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THE CATFISH RESOURCES OF SOUTH WEST COAST OF INDIA - PROSPECTS AND MANAGEMENT PROBLEMS

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ABSTRACT

The marine catfishes of the genus *Tachysurus* form an important resource along Kerala-Karnataka coast. Till early seventies this resource was mainly exploited by indigenous gears and to a lesser extent by trawlers. The sudden introduction of large number of purse seines brought in a boost in the production of catfishes along Karnataka coast. This increase in the production was achieved exclusively by exploiting shoals of brooders which frequent the coastal waters for spawning in the monsoon and post monsoon months. The exploitation of the brooders year after year has led to the decline in production, probably due to poor recruitment. The steady yield of catfishes along Kerala showed a decreasing trend after the massive purse seine operations in Karnataka. The possible extent and effects of this decline are discussed in detail. The yield trends of various species of catfishes by different gears at the important fishing centres in Kerala and Karnataka have been studied in the light of declining production, and destruction of brooders. This account is an attempt to establish the degree of destruction of brooders, spawners and eggs/larvae along the entire coastal stretch, especially during September-October period. An attempt has been made to suggest suitable managerial measures to overcome this situation, so that the maximum sustainable yield can be achieved without affecting the spawning population and thereby the stock.

INTRODUCTION

Marine catfishes of the genus *Tachysurus* form an important component in the demersal resources in the coastal waters upto a depth of 80-125 m along the south-west coast of India. Though there are some published accounts on the biology and general fishery of some of the important tachysurid catfishes from Indian waters based on data from some selected centres (Sekharan, 1973 a, 19736 Majumder 1977, 1978, Rao et al, 1977, Dan, 1977, 1980, 1985, Krishnamoorthi, 1978 and Menon, 1979, 1914 a, 1914 b), a detailed investigation on the status of this resource over the years with emphasis on the management and conservation measures, recruitment, migration and potential available is still lacking. The very objective of this account is to fill the above lacunae in our knowledge on this resource. Anon (1917) covers various aspects on the biology and fishery of important catfishes from different centres with an assessment of the stocks in the present fishing regions. The mass destruction of eggs/embryos of *Tachysurus tenuispinis* and *T. dussumieri* along the Mangalore region has been reported earlier and accordingly the Karnataka State was advised to initiate restrictive measures to save this resource from a calamitous decline. However, the destruction still continues and another species, *T. serratus* has also been affected. Though catfishes are considered as a ground fish resource, at least in some phases of their life history, they ascend the column and surface waters for purposes of feeding and breeding. In general, catfishes prefer muddy grounds, and the young ones mostly remain at the bottom feeding on the epi- and in-fauna of such grounds. As the fish grows larger and older, they ascend the column and move towards deeper waters. All available information and observations show that after attaining maturation they congregate in large schools for breeding in shallow coastal waters and remain there till the fully developed young ones are liberated. This habit of migration of schools of gestating males/spawners makes them an easy target for many of the gears operated in the coastal belt Such an exploitation caused damage to eggs/embryos in a small scale, when the same was exploited by more effective and mechanised gears, the devastation is manifold amounting to high mortality of eggs/embryos. The destruction is all the more pronounced when the entire school

of gestating males with eggs/embryos/larvae in their mouth are encircled by large purse-seine nets. Such a situation may lead to severe set backs in recruitment As catfishes have longer life span, grow to larger sizes and the age at first spawning is between 2 to 4 years in most of the commercially important species, the impact of such destruction on recruitment will not be felt immediately. However, a continuous destruction of eggs/embryos/larvae by very high purse seine effort inputs will only add to the cumulative effect on the mass destruction with severe set backs in recruitment in the coming years. Since catfishes are migratory in habit, the destruction of eggs/embryos larvae at any one centre will have its impact at other places too. Though the destruction mainly takes place along Mangalore region only, caution will have to be exercised to manage this resource after a thorough and critical study of the total estimate eggs/embryos/larval destruction year after year.

Though nothing concrete can be said about the migration pattern along the South-North direction and vice versa based on the available data, the coastward migration for breeding purpose is proved beyond doubt. An attempt has been made to interpret the South-North migration based on seasonal catch rate records from various centres along Goa to Cochin. However, only a detailed investigation by mass tagging of various species, especially shoaling ones, alone can give a clear picture of the migratory pattern of this resource. This paper examines all available data, information and observations to suggest suitable management policies by reducing the rate of removal of eggs/embryos/larvae and also to recommend methods and new avenues to explore this resource to achieve the maximum sustainable yield. The fishery managers have to bear in mind the changed conditions during the past few years and the heavy fishing pressure on the coastal environment, before formulating policies to augment production and conservation of the resource by restrictive methods. However, the ultimate management programmes should be associated with maintenance of the resource.

DATA BASE

The primary data and information were collected from important landing centres such as Cochin, Calicut, Mangalore and Karwar along Kerala-Karnataka coast and Goa. Regular gear-wise, species-wise catch, effort, size and age frequencies in the commercial fishery and other biological parameters were collected from the above centres during the period 1979-85 Past data from Fishery Resources Assessment Division as well as from various published works on the subject were also utilised for the interpretation and recommendations suggested in this paper.

ANNUAL AND SEASONAL YIELD TRENDS

Annual catfish yield along west coast alone forms 70% of the total catfish catch of the country and the contribution by south-west coast is 54% in the catch of the west coast. During the 15 year period from 1971-1985, the catch along the south-west coast varied from 8420 tonnes in 1983 to 37192 t in 1975 with the percentage contribution of 28 and 77.6 respectively in the total west coast catch having an annual mean of 20209 t. This period showed fluctuations in the yield with high crests during 1974-75. 1979-80 and 1983 and with troughs in between (Fig.1). There was a general decline in landings in the successive years which reached its culmination in 1985 inspite of high effort inputs, both in non-mechaised and mechanised sectors.

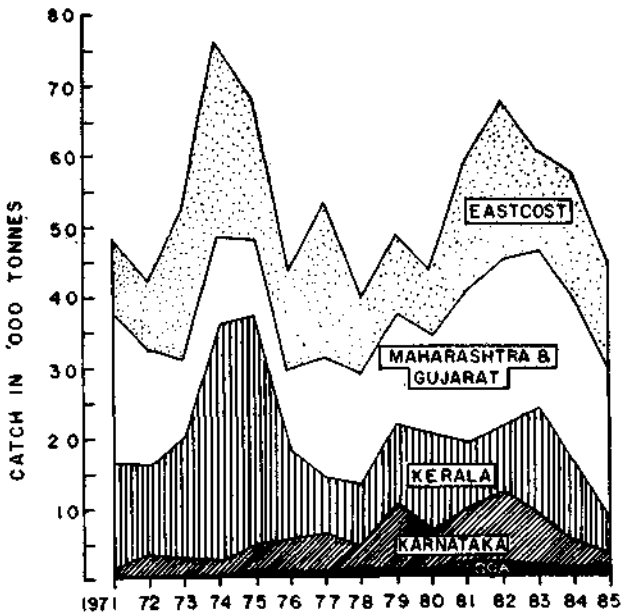

Fig. 1. Annual catfish catch trend along the maritime States of India during 1971-1985.

Kerala ranked first in the catfish catch among the maritime states of India with peak catches during 1974-75; 1979 60 and 1983, having a perfect correlation with west coast landings. The catch gradually declined and in 1985 it was at its lowest, being only 5170 t. On the other hand Karnataka, though lagging far behind till 1978, showed a boost in production after the introduction of purse seiners. But this situation continued only for a short period from 1979 to 83 and now here too the fishery is showing a declining trend with catch as low as 1572 t in 1985, a condition similar to early seventies. A review of the catch data for the past 15 years indicates that the landings in Goa do not seem to have been affected and have registered a steady but slow progress with only minimum deviation from the mean.

Annual state-wise figures show that the fluctuations, though common, have not deviated far from the mean unlike some pelagic resources. A critical study of the catch particulars of different months at the fishing centres such as Cochin, Calicut, Mangalore, Karwar and Goa emphasised the need for proper mointoring and management of this resource. At Cochin the annual yield varied from a minimum of 426 t in 1985 to a maximum of 984.9 t in 1981 with a general declining trend, May to October is the period of abundance with peak during July-September every year. Calicut centre also showed peak abundance during 1980 (190.4 t) which declined to 281 t in 1981. At Calicut the monthwise catch showed a different trend with two peaks of abundance in February, March and September-October. Tne catch trend seen at Mangalore is also similar to that of Cochin and Calicut with the minimum catch of 620.4 t in 1985 and the maximum of 5080 t in 1982, again showing a downward trend. As in Calicut, at Mangalore the landings have two major seasons, January-March, with peak in February and September-November.

