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bulletin 40

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MARINE CATFISH RESOURCES OF INDIA

EXPLOITATION AND PROSPECTS

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

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PREFACE

A comprehensive knowledge of the fishery, biology and resource potential of marine catfishes of the family Tachysuridae in Indian waters is lacking. This bulletin is an attempt to provide a baseline picture of the present status of this important resource for future planning and management of the stock. Though catfish production from the seas around India varied from 4 to 6% of the total annual marine fish landings, which is about 10% of the country's demersal catch, this group received inadequate attention of fishery experts. This was mainly due to the fact that catfish was not considered to be a quality table fish until recently. Of late, efforts made for better utilization of the resource and the heavy destruction of catfish eggs by purse seines along the Karnataka and Goa coasts (MFIS, 24, 1980) enhanced our awareness of the urgent need to regulate the exploitation of this promising resource.

This resource was exploited by traditional methods restricted to coastal waters with little ill effect on the stock. But when once this coastal fishery is subjected to heavy fishing pressure of mechanised crafts operating efficient gears, necessity arises to take a closer look on the impact of fishing pressure on this resource. The investigations carried out at this Institute have proved beyond doubt that the resource cannot withstand any additional fishing pressure in the traditional fishing areas along the coast. However, the resource is vast, extending beyond the present area of exploitation, and additional efforts are needed to rationally exploit the same.

The spawning migration of schools of catfishes towards the coastal waters during the S.W. monsoon season makes them vulnerable to indiscriminate fishing of spawning and juvenile fishes. The behavioural pattern of the males during the time of parental care, when they segregate from the spawned females and move in large schools to the surface and column waters, makes them vulnerable to easy capture especially by purse seiners.

There are classical examples of partial or complete depletion of fish stocks in other parts of the world due to intensive and indiscriminate purse seine operations. Restriction on fishing effort and regulation of mesh size in the inshore fishery of the small and medium crafts that are primarily engaged in prawn fishing, though difficult to impose, appear necessary. Increasing mechanization and use of efficient gear are indeed inevitable in developmental programmes. However, suitable conservation measures have to be adopted too, for the rational management of stocks such as of catfish.

I hope the subject matter covered in this bulletin will encourage further research on the biology and management of the resource.

Several scientists and technical staff of the Institute rendered assistance in analysing and processing data for this bulletin and Shri P. Raghavan, Photographer, helped in taking several photographs included in the bulletin. I wish to record my appreciation to all the above staff members for their interest and help. I also thank Dr. E. G. Silas, former Director of the Institute, and Shri P. R. S. Thampi, former Scientist S-3, who initiated this work.

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CHAPTER ONE

GENERAL FEATURES OF THE CATFISH FISHERIES

— C. MUKUNDAN

Catfishes had formed significant seasonal fisheries along the west and east coasts of the country since the early artisanal days, but had seldom been viewed as anything more than of local importance. The traditional gears were mostly aimed at pelagic fisheries and caught demersal species by the way when they fished in shallower coastal areas and the gear took in the bottom layers also. So the ground fish contribution to the country's total marine fish landings was small. Thus, in the earlier years of our concern with the assessment and development of marine fisheries, the sardine and mackerel fisheries easily caught the attention as national fisheries, and the prawn fisheries rapidly turned into an export-oriented industry and assumed tremendous importance as a foreign-exchange earner. Many others, potentially significant, tended to be passed over, and the catfish fishery was among them.

With the large-scale introduction of mechanized fishing, particularly in the past two decades, and a distinctive demersal fishery coming into its own, it became clear that the earlier restricted nature of the catfish fishery was not an index of the occurrence of magnitude of the resource, but only of the limitations in the exploitation. Directed fishing with greater efficiency resulted in increased ground fish production and catfishes formed a consistently important part of the demersal catches (CMFRI Annual Reports).

Such increased exploitation is, no doubt, an inevitable step in the context of the increasing demand for fish. But the mechanization did not come above at a nationally planned pace, nor was it aimed at a judicious distribution of the enhanced fishing effort. Also, the mechanization was largely confined to small and medium crafts, which did not lead to any great extension of the fishing grounds or diversification of fishing. The small trawlers, which made up the bulk of the fleet, still aimed at the lucrative prawn fisheries, but even so succeeded in more or less full exploitation of many other coastal resources as well.

A coastal fishery that is subjected to a sudden and steep increase of fishing pressure requires to be closely studied to see whether the resources can stand the rate of exploitation. This involves a comprehensive understanding of the fishery, its magnitude, distribution and pattern of variations, the species composition of its landings, as also detailed investigations on the biology of the main species that make up the catches, the dynamics of the populations fished and the present level of fishing and its impact on the stocks. Only based on such studies can realistic management policies be derived.

A study of this kind, based on the relevant work projects of this Institute at different centres over the past five to ten years, is what is attempted in the present account. Chapters on the detailed studies on particular aspects follow; a general picture of the catfish fishery of our waters is given below as background information to the specific studies.

THE FISHERY

Catfishes form important fisheries along the coasts of Kerala, Maharashtra, Tamil Nadu, Andhra Pradesh, Karnataka, Gujarat, West-Bengal and Orissa more or less in that order of abundance. The annual landings, during the decade, averaged over 53,000 tonnes; catfishes contributed approximately 10% of the country's ground-fish catches and 4-6% of the total marine fish landings. Nearly 70% of the catch came from the west coast. Statewise, the largest shares were from Kerala (29%) and Maharashtra (20%). Karnataka, since the large-

scale introduction of purse seiners, is also fast rising to a top position. (CMFRI Annual Reports).

Marine catfishes are generally bottom-living, preferring a muddy habitat, which makes it a suitable target for bottom-trawling. Some ascend the column to the surface for feeding and some species seasonally shoal near the surface, which makes them available for midwater trawling or purse-seining. A few tachysurids tolerate low salinities, even up to 5 ppm, which enable them to enter the estuaries or tidal rivers. But generally speaking, the catfishes have been observed to be most dense over inshore muddy areas particularly in 30-80m depths.

Species Composition

Though nearly a dozen species of catfish are caught along the coasts of the country, only five species are of importance from the fisheries point of view. Marine catfishes belong mostly to Tachysuridae, hence it is not surprising that 99% of the catches are of the four species of this family, viz., *T. tenuispinis, T. thalassinus, T. dussumieri, and T. serratus*. The first three are more or less uniformly abundant in the grounds off west and east coasts, *T. serratus* being more restricted to the south-west coast. The only other catfish species of importance is *Osteogeneiosus militaris* which is abundantly caught off Saurashtra coast.

Species	*Occurrence in Indian waters*
1. *Tachysurus caelatus* (Val.)	Shallow coastal waters of east and west coasts, particularly around the river mouths on east coast.
2. *T. Subrostratus* (C & V)	Coastal waters, also estuaries and tidal rivers along SW coast.
3. *T. sona* (Buch-Ham.)	Coastal waters, mainly west coast; stray catches from east coast.
4. *T. thalassinus* (Ruppell)	All along west and east coasts, also in estuaries. Seldom in shoals.
5. *T. serratus (Day)*	Along the east and west coasts, particularly during mansoon.
6. *T. platystomus* (Day)	Along the east and west coasts, abundant in Gulf of Mannar.
7. *T. tenuispinis* (Day)	Along the coasts, abundant along SW and NE coasts—large shoals in surface and columnar waters.
8. *T. jella* (Russell)	Along the coasts, abundant on east coast, also in estuaries.
9. *T. maculatus* (Thunberg)	Along the east and west coasts, also estuaries and tidal rivers.
10. *T. dussumieri* (Val.)	Along east and west coasts, large shoals in surface and columnar waters, particularly along SW and SE coasts.
11. *Osteogeneious militaris* (Linn)	Along the coasts, particularly NW and NE.

Seasonal and Regional Patterns

In the northwest sector of Gujarat, Maharashtra and Goa, the exploited area is a coastal strip up to 40-50 m depth, though exploratory trawling has been carried out to over 100 m depth. Drift-nets, hooks and lines and trawls are the important gears, though bottom-set gill nets are widely used off Maharashtra and Gujarat. The characteristic 'dol' net of the area also catches small quantities of catfish. *T. thalassinus, T. dussumieri, T. sona, T. tenuispinis, T. jella* and *O. militaris* are the species commercially caught

Off Goa catfishes form a good fishery from October-November to May-June by gillnet, trawl and purse-seine at depths up to 30 m. *T. dussumieri* and *T. tenuispinis* are the main species caught,especially by the purse-seines. Whereas, a year-round traditional fishery used to be maintained by hooks and line, mechanized trawling has, of late, more or less displaced it in all but the monsoon months and boosted the catch until catfishes now form nearly 5% of the total fish landings here. Off Maharashtra the hooks and line operate during May-October and trawls and 'dol' net from September-October to April-May; and catfish form the second largest demersal group landed here. *T. sona* constitues nearly 60% of the catfish catches along Bombay

coast. Off Gujarat, catfish constitute a relatively smaller part and are generally caught during September-May by trawlers and hooks and line.

Along the south-west coast the commercial fishing grounds are generally confined to within 35 m depth and even more restricted during the S. W. monsoon months of May-September. *T. dussumieri* and *T. tenuispinis* are the species that contribute to the bulk of the catfish landings, other important species being *T. thalassinus* and *T. serratus*. Trawls, boat-seines, hooks and lines and drift-nets are the main gear in use in Karnataka and large parts of Kerala, while trawls are scarce in extreme south Kerala where the coastal belt (except for occasional patches) is generally not suitable for trawling. As already mentioned, purse-seines have made an impact on the production in this zone, particularly off Karnataka. Catfishes are caught in all quarters, generally forming 4-8% of total fish landings. The trawl fishery is generally prevalent in February-April, drift-nets in July-October and hooks and lines in August-December. The surface-moving shoals are caught by the traditional boat-seines and lately more efficiently by Purse-seines during August-October. Exploratory surveys have shown that the seasonal shifts of shoals make available a higher concentration of catfish for a longer duration off Karnataka and Kerala coasts.

There is a rich fishery for many species of catfish along the south-east coast. *T. thalassinus T. dussumieri, T. tenuispinis, T. caelatus* and *T. platystomus* are commercially important, all except the first being seasonal. The chief fishing grounds are in the Gulf of Mannar and Palk Bay; species like *T. maculatus* and even *O. militaris* may occasionaly be caught in quantities from Palk Bay (Menon, 1979). The fishing, carried out throughout the year shifts from the Gulf to the Bay and back again according to the changing N. E. and S. W. monsoons. The depth of fishing seldom exceeds 15-20 m. Drift nets and hooks and lines are the important traditional gear. Experimental fishing by purse-seines has been attempted successfully, but it has not caught on commercially. However, the traditional gear is slowly losing ground to mechanized trawling. So the best fishing ground for catfish is the Palk Bay which has more trawlable areas and has extensive shallow muddy bottom suitable for catfish. The best fishing season for catfish appears to be the second quarter.

The main catfish fisheries in the north-east sector are along the Andhra coast (Sekharan, 1968). The commercial fishery is mostly in the shallow coastal region of less than 40 m depth, by indeginous crafts plying hooks and lines, boat seines and bottom-set gill nets and by small mechanized trawlers. The fishery is mainly sustained by *T. thalassinus; T. caelatus T. tenuispinis, T. dussumieri T. jella* and *T. maculatus* are also caught but more in West Bengal and Orissa waters. *O. militaris* is caught in bag-nets from the Hooghly-Matlah estuaries in West Bengal (Pillai & Ghosh, 1962). The high seasonal catches are in March-June. The Andhra coast produces nearly 80% of the catfish landings of the northeast sector.

Offshore Fishery and Potential Grounds

Exploratory trawling has been carried out in the northeast sector between Kakinada and Sandheads covering about 23,600 sq. km of the shelf area (Nagbhushanam, 1966; Sekharan, 1968; Kuthalingam, 1968). The coverage was not uniform and the bulk of the effort was off the Andhra coast (16°40'-21°10'), generally up to 80 m depth, occasionally to 100 m. Catfishes were found to make up 9-24% of the trawl catches. Rich grounds have been indicated off Visakhapatnam, Calingapatnam, Gopalpur and Chilaka lake. *T. tenuispinis* was dominant in the mid region (17°40'-18°40'), *T. thalassinus* abundant towards the south (16°40'-17°10') as well as the north (20°10'-21°10') (Sekharan, 1973a). The larger fish have been obtained from the deeper waters (Nagabhushanam, 1966: Sekharan, 1973b). A resource estimate of catfishes off Andhra coast over a 5-year period gave an average estimated sustainable potential yield of 5631 tonnes (Krishnamoorthi, 1974).

Off the southeast coast some detailed offshore exploratory fishing has been done in the Gulf of Mannar and Palk Bay in 1964. Catfish were found to form 2-8% of the catches from Palk Bay up to a depth of 15 m, while from the Gulf, fished up to 30 m depth, the catfish were meagre in catches (Rao, 1969).

However, later studies by acoustic surveys with experimental fishing in the Gulf of Mannar found an average catfish biomass of 3,604 tonnes. with the larger and older fish more abundant in deeper waters (Rao *et al,* 1977). Experimental purse-seining in the Palk Bay during 1970-72 indicated large shoals of *T. dussumieri* during August-December, a single haul fetching up to 50 tonnes.

Exploratory fishing between 7°30' and 15°0 'N along the southwest coast has charted out many catfish grounds even though the relative narrowness of the shelf here reduces trawling opportunities as compared to the northwest sector. The better grounds have been found to be between Calicut and Cannanore. with catfish making up about 23% of the trawl catches, with the catches diminishing southward (Tholasilingam *et al,* 1973). While exploratory surveys have shown maximum catfish abundance during the second and third quarters the commercial landings here are in the third and fourth quarters off Kerala and in the second quarter off Karnataka. The inability of artisanal and other small-sized crafts to exploit, during the monsoon period, the maximum availability of the resource point to the need for larger vessels fishing further. Acoustic-cum-experimental fishing surveys in the region have given average estimated catfish biomass as 43,791 tonnes off Kerala and 26,672 tonnes off Karnataka-Goa (Rao *et al,* 1977). These surveys have also indicated concentrations of catfish moving northward and southward according to the monsoonal drift and the proportion of large-sized fish considerably higher in the offshore waters.

Exploratory fishing has been carried out in the sector between 15° and 24° covering over 25,000 sq. miles. This sector has wide shelf areas available for trawling and catfish yield has been found to be all through the year with the maximum in November-February. The abundance was maximum off Kutch and decreased gradually through Porbundar, Cambay, Dwarka and Veraval-Bombay. However, rich grounds have been marked off Malwan and Marmagoa. The potential sustainable yield of this region has been estimated as 4254 tonnes (Rao & Dorairaj. 1968). Off southern Maharashtra the average catfish biomass has been estimated as 15,629 tonnes (Rao *et al,* 1977). The Indo-Polish Industrial Fishery survey that covered the area from 55 to 360 m depth for one year (Bapat *et al,* 1982) found catfish an important component of the catches from the offshore waters in all months except September-October. While better catch rates were recorded generally from the 55 to 90 m depth, high catch rates were observed in 91-125 m zone in February-April. The southern region was richer than the northern.

Utilization and Marketing

The catfishes are for the most part utilized fresh and so are marketed directly to local consumers. At times of abundance beyond local demand and in the likelihood of spoilage, the fish are cured by various methods. Larger fish of *T. thalassinus, T. dussumieri, T. tenuispinis, T. serratus* and *T. caelatus* are filleted while fresh and cured by salting and sun-drying. This is marketed in the interior villages. Larger fish are also sometimes slit length-wise, the viscera removed and the fish pit-cured for special markets like Sri Lanka and some East Asian countries. With the establishment of ice factories and cold storages near the landing centres at many places, fish packed with ice in boxes or baskets are also taken to interior markets. This is particularly true of the catches of the mechanized trawlers where the fishes, with entrails removed, are kept in holds with ice and sold either frozen whole or as fillets.

Small-sized catfish are used, along with the miscellaneous catch of trash fish, for the preparation of fish meal or fish protein concerntrate. Studies have shown that *T. jella* gives a product containing over 90% protein (Gopakumar and Shenoy, 1977), while the lipid content is found to be higher in other species, e. g., muscles of belly flaps of *T. dussumieri* gave nearly 38.5 g per 100g (Alexander, 1970). Tachysurids have also been found to yield phosphorus, calcium, sodium and potassium in small quantities (Kutty *et al,* 1976). Catfish liver is found to be a very good source of vitamin (Singh & Rege, 1964.)

The air-bladders of large-sized catfish are used in the preparation of isinglass. The bladder is slit, washed, dried and marketed. Because catfish bladder yields only a relatively inferior type of isinglass, the market remains limited.

In general, the marketing of catfish and its products is not well-organised and is, on the other hand, characterized by the unhygeinic conditions of beach drying and curing and, even in the marketed products like fillets, the crudity of the packing and despatch.

Limitations and Possible Conclusions of Present Study

The work reported on in this Bulletin comprises the detailed studies on specific aspects of the catfish biology carried out at seven centres along the east and west coasts, and analysis of the All-India catch and effort figures from the CMFRI data centre. In the latter, the catfishes have been estimated as a group and the separate landing figures are not available for individual species. In the centre-based observations the data have been collected for varying periods for different species and centres as the Institute's investigations started at the main centres of Waltair and Mandapam Camp in 1970-71 and the other centres were added as the work progressed; Cochin, Calicut, Mangalore and Bombay in 1978-79 and Veraval in 1980. So not all centres could be considered for all the species in the resources assessment studies. Still the conclusions that could be derived from this study have been sufficiently indicative of the trend of changes in exploitation and the direction in which further management steps should be taken.

The picture that emerges is of a resource that is potentially large, but is now exploited in coastal waters only. Here it is subjected to such intensive fishing pressure that any increased effort would be detrimental to the stocks in the area. Restrictions on effort in an inshore fishery that is mainly carried on by small and medium-sized vessels and which is primarily aimed at the lucrative prawn fishery, is difficult but appears necessary. Additional effort for increased production has to be applied elsewhere, in the potential grounds beyond.

CHAPTER TWO

TAXONOMIC CONSIDERATIONS AND GENERAL DISTRIBUTION OF COMMERCIALLY IMPORTANT CATFISHES

—N. GOPINATHA MENON AND V. N. BANDE

The taxonomy of our commercially important marine catfishes is still in a state of uncertainty. The nomenclature has suffered a lot of changes brought about by various taxonomists. When some authors have used the genus name *Tachysurus*, and hence the family name Tachysuridae, others preferred the name *Arius* and the family name Ariidae. Valenciennes (1840), Bleeker (1847), Gunther (1864), Day (1878), Weber and Beaufort (1913), Herre (1953), Jordan (1963), Fischer and Whithead (1974) and Fischer and Bianchi (1984) all have used the name *Arius* Val. 1840, whereas Fowler (1941), Chandy (1953), Munro (1955), Tilak (1965), Jayaram and Dhanze (1978 a, 1978 b) and Menon (1979) replaced the name *Arius* Val. 1840 by *Tachysurus* Lacepede 1803. Though all taxonomists agree with the characters by which the genus is identified, the controversy still remains as to the name. As the generic name *Tachysurus* was proposed first by Lacepede in 1803, this name is supposed to have precedence over *Arius* Val. and so Jayaram and Dhanze (1978 a) regarded *Tachysurus* as a valid generic name. However, later, in the preparation of FAO's Species Identification sheets for western Indian ocean (Fischer and Bianchi, 1984), Jayaram has changed the generic name over to *Arius* without giving any reason whatsoever.

The accepted family characters of Tachysuridae are: (1) elongate body without scales; (2) lateral line complete; (3) depressed head

covered by conspicuous bony shields, comprising frontal, supraoccipital, sphenotic and other otic bones, often rugose granulate; (4) presence of an adipose dorsal fin and serrated pungent spines in dorsal and pectoral fins; (5) dorsal fin with seven, ventrals with six and pectorals with seventeen to nineteen rays and anal with fourteen to twentysix rays; (6) adipose dorsal opposite to anal; (7) caudal fin deeply forked; (8) eyes usually with free lids; (9) mouth transverse or crescentic, usually terminally inferior; (10) jaws with maxillary, mandibular and mental barbels, sometimes only with maxillary or mandibular and rarely only with rudiments of mandibular; (11) one or more rows of villiform, conic or granular teeth on jaws; (12) palate with or without conic, villiform or granular teeth — if present, present in one to several patches; (13) closely placed nostrils, posterior one with valve and without barbels; (14) united gill membrane joined with isthmus or free, with low folds on the ventral side; (15) branchiostegal rays five to seven (16) vertebrae 48 to 58, of which 27 to 33 caudal; (17) air bladder large, connected with stomach by a narrow duct.

The major characters which can be easily used in differentiating the genera of the family Tachysuridae are the dentition and the number of maxillary and mandibular barbels. The genus *Tachysurus* is characterized by a single pair of maxillary and two pairs of mandibular barbels and the teeth in palate, which are either conic, villiform or granular. Only one pair of stiff osseous maxillary barbels present besides the granular teeth in palate in the genus *Osteogeneiosus*. There is only a pair of minute rudimentary mandibular barbel inserted at the chin and granular teeth in the palate in the genus *Batrachocephalus*.

On the basis of size and shape of the teeth in patches on the palate, Day (1878) had classified the genus *Arius* (= *Tachysurus)* mainly into two groups, one with villiform teeth and the other with conic teeth on the palate. These two groups were subdivided to various species on the basis of the number of palatine patches. Chandy (1953) used the number and shape of the toothed palatine plates to distinguish the species of the genus *Tachysurus*. In addition to the number and shape of the toothed palatine plates, Tilak (1965) used osteological characters as well, such as the number and arrangement of branchiostegal rays on the hyoid arch, the forms of operculum and interoperculum, the anterior and posterior fontanella on the roof of the cranium and the pattern of diagonal ridges on the pars sustentaculum, for the diagnosis of the genera and species of the family Tachysuridae. Munro (1955), following Fowler (1941), classified the genus *Tachysurus* into subgenera, and placed all the species of *Tachysurus* having a single set of conic teeth on the palate under a subgenus *Tachysurus* Lacepede; those having two groups of conic teeth on each side of the palate in a transverse row under a subgenus *Hexanematichthys* Bleeker; those with three sets of conic teeth on each side under a subgenus *Netuma* Bleeker; those with one set of granular teeth on each side of the palate in a subgenus *Pseudarius* Bleeker; and those with two sets of granular teeth on each side of the palate under a subgenus *Ariodes* Muller and Troschel. But, Tilak (1955), stating that the differences in many of the characters noticed within the genus *Tachysurus* were only of specific value, did not support the generic status being assigned to any of these species. Moreover, the magnitude of differences among the species of the genus *Tacuysurus* is not of the same degree as that among the genera themselves, namely *Tachysurus*, *Osteogeneiosus* and *Batrachocephalus*.

A key to the identification of the three Indian genera as well as 21 species of *Tachysurus* and one species each of *Osteogeneiosus* and *Batrachocephalus* is given below. In the present study, the type of teeth, the shape and number of patches of palatine teeth and their disposition on the roof of the buccal cavity and the proportions of different morphometric characters are taken into account for distinguishing species of the genus *Tachysurus*. The distribution of this family along the Indo-Pacific region is shown in Fig. 1. Since the descriptions of the species agree well with earlier accounts, only the distribution of commercially important species is given.

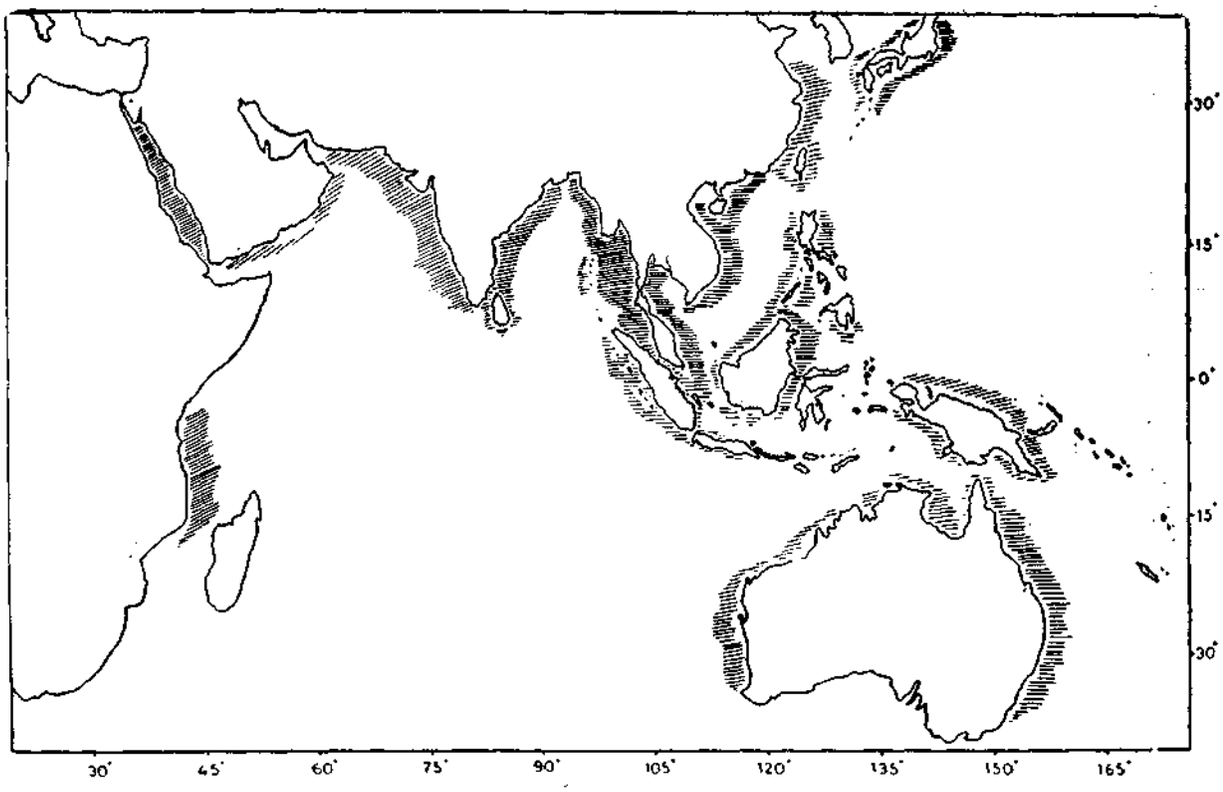


Fig. 1 Distribution of tachysurid catfishes along Indo-Pacific region.

KEY TO THE IDENTIFICATION OF THE INDIAN GENERA AND THE SPECIES OF THE FAMILY TACHYSURIDAE

I. Maxillary and mandibular barbels present- ..... *Tachysurus*

A Teeth on palate villiform, conic or pointed.

1. Teeth in one group on each side of palate.

a. Head shield highly granulated; pectoral spine shorter than dorsal; eye diameter 7 in head and 4 apart..... *T. caelatus*

b. Head shield granulated; pectoral spine equal to dorsal; eye diameter 5.5 in head and 4 apart..... *T. nenga*

c. Premaxillary band of teeth short; barbels short; snout depressed, elongate and spatulate; elongate dorsal filament reaching the adipose fin ..... *T. subrostratus*

d. premaxillary band of teeth arcuate and long; palatine patches close together reaching in middle; maxillary and outer mandibular barbels nearly of the same length..... *T. parvipinnis*

e. Premaxillary widely separate; snout duck-billed ..... *T. burmanicus*

f. Palatine patches widely separate; snout blunt ..... *T. sumatranus*

g. Palatine patches oval and separate from the jaw by a space not more than the width of premaxillary band of teeth, snout elongate and acute..... *T, acutirostris*

2. Teeth in two groups on each side of palate in a transverse row.

a. Outer palatine groups rounded or oval, larger than the inner groups, generally distinct; occipital process hemispherically rounded ..... *T. sagor*

b. Outer palatine groups triangular, with emarginate hind edge, generally united with the small groups; occipital process triangular..... *T. sona.*

3. Teeth in three groups on each side of palate.

a. Inner vomerine patches of both sides contiguous; maxillary barbels reach the outer border of operculum; dorsal spine as long as head; snout blunt ..... *T. thalassinus*

b. Inner vomerine patches of both sides separated by a smooth mesial space; maxillary barbels reach the base of pectoral fin; dorsal spine shorter than head; snout conical ..... *T. serratus*

B. Teeth on palate granular

I. Teeth in one group on each side of palate.

a. Maxillary and outer mandibular barbels shorter than head, thick and fleshy; palatine patches pear-shaped, diverging posteriorly; dorsal and pectoral spines strong..... *T. platystomus*

b. Maxillary barbels slender, shorter than head; palatine patches pear-shaped, placed far back in the buccal cavity; dorsal and pectoral spines weak ..... *T. tenuispinis*

c. Maxillary barbels extend beyond the head; palatine patches long-triangular; pectoral spine shorter than head..... ..... *T. gagora*

d. Maxillary barbels as long as head; palatine patches convex, oblong-ovate, convergent behind..... *T. jella*.

e. Maxillary barbels as long as head, black, palatine patches elongated oval, placed far forwards, convergent posteriorly ..... *T. malabaricus*

f. Maxillary barbels reach pectoral base; large equilateral triangular palatine patches, parellel; dorsal spine strong, shorter than head, with a filamentous prolongation reaching the base of adipose dorsal..... *T. maculatus*

g. Maxillary barbels reach middle of pectoral spine; pyrifom band of teeth on palate, placed well forward, widely divergent posteriorly; dorsal spine as long as head..... *T. macronotacanthus*

2. Teeth in two groups on each side of palate.

a. Posterior palatine patches elliptical and diverging posteriorly.... *T. dussumieri*

b. Posterior palatine patches pear-shaped and converging posteriorly .. .. *T. crossocheilus*

c. Posterior palatine patches elongated and with a few globular teeth .. *T. nella*

II Maxillary barbels alone present, which are stiff, and osseous ..... *Osteogeneiosus*

a. Barbels longer than head; crescentic patches of palatine with granular teeth .... *O. militaris*

III Two rudimentary barbels inserted at the chin..... *Batrachocephalus*

a. Mouth wide, lower jaw longer; two rudimentary barbels inserted at the chin; teeth in jaws conical; a broad band of granular teeth on palate ..... *B. mino*

DISTRIBUTION OF COMMERCIALLY IMPORTANT SPECIES

1. *Tachysurus caelatus (Val.)*
Fig. 2; Pl. IA

All along the shallow coastal waters of India, Sri Lanka, Pakistan, Bangladesh, Burma. Thailand, East Indies, Sumatra, Java and Borneo. Essentially marine and forms large shoals; often moves along column and surface waters. The species is particularly abundant along the southeast and northwest coasts of India and grows to about 60 cm. It forms a fishery of substantial importance in the Palk Bay.

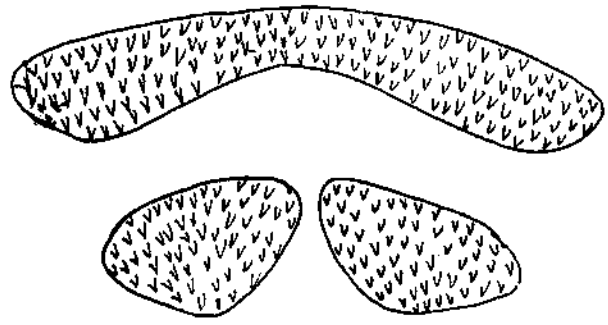


Fig. 2 Platine teeth pattern of *Tachysurus caelatus*

2. *Tachysurus subrostratus* (Cuv. and Val.)
Fig. 3; Pl. 1B

This species is distributed along the coastal waters, estuaries and more commonly in tidal rivers of the southwest coast of India; Pakistan, Singapore, Java, Indonesia, Malaya, Sri Lanka. It is purely demersal, scavenging on animal remains at the bottom, and grows to 40 cm.

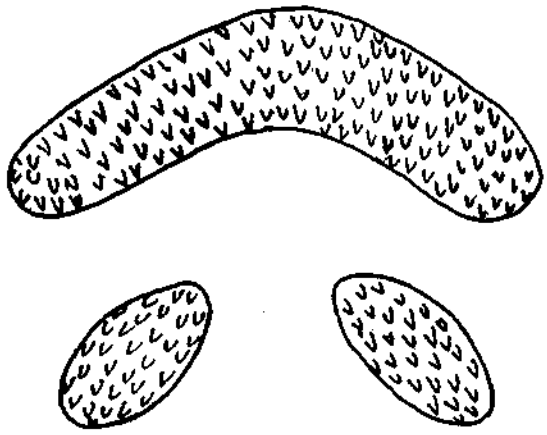


Fig. 3 Palatine teeth pattern of *T. subrostratus*

3. *Tachysurus sona* (Buchanan-Hamilton)
Fig. 4

Along the coasts of India, Pakistan, Sri Lanka, Bangladesh, East Indies and Polynesia. This species is abundant along the northwest coast of India and forms a substantial fishery off Bombay; stray occurrence along the Palk Bay and estuaries of Bengal. It reaches up to a size of 100 cm and never forms large shoals.

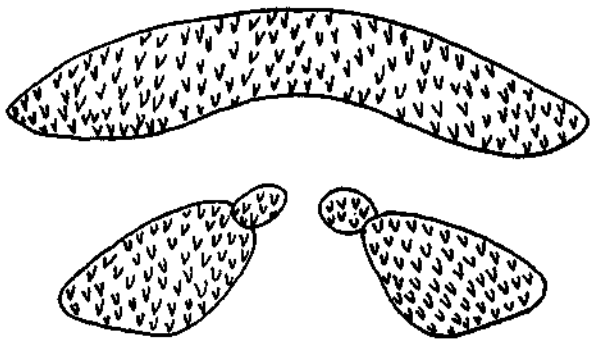


Fig. 4 Palatine teeth pattern of *T. sona*

4. *Tachysurus thalassinus* (Ruppell)
Fig. 5; Pl. 1C

The species is widely distributed all along the Indo-Pacific region, in the Red sea, and Arabian Gulf, and along Zanzibar, India, Andamans, Burma, Singapore, East Indies, Philippines, China, Japan, Austrialia, Queensland and New Calidonia coasts. Never forms large shoals, demersal, marine and estuarine and tolerates low levels of salinity. Youngones are strictly demersal, where as larger ones ascend colum waters. Commonly occurs at depth ranges of 30 to 60 metres and grow to more than 80 cm.

