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PRESENT STATUS OF EXPLOITATION OF FISH AND SHELLFISH RESOURCES : PRAWNS

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ABSTRACT

The Prawn fishery of the west coast of India is reviewed with particular reference to monsoon season and related management problems based on observations at Cochin, Calicut, Mangalore and Bombay. With an estimated average annual production of about 25,000 tonnes for the period 1984-88, the monsoon season contributes only 15% to the total prawn landings of this coast. While shrimp trawling remains almost completely suspended in most of the centres during this period, it is very active at Cochin and Sakthikulangara in Kerala Coast and moderately active in Bombay Coast. In Kerala, monsoon trawling is mainly targetted for *Parapenaeopsis stylifera* ('Karikkadi') which occupies relatively deeper waters during July-August. At Cochin, nearly 50% of the annual catch of trawlers is recorded during monsoon, with peak landings in July. In the traditional sector, though the prawn catch has considerably diminished in Cochin and neighbouring areas in recent years, the State as a whole witnessed tremendous increase in prawn production as a result of the introduction of ring seines. This fishery is chiefly supported by *Penaeus indicus* and *Metapenaeus dobsoni* which migrate to nearshore waters as a result of environmental changes taking place during monsoon season. As the contribution of 'Karikkadi' in this fishery is rather negligible, it appears that there is no clash of interest as far as exploitation of shrimp resource is concerned during the monsoon season. **As 'Karikkadi' is mainly concentrating in the offshore waters and the trawl catch does not contain an alarming proportion of breeding population, shrimp fishing in the deeper waters beyond the 30 m depth line would be advantageous to the fishery during this season.**

In the Mangalore Coast, a lucrative coastal fishery exists for prawns in the traditional sector during the monsoon period when large quantities of *M. dobsoni are* caught by 'Matabala' (a type of ring seine). Biological observations have shown that majority of the female prawns caught during this period are larger sizes far above the minimum size of attainment of maturity. As these prawns would have already spawned many times and are approaching their maximum size, it is felt desirable to exploit them and avoid natural mortality due to senility.

The monsoon trawl fishery of Bombay waters is largely supported by *P. stylifera, M. affinis* and *M. monoceros,* whose peak breeding is observed outside the monsoon season. Hence this fishery does not seem to adversely affect the breeding stock. It is, however, observed that the mean sizes of *P. stylifera* and *M. affinis* fall considerably during the early part of the monsoon season due to heavy recruitment of younger population into the fishery. If these undersized prawns are allowed to grow by observing a closed season for a short period of one or two months during June/July, it is hoped that the prawns would attain larger sizes and improve the quality of catch in the following months and enhance the economic returns of the fishermen. Possibility of increasing prawn production by extending commercial shrimp trawling in the offshore waters during the monsoon season is also pointed out.

INTRODUCTION

Among the various marine fishery resources of the west coast of India, prawns occupy a prominent position on account of its high export value. The tremedous development that has taken place in the capture fisheries along this coast during the past 3-4 decades was mainly due to the growing demand for shrimps in the overseas markets. Until about 1970, even after the advent of mechanised fishing outside the traditional fishing grounds prompted by the encouraging results of exploratory surveys, the commercial shrimp trawling prevailed only during the fair seasons extending from about September/October to May/June. The fishing activities during the monsoon season were relatively poor, being undertaken only by the indigenous craft and gears in the shallow coastal waters. The mechanised fishing, particularly shrimp trawling, remained totally suspended throughout the monsoon period due to rough weather conditions and other operational difficulties.

The fishermen of Kerala set an example in venturing the rough seas during the monsoon period for shrimp trawling by about early seventies from two centres, *viz.* Sakthikulangara (Quilon) and Cochin, where infrastructure facilities had developed for the operation of mechanised vessels. The State witnessed steady increase in prawn production during the subsequent few years and soon reached a level of stagnation. In other maritime States of the west coast, monsoon trawling commenced only very late and an attempt in this direction was made by Maharashtra to a limited extent.

In Kerala where monsoon trawling became a regular practice for exploiting prawns, many socio-economic problems began to crop-up as a result of the alleged encroachment of trawlers in the domain of the traditional sector. Outbreak of conflicts between these two sectors engaged in fishing in more or less the same fishing ground and trying to share common resources has become a regular feature in the State and also to a smaller extent in Maharashtra. It is also argued by the traditional fishermen that shrimp trawling in coastal waters during monsoon period is detrimental to the fishery wealth as well as to the coastal ecology. This has even led to the imposition of ban on trawling during the monsoon period in the last few years along the Kerala Coast. As monsoon trawling in the other parts of the west coast is likely to catch up momentum, similar situation may arise there also in future.

Many workers have attempted to study the prawn fishery of this coast and furnished information on the biology and fishery characteristics of important species from different centres. In Kerala, most of the studies carried out have been from Cochin and its neighbouring areas. Among the earlier works dealing with the fishery and biology of prawns of this coast, the studies of Panikkar (1937), Menon (1951, 1953, 1955, 1957), Panikkar and Menon (1955) and George (1960, 1961) are noteworthy. George *et al.* (1963) have provided a detailed account of the offshore prawn fishery of the area based on the catches of the Government of India trawlers operating from 1956 to 1963. Subsequent studies made by George and George (1964), Banerji and George (1967), George and Rao (1967); George *et al.* (1968), Rao (1968, 1972), Mohamed (1973), Kurup and Rao (1974), and Suseelan and Rajan (1989) have considerably augmented our knowledge of the fishery and population characteristics of prawns of the area. Alagaraja *et al.* (1986) have carried out stock assessment of important species at Cochin and Sakthikulangara based on the trawl catches of 1981-82 period. The prawn fishery of Karnataka Coast has been studied mainly from Mangalore and neighbouring centres (Ramamurthy, 1972 a; Ramamurthy and Sukumaran, 1984; Sukumaran (1987). Sukumaran *et al.* (1988) have dealt with the indigenous prawn fishery of Mangalore area during monsoon, while George *et al.* (1988) evaluated the present status of shrimp trawling and its impact on shrimp stocks of the entre Karnataka Coast. The distribution, fishery, species composition and biology of important species in Bombay waters have been elucidated by many workers, of which the contributions of Rajan *et al.* (1982), Aravindakshan and Karbhari (1983), Chakraborty *et al.* (1983), and Sukumaran and Rajan (1986) are some of the recent ones. Information on the prawn fishery of Gujarat Coast are derived mainly from the studies of Rao and Kasim (1985) from Veraval and Ramamurthy (1967), Deshmukh (1975) and Rao (1983) from Kutch region.

Apart from various regional investigations mentioned above, Silas *et al.* (1984) have made a general appraisal of the prawn fishery of the entire west coast, assessing the potential stocks at important centres. More recently, Suseelan and Rajan (1991) reviewed the coastal prawn fishery of this coast through low energy fishing methods and pointed out measures for improving the earnings of the traditional fishing sector.

Besides the investigations carried out from the sea, a number of studies have also been undertaken on the biology and exploitation of prawns from the estuaries and backwaters which serve as nursery grounds for many species of marine prawns contributing to the fishery. Some of the important contributions in this regard are the works of Suseelan and Kathirvel (1979, 1982) from Ashtamudi Backwater; Menon (1954), Gopinath (1955), Menon and Raman (1961) and George (1974) from Cochin Backwater and connected prawn filtration fields, and of Ramamurthy (1972) and Sukumaran and Nandakumar (1983) from Mangalore Estuary.

In the present paper, an attempt is made to assess the prawn fishery and connected manage-

ment problems of the west coast of India with particular reference to monsoon season.

Data Base

The gearwise catch and effort data of prawns taken from the Fishery Resources Assessment Division of CMFRI and the biological data collected by random sampling of commercial catches at Cochin, Calicut, Mangalore and Bombay during the period 1984-'88 formed the data base for this study. At Cochin, the catch and effort statistics and biological data were collected from trawlers operating from Cochin Fisheries Harbour and indigenous gears operating in the coastal waters of Ernakulam District (Sy. Zone 5). In the case of the indigenous fishery, detailed biological observations were made from three landing centres, namely Puthuvyppu, Narakkal and Fort Cochin during the monsoon season of 1988. At Calicut, the data were collected from Vellayil, where trawl net was the main gear used except during the monsoon period when the indigenous gears alone were operated. At Mangalore also, trawl net was the most important gear employed in the fishery except during the monsoon season when its operation was totally suspended. The data for trawl fishery were recorded from Mangalore bunder and indigenous fishery ('Matabala') from Ullal and Panambur Harbour. At Bombay, the data on trawl fishery were collected from two landing centres *viz.*, New Ferry Wharf and Sassoon Dock.

The prawn samples drawn from the commercial catches were analysed for species composition, size, sex and maturity condition of important species. The size refers to total length of the prawn. For size frequency and mean size analysis, the length measurements were grouped into 5 mm class intervals. The catch, effort and biological data collected from each of the centres were compiled seasonwise dividing the year into premonsoon (February-May), monsoon (June-August) and postmonsoon (September-January) seasons.

Observations

Craft and gear and fishing grounds

The shrimp fishing grounds on the west coast of India are spread over two diverse geographical regions - the southwest region comprishing of the coasts of Kerla, Karnataka and Goa and the northwest region comprising of the coasts of Maharashtra and Gujarat - where the physical Characteristics of the coastsal waters differ considerably from each other. While the southwest coast experiences strong upwelling and the consequent environmental changes during the monsoon seasons, the northwest region is characterised by strong tidal currents and a much wider continental shelf. The fishing craft and gears operating in these two regions are also suited to the prevailing physical conditions of the sea. George and Suseelan (1980) have described the distribution of different types of gears operated and their prawn production in different maritime States of this coast. In general, the indigenous fishery is based primarily on a few varieties of active gears on the southwest coast and passive gears on the northwest coast. Three major types of gears *viz.*, seine nets, fixed bag nets and gill nets are operated with the help of mechanised as well as nonmechanised country crafts such as catamarans, canoes and plank-built boats. On the southwest coast, the traditional gears (boat seines and shore seines) and the newly introduced mini purse seines ('ring seines' in Kerala and 'Matabala' in South Karnataka) are operated commonly, the later two types being intensively used during the southwest monsoon period in the coastal waters. In Kerala, the ring seines have almost replaced the boat seines locally called 'Thanguvala ', which was the principal gear used in the well known Mudbank ('*Chaakara*') fishery for ages. The 'Matabala' has turned out to be the most important gear operated now by the artisanal fishermen along Mangalore Coast during July-September. In the northwest coast, the important gears employed in the traditional sector are fixed bag nets/stake nets, which are operated against the flow of tide. The large version of these nets called 'Dol' nets are operated only during the nonmonsoon periods, while the smaller stake nets alone are used during the monsoon period in shallow coastal waters and creeks. Bottom-set gill nets made of synthetic twine are widely used along the west coast in the inshore waters, particularly during monsoon season. In certain areas of the southwest coast, as in the coast of Trivandrum District in Kerala, the regular single layered gillnets are being replaced by the tripple-walled trammel net popularly known as 'Disco vala' or 'Disco net' (Joel and Ebenezer, 1985). This net is operated upto a depth of about 35 m, with peak fishing activities during the southwest monsoon period. Another innovative gear that has been introduced in the coastal fishery in recent years is

the 'mini trawl' operated by motorised country craft without any winch facility. These nets have cod-end mesh sizes varying from 14 to 20 mm and are increasingly operated along the Kerala Coast during non-monsoon period.