At Karwar the highest catch was in 1982 (817t) and the lowest in 1985 (26 t), with a steady decline. The two peak periods of landings are February-April and October-November. The catfish landing at Goa was almost steady with fluctuations from 1151 t in 1980 to 2291 t in 1981, but with a general increasing trend. Here the main fishing season is from December-May with peaks during March and December.

GEARWISE AND SPECIESWISE ABUNDANCE

On the south-west coast this resource is tapped by non-mechanised gears, such as gill nets, hooks & line, boat seines, rampani and yendi and mechanised gear, trawl. Monthwise, gearwise and speciswise catfish catch at Cochin, Calicut and Mangalore are given in Tables 1-3. At cochin, Mangalore, Karwar and Goa in addition to trawls purse seines are also operated for catching catfish. Four species namely *Tachysurus tenuispinis, T. dussumieri, T. serratus* and *T. thalassinus* are represented in the fishery. Species abundance vary from centre to centre and gear to gear. Monthwise catch rates and gearwise CPUE at Cochin, Calicut and Mangalore are given in figs. 2-9.

TABLE 1.

Monthwise total catfish catch tonnes) at Cochin, Calicut, and Mangalore.

Months	Cochin (1981-1985 average)	Calicut (1979-1985 average)	Mangalore (1980-1985 average)
January	18.5	45.1	217.0
February	12.0	62.5	126.8
March	14.4	28.7	193.1
April	15.6	20.6	132.8
May	83.0	18.4	555.1
June	176.1	4.6	0.6
July	123.0	4.0	—
August	87.9	17.4	—
September	80.6	114.1	115.1
October	71.8	78.3	710.4
November	7.5	49.5	119.1
December	5.7	41.4	295.5
Annual average	696.1	484.6	2465.5

TABLE 2.

Monthwise and Gearwise catfish catch (tonnes) at Cochin, Calicut and Mangalore

Months	COCHIN			CALICUT			MANGALORE		
	Drift net (1981-1985 average)	Trawl net (1981-1985 average)	Purse seine (1981-1985 average)	Drift net (1979-1985 average)	Trawl net (1979-1985 average)	Hooks & line (1979-1985 average)	Purse seine (1979-1985 average)	Trawl net (1982-85 average)	Drift net (1979-85 average)
January	16.7	—	1.8	17.5	13.3	16.0	78.4	76.7	63.7
February	8.8	—	3.2	8.5	20.7	34.9	50.0	58.2	25.4
March	9.7	1.2	3.5	3.2	7.8	17.8	81.1	110.6	21.6
April	3.1	12.5	—	1.8	5.8	13.8	71.4	71.0	1.8
May	4.4	70.6	7.9	1.3	0.8	16.4	427.1	84.9	0.0
June	32.9	143.2	—	0.6	0.0	4.1	—	0.9	—
July	82.7	40.3	—	1.9	—	2.3	—	—	—
August	81.5	6.5	—	5.8	—	12.0	—	—	—
Sept.	71.5	6.1	2.9	28.2	—	73.4	91.9	—	32.9
October	65.3	5.1	1.5	18.2	0.0	61.0	567.7	—	79.0
November	6.4	1.1	—	10.3	0.8	39.6	44.0	99.2	33.6
December	4.6	1.1	—	12.5	1.4	28.4	317.5	59.0	51.9
Annual average	387.6	287.7	20.8	109.8	50.6	318.7	1729.1	560.7	309.9

TABLE 3.

All gear species wise monthly catfish catch (tonnes) at Cochin, Calicut and Mangalore

	Cochin - (1981 - 1985 average)				Calicut (1681 - 1984 average)				Mangalore (1982 - 1985 average)			
	T. dussumieri	*T. thalassinus*	*T. serratus*	*T. tenuispinis*	*T. dussumieri*	*T. thalassinus*	*T. serratus*	*T. tenuispinis*	*T. dussumieri*	*T. thalassinus*	*T. serratus*	*T. tenuispinis*
Jan	16.4	0.2	1.8	—	10.8	0.5	5.9	8.0	137.0	18.7	9.4	60.5
Feb	9.8	0.1	2.0	—	24.5	—	2.0	9.3	41.6	7.1	29.6	57.6
March	13.7	0.3	0.3	—	13.2	—	0.4	11.5	69.8	11.5	4.1	100.1
April	6.1	0.0	0.6	8.7	9.3	0.1	0.1	7.0	125.7	—	0.4	56.3
May	17.4	21.4	5.3	38.8	9.7	0.3	0.7	5.0	759.8	0.3	0.0	72.8
June	6.9	80.9	26.8	61.6	2.9	—	1.6	0.0	0.0	0.1	—	0.7
July	14.7	15.5	41.4	51.2	0.9	0.1	1.9	0.0	—	—	—	—
Aug.	27.3	13.0	27.0	20.5	5.6	0.9	0.8	8.1	—	—	—	—
Sept.	16.6	32.3	22.1	10.7	13.5	10.6	4.0	57.5	2.8	1.4	10.7	129.4
Oct.	12.0	32.8	25.4	1.5	8.4	18.3	1.9	43.4	100.4	4.2	26.7	222.9
Nov.	3.4	1.2	2.1	0.7	5.3	15.0	4.0	23.5	5.5	2.0	9.5	98.2
Dec.	4.2	0.0	0.4	1.0	7.0	2.5	2.5	15.4	9.4	1.6	15.9	67.2
Total	148.5	197.7	155.2	194.7	111.1	48.3	25.8	188.7	1252.0	46.9	106.4	865.7

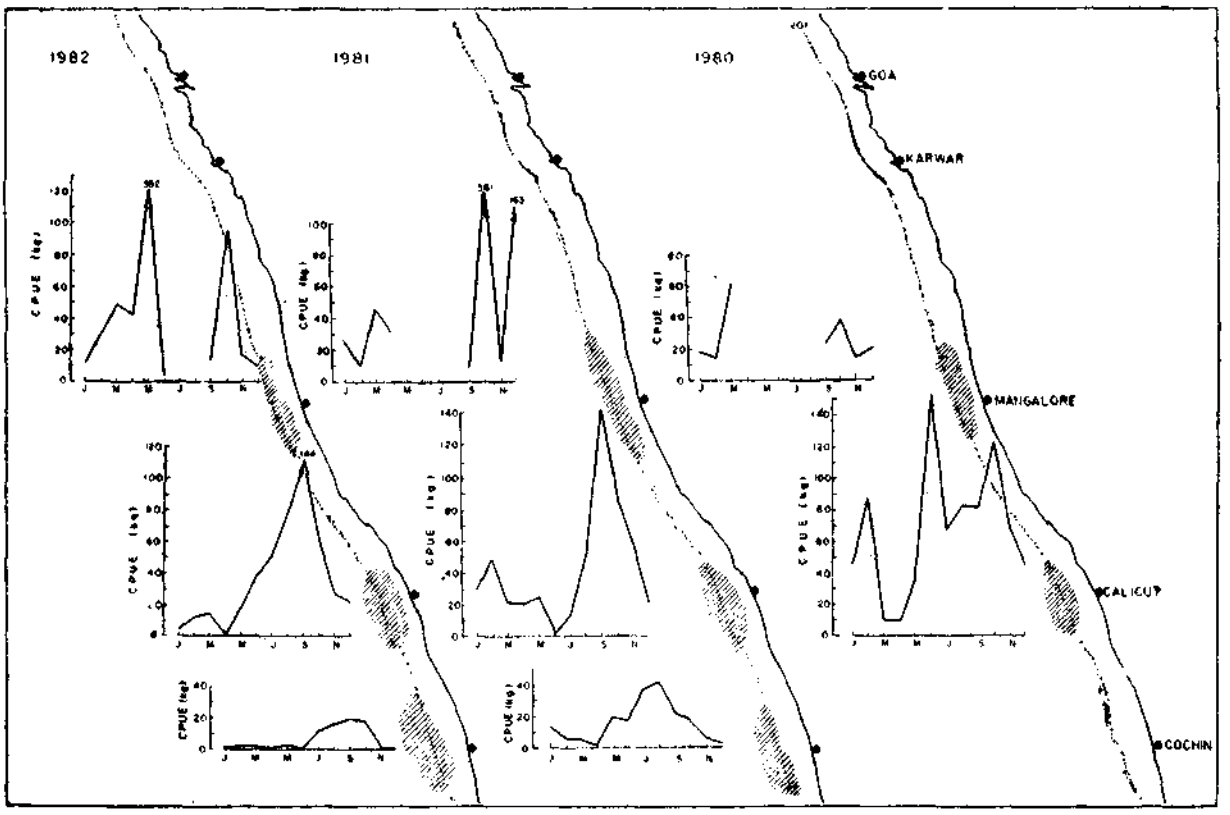

Fig. 2. Monthwise CPUE at Cochin-Calicut and Mangalore during the years 1980, 1981 and 1982 (Shaded portion denote the fishing areas)

