield rates being high in some of the earlier years, there was in the year 1967–68 a more intensive exploration, some of the vessels from Bombay having been shifted to this base for the purpose. However, there was a fall in the total catch (9,958 kg), catch rate (4·94 kg/hr) and the percentage proportion (3·53%) of the prawns fished by the vessels; the highest monthly catch rate was only 20·32 kg/hr. These results appear to indicate that the high yields of prawns are rather sporadic than regular in this region.

Mandapam

The medium vessels of the Indo-Norwegian Project using shrimp trawls fished up to 20 fathoms depth in Palk Bay (latitudes 9° 20′ N to 9° 40′ N and longitudes 79° E to 79° 30′ E) and the Gulf of Mannar (latitudes 8° 50′ N to 9° 15′ N and longitudes 79° E to 79° 30′ E). In 1965–66 the total catch by two vessels was 175,663 kg of which prawns formed about 1%. Prawns from the Gulf of Mannar region formed 1·41% and from the Palk Bay region 1·05% of the total regional catches. In 1966–67 the total catch by trawling was 54,929 kg of which prawns formed 0·95%. After March 1967 the vessels stopped fishing operations from this base. 5 to 20 kg/hr of prawns were obtained from a large number of areas in the Gulf of Mannar (8A, 9A, 9B, 10A, 10B, 14B, 15B, 15D, 16D and 17C) and from very few only in the Palk Bay (2A and 3A).

In the South-Eastern Division *Penaeus indicus, P. monodon, Metapenaeus dobsoni, M. affinis* and *M. monoceros* are the common species landed.

Shrimp Landings in North-Eastern Division

As compared with the South-Eastern Division, this division is slightly better for prawn yields in offshore fishing grounds. Fairly productive grounds off Kakinada, Visakhapatnam and in the vicinities of Chilka lake have been located in the exploratory fishing operations. However, intensive offshore fishing surveys for prawns using shrimp trawls have not so far been undertaken in this region.

Kakinada

Experimental shrimp trawling with 30 and 32 ft mechanised boats with 30 and 45 H.P. engines have been tried off Kakinada by the Research Unit of the Central Institute of Fisheries Technology and the Training Institute of the Andhra State Fisheries Department (A.S.F.D.) in grounds between latitudes 16° 50′ N to 17° 10′ N and longitudes 82° 20′ E to 82° 30′ E. Grounds which are fairly productive off Uppada and Hope Island have been located (Anon, 1967). Some of the catch particulars of prawns are given in Table VIII.

Table VIII

Prawn landings at Kakinada by experimental shrimp trawling

Year	Results of operations by boats of					
	Central Institute of Fish. Tech.			Training Institute of A.S.F.D.		
	Catch kg	C.P.H. kg	Percentage	Catch kg	C.P.H. kg	Percentage
1964	7,304·5	11·75	22·83	59,27	9·39	18·11
1965	8,806	15·45	20·00	40,103	3·99	14·11
1966	5,887	9·66	28·07	3,512	5·29	12·08

Visakhapatnam

Since 1959, when the Offshore Fishing Station of the Deep Sea Fishing Station was opened, the Government of India fishing trawlers have explored the fishery resources of a long strip of continental shelf, off the coast of Andhra and Orissa States, between the river mouths of Godavari and Mahanadi. In the annual landings by trawlers prawns formed 2 to 5% of the total catches. In 1966–67 the prawn landings were much higher than in the previous years. The annual landings of prawns, their catch rates and the percentage proportion in total landings are given in Fig. 4. The latitude zone-wise maximum monthly catch returns are given in Table IX.

There is in general an increase in prawn landings from southern to northern latitude zones. Grounds in the vicinity of Chilka lake in the latitude zone 19°–20° and those in the next below southern latitude zone of 18°–19° appear to be fairly productive.

Based on the results of the Government of India fishing vessels operating from this base during March 1963 to April 1968, the productive areas for prawns are shown in Fig. 4. In some months areas 17–83/4B, 4D, 5D, 6D, 6E and 20–88/6F have given over 20 kg/hr of prawns:

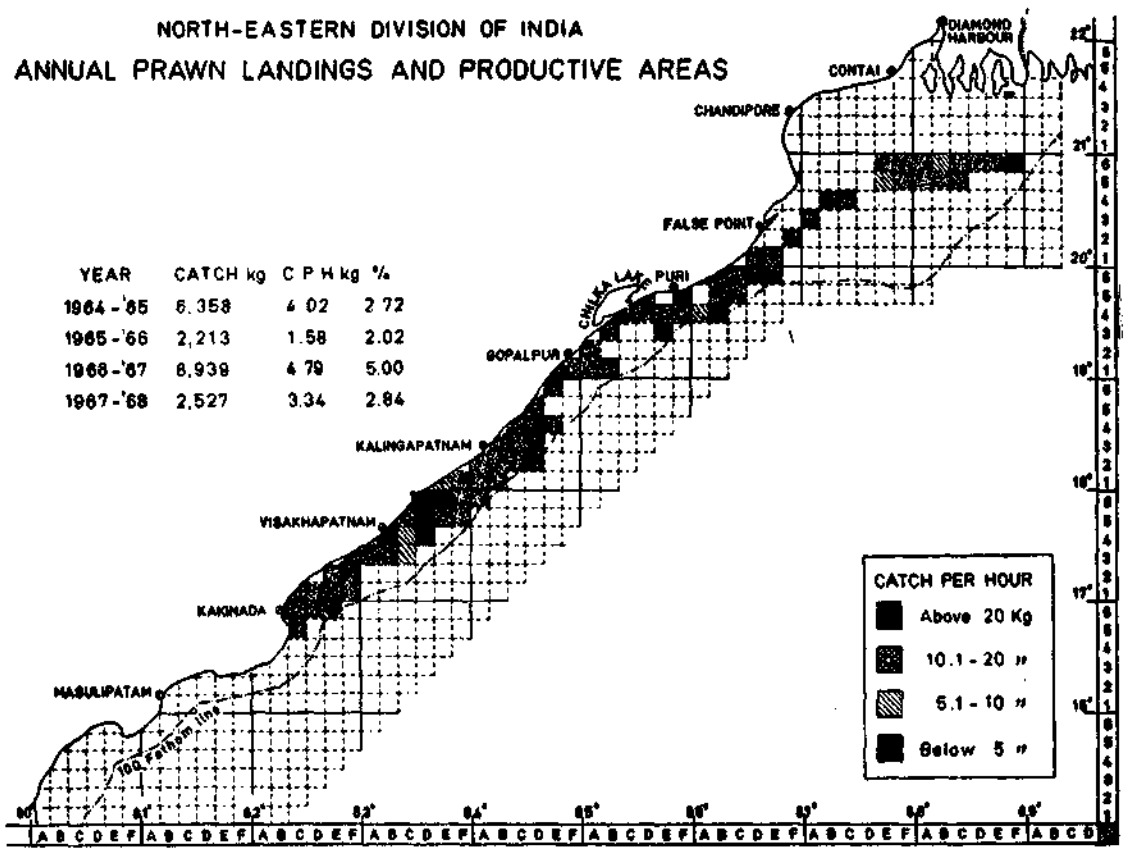


FIG. 4. Shrimp landings and productive areas revealed by the Government of India vessels in the North-Eastern Division for the period 1964-68.

TABLE IX

Latitude zone-wise maximum monthly catch rates during 1964-65 to 1967-68

Year	Latitude zone	Highest monthly catch/hr kg
1964–65	17°–18°	9.40
	18°–19°	13·57
	19°–20°	13·50
	20°–21°	4·20
1965–66	16° 40′	3·00
	17° 40′	6.80
	18° 10′	7·13
1966–67	17° 40′	13·10
	18° 10′	22·20
1967–68	17′ 40′	25·10

17–83/3A, 3B, 5C, 5E; 18–84/4C, 5D; 19–84/1F; 19–85/4E, 4F and 20–86/1E between 10·1 and 20 kg/hr and 17–83/3C, 4A, 4C; 18–83/1E; 19–86/4A; 20–87/5E and 20–88/6B between 5·1 and 10 kg/hr.

West Bengal

From 1950–51 to 1961–62 two Danish cutters and three Japanese type of trawlers (*M.T. Kalyanis* I to V—300 H.P. each) of the Directorate of Fisheries of the West Bengal were used for intensive surveys and commercial exploitation of the fishing grounds off Gopalpur in the south to Diamond Harbour and adjacent areas in the north. Fairly productive grounds have been found for demersal fishes in general but not for shrimps. In 1957 the prawn yield was 6·1 metric tons (forming 1·26% in total catch) at 235·11 kg/voyage; in 1958, 6·3 metric tons (1·81%) at 204 kg/voyage and in 1959, 1·4 metric tons (0·55%) at 64·42 kg/voyage.