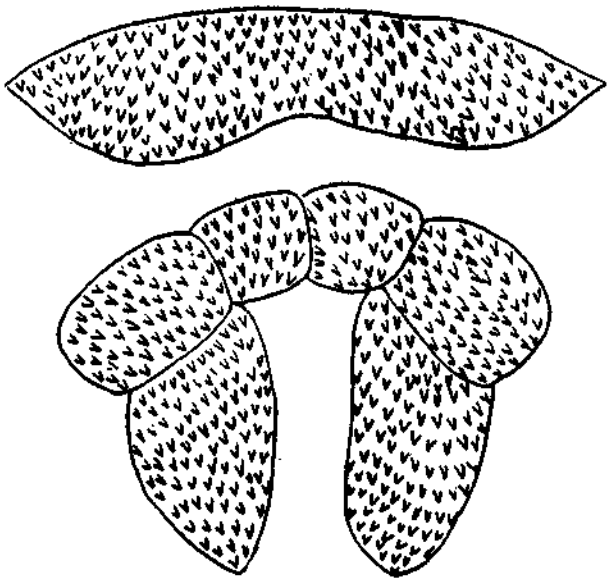


Fig. 5 Palatine teeth pattern of *T. thalassinus*

5. *Tachysurus serratus (Day)*
Fig. 6; Pl. 1D

Jayaram and Dhanze (1978 b) considered *Tachysurus serratus* to be a juvenile form of *T. thalassinus* mainly based on the shape and disposition of palatine tooth patches. They maintained that some of the palatine patches get fused as the fish grow. An extensive study on these two species from various parts of the country showed that the palatine patches remain constant with regard to their shape and disposition during growth, though perhaps not the size. The toothed palatine plates are formed even in the larval stages, as has been observed in *T. thalassinus*, and maintain their shape and character throughout the life

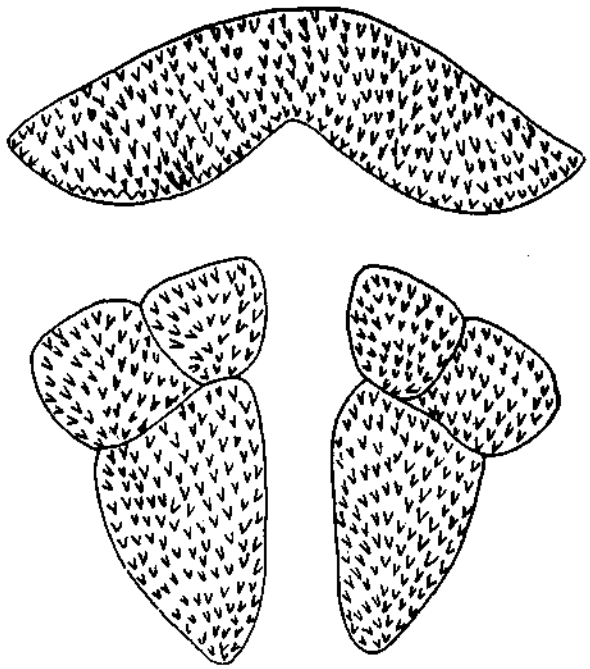


Fig. 6 Palatine teeth pattern of *T. serratus*

in both sexes (Menon, 1979). The species *T. serratus* is clearly different from *T. thalassinus* with definite specific characters like the shape and disposition of palatine toothed plates and some morphometric proportions such as length of snout, pre-dorsal length, etc.

This species is distributed along the coasts of Arab Gulf, Pakistan, India, Sri Lanka and Bangladesh. Essentially demersal and occurs at depth ranging from 4 to 120 m. It approaches shore for breeding during monsoon months. It is the largest among marine catfishes of India and grows to about 135 cm.

6. Tachysurus platystomus (Day)
Fig. 7; Pl. IE

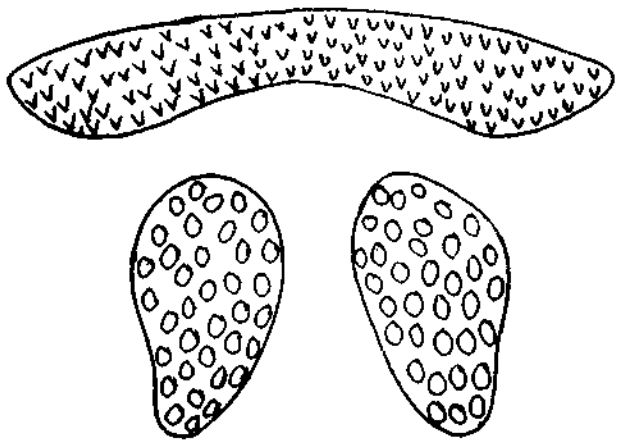
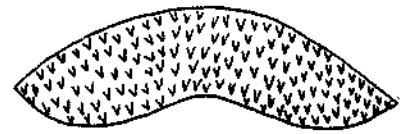


Fig. 7 Palatine teeth pattern of *T. platystomus*

Along the coasts of India, with particular abundance in the Gulf of Mannar, and along Sri Lanka. The species is purely demersal and never forms large shoals. It is found up to a depth of 90 m and grows to about 50 cm. This species forms a fishery along the Gulf of Mannar during November-February period.

7. Tachysurus tenuispinis (Day)
Fig. 8; Pl. IF

The species is distributed along both the coasts of India and appears in large shoals, moving along column and surface waters in the southwest coast. It attains a size of 60 cm and is found up to a depth of 80 m, but common at the depth range of 30-60 m.



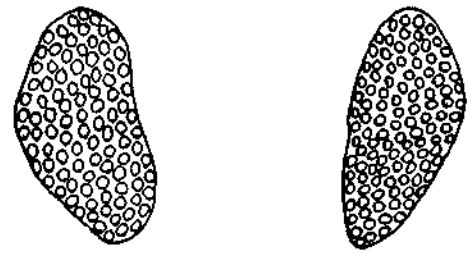


Fig. 8 Palatine teeth pattern of *T. tenuispinis*

8. Tachysurus jella (Russell)
Fig. 9

T. jella is distributed along the coast of India, Sri Lanka, and Burma, marine and esturarine. Grows up to 35 cm.

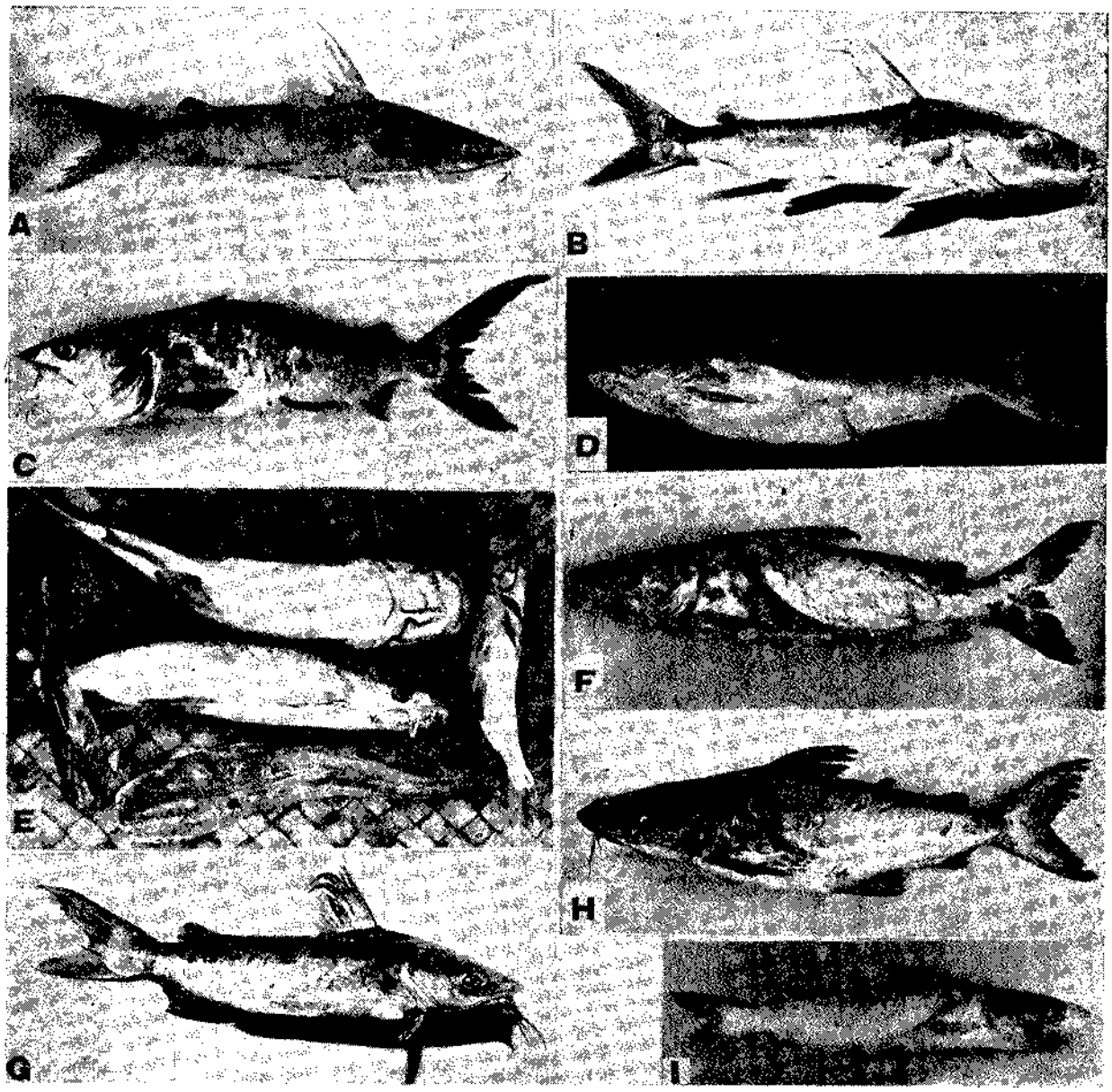
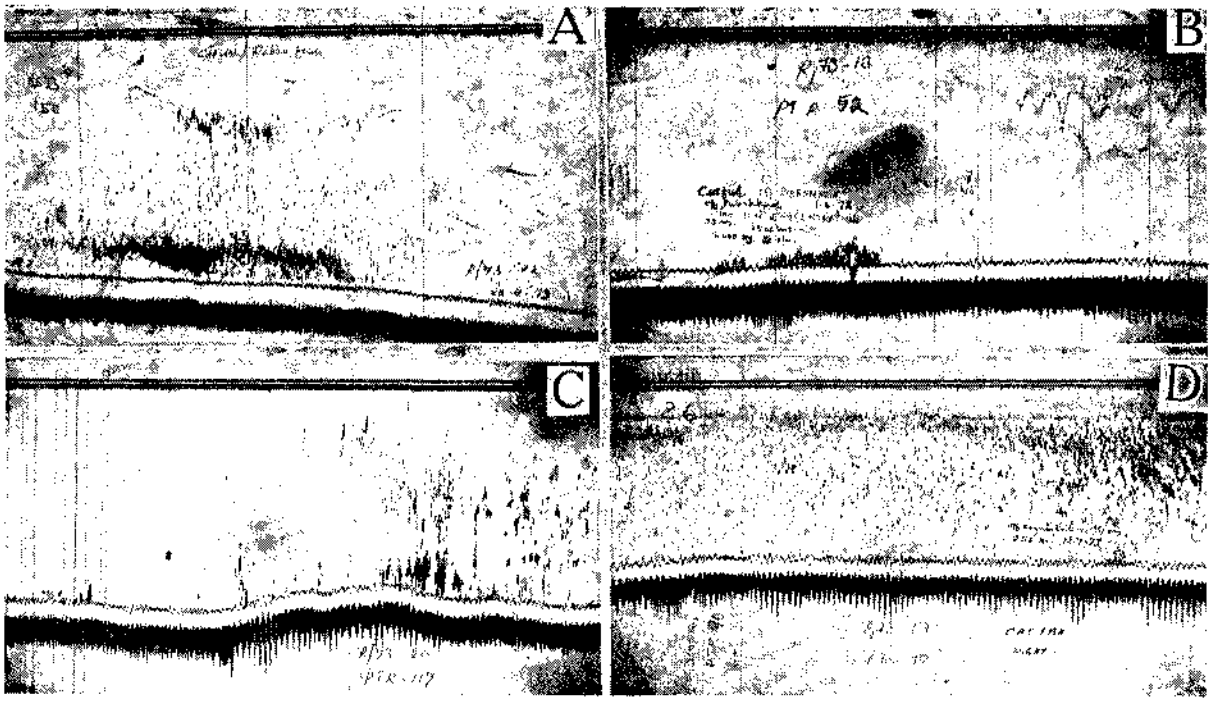


Fig (A) *Tachysurus caelatus* (B) *T. subrostratus*
(C) *T. thalassinus* (D) *T. serratus*
(E) *T. platystomus* (F) *T. tenuispinis*
(G) *T. maculatus* (H) *T. dussumieri*
(I) *Osteogeneiosus militaris*



Echograms of catfish

A) Early morning in the process of descending to the bottom
B) Dense bottom concentrations during noon
C) Late evening in the process of dispersing in the water column
D) Dispersed recordings during night.

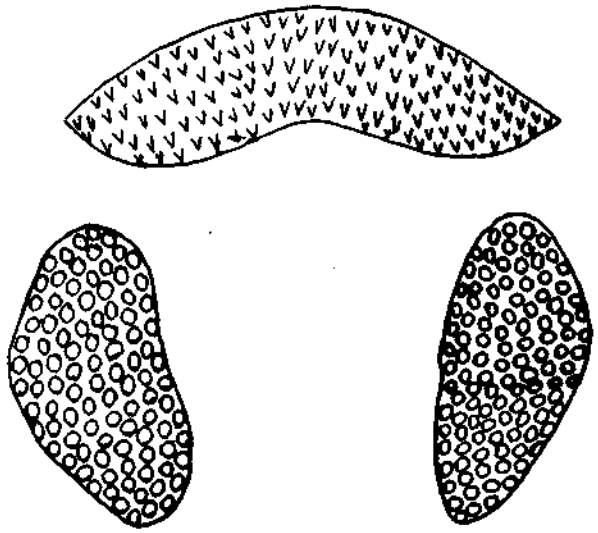


Fig. 9 Palatine teeth pattern of *T. jella*

9. Tachysurus maculatus (Thunberg)
Fig. 10; Pl. 1G

Distributed along the seas, esturaries and tidal rivers of Pakistan, India, Bangladesh, Burma, Thailand, Malyasia, China, Formosa and Japan. It attains a size of 50 cm and occurs up to a depth of 20 m. Forms large shoals along the coastal belt near river mouths, scavenging the bottom for foods.

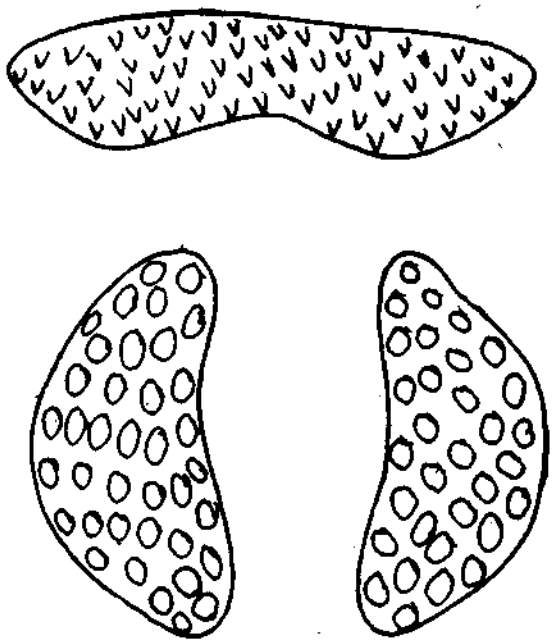


Fig. 10 Palatine teeth pattern of *T. maculatus*

10. Tachysurus dussumieri (Val.)
Fig. 11; Pl. 1H

Distributed along the east coast of Africa, the Arab Gulf, Pakistan, west and east coasts of India, Sri Lanka, Bangladesh and Burma. The species is purely marine and forms large shoals and moves along column and surface waters. It is common at the depth range 30-60 m. Attains a size of 90 cm.

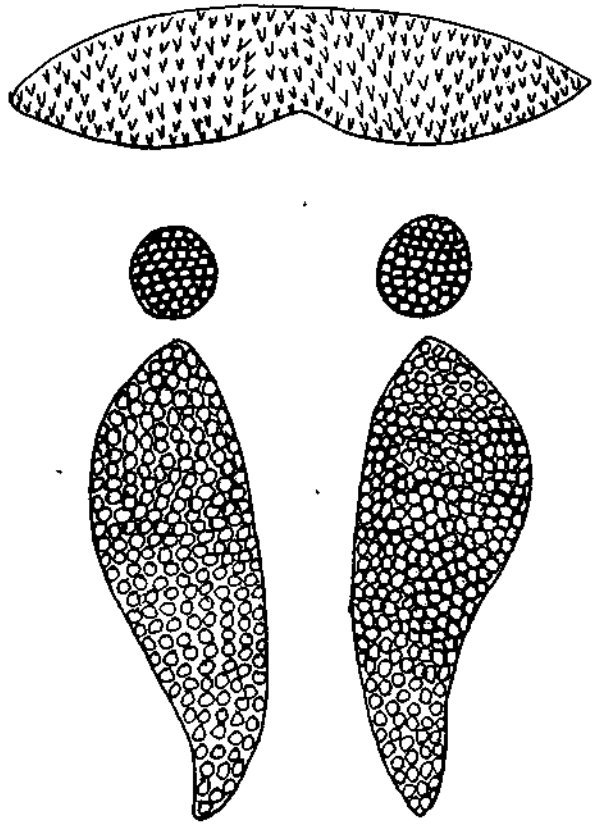


Fig. 11 Palatine teeth pattern of *T. dussumieri*

11. Osteogeneiosus militaris (Lin.)
Pl. 11

Along the coasts of Seychelles, India, Sri Lanka, Bangladesh, Burma, Malayan peninsula and East Indies. Marine and esturine. Grows up to 50 cm.

THE FISHERY AND CATCH STATISTICS OF CATFISHES

— Y. APPANNA SASTRY AND H. MOHAMAD KASIM

The catch statistics, species composition and seasonal abundance of catfish fishery are dealt with in this chapter based on studies conducted for varying periods during 1971-82 at seven different centres along the east and west coasts, viz. Waltair. Mandapam, Cochin Calicut, Mangalore, Bombay and Veraval.

THE CATCH TREND

Silas *et al.* (1976), surveying synoptically the all-India catfish fishery, have given the catch statistics for the period 1962-74. Finding that the all-India catfish landings increased three fold from 1969 to 1974, (Silas *et, al.* 1976, Fig. 8), they considered the catfish a potential demersal resource. But, analysing the survey data of EFP vessels, Krishnamoorthi (1978) has observed a decline in the total catch of catfish along the Andhra-Orissa coast during 1966-76, and has cautioned for a proper management policy against a possible danger of depletion by overfishing.

The statewise catfish landings for the subsequent period, from 1977 to 1982, compiled by the present authors, are given in Table 1. From this table it may be seen that in W. Bengal the catfish landings increased from 134 tonnes in 1977 to 9,075 tonnes in 1982. In Orissa, though there had been an increase in the landings from 1,035 tonnes in 1977 to 6,084 tonnes in 1981, the catch declined to 3,993 tonnes in 1982. In Andhra Pradesh, on the other hand, the landings, though considerably fluctuated, had a general declining trend. In Tamilnadu also the landings declined, from 15,205 tonnes in 1977 to 3,792 tonnes in 1981, but increased to 6,048 tonnes in 1982. In Kerala the landings increased from 7,949 tonnes in 1977 to 13,936 tonnes in 1980, and subsequently declined to 9,532 tonnes in 1982. In Goa the catch trend was similar to that of Orissa, with fluctuations, but with a general decreasing trend. In Karnataka, Maharashtra and Gujarat the catch fluctuated, but with a general increasing trend.

The statewise percentage contribution to the all-India catfish landings (average for 1977-82) are given in Fig. 1. The percentages varied from 2.7% to 19.7%, with Kerala topping the list. The order of contribution was Kerala, Maharashtra, Gujarat, Karnataka, Tamilnadu,

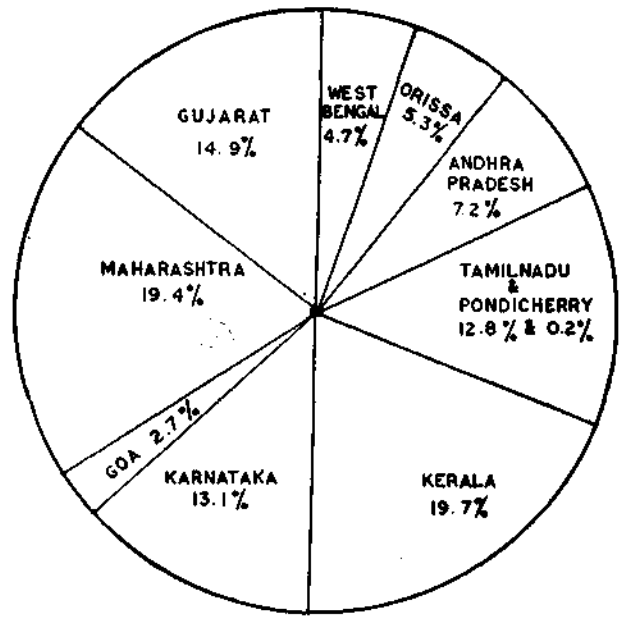


Fig. 1 State-wise percentage composition of catfish landings (Average for the year 1977-1982).

Andhra Pradesh, Orissa, West Bengal and Goa. However, this contribution does not necessarily reflect the true picture of abundance of the resource, as the contribution depends as much on the length of the exploitable coast and the effort expended as on the availability

TABLE 1

State-wise Catfish Landings in Tonnes and %age Composition in All Fish During 1977-1982

	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Anda-mans	Laksha Dweep	Total
1977													
Catfish	134	1035	5662	15205	137	7947	5162	918	8318	8958	28	—	53504
All fish	6689	15072	100756	206046	6462	345037	97152	24731	264452	189638	1532	2215	1259782
%	2.00	6.87	5.62	7.38	2.12	2.30	5.31	3.71	3.14	4.72	1.83	0	4.25
1978													
Catfish	151	1794	3281	5252	168	9125	2831	1356	11081	4159	33	—	39231
All fish	12754	139670	82116	212899	6828	373339	152860	27111	284244	201929	7077	2780	1403607
%	1.18	1.28	3.99	2.47	2.46	2.44	1.85	5.00	3.90	2.06	0.47	0	2.79
1979													
Catfish	140	1308	3799	5617	51	11328	9920	846	10433	5320	55	—	48817
All fish	10744	51808	91426	235008	10068	350509	126384	25388	293326	191312	1721	3846	1388380
%	1.30	2.52	4.15	2.39	0.51	3.43	7.85	3.33	3.56	3.78	3.20	0	3.52
1980													
Catfish	723	2198	2338	4047	78	13936	5354	1151	8653	5235	32	—	43745
All fish	6097	39375	116013	217394	9390	279543	115322	24490	231763	203494	1803	2909	1249837
%	11.86	5.58	2.05	1.86	0.83	4.98	4.64	4.70	3.73	3.57	1.77	0	3.50
1981													
Catfish	4449	6084	4250	3792	102	9562	7503	2211	11045	10370	22	—	59390
All fish	20107	35655	116143	221296	10755	274395	153349	34498	272587	234510	1862	3300	1378457
%	22.13	17.06	3.66	1.71	0.95	3.48	4.89	6.41	4.05	4.42	1.18	0	4.31
1982													
Catfish	9075	3995	3182	6048	20	9532	10253	1541	10919	12662	37	—	67664
All fish	27649	33557	118034	245961	12058	325795	154836	34041	253429	207204	3859	4201	1420624
%	32.82	11.91	2.69	2.46	0.16	2.92	6.62	5.70	4.31	6.11	0.96	0	4.76

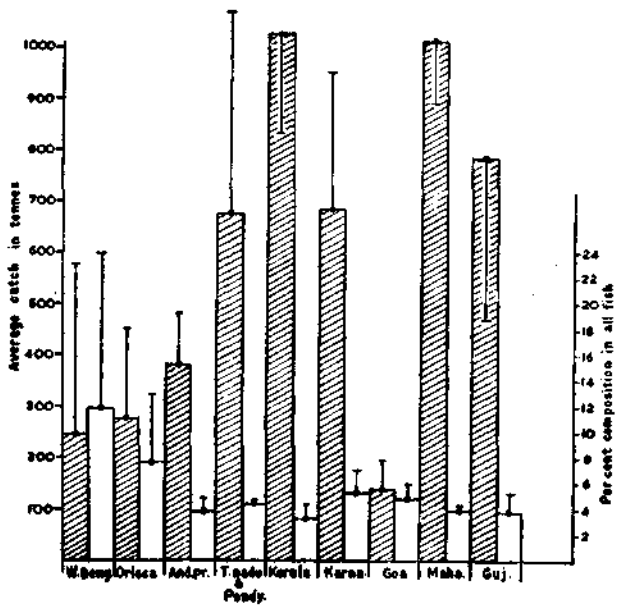


Fig. 2 State-wise average catch of catfish during 1977-1982 and percentage composition of catfish in all fish with one SD.

of resource. The statewise average catches of catfish during 1977-82 and their percentages in the all-fish catches of the respective states, which might give a clearer picture, are given in Fig. 2. Though there were good catfish landings in Kerala, Maharashtra, Gujarat and Tamilnadu, their percentages in the all-fish catches of the respective states were not as high as those in West Bengal, Orissa, Karnataka and Goa. The low percentages of catfish in the all-fish catches in Kerala, Maharashtra and Gujarat were apparently due to the more flourishing mackerel and oil sardine fisheries in Kerala and bombayduck in Maharashtra and Gujarat.

Centrewise Catch and Effort Trends

As centrewise catch and effort data are more pertinent for drawing any inference on the resource distribution, attempts are made to consider the above parameters separately for each centre. This would also help to segregate different populations, if any, at different centres. The centres where there are fullfledged fishing activities and where catfishes are a regular component in the fishery are chosen. The catfishes are mostly caught as a by-catch in trawl net. They are also caught considerably by drift gill net, hooks & line and purseseine from all along the coast. The catch per.unit effort is used as the measure of abundance of the fish though it can be affected by the availability and vulnerability of the fish to the gear concerned. The catch and effort distribution at different centres are given below.

Waltair : The study is based on the data of the survey operations conducted by the Exploratory Fisheries Project (EFP) and of the commercial trawlers based at Waltair during 1970-82.

The EFP vessels M. V. *Meena Shodhak* and M. V. *Meena Jawahar*, both 17.5 m 200HP stern steel trawlers, fished, operating 24 m trawl net, during the period 1975-80. The data of M. V. *Matsya Shikari* (39.8m, 1740 HP), which had done survey in 1980-82 with 34 m and 44.8m, bottom trawls, and of M. V. *Matsya Darshini*, which had operated purseseine (Length 221.5m, depth 50 m and mesh size 18.4 mm) during 1981, were also available, The catfish species landed by these vessels were *Tachysurus thalassinus* and *T. tenuispinis*, the former dominating in the catch. The catch per hour of trawling (CPUE) of M. V. *Meena Shodhak* and M. V. *Meena Jawahar* are shown in Fig. 3. The catch rates were fairly good in all the months except June, July and August, indicating good abundance of this resource in this region. The quarterwise data for 1978-79, given in fig. 4, show that the catfish concentrations were high during the first two quarters. The CPUE data for 1980-82 for the EFP vessels (Fig. 5) show a similar trend all along the northeast coast.

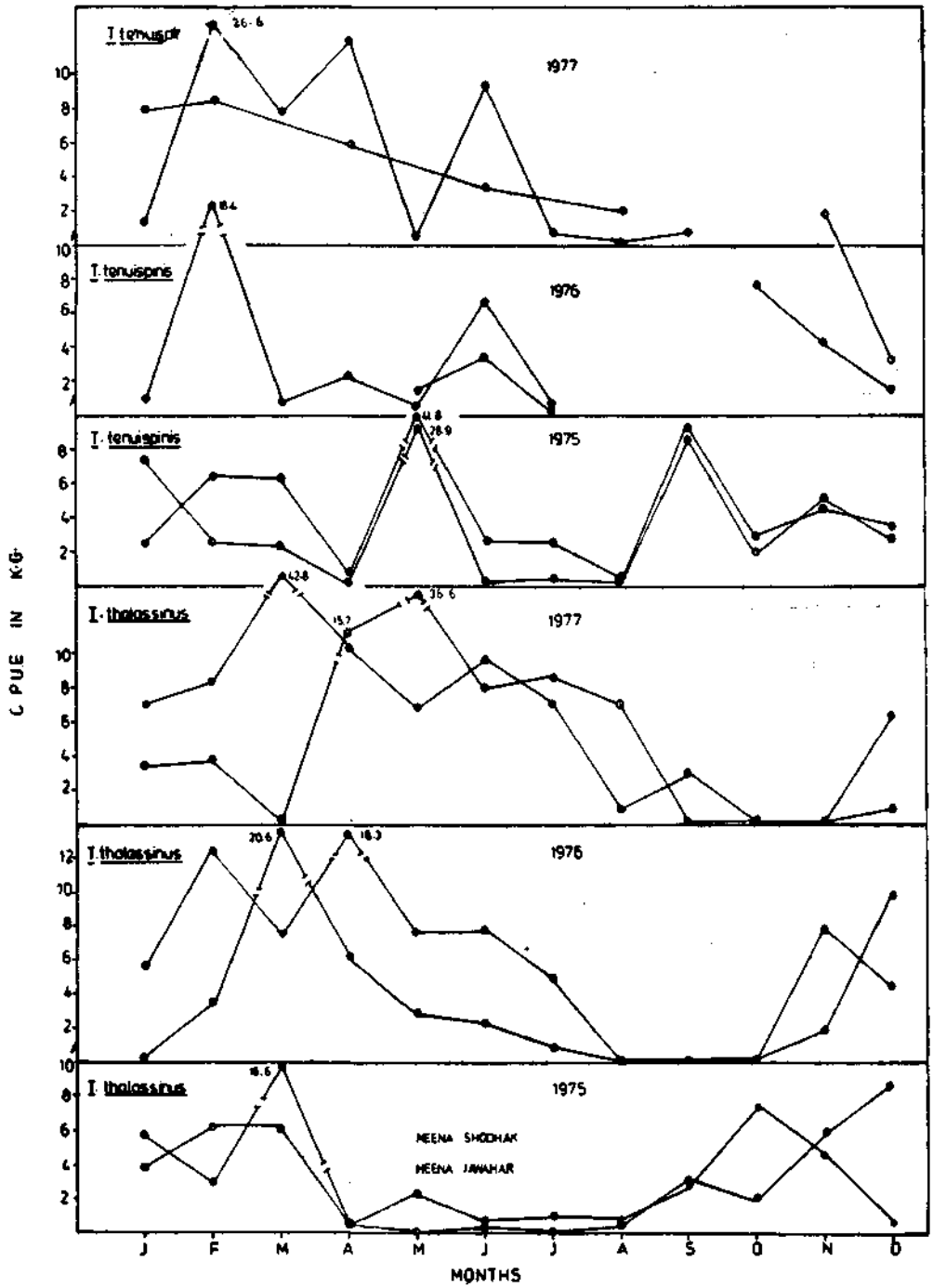


Fig. 3 Catch per unit effort of *T. tenuispinis* by EFP vessels, M. V. Meena Shodhak and M, V. Meena Jawahar at Waltair during 1975-77.