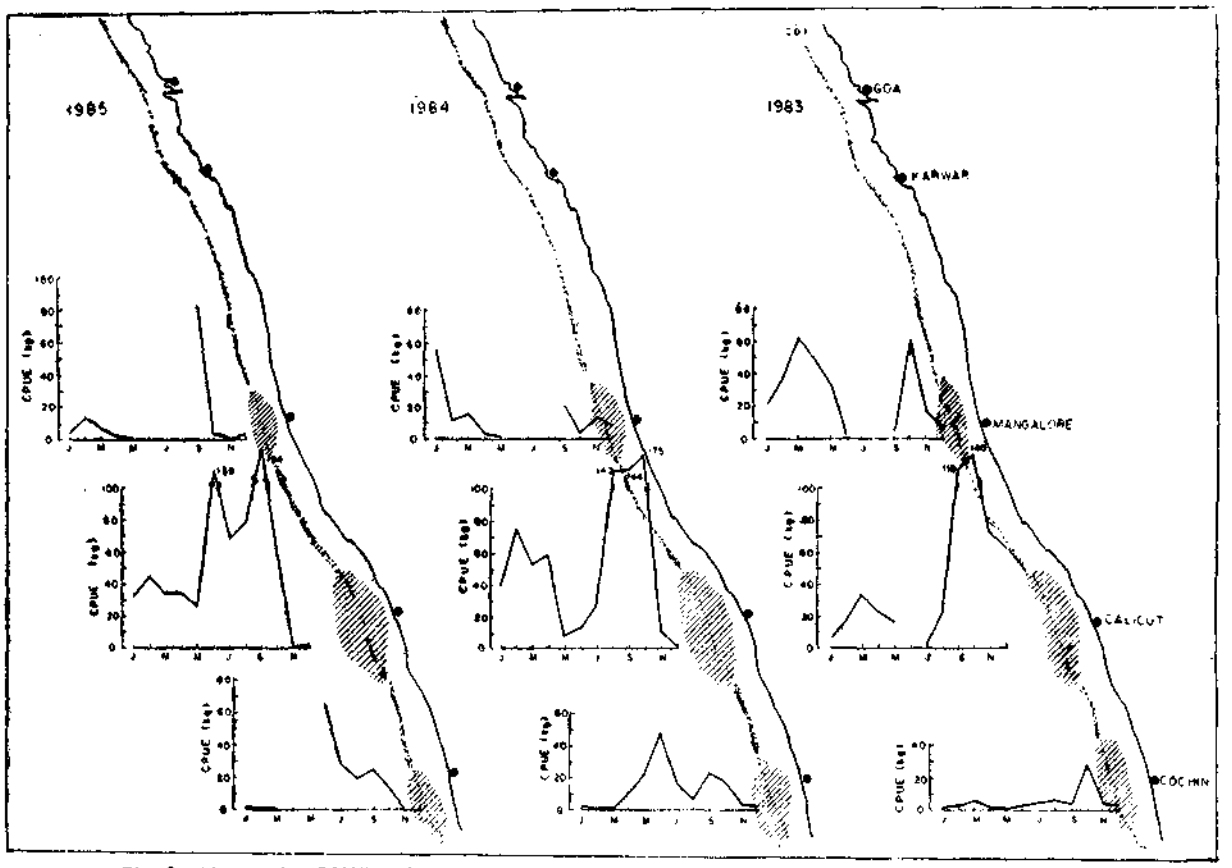

Fig. 3 Monthwise CPUE at Cochin-Calicut and Mangalore during the years 1983, 1984 and 1985. (Shaded portion denote the fishing areas)

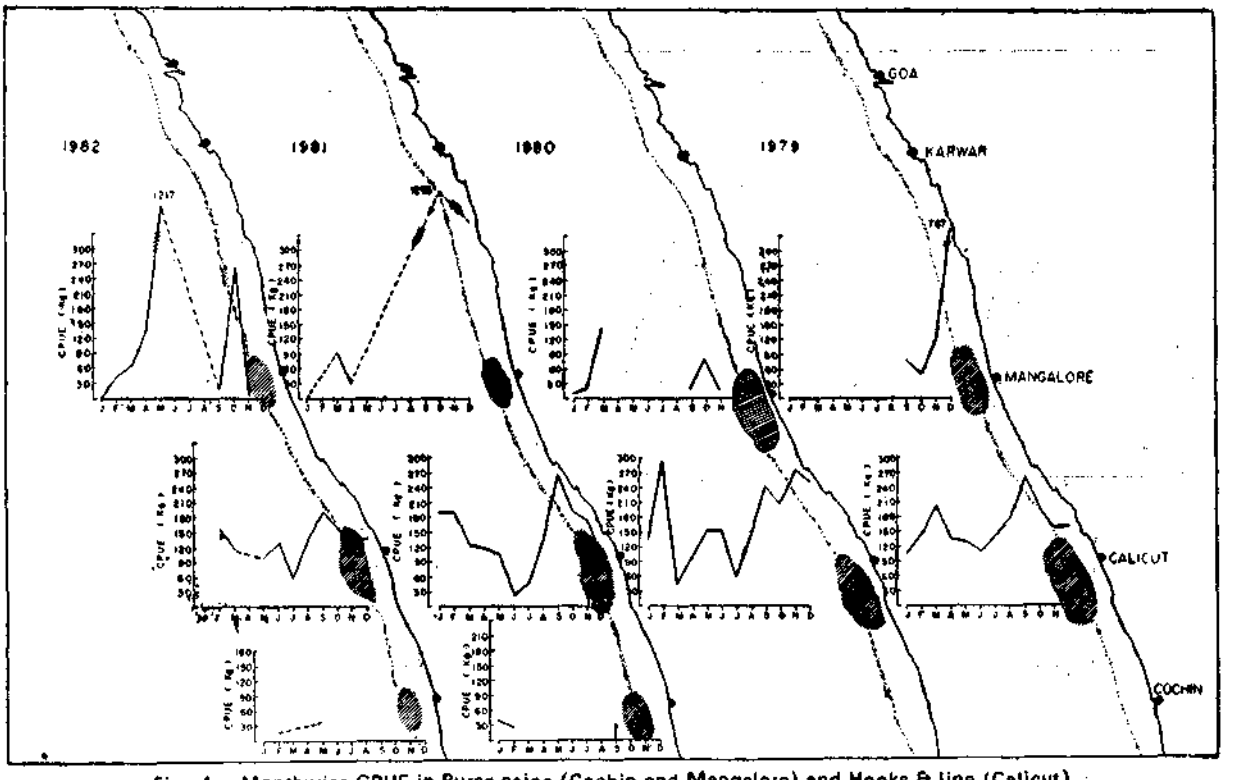

Fig. 4. Monthwise CPUE in Purse seine (Cochin and Mangalore) and Hooks & line (Calicut) during 1979, 1980, 1981 and 1982. (Shaded potion denote the fishing areas)