Based on observations made on board the vessels in 1960, it has been found that proportion of prawns in the regional catches was the highest being 2·22% in the Eastern Channel (latitudes 20° 52′ N to 20° 55′ N and longitudes 88° 05′ E to 88° 30′ E), followed by 1·73% and 1·23% in the landings from the grounds off Debi-Prachi Rivers (latitudes 19° 54′ N to 20° N and longitudes 86° 27′ E to 86° 30′ E) and Western Channel (latitudes 20° 50′ N to 20° 55′ N and longitudes 87° 50′ E to 87° 52′ E) respectively; prawn percentage was poor being 0·5 in grounds off Mahanadi (latitudes 20° 05′ N to 20° 11′ N and longitudes 86° 35′ E to 86° 47′ E) and 0·69 off Black Pagoda (latitudes 19° 45′ N to 19° 49′ N and longitudes 86° 11′ E to 86° 24′ E).

In the North–Eastern Division as a whole, *Penaeus indicus, P. monodon, P. semisulcatus* Alcock, *Metapenaeus dobsoni, M. affinis, M. monoceros, M. brevicornis, Parapenaeopsis sculptilis, Solenocera indica* are common.

Conclusion

The major component of the shrimp landings by the mechanised vessels is constituted by the penaeid prawns which as far as known spend their life-histories in two environments, *viz.*, the marine and the estuarine or brackishwater environments, exception to this being *Parapenaeopsis stylifera* which spends its entire life in the marine environment. Other penaeid prawns like *Penaeus indicus, Metapenaeus affinis*, etc., breed in the sea either in the shallow water or a little beyond in the deeper waters. The eggs, larvae and post-larvae of most species are found abundant in the inshore waters in certain seasons. The younger stages migrate to the estuarine or brackishwater environments, where they grow to fairly large size and migrate back into the sea, where sexual maturity is attained for spawning to complete the life-cycle. Because of these migratory habits the abundance of penaeid prawn resources is relatively much higher in the shallower depth zones of the inshore than in the very deep waters. Rao *et al.* (1968) have stated that high catch rates for prawns were observed from the shallower and also the deeper depth zones up to 80 metres in some of the latitude zones in the Bombay–Saurashtra waters, but taking all latitude zones together the relatively greater abundance of the prawns was from the shallower grounds up to 30 metre depths. The results of bottom trawling in the Indian seas by *R.V. Anton Bruun* have also shown that the shrimp catches were mostly from shallower depths (Hida and Pereyra, 1966).

In Cochin region the major portion of the catches of prawns come from the shallower depth zones up to 24 metres, the highest prawn percentage observed being from 15 to 19 metre depth zone (Rao, 1968). There seems to be also variation in the species distribution in the different depth zones. In depths from 14 to 20 metres *Metapenaeus dobsoni, Parapenaeopsis stylifera, M. affinis, M. monoceros* and *Penaeus indicus* were in the order of abundance, whereas in depths between 21 to 27 metres *Penaeus indicus* dominated over *M. monoceros* and *M. affinis*. In still deeper waters up to 35 metres *P. indicus* and *M. affinis* were of equal abundance (*Annual Report, C.M F.R.I.*, 1967).

The contribution of non-penaeid prawns like *Palaemon tenuipes* to the inshore fishery especially in the north-western regions is fairly high but their proportion in the offshore fishery is very negligible. That the Pandalids like *Parapandalus spinipes* along with a few other deep sea prawns as stated earlier occur in depths beyond 100 fathoms in some concentrations is now well established but the extent to which they can be harvested yet remains unexplored.

Regarding the fishing season for prawns in the inshore waters Mohamed (1967) states that the period generally extends on the west coast from November to May and on the east coast from December to August. Fishing is generally suspended during the monsoon but in the Gulf of Kutch and in the regions where there is formation of ' Mud Banks ' in Kerala, some good catches of prawns are obtained even during monsoon months. In the offshore fishing grounds from Bombay to Kutch, Kagwade (1967) states that the prawns occur throughout the year but the catches being to increase from March onwards, the best months for fishing being July to October and in some regions extending even up to December. Rao *et al.* (1968) state that in the offshore fishing ground in the latitude zone from 15° N to 22° N in the north-western division prawns generally show two peaks, the first in April — May and the second in about October. The seasonal pattern of movements in different depth zones in the annual cycle for some of the regionally important penaeid prawn species is given by George *et al.* (1968). For instance in *M. monoceros* the offshore migration commences from November and by about April those above 80 mm size move into the depth zones 9·1 to 18·3 metres and by June all around 95 mm size move into the deeper waters of 18·3 to 27·4 metres. It has also been observed that in still deeper waters prawns of large size only have been encountered. *P. stylifera*, which does not enter the backwaters at all in its life-history, is comparatively more abundant in deeper waters up to November but gets dispersed subsequently to shallower zones.