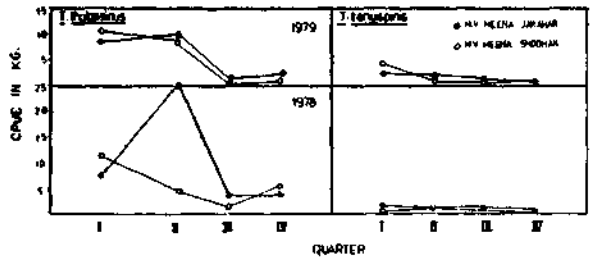


Fig. 4 Quarter-wise catch per unit effort of *T. tenuispinis* and *T. thalassinus* by EFP vessels, M. V. Meena Shodhak and M. V. Meena Jawahar at Waltair during 1978-79

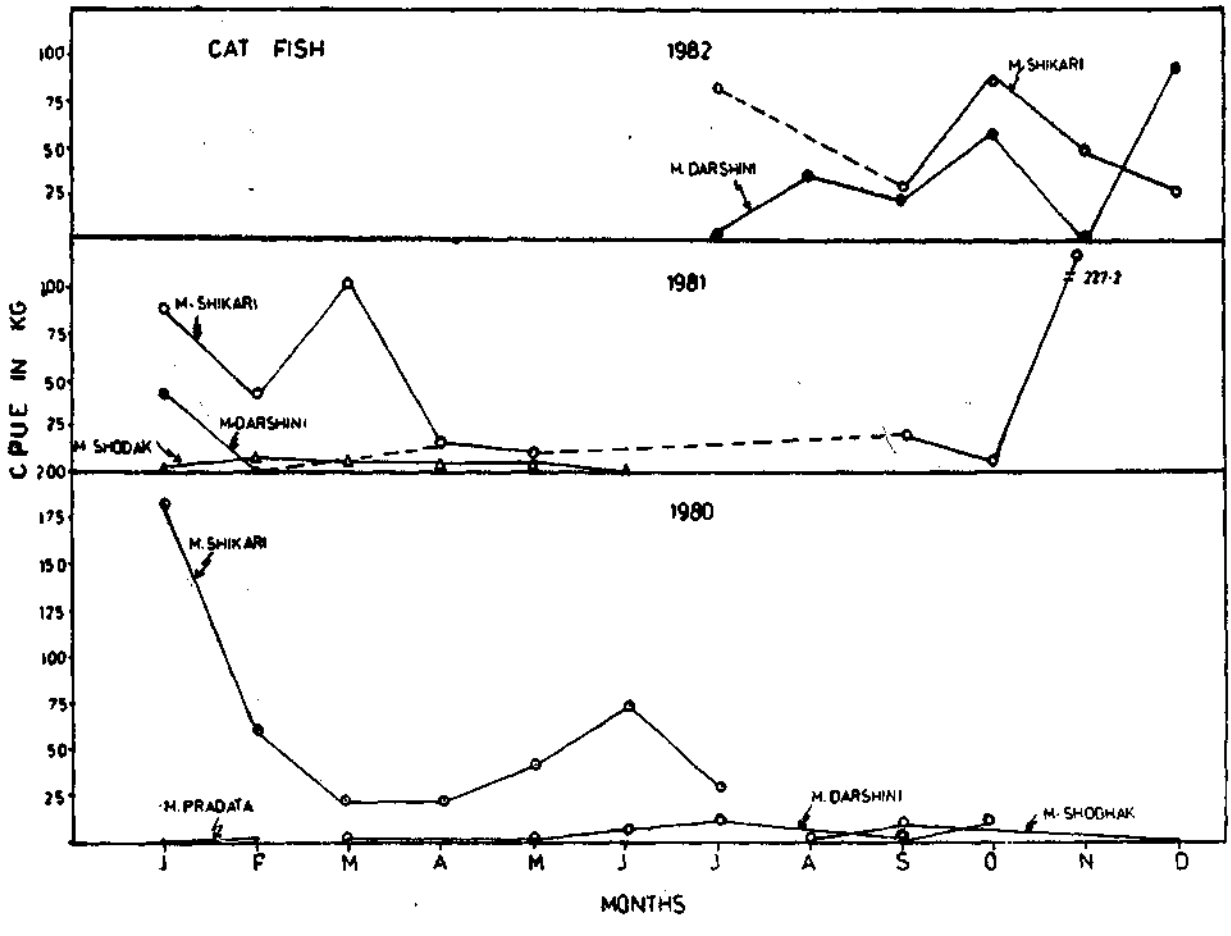


Fig. 5 Catch per unit effort of all catfish landed by EFP Vessels, M. V. Meena Shodhak, Meena Jawahar, M. V. Matsya Shikari, M. V. Matsya Darshini and M. V. Meena Pradata during 1980–1982 at Waltair.

The details of the commercial trawl operations off Visakhapatnam during 1979-82 are given in Table, 2. The catfish landings varied from 150 tonnes (2.5% in total fish catch) in 1981 to 375 tonnes (6.3% in total fish catch) in 1979. There was a steady decline of effort from 38,109 units in 1979 to 28,557 units in 1982. The annual catch rate of catfish also declined, from 9.86 kg in 1979 to 4.73 kg in 1981, however with a slight increase to 7.6 kg in 1982. The analysis of catch rate does not reveal any definite monthly trend in abundance. The operational details of bottom-set gill nets by catamarans at Visakhapatnam during 1972-82 are given in Table 3. The catfish formed, on an average, 15% of the annual all-fish catch by bottom-set gill net. The effort expended steadily increased from 1,083 units in 1975 to 10,373 units in 1978, but the catfish landings varied from 3.6 tonnes in 1979 to 34.5 tonnes in 1981 without any definite trend. The catch rate fluctuated between 0.46 kg in 1982 and 6.73 kg in 1981, with an average of 2.4 kg. *T. tenuispinis* was the most dominant species (72%), followed by *T. Thalassinus* (28%). The details of hooks & line operations by catamarans are shown in Table 4. Catfish landings by this gear varied from 13 tonnes in 1970 to 50.3 tonnes in 1982, showing an annual average of 9.8% in the all-fish total catch. Though the catch fluctuated from year to year, the catch rate remained almost constant throughout the period of study with an average of 0.84 kg. In contrast to the bottom-set gill net, the hooks & lines landed more *T. thalassinus* (80.6%) than *T. tenuispinis* (19.4%).

Mandapam : The catch-and-effort data of the commercial trawl operations for the period 1971-76 are used for this study. The month-wise catfish landings and the composition of *T. thalassinus* during this period are given in Table 5. The landings as well as the catch rate were good during the 2nd and 3rd quarters. In the trawl nets *T. thalassinus* (50%) was the common species caught, followed by *T. dussumieri, T. Platystomus* and *T. serratus* (Table 6. 7 and 8).

Cochin : The details of the operations by commercial trawlers off cochin are given in Table 9. Here the catfish catch fluctuated between 74 tonnes in 1979 and 332 tonnes in 1980, with an average of 235 tonnes. April-June was the peak period of abundance for catfishes at Cochin. The catch rate showed fluctuations between months with high values during April-June period (Table 9). The catch rate of 1.7 kg of 1979 increased to 7.2 kg in 1980 and continued without much variation in 1981 and 1982. The details of the drift gillnet operations at Cochin during 1979-82 are presented in Table 10. Catfishes formed about 17% of the total drift-net landings The catch varied from 380 tonnes in 1980 to 1118 tonnes in 1979 with catch rates of 9.4 kg and 30.2 kg respectively. July to October was the peak period of occurrence, with a high catch rate This is a clear indication that there is a good catfish resource along the coastal waters during the monsoon and post monsoon months, probably owing to shoreward migrations for feeding/spawning. This resource, which had not been properly exploited either by the trawlers or by the indigenous gear, has assumed importance with the introduction of purseseiners in late seventies. Though catfishes are bottom dwellers during part of their life, they move along both column and surface waters in large shoals and become vulnerable to purse seiners. The details of monthwise operations of purse seiners based at Cochin Fisheries Harbour during 1979-82 are shown in Table 11. The average monthly total catch varied from 1.5 tonnes in March to 32.5 tonnes in September. The bulk of the catch was in September in all the years. The catch rate shows a trend that is increasing from 1979 to 1981 and then declining in 1982.

Calicut : Specisewise catfish landings of trawl nets during 1979, 1981 and 1982 at Calicut are given in Table 12, which shows that the abundance of catfishes as indicated by the catch rate was good in 1979 but progressively declined in 1981 and 1982. The dominant species in the trawl catch were *T. tenuispinis* (78-100%) and *T. dussumieri* (22%). Catfishes were caught along Calicut by drift gill net and hooks & line, of which the specieswise catches and catch rates are shown in Table 13

and 14 respectively. Drift-net catches showed a decline similar to that of trawl net, from 169 tonnes in 1979 to 46 tonnes in 1982, with the catch rate declining from 49 kg in 1979 to 20.5 kg in 1982. All the years *T. dussumieri* was the most abundant species (53-61%), followed by *T. tenuispinis* (15-30%) and *T. serratus* (11-22%). The first and third quarters were the peak periods of landings. As regards the resource abundance, it was almost uniformly distributed off Calicut throughout the year with peak during August-October period. Hooks & line was the most effetive gear. Since different sizes of hooks were used in different branch lines, on a main line, the size selection by this gear was minimised, and all the age groups available in the area were represented in the catch. During the period the hooks & lines landed, on an average, 301 tonnes of catch annually. The total catch remained almost constant throughout. The catch rate also showed little variation between months and years, indicating the continuous abundance of this resource off Calicut. *T. tenuispinis* occurred in high percentages (30-70%), followed by *T. dussumieri* (15-42%), *T. thalassinus* (9-26%) and *T. serratus* (1.4-3.2%). Hooks and line is a gear very effective in the conservation of this resource inasmuch as gestating males and ripe females are never caught by it.

Mangalore: Though there were regular trawl operations in 1979-82, except during the SW monsoon period, along the South Karnataka coast; only in January 1981 about 36 tonnes of catfish were landed, with a catch rate of 3.24 kg per hour of trawling. The traditional drift gill nets operating during the same period, however, landed catfish all through, without much variation (Table 15). The catch by this gear fluctuated from 226 tonnes in 1979 to 489 tonnes in 1980. Annual catch rate has not shown wide fluctuations, except for a slight decline from 1980 onwards. The data on purseseine operations with regard to all-fish total and catfish landings at Mangalore during 1979-82 period are shown in Table 16. Catfish catch by purseseines were in an increasing trend from 1980 to 1982, forming 3.6% to 9.4% of total purseseine catch. September to January was the peak period of abundance along the South Karnataka coast. The catch rate of 220 kg in 1979 declined to 89 kg in 1980, but revived to 202 kg in 1982. The introduction of purse-seine in the South Karnataka had a perceptible influence on the fishery of the region, particularly that of the catfish. The catfish landings increased from an hitherto annual average of 4,000 tonnes to 10,250 tonnes in 1982, creating a need for a continuous monitoring of the fishery in order to ensure a rational exploitation of the stock, especially in view of the large-scale distruction of spawners and gestating males.

Bombay: The bottom-trawl operations of the EEP vessels based at Bombay gave only a discontinous picture of the catfish resource. However, on the available information on catch rates, the catfishes appear to be abundant allthrough except during the S W monsoon. These vessels also had operated purse-seines for a very short period, September-October 1981; of which the landings particulars are illustrated in Fig. 6.

The data on trawl operations (for the period 1980-82) collected at New Ferry Wharf (Table 17), a fishing harbour that has been established recently to accomodate the fishermen coming from Gujarat, indicate that there was a regular increase in the trawling effort from 9,575 units in 1980 to 21,302 units in 1982. There was also a corresponding increase in the total all-fish landings, from 12,070 tonnes to 31,182 tonnes. The catfish landings, too, showed a promising increase, from 240 tonnes to 1,221 tonnes. The catch rates of catfish were between 25 kg and 57 kg, showing an increasing trend from 1980 onwards. The peak landings were during the first and last quarters.

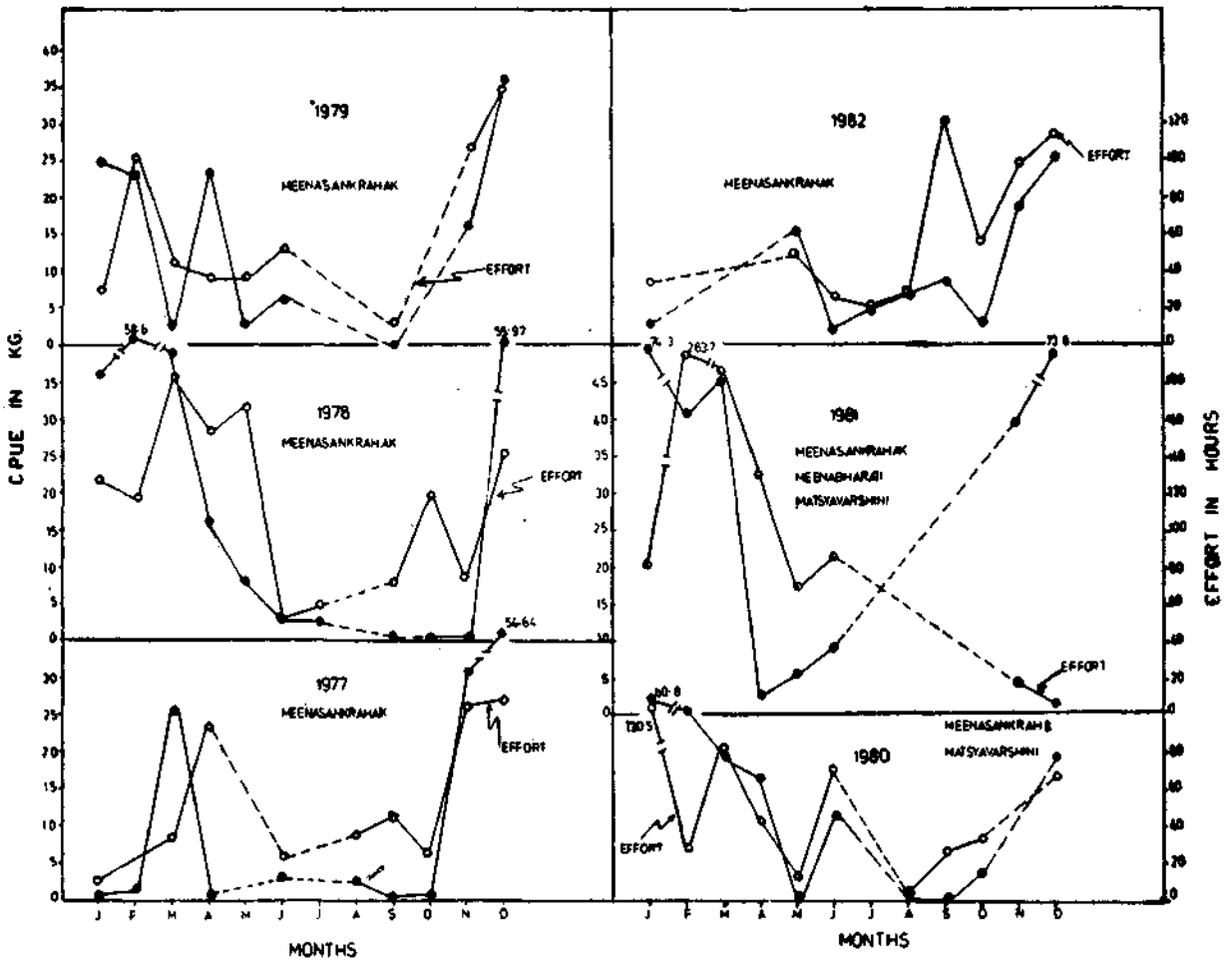


Fig. 6 Catch per unit effort (Bottom trawl) of all catfish landed by EFP Vessels, M. V. Meena Sangrahak, 1977-1982, Meena Bharati, 1981 and Matsya Varshini, 1980-1981 at Bombay.

The details of the catfish landings by trawlers at Sassoon Dock during 1979-82 are shown in Table 18. From the data it is seen that the catfish catches fluctuated during the years, however, with an improving general trend. The catch rates, though with fluctuations, remained fairly high all through the period, except during the SE monsoon, when the population presumably migrates southward. The gill-net operations during 1979-81, however, showed a different picture. The catches were very poor, except in the year 1982 (Table 19). The catch rates during 1979-81 period, too, were extremely low (0.22 kg to 1.5 kg); in 1982, however, coinciding with the total catch, the catch rates rose to 62.2 kg. This is also true in the case of 'Dol' net operations during 1979-82 (Table 20). The very low percentage of catfish in 'Dol' net landings in general may be due to the agility of catfish to avoid this passive gear.

The details of the hooks & line catches and catch rates for the years 1979-82 observed at the Sasson Dock are shown in Table 21. The catfishes formed 50 to 70% of the total catches of this gear, probably on account of the scavenging nature of the fish. The annual trends of both the total catch and the catch rate were slightly increasing over the years, but the monthly trend of catch rate was more or less uniform.

TABLE 2

Details of Landings (All Fish and Catfish) by Private Trawlers in Tonnes at Visakhapatnam During 1979-1982

	January	February	March	April	May	June	July	August	September	October	November	December	Total
1979													
All fish	698	428	313	393	485	401	619	544	321	602	569	559	5912
Catfish	62	79	2	75	29	6	3	22	12	18	9	58	375
% of cat fish	8.88	18.5	0.6	19.1	6.0	1.5	0.5	4.0	3.7	3.0	1.6	10.4	6.3
Effort in units	2680	2546	2093	2585	2724	2805	4492	3839	4003	3033	3349	3870	38019
CPUE of Cat-fish (Kg)	23.1	31.0	0.96	29.0	10.65	2.14	0.67	5.73	3.00	5.93	2.69	14.99	9.86
1980													
All fish													
Catfish	312	820	811	751	1043	370	618	975	732	679	506	434	8051
% of Catfish	40	83	16	0	0	0	2	1	23	14	3	15	197
Effort units	12.82	10.12	1.97	0	0	0	0.32	0.10	3.14	2.06	0.59	3.46	2.45
CPUE of Cat-fish (kg)	2800	4087	2568	1579	2186	2276	3423	4699	3389	3086	2794	2519	35406
	14.28	20.31	6.23	0	0	0	0.59	0.21	6.79	4.54	1.07	5.95	5.56
1981													
All fish	538	878	452	107	293	664	486	755	529	484	486	434	6106
Catfish	25	12	7	2	26	19	20	2	11	13	10	3	150
% of catfish	4 65	1.37	1.55	1.87	8.87	2.86	4.11	0.26	2.08	2.68	2.06	0.69	2.46
Efforts units	3679	3200	2604	746	1566	3275	2776	4692	3206	2164	2010	1717	31635
CPUE in kg	6.79	3.75	2.69	2.68	16.60	5.80	7.20	0.43	3.43	6.01	4.97	1.75	4.73
1982													
All fish	354	922	397	213	269	303	575	853	924	313	690	435	6248
Cat fish	16	19	16	8	5	7	19	34	36	7	28	22	217
% of cat fish	4.52	2.06	4.03	3.75	1.86	2.31	3.30	3.98	3.90	2.24	4.06	5.06	3 47
Effort units	1622	2125	1449	1280	2687	2696	2934	3734	4164	1887	2174	1805	28557
CPUE of Cat fish (Kg)	9.86	8.84	11.04	6.25	1.86	2.60	6.47	9.10	8.64	3.71	12.88	12.19	7.60

TABLE 3

Effort (units) expended, catfish catches in (kgs) C/U, % in all-fish and specise-wise distribution with their percentage occurrence in total catfish catches and Lawson's Bay.

(Unit : Catamaran; Gear : Bottom set gill net; Place : Visakhapatnam; Period : 1972-to 1982)

Particulars	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	All years Total
Effort (units)	8259	8936	3825	4349	1083	4510	10373	5200		5126	8695	60386
Catfish catch (in kg)	19,722	33,536	5,452	18,953	4,674	15,503	4,769	3,582		34,492	4,020	144,693
C/U	2.39	3.75	1.42	4.36	4.32	3.44	0.64	0.69		6.73	0.46	2.40
% in all fish	12.34	20.86	10.80	17.20	18.53	15.64	5.67	10.05		35.14	3.28	14.99
T. thalassinus	6142	7798	2213	9164	2352	4271	1976	1196		2534	2797	40443
% in catfish	31.14	23.25	40.59	48.38	50.32	27.55	41.43	33.39		7.35	69.58	27.95
T. tenuispinis	13580	25738	3239	9779	2322	11232	2793	2386		31958	1223	104250
% in catfish	68.86	76.75	59.41	51.62	49.68	72.45	58.57	66.61		92.65	30.42	72.05

TABLE 4

Effort (Units) expended, catfish catches n kg, C/U, % in all-fish and speciesewise catches with their percentage occurrence in total catfish catches at Lawson's Bay, Visakhapatnam during 1970-1982.

Uuits : Catamaran Gear: Hooks & Line.

Particulars	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	Allyears total
Effort (units)	37600	37646	37212	27785	35100	29960	28023	32201	31497	41248	27090	36628	37479	440469
Catfish catch (kg)	12960	33357	25789	28344	20576	14301	22029	46627	25531	53123	16498	22074	50301	371519
C/U	0.34	0.89	0.69	1.02	0.59	0.48	0.76	1.45	0.81	1.29	0.61	0.60	1.34	0.84
% in all fish	3.20	10.09	8.04	11.20	6.46	6.23	8.93	17.27	7.01	15.67	9.65	10.21	15.60	9.81
T. thalassinus	12484	26149	22690	19453	18862	10263	12263	40724	13324	37386	16423	21322	48264	299609
% in catfish	96.26	78.39	87.98	68.63	91.67	71.76	55.68	87.34	52.19	70.38	99.54	96.59	95.95	80.64
T. tenuispinis	485	7208	3099	8891	1714	4038	9764	5903	12207	15737	75	752	2037	91910
% in Catfish	3.74	21.61	12.02	31.37	8.33	28.24	44.32	12.66	4781	29.62	0.45	3.41	4.05	19.36

TABLE 5

Speciese-wise details of catfish landings (in kg)

Year : 1971 to 1973 Centre : Mandapam Camp Gear : Trawlnet

Month	1971				1972				1973			
	T. thala-sinus catch (kg)	Total catfish catch (kg)	Effort (units)	C/E	*T. thala-ssinus* Catch (kg)	Total Cat-fish catch (kg)	Effort (units)	C/E	*T. thala-sinus* (kgs)	Total Catfish catch (kg)	Effort (units)	C/E (kg)
Jan	1001	1820	292	6.2	563	1250	495	2.5	2586	4880	1155	4.2
Feb	510	1020	254	4.0	2215	4430	1166	3.8	1877	4170	1118	3.7
Mar	2274	3790	543	7.0	2971	4570	1624	2.8	2938	4520	1488	3.0
Apr	5525	8500	584	14.5	8078	10770	1800	6.0	2170	3100	1044	3.0
May	8162	11660	425	27.4	7917	11310	2141	5.3	3485	4710	2318	2.0
June	13846	13846	1313	15.1	9506	13850	3932	3.5	6270	9220	3034	3.0
July	17256	28760	1268	22.7	4713	7250	2281	3.2	3562	5480	1348	4.1
Aug	10689	15270	1196	12.8	1122	1870	941	2.0	1309	1870	914	2.1
Sep	12181	18740	1018	18.4	1205	2410	802	3.0	866	1925	802	2.4
Oct	4490	8980	485	18.5	2196	6275	1256	5.0	1520	3800	1347	2.8
Nov	725	2070	345	6.0	724	1810	706	2.6	8035	25110	917	27.4
Dec	760	1900	581	3.3	778	2160	838	2.6	567	1350	714	1.9
Total	77419	122290	8304	14.7	41988	67955	17982	3.8	35185	70135	16119	4.3

TABLE 6

Speciese-wise catch details of catfish landings (in kg).

Year : 1974 Centre : Mandapam Camp Gear : Trawlnet

Month	*T. thalasinus*	*T. dussu-mieri*	*T. platy-stomus*	*T. caelatus*	*T. tenuispinis*	*T. maculatus*	*O. mili-taris*	Total catfish catch (kg)	Effort (units)	C/E
Jan	1471	1260	248	285	—	—	—	3264	1357	2.4
Feb	1964	1435	460	398	—	—	195	4452	1464	3.0
Mar	6183	3680	674	200	—	250	358	11345	1640	6.9
Apr	540	60	110	62	—	—	—	772	710	1.1
May	610	35	68	—	—	—	—	713	417	1.7
Jun	680	33	123	34	—	—	—	870	600	1.5
Jul	1040	480	284	—	—	—	300	2104	1050	2.0
Aug	1219	985	165	—	—	—	170	2539	978	2.6
Sep	635	1196	113	—	—	—	65	2009	610	3.3
Oct	712	1560	15	—	—	—	—	2287	1100	2.1
Nov	435	945	87	—	—	—	—	1467	640	2.3
Dec	196	649	120	—	73	—	—	1038	375	2.8
Total	15685	12318	2467	179	73	250	1088	32860	10941	3.0

TABLE 7

Speciese-wise catch details of catfish Landings (in kg).

Year : 1975 Centre : Mandapam camp Gear : Trawlnent

Month	*T. thalassinus*	*T. dussumieri*	*T. platystomus*	*T. caelatus*	*T. tenuispins*	*T. maculatus*	*O. militaris*	Total catfish catch	Effort (units)	C/E
Jan	449	246	35	79	70	—	—	879	255	3.5
Feb	1932	1428	126	420	294	—	—	4200	643	6.5
Mar	6495	1990	410	1571	—	—	—	10475	1465	7.2
Apr	7564	1005	431	574	—	1149	718	11441	1185	9.7
May	5365	555	—	1758	—	370	1203	9251	1530	6.1
Jun	7249	735	—	840	—	630	1051	10505	1541	6.8
Jul	4733	444	222	518	296	592	592	7397	1150	6.4
Aug	4046	843	759	1012	674	253	843	8430	1230	6.9
Sep	3032	1410	846	987	282	494	—	7051	1500	4.7
Oct	2014	1802	424	636	318	—	—	5194	775	6.7
Nov	843	—	—	—	—	—	—	842	913	0.9
Dec	1292	—	—	—	—	—	—	1292	781	1.7
Total	45013	10458	3262	8395	1394	3488	4407	76957	12968	5.9
% in total catfish catch	58.5	12.6	4.2	10.9	2.5	4.5	5.7			

TABLE 8

Speciese-wise catch (kg) details of catfish landings (in kg).

Year : 1976 Centre : Mandapam camp Gear : Trawlnet

Month	*T. thala-ssinus*	*T. dussu-mieri*	*T. platy-stomus*	*T. caelatus*	*T. tenui-spinis*	*T. maculatus*	*O. militaris*	Total catfish catch	Effort (units)	C/E
Jan	8296	4060	1412	2118	1412	353	—	17651	1770	10.0
Feb	6113	3804	1630	1359	679	—	—	13585	1400	9.7
Mar	11223	3290	1355	1548	1355	—	—	18771	1290	14.6
Apr	7988	1550	1311	358	238	—	477	11922	1866	6.4
May	3536	343	—	539	—	196	245	4859	2480	10.0
Jun	3348	594	—	432	—	108	918	5400	2730	10.00
Jul	2142	428	122	184	—	—	184	3060	1800	1.7
Aug	5213	2281	869	1738	326	217	217	10861	2280	4.8
Sep	4036	3080	1274	1168	637	425	—	10620	2840	3.7
Oct	5318	5474	2033	2346	469	—	—	15640	2976	5.3
Nov	4056	2839	1014	710	1521	—	—	10140	2526	4.0
Dec	—	—	—	—	—	—	—	—	—	—
Total	61269	27743	11020	12500	6637	1299	2041	122509	23958	5.1
% in total catfish catch	50.0	22.7	9.0	10.2	5.4	1.1	1.7			

TABLE 9

Details of operations of trawlers with respect to all-fish and total catfish landings in tonnes at Cochin fishing harbour during 1979-1982.

1979	January	February	March	April	May	June	July	August	September	October	November	December	Total
All fish	396	433	1035	1057	1557	884	1058	1754	1104	103	687	1324	11392
Catfish	0	0	2	15	8	35	1	0	1	3	9	0	74
% of catfish	0	0	0.19	1.42	0.51	3.96	0.09	0	0.09	2.91	1.31	0	0.65
Effort units	3444	3578	5862	4973	7051	2942	2002	2195	779	476	3140	7383	43825
CPUE (kg) catfish	0	0	0.34	3.02	1.13	11.90	0.50	0	1.28	6.30	2.87	0	1.69
1980													
All fish	804	703	1726	1058	1643	168	171	838	54	14	71	663	7913
Catfish	0	2	95	34	185	0	1	4	2	6	0	3	332
% of catfish	0	0.28	5.50	3.21	11.26	0	0.58	0.48	3.70	42.85	0	0.45	4.20
Effort in units	7278	6067	6679	6400	8800	1175	1148	1814	285	68	638	5744	46096
CPUE (kg) catfish	0	0.33	14.22	5.31	21.02	0	0.87	2.20	7.02	88.23	0	0.52	7.20
1981													
All fish	384	476	431	423	1019	382	1050	1020	1219	0.4	144	513	7160.4
Catfish	1	0	1	5	70	67	74	27	5	0	0	3	253
% of catfish	0.26	0	0.23	1.18	6.88	17.54	7.05	2.65	0.38	0	0	0.58	3.53
Effort unit	4769	5932	5610	4940	6850	2443	3316	1319	1968	4	1984	5182	44317
CPUE of catfish (kg)	0.27	0	0.18	1.01	10.22	27.42	22.32	20.47	2.54	0	0	0.53	5.71
1982													
All fish	304	627	918	664	665	999	816	3279	547	103	450	427	10099
Cat fish	0	2	5	0	10	147	7	50	53	1	6	0	281
% of cat fish	0	0.32	0.54	0	1.04	14.71	0.86	1.52	0.69	0.97	1.33	0	2.78
Effort in units	3187	5152	5020	6465	6751	6004	3126	3752	3440	320	2996	4745	50828
CPUE of cat fish (kg)	0	0.39	1.00	0	1.48	24.48	2.24	13.33	15.41	4.54	2.00	0	5.53

TABLE 10

Details of gillnet (Drift) operations with respect to total all-fish and catfish landings in tonnes at Cochin during 1979-'82

	January	February	March	April	May	June	July	August	Sept-ember	October	Nov-ember	Dec-ember	Total
1979													
All fish	151	126	207	147	658	172	838	1051	881	527	130	120	5008
Catfish	4	10	9	1	9	18	120	435	307	188	5	12	1118
% of catfish	2.65	7.94	4.35	0.68	1.37	10.46	14.32	41.38	34.85	35.67	3.85	10.0	22.32
Effort units	2460	2045	3072	6731	3501	1314	3513	2981	3295	3802	2512	1801	37027
CPUE (kg)	1.63	4.89	2.93	0.15	2.57	13.70	34.16	145.92	93.17	49.45	1.99	6.66	30.19
1980													
All fish	118	99	322	65	352	490	286	282	183	142	192	47	2578
Catfish	10	23	54	0	3	9	60	65	64	48	43	2	380
% of catfish	8.47	23.23	16.77	0	0.57	1.84	20.98	23.05	34.97	33.80	23.39	4.2	14.74
Effort in units	1802	1653	2450	1751	3276	2625	2694	2612	2416	1713	16551	928	40471
CPUE (kg)	5.55	13.91	22.04	0	0.61	3.18	22.27	24.88	26.49	28.02	2.60	2.15	9.38
1981													
All fish	103	99	99	267	261	452	286	323	309	101	128	33	2461
Catfish	28	21	28	4	3	38	68	90	54	32	19	4	389
% of catfish	27.18	21.21	28.28	1.50	1.15	8.41	27.78	27.86	17.47	31.68	14.84	12.12	15.81
Effort in units	1607	1251	1444	1382	2712	2576	2844	2572	2327	1225	1247	760	20947
CPUE (kg)	17.42	16.78	19.39	2.99	1.11	14.75	23.91	34.99	23.21	26.12	15.23	5.26	17.72
1982													
All fish	36	121	143	97	205	271	624	300	252	202	43	59	2353
Catfish	1	2	4	1	0	8	109	97	78	38	4	2	344
% of catfish	2.78	1.65	2.79	1.03	0	2.95	17.46	32.33	30.95	18.81	9.30	3.39	14.62
Effort in units	580	1368	1907	1300	2464	2516	3370	2184	2114	1458	693	655	20609
CPUE (kg)	1.72	1.46	2.10	0.77	0	3.18	32.34	44.41	36.90	26.06	5.77	3.05	16.69

TABLE 11

Details of purse-seine operations with respect to the total all fish and catfish landings in tonnes at Cochin Fisheries Harbour during 1979-1982.