Trawl nets of various designs and sizes operated by small mechanised vessels (8-14 m) are the most important gear used for exploiting prawns along this coast. Four-seam or two-seam shrimp trawls of 12-28 m headrope length having cod-end mesh sizes of 20-25 mm are operated. The fishing ground extends upto about 60 - 70 m depth. In general, the trawling season commences by about September and lasts till the end of May or some times middle of June, the operations being totally suspended during the monsoon period. In Kerala, however, shrimp trawling is most active during the southwest monsoon season at Cochin and Sakthikulangara. At Cochin, the trawl fishing during non-monsoon period is mainly restricted to the coastal waters upto about 25 m depth, while during the southwest monsoon period (June-August) the vessels gradually move out to deeper waters and operate between 30 and 60 m depth. In Maharashtra also shrimp trawling is practised during monsoon period in a smaller scale from Bombay. Here, the fishing is carried out in comparatively deeper waters (30-70 m) during non-monsoon months, whereas during monsoon period the trawling operations are confined to nearshore areas within 30-40 m depths for relatively shorter durations in each fishing trips.

General trend of prawn production

In the total marine prawn production of India, which amounted to an average of 1,97,000 t for the period 1984-'88, the west coast accounted for about 1,64,000 t forming 83 %. The annual prawn landings recorded during the 5-year period under study along with their percentages in the All-India prawn landings of the respective years are as follows :

Year	West coast prawn landings in tonnes	% in All-India prawn landings
1984	149179	77.7
1985	161788	85.6
1986	175343	83.3
1987	160973	84.4
1988	171805	84.8

Maharashtra accounted for about 52.7 % of this fishery, followed by Kerala 27.0 %, Gujarat 13.5 %, Karnataka 4.0 % and Goa 2.8%. Gearwise analysis of the catch data (Table 1) has indicated that, as much as 57% of the prawn catch of the entire west coast was contributed by the trawl sector and the remaining 43% by the artisanal sector. It is all the more striking to note that the trawlers registered nearly 80 to 100% of the prawn landings in the maritime States of the southwest region, Karnataka and Goa having contributed always the highest percentages (88.5-99.7%). As far the northwest region, the catch contribution of both the sectors of fishing was more or less equal, Gujarat registering slightly higher catches by trawlers (55.5%) than the artisanal gears (44.5%) and Maharashtra in the reverse order.

A perusal of Table 2, which summarises the seasonwise analysis of catch, would reveal that about 85% of the prawn landing was recorded during the non-monsoon period and only 15% during the monsoon period. In Gujarat, a meagre catch of about 4% recorded during the monsoon period was almost exclusively contributed by indigenous gears. Maharashtra registered an average production of over 9000 t during the monsoon season, which formed 9% of the total prawn landings of the State. This was mainly contributed by the trawlers operating from Bombay Coast. In Goa and Karnataka, 12-13% of the annual prawn catch was landed during the monsoon season. A significant portion of this catch in Karnataka was contributed by the artisanal gears, particularly 'Matabala'. The highest production of prawns during the monsoon season was recorded along the Kerala Coast, with an average landing of nearly 16,000 t (33.6%). This was mainly due to the heavy catches in trawl and boat seines/ring seines in all the years except in 1987. A remarkable increase in prawn catch of the traditional sector during monsoon season as a result of increased fishing by ring seines is a noteworthy change that has taken place in Kerala's marine capture fisheries in the last two-three years if the data after 1988 are also considered. In 1988, about 8500 t out of the total 18,000 t landed by the traditional sector was recorded during the monsoon season, which was mainly caught by both ring seines and boat seines. In 1989, the monsoon season recorded the maximum catch of 13,000 t out of the total 17,900 t landed by this sector, which was obtained chiefly

in ring seines. The gillnet/trammel net also contributed substantially to the monsoon fishery of the State.

TABLE 1. *Statewise and sectorwise prawn landings and percentage of west coast of India 1984-'88*

	States	Trawl sector (t)	(%)	Indigenous sector* (t)	(%)	Total (t)
1984	Gujarat	10680	55.1	8704	44.9	19384
	Maharashtra	36024	43.3	47140	56.7	83164
	Goa	4634	95.5	219	4.5	4853
	Karnataka	5000	90.7	511	9.3	5511
	Kerala	24971	68.8	11296	31.2	36267
	Total	81309	54.5	67870	45.5	149179
1985	Gujarat	9402	47.4	10446	52.6	19848
	Maharashtra	37759	35.3	69214	64.7	106973
	Goa	3451	98.7	45	1.3	3496
	Karnataka	4512	98..4	72	1.6	4584
	Kerala	23438	87.2	3449	12.8	26887
	Total	78562	48.6	83226	51.4	161788
1986	Gujarat	11389	46.8	12954	53.2	24343
	Maharashtra	40612	39.2	63116	60.8	103728
	Goa	4631	98.6	64	1.4	4695
	Karnataka	4912	92.9	373	7.1	5285
	Kerala	25124	67.4	12168	32.6	37292
	Total	86668	49.4	88675	50.6	175343
1987	Gujarat	17342	75.7	5565	24.3	22907
	Maharashtra	36237	51.9	33535	48.1	69772
	Goa	5776	99.7	19	0.3	5795
	Karnataka	8821	94.1	553	5.9	9374
	Kerala	47427	89.3	5698	10.7	53125
	Total	115603	71.8	45370	28.2	160973
1988	Gujarat	12364	52.1	1137	47.9	23738
	Maharashtra	28203	41.6	39553	58.4	67756
	Goa	3939	99.4	24	0.6	3963
	Karnataka	7690	88.5	1000	11.5	8690
	Kerala	54407	80.4	13251	19.6	67658
	Total	106603	62.0	65202	38.0	171805
Average	Gujarat	12235.4	55.5	9808.6	44.5	22044
	Maharashtra	35767.0	41.5	50511.6	58.5	86279
	Goa	4486.2	98.4	74.2	1.6	4560
	Karnataka	6187.0	92.5	501.8	7.5	6689
	Kerala	35073.4	79.3	9172.4	20.7	44246
	Total	93749	57.2	70068.6	42.8	163818

* Includes the occasional catches of prawns recorded in purse-seines also.

Centrewise catch, effort and catch rates

Cochin : Trawl fishery : The seasonwise break-up of prawn landings at Cochin Fisheries Harbour is shown in Table 3. The average annual prawn landings amounted to 2908 t of which nearly 50% (1432 t) was registered during the monsoon period and rest during the non-monsoon period. The contributions of premonsoon and postmonsoon seasons worked out to 38% and 12% respectively. In the average annual fishing effort of 42802 boat trips expended on the fishery, 13724 boat trips (32%) were performed during the monsoon period yielding the highest CPUE of 91 kg/boat trip. Though the effort expended during the premonsoon season was much higher (44%) than in the monsoon season the catch rate was only 61 kg/boat trip. Postmonsoon recorded the lowest CPUE of 35 kg/boat trip.

TABLE 2. *Average catch contributions (%) of monsoon and non-monsoon seasons to the total prawn landings of west coast, 1984-'88*

States	Monsoon	Non-monsoon	
		Premonsoon	Postmonsoon
Gujarat	4.2	41.9	53.9
Maharashtra	9.0	33.6	57.4
Goa	12.1	45.1	42.9
Karnataka	13.0	44.6	42.6
Kerala	33.6	35.6	30.8
West coast Total	15.4	39.3	45.3

The annual trend in prawn production during the monsoon season indicated that the fishery was relatively poor in 1984 and 1985 seasons when greater portion of the catch (57-67%) was obtained during the premonsoon season. In the subsequent two years the catch as well as CPUE steadily increased to reach a maximum of 2575 t and 144.5 kg/boat trip in 1987 season contributing the bulk (61.7%) to the fishery of that year. In 1988 season a drop in the catch as well as CPUE was noticed in spite of a substantial increase in fishing effort.

Within the monsoon season the peak of the fishery varied between the months, the maximum frequency of peak landings having been recorded in July (Table 4). In all the years, except in 1988, over 90% of the monsoon catch was registered during June-July period. In 1988 season, which was characterised by a peak in August, exceptionally high CPUE (135.8 kg) was recorded.

TABLE 3. *Prawn landings (t), fishing effort (boat trips) and CPUE (kg) by shrimp trawlers during monsoon and non-monsoon periods at Cochin Fisheries Harbour, 1984-'85 to 1988*

Year	Particulars	Monsoon (June-August)	Non-monsoon		Annual (Feb.-Jan.)
			Premonsoon (Feb.-May)	Postmonsoon (Sep.-Jan.)	
1984-'85	Catch	883.3	1353.1	158.6	2395
	No. of boat trips	14815	19787	3812	38414
	Catch/boat trip	59.6	68.4	41.6	62.3
1985-'86	Catch	181.6	1049.9	327.1	1558.6
	No. of boat trips	6229	15458	8641	30328
	Catch/boat trip	292.	67.9	37.9	51.4
1986-'87	Catch	2087.1	1101.4	321.4	3509.9
	No. of boat trips	16031	19175	11195	46401
	Catch/boat trips	130.2	57.4	28.7	75.6
1987-'88	Catch	2575.2	1012.0	582.7	4169.9
	No. of boat trips	17819	20115	18133	56067
	Catch/boat trips	144.5	50.3	32.1	74.4
1988	Catch	1295.8	1326.6		
	No. of boat trips	18097	18387		
	Catch/boat trips	71.6	72.2		

Indigenous fishery : The role of indigenous gears in harvesting prawns from the sea has considerably diminished over the years as is evident from the poor landings in the traditional sector. An active fishery by indigenous gears continues to exist only in Cochin Backwater and the adjacent paddy-cum-prawn culture fields where juvenile prawns are exploited in large quantities. In the sea, prawns are caught occasionally in a variety of traditional gears such as boat seines, ring seines, gillnets, cast nets, stake nets (off Cochin Barmouth) and mini trawls operated from motorised as well as non-motorised country crafts very close to the shore (< 10 m depth).