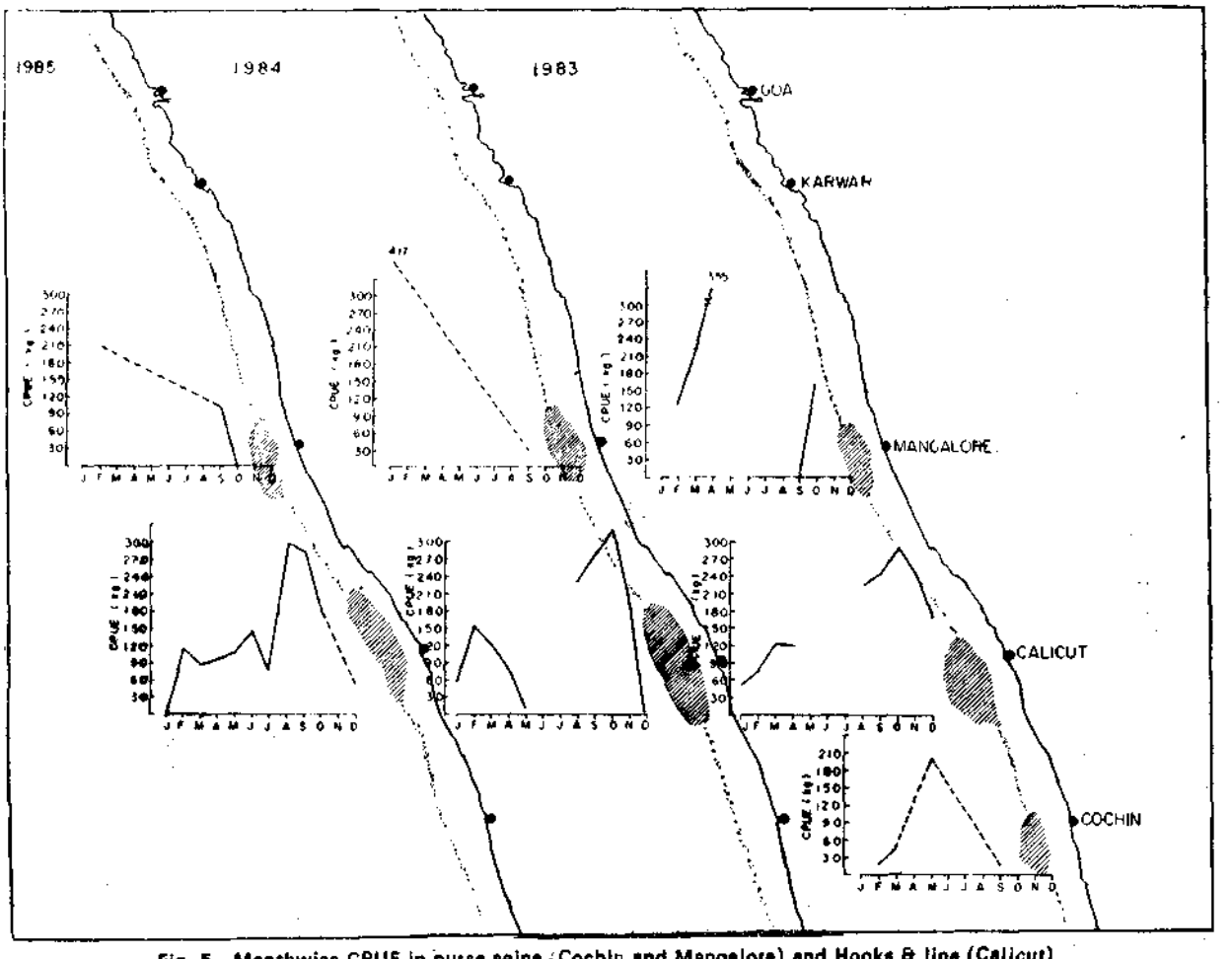

Fig. 5 Monthwise CPUE in purse seine (Cochin and Mangalore) and Hooks & line (Calicut) during 1982, 1984 and 1985. (Shaded portion denote the fishing areas).

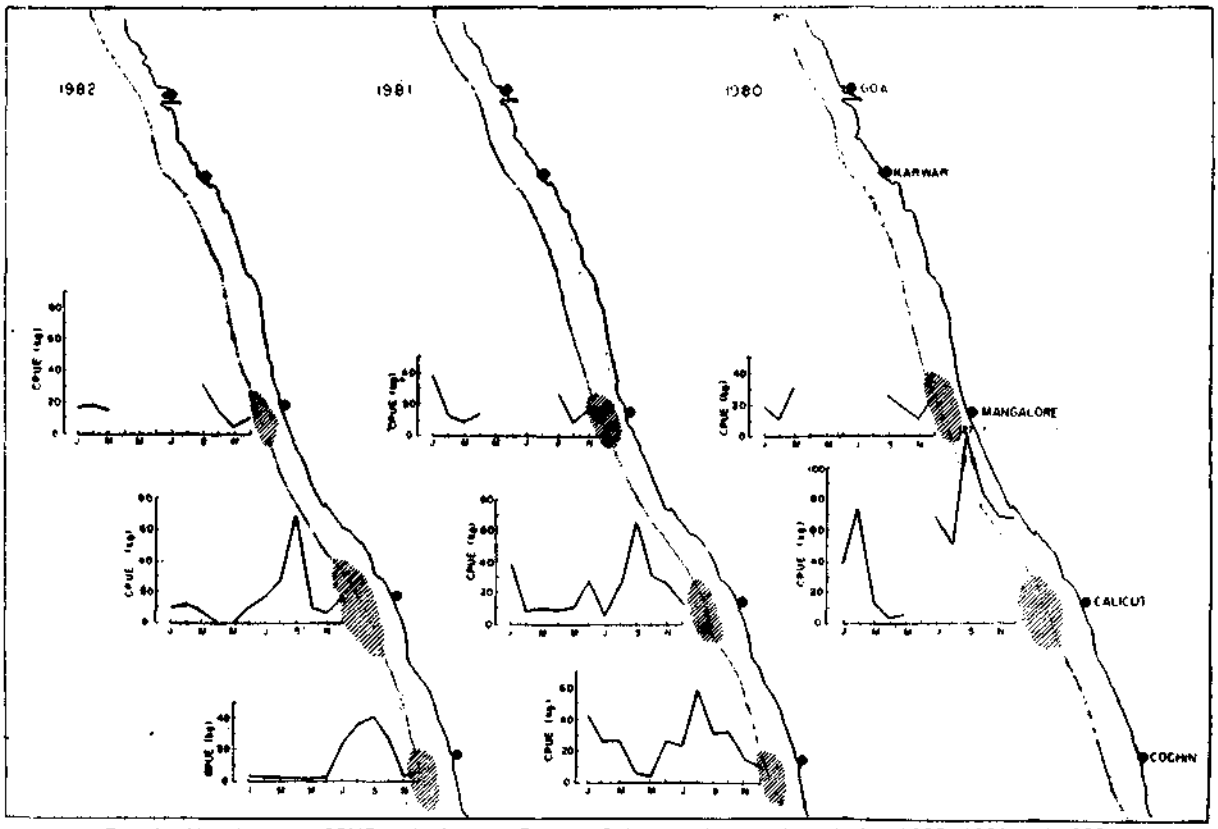

Fig. 6 Monthwise CPUE in Driftnet at Cochin, Calicut and Mangalore during 1980, 1981 and 1982.
(Shaded portion denotes the fishing areas)

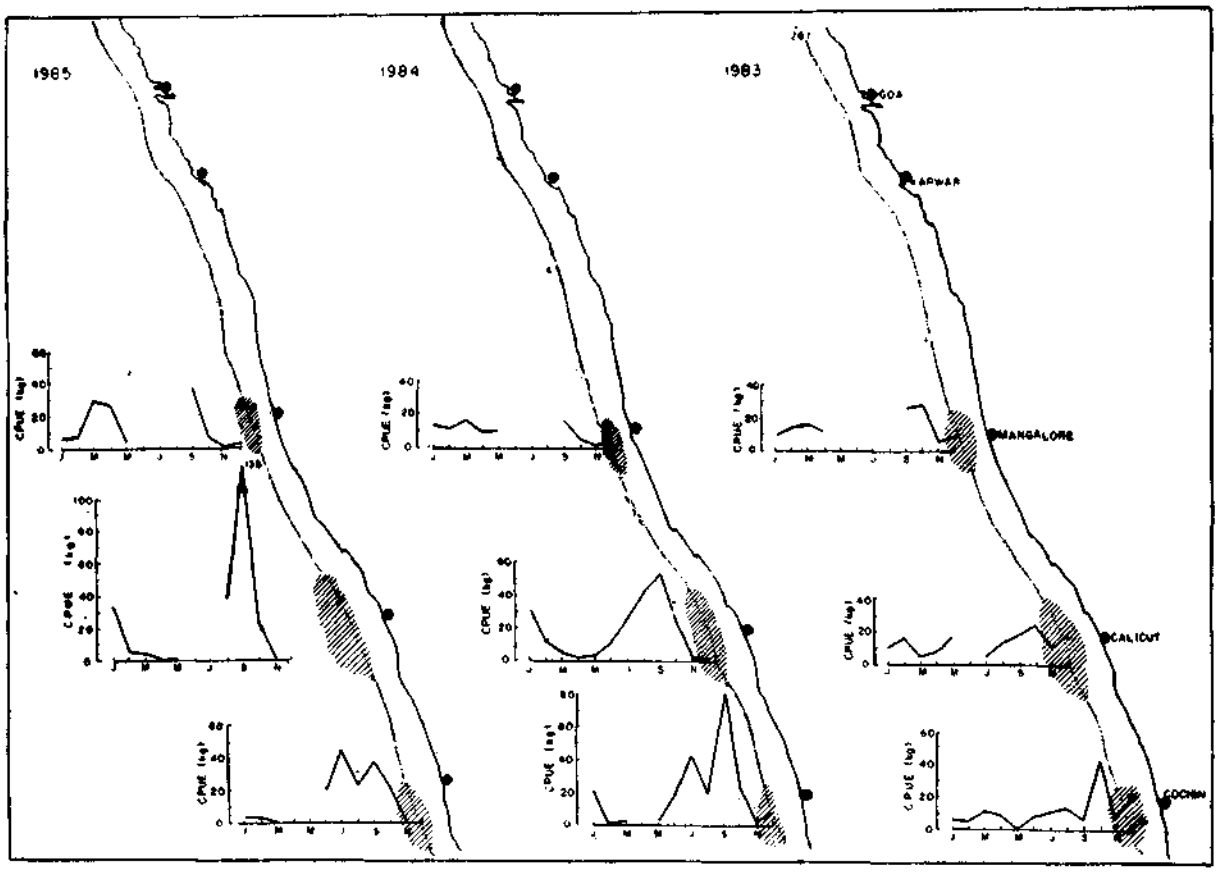

Fig. 7 Monthwise CPUE in Driftnet at Cochin, Calicut and Mangalore during 1983, 1984 and 1985.
(Shaded portion denote the fishing areas)