1979	January	February	March	April	May	June	July	August	September	October	November	December	Total
All fish									126	369	531	7	1841
Catfish									0	4	0	0	4
% of catfish			No operation						0	1.08	0	0	0.22
Effort in units									60	201	279	280	820
CPUE (kg)									0	19.9	0	0	4.88
1980													
All fish	742	762	1035	917	1002	—	—	—	1224	4255	2244	2677	14858
Catfish	0	0	6	0	0	—	—	—	41	0	0	0	47
% of catfish	0	0	0.58	0	0	—	—	—	3.35	0	0	0	0.32
Effort in units	297	382	592	1009	810	—	—	—	1020	2258	1554	1658	9580
CPUE (kg)	0	0	10.13	0	0	—	—	—	40.20	0	0	0	4.91
1981													
All fish	1916	2418	1499	1136	1831	—	—	—	860	3264	3343	1187	17454
Catfish	0	57	0	0	25	—	—	—	52	—	—	—	134
% of catfish	0	2.36	0	0	1.36	0	0	0	6.05	0	0	0	0.77
Effort units	901	810	680	810	844	—	—	—	983	1253	1193	1396	8870
CPUE (kg)	0	70.37	0	0	29.62	0	0	0	52.90	0	0	0	15.11
1982													
All fish	2113	2570	745	898	515	—	—	—	2196	1540	124	588	11289
Catfish	0	0	0	0	33	—	—	—	37	4	0	0	74
% of catfish	0	0	0	0	6.41	0	0	0	1.68	0.26	0	0	0.65
Effort units	1332	1108	625	1291	1145	—	—	—	1108	1140	392	525	8675
CPUE (kg)	0	0	0	0	28.82	0	0	0	33.39	3.48	0	0	8.53

TABLE 12

Year: 1979 Specieswise catfish catch details at Calicut Gear: Trawlnet

	T. thalassi-nus	T. dussu-mieri	T. tenuis pinis	T. serr-atus	Total	Effort (units)	(CPUE Kg)
Jan	—	600	18134	—	18734	1843	10.2
Feb	—	194	51773	—	51927	1982	26.2
Mar	—	2006	15969	—	17975	1638	11.0
Apr	—	20011	187	62	20260	1297	15.6
May	—	1903	—	—	1903	334	5.7
Jun	—	—	—	—	—	35	0.0
Jul	No operation						
Aug	-do-						
Sep	-do-						
Oct	-do-						
Nov	-do-					7	0.0
Dec	-do-					1234	0.0
Total	—	24714	86023	62	110799	8370	13.2
%	0	22.3	77.6	0.06			
Year: 1981							
Jan	—	—	5222.0	—	5222.0	1335	3.9
Feb	—	—	645.2	—	645.2	536	1.2
Mar	—	—	2660 8	—	2660.8	858	3.1
Apr	—	—	311.5	—	311.5	424	0.7
May	—	—	1732.7	—	1732.7	313	5.5
June to September	No operation.						
Oct	—	—	No catch			195	0.0
Nov	—		-do-			313	0.0
Dec	—	—	821.5	—	821.5	927	0 9
Total	—	—	11393.7	—	11393.7	4901	2.3
%	—	—	100				
Year 1982							
January to October	no data available.						
Nov	—	—	1425.0	—	1425.0	642	2·2
Dec	—	—	170.5	—	170.5	718	0.2
Total	—	—	1595.5	—	1595.5	1360	1.2
%	—	—	100	—			

TABLE 13

Year: 1979 Specieswise catfish catch details at Calicut. Gear: Driftnet

Month	T. thalassi-nus	T. dussu-mieri	T. tenuis-pinis	T. serr-atus	Total	Effort (UNITS)	CPUE
Jan	513	12324	417	1689	14943	506	29.5
Feb	240	29365	1096	1239	31940	564	56.6
Mar	—	4893	—	484	5377	223	24.1
Apr	—	477	--	—	477	25	19.1
May	170	312	—	1282	1764	68	25.9
Jun	230	34	—	204	468	19	24.6
Jul	No catch						
Aug	1737	5192	1073	1446	9448	151	62.6
Sep	11340	11471	29077	802	52690	387	130.2
Oct	3526	15861	6001	7383	32771	493	66.5
Nov	39	1334	36	2183	3592	334	10.8
Dec	—	12328	891	2291	15510	691	22.5
Total	17795	93591	38591	19003	168980	3462	48.8
%	10.5	55.4	22.8	11.3			
Year: 1981							
Jan	—	23097.1	555.9	3748.9	27401.9	673	40.7
Feb	—	2807.0	317.8	—	3124.8	386	8.1
Mar	—	2620.0	166.1	—	2786.1	271	10.3
Apr	—	1493.2	—	121.2	1614.3	190	8.5
May	—	1706.3	155.0	117.5	1978.8	189	10.5
Jun	—	315.0	—	240.0	555.0	19	29.2
Jul	—	543.5	22.0	146.3	711.8	114	6.2
Aug	—	2320.5	941.5	1211.9	4473.9	173	25.9
Sep	168.4	12162.5	12630.7	3747.6	29709.2	453	65.6
Oct	524.0	9086.0	2350.8	3144.9	15105.7	471	32.1
Nov	74.7	6975.5	26.7	8719.6	15796.5	597	26.5
Dec	18.3	4326.1	67.8	3759.0	8171.2	634	12.9
Total	785.4	68452.6	17234.3	24956.9	111629.2	4170	26.8
%	0 7	61.3	15.4	22.4			
Year: 1982							
January to June No data available.							
Jul	—	—	—	260.0	260.0	161	16.3
Aug	100.4	2100.0	3100.0	1029.0	6329.4	231	27.4
Sep	192.0	3869.0	10181.0	4152.0	18394.0	269	68.4
Oct	—	5080.6	282.4	1503.5	6866.5	676	10.2
Nov	—	2113.4	1030.0	643.8	2060.2	394	7.3
Dec	—	10899.5	65.9	186.0	11151.4	647	17.2
Total	292.4	24062.5	13732.3	7774.3	45861.5	2233	20.5
%	0.6	52.5	29.9	17.0			

TABLE 14

Year : 1979 *Specieswise catfish catch particulars at Calicut*

Gear : Hook & line

Month	T thala-ssinus	T. dussu-mieri	T. tenuis-pinis	T. serra-tus	Total	Effort (units)	CPUE
Jan	2902	9347	6442	72	18763	182	103.1
Feb	807	6582	6211	—	13600	94	144.7
Mar	501	27755	1124	—	29380	144	204.0
Apr	706	19035	—	—	19741	145	136.1
May	16866	14486	—	75	31427	242	129.9
Jun	240	1896	—	8055	10191	93	109.6
Jul	—	18	—	81	99	16	6.2
Aug	7634	6632	2341	1034	17641	99	178.2
Sep	35517	9024	30351	1114	76006	293	259.4
Oct	21387	11456	20358	388	53589	277	193.5
Nov	1183	10565	3238	45	15031	96	156.6
Dec	1032	26316	31335	88	58771	366	160.6
Total	88775	143112	101400	10952	344239	2047	168.2
%	25.8	41.6	29.5	3.2			
Year :	1981						
Jan	1741.1	8819.5	21222.7	—	31783.3	167	190.3
Feb	—	35037.3	22110.6	186.7	57334.6	299	191.8
Mar	—	12592.7	9006.8	138.7	21738.2	173	125.7
Apr	27.7	10443.5	1802.3	—	12273.5	103	119.2
May	—	10643.5	—	558.7	11201.9	104	107.7
Jun	—	274.0	—	342.5	616.5	26	23.7
Jul	517.5	502.5	—	136.5	1156.5	25	46.3
Aug	264.0	828.3	5775.0		6867.3	51	134.7
Sep	8603.0	4907.3	62397.3	197.1	7610.47	284	267.97
Oct	2490.4	2615.1	41559.4	—	46664.9	243	192.0
Nov	19833.6	9837.0	23171.9	1585.9	54428.4	306	177.9
Dec	9538.7	4981.2	13462.0	1742.3	29724.2	285	104.3
Total	143016.0	101484.6	200504.0	4888.4	349893.0	2066	169.36
%	12.3	29.0	57.3	1.4			
Year :	1982						
January to June No data available							
Jul	—	—	—	4768.5	4768.5	81	58.9
Aug	2022.0	9400.4	16000.0	—	27422.4	197	139.2
Sep	5764.0	15268.0	56748.0	540.0	78320.0	404	193.9
Oct	—	93.3	53222.8	—	53316.1	334	159.6
Nov	12596.6	892.1	16080.3	322.0	29891.0	232	128.8
Dec	—	7138.4	15207.4	—	22345.8	162	137.9
Total	20382.6	32792.2	157258.5	5630.5	210063.8	1410	153.3
%	9.4	15.2	72.8	2.6			

TABLE 15

Details of drift gillnet operations in respect of total all fish and catfish landings along the South Kanara coast during 1979-1982.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
1979													
All fish									112.6	393.9	320.9	452.8	1280.2
Catfish % of									24.4	149.7	25.1	26.9	226.1
catfish Effort			-No data-						21.7	38.1	7.8	5.9	17.7
in units									420	4103	4041	4200	226080
CPUE (kg)									58.1	36.5	6.2	6.4	17.7
1980													
Aff fish	400.6	210.8	180.4	—	No fishing operation			—	338.8	736.0	409.2	489.9	2760.7
Catfish	74.8	36.0	41.3		—				58.6	96.5	52.4	129.7	489.3
% of catfish	18.7	17.1	22.9		—				17.6	13.1	12.8	26.5	17.7
Effort in units	4484	3968	2592		—				2860	6339	5729	6375	26609
CPUE (kg)	16.7	9.1	15.9		—				20.5	15.2	9.2	20.3	18.4
1981													
All fish	505.9	207.4	148.9	30.7	— No fishing operation			—	57.9	593.4	606.1	365.6	2515.9
Catfish	188.8	39.9	18.1	4.9	—				20.5	44.7	83.5	67.4	467.8
% of catfish	37.3	19.2	12.2	15.8	—				35.4	7.5	13.8	18.4	18.6
Effort in units	6646	4200	1985	360	—				994	5892	7307	7054	34438
CPUE (kg)	28.4	9.5	9.1	13.5	—				20.6	7.6	11.4	9.6	12.6
1982													
All fish	378.6	152.2	29.0	—	No fishing operation			—	388.4	612.9	479.0	441.4	2481.5
Catfish	96.3	48.8	13.5		—				50.3	85.0	25.5	49.2	366.6
% of catfish	25.4	30.8	46.7		—				13.0	13.9	5.3	11.2	14.8
Effort in units	7876	4150	1475						2365	7211	6287	6832	36196
CPUE in kg	12.2	11.3	9.2		—				21.3	11.8	4.1	7.2	10.1

TABLE 16

Details of purse-seine operations with respect to total all-fish and catfish landings in tonnes at Mangalore during 1979-1982.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
1979													
All fish	2201	2153	3678	4499	1989	1140	—	—	6842	17645	10587	9908	60642
Catfish	24	0	18	413	0	0	—	—	143	166	258	4261	5383
% of catfish	1.09	0	0.49	9.18	0	0	0	0	2.09	0.94	2.44	43.01	8.81
Effort in units	2354	219	2206	2636	170	533	—	—	2717	6311	3612	3268	24026
CPUE in (kg)	10.19	0	8.16	156.68	0	0	0	0	52.63	26.30	71.43	1303.85	219.89
1980													
All fish	6298	3565	2615	3558	1255	—	—	—	13581	13571	14053	7072	65568
Catfish	710	23	204	78	0	0	—	—	560	614	174	9	2372
% of catfish	11.27	0.64	7.80	2.19	—	—	—	—	4.12	4.52	1.24	0.13	3.62
Effort in units	3181	1335	1608	1968	1302	—	—	—	4984	4032	4699	3501	16610
CPUE (kg)	223.20	17.23	126.86	39.63	0	0	0	0	112.36	152.28	37.03	2.57	89.14
1981													
All fish	5157	2352	2655	2560	1000	328	—	—	9874	14217	18176	19972	76309
Catfish	0	26	162	69	0	0	—	—	298	2904	40	1188	4687
% of catfish	0	1.11	6.10	2.69	0	0	0	0	3.02	20.43	0.22	5.95	6.14
Effort in units	5996	4113	4828	4706	3920	1645	—	—	5160	5419	6146	5914	47845
CPUE (kg)	0	6.32	33.55	14.66	0	0	0	0	57.75	535.89	6.51	200.88	97.96
1982													
All fish	12916	4850	3089	4466	6482	—	—	—	11617	14649	6533	1106	65708
Catfish	494	616	138	334	3149	—	—	—	273	1127	11	0	6142
% of catfish	3.82	12.70	4.47	7.48	48.58	0	0	0	2 35	7.69	0.17	0	9.35
Effort in units	4502	1948	1970	2334	3222	—	—	—	5203	6386	5575	1202	30342
CPUE (kg)	109.75	316.21	70.05	143.10	977.34	0	0	0	57.47	176.48	3.08	0	202.43

TABLE 17

Details of operations of trawlers with respect to total all-fish and catfish landings in tonnes at New Ferry Warf (Bombay) during 1980-1982.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
1980													
All fish	—	—	—	—	—	—	30	78	2561	2982	3143	3276	12070
Catfish	—	—	—	—	—	—	1	4	28	18	133	56	240
% of catfish	—	—	No operation		—	—	3.33	5.13	1.09	0.60	4.23	1.71	1.09
Effort in units	—	—	—	—	—	—	109	155	2050	2403	2299	2559	9575
CPUE (kg)	—	—	—	—	—	—	9.17	25.81	13.66	7.49	57.85	21.88	25.06
1981													
All fish	2642	2213	2103	3072	1980	66	6	83	1123	2349	2021	2530	20189
Catfish	60	69	68	67	68	3	1	3	50	39	105	86	619
% of catfish	2.27	3.12	3.23	2.18	3.43	4.54	16.67	3.61	4.45	1.66	5.19	3.40	3.07
Effort in units	2196	1925	1988	2667	1972	116	10	111	1549	2220	1870	2346	18970
CPUE (kg)	27.32	35.84	34.20	25.12	34.48	25·86	100.00	27.03	32.28	17.57	56.15	36.66	32.63
1982													
All fish	3129	2197	2066	1986	880	234	32	84	3514	5938	4906	6216	31182
Catfish	152	283	69	76	18	19	3	6	114	185	197	199	1221
% of catfish	4.86	8.33	3.34	3.83	2.04	8.12	9.37	7.14	3.24	3.11	4.01	3.20	3.92
Effort units	2682	2058	2019	2537	1511	278	116	142	2483	2840	1791	2845	21302
CPUE (kg)	56.67	88.92	34.17	29.96	11.91	68.34	25.86	42.25	45.91	65.14	110.00	69.95	57.32

TABLE 18

Details of operations of trawlers with respect to total all-fish and catfish landings in tonnes at Sasoon dock (Bombay) during 1979-1982.

	January	Feb-ruary	March	April	May	June	July	August	Sept-ember	Oct-ober	Nov-ember	Dec-ember	Total
1979													
All fish	2852	2063	1947	2059	2098	1113	1000	1102	2499	3069	2496	2285	24583
Catfish	214	92	355	121	136	41	64	101	28	138	204	124	1618
% of catfish	7.50	4.46	18.23	5.88	6.44	2.68	6.4	9.16	1.12	4.50	8.17	5.43	6.58
Effort units	3115	2261	2144	2816	2497	1710	1287	1687	2150	2625	2223	2043	26160
CPUE (kg)	68.70	40.69	165.58	42.97	54.76	23.98	47.73	78.35	13.02	52.57	91 77	60.69	61.85
1980													
All fish	2526	1830	1947	1786	1208	430	603	1038	821	1422	2129	2309	18139
Catfish	333	407	442	252	79	34	49	83	69	87	122	127	2084
% of catfish	13.18	22.24	22.70	14.11	6.54	7.91	7.07	8.00	8.40	6.12	5.73	5.50	11.49
Effort units	2076	1755	1834	1930	1958	880	1421	1802	1756	1536	2060	2458	21466
CPUE (kg)	160.41	231.91	241.00	130.57	40.35	38.64	34.48	46.05	39.29	56.64	59.22	51.67	97.08
1981													
All fish	1714	1330	1764	1758	1498	1372	552	1062	1205	2581	1912	2839	19587
Catfish	124	102	251	184	170	134	47	89	94	208	155	164	1722
% of catfish	7.23	7.67	14.23	10.47	11.35	9.77	8.51	8.38	7.80	8.06	8.11	5.78	8.79
Effort units	1953	1810	1703	1748	2009	1805	1010	1853	1666	2222	1605	2147	21540
CPUE (kg)	63.49	56.39	147.39	105.26	84.62	74.24	46.12	48.03	56.42	93.61	95.57	76.38	79.94
1982													
All fish	2066	3356	2315	2817	3131	1934	2970	2860	4250	4302	3000	3890	36891
Cat fish	191	403	27	404	380	134	175	171	221	227	181	389	2903
% of catfish	9.24	12.01	1.17	14.34	12.14	6.93	5.89	5.98	5.20	5.28	6.03	10.00	7.87
Effort in units	2221	2633	1792	1960	2195	1522	1977	1784	2380	2391	1400	2565	24810
CPUE (kg)	86.00	153.64	15.07	206.12	173.12	88.04	88.52	95.85	92.86	94.94	129.28	151.66	117.01

TABLE 19

Details of gillnet operations with respect to total all-fish and catfish landings in tonnes at Sasoon dock (Bombay) during 1979-82

	January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total
1979													
All fish	202	71	25	76	49	44	—	31	159	259	121	190	1227
Catfish	5	—	—	1	—	—	—	—	—	—	—	—	6
% of catfish	2.47	0	0	1.31	0	0	0	0	0	0	0	0	0.49
Effort in units	1436	238	48	188	114	125	—	128	657	555	180	338	4017
CPUE (kg)	3.48	0	0	5.30	0	0	0	0	0	0	0	0	1.49
1980													
All fish	179	88	74	64	95	9	0	19	36	125	103	141	933
Catfish	0	0	0	0	0	0	0	0	1	2	0	0	3
% of catfish	0	0	0	0	0	0	0	0	2.78	1.60	0	0	0.32
Effort in units	334	198	224	193	322	33	0	92	240	369	280	360	2465
CPUE (kg)	0	0	0	0	0	0	0	0	4.17	5.42	0	0	1.13
1981													
All fish	154	182	141	80	57	50	0	49	97	371	290	261	1732
Catfish	1	0	0	0	0	0	0	0	0	0	0	0	1
% of catfish	0.65	0	0	0	0	0	0	0	0	0	0	0	0.06
Effort in units	434	536	347	232	279	145	0	141	300	832	725	562	4533
CPUE (kg)	2.30	0	0	0	0	0	0	0	0	0	0	0	0.22
1982													
All fish	278	275	217	260	247	117	0	3	252	288	127	387	2451
Catfish	0	52	27	52	31	14	0	0	19	17	6	30	248
% of catfish	0	18.91	12.44	20.0	12.55	11.97	0	0	7.54	5.90	4.72	7.75	10.12
Effort in units	658	476	372	387	409	206	0	12	380	407	190	492	3989
CPUE (kg)	0	109.24	72.59	134.37	75.79	67.96	0	0	50.00	41.77	31.58	60.97	62.17

TABLE 20

Details of Dol-net operations with respect to total all-fish and catfish landings in tonnes at Sasoon dock (Bombay) during 1979-1982.

	January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total
1979													
All fish	232	243	144	195	204	116	163	96	303	511	136	52	2405
Catfish	10	—	—	—	—	3	—	—	—	1	—	—	14
% of catfish	4.31	0	0	0	0	2.59	0	0	0	0.20	0	0	0.58
Effort units	716	910	851	1020	1210	795	1634	724	1200	1443	640	434	11577
CPUE (kg)	13.97	0	0	0	0	3.77	0	0	0	0.69	0	0	1.21
1980													
All fish	121	102	54	46	176	83	160	201	231	159	88	146	1567
Catfish	0	0	0	0	0	0	0	1	7	0	0	0	8
% of catfish	0	0	0	0	0	0	0	0.50	3.03	0	0	0	0.51
Effort in units	860	1048	784	670	1156	1088	1437	1518	654	1188	1020	1139	12562
CPUE (kg)	0	0	0	0	0	0	0	0.66	10.70	0	0	0	0.64
1981													
All fish	84	147	101	165	211	197	140	163	184	332	81	120	1925
Catfish	0	0	0	0	0	0	0	0	0	0	4	0.1	4.1
% of catfish	0	0	0	0	0	0	0	0	0	0	4.94	0.08	0.21
Effort in units	818	990	984	1204	1066	1165	1581	1474	1417	1969	475	856	13399
CPUE (kg)	0	0	0	0	0	0	0	0	0	0	8.42	0.12	0.29
1982													
All fish	126	278	229	227	334	159	110	138	211	117	207	125	2261
Catfish	0	0	0	0	0	0	7	0	0	0	0	0	7
% of catfish	0	0	0	0	0	0	6.36	0	0	0	0	0	0.31
Effort in units	1116	869	661	930	1183	718	1139	1232	1426	1021	1130	1094	12519
CPUE (kg)	0	0	0	0	0	0	6.14	0	0	0	0	0	0.56

TABLE 21

Details of Hooks & line operations with respect to total all-fish and catfish landings at Sasoon Dock (Bombay) during 1979–82.

	January	February	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total
1979													
All fish	57	96	21	3	18	—	—	2	3	—	13	47	260
Catfish	45	55	11	1	8	—	—	1	2	—	10	31	164
% of catfish	78.95	57.29	52.38	33.33	44.44	—	—	50.00	66.67	—	76.92	65.96	63.08
Effort units	190	331	58	8	279	—	—	8	13	—	47	131	51065
CPUE (kg)	236 8	166.16	189.6	125.0	28.67	—	—	125.0	153.8	—	212.77	236.6	153.99
1980													
All fish	59	40	14	16	6	1	1	3	0	4	12	29	185
Catfish	36	14	4	7	2	1	1	2	0	4	9	21	101
% of catfish	61.02	35.0	28.57	43.75	33.33	100.00	100.00	66.67	0	100.0	75.00	72.41	54.59
Effort units	190	137	55	73	27	3	10	16	0	24	90	160	785
CPUE (kg)	189.47	102.19	72.73	95.89	74.07	333.3	100.0	125.0	0	166.66	100.0	131.25	128.66
1981													
All fish	56	43	56	24	1	0	0	2	4	34	84	55	359
Catfish	34	32	44	13	17	0	0	1	4	24	62	38	253
% of catfish	60.71	74.42	78.57	54.17	100.0	0	0	50.00	100.00	70.59	73.81	69.09	70.47
Effort in units	362	2220	227	112	7	0	0	14	27	176	315	217	1677
CPUE (kg)	93.92	145.45	193.83	116.07	142.86	0	0	71.43	148.15	136.36	196.83	175.11	150.86
1982													
All fish	146	81	63	39	26	15	10	9	28	31	10	62	520
Catfish	109	47	26	13	9	4	8	7	15	10	7	20	275
% of catfish	74.66	58.02	41.27	33.33	34.61	26.67	80.00	77.77	53.57	32.26	70.00	32.26	52.88
Effort units	524	238	179	124	79	73	86	85	110	137	80	248	1963
CPUE (kg)	208.01	197.48	145.25	104.84	113.92	54.79	93.02	82.35	136.36	72.99	87.5	80.64	140.09

TABLE 22

Details of operation of private fishing trawlers with respect to total all-fish landings and total catfish landings in tonnes at Veraval during 1980-1982.

	Janu.	Febr.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.	Total
1980													
All fish	7572	12562	8402	11282	1950	—	—	—	12	2135	5166	2495	51576
Catfish	200	150	28	132	260	—	—	—	—	16	21	—	807
% of catfish	2.64	1.19	0.33	1.17	13.33	—	—	—	0	0.75	0.41	0	1.54
Effort in units	9976	5376	10156	14040	5487	—	—	—	30	2201	9510	8928	65704
CPUE of catfish (kg)	20.05	27.90	2.76	9.40	47.38	—	—	—	0	7.27	2.21	0	12.28
1981													
All fish	7328	6510	3719	5707	5560	0	0	0	1244	1847	7884	6306	46105
Catfish	66	18	0	57	54	0	0	0	5	24	90	121	435
% of catfish	0.90	0.28	0	1.00	0.97	0	0	0	0.40	1.30	1.14	1.92	0.94
Effort units	13516	9296	7006	10260	8496	0	0	0	1200	2400	17550	4619	74343
CPUE of catfish (kg)	4.88	1.94	0	5.55	6.36	0	0	0	4.17	10.00	5.13	26.20	5.85
1982													
All fish	3303	4930	4661	12791	2749	13	0	0	2182	8481	3563	4230	46903
Catfish	92	11	7	193	97	1	0	0	476	192	8	33	1110
% of catfish	2.78	0.22	0.15	1.51	3.53	7.69	0	0	21.81	2.26	0.22	0.78	2.37
Effort in units	5368	8590	7626	12791	6200	30	0	0	4950	13980	7757	9357	76649
CPUE of catfish (kg)	17.14	1.28	0.92	15.09	15.64	33.33	0	0	96.16	13.73	1.53	3.53	14.48

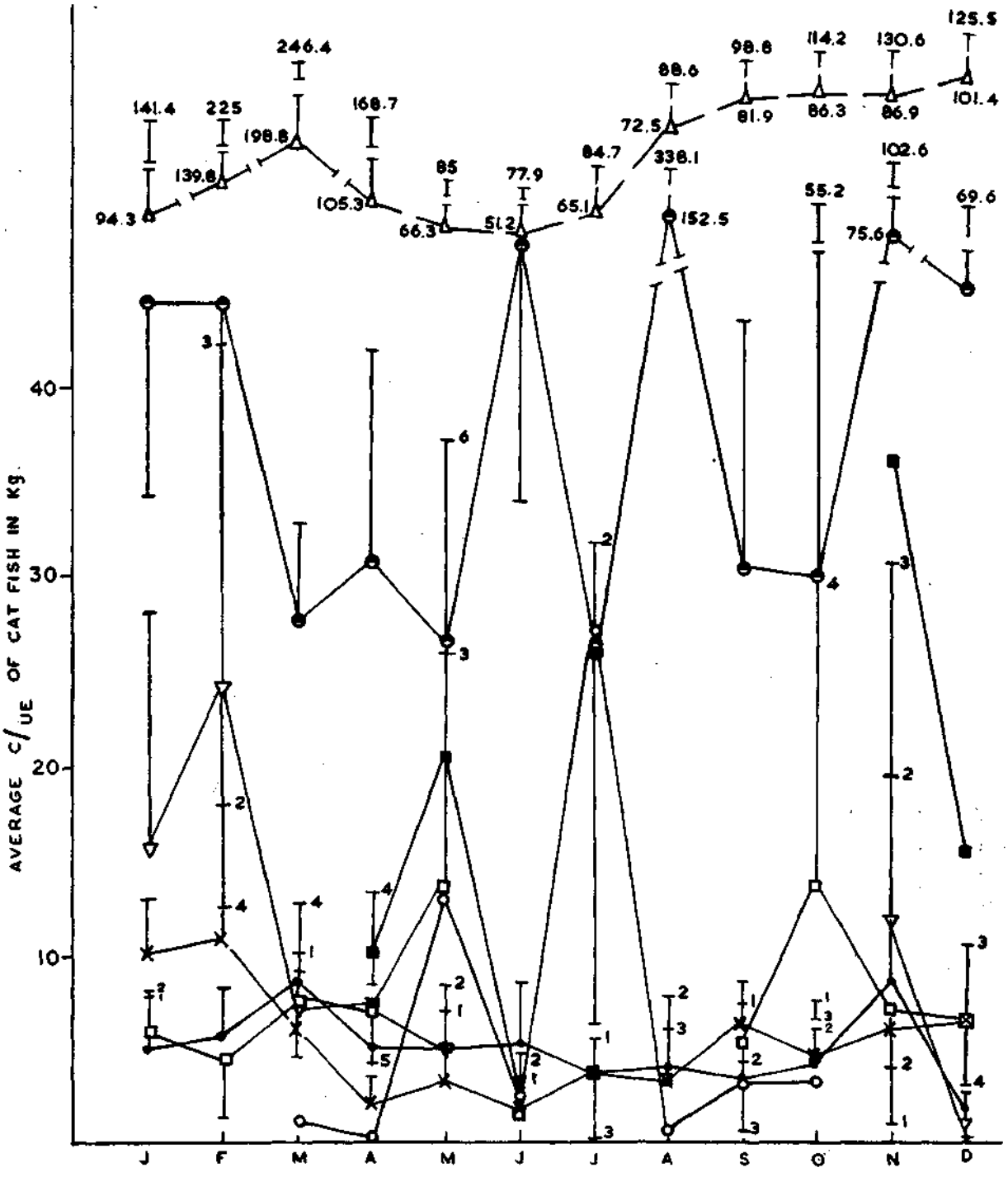


Fig. 7 Centre-wise average catch per unit effort of catfish landed by trawlers during different months

Veraval : At Veraval, the most important fishing centre along the Gujarat coast, catfishes are mainly caught by trawlers and drift gill nets. The details of the trawl operations, with the catch figures and catch rates, for 1980-82 are given in Table 22. The trawl fishery was good throughout the period except during SW monsoon, thecatfishes form 0.9 to 2.4% of the total landing. Though the resource was increasing during the years except 1981, there appears to be no definite season for the fishery, as better catches were recorded in different months without any regularity. The catch statistics

of gill nets (Table 23) also showed a similar condition. The all-fish and catfish landings were high in 1980 and 1982. In drift net, too, catfishes occurred almost round the year, except in July and August, with good catch rates.

SPECIES COMPOSITION

The catfish resource being a multispecies one with regional variations in composition, representative centres from each maritime state have been selected for this study. While few species are commonly available along both the coasts, there are others which are restricted in distribution. As on the information collected from these centres, the species composition in the different regions are discussed below.

North East Region: The fishery in the NE region, comprising W. Bengal, Orissa and Andhra coasts, is mainly supported by two species, namely *T. thalassinus and T. tenuispinis*. Other species of commercial importance are *T. dussumieri, T. maculatus, T. jella, T. caelatus* and *Osteogeneiosus militaris*, the last four species being more abundant along the West Bengal and Orissa coasts. Along Andhra coast, *T. thalassinus* and *T. tenuispinis* commonly occur in the trawl catches. At Visakhapatnam *T. thalassinus* and *T. tenuispinis* are the two species contributing considerably, on an average 67.1% and 32.9%, respectively (Table 24, 25 and 26). In the hooks & line landings, too, *T. thalassinus* is dominant; however, the bottom-set gill net showed a different picture, where *T. tenuispinis* is major contributor. On the whole, it may be stated that these two species contribute to the catches along the NE region.

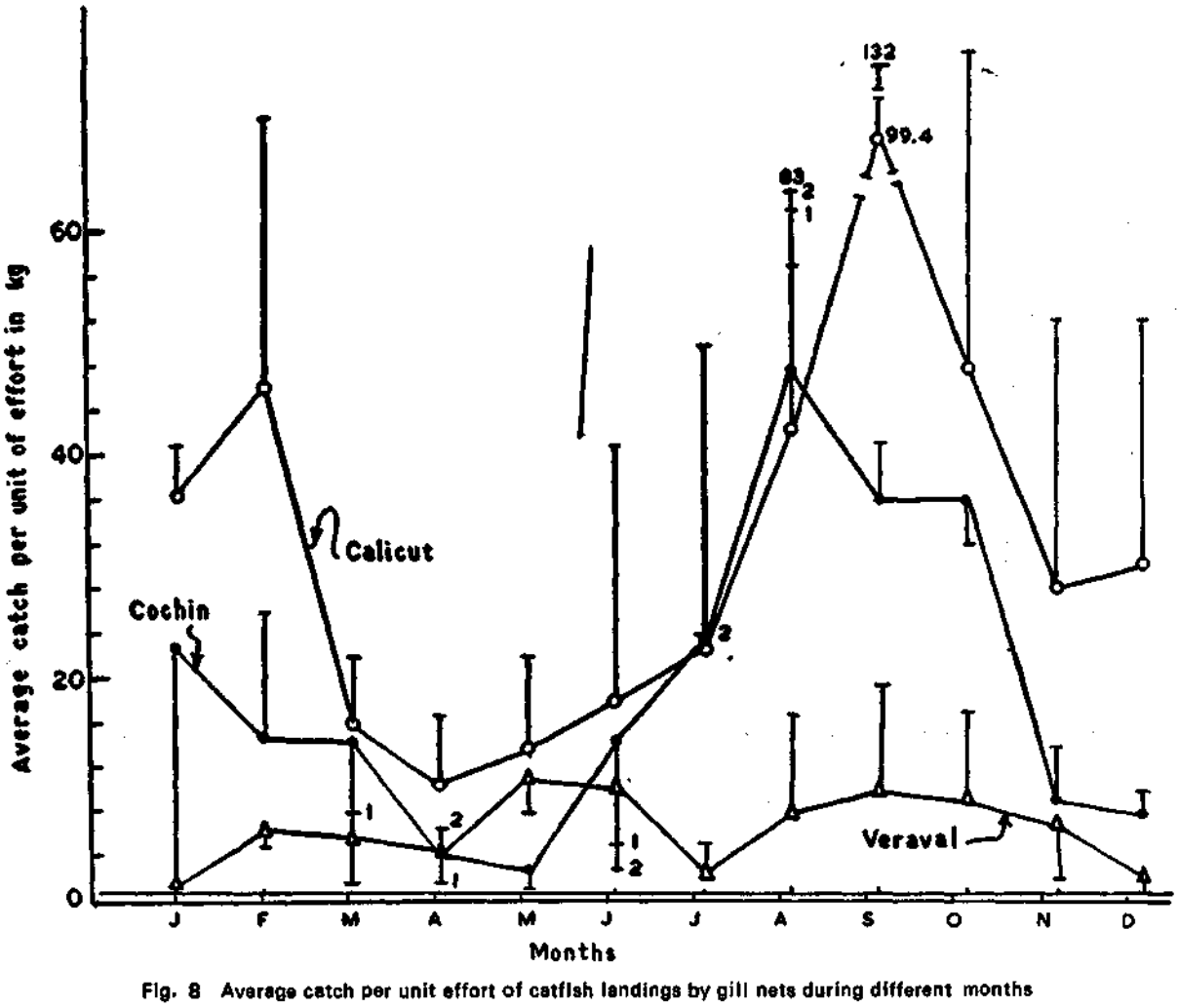


Fig. 8 Average catch per unit effort of catfish landings by gill nets during different months at Veraval, Calicut and Cochin.

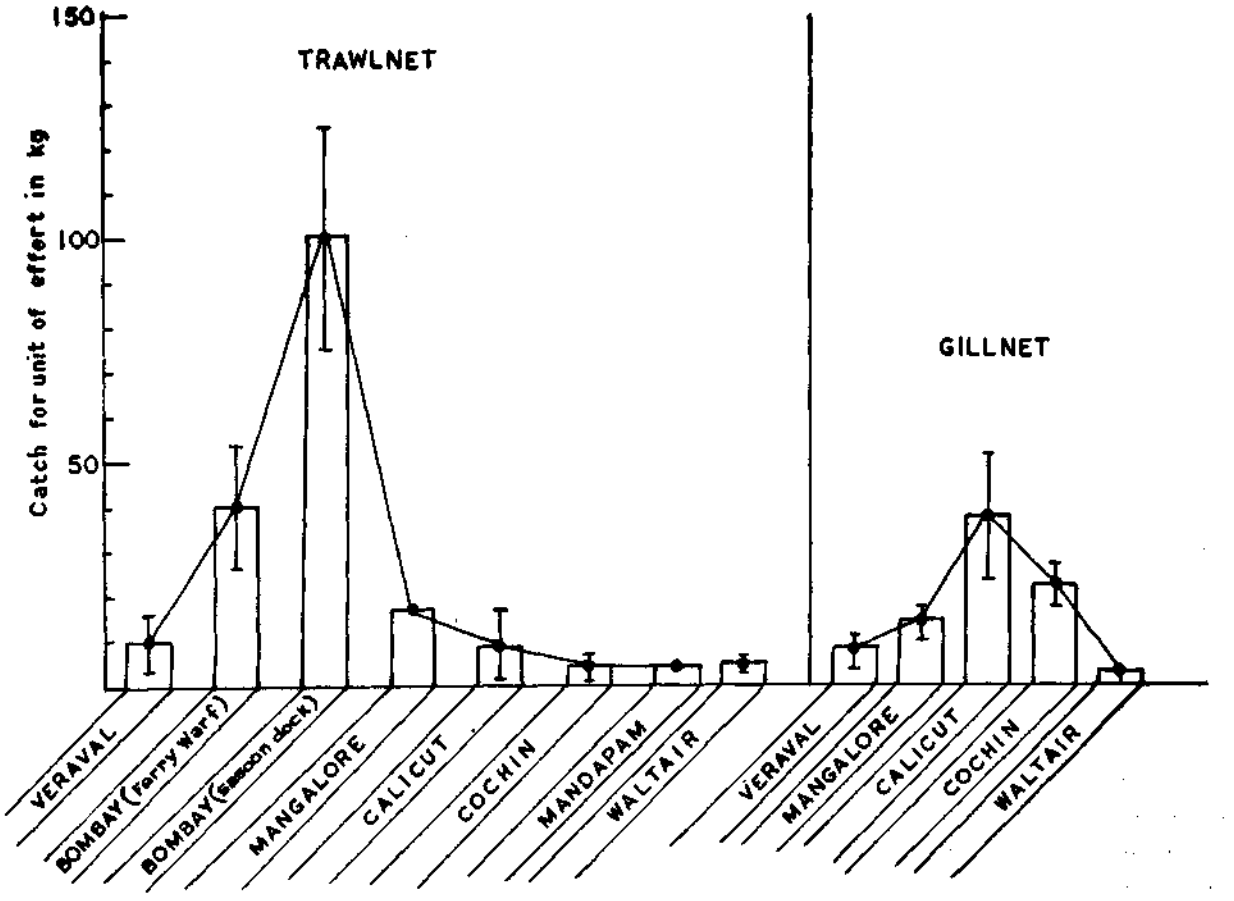


Fig 9 Gear-wise annual average catch per unit effort of catfish landings at different centres.