TABLE 4. *Monthly trends in production of prawns (t), number of boat trips and catch/boat trip (kg) by shrimp trawlers at Cochin Fisheries Harbour during the monsoon period 1984-'88 (Monthly percentage of catch in parenthesis)*

Year	Particulars	June	July	August
1984	Catch	193.6 (21.9)	640.9 (72.6)	48.8 (5.5)
	No. of boat trips	4726	5850	4239
	Catch/boat trip	41.0	109.6	11.5
1985	Catch	96.4 (53.1)	82.0 (45.1)	3.2 (1.8)
	No. of boat trips	3531	2320	378
	Catch/boat trip	27.3	35.3	8.5
1986	Catch	367.0 (17.56)	1516.9 (72.7)	203.2 (9.7)
	No. of boat trips	6371 6028	3632	
	Catch/boat trip	57.6 251.6	55.9	
1987	Catch	912.8 (35.4)	1513.7 (58.8)	148.7 (5.8)
	No. of boat trips	6276 5687	5856	
	Catch/boat trip	145.4 266.2	25.4	
1988	Catch	454.1 (35.0)	298.0 (23.0)	543.7 (42.0)
	No. of boat trips	10855	3238	4004
	Catch/boat trip	41.8	92.0	135.8

Analysis of the catch of indigenous gears operating in the coastal waters of Ernakulam District (Table 5) indicated an annual average production of about 180 t of prawns of which over 50% was landed during the monsoon season. Greater portion of this catch was recorded in June when the coastal waters experience environmental changes due to upwelling resulting in shoreward migration of some of the species of prawns which are eventually caught by indigenous gears. Of the non-monsoon periods, the postmonsoon season recorded better catch (32.6%) than the premonsoon season (15.7%). Boat seines (64%) and gill nets (18%) together accounted for about 82% of the total indigenous fishery.

TABLE 5. *Prawn landings (t) by indigenous gears in different seasons from the inshore waters of Ernakulam District, 1984-'88*

Year	Monsoon	Non-monsoon		Annual
		Premonsoon	Postmonsoon	
1984	46	23	196	265
1985	150	1	80	231
1986	-	-	-	-
1987	223	114	11	348
1988	37	-	-	37

Calicut : Trawl fishery : Shrimp trawlers operated only during the non-monsoon period except in 1986 when some fishing was attempted during monsoon (June) period also. Table 6 shows the catch, effort and catch rates recorded in this fishery. The average annual prawn landings during the non-monsoon period worked out to 240.7 t with an average catch rate of 29.6 kg/unit. During premonsoon period, the average annual catch was estimated at 91.3 t which formed about 38% of the total prawn catch by trawlers. The CPUE was estimated at 27.8 kg. During postmonsoon period, the average annual catch and catch rate were estimated at 147.4 t and 31.8 kg respectively. The peak landing and highest CPUE of this season were recorded in January and November respectively.

The monsoon trawling conducted in 1986 yielded about 10 t of prawns with a high catch rate of 47 kg/boat.

TABLE 6. *Prawn landings (t), fishing effort (boat trips) and CPUE (kg) by shrimp trawlers during monsoon and non-monsoon periods at Calicut, 1984-'85-1988*

Year	Particulars	Monsoon	Non-monsoon		Annual
			Premon-soon	Postmon-soon	
1984-'85	Catch	-	88.1	90.9	179.0
	No. of boat trips	-	1926	2844	4770
	Catch/boat trip	-	45.7	32.0	37.5
1985-'86	Catch	-	104.8	33.7	138.7
	No. of boat trips	-	2142	1024	3166
	Catch/boat trip	-	48.9	32.9	43.8
1986-'87	Catch	9.9	69.7	60.2	139.8
	No. of boat trips	210	2223	2052	4485
	Catch/boat trip	47.0	31.3	29.3	31.2
1987-'88	Catch	-	21.6	317.0	338.6
	No. of boat trips	-	974	12038	13012
	Catch/boat trip	-	22.2	26.3	26.0
1988	Catch	-	172.2	235.4	407.7
	No. of boat trips	-	9205	6073	15278
	Catch/boat trip	-	18.7	38.8	26.7

Indigenous fishery : Producing an average annual catch of about 65 t, the indigenous sector enjoyed a minor fishery throughout the year, with peak fishing activities during the southwest monsoon period (Table 7). The annual production, however, was found to be quite unsteady as observed at Cochin. During the monsoon season, which accounted for over 56 t (86%) on an average, the fishery maintained a regular pattern although the catches widely fluctuated (16-88 kg) in different years. The highest catch of 88.5 t was recorded in 1986 and the lowest in 1988. A number of gears such as boat seines ('Nethalvala' and 'Pattenkollivala'), gill nets ('Ayilachalavala' and 'Mathichalavala'), mini trawls ('Paithuvala') and cast nets were used, of which boat seines were the most important gear operated during the monsoon period.

Mangalore : Being the premier prawn fishing centre of Karnataka, Mangalore registered about 35% of the total prawn landing of the State, which was exploited by trawlers, indigenous gears and to a small extent by purse-seines. The maximum catch of 2560 t of prawns by all the gears was recorded in 1987-88 and the minimum of 1982 t in 1985-'86, the annual average being 2302 t (Table 8). Of this, the non-monsoon period contributed 97.9% and the share of monsoon period was only 2.1%.

TABLE 7. *Prawn landings (t), Fishing effort (units) and CPUE (kg) by indigenous gears during monsoon and non-monsoon periods at Calicut, 1984-'85-1988*

Year	Particulars	Monsoon	Non-monsoon		Annual
			Premon-soon	Postmon-soon	
1984-'85	Catch	70.7	13.7	2.8	87.2
	No. of units	6195	492	1110	7797
	Catch/unit	11.4	27.8	2.5	11.2
1985-'86	Catch	34.6	-	-	34.6
	No. of units	3188	-	-	3188
	Catch/unit	10.8	-	-	10.8
1986-'87	Catch	88.5	-	17.5	106.0
	No. of units	7923	-	1175	9098
	Catch/unit	11.2	-	14.9	11.7
1987-'88	Catch	73.3	0.7	-	74.0
	No. of units	3402	45	-	3447
	Catch/unit	21.5	15.6	-	21.5
1988	Catch	16.1	0.2	1.5	17.9
	No. of boat trips	1390	273	163	1826
	Catch/boat trip	11.6	0.7	9.2	9.8

Trawl fishery : There was virtually no trawl fishing at this centre during the monsoon period. A gearwise analysis of the data revealed that the shrimp trawls contributed to the bulk of the prawn catch (96.4%) obtained during the non-monsoon period. The maximum catch of 2534.6 t was obtained in 1987-88 and the minimum of 1918.8 t in 1985-86 (Table 9). The average annual catch by this gear amounted to 2218.1 t. The catch rate was relatively high in 1985-86 (6.4 kg/hr) when the total catch was the lowest and it was minimum in 1987-88 (5.4 kg/hr) when the total catch was the highest.

TABLE 8. *Seasonwise prawn landings (t) by all gears at Mangalore during 1984-'85 to 1987-'88*

Years	Monsoon	Non-monsoon		Total
		Premonsoon	Postmonsoon	
1984-'85	-	1117.2	1437.2	2554.4
1985-'86	63.1	1471.2	447.6	1981.9
1986-'87	116.7	1497.3	496.5	2110.5
1987-'88	16.9	1356.0	1186.8	2559.7
Average	49.2	1360.4	892.0	2301.6
%	2.1	59.1	38.8	

Purse-seine fishery : During the non-monsoon period, prawns were caught occasionally in purse-seines in large quantities. The annual catch estimated for this gear ranged from 8.2 t in 1987-88 to 112.0 t in 1984-85.

TABLE 9. *Prawn landings (t), fishing effort (hrs.) and CPUE (kg) by shrimp trawlers during non-monsoon period at Mangalore, 1984-'85—1987-'88 (No trawling during monsoon season)*

Year	Particulars	Pre monsoon & Post monsoon (Annual)
1984-'85	Annual catch	2442.4
	Effort	393935
	Catch/hr	6.2
1985-'86	Annual catch	1918.8
	Effort	299813
	Catch/hr	6.4
1986-'87	Annual catch	1976.9
	Effort	313794
	Catch/hr	6.3
1987-'88	Annual catch	2534.6
	Effort	46
	Catch/hr	5.4

Indigenous fishery : The prawn fishery along Mangalore Coast during monsoon season was largely dependent on the weather conditions and availability of shoals of prawns. Due to this, there has not been any consistency in this fishery. The 'matabala' fishery of the monsoon period exhibited a highly varying production trend (Table 10). At Ullal, the maximum, minimum and average annual catches of prawns were 110.6 t (1986), 11.9 t (1988) and 40.2 t respectively. The highest catch rate of 517.4 kg/unit was obtained in 1985, while the lowest (33.6 kg/unit) was observed in 1988. At Panambur Harbour, the maximum, minimum and average catches were 14.8 t (1988), 0.1 t (1987) and 4.5 t respectively. The catch rate was highest during 1986 (27.3 kg/unit), whereas, it was the lowest during 1987 (0.1 kg/unit). When the fisheries of both the observation centres were combined, the maximum catch (116.7 t) as well as CPUE (229.7 kg/unit) were recorded during 1986.

TABLE 10. *Prawn landings (t), effort (units) and CPUE (kg) of prawns by 'Matabala' during monsoon season at Mangalore, 1985-'88 (Fisheris of Ullal and Panambur harbour combined)*

Particulars	1985	1986	1987	1988
Catch	63.1	116.7	16.9	26.8
Effort	277	508	1265	1510
CPUE	227.8	229.7	13.4	17.7

Bombay : *Trawl fishery* : Monitoring of the penaeid prawn landings of shrimp trawlers at New Ferry Wharf showed a year-round fishery yielding an annual production ranging from 8553 t in 1985-86 to 11870 t in 1984-85 (Table 11), with an average annual catch of 10,112 t. During the premonsoon period, the prawn catch varied from 2137 t in 1988 to 4853 t in 1986 and the catch rate fluctuated from 5.8 kg/hr in 1988 to 13.1 kg/hr in 1986. The monsoon period recorded the lowest catch, evidently due to the lesser amount of fishing effort expended, but the catch rates were the highest in all the years. During this period, the catch varied from 406 t in 1985 to 1191 t in 1984 and the catch rate fluctuated from 25.7 kg to 67.7 kg/hr in the same years respectively. During the postmonsoon period, the catch varied from 5581 t in 1985 to 8330 t in 1984 and the catch rate fluctuated from 10.9 kg/hr in 1987 to 19.1 kg/hr in 1984. Month-wise trend in CPUE for the years 1984-88 (Fig. 1) showed a remarkable increase during August-September period in all the years.