The efficiency of the gear is one of the main factors determining the catch per unit of effort. The types of gear used in exploratory fishing operations, detailed in the earlier section, are varied. The New India Fisheries Company's vessels from Bombay base were operating the bull-trawls, the specifications of which are given by Kagwade (1967). The Government of India vessels at various bases were using mostly otter trawls and in a few cases shrimp trawls. These are of varied specifications suited to different types of vessels using them, the details of which are given by Rao *et al.* (1968) and Rao (1968). The Indo-Norwegian Project's vessels at all bases were operating mainly shrimp trawls. For comparison in this paper the results obtained by similar types of vessels only are taken into consideration for assessing the regional abundance. The recent findings have shown that the efficiency of the gear can be considerably increased by suitably modifying some of the specifications of the gear (Kurian, 1965). By attaching a tickler chain to a 10 foot beam trawl net, it was found that the catch of the shrimps increased by 47%. But this had no effect on the fish catches. To the otter trawls the attachment of the tickler chain increased the prawn landings by 71%. The increase in catch is apparently due to the disturbance caused by the movement of the chain attached to the foot rope (Anonymous, 1962). The dragging of the heavy iron chain for scaring the prawns has been in vogue in shrimp fishing in Kerala backwaters (Panikkar and Menon, 1955). The shrimp catches in an otter trawl were more when the number of floats attached to the net was less, bringing about a comparatively less buoyancy on the head rope. When additional wings were attached to the otter trawls a 50% increase in the shrimp catch was noticed, but this needs confirmation as the results obtained from different regions showed significant differences (Kurian, *loc. cit.*).

It has also been found that for a shrimp trawl a deep belly is not necessary and that by reducing it by one-third, a considerable saving of the nylon or cotton can be effected without decreasing the efficiency of the trawl (Mhalathkar and Krishna Iyer, 1967).

The rapid introduction of small, medium and larger types of trawlers in the Cochin region has no doubt increased the total volume of the shrimp landed in recent years, but the catch per unit of effort has considerably decreased. Very recently the exploratory and commercial fishing operations have shown an abundance of economic varieties of shrimps in the grounds off Bombay, Ratnagiri

and Goa. Instead of increasing any further fishing effort in Cochin region it is desirable that the as yet not adequately exploited resources elsewhere are tapped to a greater extent than is obtained at present. It is generally stated that the facilities for handling the catches at these newly discovered centres are sadly lacking. If adequate facilities for cold storage, freezing and processing are provided at Bombay, Ratnagiri and Goa the locally available resources can be satisfactorily exploited to earn the much needed foreign exchange.

Acknowledgements

The authors express their gratitude to Dr. S. Jones, former Director, Central Marine Fisheries Research Institute, for the constant encouragement given to them when this work was in progress. They are deeply thankful to Mr. S. Miskieth, Superintending Engineer, Government of India, Deep Sea Fishing Station, Officers of the Offshore Fishing Stations, the authorities of the Indo-Norwegian Project and the commercial organisations engaged in offshore fishing for making available the original log-data, upon the analysis of which by the scientific staff of Central Marine Fisheries Research Institute, the conclusions arrived at in the present paper are based.

References

Anonymous 1962. Effect of tickler chain on the catch of prawns and fishes landed by an otter trawl. *Fish. tech. Newsletter*, 3 (1): 8–9.

———. 1963. Trawling experiments to study the catch composition of prawns and other fishes during night trawling. *Ibid.*, 4 (3): 9.

———. 1967. Shrimp trawling off Kakinada (Andhra Pradesh). *Ibid.*, 8 (2): 9–10.

Banerji, S. K. 1965. A note on the production trend of marine shrimps in India. *Fish. Tech.*, 2 (1): 43–47.

FAO 1967. Catches and landings. *FAO Year Book of Fisheries Statistics for* 1966: 22.

George, M. J. 1966. On a collection of penaeid prawns from the offshore waters of the south-west coast of India. *Proc. Symposium on Crustacea, Marine Biological Association of India*, Pt. I: 337–346.