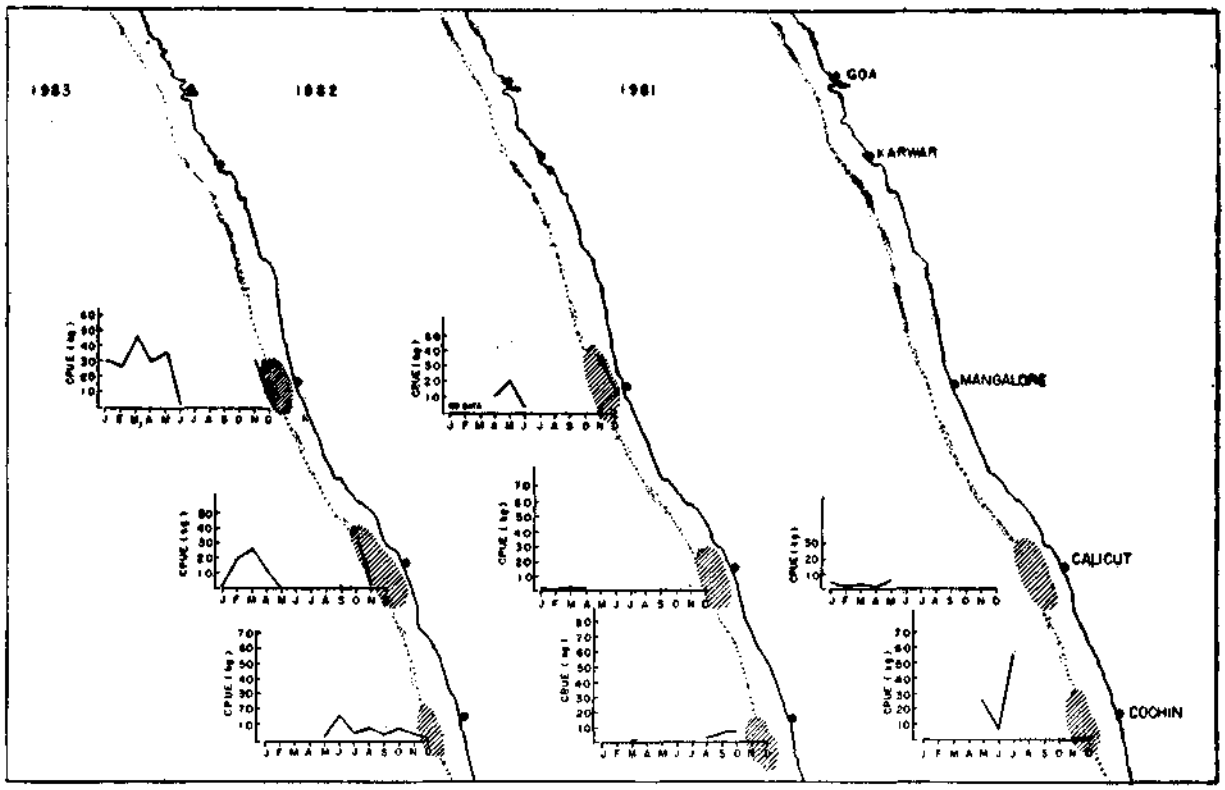

Fig. 8 Monthwise CPUE in Trawl net at Cochin, Calicut and Mangalore during 1981, 1982 and 1983.
(Shaded portions denote the fishing areas)

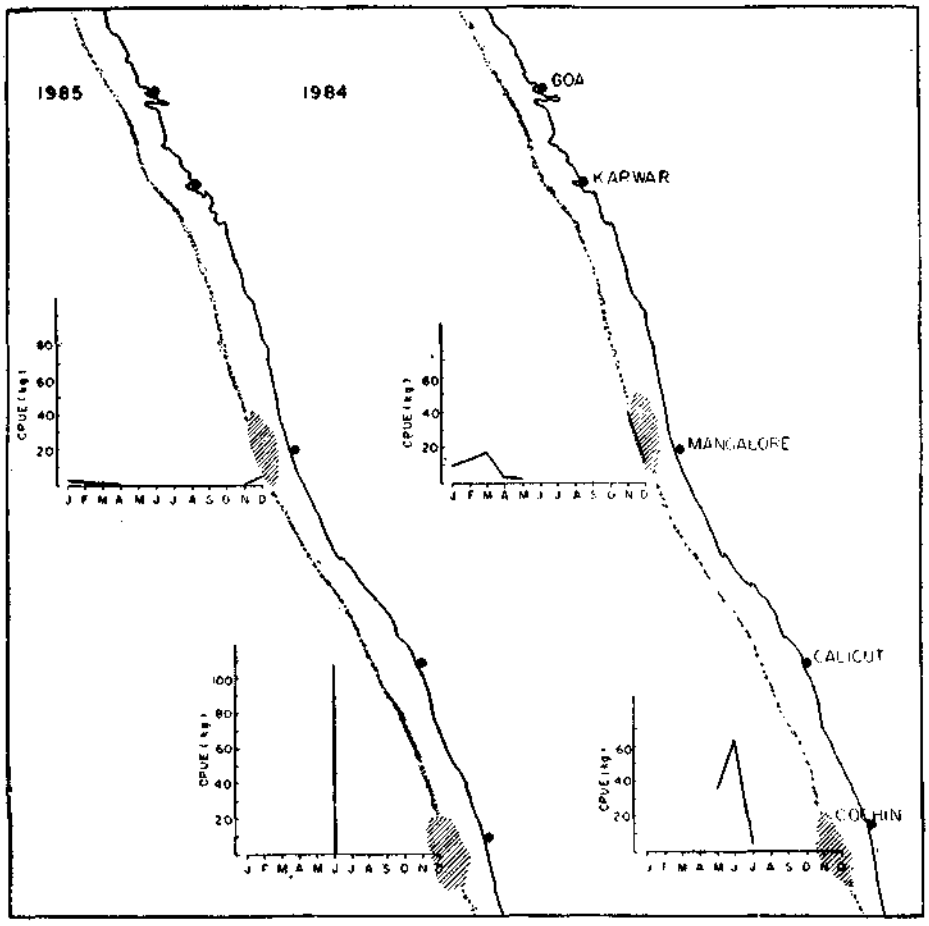

Fig. 9 Monthwise CPUE in Trawl net at Cochin, Calicut and
Mangalore during 1984 and 1985
(Shaded portions denote the fishing areas)

Cochin: Purse seine operations at Cochin commenced from 1980 but the regular data are available from 1981 onwards. The annual average catch by purse seines for 1981-85 period was 20.8 t with a peak during 1983 (56t) and a sudden decline thereafter. The annual picture of species abundance shows that *T. dussumieri* is most dominant with a percentage of 65.1 followed by *T. serratus* (22.8%), *T. tenuispinis* (11.0%) and *T. thalassinus* (1.1%). In trawl gear, the annual average catch was 287.7 t with the highest catch recorded in 1984 (536.5 t). The species that rated first was *T. tenuispinis* (50.3%) with an average catch of 144.6 t. This is followed by *T. thalassinus* (43.1%), *T. dussumieri* (6.1%) and *T. serratus* (0.5%). At Cochin drift net is the most important gear for the exploitation of catfish, with an annual average catch of 387.6t and the landings fluctuating from 256.4 to 624.7 t. *T. serratus* is the important species contributing on an average 149.5 t (38.6%), next in abundance being *T. dussumieri* (30.4%). The share of *T. thalassinus* and *T. tenuispinis* is 72.4 t and 48.0 t respectively with percentages 18.7 and 12 4.

The seasonal all gear catches showed that June to September is the peak period of abundance with the highest mean value of 151.5 t in June. Purse seines landed catfish during February-May period and trawlers in June and July with high catch rates. Drift nets also showed a similar trend with peak landings during July-October period with a catch rate ranging from 28.2 kg to 32.5 kg.

In general, the seasonal catch at Cochin by all gears showed two peaks, a minor one in February-March and major in July-August, with the average specieswise landing for *T. thalassinus*-197.7 t, *T. tenuispinis*-194. 7t, *T. serratus*-155.2 t and *T. dussmieri*-148.5 t. There was a gradual decline in the landings from 1981 to 1985, without perceptible wide fluctuations in the total yield. There were however, fluctuations in the landings of individual species and the reduction in the catch of one species was compensated by the hike in others, thereby maintaining the balance.