TABLE 11. *Penaeid prawn landings (t), fishing effort (hrs.) and CPUE (kg) by shrimp trawlers during monsoon and non-monsoon periods at New Ferry Wharf, Bombay during 1984-1988*

Year	Particulars	Monsoon	Non-monsoon		Annual
			Premon-soon	Postmon-soon	
1984-'85	Catch	1191.4	2348.6	8330.1	11870.1
	Effort	17592	306828	435904	760324
	Catch/hr	67.7	7.7	19.1	15.6
1985-'86	Catch	405.8	2566.7	5580.9	8553.4
	Effort	15792	285624	430496	731912
	Catch/hr	25.7	8.9	12.9	11.7
1986-'87	Catch	936.9	4852.9	5867.4	11656.8
	Effort	26484	368748	496704	891936
	Catch/hr	35.4	13.2	11.8	13.1
1987-'88	Catch	758.9	2505.9	6037.3	9302.1
	Effort	21396	415188	555488	992072
	Catch/hr	35.5	6.0	10.9	9.4
1988	Catch	585.1	2137.4	-	
	Effort	20112	369252	-	
	Catch/hr	29.1	5.8	-	

At Sassoon Dock also the trawl fishery continued throughout the year, with relatively less fishing operations during the monsoon season. The annual catch of penaeid prawns varied from 9000 to 13000 t.

Species Composition

The prawn fishery of the west coast of India is represented by atleast 30 species belonging to the penaeid (24 species) and nonpenaeid (6 species) groups. Of these, 18 species of penaeids such as *Metapenaeus affinis, M. brevicornis, M. dobsoni, M. kutchensis, M. monoceros, Metapenaeopsis stridulans, Parapenaeopsis hardwickii, P. sculptilis, P. stylifera, Penaeus canaliculatus, P. indicus, P. japonicus, P. merguiensis, P. monodon, P. semisulcatus, P. penicillatus, Solenocera crassicornis* and *Trachypenaeus curvirostris* and 5 species of nonpenaeids such as *Acetes indicus, A. johni, Exopalaemon styliferus, Nematopalaemon tenuipes* and *Exhippolysmata ensirostris* support the regular fishery of mechanised and nonmechanised units. The species composition of the landings vary considerably in the southern and northern regions of the coast and also in different gears and seasons. In general, the trawl fishery of northwest region is predominantly supported by the penaeid prawns *M. affinis, M. monoceros, M. brevicornis, M. kutchensis, P. stylifera, P. hardwickii, P. sculptilis, P. penicillatus, S. crassicornis* and *M. stridulans*. The nonpenaeids *Acetes indicus, N. tenuipes* and *E. ensirostris* are the major constituents of the landings of indigenous gears such as 'Dol' nets which operate in relatively shallower areas. In the upper part of the southwest region (Goa-North Karnataka) the fishery is mainly based on *P. merguiensis, M. affinis, M. monoceros* and *P. stylifera*, while on the South Karnataka and

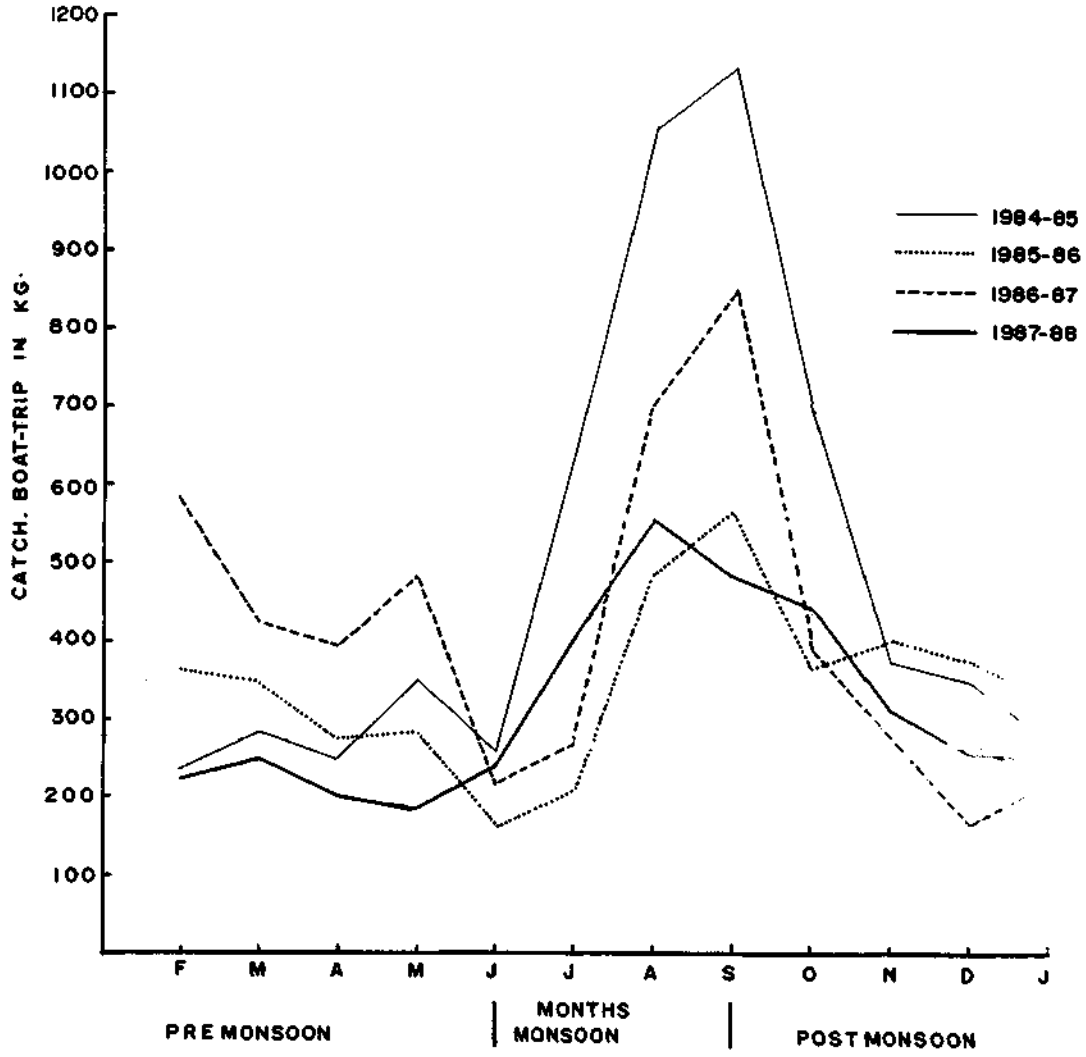

Fig. 1. Monthwise catch-per-boat trip (Kg) of penaeid prawns during 1984-85 to 1987-88 at New Ferry Wharf, Bombay.

Kerala Coasts is mainly constitued by *P. stylifera, M. dobsoni, M. monoceros, M. affinis* and *P. indicus.* Species like *P. semisulcatus, P. canaliculatus, T. curvirostris* and *M. stridulans* are also caught occasionally in large quantities by trawlers operating from Quilon and Cochin during the non-monsoon months.

The species composition and its variations noticed at the different observation centres were as follows.

In the trawl fishery at Cochin, though several species were encountered, only four namely *P. indicus* ('Naran'), *M. dobsoni* ('Poovalan'), *M. monoceros* ('Choodan') and *P. stylifera* ('Karikkadi') formed the main components. Their percentage composition in different seasons of the year is shown in Table 12. The dominant species in the catch exhibited marked variations during the monsoon and non-monsoon periods. During the monsoon season *P. stylifera* formed the bulk of the fishery (80-98 %) in all the five years of study. The mean percentage values for the various species during this period were *P. stylifera* 89.7 %, *M. monoceros* 5.4 %, *M. dobsoni*, 3.6 % and *P. indicus* 0.8 %. In fact *P. stylifera* accounted almost the entire catch when the fishery was at its peak, while the other species occurred in sizeable proportions only in the beginning of the season. *M. dobsoni* dominated in the fishery during the premonsoon (45.0 %) and postmonsoon (69.5 %) periods. The indigenous fishery (Table 13) was chiefly supported by *P. indicus, M. dobsoni* and *P. stylifera* in the order of their abundance. The most characteristic feature noticed in this fishery during the monsoon season was that *P. indicus* accounted as much as 91.3% of the catch which was mainly harvested by boat-seines and gill nets. During the premonsoon period *M. dobsoni* (82%) dominated in the fishery, whereas in the postmonsoon period both *P. indicus* (46.7%) and *M. dobsoni* (37.2%) accounted for the bulk of the fishery. It is interesting to note that the catch of 'Karikkadi' (*P. stylifera*) in the indigenous fishery was rather negligible during the monsoon season when compared to its absolute predominance and high catch rates in the trawl fishery.

At Calicut, the trawl fishery of non-monsoon period depicted more or less the same pattern as observed at Cochin Fisheries Harbour as regards catch composition. The fishery was mainly supported by *P. stylifera, M. dobsoni* and *P. indicus* along with small quantities of *M. affinis, M. monoceros* and others. *P. stylifera* contributed to the bulk of the catch, with percentages ranging between 64 and 79. While this species generally

TABLE 12. *Seasonwise percentage composition of important species in the prawn landings by shrimp trawlers at Cochin Fisheries Harbour, 1984-88*

Season	Year	*P. indicus*	*M. dobsoni*	*M. monoceros*	*P. stylifera*	Other prawns
PrM	1984	6.6	28.6	2.9	60.4	1.5
	1985	14.0	60.5	1.2	23.3	1.0
	1986	14.4	43.1	4.9	36.8	0.8
	1987	3.8	50.3	5.4	39.9	0.6
	1988	4.1	42.0	18.3	31.1	4.5
M	1984	-	-	10.2	89.3	0.5
	1985	0.2	4.0	3.0	92.4	0.4
	1986	0.8	0.3	0.7	98.1	0.1
	1987	1.9	5.7	2.9	89.1	0.4
	1988	1.3	8.2	10.3	79.7	0.5
PtM	1984-'85	22.7	62.3	2.5	10.6	1.9
	1985-'86	11.8	82.5	0.6	4.9	0.2
	1986-'87	5.6	86.8	3.3	3.9	0.4
	1987-'88	3.8	46.3	10.5	38.8	0.6

PrM = Premonsoon; M = Monsoon; PtM = Postmonsoon.