South East Region

Of the several species of catfishes occurring in the catches along the southeast coast of India, only a few species are economically important, forming substantial fishery at one centre or the other. Though eight species occur along the Palk Bay and Gulf of Mannar, only *T. thalassinus* (50%) *T. dussumieri, T. caelatus* and *T. platystomus* are the regular components of trawl catches. Species such as *T. thalassinus T. maculatus* and *O. militaris* are common in Palk Bay, whereas *T. platystomus* is abundant in the Gulf of Mannar. In the drift net catches the dominant species are *T. dussumieri* and *T. caelatus.*

South West Region

The major species contributing to the fishery in SW region, comprising Kerala and Karnataka coasts, are *T. thalassinus, T. tenuispinis, T. dussumieri* and *T. serratus.* However, occasionally *T. maculatus* is also recorded in large quantities from nearshore waters. The abundance of various species differ seasonally and from gear to gear. Along southern Kerala, *T. thalassinus* and *T. serratus* are common in hooks & line and drift net landings. In trawl-net catches *T. tenuispinis* and *T. thalassinus* are the most common species along both Cochin and Calicut, whereas *T. dussumieri* and *T. tenuispinis* dominate in the catches from southern Karnataka (Table 28 & 29) The species composition sometimes varies from year to year, depending on the availability and the migration of shoals (Table 25). The drift gill nets show altogether a different trend, in that *T. dussumieri* and *T. tenuispinis* are common along northern Kerala, as against *T. thalassinus, T. dussumieri* and *T serratus,* the major species caught at Cochin (Tables 26 & 27). In South Karnataka *T. surratus, T. tenuispinis* and *T. dussumieri* are the major contributors in the gill-net catches (Table 30). The hooks & line catches of northern Kerala are mostly of *T. tenuispinis,* next in abundance being *T. thalassinus* and *T. dussumieri.*

North West Region

A number of species, such as *T. thalassinus*, *T. dussumieri*, *T. tenuispinis*, *T. sona*, *T. caelatus*, *T. maculatus* and *O. militaris* occur along North-west Region. The yield of different species in trawl net varies from year to year; however, *T. dissumieri* and *O. militaris* are commonly caught by trawl net at Veraval (Table 31, 32 and 33). Similarly, in drift net also there are yearly fluctuations in species dominance, but in general *T. dussumieri* makes the major contribution (Table 34, 35, 36). Of the six species of catfishes occurring along the Maharashtra coast, *T. sona* contributes about 60% to the catfish catch (Singh and Rege, 1968), *T. dussumieri*, *T. tenuispinis*, *T. serratus* and *T. thalassinus* in decreasing order contribute to the catches of different gears operated along the Goa coast.

From the foregoing account it may be seen that *T. thalassinus*, which is more abundant all along the east coast and southern Kerala, shows a diminishing trend northward from central Kerala. *O. militaris* and *T. caelatus* exhibit a discontinuous distribution along the coasts. They are common in Palk Bay and in Veraval. There is a fishery for *O. militaris* also in the Hoogly estuary in West Bengal. *T. tenuispinis* and *T. dussumieri* are of a highly migratory nature and are found all along the coasts of India with abundance in South West region. *T. serratus* is distributed all along the coasts but forms a regular fishery only in South-west region.

DEPTHWISE DISTRIBUTION

Catfishes are mostly abundant in shallower waters, of less than 50 m depth. Nagabhushanam (1966) described the depthwise distribution of catfishes along the Andhra Pradesh and Orissa coasts between lat. 17°00' N and 20°00' N and long 82° 20'E and 86° 40' E. His study has shown that larger catfishes are caught more from deeper waters. Rao *et al.* (1972) has studied the depth distribution of catfishes along the lat. 15°00' N to 22°00' N and found that the catch

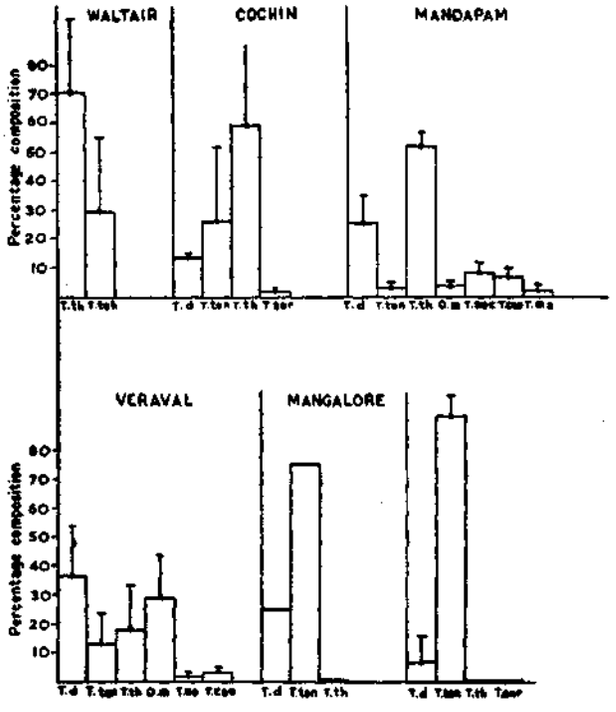


Fig. 10 Cenre-wise species composition of catfish landings in percentage with standard deviation from trawl net.
(Below right extreme is Calicut)

rates are high from all depths (5 to 85 m), but with higher concentrations in 41-60 m depths in all latitude zones. Nagabhushanam's (1966) observation is almost in close agreement with that of Sekharan's (1973) on the depthwise distribution of catfishes along the north western Bay of Bengal. Sekharan (1973) has reported that, on an annual average, *T. thalassinus* and *T. tenuispinis* have two peak abundances in two depth ranges, the first being 30-50 m and the second 60-80 m. Both the species have high abundance in shallow grounds (less then 50 m depth) in April-June and October-December and in deeper grounds in July-September. In September-December period the sizes of both species increase with increase in depth. Rao *et al*, (1977), based on acoustic surveyes and fishing results of R. V. *Rastrelliger* and R. V. *Sardinella* of P F P, reported that the catfish catches are moderately high up to a depth of 50 m in the Gulf of Mannar.

TABLE 23

Details of operations of gillnet with respect to total all-fish landings and total catfish landings in tonnes at Veraval during 1980-1982.

	January	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total
1980													
All fish	612	282	7510	486	372	201	—	274	370	443	8135	322	19007
Catfish	34	20	32	8	34	5	—	18	10	84	136	5	386
% of catfish	5.55	7.09	0.43	1.65	9.14	2.49	—	6.57	2.70	18.96	1.67	1.55	2.03
Effort in units	4792	1624	3256	2970	3162	1230	—	1240	2700	3472	8010	2542	34998
CPUE of catfish (kg)	7.09	12.31	9.83	2.69	10.75	4.06	—	14.52	3.70	24.19	16.98	1.97	11.03
1981													
All fish	463	151	183	114	490	123	49	0	469	143	195	72	2452
Catfish	40	1	5	23	99	42	2	0	38	11	3	0	264
% of catfish	8.64	0.66	2.73	20.17	20.20	34.15	4.08	0	8.10	7.69	1.54	0	10.77
Effort in units	4278	560	1581	1560	4371	510	248	0	3060	2280	2100	1209	21757
CPUE of catfish (kg)	9.35	1.78	3.16	14.74	22.65	82.35	8.06	0	12.42	4.82	1.43	0	12.13
1982													
All fish	123	339	256	397	804	246	0	10	459	642	22	459	3757
Catfish	10	10	14	69	174	51	0	0	34	58	0	21	441
% of catfish	8.13	2.95	5.47	17.38	21.64	20.73	0	0	7.41	9.03	0	4.57	11.74
Effort in units	1931	2698	1584	3960	5115	480	0	248	4320	3765	746	3455	28302
CPUE of catfish (kg)	5.18	3.71	8.84	17.42	34.02	106.25	0	0	7.87	15.40	0	6.08	15.58

TABLE 24

Species composition of Catfish

Gear: Trawlnet

Centre: Visakhapatnam Fishing Harbour

Month	T. thalassinus (%)	T. tenuispinis (%)	Total in Kg.
Year: 1980			
Jan	1320 (3.3)	38680 (96.7)	40000
Feb	46231 (55.7)	36769 (44.3)	83000
Mar	10656 (66.6)	5344 (33.4)	16000
Apr	0	0	0
May	0	0	0
Jun	0	0	0
Jul	0	2000 (100.00)	2000
Aug	472 (47.2)	528 (52.8)	1000
Sept	13432 (58.4)	9568 (41.6)	23000
Oct	10990 (78.5)	3010 (21.5)	14000
Nov	3000 (100.0)	0	3000
Dec	9810 (65.4)	5190 (34.6)	15000
Total	95911 (48.7)	101089 (51.3)	197000
Year : 1981			
Jan	12325 (49.3)	12675 (50.7)	25000
Feb	7776 (64.8)	4224 (35.2)	12000
Mar	6510 (93.0)	490 (7.0)	7000
Apr	1802 (90.1)	198 (9.8)	2000
May	15938 (61.3)	10062 (38.7)	26000
Jun	7904 (41.6)	11096 (58.4)	19000
Jul	12260 (61.3)	7740 (38.7)	20000

1981 Contd.

Month	T. thalassinus	(%)	T. tenuispinis	(%)	Total in kg
Aug	2000	(100.0)	0		2000
Sept	6171	(56.1)	4829	(43.9)	11000
Oct	9984	(76.8)	3016	(23.2)	13000
Nov	8490	(84.9)	1510	(15.1)	10000
Dec	2832	(94.4)	168	(5.6)	3000
Total	93992	(62.7)	56008	(37.3)	150000
Year : 1982					
Jan	16000	(100.0)	0		16000
Feb	17995	(94.5)	1045	(5.5)	19000
Mar	14176	(88.6)	1824	(11.4)	16000
Apr	4472	(55.9)	3528	(44.1)	8000
May	4400	(88.0)	600	(12.0)	5000
Jun	2534	(36.2)	4466	(63.8)	7000
Jul	12958	(68.2)	6042	(31.8)	19000
Aug	29954	(88.1)	4046	(11.9)	34000
Sep	35820	(99.5)	180	(0.5)	36000
Oct	3542	(50.6)	3458	(49.4)	7000
Nov	25732	(91.9)	2268	(8.1)	28000
Dec	21230	(96.5)	770	(3.5)	22000
Total	188773	(87.8)	28227	(12.2)	217000

TABLE 25

Species composition of catfish

Gear : Trawlnet — Centre: Cochin Fishing Harbour

Month	T. dussumieri	%	T. thalassinus	%	T. serratus	%	T. tenuispinis	%	Monthly total
Year : 1981									
January				No data available					1000
February				--					Nil
March				—					1000
April				—			5000	100.00	5000
May	18321	26.17	29616	42.31	2772	3.96	19291	27.56	70000
June	—	—	2426	3.62	—	—	64574	96.38	67000
July	—	—	17061	23.06	—	—	56939	76.94	74000
August				No data available					27000
September	—	—	285	5.70	—	—	4715	94.30	5000
October	—	—	—	—	—	—	—	—	—
November	—	—	—	—	—	—	—	—	—
December	3000	100.00	—	—	—	—	—	—	3000
Total	21,321	8.43	49,388	19.52	2,772	1.1	150,519	59.49	25,3000
Year : 1982									
January	—	—	—	—	—	—	—	—	—
February	—	—	—	No data available			—	—	2000
March	4642	92.84	305	6.10	53	1.6	—	—	5000
April	—	—	—	—	—	—	—	—	NIL
May	—	—	—	— No data available			—	—	10000
June	—	—	72710	49.46	72710	49.46	1580	1.08	147000
July	—	—	—	—	—	—	—	—	7000
August	—	—	50000	100.00	—	—	—	—	50000
September	—	—	53000	100.00	—	—	—	—	53000
October	—	—	1000	100.00	—	—	—	—	1000
November	—	—	—	— No data available			—	—	6000
December	—	—	—	—	—	—	—	—	—
Total	4642	1.65	177,015	62.99	72,763	25.89	1580	0.56	281000

TABLE 26

Species composition of Catfish

Year : 1981
Gear : Gillnet (Drift)

Centre : Cochin Fishing Harbour

Months	*T. dussumieri*	%	*T. thalassinus*	%	*T. serratus*	%	*T. tenuispinis*	%	Monthly total
January	27044	97.87	283	1.01	307	1.10	6	0.02	28000
February	20618	98.18	218	1.04	164	0.78	—	—	21000
March	27239	97.28	458	1.64	301	1.08	2	—	28000
April	3555	88.87	12	0.30	433	10.83	—	—	4000
May	1275	42.50	40	1.34	1678	53.93	7	0.23	3000
June	5292	13.93	1800	4.74	30625	80.59	283	0.74	38000
July	10061	14.79	3621	5.33	45015	66.20	9303	13.68	68000
August	37385	41.54	8106	9.01	37534	41.70	6975	7.75	90000
September	12321	22.82	15187	28.12	15173	28.10	11319	20.96	54000
October	11559	36.12	6405	20.02	11946	37.33	2090	6.53	32000
November	12879	67.79	928	4.88	5086	26.77	107	0.56	19000
December	3756	93.90	31	0.78	213	5.32	—	—	4000
Total	173344	44.56	37089	9.54	184475	38.17	30092	7.73	389000

TABLE 27

Species composition of catfish

Year : 1982
Gear : Gillnet (Drift)

Centre : Cochin Fishing Harbour

Months	*T. dussumieri*	%	*T. thalassinus*	%	*T. serratus*	%	*T. tenuispinis*	%	Monthly total
January	969	96.90	31	3.10	—	—	—	—	1000
February	1852	92.60	124	6.20	24	1.20	—	—	2000
March	3390	84.75	240	6.00	370	9.25	—	—	4000
April	411	41.70	66	6.60	523	52.30	—	—	1000
May	—	—	—	—	—	—	—	—	NIL
June	1083	13.54	2621	32.76	3971	49.64	325	4.06	8000
July	32274	29.61	13524	12.41	59610	54.69	3592	3.29	109000
August	19961	20.58	11681	12.04	41305	42.58	24053	24.80	97000
September	17928	22.98	24242	31.08	32252	41.35	3578	4.59	78000
October	3472	9.14	17205	45.28	16656	43.83	667	1.75	38000
November	2360	59.00	696	17.40	919	22.98	25	0.63	4000
December	1686	84.30	26	1.30	288	14.40	—	—	2000
Total	85386	24.82	70456	20.48	155918	45.33	32240	9.37	344000

TABLE 28

Species composition of catfish in the catches of trawlers and purseseiners at Mangalore in 1982

Gear : Trawlnet

Month	*T. dussumieri*	*T. tenuispinis*	*T. thalassinus*	Monthly total in kg.
January	No data available			
February	—do—			
March	—do—			
April	59116	0	0	59116
May	47090	65030	0	112120
June	275	617	420	1312
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	166294	0	166294
December	0	88635	0	88635
Total	106481	320576	420	427477
%	24.9	75.0	0.1	

Gear : Purse-seine

Month	*T. dussumieri*	*T. tenuispinis*	*Total catch in Kg.*
January	No data available		494000
February	—do—		616000
March	—do—		138000
April	334000	0	334000
May	3149000	0	3149000
June	0	0	0
July	0	0	0
August	0	0	0
September	0	273000	273000
October	431641	669359	1127000
November	11000	0	11000
December	0	0	0
Total	3925641	968359	6142000
%	80.21	19.78	

TABLE-29

Species composition of Catfish landed by Drift-gill net during 1982-1983 South Kanara.

Year : 1982

	September Catch kg	%	October Catch	%	November Catch	%	December Catch	%
T. serratus	11839	23.54	23265	27.37	5564	21.81	11668	23.7
T. thalassinus	4841	9.63	8144	9.58	1720	6.74	3019	6.14
T. dussumieri	6241	12.41	26196	30.82	4091	16.04	9824	19.96
T. tenuispinis	27372	54.43	27405	32.24	14135	55.41	24698	50.19
Total	50293		85010		25510		49209	
Effort units	2365		7211		6287		6832	

Year : 1983

	January Catch	%	February Catch	%	March Catch	%	April Catch	%	Annual Catch	%
T. serratus	20604	70.75	9195	43.38	6861	4090	—	—	88966	31.93
T. thalassinus	389	1.34	17	0.08	—	—	—	—	18130	6.50
T. dussumieri	5469	1878	9425	44.61	8428	5024	1563	100	71237	25.57
T. tenuispinis	2660	9.13	2522	11.94	1488	8.86	—	—	100280	36.00
Total	29122		21129		16777		1563		278613	
Effort units	4185		2159		1435		202		30676	

At Mangalore catfish project was initiated from 1982 (April) by that time the drift-gill net operations were over. It was resumed from Sept. onwards. To give a monthly speciese-composition picture for a year data of June-April of 1983 is included.

TABLE-30

Year : 1980 *Species composition of catfish*

Gear : Trawlnet Centre : Veraval

Month	*T. dussumieri*	*T. caelatus*	*T. sona*	*T. thalassinus*	*T. tenuispinis*	*O. militaris*	Total in kg
January	93200	3000	1000	3400	46800	52600	2,00,000
February	54450	—	—	52950	—	42600	1,50,000
March	14224	—	—	2352	4368	7056	28,000
April	54120	5016	—	—	11220	61644	1,32,000
May	224120	—	—	—	—	35880	26,000
June July August September	—	—	—	—	—	—	—
October	6688	—	—	656	8000	656	16,000
November	10374	—	—	1680	1785	7161	21,000
December	—	—	—	—	—	—	—
Total	457176	8016	1000	61038	72173	207597	8,07,000
%	56.7	1.0	0.1	7.6	8.9	25.7	

TABLE-31

Year : 1981 *Species composition of Catfish*

Gear : Trawlnet Centre : Veraval

Month	*T. dussumieri*	*T tenuispinis*	*T. thalassinus*	*T. caelatus*	*O. militaris*	Total in kg
January	5016	—	4422	—	56562	66,000
February	—	—	11700	—	6300	18,000
March	—	—	—	—	—	—
April	4389	—	8550	—	44061	57,000
May	21276	—	4806	648	27270	54,000
June July August	—	—	—	—	—	—
September	—	—	—	—	5000	5,000
October	9696	786	—	192	13344	24,000
November	630	—	38520	4770	46080	90,000
December	21175	—	65582	—	34243	1,21,000
Total	62182	768	133580	5610	232860	4,35,00
%	14.3	0.2	30.6	1.3	53.5	

TABLE 32

Year : 1982 *Species composition of catfish*
Gear : Trawlnet Centre : Veraval

Month	*T. dussumieri*	*T. tenuispinis*	*T. thalassinus*	*T. sona*	*T. caelatus*	*O. militaris*	Total in kg.
January	—	—	70564	—	—	21436	92,000
February	1496	—	8382	—	—	1122	11,000
March	959	1260	2723	77	—	1981	7,000
April	84727	15440	38407	—	—	54426	1,93,000
May	40934	—	—	—	—	56066	97,000
June	1000	—	—	—	—	—	1,000
July August	—	—	—	—	—	—	—
September	105196	228956	—	53312	10948	77598	4,76,000
October	115200	27456	45312	—	—	4032	1,92,000
November	—	232	136	—	—	7632	8,000
December	1254	1914	20592	—	—	9240	33,000
Total	350766	275258	186116	53389	10948	233523	11,10,000
%	31.6	24.8	16.8	4.8	1.0	21.0	

TABLE 33

Year : 1980 *Species composition of catfish* Centre : Veraval
Gear : Gillnet

Month	*T. dussu-mieri*	*T. caelatus*	*T. sona*	*T. thala-ssinus*	*T. macula-tus*	*T. tenuis-pinis*	*O. mili-taris*	Others	Total in kg.
January	12682	306	374	5100	—	6596	8942	—	34,000
February	16040	—	—	—	—	1060	2900	—	20,000
March	18880	—	576	1312	—	8000	3232	1	32,000
April	7712	—	—	—	—	32	256	—	8,000
May	23120	1462	—	—	680	8738	—	—	34,000
June	4695	305	—	—	—	—	—	—	5,000
July	—	—	—	—	—	—	—	—	—
August	18000	—	—	—	—	—	—	—	18,000
September	10000	—	—	—	—	—	—	—	10,000
October	78708	—	—	840	—	4452	—	—	84,000
November	85540	—	—	11424	—	34000	5032	—	1,36,000
December	3665	—	—	—	—	110	1225	—	5,000
Total	279046	2073	950	18676	680	62988	21587	—	3,86,000
%	72.3	0.5	0.3	4.6	0.2	16.3	5.6	—	—

TABLE 34

Species composition of catfish

Gear : Gillnet Centre : Veraval

Month	*T. dussumieri*	*T. tenuispinis*	*T. thalassinus*	*T. sona*	*T. caelatus*	*O. militaris*	Others	Total in kg.
Year : 1981								
January	37960	—	—	—	—	2040	—	40,000
February	773	—	227	—	—	—	—	1,000
March	4880	—	—	—	—	—	120	5,000
April	22494	—	506	—	—	—	—	23,000
May	77715	9207	—	6030	3960	2079	—	99,000
June	30430	2772	—	—	—	—	798	42,000
July	2000	—	—	—	—	—	—	2,000
August	—	—	—	—	—	—	—	—
September	—	—	—	26904	—	11096	—	38,000
October	—	4572	—	4572	1496	—	—	11,000
November	—	—	1992	—	336	672	—	3,000
December	—	—	—	—	—	—	—	—
Total	184252	16731	2725	37695	5792	16685	120	2,64,000
%	69.8	6.3	1.0	14.3	2.2	6.3	0.1	
Year : 1982								
January	1970	—	5830	—	—	2200	—	10,000
February	5130	340	4460	—	—	70	—	10,000
March	13384	—	616	—	—	—	—	14,000
April	69000	—	—	—	—	—	—	69,000
May	135024	—	—	—	38976	—	—	1,74,000
June	50439	—	—	561	—	—	—	51,000
July August	—	—	—	—	—	—	—	—
September	27744	—	—	—	2652	—	3604	34,000
October	51736	6264	—	—	—	—	—	58,000
November	—	—	—	—	—	—	—	—
December	16128	—	—	—	—	4872	—	21,000
Total	370555	6604	10906	561	41628	7142	3604	4,41,000
%	75.2	3.7	9.7	0.1	5.5	5.3	0.6	

DISCUSSION

The monthwise average catch rates of trawl nets at different centres are given in Fig. 7. Though catfishes are available along both the coasts almost throughout the year, better abundance is noticed during the premonsoon months along Gujarat, Karnataka and Kerala coasts. The gill-net landings at Calicut and Cochin show an identical picture, where the catch rate is uniformly good in all the months except March-July period (Fig 8). Along Gujarat coast also the gill net shows a similar trend in catch rates. The centrewise average annual catch rate of trawl and gill nets shows an increase from Veraval to Bombay and decline further southwards. The data from the various centres on catch rate suggest that the abundance of catfish is better along the west coast, especially off Gujarat, northern Maharashtra and northern Kerala.

Exploratory fishing operations on the shelf in the Goa-Gujarat region (15° to 24° N lat. and 67° E to 74° E long.) has shown that the catfish yields are of a high magnitude in the first and fourth quarters. Even though the catch in the third quarter is poor, the catch rate is highest, indicating a high abundance of catfish during the third quarter. Of the various centres in the area, Kutch and Porbunder yield the maximum catch rates; similarly, rich grounds of catfishes are located off Malvan and Marmagoa. It is roughly estimated that the potential sustainable yield from this region is 4,254 tonnes, as against an annual average catch of 1,091 tonnes (Rao *et al.*, 1972; Rao and Dorairaj, 1968). Surveys carried out by the Pelagic Fishery Project has given an estimate of 15,629 tonnes of catfish biomass for southern Maharashtra, which is 7.6 times higher than the average landings of this region (Rao *et al.*, 1977).

Exploratory fishings conducted by Government of India, Indo-Norwegian Project and Pelagic Fishery Project vessels have revealed that rich catfish grounds are present between 7° 30' N and 15° N lat. and 73° 40' E and 77° 33' E long. Bull-trawling operations has shown that catfishes are abundant in the Cannanore-Calicut belt, but the intensity decreases along the Cochin-Alleppy belt and altogether diminishes further south. Pelagic

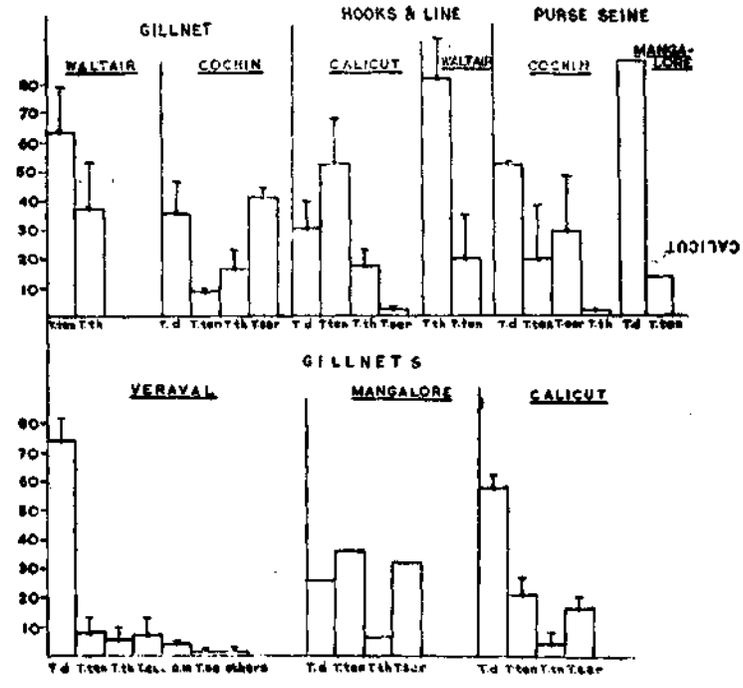


Fig. 11 Centre-wise species composition of catfish landings in percentage with standard deviation from Gill net, Hooks and line and Purse-seine.

Fishery Project surveys have shown that the second and third quarters are the periods of highest abundance of catfish along Kerala and Karnataka. The highest estimated average biomass of catfish along the coast of Kerala is 3.6 times higher than the average landings (Rao *et al*, 1977).

Offshore surveys by trawls, gill nets and hooks & lines along the south-east coast has shown that, after silverbellies, catfish is the important resource (2 to 8%) in the Palk Bay. By acoustic surveys in the Gulf of Mannar, the P. F. P. has estimated the average biomass of catfish to be 2.3 times higher than the average landings.

The exploratory trawl operations along the north-east coast has revealed that, on an average, 9.24% of the annual trawl catches consist of catfishes. *Tachysurus* in fact, constitutes the largest single generic group in the trawl catches. The exploratory trawling operations by M. T. *Ashok* in the area 16° 40' N lat. has revealed that the estimated catfish resource, by 'swept area' method (Gulland, 1965) is 23,484 tonnes and potentially sustainable yield, at 60% level, 14,090 tonnes.

Coming to the specieswise abundance, the average percentage composition of different species of catfish in different regions in trawl catches is given in Fig 11. The species of *Tachysurus* which are dominant in each gear at various centres are as follows :

Centres	Trawl net	Gill net	Hooks & Line	Purseseine
Waltair	*T. thalassinus*	*T. tenuispinis*	*T. thalassinus*	-
Mandapam	*T. thalassinus*	-	-	-
Cochin	*T. thalassinus*	*T. dussumieri* & *T. serratus*	-	*T. dussumieri*
Calicut	*T. tenuispinis*	*T. dussumieri*	*T. tenuispinis*	-
Mangalore	*T. tenuispinis*	*T. tenuispinis*	-	*T. dussumieri*
Veraval	*T. dussumieri*	*T. dussumieri*		-

Central Marine Fisheries Research Institute has estimated a potential yield of 310,000 tonnes of catfish as against an annual average yield of 58,000 tonnes from the Indian Seas which is next to Oceanic tunas (500,000 tonnes).

CHAPTER FOUR

ACOUSTIC SURVEYS AND ABUNDANCE ESTIMATION OF CATFISH

— V. N. BANDE

Many fisheries research and development projects include the evaluation of size and potential yield of the fish resources as an essential part of their objectives. While exploratory surveys depending on fishing trials alone are very time-consuming and expensive, and at best can only provide information about the distribution and abundance of the fish which are vulnerable to the type of fishing gear and method of fishing applied, the modern calibrated, highly sensitive acoustic instruments provide the under-water vision required to enumerate correctly and even to size the fish present in practically the entire water column. Exploratory surveys over large areas have proved to be nearly impossible without such under-water vision, especially as it has been shown that the so-called demersal fishes frequently move off the bottom, when they cannot be caught with bottom trawls or similar bottom gear. Consequently, good accoustic equipments are today considered indispensible for almost any sort of fishery exploratory surveys.

Acoustic surveys conducted by the erstwhile UNDP / FAO Pelagic Fisheries Project (P. F. P.) in the area between Ratnagiri and Tuticorin during the period 1972–1977 have considerably enhanced our knowledge of the resource, its abundance, seasonal distribution and methods to be adopted for exploitation. They have estimated, by the acoustic methods the average standing stock of catfishes in the project area to be about 84,000 tonnes forming 8.4% of the total fish biomass (Rao *et al.*, 1977). The peak values obtained in different years covered May/June in 1973 (86,150 tonnes); June/July in 1974 (1,66,402 tonnes) and May/June in 1975 (3,98,904 tonnes). The highest estimated average biomas was observed along the Kerala coast (43,971 tonnes), followed by Karnataka and Goa (26,672 tonnes), Southern Maharashtra (15,629 tonnes). And the lowest was in the Gulf of Mannar (3,604 tonnes). According to the acoustic estimates, greater abundance of catfish occurs during first and second quarters (January-March & April-June) along the coast of southern Maharashtra, whereas the actual landings of catfish in the region are high during the fourth quarter (October-December). Off the coast of Karnataka and Goa, estimates in general were high during second and third quarters (April-June & July-Sept) and higher landings were recorded during the second quarter. Along the Kerala coast, the period of abundance is during second and third quarters of the year, but catfish landings in the region were high during third and fourth quarters. This anomaly is mainly due to the fact that the traditional fishery cannot efficiently exploit the resources during the monsoon months when the stocks are in great abundance in the area. Biomass estimates were fairly high in the Gulf of Mannar in the third quarter and the maximum landings were also during the same period.

As regards the seasonal distribution of catfish, it is discontinuous in February-March in two wide belts between 14° and 16°N and 9° and 12°N, respectively. In April/May, recordings were scattered with concentrations off Ratnagiri, Karwar, Cochin and Quilon. During May/June, recordings were widespread in a continuous belt along the coast with medium to high concentrations in two wide belts; one between Ratnagiri and Karwar and the other between Kasargod and Cochin (Anonymous, 1976). During July/August catfish recordings were noticed in two main belts, between Mangalore and Karwar and between Cannanore and Quilon. Within these belts high concentrations were

observed in patches, mainly in the middle shelf regions off Karwar, Calicut and Cochin, and the bulk of stock was, in general, located in the central sector.

Even though nothing definite could be said about the migratory behaviour of the catfish, it appears that there is a general trend of southward shift in concentrations beginning from April till July/August, when the bulk of the stock was found in the central and southern sector of the west coast. One of the interesting findings of the project is the abundance of catfish mostly in association with the ribbonfish on the western shelf when it is covered with oxygen-deficient water during SW monsoon months. Obviously, they can thrive well in such environment which is avoided by other pelagic species.

Regular fishing trials with pelagic trawl and bottom trawl have shown the pattern of depthwise distribution of catfish. The investigations have shown the possiblity that, as the fish grows bigger and older, it moves to outer shelf. In fact, some of the best catch rates exeeding 1000kg/hr were taken by the project vessels beyond 50m depth, indicating the availability of commercial concentrations of the bigger adult fish in deeper waters.

Recordings of catfish within 10 to 50m depth were generally mixed with those of whitebait. Outside the normal whitebait zone, recordings of catfish in association with ribbonfish have been obtained in depth upto 80 m.

Catfish undertake regular diurnal vertical migrations to some extent (Plate I A-D). Generally during day time they are found close to the bottom and at night they ascend the vertical water column and disperse. Catfish are found in school concentrations at surface during daytime, especially during breeding season, along the southwest and southeast coasts.

The echograms of individual catfish, which are relatively large in size and positioned at some distance from each other while schooling, look like inverted 'V' figures spread more or less evenly. Large ribbon fishes also give similar 'V' type recordings, but on the whole, they are more compact and in straight vertical configurations. Depending on the speeds of recording paper and ship, and of beam-width, these 'V' type recordings change their shape. When the paper moves faster, the legs of 'V' converge, reducing the angle between the two, and vice versa. At high speed the individual recordings appear more or less like straight vertical lines (Natarajan *et al*, 1980).

When the ship operating an echo sounder passes over a fish, the leading edge of the sound beam first hits the fish, making a mark on the recording paper. This, however, does not indicate the true depth of the fish. The correct depth is measured only when the ship passes directly above the fish. After the ship has passed over the fish, the trailing edge of the sound beam hits the fish and the characteristic inverted 'V' recording is produced (Fig. 1).