Calicut: At Calicut catfishes are exploited mainly by hooks & line, which account for 58.2 % in the 9 year's annual average catch (318.7 t). The landings, during these years, were almost steady (205.8 t in 1985 to 478.6 t in 1980) with a high hooking rate of 66.3 kg to 105.4 kg/1000 hooks. *T. tenuispinis* is the most abundant species (48.3%), the average monthly catch varying from 26 kg in June to 43.7 t in September. The peak period of occurrence of *T. tenuispinis* is September - December with an annual average catch of 160.7 t. *T. dussumieri* contributes 28 5 % in the total catfish landings and the catches vary from 162 kg in July to 12.4 t in March, with an annual average of 93.4 t and two peaks in February-April and September respectively. *T. thalassinus* is yet another important species contributing 21.3%. The catches fluctuated from as low as 34 kg in June to 18.8 t in September with an annual average of 57.9 t and peak landings are in September-November. *T. serratus* is poorly represented in the catches (1.9%) with an annual average of 8.3 t. Peak occurrence is in June-July but the landings vary from 96 kg in October to 2.3 t in June.

A downward trend was observed in the catfish landings by drift nets, with the highest value of 217.4 t in 1930 to as low as 47.7 t in 1983. With an annual average of 109.8 t, commensurate with the increase in the landings, the fishing efforts too increased till 1982 but decreased in the subsequent years with the diminishing returns. *T. dussumieri* is the dominant species with monthly average catch varying from 0.3 t in June to 135 t in January and with two peak periods in January- February and September-October. Wide fluctuations have been observed within the catch per unit effort (CPUE) from 7 kg to 35.8 kg with mean value of 16.9 kg.

T. serratus is next in importance in the drift net catches, the catch rate varying from 0.1kg in April to 9.6 kg in October. The catches are steady during July - December period. *T. tenuispinis* is yet another important constituent in the landings by drift nets, with fairly high catch rates in September-October period. *T. thalassinus*, though not so important is also recorded during August-October.

The trawl fishery for catfish existed only till 1983. Its contribution in the total catfish

landings is 14.2% during the period 1977-83 with an average annual catch of 50.6. Maximum catch is recorded (163.4 t) in 1977 and the lowest (5.8 t) in 1982. The trawl landings are exclusively comprised of *T. tenuispinis* (CPUE 40 kg) with stray occurrence of *T. dussumieri*. January-April is the peak period of abundance.

The general seasonal trend noticed at Calicut for catfish fishery, has two peaks, first one in February-March and the subsequent one in September-October. Species like *T. tenuispinis* and *T. dussumieri* are dominant in the catfish catch.

Mangalore: Purse seines at Mangalore account for 72.5% of the all gear catfish catch from the coastal waters upto the depth of 40m. The purse seines were first introduced at Mangalore in 1979 and their number multiplied at a rapid rate till 1982. This also coincided with high returns. From 1983 onwards the purse seine catches gradually declined, resulting in the stabilisation of the effort inputs. Presently over 400 purse seine units are in operation in Mangalore region. The annual average yield is estimated to be 1729.1 t with the highest catch of 4286 t in 1982, which declined to 410 t in 1985. In 1986 there was a sharp increase in the landings to the tune of 3605 t. *T. dussumieri* was the most dominant species in the catches followed by *T. tenuispinis*. Though *T. thalassinus* and *T. serratus* are not represented in the catches in the early days of purse seine fishery at Mangalore, they are caught in fairly good quantity in 1985 and '86 along with other two species. Seasonal estimates show that January-February and May and September-October are the peak periods for the purse seine fishery. Good landings of *T. dussumieri* have been ecorded in January-February and May, whereas, September-October catches are exclusively of *T. tenuispinis*. *T. serratus* has two peak periods in February and October but *T. thalassinus* occurs only in September-October months.

The trawl gear contributes 17.3% in all gears catfish catch with an annual average of 560.7 t. The highest landings are recorded (1194 t) in 1983. The dominant species contributing to the trawl catches are *T. tenuispinis*, *T. thalassinus* and *T. dussumieri* in the order of abundance. The gear is operated from November to May with *T. tenuispinis* representing the dominant species with two peaks in March (82.9 t) and November (74.7 t).

Drift gill net's share in the all gear catfish catch is 10.2%. There was a steady decline in the landings from 1981. *T. serratus* is the dominant species (39%) in this gear; next in abundance is *T. dussumieri* (31.9%) followed by *T. tenuispinis* (23.8%) and *T. thalassinus* (5.3%). Drift gill net fishery at Mangalore has two peaks, February and September-October. *T. serratus* is abundant in January and October and *T. dussumieri* in February and October.

The seasonal landing trends at Mangalore very clearly shows peak periods of occurrence in February and September - October. Species *T. dussumieri* and *T. tenuispinis* dominate the catches at Mangalore.

Karwar: At Karwar the catfish fishery was mainly supported by non-mechanised gears, like rampan, yendi and hooks and line, and mechanised trawlers till early 1978. From 1979 onwards the bulk of the landings were brought by purse seines with a steady catch till 1982 and thereafter the fishery declined. The catfish fishery at Karwar has two peak seasons in February-March and October-November and is dominated by species such as *T. tenuispinis* and *T. dussumieri*. From 1984 onwards shoals of *T. serratus* began to appear in the purse seine catches. In the early part of 1986 large quantities of just liberated juveniles of *T. serratus* were recorded in the trawl and yendi catches.

Goa: Catfishes are generally caught in Goa by rampans, yendi, trawlers and from late 1978 onwards by purse seines too. The period of occurrence is from December to May with peak abundance in December - March. Data on species-wise catfish catch from Goa region is not available for drawing conclusions on species-wise abundance.

EXPLOITATION OF BROODERS AND SPAWNERS

Ever since the introduction of purse seines in Goa, Karnataka and Kerala, there have been

* The data provided by Shri C. Muthiah, M.R.C. of CMFRI, Mangalore is greatly acknowledged.

reports of large scale destruction of gestating males and to a smaller extent, female spawners of catfishes. The exploitation of brooders existed even before the introduction of purse seine by non-mechanised gears like boat seines (Pattankolli vala), shore seines (rampan & yendi) and drift gill nets. But the quantum of destruction of eggs/embryos/larvae in the process of harvest of brooders by these less effective non-mechanised gears was either only partial or negligible. Such a destruction is inevitable due to the fact that the brooders congregate in shallow coastal belt (Figs. 10 and 11) and are vulnerable to even indigenous gears. However, this problem has altogether taken a serious turn with the introduction of purse seines, which can encircle the entire school of brooders, resulting in the removal of large quantities of eggs/embryos/larvae from the nursery grounds every breeding season, the season varying from species to species. The purse seine when initially introduced was received by the fishermen with jubilation on account of the high rate of return. It is also true that this gear accounted for a significant spurt in the catch of pelagic shoaling fishes like oil sardine and mackerel. But unusually heavy catch of oil sardine in ripe

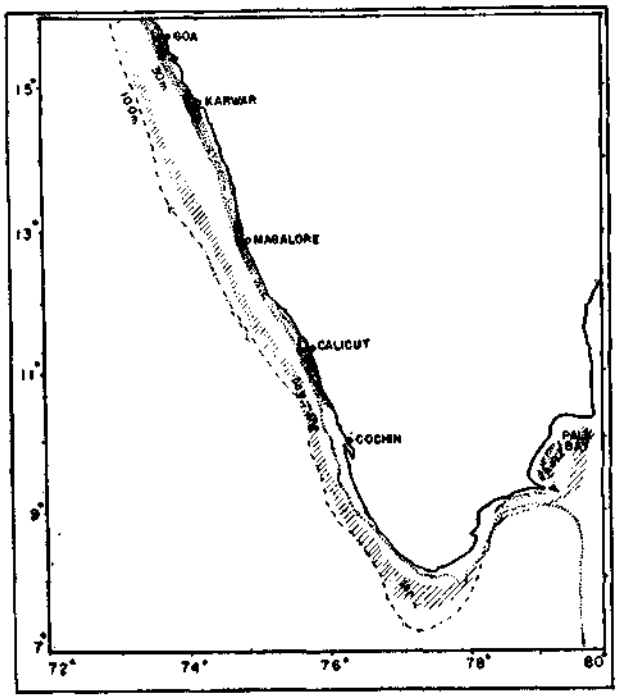

Fig. 10. Breeding grounds of *Tachysurus dussumieri* along Calicut-Goa region (stippled portion) during December-March and Matched portion porrion indicate their abundace durihg July-August.