TABLE 13. *Seasonwise species compositon of prawn catch (t) of indigenous gears from the inshore waters of Ernakulam District, 1984-'88*

Season	Year	*P. indicus*	*M. dobsoni*	*P. stylifera*	Other species	Total
PrM	1984	23	-	-	-	23
	1985	-	1	-	-	1
	1986	-	-	-	-	-
	1987	-	112	1	1	114
	1988	-	-	-	-	-
M	1984	46	-	-	-	46
	1985	147	3	-	-	150
	1986	-	-	-	-	-
	1987	193	28	-	2	223
	1988	30	2	5	-	37
PtM	1984	132	30	34	-	196
	1985	-	76	4	-	80
	1986	-	-	-	-	-
	1987	2	1	7	1	11

PrM = Premonsoon; M = Monsoon; PtM = Postmonsoon.

dominated in the fishery during the premonsoon period, the postmonsoon catch was mainly supported by *M. dobsoni* (Fig. 2). During 1984, '85 and '86, the former accounted for 79, 72 and 64% of the catch respectively during the premonsoon period, while in 1987 and '88 the same species dominated during the postmonsoon season with percentage contributions of 79 and 60 respectively. *P. indicus* occurred in the fishery at the rate of 6 to 22% during premonsoon and 2 to 10% during postmonsoon periods. During the monsoon season of 1986 when trawlers operated in the beginning of June, *P. stylifera* accounted for over 80% and *M. dobsoni* the rest. The indigenous fishery was mainly based on *M. dobsoni* which contributed over 75% of the annual catch. During the monsoon period its percentage was as high as 80-97 (Fig. 3). Among the other species, *P. indicus* (5.5%) and *P. stylifera* (4.5%) were common. During the premonsoon season, the indigenous gears caught mainly *P. stylifera*, whereas in the postmonsoon season the fishery was chiefly supported by both *M. dobsoni* and *P. stylifera*. In September, however, *P. indicus* was the only species represented in this fishery.

At Mangalore, the trawl fishery of the non-monsoon period was mainly constituted by *P. stylifera, M. dobsoni, M. monoceros* and *P. indicus* in the order of abundance. During the premonsoon season *M. dobsoni, M. monoceros* and *P. indicus* were relatively more represented in the fishery than in postmonsoon season. The species occurred in the 'Matabala' fishery of monsoon period were *M. dobsoni, P. indicus, P. stylifera* and *M. affinis* of which *M. dobsoni* was the dominant one contributing to 93 % at Ullal and 97 % at Panambur Harbour.

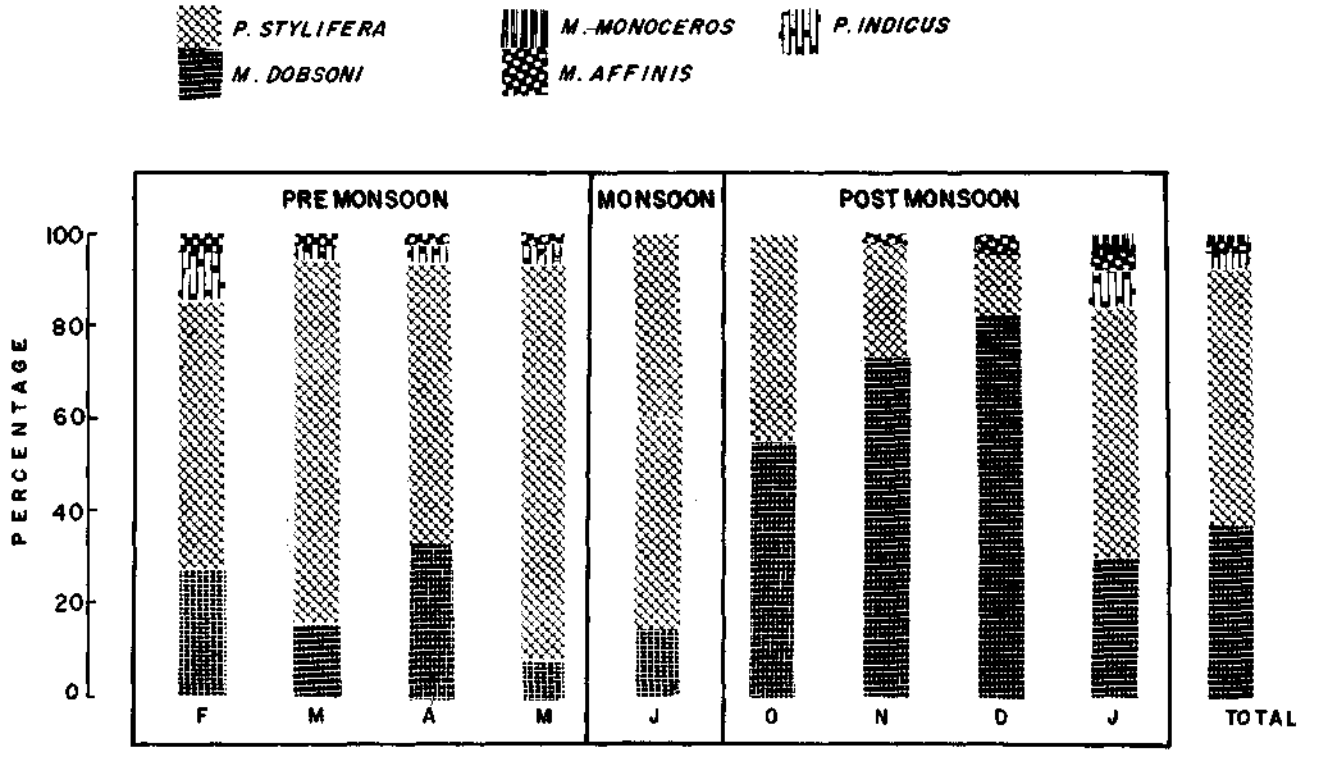

Fig. 2. Monthly/seasonal and annual average species composition of trawl catches at Calicut, 1984-88.

At Bombay, the catch composition of the trawl fishery at New Ferry Wharf and Sassoon Dock was more or less similar. At New Ferry Wharf, the penaeid prawns *P. penicillatus, M. affinis, M. monoceros, M. brevicornis, M. kutchensis, P. stylifera, P. hardwickii, S. crassicornis* and *M. stridulans* contributed to the commercial landings. Table 14 shows the specieswise catch, catch rate and percentage composition of important species during the different seasons of 1984-88 period. During the monsoon period, *P. stylifera* was the dominant

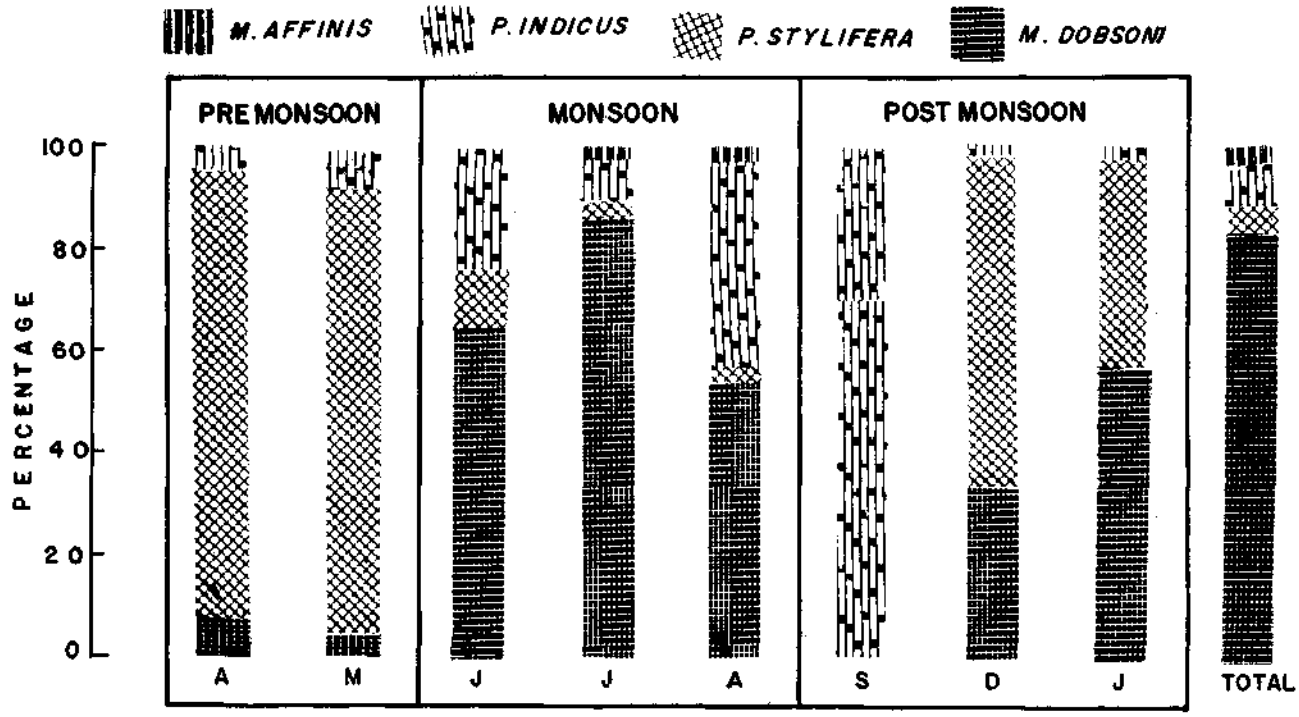

Fig. 3. Monthly/seasonal and annual average species composition of prawn catch by indigenous gears at Calicut, 1984-88.

species forming about 41 % followed by *M. affinis* and *M. monoceros* contributing 24% and 15% respectively. Thus, these three species together formed the bulk of the penaeid prawn landings. During the postmonsoon season, *P. stylifera* again dominated the catch (43%). In addition *M. affinis*, *M. monoceros*, *S. crassicornis* and *M. stridulans* also formed sizeable percentage during this period. The premonsoon period was, however, dominated by *S. crassicorins* forming one-third of the total penaeid prawn catch, followed by *P. stylifera* contributing 22%. *M. kutchensis* (2-3%) and *P. hardwickii* (2-4%) formed minor fisheries in the non-monsoon period.