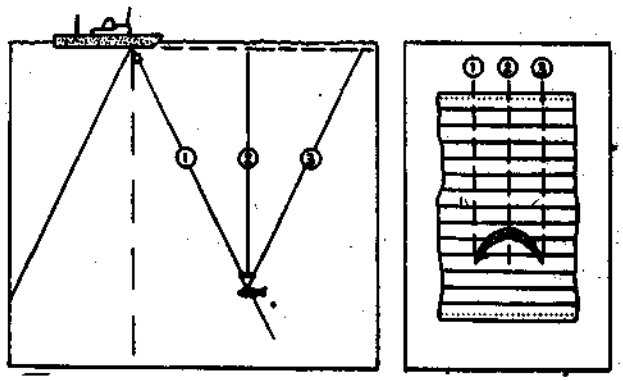


Fig 1. Diagramatic representation of the build up of a fish echo.

The average biomass of catfish in the project area, with the estimate of 84,000 tonnes is about 4.7 times higher than the average landings in the area and 2.3 times higher than the all-India landings. The findings indicate that the average biomas of catfish off the coasts of southern Maharashtra, Karnataka and Goa, Kerala and Southern Tamilnadu are 7.6, 8.8, 3.6 and 2.3 times higher than the average landings in the respective regions. Thus the present level of exploitation could easily be increased to about two and a half times without affecting the stocks. At the same time, it should be emphasized that the shelf area off southern Maharashtra, Goa and Karnataka, offers greater scope for increased exploitation, compared to the southern areas.

CHAPTER FIVE

BIOLOGY OF THE IMPORTANT SPECIES OF CATFISHES

— N. GOPINATHA MENON AND C. MUTHIAH

Information on the biology of the tachysurid catfishes from Indian waters is very meagre, and in the following account an attempt is made to compile all the published accounts and unpublished data collected from various centres on the biology of commercially important tachysurids of our waters.

AGE AND GROWTH

Tachysurus thalassinus : The age of this species have been determined by different methods, viz, length-frequency studies, using skeletal hard parts like pectoral spines, vertebrae and opercular bones as well as by rearing in the aquarium. Mojumder (1977), based on trawl data, estimated the growth of this species by the length-frequency method, and found that at Visakhapatnam, the fish attains an average length of 180 mm at the end of one year, 350 mm at the end of two years and 420 mm at the end of three years. Also utilizing the trawl data, Menon (1979) found that the species at Mandapam grows to 256 mm at the end of one year, 360 at the end of two years, 454 at the end of three years and 522 mm at the end of four years. He also determined the age of this species using skeletal hard parts like pectoral spine sections, vertebrae, and opercular bones, and the results obtained by these methods agreed closely with the results of the length-frequency studies. Rearing experiments conducted in aquarium tanks also showed similar growth values. The age-length data were used to estimate the growth parametres of the von Bertalanffy growth equation and the calculated values were in close agreement with those observed. The growth equation of *T. thalassinus* from Mandapam waters is $Lt=848.7\ [1-e^{-0.1988}(t-(-0.8113)]$.

Tachysurus tenuispinis : The age of *T. tenuispinis* was determined by length-frequency studies based on data collected from Visakhapatnam and it was estimated that the fish grew to 175, 237, 295, 355 and 395 mm by the end of 1.0, 1.5, 2.0, 2.5 and 3.0 years, respectively. Opercular bones were also utilized for the determination of age of this species and the back-calculated lengths at the time of formation of translucent rings were 111.6, 187.4, 246.4, 300.3, 357.0, 400.9 and 440.1 mm at the end of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 years, respectively. Similar results were obtained also when otoliths were used for the determination of the age of this species. The study showed that the growth rings in the opercular bone and otolith were formed twice a year, in June and December, and poor feeding might be the causative factor for the formation of rings. The von Bertalanffy growth equation was fitted to the age-length data and the calculated values were in close agreement with the observed ones. Hence, the von Bertalanffy growth equation of *T. tenuispinis* from Visakhapatnam (Dan, 1980) could be expressed as, $Lt=820\ [1-e^{-0.2108}(t-(-0.177)]$.

Tachysurus sona : Singh and Rege (1968) determined the age of *T. Sona* by length-frequency studies and found that the species grew to a size of 210 mm at the end of first year and 325, 450 and 510 mm at the end of years two, five and ten, respectively. They determined the age of this species by using vertebrae and the mean back-calculated lengths at ages 1 to 5 were 229.9, 315.6, 384.4, 417.0 and 454.0 mm, respectively. A close agreement was noticed between the observed values, based on the length-frequency data, and back-

TABLE - 1

Synopsis of the age and growth of Tachysurid catfishes from Indian waters

Method of age determination	Species	Lengths at ages (in mm)					Locality	Author
		I	II	III	IV	V		
Length frequency	*Tachysurus thalassinus*	250	370	450	522	—	Mandapam	Menon (1979)
Length frequency	*T. thalassinus*	180	350	420	—	—	Visakhapatnam	Mojumder (1977)
Pectoral spine	*T. thalassinus*	271	377	454	—	—	Mandapam	Menon (1979)
Vertebrae	*T. thalassinus*	260	355	440	—	—	Mandapam	Menon (1979)
Operculum	*T. thalassinus*	247	351	454	—	—	Mandapam	Menon (1979)
Von Bertalanffy growth equation	*T. thalassinus*	257	364	452	524	—	Mandapam	Menon (1979)
Length frequency	*T. sona*	210	325	—	—	450	Bombay	Singh and Rege (1968)
Vertebrae	*T. sona*	229	315	384	417	454	Bombay	Singh and Rege (1968)
Von Bertalanffy	*T. sona*	234	320	380	423	453	Bombay	Singh and Rege (1968)
Length frequency	*T. tenuispinis*	175	295	395	—	—	Visakhapatnam	Dan (1980)
Operculum	*T. tenuispinis*	187	300	401	—	—	Visakhapatnam	Dan (1980)
Otolith	*T. tenuispinis*	179	304	397	—	—	Visakhapatnam	Dan (1980)
Length frequency	*T. platystomus*	178	256	310	363	—	Mandapam	Menon (1984 b)
Vertebrae	*T. platystomus*	171	265	351	387	—	Mandapam	Menon (1984 b)
Operculum	*T. platystomus*	173	265	349	387	—	Mandapam	Menon (1984 b)
Von Bertalanffy growth equation	*T. platystomus*	177	272	340	388	—	Mandapam	Menon (1984 b)

calculated lengths from vertebral studies. The von Bertalanffy growth equation of *T. Sona* in Bombay waters could be expresed as:

$$L_t = 525.5\ [1 - e^{-0.3507\ (t-(-0.69))}].$$

Tachysurus platystomus:- Based on samples collected from Mandapam, the age of this species was determined by length-frequency studies, and it was found that the fish grew to a size of 171mm by the end of first year and 270 mm and 344 mm respectively by the end of the second and third years. Length-frequency studies by using probability plot technique also showed similar results, with 178 mm, 256 mm, 310 mm, 363 mm respectively at the end of the first, second, third and fourth years. The skeletal parts like vertebrae and opercular bones showed annual translucent rings, which were also utilized for the determination of the age of *T. platystomus.* From vertebral studies it was found that the species attained a length of 171 mm at the end of the first year and 265 mm, 351 mm and 387 mm respectively at the end of the second, third and fourth years. The opercular bone studies also gave similar results; the mean values of back-calculated lengths at ages 1 to 4 were 173 mm, 265 mm, 349 mm and 387 mm, respectively. The von Bertalanffy growth equation of *T. platystomus* was estimated to be

$$L_t = 497.5\ [1-e^{-0.35767(t-(-0.2305))}]$$

This relationship adequately describes the growth of *T. platystomus* in the Mandapam waters, since the calculated lengths for each age group derived from this equation were nearly identical with the mean lengths obtained by back-calculations based on skeletal parts and also with the mean lengths derived from length-frequency studies (Menon, 1984 b). All the available information on the age and growth of different species of tachysurid catfishes is given in Table 1.

LENGTH-WEIGHT RELATIONSHIP

Tachysurus thalassinus: Mojumder (1971) found no significant difference between the length-weight relationships of males and females of *T. thalassinus* from Visakhapatnam coast; he gave the equation as: $W = 0.009361\ L^{2.9689}$.

At Mandapam, the length-weight relationships were determined separately for the yolked larva, immature female, mature female and male, since there were significant differences in the slopes and elevations among these groups. The relationships for the four categories were:

Yolked larva : $W = 0.001769\ L^{1.788671}$

Immature female : $W = 0.000002434\ L^{3.224760}$

Mature female : $W = 0.000008973\ L^{3.009920}$

Male : $W = 0.000004855\ L^{3.089464}$

The values of the exponent 'b' were significantly different from the cubical relationships for yolked larva, immature female and male (Menon, 1979).

Tachysurus sona: Singh and Rege (1968) determined the length-weight relationship of *T. sona* from Bombay waters and the equation was:

$$\log W = -4.794868 + 2.932107 \log L$$

the correlation coefficient, $r = 0.9848$, being highly significant. They found that the relationship followed strictly the cube law.

Tachysurus dussumieri: The length-weight relationship of *T. dussumieri* from Mandapam waters was:

$$W = 0.0001047\ L^{2.647824}$$

the value of the exponent 'b' significantly diviating from the cubic relationship (Menon, 1979).

Tachysurus tenuispinis: The length-weight relationship of *T. tenuispinis* from two zones, the north (off False Point) and the south (off Visakhapatnam), and for different sexes were analysed separately and no significant differences was found in their regressions either for different zones or for different sexes. Hence, a formula common for both sexes and zones was worked out as:

$$W = 0.00001842\ L^{2.8860}$$

The value of the exponent was tested by 't' test and it was found that the cubic formula $W = aL^3$ does not hold good for the species (Dan and Mojumder, 1978).

RELATIVE CONDITION FACTOR

Tachysurus thalassinus : Among mature males and females of *T. thalassinus,* low values of the Relative condition factor (k_n) were observed during the months of April to August, which had coincided with the breeding season of the species. Similarly, low values of K_n were noticed at 290 mm, which could be correlated with the size at first maturity; the subsequent falls of K_n at 360—370, 450—460 and 510mm may be indicative of spawning at the second, third and fourth years, respectively (Menon, 1979).

Tachysurus sona : Singh and Rege (1968) found that the variations in the K_n values of *T. sona* at sizes 240mm, 345mm, 475mm, and 525mm correspondingly representing the spawnings at ages 2, 3, 4 and 5 years.

Tachysurus tenuispinis : Dan (1977) observed an increase in the K_n value of *T. tenuispinis* of Visakhapatnam up to May, followed by a steep fall in the subsequent months, which indicated the spawning. The K_n values in relation to size showed three peaks, at 275mm, 335mm and 400 mm.

Tachysurus platystomus : Among the mature fishes of *T. platystomus* a lowering of K_n value was observed in the months of December, January and February, which being the breeding seasons of the species. The fall of K_n value at sizes 290 mm, 350 mm, and 380 mm represented the first, second and third spawnings at age 2, 3 and 4, respectively (Menon 1984 b).

FOOD AND FEEDING HABITS

Estimates of the quantity and quality of food organisms in the given area would not only indicate the possibility of fish concentrating in these feeding grounds but also furnish at the same time, such information as the growth phase of fish moving into these grounds. It is well established that the qualitative and quantitative composition of the food of a species is essential to understand many aspects concerning the fish, such as migration, behaviour and growth. All the available information on the food and feeding habits of the techysurid catfishes from Indian waters is summarized in Table 2.

Tachysurus thalassinus : Chacko (1949) had examined the stomach contents of *T. thalassinus* from the Gulf of Mannar and reported that the species was omnivorous. Suseelan and Nair (1969) stated that *T. thalassinus* was a carnivore and that the main food comprised organisms from the bottom epifauna and infauna, along with fishes. Mojumder (1969) studied the food of *T. thalassinus* from Visakhapatnam and found that 67% of the food consisted of crabs, prawns, *Sqilla* sp. and other crustaceans, 22% teleosts and 4% molluscs. His observation showed that the larger (36 cm and above) catfishes had low feeding intensity, which has been correlated to the breeding cycle. Menon (1979) made a detailed study on the food and feeding habits of *T. thalassinus* from Mandapam and reported that the species was a voracious carnivore. Fishes from Palk Bay fed mainly on echiurids, polychaetes, crabs, prawns and other crustaceans and bottom and column fishes. On the other hand, fishes from the Gulf of Mannar fed on crabs, prawns, *Philine* sp , ostracods, amphipods, alpheids and fishes. Variation of food in relation to size showed that the smaller size groups ate polychaetes, amphipods, ostracods and other smaller crustaceans and their diet was restricted to a few items from the bottom epi - and infauna; whereas the larger fish (1-and 2-year olds) fed on a variety of crustaceans and fishes, both from the bottom and column waters. Still larger fish ate larger crustaceans and fishes. In short, the immature fish were purely bottom feeders (on a narrow food spectrum), but the mature fish frequently visited the column waters for a more varied diet. The feeding intensity was low during the breeding months of April and August in the case of mature fish. The yolked larvae, while in the parent's mouth, supplemented their diet by small planktonic organisms that get into the male's mouth along with the respiratory incurrent.

TABLE - 2

Synopsis of the food and feeding habits of tachysurid catfishes of India

Species	Major food items	Feeding intensity and habits	Locality	Author
Tachysurus thalassinus	Fishes and algae	Omnivore	Gulf of Mannar	Chacko (1949)
,,	Sea-cumcumber, cuttle fish, small crustaceans, amphipods; prawns, crabs, worms and small fishes.		West coast	Devanesan and Chidambaram (1953)
,,	Crabs, fishes, prawns, stomatopods, polychaetes and slaps	Carnivore and partial scavenger	Bombay	Suseelan and Nair (1969)
,,	Crabs, prawns, *Squilla* sp. and demersal fishes.	Larger fish (36 cm and above) have low feeding intensity during April-August, Carnivore	Waltair	Mojumder (1969)
,,	Echiurids, crabs, prawns, stomatopods, polyachaetes and fishes (Palk Bay); *Philine* sp., crabs, alpheids, prawns, ostracods, amphipods and fishes (Gulf of Mannar)	Low feeding intensity during April-August. Small fishes are true demersal feeders and larger fishes are demersal and column feeders.	Mandapam	Menon (1979)
T. dussumieri	Spine shells and *Dentalium* sp.		West coast	Devanesan and Chidambaram (1953)
,,	Polychaetes, ophiurids, bivalves and sea weeds.	Omnivore	Calicut	Venkataraman (1960)
,,	Bivalves, crabs, amphipods, polychaetes, brittle stars and teleosts.	Carnivore, bottom feeder	Bombay	Suseelan and Nair (1969)
,,	Echiurids, crabs, prawns, *Squilla* sp. and fishes	Carnivore	Mandapam	Menon (1979)

1	2	3	4	5
T. jella	Molluscus, *Lucifer*, crabs, prawns and small fishes.		West coast	Devanesan and Chidambaram (1953)
,,	Anemones, polychaetes, crabs, amphipods, stomatopods, bivalves and gastropods.	Omnivore active feeding during night	Bay of Bengal	Rao (1964)
,,	*Squilla* sp., prawns and bivalves (*Arca* sp.)		Bombay	Suseelan and Nair (1969)
T. platystomus	Crabs, echiurids, prawns, *Squilla* sp. and demersal fishes (Palk Bay)	Low feeding intensity during November-January. True demersal feeders. Carnivore.	Mandapam	Menon (1984 b)
	Crabs, prawns, *Squilla* sp., polychaetes, molluscs and echiurids. (Gulf of Mannar)			
T. tenuispinis	Crabs, prawns, *Squilla* sp., polychaetes, molluscs and echiurids.	Low feeding intensity during June-July.	Waltair	Mojumder (1981)
T. caelatus	Echiurids, crabs, fishes, prawns and polychaetes	Carnivore	Mandapam	Menon (1979)
T. serratus	Crabs, prawns, echiurids, alpheids, squids and fishes	Small fishes feed on the bottom and large fish feed both in bottom and column.	Mandapam	Menon (1979)
Osteogeneiosus militaris	Brittle stars, crabs, polychaetes, molluscs and whitebaits.		West Coast	Devanesan and Chidambaram (1953)
,,	Polychaetes, molluscs, crabs, prawns and brittle stars.	Bottom feeder.	Calicut	Venkataraman (1960)

Tachysurus dussumieri : Venkataraman (1960) and Suseelan and Nair (1969) studied the food habits of *T. dussumieri* from Malabar and Bombay waters, respectively. Menon (1979) reported that *T. dussumieri* was essentially a carnivore, feeding on the bottom epi-and infauna, though the larger size-groups appeared on the surface and fed on fishes. They fed mainly on echiurids, crabs, prawns, *Squilla* sp. and fishes. Juveniles up to a size of 12 cm mainly fed on polychaetes of the species *Diopatra variabilis* and *D. neopolitana*. Larger size-groups ate larger crustaceans, squids and fishes.

Tachysurus platystomus : This species is purely a bottom feeder, feeding on the bottom epi- and infauna. The yolked larvae of this species were found to supplement their diet by planktonic organisms like nauplii, alima and copepods, even while they were in the parent's mouth. The immature fish from the Gulf of Mannar fed mainly on polychaetes (12 to 50%) and *Philine* sp. (12 to 50%); other important food items were amphipods, prawns, crabs and ostracods. Fish from Palk Bay ate echiurids (16 to 40%), polychaetes (17 to 63%) and prawns (4 to 20%). The major food items of mature fish from the Gulf of Mannar were *Philine* sp. (14 to 40%), crabs (10 to 25%), *Squilla* sp. (10 to 20%), prawns (3 to 20%) and alpheids (4 to 23%). On the other hand the food components of the mature fish of Palk Bay were echiurids (2 to 35%), *Squilla* Sp. (14 to 22%), prawns (5 to 24%) and crabs (7 to 13%). High percentage of empty stomachs were observed during November to February, the breeding period of the species. Unlike many other species of the family Tachysuridae (Menon 1984 b), all the size groups of this species fed on the bottom fauna.

Tachysurus caelatus : A study on the food habits of *T. caelatus* from Mandapam waters showed that the species was a voraceous carnivore; the main food organisms encountered in the stomachs were echiurids, crabs and fishes. The Juveniles of this species fed mainly on the bottom fauna like *Diopatra variabilis*, small crabs and echiurids; while the larger size-groups preyed upon a variety of prawns, comprising the species *Penaeus semisulcatus*, *Metapenaeus affinis* and *Parapenaeopsis tenella*, and crabs, echiurids and column fishes (Menon 1979).

Tachysurus jella : Devanesan and Chidambaram (1953), having analysed the stomach contents of *T. jella*, reported that they fed on mollusca, lucifer, crabs, prawns and small fishes. Suseelen and Nair (1969) found that the species fed on *Squilla* sp., prawns and bivalves. Rao (1964) reported that *T. jella* was an omnivore, feeding actively during night and that the species was an exclusive bottom feeder, crabs, prawns and other crustaceans constituting the bulk of the food during night.

Tachysurus tenuispinis : A study on the food spectrum of this species had shown that they were essentially carnivores, feeding on the bottom and, at times, also on midpelagic fishes and squids. They fed mainly on crabs, prawns, *Squilla* sp. and other crustaceans. The crustacean food formed 37%, polychaetes 26%, molluscs 6.5%, teleosts 6.3% and echiurids 4.2% of the total volume of food components. As a single item, polychaetes appeared preferred. Low feeding intensity was observed during June-July, correlated with the breeding season (Mojumder, 1981)

Tachysurus serratus : The major food items of *T. serratus* from Mandapam waters were crabs, prawns, echiurids, *Squilla* sp., alpheids, squids and fishes. The smaller size-groups were true demersal feeders and the large fishes moved up the column waters for a more varied diet consisting of larger food components (Menon 1979).

Osteogeneiosus militaris : Devanesan and Chidambaram (1953) and Venkataraman (1960) had studied the food of this species and reported that they were bottom feeders, feeding mainly on polychaetes, molluscs, cuttle fishes, crabs, prawns and brittle-stars.

REPRODUCTIVE BIOLOGY

The present information on the breeding biology of tachysurid catfishes from Indian waters in relation to time, place and pre-spawning developmental changes of the gonad is very scanty. The only published accounts

are on the development of *T. Jella* by Chidambaram (1942) and on the size of eggs collected from the mouths of gestating males of *T. caelatus* by Sekharan and Mojumder (1973). Pantulu (1963), Dan (1977), Majumder (1978) and Menon (1979 and 1984 a) have given detailed accounts on the breeding biology of a few species of tachysurids from Indian waters.

The nature, function and distribution of ova in the different regions of the ovary of tachysurid catfishes showed significant difference from other teleostean fishes. In the mouth-breeding tachysurid catfishes, there were three groups of ova in the ovary with different nature and function. In a ripe ovary, of the three groups of ova, designated as 'a', 'b', and 'c, the first was comparatively small, non-yolked and translucent, occupying the oviducal region of the ovary; the 'b' ova were also non-yolked, translucent, and frothy in nature, occupying the posterior conjoined region of the ovary; whereas the 'c' ova were yolked, opaque, occupying the rest of the ovary (Plate 1 H). The first two groups were reproductively non-functional where as the last group alone was reproductively functional. At the time of spawning, the groups 'a', 'b' and ripe 'c' ova were extruded in a bunch (Menon, 1984 a). Details of the reproductive biology of some species of techysurids are given in Table 3. A breeding calender for Indian tachysurids is given in Fig. 1 to show the spawning season of various species.

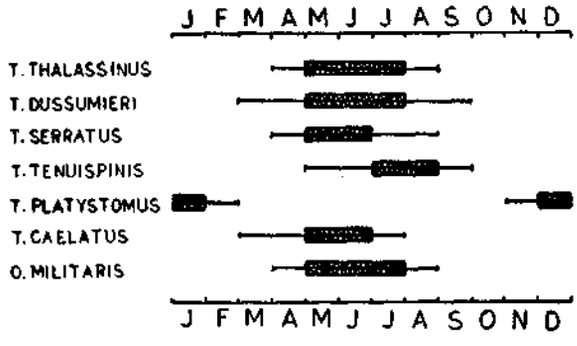


Fig. 1 Breeding calender for the tachysurids

Tachysurus thalassinus : A detailed study on the ova-diameter frequency of *T. thalassinus* from Mandapam waters had shown that there were three modes in the group 'c' ova, which were at 2.2 mm, 3.7 mm and 14.2 mm. Since there was only one batch of mature ova that was widely separated from the maturing groups, it was evident that the species spawned only once, in a short, restricted period. Even though the spawning period of individual fish was short, and only once a year, the appearance of gestating males, ripe females and juveniles over a long period of time had suggested that the population as a whole might breed over a prolonged period, with the peak breeding period from April to August. Females of *T. thalassinus* were found first to mature (stage III) at a size of 28–30 cm and male at 26-28 cm in total length. The males first spawned when they completed one year and females when they were two years old and there after every year as in males. The maturity-maximum-length relationship of the species was found to be 0.3231 for males and 0.3419 for females; this low value, of $L\infty$ / Loc perhaps indicating a low mortality (M) rate for this species (Beverton and Holt, 1957). The fecundity varied from 31 ova in a fish of 378 mm to 60 ova in a fish of 450 mm in total length. The relationship between fecundity and fish length may be expressed by the equation, log F=1.9332+ 1.3581 log L, the correlation, coefficient 'r' = 0.7059. The fecundity-fish-weight relationship may be expressed as, log F=0.3352+ 0.4524 log W and the 'r' value calculated at 0.7231. The values of the exponent in both the above relationships show that the fecundity increased at a rate less than length-weight relationship. The immature (stages I and II) fish had a gonadosomatic index of 0 to 0.1, 0.1 to 0.9 for early mature fish (stage III) and 0.9 to 14.3 for late-mature and spent (stage IV-VII) fish. In the peak breeding months, April to August, high values of G.S.I. were observed. In the larger size groups the females were outnumbered by males and during the breeding months, equal number of males and females were noticed in the catches. (Menon, 1979).

Mojumder (1978) found that off waltair coast this species breed once a year, from April to August, with peak in May–July. The size at first maturity for females was 36 cm and the fecundity varied from 25 to 42 ova.

Tachysurus dussumieri : Menon (1979), based on the ova-diameter-frequency polygon of *T. dussumieri* from Mandapam waters, observed

two widely separated distinct modes in the ripe ovary for the group 'c' ova, at 4.5 mm and 13.5 mm. The second group of gravid ova along with non-functional 'a' and 'b' ova seem to get extruded once a year during March-July in Mandapam waters. The fecundity was estimated to be 108-165 ova in fish ranging from 580 to 625 mm in total length.

Tachysurus tenuispinis : The species was found to breed only once a year, during May to September, with peak in July-August. The size at first maturity was 275 mm for both males and females. The fecundity varied from 29 to 82 in fishes ranging from 285 to 424 mm. The females dominated in the commercial catches and the male: female ratio was 1:1.79 (Dan, 1977).

Tachysurus caelatus : The ova diameter study on the functional group 'c' ova showed two distinct widely separated modes in a ripe ovary, at 3.5 and 11.5 mm. The spawnings of the individuals was found to take place once a year, over a short period of time. However the occurrence of spent female and gestating males over a long period of time suggests that the population as a whole might breed over a protracted period from March to August (Menon, 1979). Sekharan and Mojumder (1973) found three different groups of eggs in the mouth of the gestating males of *T. caelatus* with distinct modes at 11.13mm, less than 6 mm and 0.04-0.16 mm (appearently of groups 'c', 'b' and 'a' ova referred to earlier).

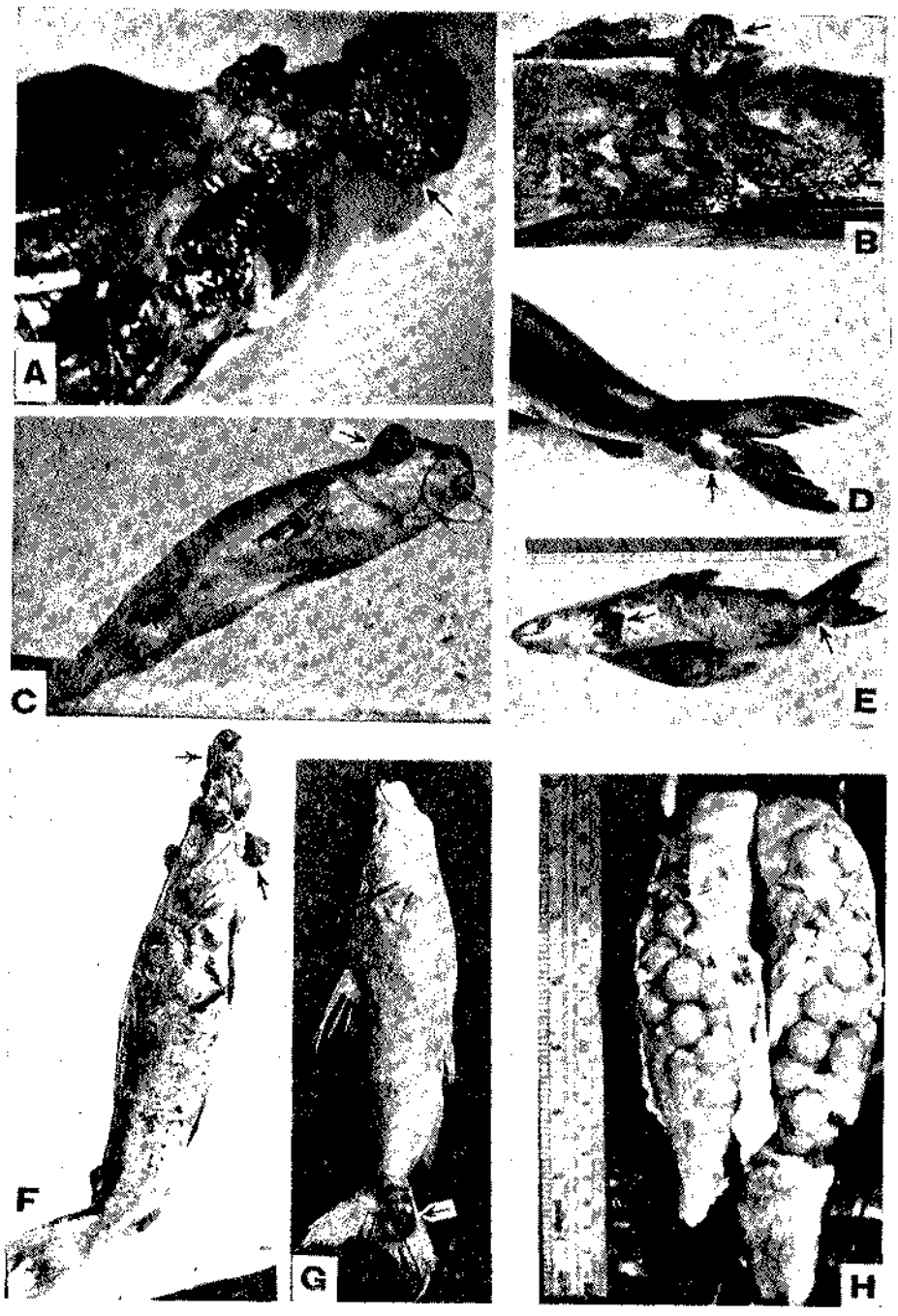
Tachysurus platystomus : The ova-diameter-frequency polygon of *T. platystomus* showed two distinct modes in the ripe group 'c' ova at 2.5 and 11.5 mm; the species spawning only once a year, in a short period of time, from November to February. The females appear first to mature at a size of 230 mm and males at 220 mm. The fecundity varied from 32 to 45 ova in fishes of 230 to 393 mm in total length. Males were numerous in the catches during the breeding season (Menon, 1984 b).

PARENTAL CARE

The low fecundity of the species of techysurids is usually compensated by the low rate of egg/larval mortality due to the type of parental care involving buccal incubation, common in all the species of the genera *Tachysurus* and *Osteogeneiosus*. When the female attains maturity, the pelvic fins get modified by way of enlarging the tissues on the first inner fin-ray. This modification of the pelvic fins reaches its culmination in the ripe stage; and then the fins get enlarged and broadened. Lee (1937), Hardenberg (1935), Gunter (1947), Balon (1975) and Menon (1979) suggested that probably these modified pelvic fins assist to transfer the spawned eggs to the mouth of males. As a preliminary to receive spawned eggs, the ripe males show some modification in the oral cavity. The volume of the oral cavity gets increased and the oral mucosa secretes more mucus, which acts as a cushion for the developing young ones. This mucus coating of the oral cavity of the parent protects the young ones from the sharp teeth in the palatine and upper and lower pharyngeal tooth plates (Oppenheimer, 1970). In all the species of tachysurids, the male carries the brood in the mouth. The period of gestation is two months in the case of *Arius jella* (Chidambaram, 1942) and one month in the case of *T. thalassinus* (Menon, 1979). The larvae remain the parent's mouth till the whole yolk get absorted.

PARASITES

Menon (1979) reported occurrence of a copepod parasite, *Caligus dakari* Van Benedon, in the buccal cavities of *T. thalassinus* and *T. dussumieri* from Mandapam waters. The infestation was maximum during September-January period. As high as 9% of the fish examined during December showed the presence of this parasite in *T. thalassinus*. *Hermilius pyriventris* Heller was found to infest the gill filaments of *T. thalassinus* and *T. platystomus* and their percentage of incidence was high in October-December period. Pillai (1962) reported the occurrence of *Hermilius longicornis* Basett and Smith from the gill filaments of *T. dussumieri* and *T. acutirostris*. Pillai (1961) recorded the occurrence of *Lepeophtheirus Longipalpus* Basett and Smith in the buccal cavity of *T. dussumieri*. A few specimens of *T. thalassinus* from Mandapam and Tuticorin (Gulf of Mannar)



Figs A—G. *Different types of tumours* (Papilloma, Osteoma, Osteochondroma) different parts of *T. tenuispinis* (see arrows)

Fig. H. Ripe ovary of *T. tenuispinis* showing both functional and non-functional ova.

were found to be infested by a new species of myxosporidian sporozoan, *Henneguya tachysuri*. The cysts of the parasite were found in the subcustaneous muscles and were easily spotted by external bulges in the skin (Menon, 1984 c). The occurrence of various forms of tumours noticed in tachysurid catfishes is also worth mentioning. Selvaraj *et al* (1973) reported the occurrence of osteochondroma and osteoma in *Tachysurus jella* from the southwest coast of India. In this species the skin, bone and fins were affected by tumours of different sizes, sometimes as large as 45 mm diameter. Menon (1975) noticed buccal papillomas in the floor of the buccal cavity of *Tachysurus platystomus*, particularly in females, from the Gulf of Mannar; the size of the tumour varied from 3 to 10 mm. Different types of tumours (papilloma, osteoma, osteochondroma) of various sizes and forms were recorded from *Tachysurus tenuispinis*, almost round the year, from Calicut during the years 1979-1985 (Plate 1 A-G). The osteomas were very common in this species affecting almost all skeletal parts of the fish including fin rays, vertabrae, etc. The tumours occur irrespective of sex and gonadial conditions.

Table - 3

SYNOPSIS OF THE REPRODUCTIVE BIOLOGY OF A FEW SPECIES OF TACHYSURIDS FROM INDIAN WATERS

Species	Locality	Methods of study	Frequency of spawning	Spawning Season	Fecundity	sex ratio M : F	Reference
T. thalassinus	Mandapam	Ova diameter Relative condition factor, Gonado-somatic index	Single spawning	April-August	31-60	1 : 1.08	Menon, 1979
,,	Waltair	Ova diameter	,,	April-August	25-42	1 : 1	Mojumder, 1978.
T. dussumieri	Mandapam	Ova diameter	,,	March-July	108-165		Menon, 1979
T. tenuispinis	Waltair	Ova diameter	,,	May-September	29-82	1 : 1.79	Den, 1977.
		Ova diameter	,,	November-February	32-45	1 : 1.12	Menon, MS
		Relative condition factor					
T. caelutus	Mandapam	Ova diameter	,,	March-August	30-70		Menon, 1979.
T. platystomus	Mandapam	Ova diameter	,,	November-February	32-45		Menon, 1984 b
Osteogeneious militaris	Hooghly estuary	Ova diameter Relative condition factor	,,	March-May	40-110		Pantulu, 1963.