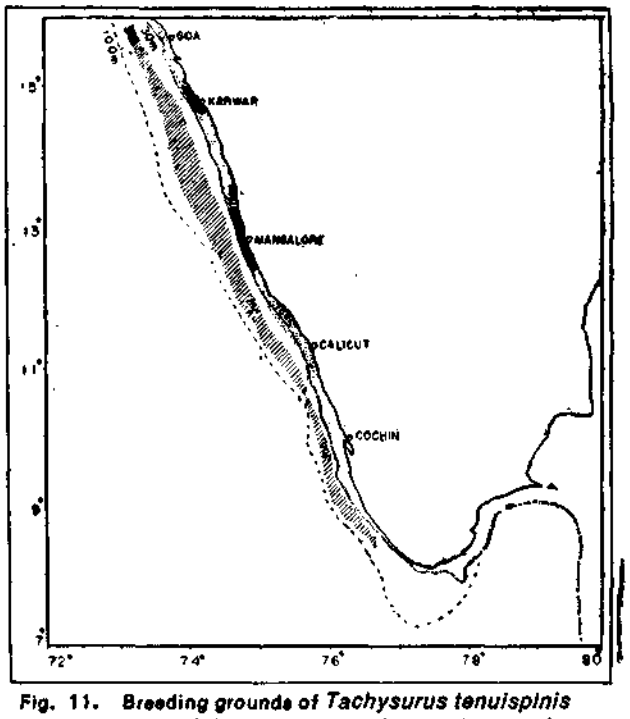

Fig. 11. Breeding grounds of *Tachysurus tenuispinis* along Calicut-Goa region (stippled portion) during September-November and Matched portion indicate their abundance in June-July

running condition during the early part of June points to the need for imposing restrictions, in the interest of conservation of the resource. The Government of Karnataka based on a timely warning from Central Marine Fisheries Research Institute, had requested the purse seine owners and other fishermen to refrain from catching spawning oil sardine and mackerel especially during May to August period.

The year 1980 witnessed another catastrophic event; the large scale landing of gestating males of catfish *Tachysurus tenuispinis* from a depth range of 25-35m, to the tune of about 528 t with an estimated 37.6 t of eggs/embryos in their buccal cavity. All this happened in a period of two months from the end of September to October from the Mangalore-Gangoli region along the South Karnataka coast (Silas *et al.*, 1980).

It is well known that large scale destruction of spawners of any species will have a deleterious effect on the recruitment and therefore on the future fishery of that resource. It is all the more evident in catfishes, whose fecundity is very low with a single spawning in the year.

Fishing of a school of gestating males accounts for 100% egg/larval mortality. More concerted action is therefore, required to conserve this resource, than any other shoaling fish, where the fecundity is very high with a high egg/larval natural mortality. This fishery is not only destructive biologically but also economically wasteful, because the eggs/embryos landed have to be discarded owing to lack of demand. Moreover, the gestating males are practically reduced in weight with a very low flesh-bone ratio due to their starvation for about two months during the gestation period.

Species-wise catfish catch by purse seines along the Mangalore coast shows that the landings of *Tachysurus dussumieri* are at its peak in December-March period and of *T. tenuispinis* during September-November, which coincided with the peak period of breeding. On an average as high as 16% of the total purse seine catch of October is composed of *T. tenuispinis* and 12% and 6.9% in December and March respectively of *T. dussumieri*. The average *T. dussumieri* catch during the four month period of December-March is 1228.7 t forming 7.4% in the total purse seine catch of the same period. The three months average *T. tenuispinis* catch (September-November) is 1199 t which comes to 6.8% in the total purse seine catch of the respective period.

The estimated average landings of gestating males of *T. dussumieri* during December-March months from Mangalore region, is 163.4 t which forms 13.3% in the total purse seine catch of this species for the corresponding period. Taking into account the mean fecundity of *T. dussumieri* as 140 ova (ranging from 108-16 ova) and the average weight of a ripe ova as 2.6 grams (2.1-3.2 grams) the average annual destruction of eggs/embryos by purse seine along Mangalore region is estimated to be 7.6 million eggs weighing 19.8 t.

The average landing of gestating males of *T. tenuispinis* during the 3 months period of September-November from the same region is estimated to be 500.6 t which forms 42% in the total *T. tenuispinis* catch by purse seine in the respective months. An estimation of the average destruction of eggs/embryos of *T. tenuispinis* in the 3 months period shows that 62 million eggs weighing 75 t are destroyed every year from the Mangalore region, taking into account the average fecundity of the species as 50 ova (ranging from 29-89 ova) with a mean egg weight of 1.2 grams (1-1.23 grams). Almost a similar trend in the catch of gestating males as well as egg/embryo destruction has been reported from Malpe during the period September 1986 onwards. Similar reports on the destruction of brooders of *T. tenuispinis* have been reported from North Karnataka region (Karwar) by purse seine fleet during September 1982. The eggs landed on two days, 23rd and 29th September 1982 amounted to 3.9 t. The gestating males are caught from the region of 45-50 km north and south of Karwar in the depth range of 20-30m It is also estimated that 4.3 million eggs of *T. tenuispinius* are destroyed in this process (Dhulkhed *et al.*, 1982).

There were further reports on the large scale netting of schools of *T. dussumieri* from shallow depths ranging from 10-20 m by purse seine off Mangalore-Hajmady region (Muthiah and Syda Rao, 1985). The gestating males caught during February-March period had as many as 100 numbers of embryos of fully developed in the oral cavity. The embryos were at late stage of development, the yolk sac almost absorbed and the size ranging from 40-75 mm, weighing between 2-4.3 gms. The size range of gestating males of *T. dussumieri* reported was between 51-82 cm with a weight range of 1.7-5.4 kg. This observation is in conformity with the size at first maturity of this species at 62 cm (after the completion of 4 years) as reported by Vasudevappa & James 1980. Further, it is the size at which they commonly occur along the coastal waters of Calicut-Karwar region during the period.

Thus, of the two species facing the calamitous situation of destruction of gestating males with eggs/embryos/larvae year after year along Mangalore-Karwar region, *T. tenuispinis* is most dangerously affected followed by *T. dussumieri*. However, there are also reports on the destruction of brooders of *T. serratus* from 10 m depth in the Karwar region. All the above reports and observations clearly show the enormity of egg/embryo/larval destruction caused year after year and point to an urgent necessity to conserve this resource.

MIGRATION

Catfishes which are essentially demersal exhibit both vertical and horizontal migration. The observation by the erstwhile Pelagic Fishery Project, based on echo traces, shows that at day time they swim down and settle at the bottom in dense concentrations and ascend to the column and surface waters during night and disperse. The acoustic and experimental fishing surveys along the south-west coast indicated migration of catfishes in the southward direction during monsoon months (Anon 1976). All the earlier reports and present observations both along east and west coasts show that schools of catfishes from offshore frequent the very shallow muddy coastal waters for breeding. After the release of young ones they migrate back to the deeper waters in the depth ranges 80-125 m. The Indo-Polish Industrial Surveys (Anon 1987) have reported that the catfishes, normally an important component in the offshore catches, are almost negligible during September-October. This is probably because of their coastward migration for breeding during these months.

A detailed study on yield trend and catch rates from various centres along Goa downwards shows that possible direction of migration is towards south starting from north in December and continuing southwards to Palk Bay along the south-east coast. Large schools of *T. dussumieri* have been reported in Palk Bay during August-September (Menon, 1979). In general catfishes have high catch rates at Goa during December, at Karwar in January, at Mangalore in February-March, at Calicut in March and at Cochin during June-July. (Fig. 12). The reverse migration commences sometime during August-September period as demonstrated by the high catch rates at Cochin (September), Calicut (September-October), Mangalore (October-November) and further north at Karwar and Goa during November and December. This high catch rates also probably indicate the shoreward migration of the two major species, *T. dussumieri* and *T. tenuispinis* during December March and September-November periods respectively for breeding purposes.

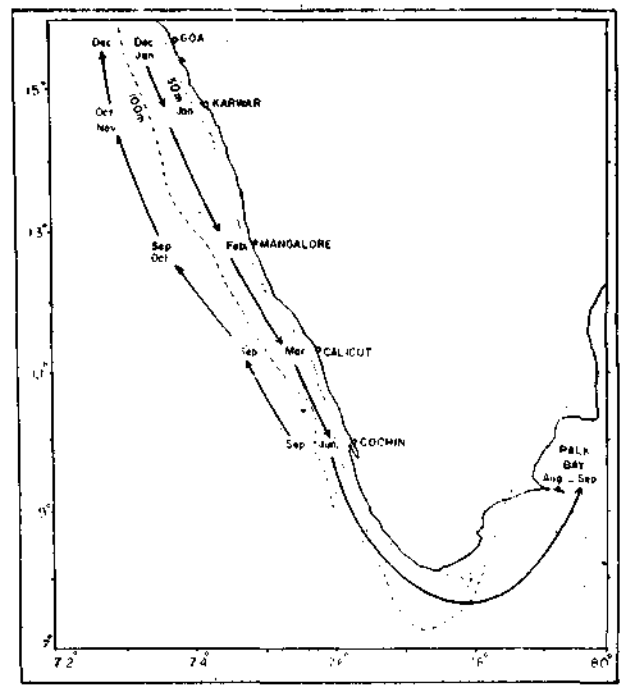

Fig 12. The probable course and period of southward and northward migrations of catfishes along south-west coast (The bold arrows indicate the direction of movements).