Biological Considerations

Size composition and sex ratios : At Cochin, the size of *P. stylifera* in the trawl fishery ranged from 36 to 100 mm for male and 37 to 125 mm for female, the bulk of the fishery being contributed by the size groups 66-85 mm and 66-95 mm for the two sexes respectively. There was no marked variation in the size compoistion of the species in different seasons of the year. The monthly size frequency distribution for the monsoon season of different years is shown in Fig. 4. In general, the peak production

Table 14. *Seasonwise catch (kg), catch rate (kg/hr) and % composition of penaeid prawns during the years 1984-88 at New Ferry Wharf, Bombay*

	Premonsoon	Monsoon	Postmonsoon
Penaeus spp.	115,,769 (0.332) 4.02%	34,996 (1.726) 4.51%	326,245 (0.680) 5.05%
Metapenaeus affinis	342,770 (0.982) 11.89%	185,571 (9.152) 23.93%	929,119 (1.937) 14.40%
Metapenaeus monoceros	286,559 (0.821) 9.94%	119,524 (5.895) 15.41%	549,390 (1.145) 8.51%
Metapenaeus kutchensis	57,490 (0.165) 1.99%	-	176,112 (0.367) 2.73%
Metapenaeus brevicornis	180,075 (0.516) 6.25%	28,415 (1.401) 3.66%	292,119 (0.609) 4.53%
Parapenaeopsis stylifera	628,479 (1.800) 21.80%	315,216 (15.547) 40.64%	2768,652 (5.772) 42.90%
Parapenaeopsis hardwickii	119,591 (0.343) 4.15%	-	155,332 (0.324) 2.41%
Solenocera crassicornis	974,955 (2.793) 33.83%	61,496 (3.033) 7.93%	676,592 (1.410) 10.48%
Metapenaeopsis stiridulans	170,364 (0.488) 5.91%	27,156 (1.339) 3.50%	530,389 (1.106) 8.22%
Other penaeid prawns	6,258 (0.018) 0.22%	3,239 (0.160) 0.42%	49,992 (0.104) 0.77%

of the species during June and July was characterised by greater abundance of younger population. The modal size of males during this period were at 71-75 mm in most of the years when the catches were high except in July 1987 when the mode was at 81-85 mm. In females, the mode generally fell within the range of 71-75 mm and 81-85 mm except in July 1987 when a higher mode at 91-95 mm was also seen. In August, the 'Karikkadi' stock was found to be mainly composed of larger size groups for both sexes during the years 1986 to 1988 when the fishery was much better than in the previous years. The modal size during these years was invariably at 81-85 mm for males, whereas in females two principal modes - one at 81-85 mm and the other at 91-95 mm, were observed. In order to understand the proportion of undersized prawns in the fishery, which were generally discarded by the industry, the length frequency data of 1986-1988 period were pooled into two categories namely, 'discards' (< 65 mm) and 'commercial sizes' (> 65 mm) seasonwise and the results are presented in Table 15. The percentage of discards in the annual catch amounted to 16.2% in 1986-87 and 18.3% in 1987-88 periods. In the total discards about 70- 90% was recorded during the monsoon season. Examination of monthwise data reveals that the peak of discards in the fishery occurred in June and July. The important size group of *M. dobsoni* was 66-100 mm in the month of June when it appeared in the fishery in fair quantities.

In the indigenous fishery observed at puthuvyppu, Narakkal and Fort Cochin, *P. indicus* had a size range of 71-155 mm for males and 76-170 mm for females. The modal sizes were between 136 and 145 mm for both sexes throughout the monsoon period except in June when the males had mode at 121-125 mm. *M. dobsoni* was represented in the size range 51-105 mm with mode at 86-90 mm for females. Though the contribution of *P. stylifera* in the indigenous fishery was insignificant, detailed biological data were collected whenever catches were encountered for comparison with the trawl fishery. Fig. 5 gives an overall picture of the size composition of the species in different gears including trawl nets during the monsoon season. It can be seen that the size of the prawns caught by the non-selective indigenous gears (cast nets, stake net and boat seines) operating in the shallow coastal waters was much larger than the size constituting the trawl fishery. The major size groups in the indigenous gears were 81-100 mm for males and 91-110 mm for females, whereas in the trawl fishery they were 71-85 mm and 71-95 mm for the two sexes respectively, when the data for the entire period of study were combined. Studying the coastal shrimp fishery by indigenous gears at Narakkal, George (1961) also observed the modal length of the species attaining the maximum (86-90 mm) by August-September.

In the trawl fishery, the distribution of sexes for *P. stylifera* during the monsoon period was characterised by dominance of females whose percentage in the catch ranged mostly between 51 and 72. The maximum disparity was noticed in August when larger size groups accounted for the bulk of the fishery. During the permonsoon and postmonsoon seasons also females were generally more in the catch than males. The overall sex ratio for *M. dobsoni* was more or less 50:50. In the indigenous fishery *P. indicus* catch showed greater proportion of males (51-65%), while in *M. dobsoni* only females were encountered. The sex ratio of *P. stylifera* was in favour of females (61-70%) in all the gears operated during the monsoon period.

At Calicut, the size range of *M. dobsoni* in the trawl fishery of non-monsoon season was 36-100 mm for males and 36-120 mm for females. The bulk of the catch was constituted by 56-95 mm size group. Fresh recruitment into the fishery was noticed during the premonosoon season. In the case of *P. stylifera*, the size range was 31-105 mm for males and 31-130 mm for females, the bulk of the fishery being composed of the size group 66-95 mm. In the indigenous fishery of monsoon period, *M. dobsoni* was chiefly represented by the size group 71-110 mm and *P. indicus* by the size group 110-140 mm. The former species showed dominance of males over females throughout this season, while in the latter, males outnumbered females in the beginning of the southwest monsoon period and as the season advanced the females became more numerous than males in the fishery.

At Mangalore, the trawl fishery of *M. dobsoni* was mainly constituted by prawns in the size range 61-90 mm for males and 61-110 mm for females, while the major size groups of *P. stylifera* were 56-95 mm for males and 61-110 mm for females. In the 'Matabala' fishery, *M. dobsoni* catch was supported by relatively large sized prawns, ranging in size from 68 to 98 mm, with mode at 88 mm in

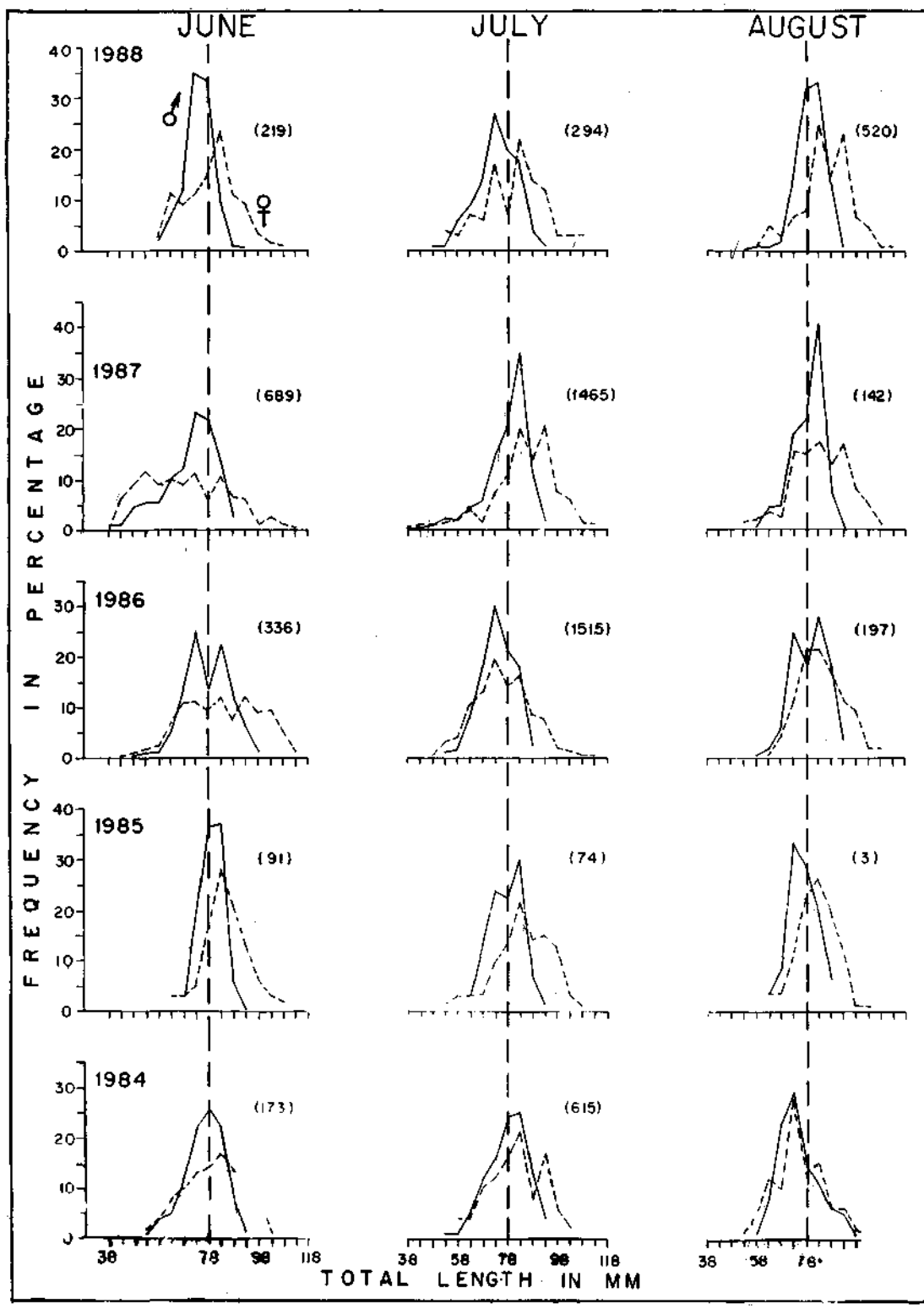

Fig. 4. Monthly size frequency distribution of *P. stylifera* in the trawl fishery at Cochin Fisheries Harbour during monsoon season. Figures in bracket indicate estimated total catch of the species in tonnes by trawlers. The broken line against 78 mm length is to indicate the changing pattern of major size groups in the fishery with the progress of season.

males and from 58 to 118 mm with modes at 93 mm, 98 mm and 108 mm in females. Males were in excess of females at both the centres of observation.