ASSESSMENT OF THE RESOURCES OF IMPORTANT SPECIES OF CATFISHES

— K. ALAGARAJA AND M. SRINATH

DATA BASE

The centres Waltair and Mandapam, in the east coast and Cochin, Mangalore and Veraval, in the west coast, where biological data on catfishes have been collected, are considered for the assessment of resources of Tachysurus *thalassinus, T. tenuispinis, T. serratus, T. dussumieri* and *Osteogeneiosus militaris*. Length-frequency data of *T. thalassinus* collected during 1974-76 at Waltair from trawl catches, during 1972-76 at Mandapam from trawl catches, during 1981 at Cochin Fisheries Harbour from the catches of trawls, purse-seines and gill nets and during 1981 and 1982 at Veraval from trawl catches are taken up for this study. For *T. tenuispinis*, the data collected during 1974-76 at Waltair from trawl catches, during 1981 at Cochin Fisheries Harbour and during 1982-83 at Mangalore both from trawls, purse-seines and gill nets are considered. For *T. serratus*, the length-frequency data collected from the catches of trawls, purse-seines and gill nets at Cochin Fisheries Harbour during 1981 and for *T. dussumieri* and *O. militaris* those collected from the catches of trawls at Veraval during 1981 and 1982 are also considered.

ESTIMATION OF GROWTH PARAMETERS AND THE TECHNIQUES USED

i. *Estimation of 'L∞' and 'K'* : Assuming that the growth of catfish is isometric and following Von Bertalanffy's growth pattern, namely

$$L_t = L\infty\left[1 - e^{-k\,(t - to)}\right] \quad \ldots\ldots\ldots(1)$$

in the usual notation, estimates for L∞ and K are obtained using ELEFAN-I (Pauly et al, 1981). Since the estimates for each species did not show much variation between centres, sets of estimates (L∞ and K) one for each species is obtained and is presented along with the corresponding estimate for W∞ in Table 1.

TABLE - 1

Estimation of growth parameters

Parameters / Species	L∞ (mm)	K(annual)	W∞ (gm)
T. thalassinus	755	0.36	4030
T. tenuispinis	560	0.78	3230
T. serratus	1100	0.25	8000
T. dussumieri	850	0.25	6000
O. militaris	540	0.78	3200

It can be seen from the above table that estimates of 'K' decrease while the corresponding values of L∞ increase. This is quite consistent with the growth model under consideration.

ii. Estimates of 'Z' the Instantaneous Rate of Total Mortality

Age-frequency distribution was found to be very difficult to obtain from the available data. Using length-frequency data and following the method of Alagaraja (1984) estimates of 'Z' for each year at each centre for every species mentioned above have been obtained along with their error estimates. In some cases three point moving averages have been taken for this purpose. That portion of the length frequency distribution which resembled the right limb of catch curve alone was considered for estimation of 'Z'. The steps taken for this purpose as well as marking the portion considered for the estimation of 'Z' are indicated in the work sheets enclosed.

The formula used for this purpose is:

$$\log\left(N_t + \Delta_t / N_t\right) = \frac{Z}{K} \log \frac{L\infty - L_t + \Delta_t}{L\infty - L_t} \quad \ldots\ldots\ldots\ldots(2)$$

Estimates of $L\infty$ and k are available from Table 1 and L_t and $L_t + \Delta t$ are the successive mid values of the length classes whose frequencies are N_t and $N_t + \Delta t$. Since constant 'Z' for the entire size range of fishing is considered, catches in numbers at successive ages C_t and, $C_t + \Delta t$ are proportional to N_t and $N_t + \Delta t$. Hence

$$N_t + \Delta t \ / N_t = C_t + \Delta t \ / C_t \quad \ldots\ldots\ldots (3)$$

This is made use of in the above formula (2) and length frequency data are used for estimation of 'Z'. The procedure for obtaining the estimates of 'Z' is as follows. The deviations of L_t from $L\infty$ $(= L\infty - L_t)$ are to be taken. Converting them to log values (common log will do), the values log $(L\infty - L_t)$ are obtained. After tabulating these values, their successive differences log $(L\infty - L_t)$ − log $(L\infty - L_t + \Delta t)$ are calculated. In the same way, the sucessive differences of log (N_t) are to be taken and tabulated as follows :

L_t	$L\infty - L_t$	log $L\infty - L_t$	$\frac{\Delta \log (L\infty - L_t)}{A}$
1	2	3	4
C_t	log C_t	$\frac{\Delta \log C_t}{B}$	$\frac{Z/K}{B/A}$
5	6	7	8

Where Δ log $(L\infty - L_t)$ and Δ log C_t are the respective successive differences.

Thus for each row of successive differences an estimate of $\bar{z}/k$ is available. If there are 'n+1' length groups then there will be 'n' estimates of $\bar{z}/k$. If the first estimate of $\bar{z}/k$ is termed as x_1, the second as x_2 and so on with the last one as x_n then

$$\bar{z}/k = 1/n \sum_{L=1}^{n} X_i \quad \ldots\ldots\ldots (4)$$

and

$$s^2 \bar{z}/k = \frac{1}{n-1}\left[\sum_{L=1}^{n} X_L^2 - \left(\sum_{L=1}^{n} X_L\right)^2 \Big| n\right] \quad \ldots\ldots\ldots (5)$$

Hence sz/k can be obtained as the square root of the above expression. The standard error of z/k(= sz/k) is $\frac{1}{\sqrt{n}} s_{z/k}$ Multiplying $\bar{z}/k$ and $s\bar{z}/k$ by the already available estimate of 'k' the estimate of $\bar{z}$ and $s\bar{z}$ are derived. The detail procedure is given in the worksheet II. The estimates thus obtained are given in tables 2-4 below along with the sample size (n), l_c and l_r where l_c indicates the size at first capture of the fully recruited phase and l_r is the size at entry to the fishery.

TABLE 2

Values of the estimates of $\bar{z}$ and its standard error and 'n' lc and l_r for T. thalassinus

Centre	Year	Values				
		$\bar{z}$	s $\bar{z}$	n	lc (mm)	lr (mm)
1. *Waltair* (Trawls)	1974	2.34	0.41	4		
	1975	2.24	0.68	7	180	100
	1976	1.16	0.54	4		
	Combined	1.98	0.37	15	180	100
2. Mandapam (Trawls)	1972	2.32	0.62	6	170	
	1973	1.54	0.27	5	230	
	1974	1.16	0.36	7	190	
	1975	2.06	0.40	11	230	60
	1976	3.72	0.55	8	270	
	Combined	2.22	0.25	37	220	60
3. *Cochin* Fisheries Harbour (Trawl & gill net)	1981	2.06	0.52	9	360	100
4. *Veraval* (Trawls)	1981	1.71	0.88	4		
	1982	1.50	0.63	4	380	100
	Combined	1.60	0.50	8	380	100

TABLE 3

Values of estimates of $\bar{z}$, and its standard error and 'n', lc and lr for T. tenuispinis

Centre	Year	Values				
		$\bar{z}$	s $\bar{z}$	n	lc (mm)	lr (mm)
1. *Waltair* (Trawls)	1974	2.14	0.64	3	220	80
	1975	2.57	0.84	3	220	120
	1976	2.95	0.73	4	180	160
	Combined	2.59	0.40	10	200	120
2. *Cochin Fisheries Harbour* (Purse seine, trawls & gill nets)	1981	3.04	1.29	5	280	100
3. *Mangalore* (Purse seine trawl & gill nets)	1982-83	2.76	0.92	9	260	40

TABLE 4

Values of estimates of $\bar{z}$ and its standard error and 'n', lc and lr for T. serratus, T. dussumieri and O. militaris

	Species	Centre	year	Values				
				$\bar{z}$	$s_{\bar{z}}$	n	lc (mm)	lr (mm)
i.	*T. serratus*	*Cochin Fisheries Harbour* (Purse-seine)	1981	2.83	0.58	5	310	200
ii.	*T. dussumieri*	*Veraval*	1981	2.64	0.68	6	250	180
		(Trawls & gill nets)	1982	1.98	0.74	5	260	120
		Combined		2.34	0·49	11	250	120
iii.	*O. militaris*	Veraval	1981	2.80	0.50	6	350	200
		(Trawl &gill nets)	1982	1.74	0.37	10	270	200
		Combined		2.14	0.32	16	300	200

It may be noted from the above tables that the estimates of $\bar{z}$ and $s_{\bar{z}}$ are not differing very much between years. The differences between centres are also not very high.

iii. Estimation of 'M' the instantaneous natural mortality rate :

Effort data available, did not lead to estimation of effective effort particularly when data for more than one gear was considered. In multi-species fishery operated on by multi-gears the usual approach of

$$Z = M + qf \quad \ldots\ldots (6)$$

may not be possible. Hence a different approach is taken here, following Alagaraja (1984) to estimate 'M' directly from the length frequency data. Assuming one present survival of fish after they attain a length of $L\infty - 0.5$cm, the age T at which $L\infty - 0.5$ is attained is obtained using

$$-\frac{1}{k}\log e\left(1-\frac{L\infty-0.5}{L\infty}\right) = T'-t_o = T. \quad \ldots\ldots (7)$$

and using

$$N_t / N_o = 0.01 = e^{-MT} \quad \ldots\ldots (8)$$

an estimate of 'M' is arrived at. For example in the case of *T. thalassinus* $L\infty = 755$ mm and $K = 0.36$. Hence

$$-\frac{1}{0.36}\log e\left(1-\frac{750}{755}\right) \simeq 14$$

$N_{14} / N_0 = 0.01 = e^{-14M}$

and $M = 0.33$

at one percent level of survival.

In this way 'M' for other species also have been estimated both at five and one percent levels of survival and the estimates are given below in table 5.

TABLE - 5

Estimates of 'M' instàntaneous rate of natural morality

Level of survival

Species	5%	1%
T. thalassinus	0.21	0.33
T. tenuispinis	0.50	0.76
T. dussumieri	0.15	0.22
T. serratus	0.15	0.21
O. militaris	0.50	0.77

For the present, estimates of 'M' at one percent level alone are considered since the values at five percent level appear to be low and at $L\infty - 0.5$cm length 'One percent survival' would not be far from the truth.

iv. *Construction of yield isopleths*

Considering the relatively long life span of cat fish and assuming isometric growth the yield equation

$$Y = FR\, W\infty\, e^{-M(t_c - t_r)} \sum_{n=o}^{3} \frac{Un\, e^{-nk(t_c - t_o)}}{F + M + nk} \quad \ldots\ldots (9)$$

(Gulland, 1969) has been considered here. Referring to the yield tables (Gulland 1969) for M/k = 1.0 yield isopleths have been drawn for $W\infty = 4030$ gm and $t_r = 9$mm. Eumetric fishing line BB' and the line AA' joining the maxima of yield-mesh curves are also indicated in fig. 1. Since for all the five species considered here, M/k remained more or less equal to unity, the same fig.1 can be used for these species with varying multiplying factors according to their $W\infty$ and t_r values. These multiplying factors are given below in table 6.

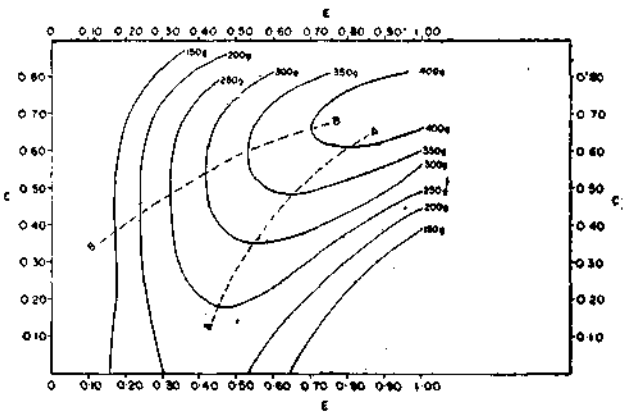


Fig. 1. Yield isopleths for the five species of cat fishes

TABLE 6

Multiplying factors to obtain actual Y/R in grams from fig. 1

Centres / Species	Waltair	Mandapam	Cochin Fisheries Harbour	Mangalore	Veraval
T. thalassinus	1.14	1.08	1.14	—	1.14
T. tenuispinis	1.01	—	0.97	0.85	—
T. serratus	—	—	2.40	—	—
T. dussumieri	—	—	—	—	1.71
O. militaris	—	—	—	—	1.24

Yield-effort curves and yield-mesh curves have also been drawn (figs.2-21) to get a clear picture of the status of fishery in each of these centres at the existing level of mesh size and effort.

From the yield isopleths (fig. 1) it can be seen the maximum sustainable yield (MSY) of about 400 gm per recruit could be obtained at the level of E=0.71 and C=0.66 where $E = F/Z$ and $C = l_c / L\infty$. The values of E and C for each species at each centre at the existing level of fishing are given in table 7.

TABLE 7

Levels of 'E' and 'C' at the existing level of fishing

Centre / Species		Waltair	Mandapam	Cochin Fisheries Harbour	Mangalore	Veraval
T. thalassinus	E	0.83	0.85	0.84	—	0.79
	C	0·24	0.30	0.48		0.50
T. tenuispinis	E	0.71		0.75	0.72	
	C	0.36		0.50	0.46	
T. serratus	E	—	—	0.93	—	—
	C	—	—	0.28	—	—
T. dussumieri	E	—	—	—	—	0.91
	C	—	—	—	—	0.30
O. militaris	E	—	—	—	—	0.64
	C	—	—	—	—	0.56

For *T. thalassinus* in all the four centres namely Waltair, Mandapam, Cochin Fisheries Harbour and Veraval the range for 'E' is 0.79 to 0.83 and for 'C' is 0.24 to 0.50. The values required for obtaining a MSY per recruit of about 400 gm are no where within the range. In other words to attain a MSY per requit of 400 gm a reduction in effort and increase in mesh size are required.

In the case of *T. tenuispinis* 'E' values are nearer to the required level for 400 gm of MSY per recruit. However, I_c values are much lower than the required level indicating that for this species also mesh size has to be increased to attain 400 gm of MSY per recruit.

So far as *T. serratus* is concerned the rate of first capture is too low. Similar is the case with *T. dussumieri*. Hence for these two species reduction in effort and increase in mesh size are required to reach 400 gm MSY per recruit.

Only in the case of *O. militaris* the level of exploitation both for effort and size at first capture is nearer to the required level for obtaining MSY per recruit of about 400 gm.

It is hence clear that the level of exploitation in general was not favourable to the fishery of all the species except *O. militaris*. In order to see the effect of fishing at the existing level of effort on these stocks yield-effort curves have been drawn. Similarly to find out the impact of mesh size used in the fishery on these stocks, yield-yield-mesh curves have been drawn (figs. 2-21).

Effects of Fishing on T. thalassinus

At waltair the yield-effort curve for the existing C=0. 24 indicated that MSY per recruit could be attained at E=0.50 which is far below the present level of exploitation, where E = 0.83 and the yield at E = 0.83 is below half of that at E = 0.50. Hence effort pressure should be considerably reduced to increase the returns from this stock at the present mesh size (Fig.2). For Mandapam at C = 0.30 and the existing level of exploitation E = 0.85 the yield per recruit is just above half of the MSY that could be obtained at E = 0.55. Here also reduction in effort is suggested to increase the returns

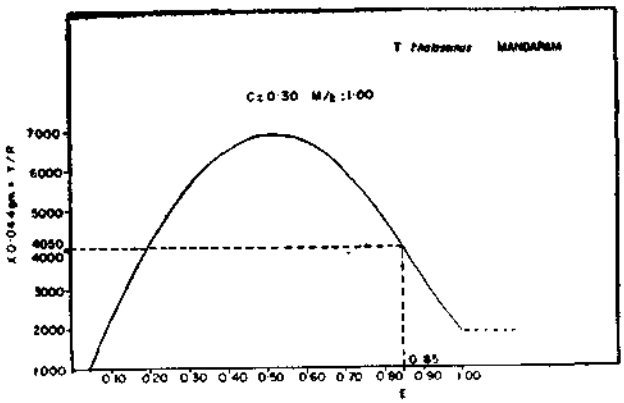


Fig. 3. Yield-effort curve for *T. thalassinus* at Mandapam

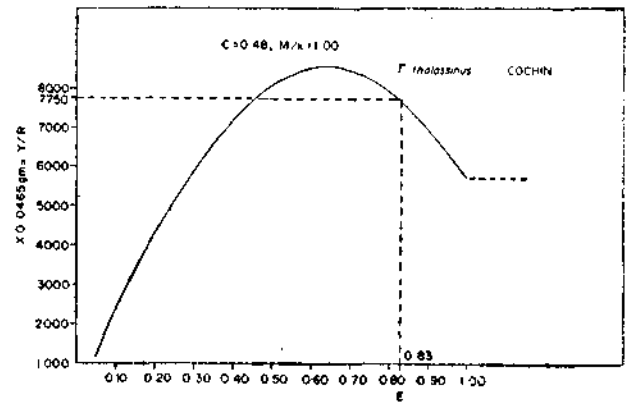


Fig. 4. Yield-effort curve for *T. Thalassinus* at Cochin

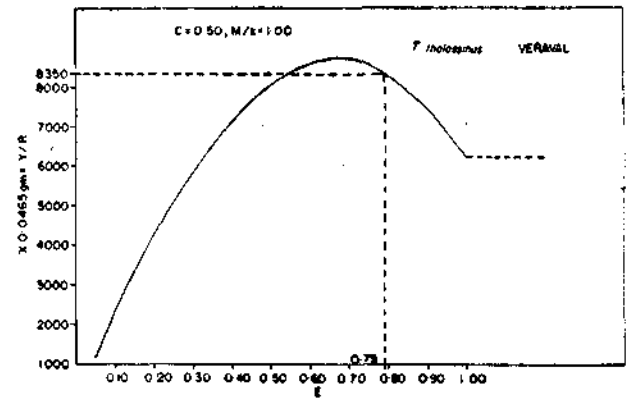


Fig. 5 Yield-effort curve for *T. thalassinus* at Veraval

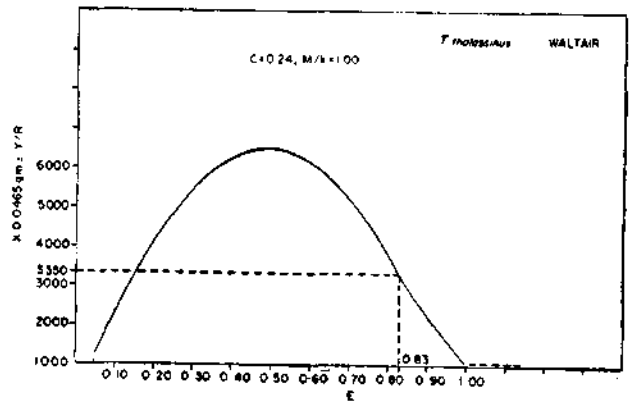


Fig. 2 Yield-effort curve for *T. thalassinus* at Waltair

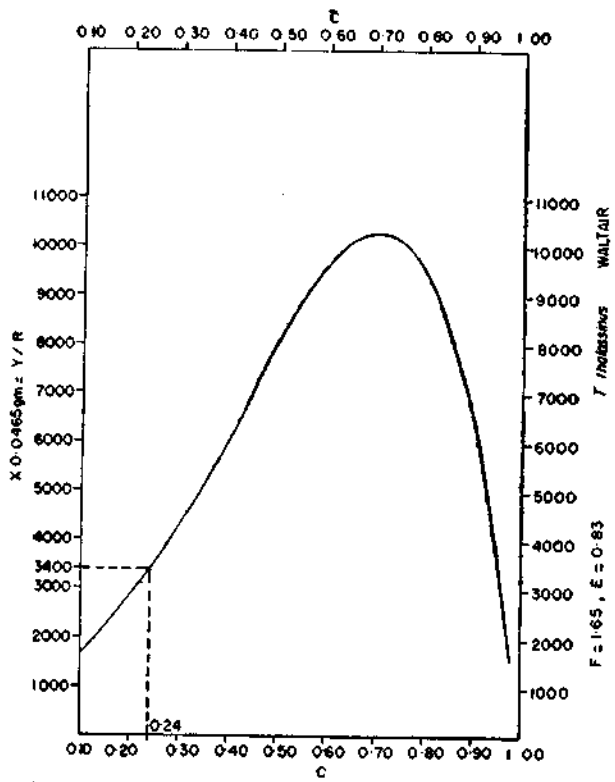


Fig. 6. Yield-mesh curve for *T. thalassinus* at Waltair

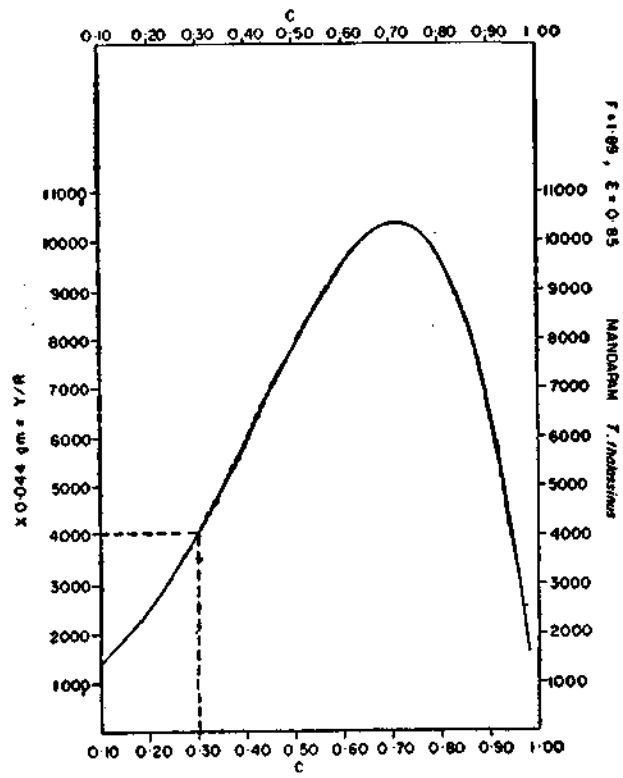


Fig. 7. Yield-mesh curve for *T. thalassinus* at Mandapam

from this species (fig.3). Though similar is the trend for *T. thalassinus* at Cochin Fisheries Harbour and Veraval the existing level of

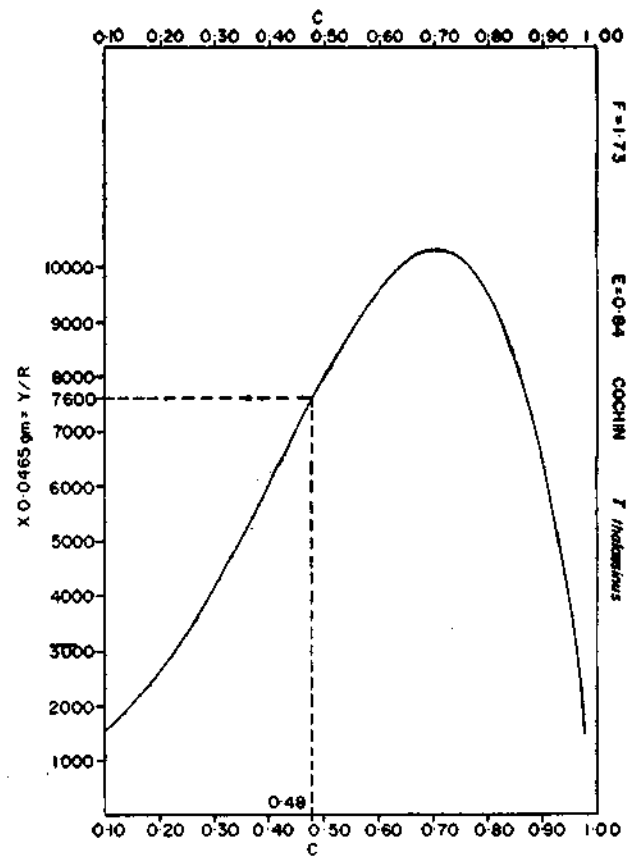


Fig. 8. Yield-mesh curve for *T. thalassinus* at Cochin

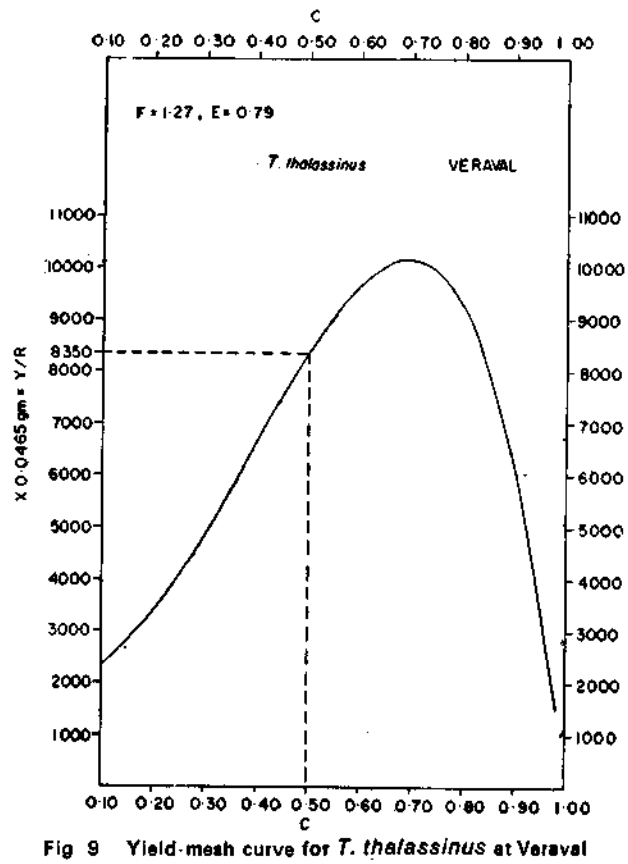


Fig 9 Yield-mesh curve for *T. thalassinus* at Veraval

exploitation is not far away from the required level to obtain MSY and relatively less reduction of effort will improve the landings at these centres (fig. 4 and 5). Yield-mesh curve for this fishery at Waltair (fig. 6) indicates that the existing mesh size (C = 0.24) is far below the required one (C = 0.70) and this mesh has to be increased considerably to gain in returns from the fishery. Similar trend is seen at Mandapam (fig. 7). Regarding Cochin Fisheries Harbour (fig. 8) and Veraval (fig. 9), relatively less increase in mesh size will improve the landings.

Effects of Fishing on T. tenuispinis

The existing levels of effort at Waltair (fig.10) Cochin Fisheries Harbour (fig. 11) and Mangalore (fig.12) are not far above the required level for obtaining MSY. This is quite in contrast to the fishery of *T. thalassinus* where considerable reduction in effort is recommended to achieve MSY. This is due to higher levels of 'C' for *T. tenuispinis*. Yield-mesh curves indicate

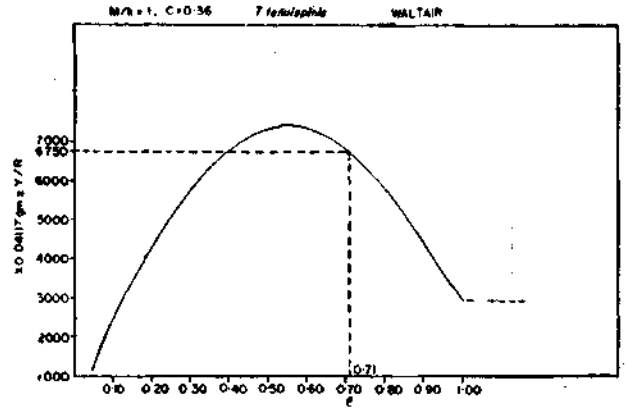


Fig. 10 Yield-effort curve for *T.tenuispinis* at Waltair

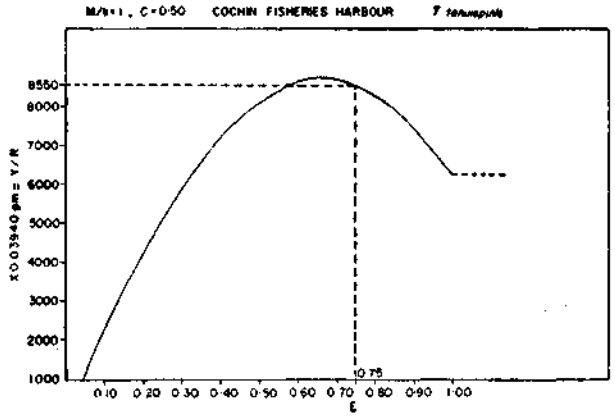


Fig. 11 Yield-effort curve for *T. tenuispinis* at Cochin Fisheries Harbour

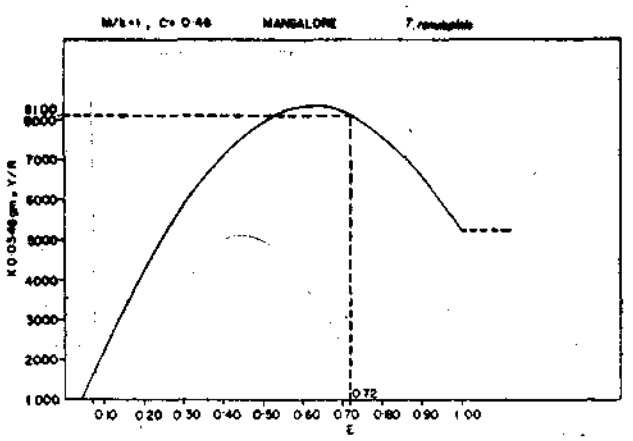


Fig. 12. Yield-effort curve for *T. tenuispinis* at Mangalore

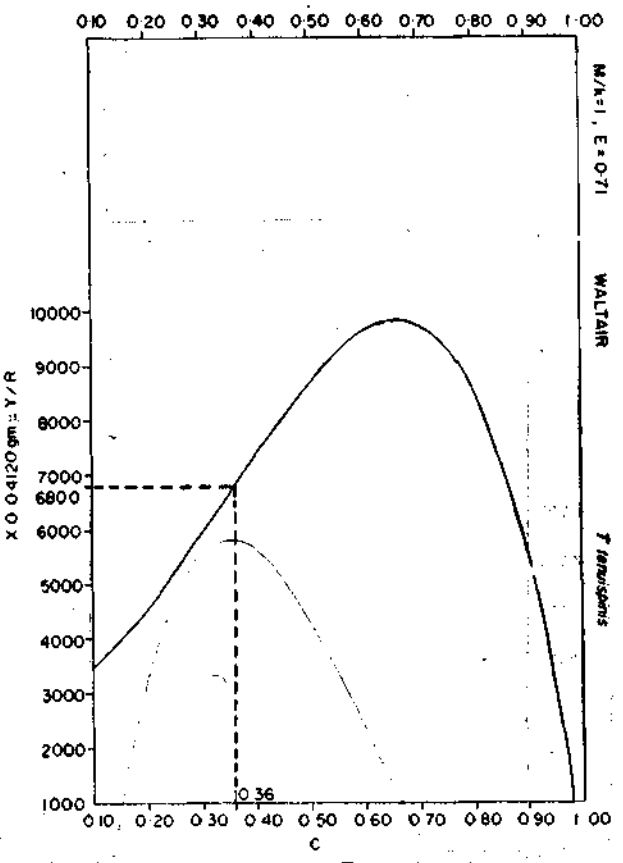


Fig. 13. Yield-mesh curve for *T. tenuispinis* at Waltair

that size at first capture at the present levels of exploitation have to be increased so as to attain MSY at Waltair (fig.13), Cochin Fisheries Harbour (fig. 14) and Mangalore (fig. 15).