MANAGEMENT OF RESOURCE

Important findings

The main points which have an important bearing on the conservation, potential and exploitation of the catfish resources are given below:

1. Breeding of marine catfishes takes place in shallow costal waters where the sea bottom is mostly muddy.
2. After breeding, sexes get segregated and male brooders move in dense schools in the shallow coastal nursery grounds.
3. Large schools of less mobile brooders are harvested en masse by purse seines along Karnataka coast leading to mass destruction of egg/embryos/larvae.
4. The coastal catfish fishery has been mainly exploited at two stages, juveniles/subadults and spawners/brooders.
5. Bottom sweeping by small trawlers along the shallow nursery grounds during post spawning months catch large quantities of juveniles.

6. An assessment of stocks off different species of commerically important catfishes from various centres indicated that all species except *Osteogeneiosus militaris* are now under heavy fishing pressure with a high rate of exploitation from the present fishing area.

7. Marine catfishes are an important component in the demersal resources in the coastal waters upto a depth of 125 m with maximum concentration in the mid-shelf region from 50-80 m.

8. They exhibit both vertical and horizontal migrations.

9. Catfishes exhibit diurnal vertical migrations; during day time they settle to the bottom in dense concentration and ascend to column and surface and disperse at night.

10. Larger members of the species are abundant in deeper water except during the breeding months.

11. Acoustic-cum-experimental fishing surveys indicate that the potential resource is rich along the mid-shelf of the south-west coast of India.

12. The need to expand and improve the use of long-line at all depths, irrespective of season is emphasised.

13. A shift in the predominance of one species to another has been noticed at some centres in the past few years.

14. Muddy bottom with rich benthic fauna is the best ground for catfish exploitation.

All the above findings suggest the need for suitable management programmes for conserving the resource on the one side and augmenting the exploitation on the other side.

Conservation

The fishing industry is aware that for a judicious exploitation and conservation of the resource, proper management programmes are necessary. But at the same time they do not want Government intervention since the implementation of conservation meassures may lead to set backs in the economic returns. Since all conservation measures are aimed to help sustained production, it is for the Government to step in and enforce some rigid conservation measures, both for biological and economic reasons. In view of the enormity of destruction of eggs/embryos of catfish which hardly fetch any price, it is necessary to restrict the purse seine operation during the peak spawning periods February and September-October along the shallow coastal belt, extending from Calicut in the South to Goa in the north up to a depth of 40 m. The justification for this restriction is to enable the brooders to complete the gestation and liberate the young ones. This will not only restrict the egg/larval mortality by fishing but will also allow the young ones to grow to larger sizes. After the completion of the incubation, the same resource can be exploited without causing any substantial reduction in total yield. In otherwords, the restrictive action is designed to maximise the catch with an economic objective but with a biological conservation policy.

Anon (1987) showed that most of the commercially important species of marine catfishes are at present under heavy fishing pressure, except a single species *Osteogeneiosus militaris* which has a very limited distribution along northwest coast and some parts of east coast. The only solution to overcome this situation is either to reduce the fishing pressure or to increase the size at first capture. Both are detrimental to the general policy of increasing yield -and against economic objectives, at least for the first few years till a sustained state is reached. As the very objective of the industry is the maximum sustainable return in money, the tendency of the industry will be to resist any type of restrictive measures imposed by the Government. The question is how and when to implement. It should first be decided whether the short term gains should take preference over the affirmed policy of achieving a maximum sustained yield. In the process of development we have to satisfy both the above needs, but without jeopardising the resource, taking care to avoid the resource being over exploited and by preventing egg/larval mortality by fishing.

To conserve the resource, which is subjected to over exploitation, some of the common methods to reduce the fishing pressure are closed season for all or selected gears, limited operation by selected gears, mesh regulation, increase in the size at first capture and increase in the hook size etc.

A closed season for all types of gears during February and September-October period is an impracticable solution; since it will have great set backs in terms of total yield and socio-economic conditions of the fishing communiy. Similarly, total ban on the operation of the harmful gears like purse seine will be totally unacceptable to the fishermen, since this is the time when they get maximum returns by catching oil sardine, mackerel and other pelagic schools which frequent the coastal waters during this part of the year. Increase in the mesh size and size of the hooks to increase the size at first capture is meaningless as far as catfishes are concerned. Because of their barbed spines, even smaller catfishes may get entangled in the larger meshes of any gear. Further, being scavengers by nature, irrespective of size, they will bite the bait from any size of hook. Both the above restrictions have, therefore, only theoretical base and no practical application in case of catfishes.

In order to conserve the resource and to prevent it from over exploitation, there is an urgent need to stop the exploitation of the brooders by purse seines. Past experience shows that the catfish schools can be readily distinguished from other pelagic schools, by skilled fishermen. To generate a willingness among the fishermen to avoid such schools during the breeding season, they should be educated to make them aware of the grave and critical situation which may result in the event of the distruction of the brooders en masse. Once the fishermen realise the implications of the large scale distruction of the eggs/embryos, the restrictions imposed on the operation of purse seine can very well be suspended. However, such a 'regulated inefficiency' has to be introduced and continued till the above situation is remedied. In extreme cases of violations punitive measures, such as stringent punishment in the form of fines and penalties may have to be imposed on the errant boat owners who land the brooders, disregarding the restrictions. Entry for selected gears, such as hooks and line, gill nets and boat seines, having less catch rate and thereby no harmful effect on the brooding stock, is a more feasible solution to minimise the egg/larval destruction.

Small scale mechanised trawlers operating in the shallow coastal waters, sweep the bottom ceaselessly day and night to harvest the highly priced prawns. In the process, during the post spawning months huge quantities of juvenile catfishes, ranging in size from 70 to 100 mm are caught. They hardly fetch any price. There are already restrictions on the operation of small trawlers in shallow coastal waters, mainly aimed to protect the juveniles and young ones of prawns and fishes which are found there. Very often these restrictions are violated by the trawlers to exploit the rich prawn varieties which are found in the coastal region during monsoon and post monsoon months. It is, therefore, necessary to strengthen the vigilance machinery for strict enforcement of the restrictions.

Resource potential

Eventhough the narrowness of the shelf of the south west coast restricts trawling operations to a much limited extent as compared with the north-west coast, the catfish catch trend by exploratory trawlers prove that there are rich grounds for this resource. Bull trawling conducted along Cannanore-Cape Comorin belt during 1957-58 revealed that catfish forms 2% in the total catch in the Cannanore-Calicut, region but declines further south in Alleppy-Cape Comorin region (Tholasilingam *et al.* 1968). The erstwhile Pelagic Fishery Project survey indicated that off Kerala the catfish abundance is at its peak during April-September period, whereas the landings are high during September-December period. Similarly, April-September are the months of highest abundance along Karnataka, while the peak landings are in January-March and September-November. Peak abundance in the mid-shelf region at one period and heavy landings in another period is mainly due to the inaccessibility of this resource by traditional gears and less effective exploitation by small mechanised gears in deeper regions during the monsoon months, when the stocks

are in highest abundance. The highest estimated average biomass is along the Kerala coast, to the tune of 43800 tonnes. Further, the course of migration indicates that the bulk of the stock remains off the Kerala and Karnataka coast for a longer duration, (July-August) at a depth range of 50-80 m (Rao *et al.* 1977). These findings give tremendous scope for the exploitation of larger fishes from deeper water by suitably deploying bottom trawls during day and mid-water/pelagic trawls during night, depending on the diurnal vertical migration. For this purpose large and stable vessels equipped with suitable trawl gears are to be added to our offshore fishing fleet. In addition, long lines and gill nets can also be utilised for effectively tapping this resource.

The shoreward migration for breeding during January-March and September-November can also be effectively utilised for increasing the rate of exploitation by increasing the effort inputs of long lines, which have high hooking rates of catfishes and at the sametime leave the brooders unaffected. Further, after giving due allowance for brooders to complete the gestation period and liberate the young ones, the spent recovering shoals of males can be exploited by purse seines. Probably this can be achieved only after the breeding season is over, when they begin their offshore migration to deeper waters.

Only through planned and judicious exploitation can the stability in production be achieved without hampering the potential stock. The excessive, wasteful and destructive fishing effort expended and the resultant devastation of eggs/embryos/larvae at a few centres along Karnataka or Kerala may have far reaching effects as the resource migrates from south to north or vice versa. In order to augment full production, the industrial fishery has to make full use of the scientific knowledge available on the biology and behaviour of catfishes coupled with their availability in space and time and vulnerability to various gears.

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