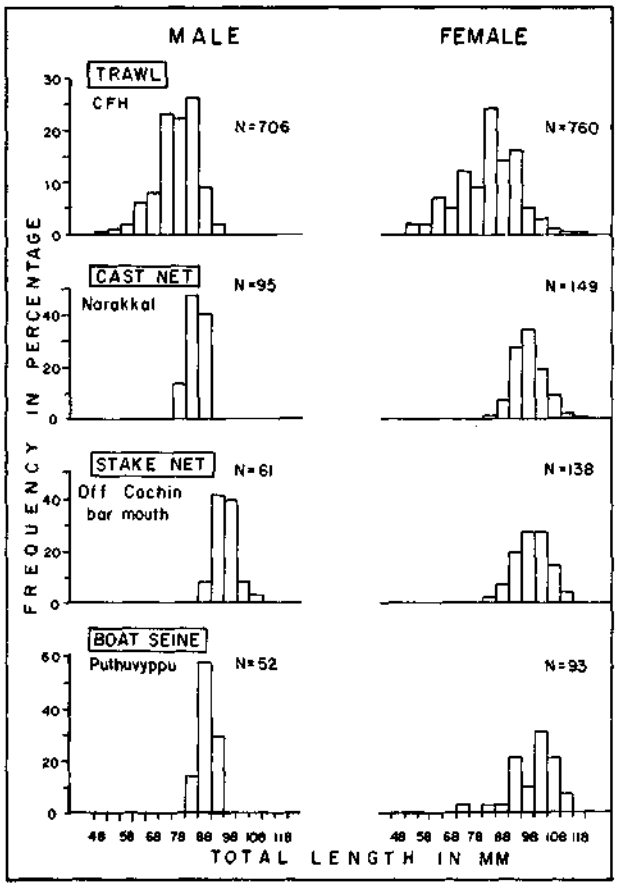

Fig. 5. Size composition of *P. stylifera* in the catches of different gears during monsoon season.

The monthly mean size distribution of important species at New Ferry Wharf at Bombay (Fig. 6) showed that, in the case of *P. stylifera* and *M. affinis*, there was considerable fall in mean sizes of both male and female during monsoon season, particularly in June and July. In *M. monoceros* and *S. crassicornis*, a similar fall in mean size was noticed during the postmonsoon season. The female prawns were found to be less abundant in the fishery during monsoon period in the case of *P. stylifera*, *M. affinis* and *S. crassicornis*, whereas they were more in *M. monoceros* and *M. brevicornis*.

Spawning Stock

In the trawl fishery at Cochin, the abundance of females of *P. stylifera* in spawning condition (maturity stages III and IV) was the least during the monsoon period (5.3-18.1%) as compared to the premonsoon (27.2-44.5%) and postmonsoon (32.4-61.9%) fisheries (Fig. 7). In the indigenous gears, on the other hand, the proportion of spawners was considerably higher than in the trawl catches during the monsoon period. The relative abundance of spawning population in the fishery of different gears is shown in Fig. 8. While the overall

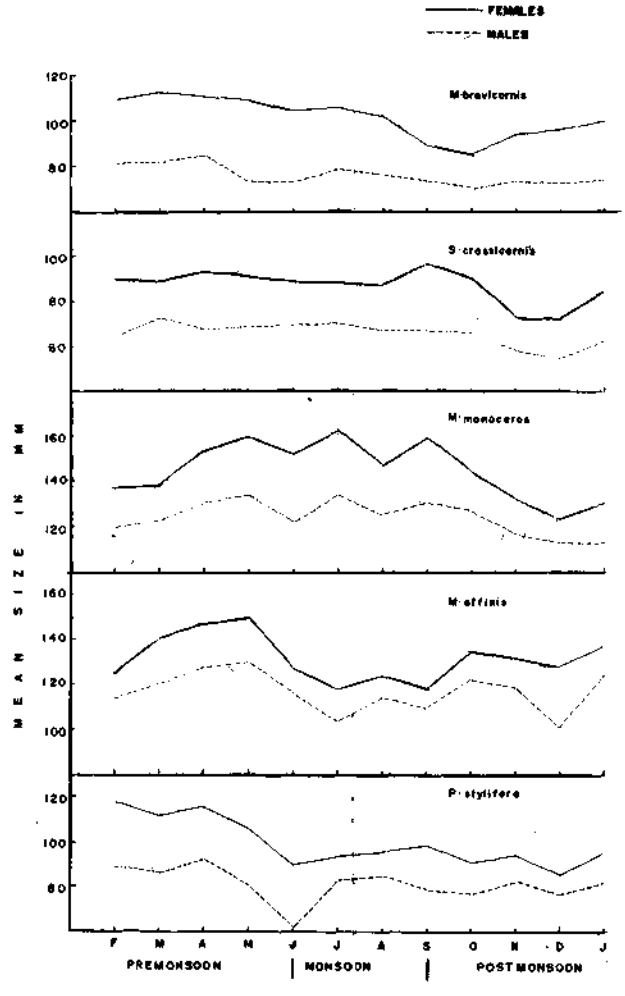

Fig. 6. Monthwise distribution of mean sizes of important species of penaeid prawns in the fishery at New Ferry Wharf, Bombay.

percentages of mature females in the trawl fishery was only 12, it was as high as 39 in stake nets, 42 in boat seines and 55 in cast nets operating in the shallow coastal waters. In the case of *P. indicus* caught by indigenous gears during the monsoon period spawners were totally absent. At Calicut, mature females of *M. dobsoni* and *P. stylifera* occurred in the trawl fishery almost through out the year in varying percentages (1-48%) with peaks

during March-May and November-January for both the species. During the monsoon period, the percentage of spawning population of *M. dobsoni* in the indigenous fishery ranged from 11 to 28. In the Mangalore Coast, the trawler catches showed peak abundance of spawners during January-May for *M. dobsoni* January-April for *P. stylifera* and February-April for *M. monoceros*. *P. indicus* recorded spawning peaks in April, October and January. In the 'Matabala' fishery of monsoon season, *M. dobsoni* showed 14-18% of females in mature

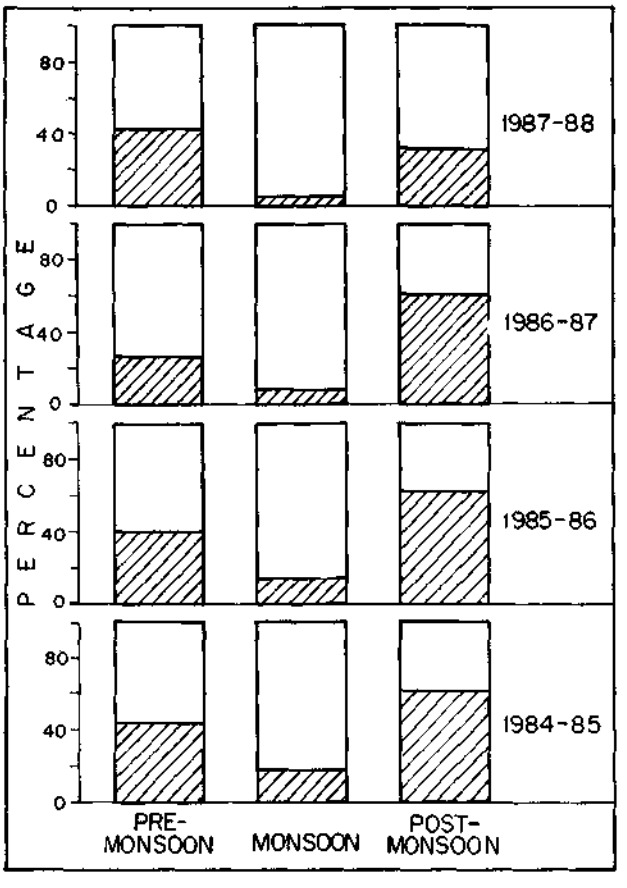

Fig. 7. Sesonal abundance of spawning population (shaded) of *P. stylifera* in the trawl fishery at Cochin Fisheries Harbour.

condition and 6-16% in spent or spent recovering stages, suggesting active spawning of the species during July-August in the coastal waters. In the case of *P. stylifera*, however, fully mature females were not encountered in this fishery. Seasonwise percentage distribution of mature females of penaeid prawns at New Ferry Wharf (Fig. 9) indicated relatively less breeding activities during monsoon season as compared to other seasons in Bombay waters for *P. stylifera*, *M. affinis*, *S. crassicornis* and *M. brevicornis*. *P. stylifera* and *M. monoceros* showed peak breeding during the premonsoon period and *P. hardwickii* during monsoon period.

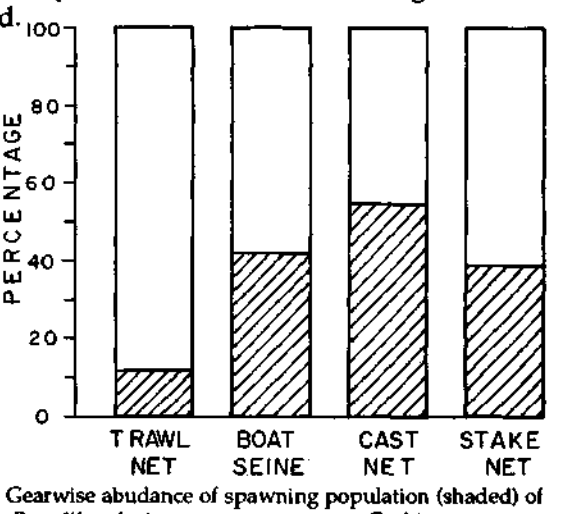

Fig. 8. Gearwise abudance of spawning population (shaded) of *P. stylifera* during monsoon season at Cochin.

Discussion

It is well known that changes in bottom hydrography brought about by upwelling during monsoon have significant effect on the demersal fisheries of the west coast of India. Upwelling is reported to occur throughout the west coast of India, although its origin, intensity and duration in a particular year vary between the southern and northern regions of the coast (Jayaraman and Gogate, 1957; Banse, 1959. Carruthers *et al.*, 1959; Anon., 1976; Murty, 1981). In the southwest coast, the upwelling commences during the premonsoon period and continues throughout the southwest monsoon season with its maximum intensity during August/Setpember (Anon., 1976). Banse (1959) reports that, as the low-oxygen layer ascends on to the shelf waters as a result of upwelling, a band of shelf bed along the southwest coast is overlayed by badly aerated water. The demersal fish and prawns abandon this portion of the shelf and migrate either to the deeper or to the shallow areas of the shelf. As a result of this shifting of fish and prawn stock from the usual fishing grounds, it is inferred that bottom trawling is profitable only in the deeper water beyond 35 m depth and occasionally in very shallow water during the southwest monsoon period. Recent experimental shrimp trawling conducted in the shelf waters off Cochin (Suseelan *et al.*, 1989) yielded added evidences in support of the above findings (Banse, 1959; Murty, 1981) on changes of shrimp stocks during the different

fishing seasons. It is observed that during the non-monsoon season (September/October to May) most of the stocks of *P. stylifera* occupy the coastal waters within 20 m depth line. With the commencement of southwest monsoon and the consequent changes in environmental conditions, the prawns leave the inshore areas in large numbers to the deeper zones. They remain mostly in the 20-40 m depth zone during June and in the 40- 60 m depth zone during July and August/September. A small population of 'Karikkadi', however, exists very close to the shore during the monsoon period, which is predominantly constituted by adult prawns in spawning condition. Menon (1958) states that on the Malabar Coast, from June to August, fishermen frequently catch prawns with cast nets, *i.e.* in quite shallow water, because the shoals come near the shore at this time of the year. All these observations point to the fact that the monsoon and the consequent upwelling bring about tremendous changes in the distribution and abundance of prawns (also fish) along the southwest coast. These changes of stocks in the fishing grounds have considerable relevance in the exploitation and management of the resource during the monsoon period.