——, S. K. Banerji and K. H. Mohamed 1967. Size distribution and movement of the commercial prawns of the southwest coast of India. *Paper presented at the FAO World Scientific Conference on Biology and Culture of Shrimps and Prawns*, Mexico; Abstract: *Seafood Trade Journal*, 3 (1): 1968, 143–149.

—— and P. Vedavyasa Rao 1966. On some decapod crustaceans from the southwest coast of India. *Proc. Symposium on Crustacea, Marine Biological Association of India*, Pt. I: 325–336.

Hida, T. S. and W. T. Pereyra 1966. Results of bottom trawling in Indian seas by *R.V. Anton Bruun* in 1963. *Proc. Indo-Pacific Fish. Council*, 11 (2): 156–711 (1964).

Jayaraman, R., G. Seshappa, K. H. Mohamed and S. V. Bapat 1959. Observations on the trawl-fisheries of the Bombay and Saurashtra waters, 1949–50 to 1954–55. *Indian J. Fish.*, 6 : 58–144.

Jones, S. 1957. The prawn fishery resources of India. *FAO World Scientific Conference on Biology and Culture of Shrimps and Prawns*, Mexico, FR: BCBP/67/E/39.

———. 1967. The crustacean fishery resources in India. *Proc. Symposium on Crustacea, Mar. biol. Ass. India*, Pt. IV: 1328–1340.

Kagwade, P. V. 1967. Prawn catches by mechanised vessels in the trawling grounds of Bombay and Saurashtra. *Ibid.*, 1348–1381.

Kuriyan, G. K. 1965. Trends in development in the prawn fishing technique in India—A review. *Fish. Tech.*, 2 (1): 64–68.

Menon, M. Devidas 1968. The Pink Tide. *Seafood Trade Journal*, 3 (1): 73–79.

Menon, M. Krishna 1965. Life-histories of prawns—A review of recent studies with special reference to Indian species. *Fish Tech.*, 2 (1): 12–18.

Mhalathkar, H. N. and H. Krishna Iyer 1967. Belly depth studies for shring trawls. *IPFC, Occasional paper*: 67–6.

MOHAMED, K. H. 1967. Prawn fisheries. *Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute, Mandapam Camp*: 75–81.

PANIKKAR, N. K. AND M. K. MENON. 1955. Prawn fisheries of India. *Proc. Indo-Pacific Fish. Council* **6** (3): 328–344.

PANTULU, V. R. 1965. Inland prawn fisheries of India and their development. *Fish. Tech.*, **2** (1): 54–58.

RADHAKRISHNAN, N. 1967. On the prawn resources of Karwar region. *Proc. Symposium on Crustacea, Mar. biol. Ass. India*, Pt. IV: 1421–1423.

RAO, K. VIRABHADRA 1967. Exploratory fishing. *Souvenir, 20th Anniversary, Central Marine Fisheries Research Institute, Mandapam Camp*: 25–36.

RAO, K. VIRABHADRA 1968. Distribution pattern of the major exploited marine fishery resources of India. *Paper presented at the Symposium on the Living Resources of the Seas around India.* Also *Bull. Cent. mar. Fish. Res. Inst.*, **6**: 1–69 (1969).

——, 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.

——, 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. *Paper submitted to the Symposium on Demersal Fisheries at the 13th Session of the IPFC, Brisbane, Australia*, October, 1968. (in press). *Preprin. IPFC/C68/Sym*: **28**: 43 *pp.*

RANADE, M. R. AND S. M. WAKNIS 1965. Prawn resources of Southern Maharashtra (Ratnagiri)—an outlook for a new industry. *IPFC, Current Affairs Bull.*, **43**: 6–10.

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.

SHARIFF, A. T. 1959. Shrimp trawling along the Malabar coast during the years 1955 and 1956. *Indian Fish. Bull.*, **6** (3): 40–43.

——— 1961. Survey of the offshore demersal fisheries of the Andhra and Orissa coasts, 1960. *Souvenir, Fisheries of Gujarat*: 46–54.

TAGORE, PRADIP 1965. Prawn fishery by *M.F.V. Jheenga* in Bombay waters. *Fish Tech.*, **2** (1): 59–62.

THOLASILINGAM, T., G. VENKATARAMAN, K. N. KRISHNA KARTA AND P. KARUNAKARAN NAIR 1967. Results of exploratory trawl fishing on the continental slope of the south-west coast of India by *M.F.V. Kalava. Adv. Abstr. contr. Fish. Aquat. Sci. India*, **1** (4): 19.