Effects of Fishing on T. serratus, T. dussumieri *and* O. militaris

The fishery of *T. serratus* as observed at Cochin Fisheries Harbour is facing high fishing

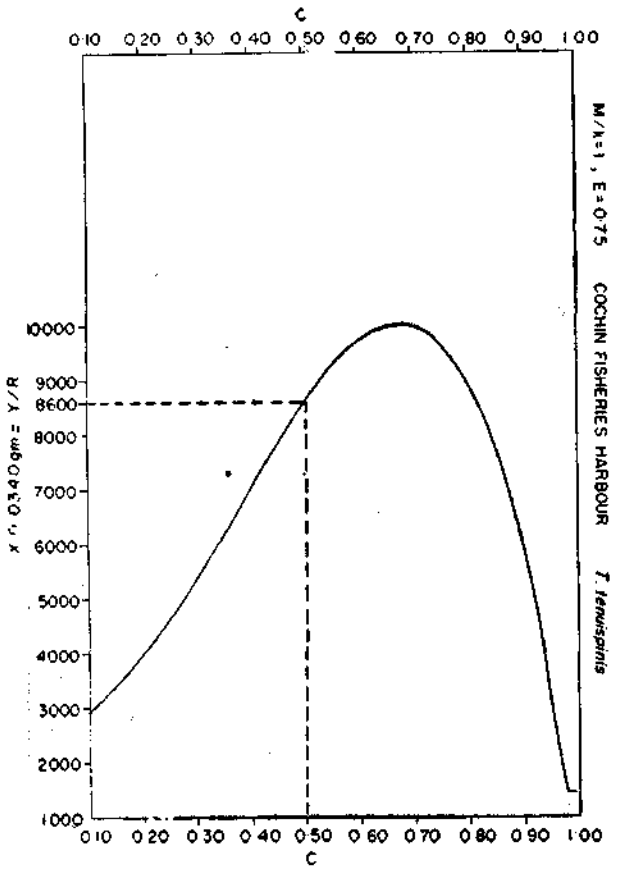


Fig. 14. Yield-mesh curve for *T. tenuispinis* at Cochin Fisheries Harbour

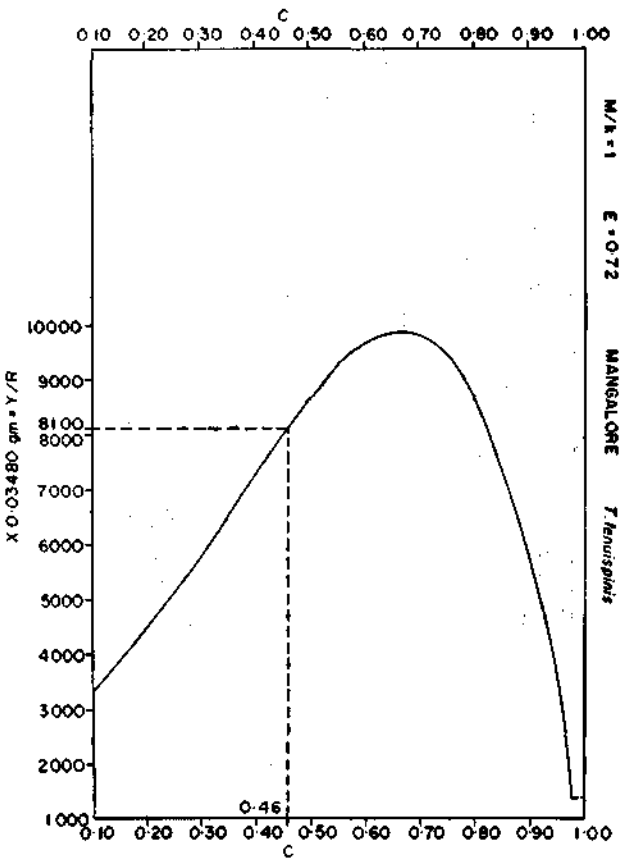


Fig. 15. Yield-mesh curve for *T. tenuispinis* at Mangalore

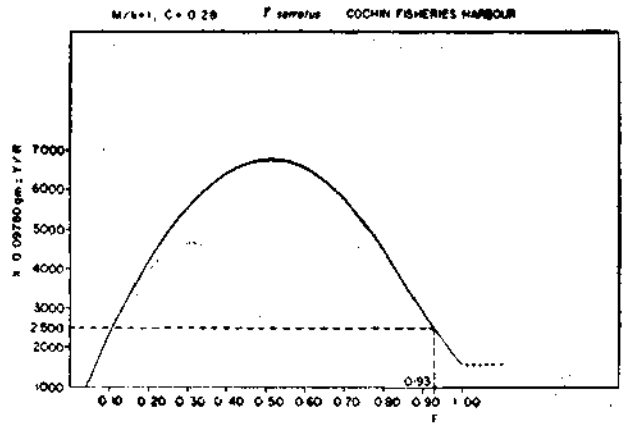


Fig. 16. Yield-effort curve for *T. serratus* at Cochin Fisheries Harbour

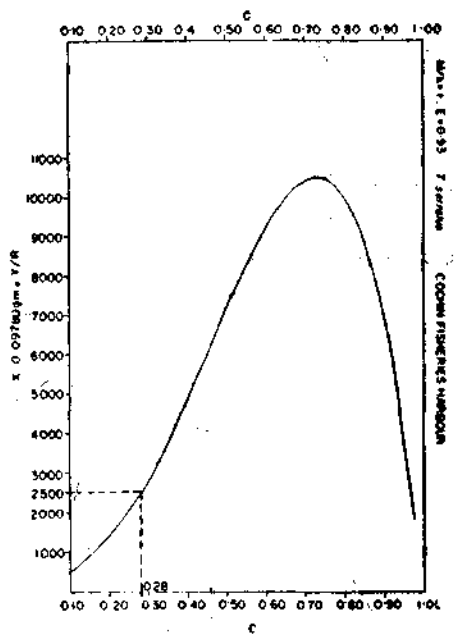


Fig. 17. Yield-mesh curve for *T. serratus* at Cochin Fisheries Harbour

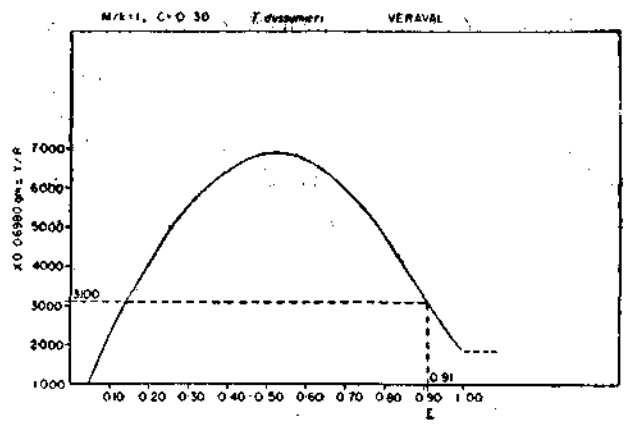


Fig. 18. Yield-effort curve for *T. dussumieri* at Veraval

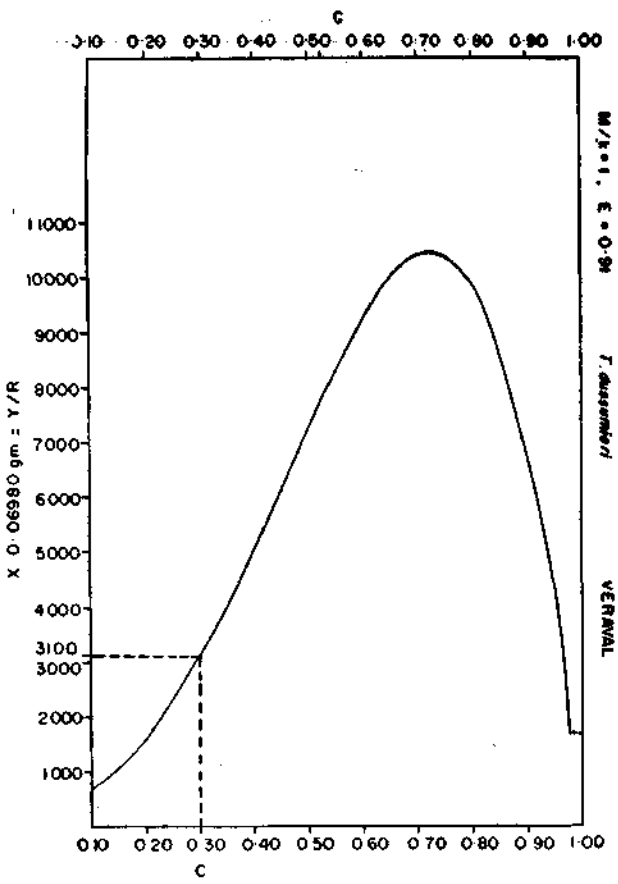


Fig. 19. Yield-mesh curve for *T. dussumieri* at Veraval

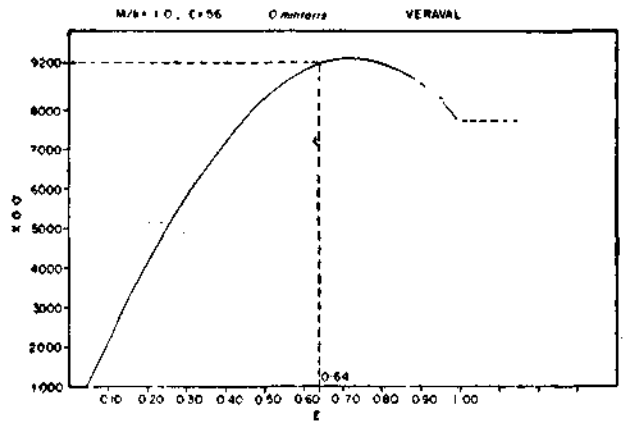


Fig. 20. Yield-effort curve for *O. militaris* at Veraval

pressure (fig. 16) and at this level the yield per recruit is only just above one third of MSY that could be obtained had the effort been reduced considerably. Yield-mesh curve also

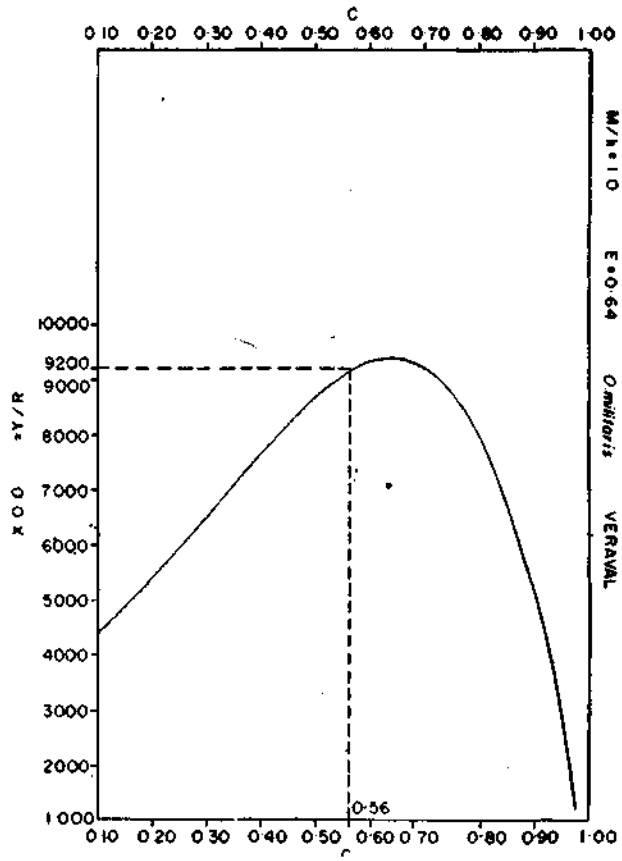


Fig. 21. Yield-mesh curve for *O. militaris* at Veraval

indicates (fig. 17) that at this level of fishing pressure the size at first capture should be increased two and half times so as to get MSY without effecting the stocks.

The fishery of *T. dussumieri* at Veraval is very similar to that of *T. serratus* as seen above. The yield-effort curve (fig.18) and yield-mesh curve (fig.19) indicate the same trends as in those of *T. serratus*. Hence heavy reduction of fishing pressure at the present level of 'C' or steep increase in the level of 'C' for the existing fishing pressure along will lead to MSY.

However, in the case of *O. militaris* the present level of exploitation at Veraval appears to be ideal both in terms of effort (fig.20) and the size at first capture (fig.21).

CONCLUSIONS

The stocks of the four species of catfish considered here other than O. militaris were under heavy fishing pressure. It is hence indicated that in order to get MSY from these stocks either the fishing pressure is to be reduced at the existing level of 'C' (the index of the size at first capture) or the present level of 'C' is to be increased considerably at the existing level of fishing pressure.

Suggestion to increase mesh size so as to increase 'C' may not be appreciated as the trawl fishery is mainly aimed at shrimp fishing and shrimp fishery may not be profitably exploited at the increased level of mesh size. However, effort pressure may be brought down so as to attain MSY from these stocks.

Instead of studying catfish fishery from trawl landings in isolation, it would be better to study this fishery along with other stocks particularly the shrimps to arrive at final conclusion on the suitable levels of mesh size and effort pressure. As indicated above so far as *O. militaris* is concerned present level of exploitation at Veraval appears to be ideal.

Annual catch estimates (Y in tonnes) for Waltair are based on the years 1978-80, for Mandapam on 1972-'76, for Cochin on 1981, Mangalore on 1982-'83, and for Veraval on 1981 and 1982. But for Mandapam, at other centres the estimates on average annual stock and average standing stock are comparable as these are based on the recent years.

For *T. thalassinus* Waltair region appears to be better when compared to other areas. However, for *T. tenuispinis* Managalore region indicates the maximum average annual stock. Regarding other species though region-wise comparision is not possible, from the present data base it can be said that the Veraval region hosts *T. dussumieri* and *O. militaris* more in abundance than *T. thalassinus*. Similarly Cochin region appears to be more favourable to *T. tenuispinis* than to *T. thalassinus* and *T. serratus* (Table 8).

TABLE 8

Estimates of annual catch (Y in tonnes), average standing stock (Y/F in tonnes) and average annual stock (Y/U in tonnes)

Species	Centre	F	$\left(\frac{F}{Z}\ \frac{U}{(1-e^{-Z})}\right)$	Y	Y/F	Y/U
					(tonnes)	
I. *T. thalassinus*						
1.	Waltair	1.65	0.72	151	92	210
2.	Mandapam	1.89	0.76	40	21	53
3.	Cochin	1.73	0.73	116	67	159
4.	Veraval	1.27	0.63	99	78	157
II. *T. tenuispinus*						
1.	Waltair	1.83	0.65	158	86	243
2.	Cochin	2.28	0.71	209	92	294
3.	Mangalore	2.00	0.68	1008	504	1482
III. *T. serratus*	Cochin	2.62	0.87	165	63	190
IV. *T. dussumieri*	Veraval	2.12	0.82	438	207	534
V. *O. militaris*	Veraval	1.37	0.57	275	200	482

WORK SHEET I-A

A. *T. thalassinus* (Catch in numbers)

i. Mandapam

Mid point (mm)	1972	M. A.*	1973	M. A.*	1974	M. A.	1975	M. A.*	1976	M. A.*
70	6673		1721		448		4396		5982	
90	17629	16505	4816	4220	776	1568	11305	10918	16597	16892
110	25214	22383	6125	6886	3479	3875	16513	16818	28089	25272
130	24305	24760	10018	11036	7371	7563	22937	23071	31120	32906
150	24761	25223	16965	15914	11839	10817	29763	28794	39502	38138
170	26604	26961	20758	20130	13242	12961	33683	34237	43792	44069
190	29519	26756	22666	22658	13801	13624	39264	37720	48914	47183
210	21446	24056	24550	24206	13830	13283	40213	39277	48842	50346
230	18496	18995	25403	24299	12217	12805	38354	39811	53282	52947
250	14344	13738	22944	22781	12367	10704	40866	38448	56715	56369
270	8385	9560	19997	19640	7637	8709	36123	34866	59110	56870
290	5662	5802	15978	15660	6123	6389	27608	26917	54784	51077
310	3069	6434	11004	12198	5406	6315	17021	21257	39336	39308
330	10272	...	9611	9689	7415	5367	19141	17265	23805	25061
350	15931	...	8452	10175	3280	5580	15634	15987	12041	13510
370	19574	...	12463	...	6046		13187	12652	4686	6764
390	17968		12285		1911		9136	8636	3566	3395
410	9689		3388		1139		3586	5191	1933	1928
430	1719		732		501		2852	2279	284	943
450	460		90		1606		398	1417	612	345
470	789		0		31		1001	—	140	
490	108		146		—		—	—	...	

ii. Waltair (Catch in numbers)

Mid point	1974	1975	M.A.*	1976	M. A*
100	—			7936	
140	—	4928		18681	14341
180	21805	35333	16213	16407	17998
220	13071	8379	15726	18907	17410
260	7790	3465	4865	16917	15813
300	3684	2750	2841	11617	10588
340	2693	2308	2527	3229	5218
380	527	2523	1964	808	
420	—	1060	1321		
460		381	489		
500	—	25			

iii. *Veraval* (Catch in numbers)

Mid point	1981	1982
380	23765	43358
420	21144	36595
460	14038	18939
500	9394	5359
540	1226	4293

Note:-

1. M. A. * indicates three point moving average.
2. Bracketed portion alone is considered for the estimation of 'Z'.

T. thalassinus (Catch in numbers) contd.

iv Cochin 1981

Mid point	Trawl	Gill net	Total	M. A.*
110	994	—	994	
130	35790	—	35790	13633
150	4114	—	4114	13821
170	1517	42	1559	2822
190	2511	281	2792	4639
210	9189	377	9566	8157
230	12034	78	12112	12392
250	15121	377	15498	26716
270	51949	588	52537	34844
290	35159	1340	36499	39608
310	26297	3492	29789	35536
330	35735	4586	40321	30233
350	15592	4997	20589	30331
370	22282	7801	30083	22204
390	6017	9923	15940	20915
410	9052	7670	16722	13315
430	3034	4248	7282	8779
450	—	2334	2334	3736
470	—	1593	1593	1890
490	—	1744	1744	1620
510	—	1522	1522	1460
530	—	1115	1115	1190
550	—	935	935	1235
570	—	1655	1655	1418
590	—	1664	1664	1620
610	—	1542	1542	1526
630	—	1374	1374	1398
650	—	1277	1277	955
670	—	213	213	564
690	—	201	201	149
710	—	33	33	81
730	—	10	10	

Note: 1. M. A.* indicate three point moving average.
2. Bracketed portion alone is considered for estimation of 'Z'

WORK SHEET I - B

B. *T. tenuispinis* (Catch in numbers)

I. Waltair

Mid point (mm)	1974	M. A*	1975	M. A*	1976
100	4295	...			
140	26646	10961	2152	8734	11402
180	1943	21916	13858	12150	8534
220	37160	19322	10193	9366	6809
260	18865	27692	12399	6665	3370
300	27053	20617	5505	2682	1279
340	15933	15298	3091		310
380	2909	6349	450		
420	204				

ii. Cochin 1981

Mid point	Purse seine	Trawl	Gill net	Total	M. A*
110	—	2238	—	2238	
130	—	21958	—	21958	11092
150	—	9080	—	9080	13366
170	—	9061	—	9061	11349
190	—	15906	—	15906	22387
210	—	42192	40	42233	27822
230	295	25367	141	25803	31430
250	1182	26730	876	28688	42630
270	5908	75795	1381	83086	58451
290	103304	72828	3262	86394	73683
310	8272	72426	7644	88342	70809
330	2954	67174	18327	88455	66327
350	591	59380	29515	89486	49061
370	295	20630	23559	24484	28389
390	—	5157	8830	13987	9942
410	—	4038	1080	5118	—
430	—	—	74	74	—
450	—	—	128	128	—
470	—	—	—	—	—
490	—	—	—	—	—
510	—	—	—	—	—
530	—	—	—	—	—
550	—	—	160	160	—

Note: 1. M. A. * indicates three point moving average.
2. Bracketed portion alone is considered for the estimation of 'Z'..

T. tenuispinis (Catch in numbers)

Mangalore 1982—83

Mid point (mm)	Purse-seine	Trawl	Gill net	Total	M. A*
50	—	18482	—	18482	
70	—	255058	—	255058	124448
90	—	99805	—	99805	122897
110	13827	—	—	13827	40260
130	1887	5262	—	7149	70139
150	—	189440	—	189440	426926
170	—	1084189	—	1084189	784129
190	—	1078758	—	1078768	1259842
210	—	1616579	—	1616579	1111906
230	37	630345	—	640382	1001129
250	37	746389	—	746426	850307
270	9853	1153764	497	1164114	927855
290	29632	841002	2391	873025	787685
310	45392	271878	8645	325915	543195
330	273013	127460	30173	430646	415453
350	275856	179044	34897	489797	409271
370	189728	76763	40880	307371	319951
390	118360	10992	33333	162685	246431
410	155292	57946	56000	269238	173910
430	42477	10992	36339	29808	148035
450	—	—	12183	12183	95698
470	—	—	5672	5672	6335
490	—	—	1150	1150	—

Note: 1. M. A* indicates three point moving average.
2. Bracketed portion alone is considered for the estimation of 'Z'.

WORK SHEET I — C

T. serratus (Catches in numbers)

Cochin Fisheries Harbour

Mid point (mm)	Purse seine	Trawl	Gill net 1981
210	—	3427	—
230	20	—	10
250	82	—	44
270	61	—	41
290	204	3427	35
310	204	3427	159
330	163	—	41
350	122	3427	297
370	61	—	570
390	41	—	421
410	41	—	197
430	41	—	64
450	—	—	112
470	—	—	285
490	—	—	1350
510	—	3427	1150
530	—	—	1790
550	—	—	1762
570	—	—	1309
590	—	—	1243
610	—	—	2019
630	—	—	3216
650	—	—	4226
670	—	—	4139
690	—	—	3541
710	—	—	2132
730	—	—	1681
750	—	—	2674
770	—	—	2468
790	—	—	3194
810	—	—	3252
830	—	—	2728
850	—	—	3116
870	—	—	2667
890	—	—	1709
910	—	—	1665
930	—	—	829
950	—	—	774
970	—	—	230
990	—	—	26

Note:- 1. The repetition of the frequency 3427 in trawl catches does not appear to be representative of the landings.

2. Regarding gill net catches also, the characteristics of gill net landings do not conform to the data available here.

3. Hence considering purse seine data alone and taking three point moving average **

l_t (mm)	M. A.** (Nos)
250	54
270	116
290	156
310	190
330	163
350	115
370	75
390	48
410	41
430	—

** (M. A.) the bracketed portion shown below is taken for the estimation of 'Z'.

WORK SHEET I-D

T. dussumieri (Catch in numbers)

Veraval:

Mid point (mm)	Trawl	1981 gill net	M.A 1 (trawl only)	1982 Trawl	Gillnet	Mid point (mm)	M. A 2 (Trawl only)
130	—	—	—	273	—		
150	—	—	—	—	—	140	
170	—	—	—	273	—	180	14174
190	3273	—	—	289	—	220	32559
210	7102	—	9837	13727	—	260	48520
230	19137	—	12165	28657	—	300	40387
250	10257	—	13413	16516	—	340	22690
270	10844	—	10053	38913	—	380	7216
290	9097	112	9519	13952	—	420	1876
310	8658	—	7486	34392	—	460	1837
330	4743	—	5035	16811	—		
350	1705	575	2269	578	—		
370	359	463	1185	969	—		
390	1490	1842	1414	1369	—		
410	2392	535		611	926		
430	1894	911		1310	1184		
450	868	1560		1027	1028		
470	1455	1242		344	1075		
490	85	1620		1226	3216		
510	601	2050		995	3849		
530	247	2384		1258	4464		
550	—	1831		3259	4914		
570	—	610		958	3537		
590	—	2077		1769	6096		
610	—	2538		2058	3589		
630	—	3808		395	3802		
650	—	3592		647	5107		
670	—	2448		711	3105		
690	—	4227		857	3390		
710	—	2727		857	3579		
730	—	1447		459	3090		
750	—	620		84	1526		
770	—	—		—	18		
790	—	68		—	—		
810	—	211		—	—		

Note: 1. Data for gill nets do not appear to be the representative of gill net landings. Hence catch in numbers of three point moving average for trawls alone are considered for estimating 'Z'.

2. In this case successive classes have been merged forming a single wider class and for such wider classes three point moving average is taken.

3. Bracketed portion alone is considered for the estimation of 'Z'.

WORK SHEET 1-E

O. militaris (Catch in numbers)

Veraval

Mid point (mm)	1981 Trawl	Gill net	Total	M. A*	1982 Trawl	Gill net	Total	M.A.*
190	—	—	—	—	—	—	—	—
210	1543	53	1596	—	5226	895	6121	—
230	13806	311	14117	18619	10429	958	11387	16090
250	38825	1318	40143	33980	29580	1181	39761	26154
270	46361	1319	47680	48571	32516	3799	36315	37600
290	56074	1816	57890	52365	41640	4085	48725	35973
310	49976	1549	51525	52157	23908	1970	25878	32127
330	44824	2233	47057	44979	22051	2727	24778	24414
350	35036	1319	36355	45682	16958	2929	22587	24226
370	52860	773	53633	35950	23125	2190	25315	21406
390	17532	357	17889	26749	13699	2617	16316	17648
410	8583	143	8726	10577	9461	1751	11312	11536
430	5022	94	5116	5445	6900	3079	6970	6776
450	2461	31	2492	2842	1884	153	2037	3263
470	917	—	917	1228	—	773	773	979
490	276	—	276	—	126	—	126	—

Note:
1. M. A.* indicates three point moving averages.
2. Bracketed portion alone is considered for the estimation of 'Z'.

WORK SHEET II

Estimation of 'Z' for A. thalassinus *at Mandapam from the bracketed portions of work sheet I. A for the year 1972.*

$l\infty = 755$ mm and $k = 0.36$.

l_t	$l\infty - l_t$	$\log (l\infty - l_t)$	Their difference (A)	C_t	$\log C_t$	Their difference (B)	B/A x_i
170	585	2.7672		26961	4.4307		
			0.0152			0.0033	0.22
190	565	2.7520		26756	4.4274		
			0.0156			0.0462	2.96
210	545	2.7364		24054	4.3812		
			0.0162			0.1026	6.33
230	525	2.7202		18985	4.2786		
			0.0169			0.1407	8.32
250	505	2.7033		13738	4.1379		
			0.0176			0.1574	8.94
270	485	2.6857		9560	3.9805		
			0.0182			0.2169	11.92
290	465	2.6675		5802	3.7636		

$\bar{x} = 6.45$ $\quad n = 6.$

$$s^2_x = \frac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2 \Big/ n\right]$$

$$= \frac{1}{5}\left[340.11 - (38.69)^2/6\right]$$

$$= \frac{1}{5}\left[340.11 - 249.49\right]$$

$$= 18.12$$

Hence $s_x = \sqrt{18.12} = 4.26$ and $s_{\bar{x}} = 4.26/\sqrt{6} = 1.74$

Now $\bar{x} = \bar{z} / k$. Hence $\bar{z} = k\bar{x} = 0.36 \times 6.45 = 2.32$

$s_{\bar{x}} = s_{\bar{z}}/k$. Hence $s_{\bar{z}} = k\, s_{\bar{x}} = 0.36 \times 1.74 = 0.62$

Thus $\bar{z} = 2.32$ and $s_{\bar{z}} = 0.62$

CHAPTER SEVEN

SOME SPECIAL FEATURES OF CATFISH FISHERIES FOR CONSIDERATION IN DEVELOPMENTAL PROGRAMMES

-- C. MUKUNDAN

There are some aspects of the catfish biology and behaviour that are significant from the point of view of exploitation and which, by the same token, make the fish vulnerable to indiscriminate fishing at the juvenile and spawner stages.

The first is the catfish migration to near-shore areas for spawning and for the feeding of juveniles, which makes the fish concentrate for limited periods within easy reach of the small vessels. As the breeding season approaches, many tachysurids move into shallower areas of muddy bottom for the juveniles and the young fish to feed on the rich benthic infauna and epifauna. The small-mesh nets used for the catfish fishery by the artisanal fishermen have always caught small fish as well as juveniles. But the harm done was limited, as the traditional fishery was less mobile and its gears limited in their area of operation. But when more efficient motorised craft using nets of small-sized mesh came on the scene the harm done to the population was more. Such extreme pressure in a limited area is by itself bad enough, but it is compounded by the low facundity of the fish which makes it a group that has to be protected in the spawning phase.

Besides such shore-ward migrations, large shoals, particularly of *T. tenuispinis* and *T. dussumeri*, move along the coastal waters in a southerly or northerly direction depending on the prevailing monsoon drift (Rao *et al.* 1977) and these shoals are easily accessible to bottom and midwater trawling.

Another behavioural pattern that lends itself to easy exploitation is the parental care in catfish. The males collect the fertilised eggs in the mouths (which are specially transformed as temporary brood pouches) and retain them until the young ones hatch out and the yolk gets absorbed. In the context of the artisanal fishery employing hooks and line, this would normally be a case of relative protection from exploitation, since the spawners and gestating males competely refrain from feeding and so do not 'bite'. Such a built-in conservation measure fails for the other gears. Particularly this is the time when the males segregate and such concentration of males prove good targets for gears such as purse-seines.

The purse-seine, as already mentioned, has proved to be an extremely efficient gear in boosting the landings of catfishes. But the effect of such large-scale removal of brooders and the destruction of eggs makes itself felt in subsequent years, though an immediate impact may not be discernible in such long-lived fish. The destruction of about 37 tonnes of incubating eggs of *T. tenuispinis* in septem-ber-October 1980 and similar quantities in subsequent two years from the Karnataka waters is an index of the magnitude of such fishing activities. A special monitoring study during this period covering Mangalore, Malpe and Gangoli (Silas *et al*, 1980) showed the capture of nearly 530 tonnes of fish and over 37 tonnes of eggs. The quantity of eggs that must have fallen through during the fishing operations and the transfer of catches to the deck of the fishing/carrier boats would be in addition to this. From sample weights the number of eggs landed during the period has been estimated as 23 million. As the percent-

age of ova with no sign of development was extremely low, the significance of such fishing on future recruitment has to be carefully considered. No doubt, capture of a portion of the shoals of incubating males has been there always by the boat-seines of the artisanal fishermen. But the proportion is different, since the extent of the reach, the continuity of operations and the quantum of the catch of the country crafts are limited enough as to leave no perceptible ill-effects later on. But mechanised craft that can cover wider areas and gears that can encircle whole shoals of incubating males are a different matter, particularly when the operations can be kept up continuously.

Increasing mechanization of the craft and the use of wide-reaching efficient gear are inevitable in the developmental programme for the fisheries, but fishing in such sensitive areas and periods has to be controlled so that the stocks are not damaged by consideration of short-term gains.

Another interesting aspect revealed by exploratory fishing off the west coast is the abundance of catfish in the western shelf area when it is covered with oxygen-deficient water during the south-west monsoon and when the grounds are devoid of most other groups (Rao *et al*, 1977). It has also been suggested that the food preferences of catfishes could be used for better exploitation with hooks and line which continues to be one of the major gears in many places. The hooks are at present baited with sardine, anchovy and such other small fish. Food studies on the east coast have revealed a preference to squilla and other crustaceans (Mojumder, 1969) while experiments off Veraval (Kartha *et al*, 1973) on selective action of differently baited hooks in bottom drift long lines has shown that catfish prefer cuttlefish to crustaceans and fish.

CHAPTER EIGHT

GENERAL REMARKS AND FUTURE APPROACH

— B. KRISHNAMOORTHI

Consequent upon the recent introduction of mechanised fishing on a large scale with trawls as the chief gear all along the Indian coast, many hitherto less known demersal fisheries have come to occupy a prime place on the fisheries map of India. One such group is the catfish assemblage. With an estimated annual average catch of 52 thousand tonnes over a five year period from 1977 to 1982, the catfishes constituted about 4% of the total estimated 'all-fish' catches. Though the increase in the catfish landings was nominal during the 8-year period from 1962 to 1969, a three fold increase was noticed during the succeeding period up to and inclusive of 1984. This increasing trend is reflected in the estimated landings in most of the maritime states of India. Thus, while a nine-fold increase was noticed in West Bengal during the period from 1977 to 1982, in Orissa a six-fold increase up to 1981 was reduced to a four-fold increase in 1982. In both the Andhra and Tamil Nadu states, the estimated landings, however, were characterised by decreasing trends. In Kerala, Goa, Karnataka, Maharashtra and Gujarat increasing trends in the estimated landings were reported. Thus, among the eight maritime states, excepting Andhra and Tamil Nadu states, the general nature in the production of catfishes was one of increasing trend. Importantly, no state was without the catfish component in their fisheries wealth. Hence, catfishes are bound to play a very important role in future plans of many states for diversification towards better utilisation of fisheries resources that abound their waters.

Although the trawl is the chief gear in most states, exploitation of catfishes by other indigenous non-mechanised gears, such as hooks & line, drift nets, bottom-set gill nets, boat seines, purse seines etc., is also prevalent depending upon the regional bias towards a particular method of harvesting. Thus, while drift nets are of considerable importance along the Gujarat coast, purse seines are noteworthy in Karnataka and to a lesser extent in Kerala, Among the maritime states on the east coast viz., West Bengal, Orissa, Andhra and Tamil Nadu, hooks & line, boat seines and bottom-set gill nets appear to be the chief gears of operation for catfishes. It may, nevertheless, be said that presently the catfishes are being exploited by both mechanised and non-mechanised craft and gear. The future success of the fisheries for catfishes, however, would largely depend on how best the mechanised trawl fishing is organised, developed and deployed because of the single factor that the major contribution to the fishery wealth of catfishes is made by the trawls.

Although many species constitute the catfish group, only a few are of fisheries in importance. They are: *Tachysurus thalassinus*, *T. tenuispinis*, *T. serratus*, *T. dussumieri* and *Osteogeneiosus militaris*. With a wider distribution and larger contribution all along the coasts of West Bengal, Orissa, Andhra and Tamil Nadu on the east coast of India and up to Kerala on the west coast of India, *T. thalassinus* is the single important species of catfish among the five species that support the fisheries for catfishes. With an equally wider distribution but with lesser contribution, the next important species of catfish is *T. tenuispinis*. *T. tenuispinis* is however, more abundant along the West Bengal, Orissa, Andhra and in north Tamil Nadu than in other maritime states. In south Tamil Nadu, Kerala, Karnataka and Maharashtra, *T. dussumieri* appears to dominate. *O. militaris* appears to be endemic to Gujarat, where it is a fisheries of importance. Similarly *T. serratus* is more abundant off south Tamil Nadu and Kerala than they are in other states. The lesson seems clear that the future abundance of catfish fisheries is largely dependent upon and revolves round the question of how best research and operational efforts are directed towards understanding and harvesting populations of and fisheries for *T. thalassinus* and *T. tenuispinis*.

In the light of the above findings, a knowledge of the extent of stocks of catfish available in our waters is vital if steps for expansion and (or) more exploitation are to be recommended or implemented. Based on data inputs such as the various growth parameters, rates of mortality, present length at first capture (l_c) and the exploitation rate (E) obtained from an analysis of samples from trawler catches only, a maximum sustainable yield (MSY) of about 440 per recruit could be obtained at levels of E = 0.70 and C = 0.66 for all the five species of catfishes considered in the present study. But for *T. thalassinus* at all the centres studied, Eranged from 0 79 to 0.83 and C form 0.24 to 0.50. In other words, the values required for obtaining a MSY-400 g/recruit are nowhere in the range and, therefore, a reduction in effort and an increase in mesh size are indicated. Although E was nearer to the required level in the case of *T. tenuispinis*, the C values are at much lower levels indicating the need to increase the mesh size. For *T. serratus* and *T. dussumieri*, the C values are too low. Hence, as in the case of *T. thalassinus*, a reduction in both E and C are indicated. *O. militaris* appears to be the only species which has both the values of E and C at the required level.

Hence, considering the fact that all the four species of catfishes are under heavy fishing pressure, it is quite obvious that either C is increased or fishing pressure reduced if C is to be maintained at the present level. In view of the fact that trawling presently is so designed and directed towards exploitation of prawns, it is extremely unlikely that the former recommendation would be accepted, although a rational exploitation of the stocks of catfishes in future would yet seem to depend upon such a course of action and implementation.

CHAPTER NINE

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