In the northwest coast, the upwelling is observed to occur in Bombay region with a different origin (Jayaraman and Gogate, 1957). Here, the offshore winds during the northeast monsoon favours local upwelling during October/November. As a result of this, demersal fish migrate to shallower areas during the northeast monsoon period inorder to escape the lethal low oxygen condition of upwelled waters (Carruthers *et al.*, 1959). The present study reveals that a shore ward concentration occurs in the case of prawns also as the catches of prawns were very high during late monsoon and early postmonsoon period (August-September). The percentage of prawns in trawl catches during monsoon is found to be higher than in the postmonsoon and premonsoon periods.

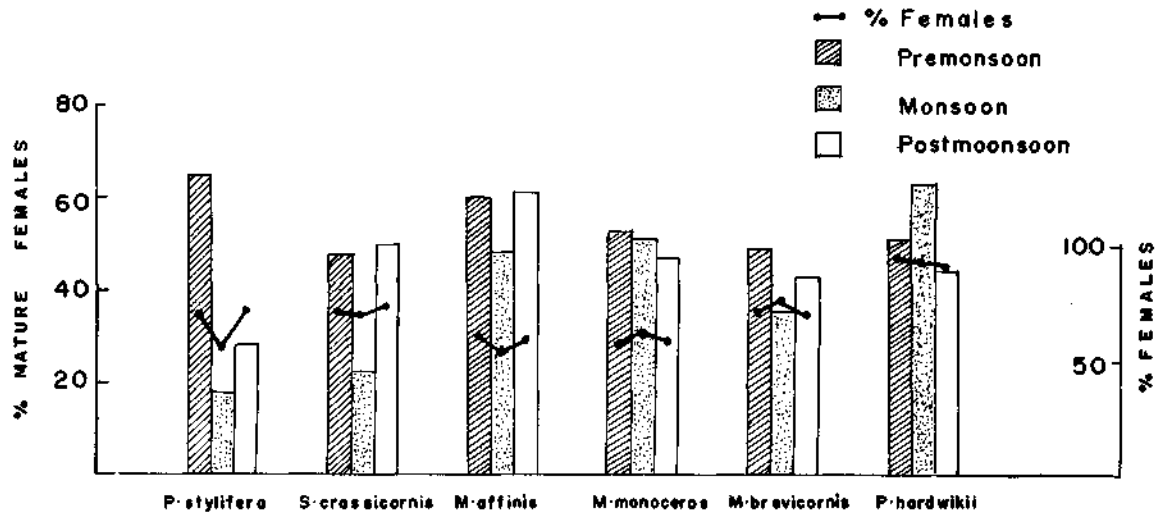

Fig. 9. Percentage distribution of mature females of important penaeid prawns in the fishery during monsoon and non-monsoon seasons at New Ferry Wharf, Bombay.

The present analysis of available data on the shrimp fisheries at different observation centres reveals the following facts which deserve attention in the context of management of the fishery during the monsoon period.

At Cochin, the prawn landings of the monsoon period is almost entirely through the contribution of shrimp trawlers whose area of operation is quite different from the area exploited by the traditional fishermen. This is because of the peculiar behaviour of *P. stylifera* which migrate in large numbers to the deeper waters during the monsoon period (June-August) as a result of changes in the environmental conditions of the inshore areas. The fact that the abundance of spawners in the trawl fishery is very low during the monsoon season as compared to other seasons of the year precludes the possibility of offshore migration of the species for breeding purpose. In

fact the usual breeding ground of *P. stylifera* is considered to be the coastal waters within about 22 m depth (Menon, 1953) and even during the monsoon season the small population of the species lingering very close to the shore and being caught sporadically in the indigenous gears (Suseelan *et al.*, 1989), contains a high percentage of spawners. The minor fishery that is existing in the traditional sector is chiefly supported by other species that tend to migrate shoreward with the commencement of monsoon. ***Thus, apparently there is no clash of interest as far as the exploitation of shrimp resource is concerned during the monsoon season.***

Taking into account the crucial role played by 'Karikkadi' in earning foreign exchange worth several millions of rupees during the monsoon period, it is imperative that this resource has to be exploited at the appropriate time. The only possible way of achieving this is by shrimp trawling since the indigenous gears cannot harvest 'Karikkadi' from the deeper waters. Opinion is expressed from certain quarters that if 'Karikkadi' is not exploited during the monsoon period by shrimp trawlers, will it be available to the indigenous fishery in the nearshore waters after the monsoon is over ? Though direct evidences are lacking to fully rule out this possibility there are indications to presume that the species may not return to the coastal waters and unless they are fished out they may perish due to prolonged exposure to the unfavourable hydrographic conditions prevailing in the offshore waters.

Analysing the catch data of FORV *Sagar Sampada*, Suseelan *et al.* (1990) observed the occurrence of 'Karikkadi' in varying densities in the offshore waters upto 53 m depth during the southwest monsoon period almost as a continuous belt between Quilon and Marmagoa. This would indicate that the offshore migration of 'Karikkadi' stock is taking place throughout the southwest coast during the monsoon season. But its fishery at the northern centres like Calicut, Mangalore, etc. where monsoon trawling is non-existent, becomes active only by November or December. Even at Cochin and Sakthikulangara in Kerala, it is observed that the postmonsoon fishery for 'Karikkadi' is preceded by a lean period of one or two months when the catch includes mainly fresh recruits which are much smaller than the dominant sizes constituting the trawl catches of August (Fig. 4). Studying the coastal shrimp fishery of Cochin (Narakkal) and Alleppey region, George (1961) also observed that after August-September the larger size groups disappear from the catches and the smaller groups become dominant. All these indirectly suggest that the offshore population of 'Karikkadi' may not return to contribute to the coastal fishery after the cessation of monsoon. However, a detailed study is needed to arrive at a definite conlcusion in this regard.

That the prawn production in the artisanal sector has considerably declined over the years is evident from the available catch statistics. According to George (1961) an active fishery prevailed at Cochin in late fifties with peak catches during July-September when the fishery was mainly supported by *M. dobsoni* (65-99%). *P. stylifera*, though formed second in abundance in the fishery, was prominent only in the postmonsoon period. Present analysis of the catch data (Table 13) indicates that the production of *M. dobsoni* in the artisanal sector has gone down drastically over the past several years. It is now relegated to a secondary position by *P. indicus*. The decline in catch could have been the cumulative effect of many attributes, such as constant fishing pressure in the coastal waters by shrimp trawlers, destruction of young ones and other man-made activities in the nursery grounds of important species. Unlike *P. stylifera* which spends its entire life in the sea, species like *M. dobsoni* and *P. indicus* face commercial fishing in both the environments, adults in the sea and juveniles in estuaries and backwaters. The extensive backwater system of Vembanad Lake has been the grazing field for thousands of traditional fishermen for 'Thelli' the juvenile of *M. dobsoni*, from time immemorial. Added to this, many man-made changes in these nursery areas and other destructive processes on the juvenile population (Suseelan, 1987) would have caused far-reaching effects on the stock leading to gradual decline in the coastal fishery. In the inshore sea also, indiscriminate capture of undersized prawns and heavy exploitation of the spawning population of *P. stylifera* and *M. dobsoni* by shrimp trawlers during the non-monsoon period would have adversely affected this population. More recently the operation of 'mini trawl', which has mesh sizes as small as 14 mm at cod end, is increasingly practised along the coastal waters of Kerala by motorised country crafts. This is highly detrimental to the fishery,

since the catch includes an alarming proportion of juvenile prawns.

At Calicut and Mangalore, the prawn fishery is least active during the monsoon season due to the suspension of trawl fishing. In the artisanal sector, however, fairly good catches of prawns are recorded on certain occasions, which are mainly constituted by larger size groups of *M. dobsoni*. This species is also found to breed actively in the coastal waters during the southwest monsoon period. The capture of large quantities of *M. dobsoni* with ripe ovaries by 'Matabala' during monsoon period has been alleged to cause depletion of the resource in Mangalore Coast. The present observations have shown that the modal lengths of the monsoon catch are at 88 mm in males and 93 mm, 98 mm and 108 mm in females, which are much higher than the minimum sizes at first maturity of the species. As most of these prawns would have already spawned two/three times and are approaching their maximum size it may be desirable to exploit them and avoid natural mortality due to senility. ***Therefore, imposing any restriction on the exploitation of this valuable resource from the point of view of conservation needs careful consideration.***

The monsoon trawl fishery of Bombay waters is largely supported by *P. stylifera*, *M. affinis* and *M. monoceros* which together constitute more than 80% of the total penaeid prawn fishery of the area. Though these species breed throughout the year, peak breeding is observed outside the monsoon season. Further, the lowest mean sizes recorded for the females of these species during monsoon period are 89.8 mm for *P. stylifera*, 117.5 mm for *M. affinis* and 144.6 mm for *M. monoceros*, which would indicate that the prawns caught during this season are well above their estimated minimum sizes at first maturity (George, 1967; Rao, 1967). ***Hence, monsoon fishing does not seem to adversely affect the breeding stock.*** The mean sizes of prawns show considerable fall during monsoon in the case of *P. stylifera* and *M. affinis*, whereas *M. monoceros* shows an upward trend. This fall in mean size may be attributed to heavy recruitment resulting from the peak breeding activity during the premonsoon period. Removal of such undersized prawns in monsoon period may result in growth overfishing as well as lower returns to the fishermen. If these undersized prawns are allowed to grow during early monsoon period by observing a closed season for a short period by about June/July, the prawns would grow to larger sizes and improve the quality of catch in the following months and thereby enhance the economic returns of the fishermen. At present, monsoon trawling in Bombay waters is restricted to the inshore areas within 30-40 m depth and it does not pose any management problem as the operation of 'dol' nets, the major gear of the traditional sector, is totally suspended. Recent bottom trawling surveys conducted in the offshore waters (Anon., 1989) have revealed that large concentrations of *P. stylifera* exist along with other species of prawns between 60 and 85 m depth in the area on latitude 18°N. **This indicates that there is scope for increasing the production of penaeid prawns in this region during monsoon period by extending commercial trawling operations to deeper waters.**

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